Seventeenth World Meteorological Congress

Geneva
25 May–12 June 2015

Abridged final report with resolutions

World Meteorological Organization
Weather • Climate • Water

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ANNEXES

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. ORGANIZATION OF THE SESSION (agenda item 1)

1.1 Opening of the session (agenda item 1.1)

1.1.1 The President, Mr David Grimes, opened the seventeenth session of the World Meteorological Congress at 10.00 on 25 May 2015 at the International Conference Centre of Geneva (CICG) and welcomed all participants to the Congress. The list of participants is given in the appendix to the present report. In reflecting on the last four years, the President noted the growing relevance of the societal needs and priorities identified in the Organization's planning. The President noted that the draft Strategic and Operating Plans for the 2016–2019 period reflected the needs of Members and in their final form must speak not only to governments and heads of NMHS, but also to WMO partners. With respect to setting future priorities, a number of driving factors could be identified, including seeking to align climate and disaster risk reduction-related activities, with the corresponding international climate change negotiations and the new disaster risk framework. He further underscored the essential role of Partnerships for executing the work of the Organization, including with scientific institutions, centres of excellence and the private sector, among principal actors. The President stressed that Members need to be prepared with a clear vision on the Organization's governance structure and proceed with efforts for continuous improvements of processes and procedures. He paid tribute to the Secretary-General and his contribution to the Organization, noting he had served 20 years within the Organization in a senior capacity.

1.1.2 The Secretary-General, Mr Michel Jarraud, welcomed all participants to the session, extending a warm welcome to South Sudan and Tuvalu for having acceded to the WMO Convention since the last Congress. He also expressed condolences to Nepal for the tragic earthquakes that had hit the country in 2015. He underlined that the session was taking place in a critical year due to the culmination of some of the most important global processes at the UN level dealing with disaster risk reduction, Small Island Developing States, financing for development, post-2015 development agenda and climate change. He expressed confidence that Members' National Meteorological and Hydrological Services (NMHSs) would play a key role in supporting their countries in fostering sustainable development. He emphasized that in light of the above-mentioned global processes, the Congress had a great opportunity to set up a strong strategic vision and ensure reinforcements both at the level of NMHSs and of WMO. In this regard, he encouraged Members to support the proposed Strategic Plan and Budget proposal for 2016–2019 together with the Operating Plan as enablers of such a stronger role of WMO.

1.1.3 H.E. Mr Alain Berset, Head of the Federal Department of Home Affairs of the Swiss Confederation, welcomed all delegates on behalf of Switzerland and expressed the satisfaction of his Government that Geneva is the host of WMO and another thirty-five international organizations many of them dealing with the environment and disaster risk reduction. He underlined that this session of the Congress represented a critical opportunity to define a four-year strategy for WMO in the context of the international frameworks for disaster risk reduction and climate change. He emphasized that Switzerland is very committed to support international cooperation to address both these challenges and that WMO and the Intergovernmental Panel on Climate Change (IPCC) play a fundamental role in informing decision-making through science. Mr Berset confirmed the support of Switzerland to WMO and the Global Framework for Climate Services (GFCS) and its readiness to support an increase of the budget of the Organization to adequately resource the Organization. Finally, he paid homage to the Secretary-General for his leadership in WMO for twenty years in the most senior positions.

1.1.4 Mr Ban Ki-moon, the Secretary-General of the United Nations, in his video message addressed to the Congress, underlined that the seventeenth session was taking place at a pivotal moment, as in 2015 Member States would make critical decisions on the sustainable development agenda and a universal climate change agreement. He called on the meteorological community represented by WMO to provide leaders, businesses and the society at large the scientific

information needed to make informed choices, emphasizing that in a world characterized by global warming, meteorological services are needed more than ever. He recalled the important role of the "weather reports from 2050" in raising awareness on climate change and encouraged WMO to continue this effort in the wake of COP 21. Finally, he expressed the wish to continue the collaboration with the WMO community to advance bold climate action to improve the lives of people and the health of the planet.

1.1.5 Brazil informed that the Third Vice-President, Mr Antonio Divino Moura, due to unforeseen circumstances, could not attend the opening session, but confirmed that he and the Brazilian Government remained committed to actively contributing to the institutional strengthening of WMO and recognized its essential role.

1.2 Establishment of the Credentials Committee (agenda item 1.2)

In accordance with Regulations 23 and 24 of the General Regulations (2012 edition), Congress established a Credentials Committee, comprising principal delegates of the following Members:

Regional Association I – Botswana, Burkina Faso, Cameroon, Comoros;

Regional Association II – India, Oman, Republic of Korea;

Regional Association III – Chile;

Regional Association IV – British Caribbean Territories, Panama;

Regional Association V – Malaysia, Solomon Islands;

Regional Association VI – Azerbaijan, Czech Republic, Portugal and Switzerland.

Dr G. Navarro (Chile) was elected chairperson of the Credentials Committee.

1.3 Approval of the agenda (agenda item 1.3)

Congress approved the proposed agenda, as shown in the table of contents.

1.4 Report of the Credentials Committee (agenda item 1.4)

The Credentials Committee submitted two reports concerning the credentials of the delegates of Members, Non-members, organizations of the United Nations system, and other intergovernmental and other organizations. Those reports were approved by Congress.

1.5 Establishment of committees (agenda item 1.5)

1.5.1 The Congress decided to work in plenary throughout the session with the President, Second and Third Vice-Presidents as delegated Chairpersons.

1.5.2 In accordance with the provisions of Regulations 25 and 26 of the General Regulations (2012 edition), the Nomination Committee was established composed of the principal delegates of the following 12 Members:

Regional Association I – Algeria, Ethiopia, Namibia;

Regional Association II – China, Kuwait;

Regional Association III – Ecuador;

Regional Association IV – Costa Rica, Curaçao and Sint Maarten;

Regional Association V – New Zealand;

Regional Association VI – Armenia, Croatia and Norway.

Dr A. Martis (Curaçao and Sint Maarten) was elected chairperson of the Nomination Committee. The Committee submitted three reports to the Congress on agenda items 14.1, 14.2 and 14.3.

Coordination Committee

1.5.3 The Coordination Committee was established and comprised the President and the Vice-Presidents of WMO, the Secretary-General or his representative, and the chairpersons of the committees of the body other than the Credentials and Nomination Committees. The Committee was assisted by the Deputy Secretary-General and the Assistant Secretary-General.

Sub-Committees

1.5.4 The following subcommittees were established for in-depth discussion and detailed consideration of particular items:

Committee on Strategy and Budget 2016–2019, Chairperson, Tyrone Sutherland (British Caribbean Territories);

Drafting Group on Open Data Policies, Chairperson, Wayne Elliott (United Kingdom of Great Britain and Northern Ireland);

Drafting Group on Climate Data and Exchange – Resolution 60 (Cg-17), Chairperson, Gerhard Adrian (Germany).

1.5.5 Congress appointed Ms Flaviana Hilario (Philippines) as Rapporteur on Review of the Previous Resolutions of Congress. The rapporteur reported to Congress on agenda item 13.6.

1.6 Programme of work (agenda item 1.6)

Congress decided on the following working hours:

Monday to Friday 9.30 a.m. – 12.30 and 2.30 p.m. – 5.30 p.m.

Saturday 9.30 a.m. – 12.30 p.m.

1.7 Approval of the minutes (agenda item 1.7)

1.7.1 Congress suspended Regulation 112 of the General Regulations (2012 edition) for the duration of its session and decided that no minutes of plenary meetings at sessions of Congress should be prepared unless otherwise decided for special items. Audio recordings of plenaries would continue to be made and would be retained for the record.

1.7.2 Congress also decided to suspend Regulation 110 of the General Regulations (2012 edition) for the duration of the Congress and agreed on the distribution of documents eight hours prior to discussion at plenary meetings.

2. HIGH-LEVEL SEGMENT AND REPORTS (agenda item 2)

2.1 The following Ministerial and High-Level representatives delivered Statements to Congress. Full copies of the Statements will be included in Part II of the abridged final report with resolutions of Seventeenth Congress.

H.E. Mr Wang Yang

Vice Premier, delivered by H.E. Mr WU Hailong Ambassador, Extraordinary & Plenipotentiary and Permanent Representative, Permanent Mission of the People's Republic of China to the United Nations Office and other International Organizations in Switzerland (on behalf of the Vice Premier of China)

H.E Ms Edna Molewa

Minister of the Department of Environmental Affairs, South Africa

H.E. Emanuel Antero Veiga

Bureau Chairperson of AMCOMET & Minister of Environment, Housing and Land Management, Cabo Verde

H.E. Mrs Charafat Afilal

Ministre déléguée auprès du Ministre de l'Energie, des Mines, de l'Eau et de l'Environnement, Chargée de l 'Eau, Morocco

H.E. Mr Jacques Ulrich Andriantana

Ministre du Tourisme, des Transports et de la Météorologie delivered by Dr Samuëline RAHARIVELOARIMIZA, Permanent Representative of Madagascar with WMO

H.E. Mr Y. S Chowdary

Minister of State for Science and Technology & Earth Science, India

H.E. Mr Abdula Majeed

Minister of State for Environment & Energy and Permanent Representative of Maldives with WMO

H.E. Mrs Päivi Kairamo

Ambassador, Extraordinary & Plenipotentiary and Permanent Representative, Permanent Mission of Finland to the United Nations Office and other International Organizations in Geneva

H. E. Mr Faisal bin Hassan Trad

Ambassador and Permanent Representative, Permanent Mission of Saudi Arabia to the United Nations Office and other International Organizations in Geneva

H.E. Mr Mohammed Nasser Al-Zaabi

Chief Executive Officer, Public Authority for Civil Aviation, Oman

Mr Abdulaziz Mohamed Al-Noaimi

Chairman, Qatar Civil Aviation Authority

2.2 Congress noted with appreciation the Statements made by the High-Level Speakers.

2.1 Report by the President of the Organization (agenda item 2.1)

2.1.1 Congress noted with appreciation the report of the President which summarized the overall activities of the Organization, its constituent bodies and the Secretariat since the close of the Sixteenth Congress.

2.1.2 The President noted with appreciation the leadership of the three Vice-Presidents, the contributions of members, past and present, of the Executive Council, the leadership shown by the presidents of regional associations and technical commissions and the professionalism of the Secretariat for their dedication and service to the global weather, climate and water enterprise. The

President noted that this would be the last Congress for Michel Jarraud, the Secretary-General of WMO, and on behalf of Congress applauded his leadership and guidance over the past 12 years. WMO has made significant progress over this period and all Members have been beneficiaries.

2.1.3 The President noted that his report touched on highlights that illustrated the Organization's collective accomplishments and raised awareness on a few issues thought to be challenging for the future. Details on the activities of the Organization, its constituent bodies and the Secretariat since the close of Sixteenth Congress are reported in detail in separate documents under the appropriate agenda items.

2.1.4 The President noted that the membership of the Organization had increased to 191; in accordance with its Article 35, the Convention entered into force for Tuvalu on 22 September 2012, and South Sudan on 14 December 2012.

2.1.5 The President underlined the importance of focusing on priorities for the Organization and expressed his appreciation to Members for the contribution of their experts to achieve collective success. He made the following remarks in relation to the overall plan and the five priorities as codified in the WMO Strategic Plan (2012–2015).

2.1.6 *Strategic and Operational Planning*; since Sixteenth Congress, the Executive Council had further refined and significantly shaped the WMO Strategic Plan for 2016–2019 and beyond. The current draft articulates the future directions of the WMO, its priorities, expected results and performance indicators which supported the preparation of the WMO Integrated Operating Plan (OP) and proposed budget. This will guide Congress in deciding WMO's Programme priorities and Results-based Budget (RBB) for 2016 through 2019 which would bring improved socioeconomic benefits to Members and enhance the performance of their NMHSs.

2.1.7 *Global Framework for Climate Services (GFCS)*; the first ever Extraordinary World Meteorological Congress was held in 2012 which established the Intergovernmental Board on Climate Services (IBCS) and approved the GFCS 10 year implementation plan with the goal of equipping all Members with the scientific and technical capacity necessary to support climate smart decisions at national, regional and global levels. The IBCS has conducted two meetings to review progress, including establishing Management and Partner Advisory Committees that recognize that the successful implementation of the GFCS hinges on the effective engagement of Members and contributing partners and stakeholders. In this regard, NMHSs and WMO's constituent bodies are focused on early actions to strengthen the production, availability, delivery and application of science-based climate predictions and services. The President also noted that extrabudgetary resource mobilization had been very effective in these initial stages and thanked all those who contributed. A WMO policy resolution on climate data will be considered at this Congress ensuring better unfettered access to climate data, information and products, recognizing its value for sustainable communities but also its cost-benefit considerations, in particular with respect to issues of cost-recovery and long-term investments in climate-related infrastructure. The Chairperson of the IBCS, a body accountable to the Congress, will report on progress and seek further guidance on a number of issues on its governance, its relationships with partners, GFCS implementation and its resourcing. The most recent findings of the IPCC Fifth Assessment Report lend even greater urgency to advancing our understanding of climate variability and change and to improving climate services to mitigate and adapt to the risks and opportunities.

2.1.8 *WMO Information System (WIS) and WMO Integrated Global Observing System (WIGOS)*; the President noted the significant advancements of the WIS/WIGOS priority. Regulatory material had been drafted under the mandate of the Inter-Commission Coordination Group on WIGOS (ICG-WIGOS) with inputs from Members, ICG-WIGOS representatives and their technical experts. The WIGOS Framework Implementation Plan (WIP) and Regional Plans provide for improved interoperability and better monitoring of the Earth System as the Pre-Operational Phase for WIGOS starts toward the end of 2015. As of September 2014, 363 centres had been registered in WIS including 223 National Centres (NCs), 125 Data Collection and Production Centres (DCPCs) and 15 Global Information System Centres (GISCs). Together, WIGOS and WIS implementation are foundational to the success of the weather, climate and water enterprise.

2.1.9 *Capacity Development*; the WMO Strategy for Capacity Development has been mainstreamed into WMO's efforts to address the needs of NMHSs throughout the world. The President noted also that WMO was making progress in resource mobilization to better support its priorities and Programmes. The President acknowledged the efforts of Members and the Secretariat for their efforts in attracting the World Bank, European Commission and other investors. The President also recognized the valued contribution of Members who provide support directly, indirectly or in-kind through such mechanisms as the Voluntary Cooperation Programme, and to education and training activities, including regional training centres, essential for human resource development, noting encouraging progress on the "Global Campus" concept. He highlighted the accomplishments of the Executive Council Working Group on Capacity Development that developed the Capacity Development Strategy Implementation Plan for 2012–2015. Congress will need to further guide WMO's approach to enhancing the capacity of NMHSs through human resource development, technical and institutional capacities and improved infrastructure, particularly in developing, least developed and small island developing States. The President underscored the importance of the role the private sector can play in supporting these outcomes and encouraged the Organization to explore ways and means to more deeply engage with the private sector, including the Association of Hydro-Meteorological Equipment Industry (HMEI), in such efforts.

2.1.10 *Disaster Risk Reduction (DRR*); building resilience to extreme weather and climate conditions is a core component of WMO Members' responsibility supported by multi-hazard early warning and service delivery infrastructures. Following on the outcomes of the World Conference on Disaster Risk Reduction in Sendai, Japan, Congress was now in a position to better guide and decide on the future priorities of WMO's contribution to DRR. Over the last four years, the Executive Council had been shaping WMO's DRR roadmap where NMHSs would be better positioned to contribute to the international efforts on disaster risk reduction, resilience and prevention by delivering high quality, impact-based forecasts and multi-hazard, risk-based early warnings. As well, the Executive Council strongly endorsed the complementary WMO Strategy for Service Delivery and its Implementation Plan (IP) to help guide activities to achieve greater user satisfaction, better value for the investment of public funds, and increased awareness of the role of NMHSs in the protection of life and property. The President underlined the importance of the outcomes of the *Conference on Gender Dimensions of Weather and Climate Services* held in November 2014 and encouraged Congress to consider ways to integrate gender equality as both a goal and cross-cutting issue in its programmes, thereby eliminating impediments that limit women's and girls' ability to effectively participate in and benefit from DRR policies and initiatives.

2.1.11 *Aviation Meteorological Services*; central to these discussions will be the meteorological support to the "One Sky" concept as it relates to the ICAO Global Air Navigation Plan and the Aviation System Block Upgrades (ASBU) approach. The President noted that with a horizon of 2028, ICAO seeks solutions to bring improvements to reduce congestion within the global air traffic management system. Furthermore, despite the good progress by some Members, many have not yet implemented their Quality Management System in compliance with ICAO Annex 3/WMO Technical Regulations Vol. II, or the WMO competence requirements for aeronautical meteorological personnel in their supporting role for Air Navigation Safety Management Systems. The President urged WMO Members to continue their work to comply with these standards.

2.1.12 The President then noted that, in addition to continuing the pursuit of excellence on the above initiatives, there were a number of matters which he considered to warrant close attention.

2.1.13 *Social and Economic Benefits*; derived from the delivery of "fit for purpose" services to various user groups, the President noted that benefits accrue to Members from improvements made in the capability of NMHSs to produce and deliver those services. This may be particularly important for climate services under the GFCS. Important to this issue is an objective assessment, with some precision, of the socioeconomic benefits of these services. The Congress is invited to consider a follow-up to the Madrid Conference held in March 2007 on "Secure and Sustainable Living; Social and Economic Benefits of Weather, Climate and Water Services" in 2017, tentatively entitled, "Madrid plus 10" that may further help this work.

2.1.14 *Polar and High Mountain Activities*; under this item, Congress will consider the Implementation Plan of the Global Cryosphere Watch (GCW) including the GCW governance and working structure, the establishment of a core GCW network called CryoNet and the need to mainstream GCW as a core WMO activity under WIGOS. Furthermore, there is an ongoing need to strengthen the Antarctic Observing Network (AntON), a historically under-sampled area of the world. The President emphasized the opportunities presented by the implementation Plan for the Year of Polar Prediction focusing on 2018 and the International Polar Partnership Initiative to improve coordination between WMO and other institutions. The President invited Congress to consider these and other Polar and High Mountain activities in its discussion of priorities, programmes and budget to guide the implementation of Polar and High Mountain activities over the next four years.

2.1.15 *Climate engineering*; is a deliberate large-scale intervention in the environment with the aim to mitigate the impact of increasing greenhouse gases. The President noted that the Commission for Atmospheric Sciences identified this as an area of research priority to respond to the growing debate. At this time, increasing research activity and public interest are compelling some governments to reflect on the values of taking action on climate engineering including the management of research and governance of various climate engineering methods. Congress needs to respond to this pressure with advice on the science, governance, and to define WMO's role in these international deliberations.

2.1.16 *Space Weather*; it is well known that Members' Earth- and space-based observation and telecommunication systems are at risk of being disrupted by solar flares or geomagnetic storms. These solar events have significant impacts on economic sectors such as aviation, communications, satellite operations and electricity transmission. This Congress will discuss a four-year plan to frame the activities of Members in Space Weather service delivery.

2.1.17 *WMO Governance and Continuous Improvement*; WMO has made significant progress to strengthen the role and influence of regional associations as reflected in proposed amendments in the General Regulations. However, the President noted that in addition to the six regional associations, WMO carries out its work through eight technical commissions (TCs), nineteen scientific and technical programmes as well as twenty-one bodies which report to the WMO's Executive Council, including Panels, Working Groups, Task Teams, Committees, Focal Points and others. Furthermore, each constituent body has sub-structural components. Together, these are designed to assist all Members to provide, and benefit from, a wide range of meteorological and hydrological services to address present and emerging challenges. Considering the complexity of this structure, the President referenced that Congress would be asked to give consideration to a strategic review of WMO structures, operating arrangements and budgeting practices with the aim of improving effectiveness of constituent bodies and Secretariat arrangements. The President further noted that Congress would consider other important issues such as the number of terms for the Secretary-General, the overall budget for our activities and the number and distribution of seats on the Executive Council.

2.1.18 The President highlighted that the Organization's success is rooted in more than a century of scientific and technical cooperation. In this time, WMO has established important, longstanding programmes including, inter alia, the World Weather Watch which celebrated its 50th anniversary in 2013, the World Climate Programme and the Atmospheric Research and Environment Programme. Over the next four years, and rooted in this heritage, the Organization will deliver against its new targets and milestones that will be set within WMO's approved Strategic and Operating Plans. The implementation will drive the evolution of the programmes and services to respond to the demands of governments, partners and clients. The President noted that success also depends on how well we engage partners and their contributions with other UN bodies, the International Council for Science and its Future Earth Initiative, the Group on Earth Observations and the private sector including the HMEI.

2.1.19 Congress expressed its satisfaction with WMO's achievements since the Sixteenth Congress and expressed its appreciation to the President for actions taken on behalf of the Executive Council since its sixty-second session.

2.1.20 Those matters in the President's report which called for specific action by Congress were considered under the appropriate agenda items. Congress noted WMO's achievements, current operations and future development of the Organization as summarized in the President's report.

2.2 Report by the Secretary-General (agenda item 2.2)

2.2.1 The Secretary-General presented his report, noting that various issues addressed by it would be considered in depth under relevant agenda items.

2.2.2 The Secretary-General provided an overview of the implementation of the WMO Strategic Plan for 2012–2015 as reflected in the WMO Operating Plan 2012–2015. In particular, he highlighted activities undertaken to support Members and their National Meteorological and Hydrological Services in the attainment of Expected Results in service delivery; better weather, climate and water observations; incorporation of scientific and technological advances into hydrometeorological operations; capacity development; and improved effectiveness.

2.2.3 He recalled that the WMO Strategic Plan 2012–2015 represented the second cycle of the long-term planning framework adopted by Congress at its fifteenth session (Geneva, 7–25 May 2007) as an evolution of the WMO Long-term Plan and that such long-term planning process included the WMO Secretariat Operating Plan and the WMO Results-based Budget.

2.2.4 The Secretary-General underlined that the WMO Strategic Plan 2012–2015 defined three global societal needs to which the Organization contributed by addressing five strategic thrusts and eight related expected results. He further emphasized that within the vision of the Strategic Plan five strategic priorities had been identified in which the Organization made significant progress: the Global Framework for Climate Services (GFCS); aviation meteorological services; capacity-building for the developing and least developed countries; implementation of the WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS); and disaster risk reduction.

2.2.5 For each of the strategic priorities of the WMO Strategic Plan 2012–2015, the Secretary-General provided an overall assessment, key achievements, challenges, lessons learned and implications for the Strategic Plan 2016–2019. Detailed information on the implementation of the WMO Strategic Plan 2012–2015 in the different programme areas were addressed in the documentation related to the relevant agenda items (in particular agenda items 3, 4, 5, 6, 7, 8 and 11), while a systematic assessment of the attainment of Expected Results was provided by the Monitoring and Evaluation report (agenda item 7.2).

2.2.6 The Secretary-General underlined the important achievements during 2012–2015 in the establishment and implementation of the GFCS as a cross-cutting initiative in cooperation with partners from the United Nations system, other international organizations and civil society organizations.

2.2.7 The Secretary-General further reported on the cooperation of WMO with the United Nations system through an active participation in, and contribution to, relevant coordination mechanisms, processes, conventions and initiatives, as well as with other international and regional organizations, forums and scientific initiatives in the areas of weather, climate and water. He gave particular attention to the release in 2013–2014 of the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) and its role in informing policymakers with the latest climate science; climate change impacts, adaptation and vulnerability; and options for mitigation.

2.2.8 The report by the Secretary-General pointed out the importance of WMO work in the light of the numerous global processes underway under the umbrella of the United Nations and expected to be finalized by the seventieth session of the General Assembly (15–28 September 2015). In particular, he highlighted the overarching role of the post-2015 development agenda and associated Sustainable Development Goals, the climate agreement to

be considered by UNFCCC COP 21, the post-2015 framework for disaster risk reduction, as well as the follow-up to the Third International Conference on SIDS ('Samoa Pathway').

2.2.9 During the sixteenth financial period, the Secretary-General continued his efforts to strengthen internal controls, including enhanced ethics and financial disclosure functions, staff training and periodic briefings to Permanent Missions in Geneva. At the same time, significant attention was paid to enhancing the efficiency of the WMO Secretariat and its environmental sustainability. He expressed his appreciation for the contribution of the Audit Committee and the External Auditor, as well as his satisfaction at receiving the eleventh unqualified opinion on WMO financial statements.

2.2.10 In his presentation on the results achieved during 2012–2015 and implications for the financial period 2016–2019, the Secretary-General emphasized the continuing challenge for WMO to discharge at best its mandate in support of its Members. Among many aspects, the increasing influence of climate change on weather, climate and water extremes and associated natural disasters, the increasing role and responsibilities of National Meteorological and Hydrological Services (NMHSs) in often challenging budgetary and staff constraints, scientific and technological developments and the contribution to the post-2015 global agenda, all highlighted the need for a strong coherence among the WMO Strategic Plan, Operating Plan and budget proposal for the seventeenth financial period and for the provision of adequate resources to the Organization.

2.2.11 During the sixteenth financial period, the Secretary-General continued to ensure the overall coordination and supervision of the Secretariat. Following the first extraordinary session of Congress (Geneva, 29–31 October 2012) that established the Intergovernmental Board on Climate Services (IBCS) and adopted the Implementation Plan for the GFCS, significant efforts were devoted to the launch and promotion of the GFCS, including the organization of two sessions of the IBCS (Geneva, 1–5 July 2013 and 10–14 November 2014). Also two major conferences were organized by WMO in 2014, the World Weather Open Science Conference (Montreal, Canada, 16–21 August) and the Conference on the Gender Dimensions of Weather and Climate Services (Geneva, 5–7 November).

2.2.12 The Secretary-General deployed significant efforts to the promotion of WMO on the international arena and of the role of NMHSs as enablers of sustainable development by supporting disaster risk reduction, informing economic sectors, providing vital scientific information for policymakers and the public. In this regard, he visited numerous Member countries from all WMO Regions, meeting with high-level representatives of national authorities and giving interviews to local and international media. He paid particular attention to least developed and developing countries, especially those affected by hydrometeorological disasters. The Secretary-General constantly interacted with Members, intergovernmental and international institutions in Geneva and elsewhere, and also provided regular briefings to Permanent Missions.

2.2.13 As the Executive Head of WMO, the Secretary-General attended various United Nations meetings, in particular the regular sessions of the Chief Executives Board, chaired by the Secretary-General of the United Nations and relevant parts of sessions of the General Assembly, as well as the High-level Political Forum on Sustainable Development under the auspices of ECOSOC and meetings of the Open Working Group on Sustainable Development Goals. He also led the WMO delegation to global summits such as the Third United Nations Conference on Sustainable Development (Rio+20 Conference) (Rio de Janeiro, Brazil, 20–22 June 2012), the Third United Nations Conference on Small Island States (Apia, Samoa, 1–4 September 2014), the UN Climate Summit 2014 (UN Headquarters in New York, 23 September 2014) and the Third UN World Conference on Disaster Risk Reduction (Sendai, Japan, 14–18 March 2015).

2.2.14 The Secretary-General regularly attended the annual meetings of the Conference of the Parties to the UNFCCC as well as the biennial Global Platform for Disaster Risk Reduction organized by UNISDR. He also participated in a number of relevant meetings of other UN and partner organizations. As Chairperson of UN-Water since 2012, the Secretary-General attended regular coordination meetings and relevant high-level events, including major conferences, and the launch of major publications such as the World Water Development Report in 2012 and 2014.

2.2.15 As Executive Head of a co-sponsoring organization, the Secretary-General supported the release, between 2013 and 2014, of the AR5 of IPCC and in particular the report of its Working Group I on the physical science basis as well as the overall synthesis report.

2.2.16 Congress noted the report by the Secretary-General.

2.3 Report by the Chairperson of the Financial Advisory Committee (agenda item 2.3)

Congress considered the report of the Financial Advisory Committee. It noted with appreciation the various recommendations of the Committee contained in Annex I to the present report. Congress took account of those recommendations in making its decisions under the various related agenda items.

2.4 Reports by presidents of regional associations (agenda item 2.4)

Meetings of the Presidents of Regional Associations

2.4.1 Congress noted that the Meetings of the Presidents of Regional Associations (PRAs) held in conjunction with Congress, the Executive Council (EC) and the Bureau during the intersessional period exchanged information on the activities of the individual regional associations (RAs) and shared best practices, and provided advice to Congress, EC and other WMO constituent bodies on common regional issues of concern. PRAs exchanged information and views on key priority areas in the Regions and outcomes of the sessions of RAs.

2.4.2 Congress recognized that PRAs discussed and coordinated preparation of their respective operating plans and provided inputs to the preparation of the WMO Strategic and Operating Plans 2016–2019 and their observations were considered by EC and its Working Group on Strategic and Operational Planning (WG-SOP). Congress noted that PRAs reflected on Regions' positions regarding the number of seats in EC. This issue was further discussed by EC and is addressed by Congress under agenda item 13.1. Congress noted that PRAs also discussed lessons and approaches for the effective and efficient organization of sessions.

2.4.3 Congress noted that PRAs developed the proposal for a better definition of the role and responsibilities of RAs which was recommended by EC for Congress consideration and is addressed under agenda item 13.3.

Meetings of Presidents of Regional Associations and Presidents of Technical Commissions

2.4.4 Congress noted that that the Meetings of the Presidents of Regional Associations and Presidents of Technical Commissions (PRA-PTC), held in conjunction with Congress, EC and the Bureau during the intersessional period, discussed common issues of regional associations and technical commissions (TCs) and strengthened the linkage and collaboration between RAs and TCs. PRA-PTC exchanged views and discussed enhanced cooperation between TCs and RAs on key priority areas of WMO.

2.4.5 Congress noted that PRA-PTC agreed to work towards improving interaction between RAs and TCs and cooperation which led to more integrated WMO Strategic and Operating Plans that take into account the needs and priorities of the RAs supported by actions of the TCs. It considered mechanisms for improving cooperation, coordination and communication between RAs and TCs including through various contact points.

2.4.6 Congress noted that PRA-PTC discussed the promotion of culture of compliance in relation to the roles of RAs and TCs in promulgation and implementation of WMO Technical Regulations and agreed that routine procedure for evaluation of Members' compliance with standards should be developed and that RAs would assist in ensuring that WMO Technical Regulations are promulgated through national legislation and regulation and implemented by Members.

2.4.7 Congress noted that PRA-PTC shared the experiences in organizing sessions of RAs and TCs including some measures taken to improve session documentation and decision-making. The details of such experience are reported under agenda item 7.7.

Report by the president of Regional Association I

2.4.8 Congress expressed a warm welcome to South Sudan for its new membership with WMO as from 14 December 2012.

2.4.9 Congress noted with appreciation the most important activities and achievements in RA I, which included the following:

(a) The successful organization of the sixteenth session of RA I (RA I-16) in Praia, Cabo Verde, 3–9 February 2015;

(b) Establishment by RA I-16 of a new work structure for the good governance and efficient management of the Region: the Management Group (MG); five Working Groups (WG on Observations, Telecommunication and Infrastructure; WG on Climate Services and Applications; WG on Hydrology and Water Resources; WG on Improved Weather Forecasting, Natural Disaster Reduction, Service Delivery, and Communication; and WG on Compliance Issues in Marine and Aeronautical Meteorological Services and Cost Recovery); the Tropical Cyclone Committee for the South-West Indian Ocean; and two Task Teams (TT on Aeronautical Meteorology in RA I; and TT on WIGOS);

(c) The implementation of the regional components of WMO major initiatives: WIGOS, GFCS, implementation of QMS for aviation weather services, the Capacity Development Strategy and the WMO Programme for LDCs;

(d) The roles of the WMO Offices for Africa and LDCs including the WMO Office for North, Central and West Africa (Abuja, Nigeria) and the WMO Office for Eastern and Southern Africa (Nairobi, Kenya) in meeting the increasing needs of Members in various regional capacity development activities which include, facilitating implementation of WMO regional events, maintaining close contact with Members, providing support to meet Members requirements, and addressing WMO cross-cutting programmes, all being carried out in close collaboration with Members and relevant regional organizations; and the ongoing process to identify location for the Offices for Africa and LDCs;

(e) Continuation of the organization of the West African Climate Outlook Forum (PRESAO), the Greater Horn of Africa Climate Outlook Forum (GHARCOF), the Central African Climate Outlook Forum (PRESAC), the Northern Africa Climate Outlook Forum (PRESANORD), and the Southern Africa Climate Outlook Forum (SARCOF), which products are widely used by national governments and other stakeholders in the Region;

(f) Successful organization of the Second and Third Sessions of the African Ministerial Conference on Meteorology (AMCOMET-2 and AMCOMET-3) in Victoria Falls, Zimbabwe in October 2012 and Praia, Cabo Verde in February 2015, respectively. The sessions were jointly organized by WMO, the African Union Commission (AUC) and the Governments of Zimbabwe and Cabo Verde respectively. It was noted with appreciation that several partners contributed to a Trust Fund that supported the AMCOMET Secretariat and implementation of AMCOMET process;

(g) During the AMCOMET-3 session, a number of important decisions were made by the Ministers Responsible for Meteorology in Africa which included:

   i. Election of a new five-Member Bureau and five Task Forces;

ii. The approval of the Integrated African Strategy on Meteorology (Weather and Climate Services) and its subsequent endorsement by the AU Summit of Heads of State and Government in January 2013;

iii. The approval of the Constitution and Rules of Procedures of AMCOMET;

iv. The approval of the 2015–2016 AMCOMET annual budget;

v. The approval of the Implementation and Resource Mobilization Plan for the Integrated African Strategy on Meteorology (Weather and Climate Services);

vi. The engagement of the African Union (AU) to ensure that AMCOMET is appropriately positioned within the new structures of AU Specialized Technical Committees (STCs) to allow for its efficient and visible operations;

vii. The ongoing process for the establishment of a Regional Climate Centre (RCC) for Central Africa;

viii. The initiative to develop an African Regional Space Programme in collaboration with the AU Space Working Group, the African Ministerial Conference on Science and Technology (AMCOST) and the African Union Conference of Ministers in Charge of Communications and Information Technologies (CITMC);

ix. The necessary steps to ensure that all African NMHSs achieve and sustain compliance with QMS and competency requirements of ICAO and WMO.

2.4.10 South Africa commended the work of the president, the vice-president and the team of RA I, particularly in capacity-building and infrastructure development. Congress noted that South Africa made financial contributions to the GFCS and to the Gender Mainstreaming Conference as well as the secondment of a staff member to the WMO Secretariat to assist the development of the gender programme. South Africa, fulfilling a number of regional responsibilities including RTH, GISC, RSMC, RTC and GPC for Long-Range Forecasts, committed to put its resources to support these regional responsibilities to enhance meteorology and contribute to regional and global sustainable goals.

2.4.11 Congress noted that there are still many challenges facing NMHSs in Africa in performing their mandates, and noted current RA I priorities that included:

(a) Capacity development (human capital, infrastructure development, institutional transformation of NMHSs into autonomous entities);

(b) Aeronautical meteorological services;

(c) GFCS;

(d) Service delivery;

(e) Strengthening capacity of the WMO Offices in the Region in order to serve Members more effectively and strengthening the AMCOMET Secretariat.

2.4.12 Congress noted with appreciation the partnership existing between WMO and the AU which had resulted in tangible benefits to the further development and visibility of NMHSs in Africa. Congress urged the Secretary-General to continue with the support to the AMCOMET Secretariat and its activities. Congress expressed gratitude to the Members and development partners who had continued to contribute to the AMCOMET Trust Fund and invited them to continue their support.

2.4.13 Congress was informed that Dr Mohamed Mhita, former president of RA I, had passed away on 7 April 2015. His family expressed their gratitude for the condolence messages received from Members through the PR of the United Republic of Tanzania with WMO.

Report by the president of Regional Association II

2.4.14 Congress noted the most important achievements in RA II, which included:

(a) Refinement and implementation of the RA II Operating Plan 2012–2015, and development of the RA II Strategic Operating Plan 2016–2019 for the Enhancement of National Meteorological and Hydrological Services in Regional Association II (Asia) based on a survey to identify institutional arrangements, current challenges, and future priorities in RA II and subsequent discussion at the sixth session of the Regional Conference in RA II in December 2014;

(b) Implementation of the new working mechanism of the Association for effective implementation of the RA II Strategic Plan by establishing the Management Group, four Working Groups with sub-groups and themes, two Implementation and Coordination Teams to handle cross-cutting activities;

(c) Establishment and implementation of five new Pilot Projects in the areas of: information sharing on climate services; NWP; regional severe weather warnings and advisories; collection and application of Aircraft Meteorological Data Relay Data; and provision of official weather forecasts for the medium-range;

(d) Implementation of Regional WIGOS and WIS Implementation Plans in RA II, particularly progress on WIS implementation through operational services at three GISCs and trial operations at three conditionally designated GISCs, and an agreement on the preliminary list of principal GISCs.

2.4.15 Congress noted the highest priority areas for RA II identified by the survey and subsequent discussion at the sixth session of the Regional Conference (December 2014), as follows:

(a) Improvement of Early Warning System (EWS) for Disaster Risk Reduction (DRR) to meet the increasing demands for effective and more accurate location- and time-specific forecasts for stakeholders to issue early warning and render emergency services;

(b) Implementation of WIGOS and WIS including GISC to maintain and improve real-time observing systems including META data, the quality and quantity of observations (particularly in mountains, deserts and oceans), improve communication and information sharing, telecommunication and IT infrastructures and database management, regional and national implementation of WIGOS;

(c) Enhancement of hydrological, aviation and public weather services for the development of the capacity for adequate services in support of public weather services, aviation, and hydrology, including nowcast, short- and medium-range forecast services;

(d) Strengthening of climate services including GFCS for improved climate services including climate change, variability and prediction services; and the implementation of GFCS at national and regional levels;

(e) Capacity development in terms of budget and staffing resource deficiencies, education and training needs, twinning of experts and modelling such as NWP;

(f) Improvement of QMS in terms of training and education in support of implementation of personnel qualification, competency and QMS to leverage cost-recovery systems to improve aviation services.

2.4.16 Congress also noted specific challenges to RA II as follows:

(a) Inadequacies of climate services, extended forecast (sub-seasonal to seasonal) at high resolution;

(b) The lack of qualified personnel and needs for capacity-building;

(c) Need for ongoing competency assessments and implementation of a quality management system, particularly in the field of aeronautical meteorology;

(d) Need to improve development, access and usage of NWP guidance material as underlying support to prepare skilful, location-specific weather forecast for improving service delivery;

(e) Inadequate capabilities (meteorological and hydrological observing systems, data communication systems and effective dissemination systems) to deliver end-to-end multi-hazard early warning systems to support DRR;

(f) Interregional cooperation with Regional Associations I (Africa), V (South-West Pacific) and VI (Europe) through the partnership with interregional partner organizations, including the Association of Southeast Asian Nations (ASEAN), the United Nations Economic and Social Commissions for Asia and the Pacific (UNESCAP) and for West Asia (UNESCWA), the League of Arab States (LAS) and the Gulf Cooperation Council (GCC).

Report by the president of Regional Association III

2.4.17 Congress noted the most important activities in the Region, which included:

(a) Significant progress in the implementation of three RCCs in RA III, including the demonstrative phase of the western-South America RCC (established in the International Research Centre on El Niño Phenomenon (CIIFEN) based in Guayaquil, Ecuador) and the southern-South America RCC (virtually implemented between NMHSs of Argentina, Brazil, Paraguay and Uruguay), while the northern-South America RCC (coordinated by NMHSs of Brazil and Guyana) is in its inception phase;

(b) Continuation of the Ibero-American Cooperation Programme in Meteorology and Hydrology, funded by the Spain State Meteorological Agency (AEMET), in support of several activities and meetings related to data processing, climate change, flood management, seasonal forecasting, instruments for statistical forecasting, use of satellite data products from the European Centre for Medium-Range Weather Forecasts (ECMWF) and various other issues. The Programme also supported various courses related to hydrological and seasonal forecasting, flooding in coastal areas, telecommunications and interaction with the media;

(c) Participation in the Regional Forum on the Probable Climate Evolution (RFPCE), aimed to provide seasonal climate forecasting. Two groups of countries published monthly bulletins of seasonal forecasting. One was integrated by the Plurinational State of Bolivia, Colombia, Chile, Ecuador, Peru and the Bolivarian Republic of Venezuela, while the other by Argentina, Brazil, Paraguay and Uruguay;

(d) Development of the Virtual Centre for Severe Weather Monitoring and Forecasting for the South-East of South America by the NMHSs of Argentina, Paraguay and Uruguay, with the financial support of the Ibero-American Cooperation Programme and a contribution from the Brazilian NMHS. This model is to be replicated in the near future in Central America;

(e) Development and implementation of QMS, requested by ICAO to those NMHSs providing aeronautical services. The QMS was achieved by means of horizontal

cooperation and support of NMHSs in the Region. In this regard, several missions and seminars were held with the funding of the Ibero-American Cooperation Programme;

(f) Establishment of a Regional Training Centre in La Molina National University (Lima, Peru) extending the options of human capacity development, complementing the training institutions in the area (Argentina, Brazil, Costa Rica and the Bolivarian Republic of Venezuela) and offering degrees to meet the education demands in the Region;

(g) Participation of certified professionals on Integrated Flood Management from the Region in national workshops and other regional activities, including compound of demonstrative projects such as the case of the Plurinational State of Bolivia and Paraguay;

(h) Active participation of the president of RA III in a number of WMO meetings and sessions, including Cg-XVI (2011), Cg-Ext.(2012), EC sessions, meetings of the EC Working Group on Strategic and Operational Planning (EC WG/SOP) and the EC Working Group on Capacity Development (EC WG/CD);

(i) The extraordinary session of the Commission for Basic Systems (CBS-Ext.(2014)) held in Asunción, Paraguay, 8–12 September 2014, prior to the Regional Conference "Future Challenges and Opportunities for RA III" (12–15 September 2014) was the first technical commission session held immediately before the session of a regional association. It demonstrated and underlined the benefits of integrating the work of technical commissions with the activities of regional associations. Furthermore, technical discussions of a Commission on the Region could be immediately incorporated in the plans and regional activities;

(j) The sixteenth session of RA III (RA III-16) held in Asunción, Paraguay, 15–20 September 2014 which adopted the Strategic Plan 2014–2019 for RA III (South America) (SP-RA III) contributing to the implementation of WMO Strategic Plan 2016–2019, and also decided the development of the RA III Operating Plan 2016–2019 as part of the WMO-wide Operating Plan 2016–2019. The session also approved Resolution 11 (RA III-16), requesting Seventeenth Congress to consider recognizing the Consortium of Brazilian institutions (CVEM) as a WMO Virtual Regional Training Centre in Brazil;

(k) Continuation of the working structure consisting of one Management Group and three working groups with corresponding experts (WG on Infrastructure and Technological Development (WG-ITD), WG on Climate (WG-CL), and WG on Hydrology and Water Resources (WG-HWR)), as well as focal points designated for WIGOS and WIS matters;

(l) Several regional conferences, workshops and other events with active participation of RA III Members, among which it is worth to mention:

i. The Joint Workshop of RA III and RA IV on the WIGOS Regional Implementation Plan;

ii. The Joint Seminar for Spanish-speaking countries from RAs III and IV on Development and Use of BUFR Codes and Migration Tables;

iii. Various working meetings for the implementation of three Regional Climate Centres (RCCs);

iv. Integrated Flood Management courses for professionals in the Region with instructor's certification;

(m) Implementation of the Climandes project, which is a twinning project between the Servicio Nacional de Meteorología e Hidrología (SENAMHI) of Peru and MeteoSwiss, aiming to strengthen the Peruvian capacity to develop and implement climate services, funded by the Swiss Agency for Development and Cooperation (SDC). An education and training component for the RA III Andean countries is also developed with the RTC at the Agrarian University of La Molina.

2.4.18 Congress noted that the highest priorities in the Region were identified by RA III-16 as follows:

(a) WIGOS/WIS;

(b) Impact-based forecasts and early warnings for DRR;

(c) Capacity development for NMHSs;

(d) GFCS.

2.4.19 Congress also noted specific challenges in RA III, including: the recognition of the BIP-M and old degrees for Class II Meteorologists; the traceability of meteorological instrument calibration and measurement; the need for research to improve understanding of climate variability and change and their linkages to changing cycles and characteristics of El Niño/Southern Oscillation (ENSO) and its impacts on hydrometeorological hazards; the use of regional forums to promote meteorology, hydrology and environmental issues, and raise policymakers' awareness of the role of the NMHSs and WMO in contributing to sustainable development and disaster risk reduction; the need for a coordinated framework of the GFCS and RCCs which include the development of tools and climate products and services to address disaster risk reduction at different timescales; and the need to mobilize resources and provide assistance to the NMHSs in the Region.

Report by the president of Regional Association IV

2.4.20 Congress noted the most important activities in the Region, which included:

(a) Successful development of the Strategic Plan for the Enhancement of National Meteorological and Hydrological Services in RA IV (North America, Central America and the Caribbean) (2009–2011) and the development of the RA IV Strategic Operating Plan for 2012–2015;

(b) Establishment of a new simplified work structure for the efficient management and good governance of the Region, consisting of the Management Group, the Hurricane Committee, the Working Group on Hydrology and ad hoc task teams to address regional priorities;

(c) Development of the RA IV Strategic Operating Plan for the Enhancement of NMHSs in RA IV (North America, Central America and the Caribbean) 2013–2016 and the implementation in the Region of the high priority activities decided by Sixteenth Congress (2011) in the areas of: GFCS; implementation of WIGOS/WIS; Aeronautical Meteorology; Capacity Development; and Disaster Risk Reduction (DRR);

(d) Continuation during the intersessional period of the Project Office in Mexico to support the National Water Commission in achieving integrated, sustainable management of water and the PREMIA project aimed to, as outlined in the agreement between the WMO and the Government of Mexico, the efficient management of water, technical support in the fields of hydrology, meteorology, climate variability and change and their effects on water availability, in particular ground water reserves; prevention of floods will be also another area to be covered;

(e) Continuation of the Meeting of Directors of Ibero-american Countries with the attendance of the Spanish-speaking Members of RA III and RA IV. The main lines of action of the three-year plan include: institutional strengthening of NMHSs and resource mobilization; development of climate services through pilot projects; education and training; and development of subregional virtual centres for the prevention and monitoring of extreme events;

(f) WMO, through the trust fund from Spain, supported during the intersessional period, several activities including courses on automatic weather stations maintenance, data processing, climate change, administration of meteorological and hydrological services, flood management, seasonal forecast, hydrology, statistic forecast tools, use of forecast products and satellites, and other topics. Additionally, a series of seminars and workshops were also supported, especially in hydrological forecasts, seasonal forecasts, coastal flooding, and telecommunications interaction. Several countries in RA IV have already benefited from the open source of Meteorology, Climatology and Hydrology (MCH) Database Management System, donated by Mexico to WMO, and provided by the Conference;

(g) Revision of the Technical and Operational Plans of the Hurricane Committee during its annual meetings (34th to 37th) successfully carried out with support from WMO, in Ponte Vedra Beach, Florida (United States of America), Willemstad (Curaçao and Sint Maarten), Cancun (Mexico), and San Jose (Costa Rica), respectively;

(h) Environment Canada and WMO signed a USD 6.5 million Financing Agreement to support the programme “Haiti Weather Systems Programme – Climate Services to Reduce Vulnerability in Haiti”. The five-year project aims to develop the capacity of the NMHS of Haiti to deliver Early Warnings and also general weather, climate and hydrological services to the people of Haiti. Activities of the project up to December 2014 include:

i. Setting up of internal project management process;

ii. Establishment of WMO Project Office in Haiti;

iii. An Agreement with UNOPS finalized for the building component of the project;

iv. Acquisition of land for new offices for National Meteorological Centre – National Water Resources Service (CNM-SNRE);

v. Initiation of process for the CNM-SNRE 5-year Business Plan;

(i) Development of a Regional WIGOS Implementation Plan for RA IV through the establishment of the Task Team;

(j) RA IV representation in the Management Committee of the IBCS through British Caribbean Territories (BCT), Canada, Costa Rica and USA;

(k) Participation of the president of RA IV in meetings of the Presidents of Regional Associations and Presidents of Technical Commissions of WMO, which allowed for excellent coordination;

(l) Creation of a virtual forum on hydrology as support for the work of the Working Group on Hydrology;

(m) Representation of RA IV at the Regional Platform for Disaster Risk Reduction in Americas, Guayaquil, Ecuador;

(n) Participation in RA III-16, Asunción, Paraguay, which allowed the president to discuss several issues of common interest to both RA III and RA IV and to initiate collaborative activities in different areas.

2.4.21 Congress noted identified priorities in RA IV, including:

(a) GFCS: There should be a focus on the technological transfer of climate research and know-how into services that benefit users as well as other partners and stakeholders that are critical to the delivery of effective climate services. Special attention should be accorded to the establishment of effective networks of Regional Climate Centres;

(b) DRR: Partnerships with national and regional stakeholders to identify evolving hydrometeorological and climate risks and develop appropriate, cost-effective, sustainable solutions and mechanisms to reduce these risks will be key to the DRR agenda;

(c) WIGOS: WIGOS implementation should remain as an ongoing priority activity, including its implications for WIS and the resulting evolution and ongoing maintenance requirements for the WIS platform;

(d) Capacity development: There should be a continued focus on capacity-building in Small Island Developing States (SIDS) and least developed countries (LDCs);

(e) Aviation and marine meteorology: Continuous and sustained attention will be required to meet the needs of these important sectors, particularly in terms of ongoing implementation and maintenance of quality management systems and human resource competencies and in light of the trend towards regionalization of services;

(f) Research: Special attention should be accorded to technological transfer of research into products and services that contribute to key outcomes. Critical areas in this regard are seamless prediction on all timescales and research related to polar and coastal zones.

2.4.22 Congress also noted specific challenges in RA IV including:

(a) The enhancement of the availability of university level education opportunities for meteorological personnel;

(b) The revised plans of ICAO for the implementation of a recognized Quality Management System for meteorological services to civil aviation;

(c) The work with regional intergovernmental organizations and the use of regional forums to promote meteorology, hydrology and environmental issues, and raise policymakers' awareness of the role of the NMHSs and WMO in contributing to sustainable development and disaster risk reduction.

Report by the president of Regional Association V

2.4.23 Congress expressed a warm welcome to Tuvalu for its new membership with WMO as from 22 September 2012, and encouraged Marshall Islands, Nauru and Palau to take the necessary steps towards becoming Members of WMO.

2.4.24 Congress noted the most important achievements in RA V, which included:

(a) Refinement and implementation of the Strategic Operating Plan for the Enhancement of National Meteorological and Hydrological Services in Regional Association V (South-West Pacific) 2012–2015 (RA V Strategic Operating Plan) and the development of its subsequent RA V Operating Plan (OP) 2016–2019 reflecting the regional priorities

approved by the sixteenth session of RA V for the enhancement of National Meteorological and Hydrological Services in the South-West Pacific;

(b) Development of the RA V workplan 2014–2015 for newly established four working groups with thematic task teams and the Tropical Cyclone Committee for the South Pacific and South-East Indian Ocean (TCC), and finalization of the membership of subsidiary bodies based on a new working mechanism by strengthening the Management Group for effective implementation of the RA V Strategic Operating Plan;

(c) Assistance provided by Members and the Secretary-General to support the disaster-affected Member NMHSs, in particular to the Philippines following Typhoon *Haiyan* in November 2013 and Fiji following consecutive severe flooding incidents in January and March 2012;

(d) Assistance provided by Members and the Secretary-General to support development of legal instruments or equivalents for NMHSs and development of national and regional strategy and implementation plans for enhancement of meteorological services for Small Island Developing States (SIDS) in the Pacific;

(e) Implementation of GFCS through existing mechanisms such as Regional/Subregional Climate Outlook Forums (RCOFs) including the establishment of the ASEAN Climate Outlook Forum (ASEANCOF); the establishment of the Pacific Island Climate Services (PICS) Panel to provide advice to the Pacific Meteorological Council (PMC) on climate services matters; and progress on National Climate Outlook Forums for Kiribati, Papua New Guinea and Tonga;

(f) Adoption and implementation of the Regional WIGOS Implementation Plan (R-WIP-V) and the Regional WIS Implementation Plan for 2016–2019;

(g) Establishment of a WMO RTC in Indonesia, and increased number and stabilization of meteorologists/tropical cyclone forecasters at RSMC Nadi.

2.4.25 Congress noted that WMO participated in the Third International Conference on SIDS held in Apia, Samoa from 1 to 4 September 2014, and held side events organized by WMO or with other partners including: *Increasing community resilience through improved weather and climate services for SIDS; Managing cyclones from Cuba to Samoa; Weatherfront – how weather and climate services are protecting small island communities*; and signing of a Memorandum of Understanding between WMO and the Indian Ocean Commission (IOC).

2.4.26 Congress noted continued partnership with regional organizations in the Pacific subregion such as SPREP through the Pacific Meteorological Council (PMC) and the Pacific Meteorological Desk Partnership (PMDP) for the implementation of various programmes and projects in the Pacific including the organization of the PMC's meeting, the Programme for Implementing GFCS at the Regional and National Scales across Small Island States in the Caribbean and South-West Pacific and the Finland-Pacific (FINPAC) Project; the Applied Geoscience and Technology (SOPAC) Division of the Secretariat of the Pacific Community (SPC/SOPAC Division) through continued dialogues on water resources management and disaster risk reduction matters; and ASEAN in the South-East Asian subregion.

2.4.27 Congress further noted the highest priority areas for Region V identified by the survey and subsequent discussions at the sixteenth session of the Association, as follows:

(a) Maintenance and improvement of observations and telecommunication networks at the regional and national level through completion of the implementation of WIS and WIGOS;

(b) Delivery of improved climate services through the establishment of the optimum network of RCCs to sustainably implement the GFCS;

(c) Implement effective education and training programmes that build the capability of NMHSs in resource management, advocacy and outreach, and NWP utilization;

(d) Achievement by all Members of the standards required for quality management and staff competencies, with a focus on aviation and marine meteorology.

2.4.28 Congress further noted specific challenges to and needs for RA V, among others related to: lack of qualified personnel and the need for ongoing competency assessments, particularly in the field of aeronautical meteorology; need to improve institutional arrangements of Member NMHSs, including enabling legislation, support effective fiscal management, and securing of financial resources from Governments and other sources; need to improve partnerships with key national, regional and global bodies, including funding agencies in order to enhance the service delivery and sustainability of the Member NMHSs; need to improve access to, and usage of, NWP guidance material as underlying support to make service delivery better; need to address inadequacies in regional observing and telecommunications systems for monitoring, forecasting, and dissemination of products for weather, water and climate; need to address inadequacies of early warning services supporting DRR; need to fully implement and sustain a quality management system; and need to improve communication with users and stakeholders for better delivery of user-focused services (e.g. climate services to support the agriculture sector).

Report by the president of Regional Association VI

2.4.29 Congress noted the most important activities and achievements in the Region, which included:

(a) The successful implementation of the new structure of the subsidiary bodies: management group, three working groups and a number of task teams. This action-oriented working mechanism contributes to the effective work throughout the intersessional period, and to delivery of the expected outcomes;

(b) Successive accomplishment of the RA VI Action Plan based on the RA VI Strategic Plan (2008–2011). Establishment of the RA VI Operating Plan (2012–2015) with a continuous process in review, update and the Operating Plan performance following the adoption by Cg-XVI of the WMO Strategic Plan (2012–2015). Development of a new RA VI Operating Plan (2016–2019) that is harmonized with the new WMO Draft Strategic Plan 2016–2019. This Operating Plan is closely holding the two consecutive periods: (2015–2017) and (2018–2019), in order to facilitate proper performance of the existing RA VI subsidiary bodies;

(c) The progress in the implementation of the regional elements of the GFCS such as: the successful completion of the pilot phase of the RA VI RCC-Network, and its formal designation; the implementation of pilot activities in introducing of Climate Watch Services in the Region; achieved sustainability of the South-East European COF (SEECOF) and the further expansion of the RA VI RCOFs by the establishment of the North-Eurasia COF (NEACOF) with the participation of RA VI and RA II Members, and Mediterranean COF (MEDCOF) interregional cooperation between RA VI and RA I with the bridging collaboration with SEECOF;

(d) The significant progress in the implementation of WIS including: establishment of an effective mechanism for monitoring the WIS implementation through a regional focal point (provided by the DWD, Germany); putting into operation of the planned GISCs in RA VI by the respective host countries; designation of the National Centres (NCs) and WIS focal points by the Members; deployment of the new RMDCN led by ECMWF along with the steady progress with the migration to the table-driven code forms (TDCF) by the majority of the RA VI Members;

(e) Interregional collaboration between the three regional associations (RA VI, RA I, RA II) has been established by setting up of the first Regional Specialized Meteorological

Centre (RSMC) on Atmospheric Sand and Dust Forecast for Northern Africa, Middle East and Europe through the joint partnership of the AEMET and the Barcelona Supercomputer Centre;

(f) The preparation of the RA VI WIGOS Implementation Plan for regional and national WIGOS-related activities during the next intersessional period, that was facilitated by the Regional WIGOS Conference organized in collaboration with Spain;

(g) The establishment of the RA VI Hydrology Forum as a platform for hydrologists within the Region to discuss matters of common concern;

(h) The progress in developing methodologies, sharing experience and engaging Members in conducting analysis of the socio-economic benefits (SEB) that was facilitated by the Regional SEB Conference organized in collaboration with Switzerland and followed-up by TT-SEB;

(i) Continuous DRR capacity development activities through: (1) the completion of a two phased project for the Western Balkans and Turkey with financial support from the European Commission DG for Enlargement, and in close collaboration with the UNDP (in phase one) and with the UNISDR (in phase two); (2) the two Flash Flood Guidance Systems projects for the South Eastern Europe, Black Sea and Middle East, in cooperation with NOAA and financial support from USAID; and (3) project in the Middle East (Jordan and Lebanon) for provision of services in support of water management, DRR and adaptation to climate change what was financially supported by the Swiss Agency for Development and Cooperation (SDC);

(j) Active involvement of the Association, through its president, in the teamwork and partnership with the WMO constituent and subsidiary bodies along with the close collaboration with the WMO Secretariat, in particular the Regional Office for Europe; several initiatives for the improvement of the effective and efficient performance of WMO, in particular regarding the proposal for the amendment to the WMO General Regulations considering the role and responsibilities of the regional associations;

(k) Initiative for issuing WMO/GCOS guidance or recommendation to Members in performing the transition process from manned to automatic observation stations to preserve homogenization of the referent climate stations.

2.4.30 Congress acknowledged the NMHSs' priorities, agreed by the Association, that have been highlighted through the regional survey, were relevant for most Members and subregions, namely:

(a) Coping with issues related to the economic conditions affecting the NMHSs: constant pressure for budget and staff cuts, insufficient qualified personnel, and difficulties to maintain and sustain basic functions, due to lack of resources;

(b) Enhancement of climate services – implementation of GFCS at regional and national level;

(c) Implementation of WIGOS and WIS (noting that WIS implementation has already been in progress), including focus on concrete and urgent needs related to the maintenance and improvement of the observing systems and the quality of observations;

(d) Enhancement of services: PWS, DRR/EWS, aviation and related services as well as demonstration and communication of the resulting social and economic benefits;

(e) Enhanced international cooperation and partnership: raising the effectiveness and efficiency of the regional activities, building common position on issues like data policy, commercialization and public/private sector relationships.

2.4.31 Congress also noted specific challenges in RA VI related to: continuous budget and staff cuts by governments; harmonization with the capacity development segments of the Copernicus Programme (including harmonization of vocabularies and metadata); fussy status of the aeronautical meteorological services, increasing role of the private sector in service delivery and requirements for compliance with data policies; and the need to fill technological and institutional gaps between the developed and developing NMHSs.

2.5 Reports by presidents of technical commissions (agenda item 2.5)

Report by the president of the Commission for Basic Systems (CBS)

2.5.1 Mr Fredrick Branski, president of the Commission for Basic Systems (CBS), highlighted the high priority activities and achievements over the four years since Cg-XVI.

2.5.2 Congress expressed appreciation to Indonesia and Paraguay for supporting the fifteenth session of CBS in 2012 and the CBS extraordinary session 2014 respectively, as well as the technical conferences on WIGOS and Valuing Systems and Services in Jakarta and in Asunción on Future Challenges and Opportunities for CBS and WIGOS framework Implementation. Congress particularly appreciated that the CBS extraordinary session 2014 had been arranged so that it was possible to hold a joint technical and regional conference with the sixteenth session of Regional Association III. Congress congratulated CBS on reducing the length of its sessions but noted that an impact of this had been to limit the depth of discussion that was possible during the session.

2.5.3 Congress was pleased that significant progress had been made with WIS and WIGOS (see agenda items 4.2.2 and 4.2.3). Congress expressed its appreciation for the initiative for the development of a 2025 Vision for the GDPFS (see paragraphs 4.1.7–4.1.35) to ensure the System is agile and flexible to adapt to emerging and complex needs of users, as well as providing high-quality information in support of Multi-Hazards Early Warning Systems (MHEWS; see agenda item 3.2). In this context, Congress noted that the Secretary-General and CBS, in coordination with other technical commissions, were working to develop the related strategy for achieving this vision. Congress also expressed its appreciation that Severe Weather Forecasting Demonstration Project (SWFDP) had involved 41 countries and had improved the ability of many WMO Members to improve their forecasting capabilities as well their capacity to deliver weather forecasts and warnings. Extending these successes to other areas and ensuring that the new capabilities were implemented in a sustainable way would be significant challenges for the next intersessional period (see paragraphs 4.1.1–4.1.6).

2.5.4 Congress noted that CBS had made increasing use of teleconferencing and other electronic collaboration methods. It had also made good use of procedures to update components of the *Manual on Codes* and the *Manual on WIS* between sessions of CBS (see agenda item 4.2.4), and had proposed many other changes to these, and the *Manual on the Global Observing System*, to Congress (see agenda item 4.2.2). It further noted that CBS had led the development of the *Manual on WIGOS* and associated changes to technical regulations (see agenda item 4.2.2) and had proposed these together with a plan for a completely revised edition of the *Manual on the Global Data-processing and Forecasting System* for consideration (see paragraphs 4.1.1–4.1.6).

2.5.5 Congress noted that CBS had increased its focus on working with regional associations and that implementation of the SWFDP had been based on a subregional approach to better meet the needs of WMO Members. Both WIGOS and WIS implementation were being coordinated in the regional associations with the assistance of CBS. Meeting the needs of the GFCS, supporting disaster risk reduction, and many other activities needed increasing interaction between National Meteorological and Hydrological Services (NMHSs) and other organizations at global, regional and national scales, and CBS had a key role in providing the technical infrastructure to support this.

2.5.6 Congress noted that CBS would take a leading role in developing best practices for impact-based forecasting, the development of WMO Guidelines on Impact-based Forecast and

Warning Services in all WMO languages, development and implementation of PWS competencies that it had recommended for consideration by Congress, assisting NMHSs to take advantage of opportunities provided by mobile technologies to increase communication channels for forecasts and warnings, implementing the WMO Strategy for Service Delivery (see paragraphs 3.1.1–3.1.12), implementing WIGOS (see agenda item 4.2.2), coordinating the protection of radio frequencies used by meteorology, oceanography and climate, and including data management best practices in the WIS standards.

2.5.7 Noting that much of the work of CBS culminated in the specification of best practices or technical regulations, Congress noted that the ability of CBS to further improve its working practices was constrained by the governance framework for intergovernmental decision-making; it encouraged CBS to propose methods of working that would allow decisions to be made in a timely fashion but that also ensured that there was adequate provision for informed debate about critical issues.

Report by the president of the Commission for Instruments and Methods of Observation (CIMO)

2.5.8 Prof. Bertrand Calpini, president of the Commission for Instruments and Methods of Observation (CIMO), highlighted the high priority activities and achievements of the Commission over the four years since Cg-XVI.

2.5.9 Congress expressed its appreciation to the Russian Federation for supporting the sixteenth session of CIMO and the WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation in St. Petersburg in 2014, and to Belgium for hosting the WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation in Brussels in 2012.

2.5.10 Congress expressed its appreciation to all Members for the assistance of their experts during the last intersessional period to the development of a major new edition of the WMO *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8, CIMO Guide), and in preparatory work towards a new, primarily web-based edition of the International Cloud Atlas. Congress was pleased by the excellent collaboration that took place between CIMO and the Commission for Atmospheric Sciences (CAS), the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM), the Commission for Basic Systems (CBS) and Global Climate Observing System (GCOS), in developing specific contributions for the update of the CIMO Guide. Congress expressed its thanks to France, the Russian Federation and Spain for their support in enabling the publication of the CIMO Guide in French, Spanish and Russian.

2.5.11 Congress acknowledged the significant role played by CIMO in the implementation of WIGOS, among others through its involvement in ICG-WIGOS and its Task Teams dealing with regulatory material and metadata and the commitment of CIMO in assisting in the development of OSCAR. It also noted the exemplary role played by CIMO in working more closely with the other technical commissions and regional associations to develop guidance material for capacity development in management and operation of integrated observing systems. Congress noted and agreed with the need to seek synergies with the current working structures in WMO and CIMO when considering the future development of the Global Framework for Climate Services (GFCS) to enable society to better manage the risks and opportunities arising from climate variability and change, in particular its pillar related to observations and their quality assessment.

2.5.12 Congress noted the efficient ongoing collaboration that is occurring between WMO and instrument manufacturers through the Association for Hydro-Meteorological Equipment Industry (HMEI), and expressed its appreciation to the many HMEI experts who are positively contributing to the work of CIMO Expert Teams, training workshops and instrument intercomparisons. Congress also expressed its appreciation for the increased collaboration between WMO/CIMO and the International Standardization Organization (ISO) on the development of common ISO/WMO technical standards.

2.5.13 Congress expressed its appreciation for the valuable contribution made to the improvement of standardization and traceability of observations by a number of international instrument intercomparisons either completed or commenced during the intersessional period, notably the 8th International Radiosonde Intercomparison (Yangjiang, China, 2010), the 11th International Pyrheliometer Intercomparison (Davos, Switzerland, 2010) and the Solid Precipitation Intercomparison Experiment (underway at numerous sites globally).

2.5.14 Congress noted that CIMO had made increasing use of teleconferencing and other electronic collaboration methods during the intersessional period to maximize its efficiency and effectiveness, and had slightly restructured its Open Programme Area Groups and their Expert Teams for the new intersessional period to better target its activities to strategically address the needs of the WMO priority areas, in particular the implementation of WIGOS, GFCS and GCW. Congress noted that the key priorities for CIMO during the period would be targeted towards improved guidance material for Members in the integrated operation of observing systems, further increasing standardization of observations and traceability of data, and in working with the Education and Training Programme to further improve capacity development, particularly for developing countries.

Report by the president of the Commission for Hydrology (CHy)

2.5.15 Congress was informed by the president of the Commission for Hydrology (CHy), Mr Harry Lins, that the fourteenth session of CHy was held in Geneva from 6 to 14 November 2012. Congress noted that CHy had adopted five priority areas of work for the intersessional period 2013–2016: Quality Management Framework – Hydrology (QMF–Hydrology); Data Operations and Management; Water Resources Assessment; Hydrological Forecasting and Prediction; Water, Climate and Risk Management. Congress was pleased to note that the Commission had aligned its activities with the priorities as established in the WMO Strategic Plan and, in particular, the importance placed on the Commission's contributions to the Global Framework for Climate Services (GFCS) and the WMO Global Integrated Observing System (WIGOS).

2.5.16 Congress was informed of the role played by CHy in the preparation of the Water Exemplar for the GFCS and also of the progress being made through the joint WMO-Global Water Partnership initiatives, such as the Associated Programme on Flood Management and the Integrated Drought Management Programme under the water sector of the UIP. These initiatives have benefited from support provided by Canada, Denmark, Germany, Italy, Switzerland and USA. Congress was also informed that UN-Water had designated a focal point on the Global Framework for Climate Services, further ensuring UN-Water's contribution to the User Interface Platform from a water perspective. Congress also noted the work being undertaken by CHy in association with the Commission for Climatology (CCl) on Extended Hydrological Prediction and the Commission for Atmospheric Sciences (CAS)-CHy-Commission for Basic Systems (CBS) inter-commission research and forecasting demonstration project: Coupled Hydrology-Atmospheric Modelling and Prediction in the Laurentian Great-Lakes-St Lawrence River of North America.

2.5.17 Congress noted with appreciation that, in association with CBS, CHy was progressing with a project, including testing, that could see the potential adoption of the WaterML 2.0 as a WMO standard for water information exchange and to register this standard as a joint WMO/ISO standard. The adoption of WaterML 2.0 will also greatly assist in the establishment of the WMO Hydrological Observing System (WHOS), as proposed by the president of CHy. WHOS is conceived as a portal to facilitate access to already available online real-time and historical data, drawing from the water information systems of countries around the world that make their data freely and openly available, including HYCOS projects. A prototype WHOS portal has been developed and the CHy Advisory Working Group has endorsed the concept and development of WHOS, and agreed that WHOS should represent the CHy contribution to WIGOS. Congress urged the promotion of WHOS among NHSs and the hydrological community.

2.5.18 Congress noted that detailed information on the activities of CHy is reported under agenda items 3 and 4.

Report by the president of the Commission for Atmospheric Sciences (CAS)

2.5.19 Congress was informed by the president of the Commission for Atmospheric Sciences (CAS), Dr Øystein Hov, that the sixteenth session of CAS was held in Antalya, Turkey, from 20 to 26 November 2013. Congress noted that CAS had identified six emerging challenges and opportunities for the decade to come which will guide the work for the intersessional period 2014–2017, as follows: High-impact weather and its socioeconomic effects in the context of global change; Water: modelling and predicting the water cycle for improved disaster risk reduction and resource management; Integrated Greenhouse Gas Information System: serving society and supporting policy; Aerosols: impacts on air quality, weather and climate; Urbanization: research and services for megacities and large urban complexes; and, Evolving technologies: their impact on science and their use. Congress was pleased to note that the Commission had aligned its activities with the priorities as established in the WMO Strategic Plan and, in particular, the importance placed on the Commission's contributions to the Global Framework for Climate Services (GFCS) and the WMO Global Integrated Observing System (WIGOS).

2.5.20 Congress took special note of the advice by the president of CAS to integrate atmospheric composition and weather and climate research in order to have a more comprehensive description and understanding of the Earth System. In this regard the president of CAS complimented the Global Atmosphere Watch (GAW) Programme for the increased emphasis on atmospheric composition modelling within GAW and highlighted the achievements of the pilot projects related to air quality forecasting by the GAW Urban Meteorology and Environment (GURME) project as good examples of linking atmospheric composition to user needs.

2.5.21 Congress was informed of the role played by CAS in close cooperation with the World Climate Research Programme (WCRP) in the preparation of the Research, Modelling and Prediction Pillar of the GFCS and also of the progress being made by CAS and WCRP through projects on subseasonal to seasonal prediction and polar prediction which are both contributing towards advancing climate services. Congress supported the emerging cross-commission initiatives, including the Commission for Hydrology (CHy)-CAS-Commission for Basic Systems (CBS) inter-commission research development and forecasting demonstration project (RDP/FDP): Coupled Hydrology-Atmospheric Modelling and Prediction in the Laurentian Great-Lakes-St Lawrence River of North America, and the Commission for Aeronautical Meteorology (CAeM)-CAS-CBS Aviation RDP aimed at developing advanced nowcasting and very short-range forecasting products required by the trajectory based operations of next generation aviation initiative, namely Aviation System Block Upgrade (ASBU).

2.5.22 Congress noted with appreciation the thorough preparation by CAS that ensured a smooth transition and maintained the research momentum of THe Observing system Research and Predictability EXperiment (THORPEX) within the World Weather Research Programme (WWRP) when this experiment was concluded after ten years at the end of 2014. Congress further acknowledged the important role of the World Weather Open Science Conference, which was held from 16 to 21 August 2014 in Montreal, Canada, in highlighting the significant advances in weather science and predictive skill made in the past few decades, in identifying how to achieve further progress in the future and in strengthening the links between the weather science and user and application communities. In addition, Congress was reminded of the milestone reached by the Global Atmosphere Watch (GAW) Programme which celebrated its 25th anniversary, from 22 to 26 September 2014 in Natal, Brazil, in conjunction with the 13th Science Conference of the International Global Atmospheric Chemistry (IGAC) Project.

2.5.23 Congress noted the arguments presented by the president of CAS that research is the foundation to new and improved weather, climate, water and related environmental services designed to meet the rapid evolving needs of the growing global population faced with new environmental challenges. Members are encouraged to invest, participate and draw benefits from the WMO global research effort and to take note of emerging issues as identified by CAS in their own planning.

Report of the president of the Commission for Aeronautical Meteorology (CAeM)

2.5.24 Mr Chi-ming Shun, the president of CAeM, highlighted the progress made by the Commission since Cg-XVI and recalled that a positive factor was the recognition of aeronautical meteorology as one of the five strategic priorities of the WMO Strategic Plan for the sixteenth financial period 2012–2015. This had helped improve some of the long-standing resource difficulties faced by CAeM in the past.

2.5.25 Congress noted that aeronautical meteorology was entering into an era of rapid and fundamental changes, in response to the continuous growth of aviation transport and the need of new concepts for Air Traffic Management (ATM). The new 2013 version of the ICAO Global Air Navigation Plan (GANP) introduced a consensus-driven Aviation System Block Upgrades (ASBU) methodology aiming at safe, sustained growth, increased efficiency and responsible environmental stewardship. The ASBU included upgrade modules for aeronautical meteorology, in 5-year blocks out to the timeframe of 2028 and beyond. Congress recognized that these changes could pose significant challenges to WMO Members, as well as provide new opportunities.

2.5.26 Congress was informed that the CAeM Management Group (MG) had laid down an Operating Plan for 2011–2015 with clear deliverables, Key Performance Indicators (KPIs), Key Performance Targets (KPTs) and Key Outcomes (KOs) for 5 top level strategic priorities, with the following results achieved up to the CAeM-15 session held conjointly with the ICAO Meteorology Divisional Meeting in July 2014 (MET DIV 2014): (a) development of proposals for Meteorological Services to Air Traffic Management (MSTA); (b) development of AMP Competency Assessment Toolkit (CAT) and provision of support to Members in implementation; (c) provision of support to Members in implementation of Quality Management System (QMS); (d) improvement of SIGMET provision and resolution of long-standing deficiencies; and (e) development of proposals for emergency responses including volcanic ash (VA), nuclear emergencies and space weather.

2.5.27 Congress was also pleased to note that, in the past four years, the CAeM MG had pioneered innovative steps to effectively manage the operation of the Commission, including: strategic planning with defined measures of success, adoption of concise and action-oriented documents and reports for meetings, making extensive use of teleconference and Internet for MG and ET meetings, reducing the lengths and overheads for Commission sessions (notably, with the major deliberations taken place at the Conjoint Meeting with ICAO, CAeM-15 was successfully completed within two days), which helped that CAeM progress was sustained within the budget constraints. Such performance improvements would not have been possible without Members contributing experts and other in-kind contributions, including hosting numerous meetings, training workshops, websites, translation of documents, etc., that had ensured the work progress. Congress expressed appreciation to these contributing Members.

2.5.28 Congress noted concerns regarding the anticipated changes in the business and service delivery modalities in aeronautical meteorology, including regionalization of service delivery and increased competition for provision of services to aviation users. Recognizing that aviation was a significant source of revenue for many NMHSs, Congress noted that such changes could have serious impacts on the financial and organizational viability of many NMHSs. Congress recognized that in order to represent the views and needs of WMO Members, CAeM would need to further enhance coordination with ICAO and other aviation stakeholders and partners on the development of appropriate regulatory, governance and cost recovery frameworks and underpinning infrastructures to support the future provision of local, subregional, regional and global aeronautical meteorological service delivery. In view of these developments, Congress agreed with the CAeM president that aeronautical meteorology should remain a strategic priority of the Organization during the seventeenth financial period (2016–2019). Congress also recognized the long-term planning envisaged in the GANP and ASBU with a time horizon of 2028 and beyond and agreed with the need for the CAeM to ensure synchronized planning of related WMO activities, as foreseen in Recommendation 2 (CAeM-15) provided in Annex II to the present report. The challenges and opportunities in the future development of integrated meteorological services for global Air Traffic Management were further discussed under agenda item 9.2.

2.5.29 Congress also recognized that the future viability and sustainable development of NMHSs as aeronautical meteorological service providers would be underpinned by Members' implementation and maintenance of QMS and compliance with AMP competency and qualifications standards. Recognizing that the related regulatory framework would need to be updated to reflect the latest ISO Standards and expected changes in aeronautical meteorological services provision, the CAeM MG will sustain its continual efforts, in cooperation with the Education and Training Programme, in providing the necessary assistance to Members in need (including training, development of guidance material, and facilitating twinning/mentoring arrangements), in particular to least developed and developing countries, and small island developing States.

2.5.30 Congress agreed with the CAeM president that effective communication, coordination and partnership with Members, regional associations, other technical commissions and other relevant WMO bodies, as well as with partner organizations would become even more important in the successful development and implementation of the forthcoming changes in the aeronautical meteorological services provision and in assessing feedback and responding to Members' request for advice, guidance and assistance.

2.5.31 Congress noted that while the new concepts for Air Traffic Management (ATM) were expected to pose significant challenges for WMO Members, the pull-through into services of new science and other advanced technologies would also provide many opportunities for user-focused service enhancements to be realized in close cooperation with the scientific and research communities. In this connection, Congress noted with interest the development of a joint CAeM/CAS/CBS Aviation Research Demonstration Project (AvRDP), with a view to demonstrate the capability of nowcasting and mesoscale modelling techniques in support of so-called "trajectory-based operations (TBO)", with a planned 'fast-track' transfer of the research results into operational applications facilitated through a forecast demonstration phase.

2.5.32 Congress further noted that issues related to impacts of climate change and variability on aviation would also be dealt with by CAeM in coordination with the relevant WMO and ICAO bodies and programmes such as the Global Framework for Climate Services (GFCS) and the ICAO Committee on Aviation Environmental Protection (CAEP).

2.5.33 Congress was pleased to note that a new structure for the CAeM subsidiary bodies had been established by CAeM-15 to address the work areas highlighted in paragraphs 2.5.28 to 2.5.31 above, which comprises five small and focused Expert Teams.

2.5.34 Congress considered the recommendations submitted by CAeM-15, and adopted Resolution 1 (Cg-17) – Report of the fifteenth session of the Commission for Aeronautical Meteorology, including revised terms of reference of the Commission.

Report by the president of the Commission for Agricultural Meteorology (CAgM)

2.5.35 Congress noted the outcomes of the sixteenth session of CAgM held in Turkey in April 2014 which included the establishment of four Open Panels of CAgM Experts (OPCAMEs). These OPCAMEs or Focus Areas are: (1) Operational Agricultural Meteorology; (2) Science and Technology for Agricultural Meteorology; (3) Natural Hazards and Climate Variability/Change in Agriculture; and (4) Capacity Development in Agricultural Meteorology. Congress noted the creation of an additional OPCAME which is in line with the GFCS and which would assist Members in providing better weather and climate services to their users in the agricultural community. More details about the outcomes of CAgM-16 and its workplan for 2014–2018 work can be found at the Report of the sixteenth session of the Commission for Agricultural Meteorology.

2.5.36 Congress appreciated the work of the CAgM president, Dr Byong Lee, in developing the concept of Global Initiatives in Agricultural Meteorology (GIAM) which corresponds to each pillar of the GFCS in order to facilitate the contribution of the Commission to the objectives of the GFCS. These GIAM Initiatives include the following: Global AgroMeteorological Outlook System (GAMOS), Global AgroMeteorological Pilot Projects (GAMPP), Global Alliance of Phenology

Observation Network (GAPON), Global Federation of AgroMeteorological Societies (GFAMS), Next Phase WAMIS project, and Global Centres of Research and Excellence in AgroMeteorology (GCREAM). These initiatives are further elaborated in paragraphs 3.1.138–3.1.162, which will clarify CAgM's position in these components and to ensure that the initiatives are well coordinated within Commission structures.

2.5.37 Congress noted with satisfaction that key CAgM accomplishments during the intersessional period included:

(a) Publication of Reports for each of the three CAgM Implementation/Coordination Teams (ICT) including the reports the Expert Teams;

(b) Publication of selected papers from the International Workshop on Climate and Oceanic Fisheries held in Cook Islands, Oct 2011 (*Climatic Change*, Volume 119, Issue 1, 2013);

(c) Support and interaction of CAgM Experts in the High-Level Meeting of National Drought Policies (HMNDP) and the Integrated Drought Management Programme (IDMP);

(d) Publication of selected papers from the High Level Meeting on National Drought Policy in Weather and Climate Extremes, Volume 3, June 2014;

(e) Publication of *Standardized Precipitation Index: User Guide* (WMO-No. 1090);

(f) Continuation and expansion of the World Agrometeorological Information Service (WAMIS-www.wamis.org);

(g) Development of the WAMIS-DCPC with the support of the Korea Meteorological Administration.

2.5.38 Congress noted with appreciation the outstanding support from the host countries, not only logistically, but also by volunteer scientists and technical experts involved in the meetings of different Expert Teams (ETs) of the previous Open Programme Area Groups (OPAGs) of the Commission. Congress also noted with satisfaction that the Implementation/Coordination Teams (ICTs) evaluated the Expert Team reports and produced a large number of recommendations for implementation at the regional level and urged Members to review and use these recommendations to improve their agricultural meteorological services.

Report by the president of the Commission for Climatology (CCl)

2.5.39 Congress was informed by the president of CCl Dr Thomas Peterson that, during its sixteenth session in July 2014, CCl established five Open Panels of CCl Experts (OPACEs). These are focused on development of information, guidance, best practices and capacity-building to assist National Meteorological and Hydrological Services (NMHSs) in their efforts to address the technical issues inherent in enhancing the provision of climate services and addressing climate-related socioeconomic issues. The OPACEs address: (a) climate data management; (b) global and regional climate monitoring and assessment; (c) climate prediction, projection and delivery mechanisms; (d) User Interface for climate adaptation and risk management; and (e) capacity development. The Commission's working structures and experts now also include a cross-OPACE implementation coordination team on the Climate Services Information System, communications advisers, and a high level adviser on the Global Framework for Climate Services (GFCS). Congress noted that the Commission contributes to all GFCS components and welcomed the additional measures to strengthen CCl's ability to support GFCS implementation, including at country level, which Congress agreed remained a top CCl priority. In light of the emphasis that IBCS-2 put on the need to strengthen technical inputs to the GFCS including through strengthened linkages with WMO Technical Commissions, Congress encouraged the GFCS to take the fullest advantage of CCl capabilities. Details about CCl's work can be found at http://www.wmo.int/pages/prog/wcp/ccl/index_en.php.

2.5.40 Congress congratulated Ms Barbara Tapia (Chile) on her election during the sixteenth session of CCl as the first female vice-president in the history of the Commission. Congress further commended the Commission for having confirmed during the session the selection of most of the experts needed for its working structures based on input from Members, ensuring regional and gender balance as well as appropriate expertise.

2.5.41 Congress noted with satisfaction that key CCl accomplishments during the fifteenth intersessional period included, inter alia:

(a) Elaboration of a Climate Data Management Systems (CDMS) specification publication to ensure that CDMS's address the needs of NMHSs using them;

(b) Drafting definitions of National Climate Monitoring products so that Members' climate monitoring reports can be directly compared;

(c) Continued expansion of the global coverage of Regional and National Climate Outlook Forums (RCOFs/NCOFs) and National Climate Forums (NCFs) with new RCOFs initiated in the Caribbean, Mediterranean, South-East Asia, South-West Indian Ocean, East Asia, Gulf of Guinea, Arab Region, Sudano-Sahelian region and NCOFs/NCFs initiated in Mozambique, Belize, Maldives, Mexico, and Peru;

(d) Preparation of a guidance document on Climate Risk Management as a reference for NMHSs to consult when seeking to implement climate risk management at national level; and

(e) Publication of the third edition of the *Guide to Climatological Practices* (WMO-No. 100) in all UN languages.

2.5.42 Congress noted with satisfaction that since the fifteenth session of the CCl, four additional Regional Climate Centres (RCCs)/RCC-Networks had been reviewed and recommended for formal designation by CCl and CBS. Of these, RCC Moscow (RA II) and the RCC Network (RA VI) were approved by EC-65 for inclusion in the *Manual on the Global Data-processing and Forecasting System* (GDPFS) (WMO-No. 485) in May 2013. In addition the RCC for Western South America hosted by CIIFEN (RA III) and the RCC for Africa hosted by ACMAD (RA I) were reviewed and recommended for formal designation by CCl and CBS in 2014. A number of RCC candidates have also commenced their demonstration phases to seek formal designation.

2.5.43 Congress thanked all the experts who participated in the four OPACEs during the CCl fifteenth intersessional period for their voluntary contributions of time and effort, and Members for facilitating the active participation of their experts in CCl activities. Congress appreciated the accomplishments of the various teams, and noted with satisfaction that much of the work was well documented including in peer-reviewed literature. Congress further appreciated that several CCl experts actively contributed as authors on the Intergovernmental Panel on Climate Change Fifth Assessment Report, helping to extend the experience and knowledge of the Commission globally.

2.5.44 More detailed information is provided under paragraphs 4.1.49–4.1.92 and 4.2.6.1–4.2.6.29.

Report by the co-presidents of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)

2.5.45 Congress was informed by the co-presidents of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), Mr Johan Stander and Dr Nadia Pinardi, that the fourth session of JCOMM was held in Yeosu, Republic of Korea from 28 to 31 May 2012.

2.5.46 Congress noted that JCOMM had reviewed and adopted the Executive Summary for the Revised JCOMM Strategy for 2013–2016 as given in Annex IV to the Abridged Final Report of

the Fourth Session of WMO/IOC JCOMM. Congress noted with appreciation that JCOMM had considered and based the Strategy on the priorities identified by the Sixteenth WMO Congress and twenty-sixth session of the Intergovernmental Oceanographic Commission (IOC) Assembly.

2.5.47 Congress further noted JCOMM's continuing development of the Strategy to deliver on JCOMM's long-term objectives (including maritime safety) by establishing key priorities for intersessional implementation: weather and ocean forecasting; Disaster and Risk Reduction; Global Framework for Climate Services (GFCS) implementation; WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS) implementation; and capacity development. Congress appreciated the JCOMM activity to conduct succession planning for the key positions in the Commission and its teams while considering gender and regional representation.

2.5.48 Congress noted with concern the continued risks to the sustainability of the implementation of elements of the global ocean observing system. Congress noted the good progress with regard to pilot activities such as the use of new satellite data telecommunication systems, Argo drifting floats, OceanSITES, technology developments, instrument intercomparisons, and impact studies. Congress expressed concerns that, other than the Voluntary Observing Ships (VOS) and drifting buoy components, the majority of the network depends on research funding rather than sustained network funding. Congress urged Members to consider sustained funding models.

2.5.49 Congress noted the progress in the implementation of the Worldwide Met-ocean Information and Warning Service (WWMIWS) as part of the Global Maritime Distress and Safety System, through the International Maritime Organization (IMO) resolution A.1051 (27) and reaffirmed the importance of internationally coordinated met-ocean information, forecasts and warning services. Congress noted in particular the close collaboration with IMO, the International Hydrographic Organization (IHO) and other relevant organizations in the area of maritime safety, particularly with reference to the production and maintenance of reference manuals, including the Joint IMO/WMO/IHO *Manual on Maritime Safety Information*, and encouraged Member States to continue to support JCOMM's work in this area.

2.5.50 Congress noted that the network of WMO-IOC Regional Marine Instrument Centres (RMICs), which comprised two centres for Regional Associations IV and II per last Congress decision through Resolution 9 (Cg-XVI), was used to provide regional support and training on ocean instrument best practices. The network continues to expand with the planned establishment of a third centre for RA I in Casablanca, Morocco. The Regional Marine Instrument Centre (RMIC) in China has offered assistance to others in establishing an RMIC.

2.5.51 Congress noted that progress was made with regard to the development of the JCOMM Marine Climate Data System (MCDS) in collaboration with the International Oceanographic Data and Information Exchange (IODE) Committee of the IOC. In particular, it is proposed that this Congress establish the first WMO-IOC Centre for Marine Meteorological and Oceanographic Climate data (CMOC) in Tianjin, China. CMOCs are expected to play a key role with regard to the integration of ocean climate data from various sources, including higher level quality control, and bias correction, and with regard to data rescue.

2.5.52 Congress noted JCOMM has also initiated efforts to improve the interoperability with WIS of the near real-time and delayed mode data sets of ocean observations, as well as of analysis and forecasting products. Congress noted JCOMM had established a Task Team for Integrated Marine Meteorological and Oceanographic Services within WIS (TT-MOWIS) to specifically address this interest. Congress commended JCOMM for the active implementation of recommendations from the JCOMM Pilot Project for WIGOS that were received at the Sixteenth World Meteorological Congress. Congress requested that JCOMM continue to actively work on ensuring data interoperability between WIS and the Ocean Data Portal (ODP) to improve accessibility for metocean data and information. Congress noted that continued active collaboration by JCOMM with WIGOS/WIS, including through the Intercommission Coordination Group (ICG)-WIGOS, was essential to success.

2.5.53 Congress noted the work of the Expert Team on Operational Ocean Forecasting (ETOOFS) supporting the achievements of JCOMM through the development of the Guide for Operational Ocean Forecasting Systems and the development of effective working relationships with GODAE OceanView to improve operational ocean forecasting. Congress noted with appreciation the outstanding support from the host countries, not only logistically, but also by volunteer scientists and technical experts involved in the meetings of different Expert Teams (ETs), Panels and Groups of the Commission.

2.5.54 Congress noted JCOMM had established a Task Team on Satellite Data Requirements (TT-SAT) to work closely with other satellite fora (within WMO, Integrated Observing Systems (IOS) and beyond) to identify data requirements and gaps in the observing system considering in situ and satellite data together. Congress encouraged this close collaboration to support improved metocean data, products and services.

2.5.55 Congress recalled Recommendation 4 of JCOMM-IV regarding marine environmental emergency response and welcomed the JCOMM initiative (through an ad hoc Task Team) to enhance the support given in the event of marine environmental emergencies. Congress welcomed the intention of the recommendation to broaden the range of environmental emergencies to which support may be provided, including those relating to radioactive releases both in the water column and the atmosphere and to other pollutants, whilst enhancing the support Members currently provide to other marine emergencies such as Search & Rescue. Congress also noted that effective response to marine environment emergencies may require elements of capacity development in some areas and close liaison with other bodies engaged in response tasks, such as the International Atomic Energy Authority (IAEA), IMO and others, to identify user perspectives and information requirements.

2.5.56 Congress noted the WMO *Manual on Marine Meteorological Services* (WMO-No. 558) supported by the WMO *Guide to Marine Meteorological Services* (WMO-No. 471) for the globally agreed procedures and process for marine meteorological services. Congress noted the ongoing work of JCOMM to review the Manual and Guide, and to provide up-to-date advice to the Joint IMO/IHO/WMO *Manual on Maritime Safety Information* (Joint Maritime Safety Information (MSI) to ensure the consistency along with the ongoing process for the review of WMO Technical Regulations (Resolution 26 (EC-64)). Congress agreed that the ongoing review and revision of WMO-No. 558 and its associated publication would greatly assist the Members to ensure consistent and streamlined service provision.

2.5.57 Congress, recalling the recommendation of Cg-XVI to all technical commissions to define competency requirements for their core job-tasks, welcomed the development of the WMO Marine Weather Forecaster (MWF) Competence Standards Framework. Congress noted that the MWF competencies proposed for adoption reflected the diversity present in the respective regional/national functions and priorities.

2.5.58 Congress noted with satisfaction the joint effort by JCOMM and the Commission for Agricultural Meteorology (CAgM), through the Joint JCOMM-CAgM Task Team on Weather, Climate and Fisheries (TT-WCF: http://www.jcomm.info/TT-WCF), to enhance understanding and capabilities in marine climatology/oceanography and their impact on ocean fisheries, particularly in the Pacific Island Countries (PICs).

2.5.59 Congress recalled the joint efforts of JCOMM and Commission for Hydrology (CHy) through the Coastal Inundation Forecasting Demonstration Project (CIFDP; http://www.jcomm.info/CIFDP), to demonstrate how integrated coastal inundation forecasting and warnings can be improved and effectively coordinated by the National Meteorological and Hydrological Services (NMHSs).

2.5.60 Congress noted the extensive partnerships JCOMM utilized in the design, development and delivery of capacity development activities and that, at JCOMM-4, JCOMM had adopted revised CD principles to guide their activities. These principles guide JCOMM to work closely with the WMO Education and Training Programme, the International Oceanographic Data and

Information Exchange (IODE) of IOC and take advantage of the tools and partnerships available through these organizations. Congress noted that capacity development activities had also successfully been organized for providing: (i) enhanced support to the implementation of the ocean observing systems, marine services, through enhanced partnerships; and (ii) training on ocean data use.

2.5.61 Congress noted that detailed information on the activities of JCOMM is reported under agenda items 3 and 4.

2.5.62 Congress acknowledged the kind offer of the Government of Indonesia to host the fifth session of JCOMM in 2017.

2.6 Report by the Chairperson of the Intergovernmental Board on Climate Services (agenda item 2.6)

2.6.1 Congress noted with appreciation the report by the Chairperson of the Intergovernmental Board on Climate Services (IBCS) including the summary of activities and achievements in the field, and the main outcomes of the first (IBCS-1) and second sessions (IBCS-2) of the IBCS.

2.6.2 The Chairperson underlined the significant progress and importance of the work done under the Global Framework for Climate Services (GFCS) during the intersessional period and expressed his appreciation to all those who had contributed to the achievements and successes of the GFCS.

2.6.3 The Chairperson noted that the Framework is being implemented over 2-, 6-, and 10-year time frames to facilitate review at the World Meteorological Congress sessions. The first two years are the start-up phase for establishing the Framework's infrastructure and for initiating and facilitating the establishment of coordination mechanisms for implementation of flagship projects and activities in the four priority areas to enable the development of a Proof of Concept. The Framework's implementation emphasizes strengthening institutional capacities needed for development of national capacities for co-design and co-production of climate services and their application in support of decision-making. Establishment of regional capacities through climate centres to support national institutional capacities is a major focus. During the second phase of implementation the Proof of Concept developed through the flagship projects will be replicated in other parts of the world to ensure worldwide improvements in climate services for the four priority areas by year 6. After agreeing on new priority areas there will be an extension of projects beyond the initial four priorities. Significant improvements in national climate service provider capabilities will be realized during this phase because the regional infrastructures will be in place for supporting the development of national capacities. After ten years of implementation, there will be improved climate services throughout the world, across all climate-sensitive sectors and across global, regional and national spatial scales. The improved provision of climate services will facilitate the reduction of society's vulnerability to climate-related hazards and the advancement of the key global development goals.

2.6.4 The Chairperson recalled that the GFCS is a major undertaking and that addressing the needs of the 70 countries identified as requiring support to enhance the production and application of climate services needs to be done in a strategic manner. Implementation of activities so far has shown the need for more resources than what has been made available to the GFCS, either directly to the GFCS Trust Fund or support to GFCS projects and activities as contained in the GFCS Implementation Plan and the Compendium of projects and activities. At the same time various actors are spending vast amounts of resources in support of climate-related activities in some of the countries that need support. For example, an exercise conducted as part of the GFCS Implementation Coordination Meeting held at the end of September 2014 identified in 16 countries alone, expenditure of more than 700 million dollars. Thus, key to the success of the GFCS is identification and linkage with the actors who are currently spending, or planning to spend, resources in support of climate-related activities to nurture effective partnerships at global and national levels. This would ensure that these activities integrate the priorities and needs under the

GFCS. However, to ensure that there is effective linkage with the various actors there is a need for resources to put in place an adequate infrastructure under the GFCS Office and to support the GFCS substructures.

2.6.5 Considering the importance of energy for development and particularly for the functioning of the four priority areas of the GFCS, and the current movement for the establishment of Sustainable Development Goals (SDGs), in replacement of the current Millennium Development Goals (MDGs), which include a specific global goal and targets on energy; the establishment of the Sustainable Energy for All initiative (SE4ALL) in 2011 by UN Secretary-General Ban Ki-moon, which is now a strong partnership involving more than 100 countries (including 85 developing countries); and the fact that energy systems and production of renewable energy are sensitive to weather and climate, energy is at the centre of interest of Members and partner organizations, meriting adoption as the next priority area of the GFCS. WMO should play an important role in energy undertakings at global level through the development and implementation of an Energy Exemplar.

2.6.6 The Chairperson conveyed to Congress the following recommendations of IBCS-2:

Recommendation 1: Considering the cost implications of the governance structure of the IBCS, to have ordinary plenary meetings of the IBCS only once in the intersessional period prior to WMO Congress sessions and for the Management Committee to meet once a year to provide advice, oversight and Management of implementation of the GFCS in the intersessional period.

Recommendation 2: In view of the need to establish and improve the relationship and interaction between the IBCS and the constituent bodies of WMO as well as substructures of partner organizations, to adopt the following arrangements:

(a) *Executive Council*: The IBCS Chair, with the Vice–Chairperson as alternate, unless they are EC members themselves, shall be invited to inform the WMO Executive Council at its sessions, on progress and requirements and needs of the IBCS. The IBCS Chairs shall extend an invitation to the Executive Council of WMO to designate a representative to attend IBCS sessions as well as the Management Committee sessions;

(b) *Regional Associations*: Regional associations shall invite the IBCS to their sessions, to inform the Associations on progress and requirements and needs of the IBCS for that specific Region as appropriate. The IBCS shall delegate the responsibility to a member of its Management Committee from that Region or to the Chairperson or Vice-Chair/Co-Vice-Chairs as appropriate;

(c) *Technical Commissions*: Technical commissions shall invite the IBCS to their sessions, to inform the Commissions on progress and requirements and needs of the IBCS as appropriate. The IBCS shall delegate the responsibility to a member of its Management Committee or to the Chairperson or Vice-Chair/Co-Vice-Chairs as appropriate. The Chairperson of the IBCS shall invite the presidents of the WMO Technical Commissions, as deemed appropriate, to attend the IBCS as well as the Management Committee sessions;

(d) *Relevant WMO Commissions and Programmes*: Relevant WMO Commissions and Programmes should, if they have not done so, identify a GFCS Liaison, as the Commission for Climatology has already done. These individuals can report through the technical commission management groups on ways to better align technical commission operating plans with GFCS activities and, conversely, inform IBCS of relevant technical commission activities that support the GFCS;

(e) *WMO:* The WMO should reach out to partner's technical commissions or equivalent, as needed, for input into Partner Advisory Committee activities. WMO should also submit

relevant activities as GFCS contributions via the existing process(es) established for other Members and partners.

Recommendation 3: Based on the specific GFCS requirements for 2015–2018, invite Congress to consider the proposal of the Secretary-General:

(a) For the WMO regular budget for the financial period 2016–2019 in particular for the governance and GFCS Office;

(b) The WMO Compendium of projects for the same period to be funded through voluntary contributions.

Recommendation 4: Given the importance of energy for global sustainable development, including in the four priority areas of the GFCS, and the potential of GFCS to contribute to improved energy-related outcomes, in terms of promotion of renewable energy sources and through protection of energy infrastructure and delivery systems, to adopt energy as the next priority area of the GFCS.

Recommendation 5: Recognizing that the GFCS is a new concept to Members and partners, who require guidance and successful examples of implementation to embrace it, to focus GFCS implementation in its initial stages on developing specific projects under the priority areas to develop a Proof of Concept which could be replicated. Experiences from implementation should support the development of guidelines to support implementation by Members and partners.

2.6.7 Congress considered the recommendations of the IBCS as contained in the report of the Chairperson of the IBCS and made decisions and further discussed WMO's contribution to the GFCS more broadly under agenda item 8.

3. IMPROVING SERVICE QUALITY AND SERVICE DELIVERY (agenda item 3)

3.1 Service delivery (agenda item 3.1)

"The WMO Strategy for Service Delivery"

3.1.1 Congress recalled that the WMO Strategic Plan for the period 2016–2019 had recognized "Improved service quality and service delivery" as an Expected Result for the Organization. This Expected Result is aimed at improving the operational, end-to-end framework for NMHSs to translate leading-edge science into information that is actionable and easy to interpret by different sectors of society. The Plan highlighted the fact that it is through effective and timely delivery of services that users derive a high level of return on NMHSs' investment in basic infrastructure (such as observing systems, modelling, communications and human resources) and that nations derive a high level of return on their investments in National Meteorological and Hydrological Services (NMHSs). Congress emphasized the value of NMHSs continuing to strengthen relations with the media and other key partners in reaching end users. Congress therefore recognized Service Delivery as the core business of NMHSs, that is, providing essential meteorological, hydrological and related environmental services and information to communities, for the purpose of saving lives and livelihoods, and for improving the quality of life as well as enhancing national economies.

3.1.2 Congress recalled that during its sixteenth session, it had approved The WMO Strategy for Service Delivery (herein referred to as "the Strategy") to guide all activities and programmes of the Organization. Congress further recalled that, in approving the Strategy, it had also requested the preparation of an implementation plan to guide Members' efforts in implementing the Strategy at the national level. It therefore expressed appreciation that the Executive Council had approved the Implementation Plan at its sixty-fifth session. Congress noted with satisfaction that the "WMO Strategy for Service Delivery and its Implementation Plan" had been published (WMO-No. 1129) and that the publication was publicly available online at the WMO library website, as well as in hard

copies. In line with its recognition of the importance of Service Delivery, Congress strongly encouraged Members to implement the Strategy, using the Implementation Plan, with a view to improving the quality and delivery of the services they provide to the public. In this regard, Congress adopted Resolution 2 (Cg-17) – Implementation of the WMO Strategy for Service Delivery.

The Implementation Plan of the Strategy

3.1.3 Congress noted that the Implementation Plan for the Strategy had been developed to guide service providers in improving the quality and usefulness of meteorological and hydrological services. It further noted that the Implementation Plan outlines an approach that advises NMHSs on how to convert users' growing awareness of the importance of high-quality service delivery into action. It recognized the Service Delivery Progress Model (SDPM), as a practical tool of the Implementation Plan, aimed at enabling NMHSs improve their respective levels of Service Delivery. Congress adopted the Implementation Plan as approved by EC-65, and strongly encouraged its use by Members. In this respect, Congress recognized the key role of the PWS programme in establishing a well-defined pathway in service delivery and the value of NMHSs having a focused suite of channels for effectively reaching the community. Congress recognized the value of the past regional training seminars on service delivery and requested that similar events be organized in the next financial period. It further encouraged WMO constituent bodies to initiate, support and monitor the progress of Members in improving the quality of their service delivery (ref.: paragraphs 3.1.34–3.1.62). Congress requested the Secretary-General to facilitate and monitor the implementation of the Strategy for Service Delivery.

Service delivery through Impact-Based Forecasting and Risk-Based Warning

3.1.4 Congress recognized that understanding disaster risk and forecasting hydrometeorological impacts is generally beyond the remit of meteorologists and hydrologists and that the complexity of issues related to impact-based forecasting and risk-based warning requires planning and forging of partnerships at many levels and with many other government agencies, scientific institutions and stakeholders. It noted that the Executive Council had discussed this issue in the provision of public weather and warning services in support of social and economic resilience, and that the Commission for Basic Systems (CBS), at its extraordinary session (CBS-Ext.(2014), September 2014) had approved a set of guidelines for Members on this subject (ref.: paragraphs 3.1.34–3.1.62).

3.1.5 Congress agreed that in order to implement impact-based forecasting and risk-based warning successfully, it was necessary for Members to include these practices in future modernization programmes, to develop new skills in NMHSs and other involved institutions, to develop effective partnerships among a diverse group of stakeholders providing the necessary information for impact-based forecasting, to cross-train staff of NMHSs and emergency responders, and to develop operational pilot projects as a basis of developing national and regional capacities to institute these practices. Congress requested the Secretary-General to provide assistance as required to Members in their efforts to move towards impact-based and user-tailored forecasting and risk-based warning practices.

Service Delivery for Megacities and Large Urban Complexes

3.1.6 In relation to densely populated and complex urban environments, Congress acknowledged the need for climate, weather and environmental services in order for megacities and large urban complexes to be resilient in withstanding environmental hazards. It agreed that NMHS services to megacities and large urban complexes needed to deliver user-relevant services with targeted improvements in communication and client relations through a robust multi-channel system of dissemination and communication of information to all partners and the public. In this context, Congress welcomed the work of the PWS Programme to address these challenges, including contribution to a set of guidelines for establishing weather, climate, water and related environmental services for megacities and large urban complexes. It supported the request by

EC-66 that service delivery for megacities and large urban complexes be given focused consideration, alongside research activities (ref.: agenda item 9.8).

Service Delivery for Health

3.1.7 Congress noted that weather and climate are inextricably linked to some of the most fundamental determinants of health: air, water, food, shelter and disease. Many people are incapacitated, at a huge cost to society and economy, by indirect effects of weather and climate events and their relationship with vector and water-borne diseases. Hence there is a need for NMHSs to provide weather and climate services for application to the health sector. Congress noted with appreciation that the PWS Programme had successfully implemented several projects, including in Madagascar, to demonstrate the application of weather and climate information in the health sector. This was done through the establishment of "Weather, Climate and Health Working Groups", which brought together meteorological and public health experts, and also provided training and materials to the staff of NMHSs to produce and provide services to the health community for application in responding to specific diseases (ref.: paragraphs 3.1.34–3.1.62). Congress welcomed the establishment of a joint WMO-WHO office under GFCS to provide focus for the work of WMO in the area of health and meteorology and agreed that a coordinated approach be adopted among all the activities of various programmes which promote and contribute to the services provided to the health sector.

Service Delivery for Energy

3.1.8 Congress noted that for most NMHSs the energy sector was a relatively new market. Meteorological information is needed for the efficient operation of utility companies, energy management and saving, as well as for the generation of renewable energies such as hydro-power, wind, solar and marine-based power and the siting of the power plants built and in daily energy generation. Congress requested Members to consider including this important sector as recipient of the range of services that they provide.

Service Delivery for Water

3.1.9 Congress noted that service delivery in the context of water management encompasses the entire suite of WMO thematic responsibilities: weather services, climate services, and hydrological services. Effective water management is critically dependent upon extensive and widely available data and products from all three sectors, as well as on point forecast products having quantified uncertainty. There is also a growing need for information such as comprehensive water resource and related assessments, statistics of precipitation, flood and drought events, as well as meaningful assessments of spatial and temporal trends in surface-water and in ground water quantity and quality. Towards this end, the Commission for Hydrology (CHy) is developing a manual on downscaling of climate models for hydrological applications to assist National Hydrological Services in applying the methodology for hydrological applications. Given the specific needs of water management, weather, climate and hydrological services should ensure that the uncertainties intrinsic to their data and forecasts are understood and quantified. Congress agreed that, in general, the practices and procedures in service delivery are applicable across all weather-, climate and water-related services.

Climate Service Delivery

3.1.10 Congress was pleased to note the progress that had been achieved in providing guidance for climate services delivery through WMO contributions to the GFCS, in particular, through the Climate Services Information System (CSIS) pillar of the GFCS. Congress recalled that, through Resolution 17 (Cg-XVI), it had established the CSIS with global, regional and national entities providing operational climate information, including data, monitoring and prediction products within the GFCS, and decided that the implementation of CSIS should be guided by the Commission for Climatology (CCl) in close collaboration with CBS. Congress noted that CCl, keeping in view the importance of the implementation of CSIS to its work, and the Congress decision, had established, in the fifteenth intersessional period, a dedicated Expert Team on CSIS.

CSIS is being designed to routinely generate climate information, including data, diagnostics, assessments, monitoring, climate watches, predictions, projections, etc., that users need for a broad range of climate sensitive decisions at different levels.

3.1.11 Congress noted that EC-64 had requested CCl to scope out the development of a CSIS Technical Reference Manual, building on the existing WMO Manuals and Guides (e.g., Manuals on Global Observing System (GOS), Global Data-Processing and Forecasting System (GDPFS), WMO Information System (WIS), Global Climate Observing System (GCOS), climate monitoring principles, the WMO Strategy for Service Delivery, etc.). The CSIS Manual will therefore also define the interfaces that facilitate the flow of information, interactions and support linkages with other GFCS pillars. Congress agreed that the real success of CSIS implementation will depend on the effective operation of the CSIS entities at the national level. It therefore supported the CCl decision to establish national focal points to facilitate communication between the global, regional and national entities of the CSIS, and also to coordinate CSIS operations within the country.

Gender-sensitive Service Delivery

3.1.12 Congress noted that the International Conference on the Gender Dimensions of Weather and Climate Services, had been held in Geneva from 5–7 November 2014. The Conference had focused on four main areas of disaster risk reduction, public health, water resources management, and agriculture and food security, which are all highly weather- and climate-sensitive, and addressed the interaction of gender with weather and climate services in these four areas. A main message from the Conference was that to be effective, weather and climate information services needed to meet the needs of women as well as men, who can be affected differently by weather and climate, and can provide, access and use weather and climate information differently. Weather and climate services therefore, need to be designed and communicated in a gender-sensitive manner. Congress further noted that the Conference had guided the development of recommendations to facilitate incorporation of gender and weather and climate services into the work of United Nations agencies, civil society, regional, and local authorities, and the private sector. The Conference also recommended strategies to empower women to participate in the career opportunities available nationally and internationally in science, technology, engineering and mathematics (STEM) (ref.: agenda item 7.8). Congress welcomed the recommendations that resulted from the Conference and strongly encouraged Members to implement those recommendations in the work of NMHSs as a means of ensuring that the society as a whole benefited from the services that they provided.

Aeronautical Meteorology – Priority

3.1.13 Congress acknowledged that the activities under the Aeronautical Meteorology Programme (AeMP) during the intersessional period were guided by the following agreed priorities: support to Members in the implementation of the ICAO and WMO requirements for QMS and competence; development of proposals for meteorological services to Air Traffic Management (ATM); improvement of SIGMET provision and resolution of long-standing deficiencies; and development of proposals to mitigate the impacts of large-scale, high-impact events such as volcanic ash (VA), nuclear emergencies and space weather. Congress recognized that, as one of the constitutional purposes of the Organization, furthering the application of meteorology to aviation will become ever more important in the next 10 to 15 years during which time substantial changes will happen in all areas of air navigation services in response to the significant growth of air traffic, rigorous requirements for reducing environmental impacts of aviation, and the need to increase efficiency of air traffic operations whilst maintaining the highest standards of flight safety. Therefore, Congress agreed that the AeMP should strive to maintain the WMO role in the development of effective methods for the provision of meteorological services to aviation, in partnership with ICAO and other aviation stakeholders (further discussion under agenda item 9.2).

Progress in the implementation of QMS

3.1.14 Congress appreciated the significant progress made by Members during the intersessional period in achieving compliance with the ICAO and WMO requirements for the

establishment of a quality management system (QMS) for the provision of aeronautical meteorological service. It was recalled that, as of 15 November 2012, the QMS requirement became a standard practice, supplemented by a set of recommendations on the conformity of the QMS with the International Organization for Standardization (ISO) 9000 series of quality assurance standards.

3.1.15 Congress commended the CAeM and its task team on QMS (TT-QMS) for the substantial assistance provided to Members in the implementation of the QMS requirements. Thanks to a concerted effort involving TT-QMS, the Secretariat, a number of Members with advanced expertise in QMS, and partner international organizations, the attained level of compliance with the QMS requirements at the end of the intersessional period reached 110 Members whose aeronautical meteorological service providers (AMSP) have implemented a QMS. Moreover, the majority of those Members had also obtained the recommended ISO 9001:2008 certification.

3.1.16 Congress considered the implementation of QMS for the aeronautical meteorological services as a good showcase of a well guided and closely monitored implementation of the WMO technical regulations, supported by appropriate capacity development actions. Congress recognized that the QMS brought tangible benefits to the NMHSs and other AMSPs through optimized processes and procedures, accountability and continuous improvement culture. Congress noted further that the ISO 9000 certification requires a continuous resource-consuming maintenance effort through regular checks and re-certification audits. In this regard, Congress emphasized the link between the sustainability of the QMS and the cost recovery, in particular, for the developing and least developed countries.

3.1.17 Noting that there were still a number of Members that had been unable to reach the required level of compliance with the QMS requirements and that such a situation was classified as a serious deficiency against the ICAO requirements, Congress requested the Secretariat to analyse the reasons for all those cases, in particular the Members where the implementation had not yet been started. Congress reaffirmed its strong encouragement to all Members to complete and sustain the QMS for the provision of meteorological service to aviation and requested the Secretary-General, supported by the CAeM, to continue to provide assistance to the Members in need. Recognizing the effective use of the twinning and coaching arrangements between Members, Congress strongly recommended further utilization of these approaches on bi-lateral and multilateral bases.

Implementation of competency standards for aeronautical meteorological personnel

3.1.18 Congress recalled that during the intersessional period, the provisions of the WMO *Technical Regulations* (WMO-No. 49, Volume I, Chapter 5) concerning the required competency of aeronautical meteorological personnel (AMP, including aeronautical meteorological forecasters (AMF) and aeronautical meteorological observers (AMO)), became standard practices as of 1 December 2013. Consequently, all Members were expected to undertake the necessary measures to ensure compliance with those standards and inform the Secretariat thereof.

3.1.19 Congress appreciated the development of underpinning guidance material on the implementation of the competency requirements by the CAeM Expert Team on Education, Training and Competencies (ET-ETC) well in advance of the applicability date, which was made accessible online (http://www.wmo.int/aemp/?q=implementation_areas and http://www.caem.wmo.int/moodle). In addition, an extensive training programme had been developed and implemented by the CAeM, together with the Secretariat and active support by a number of Members, which resulted in more than 10 training workshops in all WMO Regions during the intersessional period and more than 280 experts trained as competency assessors.

3.1.20 Congress noted that the Secretariat has been monitoring the status of implementation of the competency standards through various means and communication channels. Recognizing that the competency assessment was a time- and resource-consuming task, Congress encouraged all Members who have not completed their competency assessment programmes for

the AMP, to do so as soon as possible and report to the Secretariat on the achieved level of compliance. Congress further emphasized that such programmes should be an integral part of a continuous career development process to ensure that operational aeronautical meteorological personnel remain fully competent and able to demonstrate compliance with user demands for quality and performance of the service. Congress requested the Secretariat to maintain the rigorous tracking and reporting practices with regular reports to the Executive Council on the attained compliance by Members, related deficiencies and capacity development needs. Congress further requested the CAeM to continue its efforts in assisting Members' implementation and maintenance of the AMP competency standards through appropriate guidance and training activities based on an ongoing analysis of prioritized needs by the regional associations.

Qualification standards

3.1.21 Congress recalled that the qualification requirements for AMF in the WMO Technical Regulations will become a standard practice on 1 December 2016. Consequently, Members will be required to ensure that the level of qualification of the operational AMF personnel follows the WMO qualification standard, i.e., to be compliant with the relevant sections of the Basic Instruction Package for Meteorologist (BIP-M), and inform the Secretariat thereof.

3.1.22 Congress urged Members to initiate preparation for compliance with the qualification requirements in due time in order to avoid a big lag between the applicability date and actual implementation. Such preparation would require an assessment of the qualification records of existing operational AMF, job descriptions, and consultation with relevant educational institutions to ensure the conformity of their curricula and training programmes with the WMO BIP-M. In instances of identified gaps in the qualification of existing AMF personnel, Members should arrange for appropriate training, where necessary in consultation with the relevant training institutions. Congress appreciated the information shared by the United Republic of Tanzania about their approach to validate that the curricula and training programmes of the University of Dar es Salaam (UDSM), University of Pretoria (UP) and Tanzania National Training Centre (NMTC) are in conformity with the WMO BIP-M. Congress agreed that the Regional Training Centres (RTC) could be instrumental in this process by providing focused training courses on such components of the BIP-M for which there is a regional demand. Congress requested the CAeM and its ET-ETC, in coordination with the Education and Training Programme, to develop and make available clear guidance on the necessary steps to be undertaken by Members and the relevant training institutions in order to facilitate national and regional implementation actions including Members' resource planning.

Meteorological services to air traffic management (ATM)

3.1.23 Congress appreciated the work done by the CAeM Expert Teams, in close cooperation with the relevant bodies of ICAO, on the development of advanced products and services to support ATM, including meteorological services for the terminal area (MSTA) and for trajectory based operations (TBO). Considerable effort has been done to strengthen the consultation with representatives of the user groups, in view of the evolving user requirements expressed in regional ATM modernization projects, such as NextGen (USA), CARATS (Japan) and SESAR (Europe). The former CAeM Expert Team on Meteorological Services for ATM and Meteorological Information Exchange (ET-M&M) had a major task to provide an overview of the current and foreseen meteorological capabilities in support to ATM, associated with comprehensive information on verification techniques and results that could help understand the current skill in forecasting high-impact weather. ET-M&M also contributed to the development of a MET Information Integration for the TBO Concept and Roadmap that was considered by the Conjoint ICAO/WMO MET Divisional Meeting (July 2014). Congress requested the CAeM and its Expert Team on Information and Services for Aviation (ET-ISA) to continue its work on the development of advanced methods and services in support of ATM envisaged in the Global Air Navigation Plan (GANP) and Aviation System Block Upgrades (ASBU), in collaboration with CBS and CAS, and to provide experts to work closely with the relevant bodies of ICAO in the development of respective provisions and guidance material.

Aeronautical meteorological information exchange

3.1.24 Congress noted the cooperation between CAeM and CBS through the CBS OPAG-ISS Task Team on the Aviation XML (TT-AvXML). The Task Team had developed XML/GML representations of METAR/SPECI, TAF and SIGMET, to be known collectively as ICAO meteorological information exchange model (IWXXM), together with a mechanism for combining several reports into one message. Congress noted further that in the next intersessional period, ICAO planned to move to the use of XML/GML for the exchange of operational aeronautical meteorological information; such an exchange would be a major step towards the realization of the GANP objectives for a 'data-centric' rather than 'product-centric' information delivery model based on a digital exchange envisaged by the ICAO System-Wide Information Management (SWIM). The logical data models supporting IWXXM contain components that describe the basic meteorological information (primarily WMO's area of expertise), and others that govern how that information is applied for international air navigation purposes (primarily ICAO's area of expertise). Although WMO had taken the lead in developing IWXXM, the governance responsibilities for further development and maintenance of the components of IWXXM should be defined so that each component would be managed by the appropriate organization. Noting that such arrangements should be a distributed responsibility between WMO and ICAO, Congress recommended that this issue should be properly addressed in the forthcoming review and amendment of the Working Arrangements between WMO and ICAO. Noting concerns expressed by some Members related to the need to develop their technical capacity for applying the new requirements, Congress encouraged the CAeM and the regional associations to work towards development of migration plans in close cooperation with respective ICAO regional bodies in order to ensure a harmonized and synchronized implementation process.

3.1.25 Congress recognized that WMO would need to work strategically with ICAO to ensure that Members continued to be able to meet the needs of international civil aviation, most notably: the standards used in WIS and SWIM would need to be interoperable, and so WIS experts should participate in the design and specification of the SWIM; to ensure that the benefits that international civil aviation currently derives from the authoritative source of fit-for-purpose information and the additional knowledge applied during the creation of products would be retained under the data-centric approach; and to identify and implement standards needed to ensure that end users, such as pilots, were able to use the information effectively when making their decisions.

Volcanic ash

3.1.26 Congress recognized that widespread and prolonged disruptions of international air navigation caused by the eruptions of volcanoes in different part of the world had resulted in significant pressure placed by the aviation industry on the aviation meteorology community and particularly on the nine Volcanic Ash Advisory Centres (VAACs), hosted by WMO Members. There had been a strong demand for the provision of enhanced levels of volcanic ash information, to allow users to make informed decisions on their operations without compromising the safety.

3.1.27 Congress was pleased to recognize the scientific contributions of the Volcanic Ash Scientific Advisory Group (VASAG) co-sponsored by the WMO and the International Union of Geodesy and Geophysics (IUGG). Assisted by the VASAG, WMO had provided inputs to the 'ICAO Roadmap for IAVW in Support of International Air Navigation' for consideration by the Conjoint ICAO/WMO MET Divisional Meeting (July 2014) which would be the basis for further development of the International Airways Volcano Watch (IAVW).

3.1.28 Congress expressed appreciation to Members providing experts to the WMO/IUGG VASAG, who had not only provided excellent scientific inputs into the ICAO processes, but were so far practically unfunded by WMO. Given the evolving nature of volcanic ash science pulled through into operations, Congress agreed on the need for the continuation of the VASAG work with updated terms of reference and requested the Executive Council to consider to re-establish the group, in accordance with the working arrangements between WMO and IUGG (WMO-No. 60, Working Arrangements with the International Union of Geodesy and Geophysics).

Nuclear emergencies

3.1.29 Congress noted that in the aftermath of the Fukushima nuclear accident, significant work has been done to improve the provision of SIGMET for radioactive clouds. Issues related to the operational access to near real-time at-source monitoring information, through the International Atomic Energy Agency (IAEA), and near-source atmospheric data, in particular wind information needed for the dispersion models, remained high priority. WMO had provided inputs to the draft 'ICAO Concept of Operations for Radioactive Material Information Services' considered by the Conjoint ICAO/WMO MET Divisional Meeting and will work with ICAO to develop further provisions for information on the release of radioactive material in the atmosphere, consistent with the GANP and ASBU, and taking into consideration the tasks, structure and capabilities of the WMO Regional Specialized Meteorological Centres (RSMC) for the provision of transport model products for environmental emergency responses.

MET deficiencies, governance, cost recovery and business model issues

3.1.30 Congress expressed concern that some deficiencies in the provision of aeronautical meteorological service persisted despite the efforts to resolve them. Among those deficiencies, the inadequate provision of SIGMET information by some Members was a major safety concern. Congress noted that a new approach to overcome the limited capabilities of such Members to provide effective SIGMET service was discussed by the Conjoint ICAO/WMO MET Divisional Meeting and a proposal for a regionalization of the SIGMET provision in such areas was to be further developed in the ASBU framework (further discussion under agenda item 9.2).

3.1.31 Congress noted that lack of adequate cost-recovery for the provision of meteorological service to aviation continued to be an issue for many Members. Congress appreciated that several VCP-funded projects have been carried out in Region I and Region II in an attempt to promote the best practices in cost recovery and establish the needed national agreement between the stakeholders, following the relevant ICAO and WMO guidance. It was expected that more requests for such projects would be coming from Members in the near future. Development of an appropriate cost recovery mechanism for those Members with low traffic volumes (i.e., the SIDS), with due consideration of the specifics of the flight operations, should also be considered. Congress encouraged Members to share experience with existing different cost recovery mechanisms and requested the CAeM through its Expert Team on Governance, supported by the Secretariat, to continue their effort in advising and assisting the NMHSs of developing countries to establish cost recovery mechanisms, and enhance the related guidance material provided in the *Guide to aeronautical meteorological services cost recovery: principles and guidance* (WMO-No.904). Congress recommended further that Members should conduct analysis of existing business models for the provision of meteorological services to aviation in view of the evolving requirements for air navigation services and bring the results of such analysis to the attention of the respective civil aviation administrations and governing structures in order to ensure support for the current and future aeronautical meteorological activities.

3.1.32 Congress noted that in an increasing number of Members, the meteorological services for aviation are provided outside the NMHSs by different entities, including private sector providers. Congress noted further that the expansion of the private sector in the provision of aeronautical meteorological services may have a negative impact not only on the capabilities of NMHSs to provide services to aviation, but also to the sustainability of their basic infrastructure. Therefore, Congress recommended that the related issue of cost-recovery should be approached from a risk management perspective and that such risk analysis should be conducted during the intersessional period to evaluate the impacts on Members and their NMHSs. Congress requested the president of CAeM to coordinate related activities and provide guidance to interested Members.

Future of the Aeronautical Meteorology Programme

3.1.33 Considering the numerous challenges facing Members in the provision of aeronautical meteorological service and its further development in the coming 10 to 15 years, Congress agreed that the Aeronautical Meteorology Programme should continue to be a priority area and be suitably

resourced to meet the Members' needs for guidance and advice. Congress also agreed with the proposed amendments to the AeMP description as given in Annex III to the present report, including its long-term objectives, purpose and scope, governances and priorities, and adopted Resolution 3 (Cg-17) – Aeronautical Meteorology Programme.

Public Weather Services

3.1.34 Congress recognized that over the last two decades, the Public Weather Services (PWS) Programme had assisted many National Meteorological and Hydrological Services (NMHSs) through hundreds of training activities; facilitating the work of numerous experts who have produced dozens of guidelines and reports, and the implementation of projects to create dialogue and promote partnerships between the user communities and producers of meteorological information. This had acted as a catalyst in the formation of the International Association of Broadcast Meteorology to create a focus for closer collaboration between WMO and the international broadcast meteorology community. Congress noted that the PWS Programme had been successfully implemented during the sixteenth financial period according to the WMO Strategic Plan. Congress emphasized that the core business of NMHSs was to serve the public good by providing essential and reliable weather, climate and related environmental information to the community at large and noted that some Members reported fewer fatalities following recent severe weather events, attributing this to improved communication of warning messages. While NMHSs face many challenges, such as funding, maintenance of observational networks, widely available alternative services from well-resourced private sector providers, staffing, evolving technology and pressure to provide an ever increasing range of better services to larger populations in urban areas, dependable, useable, credible and available public weather services are the most visible part of the work of NMHSs, and contribute significantly to their credibility in facing these challenges. Congress firmly believed that it was primarily through the timely and effective delivery of PWS that governments recognized the value of NMHSs and realized a high level of return on their investments in NMHSs.

3.1.35 Congress acknowledged that the PWS Programme had contributed to the achievement of WMO Expected Result (ER) 1, by focusing on users and their requirements and striving to respond to those requirements. Assisting NMHSs to develop capacities for the continual improvement of quality in the delivery of weather and related environmental services to user communities, and in particular to the public, is the underpinning of the PWS Programme. Congress supported the strengthened focus of the PWS Programme on advocating a collaborative approach with partners whereby the meteorological community could benefit from the skills and experiences of other agencies. Congress requested that this focus be further reinforced to enable full realization of potential benefits of national PWS activities, particularly in developing and Least Developed Countries (LDCs).

The Implementation Plan of the WMO Strategy for Service Delivery

3.1.36 Congress recalled that following the adoption by Cg-XVI of The WMO Strategy for Service Delivery (herein referred to as "The Strategy"), the Implementation Plan for the Strategy had been approved by the sixty-fifth session of the Executive Council, and that the Strategy and its Implementation Plan had since been published and publicly available online: (http://library.wmo.int/opac/index.php?lvl=notice_display&id=16002#.VL9j2EfF_yE). It recognized that the principles and methodologies contained in the WMO Strategy for Service Delivery and its Implementation Plan (WMO-No. 1129) were applicable to all WMO Programmes and activities, and, in particular, to the PWS Programme, whose mandate focuses on excellence in the provision and delivery of services to a diverse spectrum of users. Congress requested that in fulfilling its mandate, the PWS Programme continue to apply the guidance provided in the Implementation Plan of the Strategy, thus ensuring a coordinated and pragmatic approach to service delivery.

3.1.37 Congress supported the follow-up actions taken by the PWS Programme in the implementation of the Strategy, including conducting a survey, as required in the Implementation Plan, among Members to help them assess their current levels of service delivery against those described in the Plan, leading to the identification of actions required to move from their current

level to higher levels of service delivery. The result of the survey should enable the Secretariat to determine the training and capacity development activities and resources that would be required in assisting Members.

3.1.38 Congress noted the work of the PWS Programme with regard to implementing the Strategy, by organizing seminars for the senior management of NMHSs in regional associations RA I (Africa), RA IV (North America, Central America and the Caribbean) and RA V (South-West Pacific) to familiarize them with the Strategy and its Implementation Plan, and recognized the need to extend this effort to the remaining regional associations. It emphasized the need for a coordinated approach to implementing the Strategy in several important areas, such as impact-based forecasting, health, agriculture and food security, land transportation and services to megacities and large urban complexes. Congress requested the Secretary-General to organize country-specific training for NMHSs and to implement pilot projects, within available resources, to further assist Members with the implementation of these activities.

Challenges and Opportunities for PWS delivery

3.1.39 Congress acknowledged that advances in technology and communications have revolutionized the way environmental information is being collected, integrated, disseminated and shared. These advances have pushed the expectations of users to such levels that they expect the information to be delivered to them when they want it, where they want it, and in their preferred formats customized to their needs. Furthermore, the proliferation of weather information from various sources on the Internet, media and social networks also pose significant challenges to the NMHSs in delivering consistent authoritative forecast and warning messages to members of the public, especially during extreme weather situations. To respond to these expectations, a number of NMHSs have already moved to multi-channel delivery methods, using interactive push technologies and customized services. It is expected that many more will follow suit in order to further improve timely access to information. Dissemination of information has also evolved at a rapid pace, and sophisticated graphical formats have been created for better visual displays of forecasts. The emergence of the Global Positioning System (GPS), smart phones and automated alerting systems means seamless ingestion of data and display of graphical weather forecasts and warnings, and allows the provision of location-specific and tailored weather information for travelling public. Congress agreed that these developments presented challenges, but also opportunities to NMHSs, particularly with respect to delivery of time-sensitive warning information in a manner that protects the public. The main challenge would be the optimum use of technology in the provision of weather information in ways that will fully satisfy the users. Opportunities are afforded in the availability of solutions on various platforms and degrees of automation to facilitate the continuous availability of public forecasts and warnings, including mobile applications and social networks. Congress called on Members to embrace these opportunities so as to enable their NMHSs to provide the best possible consistent and authoritative weather information and services to users, and to share best practices. Congress also agreed that increased efforts in communication and public education by NMHSs will be essential to ensure that the public receives and understands the authoritative weather information and warning messages issued by NMHSs for taking timely and appropriate actions. Congress requested that CBS investigates how the efforts of Members in applying these technologies could be coordinated in order to achieve interoperable approaches.

3.1.40 Congress agreed that the biggest impact on the nature, range and delivery of PWS over the next few decades would probably be on services related to food production and water resource management, and that NMHSs would increasingly be expected to support governments in the sustainable use of scarce resources, such as water and energy. Congress emphasized that the successful evolution of NMHSs would depend on the degree of their engagement with partners, citizens and clients since as primary conduits of weather and related information, they would have to provide a variety of new products and services that would inform sound decision and policy-making at the local, national, and international levels. To be effective and to remain relevant, Congress urged Members to monitor and recognize the evolution of user needs, means and capabilities and to integrate improved science, new technologies and applications to expand decision support services.

Implementation of the PWS Programme

3.1.41 Congress endorsed the areas of principal focus of the PWS Programme, which follow the PWS strategic objectives, are in accordance with the WMO Strategic Plan, and are based on the challenges and opportunities for PWS delivery (see paragraphs 3.1.39 and 3.1.40 above), as well as Members' requirements as indicated through the Executive Council, regional associations and technical commissions, in particular, the Commission for Basic Systems (CBS). These include: excellence in end-to-end service delivery; Multi-Hazard Impact-based Services; enhancement of economic and social well-being; capacity development; dissemination and communication of multi-hazard warnings for an effective early warning systems (EWS); and communications, public education and media skills.

Delivery of Impact-based Forecasts and Warnings

3.1.42 Congress acknowledged that each year the impacts of severe hydrometeorological hazards cause multiple casualties as well as significant loss and damage to property and infrastructure. These hazards have adverse economic consequence for communities, in spite of the fact that many of these severe events had been well forecast, with accurate warning information disseminated by the responsible NMHSs. The reasons for this apparent disconnect lie in the gap between forecasts and warnings of hydrometeorological events and an understanding of their potential impacts, both by the authorities responsible for civil protection/emergency management and by the population at large. Closing this gap, and improving the understanding of the potential impacts of severe hydrometeorological events poses a challenge to NMHSs and their partner agencies, particularly Disaster Reduction and Civil Protection Agencies (DRCPAs). Progressing from weather forecasts and warnings to multi-hazard impact-based forecast and warning services represents a paradigm shift in service delivery for many NMHSs, but a necessary step to enable those at risk take appropriate action to avoid harm. Congress agreed that historically, all NMHSs have featured forecasting of the weather as central to their mission, and most also issue weather warnings in the case where hazardous weather is expected. In the case of both weather forecasts and warnings, the focus is on what the weather will be. It is now advocated that this weather-based paradigm evolve to one, which is focused primarily on forecasting impacts. In other words, the focus should evolve to what the weather will do. Impact-based forecasts and warnings should be accurate and understandable and be delivered in a timely manner.

3.1.43 Congress recognized the merit of advancing toward this paradigm shift, despite the complexity of impact-based forecasting and risk-based warnings, and supported the outcome of discussions at EC-66 on this approach. It welcomed the preparation of the *WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services* by PWS experts and its publication following approval by the extraordinary session of CBS (CBS-Ext.(2014)). Congress encouraged the use of these Guidelines by Members in the preparation in moving towards impact-based practices in their respective NMHSs.

3.1.44 Congress welcomed the initiative by the PWS Programme to launch a pilot project in Mozambique on the implementation of impact-based forecasting and warning to test the application of principles contained in the Guidelines. The project will focus on developing effective partnerships among various stakeholders; collection of data necessary for impact-based services; and training of the staff of partner agencies on new skills in delivering impact-based information services. Congress requested the Secretary-General to initiate similar projects, within available resources, in other regions with the eventual aim of assisting Members to mainstream impact-based forecasting and warning services into their operations.

Service Delivery for Land Transportation

3.1.45 Congress agreed that the travelling public and various organizations and agencies tasked with different aspects of managing safe and efficient road and rail transport systems needed access to fit for purpose weather and related environmental services. Congress recalled that this issue had been addressed by EC-66, which, while acknowledging the potential benefits

from improved services to this important sector, had also expressed a desire to investigate in the first instance the current and emerging needs of the transport sector. Further discussions at CBS-Ext.(2014) indicated a willingness by CBS to work with the Commission for Instruments and Methods of Observations (CIMO), as well as representatives of a number of NMHSs and the users in an ad hoc working group to explore, as a first step, the requirements of Members for assistance in this area. The PWS Programme coordinated the organization of the ad hoc meeting in Geneva in January 2015 with a focus on how WMO could provide guidance to Members regarding observations, data management, data processing and delivery of services based on user requirements for road and rail transport. On reviewing the outcome of this consultation process, Congress requested the Executive Council to examine the potential benefits for Members in this regard and propose the most appropriate means of pursuing this initiative.

Service Delivery for Megacities and Large Urban Complexes

3.1.46 Congress noted that megacities, defined as “metropolitan areas with a total population in excess of ten million people”, and other large urban complexes, were characterized by concentrated transport and the densely constructed environment leading to specific weather and climate patterns that cause anomalous heat fluxes, small-scale turbulent flows and smog. Such large urban complexes are often located along coasts or near major rivers and deltas and face additional challenges due to their geographical locations. Consequently, such complexes require specific weather, climate and environmental services in order to be resilient in withstanding environmental hazards. Climate information and services are needed for long-term planning of infrastructure, whereas weather information and services respond to the needs of the population and the authorities for handling severe and high-impact, as well as routine weather situations. Access to nowcasting systems to forecast severe thunderstorms resulting in flash flooding which could threaten lives as well as causing severe disruption in the operation of an urban complex, as well as effective means of dissemination of the information, is a critical element of addressing environmental challenges in such cities. The role of impact-based forecast and warning services becomes even more vital in such urban areas. Congress supported the contribution of the PWS Programme to develop strategies for megacities and other large urban complexes to address weather, climate and environmental issues and the improvement of related services, including its collaboration in the preparation of a set of guidelines for establishing weather, climate, water and related environmental services for megacities and large urban complexes, available through: http://www.gfcs-climate.org/sites/default/files/events/Expert%20Workshop//WMO_Megacity_IMP_Plan.pdf. Congress requested the Secretary-General to consolidate the current efforts in addressing the issues related to megacities and large urban complexes, while continuing with the collaborative work of the related WMO Programmes and technical commissions in this area.

Service Delivery for Health

3.1.47 Congress recalled that the PWS Programme had initiated a series of demonstration projects entitled “Learning Through Doing” (LTDs), with the aim of assisting the participating Members through maximizing current capabilities, to make existing and potential end users aware of the range of both available and potential new products and services, and the benefits for users, as well as to enhance the capacities of the NMHSs to effectively disseminate and deliver such products and services. The focus of these projects in Chile, Madagascar and Peru were on the use of weather and climate information in support of health services. Given the needs of the health services in most developing countries, and, especially in Africa, the projects sought the creation of a collaborative partnership between the NMHSs and the health sector through the establishment of “Weather, Climate and Health Working Groups”. Congress was pleased to note that while the demonstration project was concluded in Madagascar, this activity which successfully demonstrated the mutual benefits from such collaboration was ongoing with the support of the public health sector and the NMHS. Congress further noted other activities of the PWS Programme which focused on service delivery to the health sector. These included facilitating the provision of high-resolution climate data “Enhanced National ClimaTe Services (ENACTS)”, to some Members in RA I for use in improved services to the health sector; and contribution to the “Atlas of Health and Climate” jointly published by WMO and the World Health Organization. In welcoming the creation of a joint WMO-WHO office through (GFCS), Congress requested the Secretary-General to

continue promoting service delivery to the health sector through a coordinated approach among the relevant WMO Programmes.

Service Delivery for the Energy Sector

3.1.48 Congress noted that the utility companies are increasingly focusing on decreasing generation costs by increased operating efficiencies through application of weather and climate information. There are many meteorological and hydrological services required by the energy sector, from long-term rainfall and temperature records for planning purposes, fluctuation in capacity for energy generation as well as for optimal planning of contingency measures. Likewise, NMHSs provide services to enable energy providers balance the energy supply and demand effectively depending on energy needs due to a heat wave or extreme cold. Many more weather and climate-related services are required for renewable energy generation and energy saving. Congress acknowledged that NMHSs could, according to their national mandates, meet much of the needs of the energy sector through provision of tailored services built on the basis of public weather services, thus extending the reach and utility of their PWS.

Capacity-Development

Knowledge transfer, publications and guidance materials

3.1.49 Congress acknowledged with appreciation the voluntary contribution of experts to the success of the PWS Programme, through their work in various expert teams, forums, training activities and preparation of guidance materials. Congress noted with appreciation the publication of eight guidelines during the intersessional period, all of which were freely accessible on the WMO library website, and addressed key aspects of PWS. Congress encouraged Members to ensure that their staff performing PWS duties were familiar with this important resource and that they made maximum use of the publications and requested that the PWS Programme continue to prepare such guidance materials.

PWS Competencies

3.1.50 Congress recalled that Cg-XVI had recommended that all technical commissions make the definition of competency requirements for the core tasks in meteorology and hydrology a high priority activity and incorporate this task into their work programmes. Congress noted with appreciation that the PWS Programme, in close consultation with the Executive Council Panel on Education and Training had developed the “Competency Framework for PWS Forecasters and Advisors”. Congress reviewed the recommendation of CBS-Ext.(2014) of relevance to PWS that included amendments to WMO *Technical Regulations, Volume I: General Meteorological Standards and Recommended Practices* (WMO-No. 49). Congress adopted Resolution 4 (Cg-17) – Report of the extraordinary session (2014) of the Commission for Basic Systems relevant to Technical Regulations concerning Public Weather Services competencies.

Training

3.1.51 Congress noted that 38 PWS-related training workshops and seminars had been conducted for NMHSs from all WMO Regions during the intersessional period, a number of which had been in collaboration with the Tropical Cyclone Programme (TCP) and the Data Processing and Forecasting System (DPFS) Programme. Congress reiterated the value of PWS training activities and encouraged the continuation of the collaborative approach whenever possible, with relevant programmes in order to leverage the available resources in an optimum manner. Congress expressed appreciation to Members who had hosted these training events and made available their experts as resource persons.

The PWS National Focal Points

3.1.52 Congress noted that the network of the PWS National Focal Points continued to provide a valuable link between the Secretariat and NMHSs at working level and played a useful role in supporting the implementation of PWS among Members. Congress requested all Members to

nominate and support national PWS Focal Points, to assist them in keeping abreast of the activities of the PWS Programme and in sharing that information with relevant staff of the NMHS.

Demonstration Projects

Severe Weather Forecasting Demonstration Project (SWFDP)

3.1.53 Congress endorsed the activities of the PWS Programme in the implementation of the PWS component of the SWFDP in Eastern and Southern Africa, the South Pacific, East Asia and the Bay of Bengal. It noted that this component focused on: identification of gaps in service delivery in NMHSs; assessment of warning service practices in NMHSs and their improvement; introduction to impact-based forecast and warning services; the use of modern communication technologies, including mobile technology applications and social media; provision of equipment and training for media presentation; implementation of the Common Alerting Protocol (CAP) standard; and working effectively with the media and disaster reduction communities. In addition to the regular training sessions, the PWS Programme had, through country visits and close contact with individual NMHSs, provided tailor made assistance addressing the above issues. Congress agreed that the benefits of improved forecasts and warnings achieved through the SWFDP could not be fully realized without a strong service delivery element and fully supported the continued engagement and support of the PWS Programme in the existing and future SWFDP sub-projects.

3.1.54 Congress recalled that Cg-XVI had recognized the European Multi-service Meteorological Awareness (EMMA) Project and the Meteoalarm website as an example of best practice in international cooperation by 27 European countries in disseminating weather warnings. It welcomed the initiative of the PWS Programme to share this practice with Members participating in the Eastern and Southern African SWFDP sub-projects with a view to the eventual implementation of a homogenous colour-coded warning visualization system in those countries.

International exchange of public forecasts and warnings

3.1.55 Congress emphasized the need to uphold the authoritative role of NMHSs in the provision of weather products and services for the protection of life and property and the well-being of all nations. In this regard, Congress noted the significant accomplishments in the implementation of the World Weather Information Services (WWIS) website, including a major modernization and refurbishment process which made the site more attractive and more user friendly with modern features. The site was available in ten language versions namely: Arabic; Chinese; English; French; German; Italian; Polish; Portuguese; Russian and Spanish, and that it had recorded over 1 billion accumulated visits. Congress further noted that 166 Members were providing official weather and climate information for 1,719 cities, thus strengthening the recognition of NMHSs as official authoritative sources of warnings and public weather forecasts. Congress expressed its appreciation to all the host language countries for volunteering to host, operate and maintain the sites on behalf of Members. Congress recognized the major role played by Hong Kong, China in designing the site and coordinating all the website hosts, as well as its recent refurbishment. Congress agreed that a clear data policy would better facilitate the wider distribution of the official weather information to the public through non-commercial as well as commercial activities. Congress also noted that the CBS OPAG PWS Expert Team on Services and Products Improvement and Innovation (ET/SPII) had a plan to enhance the WWIS with more weather information, including current weather observations, additional types of weather data and products, and was undertaking an investigation on the feasibility of including weather warnings on WWIS to promote a one-stop shop access to authoritative weather information by members of the public and the international media in the future. Congress urged all Members to support the further development of WWIS by being engaged and contributing current weather observations, additional types of weather data and products.

3.1.56 Congress urged Members to consider the complexity of the issues which are rapidly developing relating to the way forecasts, warnings and information are shared as a result of emerging technologies. Congress encouraged Members to consider the existing and future technical skills required to address these issues.

3.1.57 Congress was informed that the Severe Weather Information Centre (SWIC) website continued to play the role of the portal to official tropical cyclone warnings from Members, in addition to providing information on heavy rain and snow, thunderstorms, gale and fog. Congress encouraged further improvement of the site for the ease of navigation and quick access to the required information by visitors to the site.

3.1.58 Congress noted that the online "International Register of Alerting Authorities", launched by the PWS Programme, had continued to grow, and that there were now 124 Members that had assigned editors for their respective country pages of the register. Congress emphasized the importance of the Register in achieving a "single official voice for dissemination of weather warnings". It requested Members to keep the Register updated, and to make reference to their membership of this Register when asserting their authoritative role in issuing national warnings.

3.1.59 Congress noted that the implementation of the Common Alerting Protocol (CAP) standard format for exchange of all alerts through all media was progressing well. Congress noted that the PWS Programme had organized several annual WMO CAP Jump-Start and Implementation Workshops in which Members had participated. Additional training and installation of the CAP standard had been achieved during SWFDP training workshops, as well as through direct country visits by CAP experts. Congress reaffirmed the value of CAP and encouraged Members to take advantage of the WMO CAP Jump-Start Offer, which is coordinated by the PWS Programme. Congress also noted that the SWIC, as a centralized source of official weather warnings, could be enhanced as another channel for disseminating weather warnings in CAP format and that this development be taken forward. Congress stressed the need for further guidance to Members on their conversion of weather warnings into CAP format and for enhanced technical assistance to Members, as needed, for the implementation of the CAP standard.

Social and economic applications of PWS

3.1.60 Congress noted that the PWS Programme had continued to coordinate initiatives to assist NMHSs in assessing and demonstrating the socio-economic value of the services they provide to their respective users. At the request of EC-64, a major effort had been the production of a joint WMO/World Bank authoritative publication on methodologies for assessment of socio-economic benefits of meteorological and hydrological services. A considerable pool of experts in both atmospheric and social sciences contributed to the publication. Congress welcomed that the publication had been made available through the link http://library.wmo.int/opac/index.php?lvl=notice_display&id=17225 and that a number of regional seminars and training workshops that had been organized to familiarize Members with the concepts contained in the publication, and requested the Secretary-General to arrange for organization of further training events, as well as developing pilot projects for testing the methodologies, within the available resources. Congress urged Members to make use of the publication as reference material to demonstrate the benefits of their services.

3.1.61 Congress recalled The International Conference on Secure and Sustainable Living: Social and Economic Benefits of Weather, Climate and Water Services (2007), which had produced the Madrid Action Plan (MAP). It considered that while EC-66 recommended that a Madrid plus Ten Conference be organized in 2017, to follow up on the outcomes of the Madrid Conference, and, in particular, on the methodologies for analysing socio-economic benefits of services, a proposal should be brought forward to Congress on holding a Madrid +10 Conference based on an analysis of the benefits of such a conference (ref.: agenda item 9.7).

3.1.62 Congress adopted Resolution 5 (Cg-17) – Public Weather Services Programme.

Tropical cyclone coordination and services

3.1.63 Congress was pleased to note the achievements of tropical cyclone (TC) coordination and services under the Tropical Cyclone Programme (TCP) during the sixteenth financial period.

Response to tropical cyclone-related disasters since Cg-XVI

3.1.64 Congress recalled that there had been many severe tropical cyclones that have affected Members since Cg-XVI, notably hurricane *Sandy* that impacted the Eastern USA in 2012, severe tropical cyclone *Evan* affected Samoa and Fiji in December 2012, severe tropical cyclone *Phailin* that affected India in October 2013, typhoon *Haiyan* crossing the Philippines in November 2013, severe tropical cyclone Ian that impacted Tonga in January 2014, and severe tropical cyclone *Pam* that devastated Vanuatu in March 2015. Congress further recalled that in September 2013, Mexico was simultaneously affected by two hurricanes, *Ingrid*, in the Atlantic basin, and *Manuel*, in the North-east Pacific basin, which caused hundreds of deaths and severe damage. The country had only experienced a similar event in 1958 when it was hit simultaneously by two tropical cyclones in both basins. Congress noted that loss of lives caused by those unprecedentedly strong tropical cyclones were minimal in the respective countries, in comparison with similar events which occurred 20 years earlier. Congress appreciated the significant reduction of disaster risks by tropical cyclones in terms of loss of lives and noted that this can be credited to the well-established nationally and regionally coordinated early warning mechanisms under the TCP and increased accuracy of TC forecasting and preparedness. These have been in place round the clock, in particular, in the six RSMCs and the six TCWCs which provided accurate and timely forecasting advisories to enable the relevant national services to issue their accurate and reliable early warnings on tropical cyclone movements and strong wind force, rainfall, and associated storm surges. Congress stressed that such early warning mechanisms should be further strengthened and improved by making use of all available modern technologies and advances in sciences which can contribute to improved DRR services.

Full coverage of the regionally coordinated systems to All Members

3.1.65 Congress noted that the regionally coordinated systems under TCP had covered all ocean basins prone to tropical cyclones. However, Congress noted that some Members on the periphery of ocean basins such as the Arabian Sea are occasionally struck and/ or influenced by tropical cyclones, although there is no reference to the handling of such tropical cyclones in the existing warning system procedures. Considering the essential roles of the regionally coordinated system in supporting Members of the five regional tropical cyclone bodies to provide reliable and timely forecasts of tropical cyclone tracks and intensities, and related forecasts of strong winds, heavy rainfall, and storm surges, etc., Congress requested the Secretary-General to establish a reliable link, and develop a mechanism with the support of the regional associations, to include all Members affected by this hazard into the regionally coordinated system.

Capacity development

3.1.66 Congress was pleased to note that a number of training programmes were successfully held to develop the capacities and upgrade the warning capabilities of developing countries subject to tropical cyclones. Congress noted with appreciation that the TCP/Public Weather Service (PWS) joint training workshops hosted by Météo-France, NHC/NOAA and the Bureau of Meteorology in RAs I, IV and V respectively, had made a significant contribution in that regard, covering a wider range of operational forecasting and warnings challenges, including service delivery. It noted with appreciation that the training workshops in RAs I and V, in which the TCP collaborated with the Global Data-processing and Forecasting System (GDPFS), included the Severe Weather Forecast Demonstration Project (SWFDP) being implemented in these Regions. Congress also took note of the effectiveness of the attachment training at TC RSMCs which allowed forecasters to acquire practical techniques and expertise through on-the-job experience.

3.1.67 Congress was of the view that developing countries, especially Small Island Developing States (SIDS) and the Least Developed Countries (LDCs), continue to be in urgent need of improving the tropical cyclone forecasting skills and competencies required for effective operational capacity. To that effect, Congress requested that the Secretary-General should continue to give high priority to capacity development in tropical cyclone forecasting, and make the necessary arrangements to extend training activities to cover all the five regional tropical cyclone bodies.

Support to operational forecasting

3.1.68 Congress recognized the changing tropical cyclone forecasting environments in step with evolving new technologies for increased availability of observational data and new forecasting guidance products, and with the growing demand of users for greater accuracy and longer lead times of forecasts. These developments require the tropical cyclone forecasters to update and upgrade their forecasting knowledge, skills and competencies to understand, mine, refine and integrate the large quantities of available new data and guidance products to find out essential information which increases certainty and confidence in forecasting. In this regard, Congress encouraged the TCP to collaborate more closely with CBS on this issue and endorsed those measures undertaken through the TCP which are necessary to address the challenges and to support tropical cyclone forecasters, particularly those from developing countries.

3.1.69 Congress noted that updated draft of the Global *Guide to Tropical Cyclone Forecasting* (WMO/TD-No. 560) had been completed. It expressed its appreciation to all the authors lead by Mr Chip Guard (US NOAA/NWS) for their dedication and invaluable contributions. Congress encouraged the TCP to further coordinate with the DPFS, tropical cyclone regional bodies and RSMCs/TCWCs to facilitate its wider use. The availability of the updated Global Guide would be announced to all Members prone to tropical cyclones, after completion of the formal review and editorial processes in accordance with the WMO Standing Instructions and with WMO Publishing Policy. The new Global Guide provided comprehensive guidance on tropical cyclone forecasting from a multi-hazard point of view. It is now web-based (http://www.wmo.int/cycloneguide) with a view to facilitating timely updating and easier access. The Global Guide will also achieve synergetic effect with the TC Forecaster website (http://severe.worldweather.wmo.int/TCFW/) which is hosted by Hong Kong, China to provide a wide range of readily accessible sources such as forecast tools, observation and product data, advisories and warning centres, training material, WMO technical publications, TC research, TC Data archive, etc. These two information sources will be linked with the TCP page of the WMO website to serve as a comprehensive source of information/material/data that is expected to be of great value to operational forecasters. Congress also recommended the distribution of a limited number of hard copies to WMO Members and WMO Regional Training Centres (RTCs) concerned.

Application of Research and Development

3.1.70 Congress noted that the TCP and the World Weather Research Programme (WWRP) jointly organized various forums where operational forecasters and researchers exchanged their views and shared knowledge and identified the direction of their collaborations for the future. Those included the Eighth International Workshop on Tropical Cyclones (IWTC-VIII)/3rd International Workshop on Tropical Cyclone Landfall Processes (IWTCLP-III) that had been organized in Jeju, Republic of Korea, December 2014, and the Workshop on High Impact Weather in Ningbo, China, January 2015. Workshops and projects organized jointly by the TCP and WWRP provided excellent opportunities for active interaction between operational forecasters and researchers focused on facilitating the transfer of research and technology developments to operations.

3.1.71 Congress further noted that as part of the collaborative actions taken by the TCP and WWRP for promoting application of research outcomes to operational forecasting, two projects have been implemented within the framework of the Typhoon Committee, North Western Pacific – Tropical Cyclone Ensemble Forecast Project (NWP-TCEFP) which aims to explore the utility of ensemble forecast products through THORPEX interactive Grand Global Ensemble (TIGGE) and thus to extend the use of ensemble products in TC operational forecasting, and the Typhoon Landfall Forecast Demonstration Project (TLFDP) which is aimed at enhancement of the timeliness and accuracy of typhoon forecasts particularly during the landfall process, with particular focus on the verification of TC forecast guidances produced in the Typhoon Committee region to assess the currently available forecast techniques. Congress requested the WMO Secretariat to take necessary actions for sharing the outcomes of TCEFP and TLFDP between the regional TC bodies, and endorsed extension of the NWP-TCEFP and TLFDP until 2018 to incorporate the outcomes into operational TC forecasting services.

3.1.72 Congress also noted that RSMC Tokyo was planning to provide TC ensemble guidance over the North Western Pacific in real time to the ESCAP/WMO Members, following the success of the NWP-TCEFP, in order to further promote the operational use of such ensemble guidance. Congress welcomed with appreciation this initiative of RSMC Tokyo and encouraged timely and sustainable dissemination of forecasts by NWP centres operating global ensemble prediction systems to support such initiative.

3.1.73 Congress also noted the project "Experiment on Typhoon Intensity Change in the Coastal area (EXOTICA)" which was being taken forward by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) / WMO Typhoon Committee.

Enhanced Operational Centres Services

3.1.74 Congress noted with appreciation the recommendations from IWTC-VIII and IWTCLP-III, with particular relevance to operational centres services, and to that end it encouraged coordination through tropical cyclone regional bodies, relevant technical commissions and Tropical Cyclone RSMCs/TCWCs Technical Coordination Meeting (TCM):

(a) Regional Specialized Meteorological Centres/Tropical Cyclones Warning Centres (RSMCs/TCWCs) to provide TC forecast uncertainty as part of their TC warnings when appropriate, and to share the successfully researched guidance products specifying TC forecast uncertainty within operational centres to the widest extent possible recognizing the growing importance of ensemble techniques and probabilistic forecasts;

(b) RSMCs/TCWCs to archive all observations for each tropical cyclone, including those unavailable operationally, and make them available to the TC community on a voluntary basis, with as many details as possible summarizing the observation source;

(c) RSMCs/TCWCs to reanalyse their historic best tracks to help provide the most complete and accurate tropical cyclone databases possible to the TC research and other communities;

(d) All global modelling agencies to make real-time TC track details available to RSMCs/ TCWCs to improve forecast interpretations;

(e) National TC warning centres to support and encourage emergency response agencies to undertake or continue studies that identify those areas most at risk from storm tide impacts so that appropriate warning communication and mitigation strategies can be developed and improved;

(f) The TC operational community to engage with social scientists to develop tools and provide education and training for meaningful communication of risk to end users based on: (1) warnings; and (2) the forecast uncertainty associated with those warnings. This will help ensure that appropriate community actions are taken in response to those TC warnings.

3.1.75 Congress recommended that operational TC centres should identify their most difficult forecast cases as well as extreme events and make them available to the TC community via an online site (e.g., http://severe.worldweather.wmo.int/TCFW/), and encouraged the TC research community to investigate this list with focus on model performance, and to explore the predictability of these events.

3.1.76 Congress encouraged the Secretary-General to take all measures possible to facilitate the transition of new, successfully-tested TC techniques and algorithms from researchers/ developers to operational environments. For example, innovative satellite-based methods that are showing promise for TC analysis need to be integrated into local TC analysis/forecast offices for optimal employment as guidance in the TC forecast process. Congress stressed the importance of strengthening the linkages between operational forecasters and researchers through various

gatherings on both global and regional levels to ensure transfer of research and development outcomes into operational forecasting capacities and capability, in particular for the developing countries, LDCs and SIDS. Congress requested the Secretary-General to make all efforts to support this transition and subsequent trainings.

Storm surge services

3.1.77 Congress appreciated Members actions to develop, test and implement storm surge watch products and services as well as activities organized in different Regions to encourage such products and services. Congress also took note of the storm surge advisory service in the Bay of Bengal and the Arabian Sea provided by the RSMC New Delhi in 2009 in cooperation with Indian Institute of Technology (IIT). RSMC Tokyo started provision of the storm surge forecast map in 2011, and upgraded it in 2012. RSMC La Réunion implemented a study on the application of Météo-France's storm surge model to RA I SSWS. RSMC Miami issued an experimental potential storm surge flood map for the U.S. and explored with participants in the recent Workshop on Storm Surge and Wave Forecasting (Miami, USA, January 2015) to expand implementation and application of the SLOSH model and storm surge forecasting more generally to Members of the RA IV Hurricane Committee.

3.1.78 Congress noted that the recent WMO sponsored 3rd International Workshop on Tropical Cyclone Landfall Processes (Jeju, Republic of Korea, December, 2014) held a session concerning storm surge which produced significant recommendations to improve the modelling, forecasting and warning of storm surge. Congress requested the Secretary-General to consider these recommendations and provide the necessary integration of relevant projects or programmes to assist Members in the further implementation of the storm surge watch scheme.

3.1.79 Congress appreciated the cooperation of the TCP with the Joint Technical Commission for Marine Meteorology (JCOMM) and the Commission for Hydrology (CHy) in the ongoing development and delivery of the Coastal Inundation Forecasting Demonstration Project (CIFDP.) Congress noted that when these demonstration projects are completed, lessons learned can be applied in providing storm surge forecasts and warnings in other affected areas. Congress requested the Secretary-General to consider the results of the CIFDP projects and distill these into advice for Members.

3.1.80 Congress noted the continuing work of the TCP in collaboration with the Marine Meteorology and Oceanography Programme (MMOP) in capacity development through the organization and delivery of storm surge workshops and training, such as the seventh Storm Surge Workshop in Macao, China for the Members of Typhoon Committee in October 2011 and the eighth workshop in Kenya for the Members of the RA I Tropical Cyclone Committee in November 2012, and a Workshop on Storm Surge and Wave Forecasting in the USA in January 2015 for the RA IV Hurricane Committee Members. TCP continued annual attachment training at the Indian Institute of Technology (IIT) New Delhi for the Members of the WMO/ESCAP Panel on Tropical Cyclones. Congress requested the Secretary-General to continue providing support for such capacity development actions to ensure the provision of effective storm surge forecast and warning capability for all exposed Members. Congress noted that in 2013, in RA IV, Mexico started a Marine Meteorology Programme, with support from the Secretariat's Marine Meteorology and Oceanography Programme, which aims to comply with the procedures laid down in the WMO guide. The Programme initiated by Mexico intends also to provide timely and reliable information for the Tropical Cyclone Programme from which the RA IV Regional Specialized Meteorological Centre draws timely meteorological and oceanographic data to improve tropical cyclone forecasting in the region, thus representing a good example of cross-cutting programmes.

3.1.81 Congress noted the development of the use of impact-based forecasting and warning systems by some Members to improve the effectiveness and utility of forecasts and warnings to users. Congress encouraged the TCP to engage Members through the TC regional bodies and to coordinate with CBS and JCOMM when considering such impact-based forecasting and warning approaches in the further development of storm surge watch systems.

TC global coordination

3.1.82 Congress noted that the Seventh Tropical Cyclone RSMCs/TCWCs Technical Coordination Meeting (TCM-7) took place in Citeko, Indonesia in November 2012. The TCM meeting is held once every three years for promoting the harmonized development of regional warning services and operational procedures. The TCM-7 discussed the concerns of the RSMCs and TCWCs in applying the recommended conversion factors between the wind speeds of different time ranges, based on the study distributed as a WMO Technical Document (WMO/TD-No. 1555) to all members of the five TC regional bodies in October 2010, to their operational services, and reached the consensus that the conversion factors are not to be recognized as a baseline from practical aspects since its operational application would face many problems such as unrealistic biases in maximum storm intensities and increase in the number of tropical cyclones. In that context, Congress:

(a) Acknowledged the importance of inventory of operational practices of different centres and the practices of RSMCs and TCWCs;

(b) Recognized the importance of harmonized procedures and products between the Regions;

(c) Emphasized the significant role of TCM for securing the coordination among the RSMCs and TCWCs as an essential mechanism to continue efforts in exploring the feasibility of standardization of procedures, and harmonized practices in TC forecasting operations and post analysis in consideration of the regional practices.

3.1.83 Congress also recognized that any changes of operational procedures on tropical cyclone forecasting and warnings may have societal implications in response by the general public to the warning messages, thus leading to unexpected circumstances in reduction of disaster risks by tropical cyclones. Considering that harmonization of tropical cyclone warnings and advisory products provided by different TC RSMCs, TCWCs and WMO Members will contribute to proper understanding and use of the authoritative warning messages issued by the NMHSs. Congress requested TCM to continue to play leading roles in initiating, in consideration of respective regional circumstances, discussions on globally coordinated TC forecasting services ensuring synergy between TC RSMC and TCWCs.

3.1.84 Congress noted that the TCM-7 also discussed the proposal about the role that IBTrACS (International Best Track Archive for Climate Stewardship) could play in aiding the issue on the wind-conversion factors. The regional centres could provide their metadata to IBTrACS, and use this in conjunction with the wind-conversion study (WMO/TD-No. 1555). IBTrACS could take wind-conversion factors and work to produce a standardized and homogenized wind averaged dataset that could be used by everyone, and this also would not require the centres to change their data holdings. IBTrACS could work with all the centres to run tests for consistencies. Noting the establishment of a cooperative relationship between TCM and IBTrACS, Congress agreed to continue its support to IBTrACS by providing regional best track data and adequate guidance for integration of the data.

3.1.85 The TCM-7 reviewed and adopted the terms of references of both TC RSMCs and TCWCs for inclusion in the Manual on the GDPFS. Noting the outcomes of TCM-7, Congress recognized the need for a description of TC RSMCs and TCWCs responsibilities, linkages with IBTrACS and the responsibilities of Meteorological Watch Offices in terms of TC Advisory arrangements with ICAO.

3.1.86 Congress noted the availability of graphical TC advisories by some of the designated Tropical Cyclone Advisory Centres (TCACs) as per International Civil Aviation Organization (ICAO) requirements. Congress recognized the role of TCM in encouraging the TCACs to concentrate efforts in making the graphical TC advisories increasingly available as per ICAO requirements especially according to the amendments to ICAO’s Annex 3.

3.1.87 Congress noted that the development of tropical cyclone forecasting competencies was consistent with a Quality Management approach which is now being implemented for aviation forecasters and being promoted more broadly by WMO for the delivery of all hydrometeorological services. It further noted that various Centres have already undertaken considerable work in this area. Congress was pleased to note that RSMC La Reunion has developed a set of competencies and encouraged that tropical cyclone forecasting competencies be developed in other basins.

3.1.88 Congress noted the efforts of TC regional bodies in collaboration with TC RSMCs and TCWCs and the NMHSs in resolving the inconsistencies concerning different operational upgrade timings from tropical depressions to tropical cyclones. Congress recognized that such inconsistencies caused confusion among the disaster managers and media and noted that although the difference in TC analyses between the TC RSMC and the NMHSs is inevitable because of the inhomogeneity in operational procedures between the centres, scientific efforts and consultation should continue to minimize such differences including the promotion of operational observational data exchange, for more harmonized and consistent forecasting in the TC body regions.

3.1.89 Congress noted that meteorological data collected from reconnaissance flights operated by a government aircraft of Hong Kong, China into tropical cyclones over the northern part of the South China Sea had become available in recent years, and that dropsonde data would also become available in the coming year after replacement of the aircraft. Congress recognized that these efforts would contribute very useful data in determining the intensity of tropical cyclones and improving their track forecasts, and was pleased to note that Hong Kong, China was coordinating with code experts on data encoding issues to facilitate international dissemination of the collected data.

TC regional bodies

3.1.90 Congress recognized the important role of TC regional bodies in the various regional projects of relevant WMO Programmes such as Disaster Risk Reduction (DRR), Data Processing and Forecasting Systems (DPFS), Marine Meteorology and Oceanography Programme (MMOP), World Weather Research Programme (WWRP) and Hydrology and Water Resources (HWR). The RA IV Hurricane Committee has been supporting the development and implementation of the DRR Central American Pilot Project on Early Warning Systems and DRR Initiative to Strengthen MHEWS Capacity in the Caribbean. The RA V Tropical Cyclone Committee (TCC) has been supporting the Severe Weather Forecast and Disaster Risk Reduction Demonstration Project (SWFDDP). The ESCAP/WMO Typhoon Committee established linkages with the RA II Working Group on Hydrology through joint activities, including for the management of urban floods and flash floods in their Region. The CIFDP projects in the Caribbean and the North Indian Ocean have been linked with the activities of the Hurricane Committee and the WMO/ESCAP Panel on Tropical Cyclones, respectively. Congress noted that in September 2014, in RA IV, Mexico began a cooperation programme with NOAA, which, on a trial basis, will allow NOAA hurricane hunter aircraft to land in Mexican aeronaval bases (La Paz and Tapachula). This will avoid long flights from Florida to the North-east Pacific and back, and increase flights above tropical cyclones, as the aircraft will be able to pass the night in places close to the storms.

3.1.91 Congress also noted the activities of TC regional bodies in furthering their partnership with various international and regional agencies. The Hurricane Committee has been extending cooperation to the Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE EWS) and the WMO/ESCAP Panel on Tropical Cyclones has been engaged with the Pacific and the Indian Ocean Tsunami Warning and Mitigation Systems (ICG/PTWS and ICG/IOTWS). The ESCAP/WMO Typhoon Committee and the Panel on Tropical Cyclones developed mutual cooperation in implementation of ESCAP-funded project Synergized Standard Operating Procedures (SSOP) for Coastal Multi-hazards Early Warning System for the Indian Ocean and South-East Asian Countries.

3.1.92 Congress recognized the need for extensive mutual collaboration among the national organizations within Members for improved disaster risk reduction and the growing role played by the regional TC bodies as the platforms for the development of multi-hazard early warning systems in the respective Regions. Congress also recognized the need to strengthen linkages between the three key areas of regional activities – meteorology, hydrology and disaster risk reduction. From that perspective, Congress urged Members and encouraged the Secretary-General to promote the involvement of hydrologists and DRR experts in the activities of regional TC bodies, in particular their annual and biennial sessions, to maximize the synergies between the three areas and thus fully meet the varied regional requirements.

3.1.93 Congress recognized the success of the regionally coordinated activities under the regional tropical cyclone bodies and it requested the WMO Secretariat to support the regional bodies for further promoting their activities in cooperation with TCP, MMOP and other related WMO Programmes.

Support to the Sendai Framework for DRR

3.1.94 Congress noted that the priority area 4 of the Sendai Framework for Disaster Risk Reduction, adopted at the Third United Nations World Conference on Disaster Risk Reduction (WCDRR-III) held in Sendai City, Japan in March 2015, focused on enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction. Congress also noted that the global target 7 of the Framework calls for substantially increasing the availability of, and access to, multi-hazard early warning systems. To achieve this priority and the target, the Sendai Framework calls for investments in developing, maintaining and strengthening people-centred multisectoral forecasting and early warning systems, disaster risk and emergency communications mechanisms, hazard-monitoring telecommunications systems and for supporting, as appropriate, relevant United Nations agencies to strengthen and implement global mechanisms on hydrometeorological issues, in order to raise awareness and improve understanding of water-related disaster risks and their impact on society, and advance strategies for disaster risk reduction. Congress emphasized the cross-cutting nature of the activities of the Tropical Cyclone Programme in addressing this priority area of the Sendai Framework and it reaffirmed that the TCP should continue to place emphasis on the people-centred early warning systems of tropical cyclones and further strengthen the global mechanisms to reduce the disaster risk associated with the tropical cyclones.

Climate services related to tropical cyclones

3.1.95 Congress noted that effective climate services can provide advance warning of future potential risks and opportunities several weeks, months, years and decades ahead, depending on the nature of the risk and that this advance warning can be particularly effective when integrated with weather services. The climate service enables decision-makers and user communities to assess, and prepare for, potential impacts of cyclones; the weather service enables action in response to incidence of specific cyclone events as they become imminent. Congress also noted that climate information was critical for analysing patterns and trends of cyclones and that this information may be complemented by other inputs (such as socioeconomic data and analysis) for vulnerability assessment. With this knowledge, governments can manage cyclone risk through early warning systems and preparedness, sectorial planning, insurance and financing mechanisms. Congress also recognized that the TC forecasting services contribute to the development of TC climate services therefore they support building a climate resilient society.

3.1.96 Congress recalled Resolution 23 (Cg-XVI) – Tropical Cyclone Programme. It emphasized that the establishment of an effective warning system through a multidisciplinary and impact-based approach was a high priority requirement for reducing the social-economic impacts of tropical cyclones, and that implementation of the TCP should be guided by the WMO Strategy for Service Delivery, and should comply with the WMO Strategic Plan, especially WMO strategic priorities on DRR and Capacity Development. Congress requested the Secretary-General to enhance the contribution of the TCP to DRR services delivery through the implementation of impact-based monitoring, forecasting and risk-based warnings as well as through enhanced

coordination of the TCP with other technical programmes. Congress also recognized that effective partnerships with disaster management authorities and other relevant national and regional agencies could also facilitate contribution to DRR services delivery.

Global Coordination

3.1.97 Recognizing the support already provided through the WWW and the importance of the TCM activities, Congress noted that inclusion of the TCP as a component of the WWW would be one of possible solutions to enhance the status of the TCM as well as strengthen the operational linkages. Congress also recognized this would not alter the status nor the existing coordinating and operating procedures of Regional TCP related working bodies and in fact it should strengthen the support provided and provide a mechanism to further improve cross-coordination.

3.1.98 Congress agreed to further enhance the roles of the TCM to facilitate the technical coordination at the global level and implementation of WMO quality management practice by developing tropical cyclone forecasting competencies and ensuring review of compliance of GDPFS centres to be stated in the new GDPFS Manual.

3.1.99 Congress requested the TCM in consultation with the appropriate constituent bodies and partners to develop a proposal to enhance its roles and activities and to report back to EC. Congress requested EC to support this work and to decide on the recommendation provided.

Marine Meteorology and Oceanography

Marine Meteorology and Oceanography Programme (MMOP)

3.1.100 Congress reaffirmed the MMOP as the key operational programme providing assistance to Members in the sustained provision of global and regional coverage of marine observational data, products and services to address the continued and expanding requirements of the maritime and coastal user communities for met-ocean services and information, focusing on safety of life and property at sea, integrated coastal management and societal impacts. An amended description of the MMOP is given in Annex IV to the present report.

3.1.101 Congress noted the extensive inter-agency coordination and collaboration required to effectively deliver the MMOP. Congress encouraged the continuing strong partnership with the International Oceanographic Commission (IOC) as represented by the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) which advises on the delivery of the MMOP including collaborative development and delivery with the International Maritime Organization (IMO) and the International Hydrographic Organization (IHO). Congress appreciated the use of Memorandum of Agreements with such agencies to formalize these collaborations and encouraged their continued development. In addition, Congress appreciated the resulting contributions to the Global Framework for Climate Services (GFCS), the World Climate Research Programme (WCRP), the Global Climate Observing System (GCOS) and the Global Ocean Observing System (GOOS).

3.1.102 Congress noted with appreciation the work accomplished by the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), during the past intersessional period, and congratulated the Commission for its work. Congress reaffirmed the success of a jointly sponsored technical commission in bringing together the marine meteorological and oceanographic communities, and integrating operational marine activities. Congress invited the Intergovernmental Oceanographic Commission (IOC) to give priority and support to the joint Commission programmes and emergent issues.

3.1.103 Recalling the report of the co-presidents of JCOMM under agenda item 2.5 regarding the JCOMM strategy, Congress requested the Secretary-General ensure the MMOP support effective implementation of the strategy.

3.1.104 Considering the work achieved or underway, Congress noted and supported the ongoing priority areas for JCOMM, as detailed in the JCOMM strategy and under other agenda items, including:

(a) Weather and ocean forecasting: continued implementation of operational ocean forecasting services; enhancing communication between IOC oceanographic Institutions and WMO National Meteorological and Hydrological Services (NMHSs);

(b) Disaster Risk Reduction (DRR): mitigation of coastal hazard risks through improved forecasting; support for Marine Safety Information Services through improved services in Polar Regions, assessment of user requirements and review of technical regulations;

(c) WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS) Implementation: improving the capability for real-time monitoring of the oceans, engagement of WMO Members and IOC Member States in global ocean observing efforts; developing synergies between satellite and in-situ observing components; review and design oceanographic components of the WIS;

(d) Capacity Development (CD): identifying national and regional needs and addressing deficiencies; enhancing capabilities for met-ocean service delivery, observations and data management; updating capacity development activities in collaboration with partners.

3.1.105 Congress urged Members to strengthen their marine meteorological and oceanographic services in support of safety of life and property at sea as required under the International Convention for the Safety of Life at Sea (SOLAS). Congress noted that operational, sustained funding for the national ocean observing systems was critical to the provision of these services. Congress further noted the important responsibilities of MetArea coordinators and encouraged Members to provide them with appropriate training and support.

3.1.106 Congress recognized the important work of the MMOP. Congress urged Members to provide the additional in-kind and voluntary resources necessary for full implementation, to address the continuing requirements of the maritime and coastal user communities for met-ocean services and information. Congress noted the increased requirements for capacity-building and training to support, for example, the development of quality management, the implementation of the forecaster competency requirements and the implementation of programmes and services developed through the Coastal Inundation Forecasting Demonstration Project.

Marine Services for Disaster Risk Reduction

3.1.107 Congress noted the pro-active approach of JCOMM to address priority issues under the disaster management programmes, in particular related to coastal and marine hazards. Congress further emphasized the importance of an integrated effort for developing and improving forecasting capabilities and service delivery in coastal risk reduction with regional focus. In particular, Congress noted the *Guide to Storm Surge Forecasting* was finalized, and the Storm Surge Watch Scheme (SSWS) was being developed through collaborative efforts of JCOMM and the Tropical Cyclone Programme (TCP), regional bodies and the Commission for Basic Systems (CBS). Congress encouraged the Commissions to undertake collaborative and joint activities and projects for accelerated implementation of these and other activities for risk reduction in coastal areas.

3.1.108 Congress noted the achievements of the joint JCOMM-CHy Coastal Inundation Forecasting Demonstration Project (CIFDP) and reaffirmed its importance in demonstrating the value of integrated coastal inundation forecasts and warnings. Congress noted with appreciation that the CIFDP, by integrating the hazards of storm surge, tides, floods and intense precipitation, effectively demonstrates the values of the Multi-hazard Early Warning System (MHEWS). Congress concurred that CIFDP is a direct contribution in enhancing NMHSs DRR actions through the provision of these impact-based forecasting services for coastal communities.

3.1.109 Congress requested JCOMM and the Commission for Hydrology (CHy), with support from the Secretary-General, to ensure continuing and close coordination on CIFDP, and advise on possible ways to take maximum benefit from these projects for the Members of the Regions who have similar issues of coastal inundation and requirements for integrated multi-hazard forecasting for coastal zones.

3.1.110 Congress requested the Commission to further extend its close collaboration on CIFDP with the concerned NMHSs, regional bodies, other Commissions and external programmes such as the UNESCO/IOC Integrated Coastal Area Management (ICAM) and related activities under Regional Tsunami Warning Systems. Congress noted that the experience, knowledge and tools developed under CIFDP will greatly benefit a holistic, interdisciplinary and fully integrated approach to forecasts and warnings.

3.1.111 Considering the opportunity to improve services in an efficient and effective manner, Congress encouraged JCOMM to develop a strong collaboration between the CIFDP, the WMO Severe Weather Forecasting Demonstration Project (SWFDP) and the Tropical Cyclone Programme (TCP). Congress encouraged CIFDP, SWFDP and the TCP to work together to ensure the systems developed in SWFDP (e.g. cascading prediction framework) and the TCP effectively enable the operational delivery of improved marine weather services including coastal inundation predictions.

3.1.112 Congress noted the continued close collaborative work with the International Maritime Organization (IMO) and the International Hydrographic Organization (IHO) in particular, to follow-up with the IMO resolution on the Worldwide Met-ocean Information and Warnings Service (WWMIWS). Congress noted the progress in the continued implementation of this Service including the further development of METAREAs and the closer coordination with NAVAREAs and recognized the need for continued close collaboration between the METAREA and NAVAREA Coordinators to ensure a cohesive service regarding maritime safety information. Congress reaffirmed the importance of the promulgation of internationally coordinated met-ocean information, forecasts and warning services and requested the Secretary-General to continue his efforts to ensure close collaboration with IMO and IHO in this respect. Congress also noted with satisfaction the establishment of the WWMIWS as an integral part of the Global Maritime Distress and Safety System (GMDSS) Marine Broadcast System.

3.1.113 Congress expressed its support for the ongoing development of operational capability in ocean analysis, forecasting and associated product delivery, to provide services to support a wide range of applications and societal benefit areas. Congress noted the work of the JCOMM Expert Team on Operational Ocean Forecast Systems (ETOOFS) to, among other actions, work to contribute to ocean forecasting and service provision requirements to the WMO Rolling Requirement Review (RRR) database, to assess existing operational ocean forecasting systems and to undertake the development of a Guide to Operational Forecasting Systems.

3.1.114 Congress recognized the achievements of Members in improved operational ocean analysis and forecasting products and services (for example, BLUELink ocean forecasting system in Australia, Mercator in France and the MarineMet Project in West Africa, funded by Spain) achieved through domestic and international cooperation with research, monitoring and forecasting agencies, and noted also the agreement of the countries surrounding the Caspian Sea for providing hydrometeorology services. Congress encouraged Members to consider opportunities to improve marine products and services through the development of such operational systems.

3.1.115 Noting the achievements to date in operational ocean forecasting, Congress requested JCOMM continue to support the operational implementation of ocean forecast services and facilitating the adoption of new products stemming from ocean forecasting and analysis services. Congress requested the MMOP, working with JCOMM, to develop a marine services implementation plan that is coherent with the implementation plan for the WMO Strategy for Service Delivery and considers learnings from the Global Data-processing and Forecasting System (GDPFS.)

3.1.116 Congress appreciated the actions of JCOMM to develop an implementation strategy and plan for an international coordination framework to support response to marine environmental emergencies, with a focus on the maritime discharge of radioactive hazardous materials and to facilitate the global coordination of marine environmental emergency responses thereby ensuring that existing capabilities within the Marine Pollution Emergency Response Support System (MPERSS) for the high seas, (including Synthetic Aperture Radar (SAR)) are effectively coordinated.

Global Framework for Climate Services (GFCS) and the Marine Environment

3.1.117 Congress noted the Joint JCOMM-CAgM Task Team on Weather, Climate and Fisheries (TT-WCF) established to enhance understanding and capabilities in marine climatology/ oceanography and to develop tools for use by the Pacific Island countries and Territories (PICTs) to assess the impacts of climate variability and change on ocean fisheries. Congress encouraged the production of a synthesis report/policy brief with an emphasis on comparative impact/relevant importance of climate information, and with a focus on climate variability's side tools, management responses, etc. in time for upcoming sessions of JCOMM and the Commission for Agricultural Meteorology (CAgM). The delegation of Indonesia noted that as an archipelago country with 70% of the area being ocean, Indonesia supports GFCS attention to fisheries related activities. Indonesia has commenced these activities with a Climate Field School (CFS) to inform farmers to understand technical weather and climate information for their decision-making.

3.1.118 Congress noted that the core competencies of JCOMM in marine meteorology, including the directions of the JCOMM strategy, directly contribute to the development, enhancement and delivery of climate services for the marine and coastal community thereby contributing to the implementation of the GFCS for the marine and coastal community.

3.1.119 Congress noted with appreciation that the developing Marine Climate Data System (MCDS, see paragraph 4.2.3.32) would be one of JCOMM's contributions to the implementation of the GFCS as the MCDS is meant to assure the flow to the long-term archives of the required marine meteorological and oceanographic observations, while providing higher level quality control, and added value.

Contributions to WIGOS and WIS

3.1.120 Congress noted with satisfaction the substantial contribution of observational data to WIGOS through monitoring programmes coordinated by the MMOP relying on the Observations Programme Area of JCOMM as reported under agenda item 4.2.2. Congress encouraged MMOP and JCOMM to continue to sustain and grow these observational programmes including the investigation of new methods and technologies (e.g. the use of submarine cables for climate monitoring and disaster warning). Congress urged Members to maintain and enhance their essential marine meteorological and oceanographic observation systems and to make available in real-time of the data collected by the systems, including ship-based sounding system, weather buoys, oil-rigs and the tide gauge network to WIGOS. In regard to WIGOS on Observation activities or WIGOS/WIS, Indonesia expressed its appreciation to the United States of America for the support in successfully conducting Indonesia Program Initiative of Maritime Observation and analysis (PRIMA) where collaborative observation has been executed in the Indian Ocean.

3.1.121 Congress noted with satisfaction the Commission's establishment of a cross-cutting Task Team for Integrated Marine Meteorological and Oceanographic Services within WIS (TT-MOWIS.) Congress agreed on the critical need to improve the interoperability of Marine Meteorological and Oceanographic (MMO) data and metadata standards, and ocean analysis and forecasting product standards in line with the WIGOS/WIS requirements. Congress encouraged significant partner organizations collaboration to build and activate the interfaces between MMO services and the WIS to improve data interoperability supporting improved ocean analyses and forecasting products.

3.1.122 As a contribution to the WIS, Congress requested the Commission to keep its Data Management Plan up-to-date, Congress recognized the importance of collecting and sharing instrument/platform metadata for ocean observations, with a view to enhanced traceability of the observations to standards, bias correction, and improved data consistency. It requested Members to ensure that the metadata are collected, recorded, and distributed in both real-time (for the required sub-set) and delayed mode through the Marine Climate Data System (MCDS), which is under development (see paragraph 4.2.3.34).

3.1.123 Congress noted the planning underway by the Scientific Committee on Oceanic Research (SCOR), IOC/UNESCO, and the Indian Ocean Global Ocean Observing System (IOGOOS) for the Second International Indian Ocean Expedition (IIOE-2) which will include missions to advance our understanding of oceanic and atmospheric processes and their interactions in the Indian Ocean. Congress encouraged Members to participate in this expedition reflecting the importance of Indian Ocean observing arrays and the potential of this science to improve marine products and services. Congress requested JCOMM to coordinate with interested Members to develop a coherent plan of collaboration.

Marine Services for the Polar Regions

3.1.124 Congress noted the significant value of current JCOMM programmes to the polar priority of WMO including the Global Cryosphere Watch (GCW) and the Global Integrated Polar Prediction System (GIPPS). Congress urged Members to actively maintain and enhance their marine observing platforms in the Polar Regions in recognition that essential observations will improve our understanding of changes in the cryosphere while also supporting improved forecasts and services. Congress also noted the valuable contribution of the JCOMM Expert Team on Sea Ice (ETSI) to the Global Cryosphere Watch (GCW).

3.1.125 Congress noted with approval the JCOMM collaboration with the IHO and IMO to support and enhance the polar components of the GMDSS through the development of a “Polar Code” supporting navigation in ice-infested waters for ships operating in the Polar Regions. Congress noted the significant results in developing updated sea-ice product standards achieved through the JCOMM Expert Team on Sea Ice and the International Ice Charting Working Group. Congress requested JCOMM to continue to develop and deliver such collaborations to improve marine services and to ensure ice information is available for mariners around the world.

3.1.126 Congress noted that JCOMM programme areas (from observations through predictions to services) all are integral to achieving the WMO priorities for the Polar Regions and requested JCOMM to prioritize their polar programmes and to seek opportunities to effectively integrate results achieved in operational marine services for Polar Regions.

Capacity Development

3.1.127 Congress noted the revised JCOMM Capacity Development Principles adopted at JCOMM-4 and agreed that JCOMM should work with, and build upon, existing WMO and IOC CD activities utilizing existing resources as much as possible to develop national structural and embedded capacity that can be sustained by national funding sources.

3.1.128 Congress appreciated the JCOMM capacity development activities to support Members in the conduct of marine meteorological and oceanographic observations, marine monitoring and the provision of services in support of marine safety. Congress encouraged the continuing training to support improved marine forecasts and services (including the METAREA coordinators) as well as training workshops such as those on wave and storm surge forecasting. Congress requested JCOMM, with the support of the Secretary-General, to continue to evaluate national and regional requirements for CD and to develop strategies for addressing identified deficiencies for the delivery of met-ocean programmes including observations, communications, data management, forecasting and services. Congress further encouraged Members to identify their developmental requirements and to participate actively in capacity-building activities including through the enhancement of

national and regional training facilities and programmes as well as through partnerships between Members.

3.1.129 Congress noted the participation of MMOP in the joint IHO/IMO/WMO/IOC/International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA)/International Atomic Energy Agency (IAEA) capacity development discussions within the United Nations system. Congress requested the Secretary-General and JCOMM continue to share information and work closely with other UN agencies to effectively utilize joint resources in the delivery of ocean-related capacity-building.

Quality Management

3.1.130 Recalling Resolution 26 of Cg-XVI on the WMO Quality Management Framework, Congress noted with appreciation the successful conclusion of the demonstration project for the International Organization for Standardization (ISO) 9001 certification of marine weather services that was conducted by the Australian Bureau of Meteorology on behalf of JCOMM. Congress noted the opportunity this project created and appreciated the resulting guideline document created to assist other countries in taking similar initiatives. Congress requested the Commission to continue to develop the quality management approach for marine and oceanographic services within the overall WMO approach and to encourage adoption of quality management by other Members. Congress noted that JCOMM had conducted an initial assessment of the functioning of the Commission following the ISO approach. Congress encouraged JCOMM in the continuing development of quality management processes and their application to the work of the Commission.

3.1.131 Noting the decision by the Executive Council at its sixty-fourth session (EC-64) to review and revise the WMO Technical Regulations, Congress noted the progress and emphasized the importance of the ongoing review and revision of the *Manual on Marine Meteorological Services* (WMO-No. 558) and the *Guide to Marine Meteorological Services* (WMO-No. 471). Congress requested that the Secretary-General submit amended regulations to the Executive Council, noting that both of these documents are referenced in external publications and particularly in IMO resolution A.(10527) regarding the Worldwide Met-ocean Information and Warming Service.

3.1.132 Congress noted that for an increasing number of Members, marine meteorological services are provided by the National Meteorological and Hydrological Services although without full special consideration for cost recovery for maritime service provision. It recommended that cost recovery be considered under risk management, and that a risk analysis be carried out in the intersessional period to allow for an evaluation of the impacts on Members and their NMHSs. Congress requested the co-presidents of JCOMM and the Secretary-General in consultation with IMO to consider this matter, taking into consideration other cost recovery processes such as with aviation services, in order to provide guidance to the Members concerned.

Competence Requirements for Marine Weather Forecasters

3.1.133 Recalling the recommendation of Cg-XVI to all technical commissions to define competency requirements for personnel performing core job-tasks, Congress appreciated that JCOMM had developed a set of qualification and competency requirements for marine weather forecasters (MWF). Similar to the requirements for aeronautical meteorological personnel that are already part of the WMO *Technical Regulations*, Volume 1, Chapter 5, the competency requirements for the MWF are to be incorporated in the *Technical Regulations* as a recommended practice.

3.1.134 Congress noted that the harmonization of the competence of MWF at the global level would take into account the considerable variations in the legitimate functions of the Marine Weather offices, including the local conditions (legal, climatological, user-driven). Noting further that, based on the experience in aeronautical meteorology, Members will need practical guidance on the implementation of the competency requirements, including well defined competency

assessment procedures, Congress requested that JCOMM develop such guidance material and advice to Members to enable an effective and harmonized implementation of the MWF competency requirements. Congress also considered the need for training of competency assessors on a regional basis to facilitate this process. Congress encouraged Regions to promote the implementation of the MWF competency requirements in their Region.

3.1.135 Congress adopted Resolution 6 (Cg-17) – Competence requirements for marine weather forecasters. Congress requested the Secretary-General to publish the new competency requirements for MWF in the 2015 edition of the *Technical Regulations*.

Future of the Marine Meteorology and Oceanography Programme

3.1.136 Considering the significant requirements for improved marine meteorological services (from observations through forecasts) and recalling the revised MMOP description as given in Annex IV to the present report, including its long-term objectives, purpose and scope, governance and programme structure, Congress kept in force Resolution 24 (Cg-XVI) – WMO Marine Meteorology and Oceanography Programme.

3.1.137 Congress noted with appreciation IOC Executive Secretary information, and noted the top priority allocated to the oceans for the building of the so-called "Blue Economy," and to the prediction of mega-disasters. Congress also noted with satisfaction the opening of the JCOMM Observing Programme Support Centre (JCOMMOPS) in Brest, France in March 2015, and the IOC's commitment to continue working jointly on ocean and meteorological aspects of safety of life and property at the coast and at sea, weather and climate services, and climate change adaptation and mitigation, as well as in the strengthening and development of Global Climate Observing System (GCOS) and the Global Ocean Observing System (GOOS).

Agricultural Meteorology Programme

Commission for Agricultural Meteorology

3.1.138 Congress noted with appreciation the progress achieved in implementing the Agricultural Meteorology Programme (AgMP) since the Sixteenth Congress in 2011. It also noted the report of the sixteenth session of the Commission for Agricultural Meteorology (*Abridged Final Report with Resolutions and Recommendations of the Sixteenth Session of the Commission for Agricultural Meteorology* (WMO-No. 1134)) which was approved by Resolution 9 (EC-66). Congress expressed its satisfaction with the successful implementation of the Programme according to the direction provided in the WMO Strategic Plan (2012–2015) and by the Sixteenth Congress (see agenda item 2.5). In addition, Congress noted the lead role of the AgMP in the Integrated Drought Management Programme (IDMP) and other WMO drought activities (see paragraphs 4.1.88–4.1.92).

3.1.139 Congress acknowledged with appreciation the work of the Secretariat in organizing the International Conference on Promoting Weather and Climate Information for Agriculture and Food Security that preceded the CAgM-16 session. Congress thanked the Government of Turkey for hosting the workshop and CAgM-16 session.

Implementation of the AgMP

3.1.140 Congress noted the contribution of AgMP to the Commission for Basic Systems (CBS) Severe Weather Forecasting Demonstration Project (SWFDP) for Eastern Africa especially with respect to the definition of agrometeorological user requirements for weather forecasting products and incorporation of improved forecast information in agrometeorological bulletins. Congress encouraged the two commissions to continue to liaise on SWFDP in the various regions of the world.

3.1.141 Congress noted that in addition to the impacts of air pollution on human populations it also negatively affects agricultural production. Congress encouraged CAgM and the Commission

for Atmospheric Sciences (CAS) to hold a joint workshop on Atmospheric Chemistry and Agricultural Meteorology in 2015 to review these impacts and to propose possible joint expert teams.

3.1.142 Congress noted that the CAgM International Workshop in 2014 recommended that a pilot project on using outputs from the World Weather Research Programme Sub-Seasonal to Seasonal Forecasting Project be developed for agricultural applications. Congress noted that the development of these pilot products would be undertaken by the Korea Institute of Science and Technology Information (KISTI) and Pukyong National University which works very closely with the Korea Meteorological Administration (KMA).

3.1.143 Congress noted the importance of phenology for monitoring the climate and that the Commission for Climatology (CCl) has traditionally been involved in this issue. Congress appreciated the work of CAgM in phenology and in coordinating with the International Society of BioMeteorology (ISB). Therefore, Congress requested both commissions and the Secretary-General to examine the establishment of a Joint CAgM/CCl Expert Team on Phenology which would also include the close collaboration with ISB.

3.1.144 Congress noted the need to develop standards and guidelines for in-situ agricultural meteorological measurements, especially for soil moisture, which can improve agricultural meteorological products and for the development of integrated in-situ and remote sensed products and information for Members. Congress supported the CAgM recommendation to establish and coordinate a Soil Moisture Demonstration Project (SMDP) to develop these standards, guidelines and activities which would also contribute to the objectives of the WMO Integrated Global Observing System (WIGOS) and the Global Framework for Climate Services (GFCS).

Regional activities in agrometeorology

3.1.145 Congress noted that most regional associations (RAs) have established, or are in the process of establishing, Working Groups on Climate Services with Sub-groups on Agricultural Meteorology. Congress agreed with the CAgM-16 recommendation that the Secretariat liaises with the RAs to establish these groups for all Regions. Congress noted that only three Sub-groups on Agricultural Meteorology (in RAs III, V, and VI) were able to meet. Congress urged the Secretary-General to make efforts to enable these groups to meet in the next intersessional period and to try to coordinate these regional meetings with CAgM Expert Team or Task Team meetings. It also recommended that team leaders from the RAs be invited to CAgM Implementation/Coordination Team (ICT) and other CAgM meetings.

World Agrometeorological Information Service (WAMIS)

3.1.146 Congress noted with appreciation that the WAMIS (http://www.wamis.org) now has products from over 60 countries and organizations and provides tools and resources to help countries improve their bulletins and services. Considering the benefits of WAMIS to Members, Congress urged Members to participate and disseminate their products to the global community. Congress acknowledged the assistance of the USA in providing support to the main and backup WAMIS server and Italy and the Republic of Korea in providing WAMIS mirror servers.

3.1.147 Congress thanked CAgM and KMA for ensuring with the infrastructural and technical assistance from KISTI that the WAMIS DCPC (Data Centre and Production Centre) is now operational. WAMIS DCPC aims to produce, collect, retrieve, and disseminate agricultural meteorology-related data across the globe, while providing web addresses of raw data as well as metadata. Congress appreciated the German Weather Service (DWD) for its collaboration with CAgM and KMA in using the WIS interface with the GEO Common Infrastructure (GCI) and as a potential DCPC backup. It was noted that the Qatar Meteorological Department (QMD), Brazil Meteorological Service (INMET) and the United States National Center of Atmospheric Research (NCAR) expressed their willingness to provide in-kind contributions to this effort. Congress encouraged the Secretary-General to consider expanding the capability of the WAMIS DCPC in the handling of non-meteorological data as well as providing access to Members.

3.1.148 Congress supported the efforts of the Secretary-General and WMO partners in developing WAMIS to assist WMO Members in disseminating agrometeorological bulletins and information. Congress supported the CAgM-16 recommendation to formally create a WAMIS Expert Team to work on the development of the WAMIS Next Phase. Congress appreciated the new mirror servers in Australia and Brazil in RAs V and III and endorsed the expansion of additional WAMIS web nodes to provide platforms to test and demonstrate web-based agrometeorological applications.

3.1.149 Congress noted the request of Members for operational exchange of meteorological and environmental information on in-situ measurements and forecasts of allergenic reactive pollen. CAgM and CBS are requested to develop content and a format for the exchange of this information.

Training and Capacity-building

3.1.150 Congress appreciated the outcomes of the METAGRI project (2008–2011) and METAGRI OPERATIONAL project (2012 onwards) and thanked the Spanish State Meteorological Agency (AEMET), the Government of Greece, and the Ministry of Foreign Affairs of the Norwegian Government for providing financial support to these projects which enabled 17 West African NMHSs to organize Roving Seminars on Weather, Climate, and Farmers in their countries. Congress noted with satisfaction that through these projects, a total of 350 seminars were organized and around 14,000 persons were trained. A total of 7,200 simple raingauges were distributed to farmers. Congress encouraged that feedback from farmers and recipients of the raingauges be obtained in order to build on progress made so far in the projects and to ensure their sustainability.

3.1.151 Congress was made aware that only 10% of the participants of the Roving Seminars were women. Congress noted the outcomes and lessons learned from the WMO Conference on Gender and encouraged the Secretary-General to help Members increase the participation of women in Roving Seminars, CAgM formal meetings and other activities.

3.1.152 Congress noted the preliminary comparisons of the rainfall measurements of simple raingauges distributed to farmers under the METAGRI OPERATIONAL project with the standard raingauge measurements made by NMHSs have shown a very high correlation. Congress requested the Secretary-General to continue these comparisons and pursue standardization of the simple plastic raingauges, through collaborative efforts among the Commission for Instruments and Methods of Observation (CIMO), Commission for Hydrology (CHy), CCl and CAgM. Congress noted that this activity would also contribute to the WIGOS.

3.1.153 Congress expressed its appreciation that the Secretariat was able to provide support to the NMHSs of India, Croatia, Ecuador, Peru, Romania and the Republic of Moldova to organize Roving Seminars on Weather, Climate and Farmers. Congress requested the Secretary-General to make efforts to mobilize financial resources to support, to the extent possible, Roving Seminars in other countries as well as dialogue roundtables between farmers and providers of weather and climate information, and to liaise with other United Nations agencies such as the Food and Agriculture Organization of the United Nations (FAO) in organizing these Seminars and to continue promoting Roving Seminars as a useful tool to convey weather and climate information to final users.

3.1.154 Congress noted that since 2007 Indonesia has held Climate Field School programmes in order to improve the understanding of farmers and extension workers on weather and climate phenomena through training. Congress also noted that the ‘learning by doing’ process serves is effective for transferring climate knowledge or climate information to farmers. Congress recognized that Climate Field Schools involve real engagement and provide a User Interface Platform, one of the GFCS components. Congress requested the Secretary-General to facilitate efforts for mobilization of financial resources to support such Climate Field School programmes in other regions. Congress also expressed its appreciation for the successful completion of a Training of Trainers of Climate Field School for Agrometeorological Staff from NMHSs in Asia-Pacific

countries that was held from 26–29 August 2014 at the Indonesia-RTC, Citeko, Indonesia. Congress recognized this programme as a regular programme in the Indonesia-RTC and urged the Secretary-General to find funding for this activity to ensure its continuation.

3.1.155 Congress noted with appreciation the successful completion of the following projects coordinated and facilitated by the AgMP: Training of Trainers on Weather and Climate Information and Products for Agricultural Extension Services in Ethiopia with the National Meteorological Agency of Ethiopia (NMAE), funded by the Rockefeller Foundation, and the Caribbean Agrometeorological Initiative (CAMI) project funded by the European Union. Congress recommended that the Secretary-General continue to support similar projects in the future and to ensure that there are sufficient human resources engaged with donor funds to adequately manage any future project.

3.1.156 Congress noted the concern of the president of CAgM with regards to the decline in the number of agricultural meteorologists especially in the NMHSs. Congress encouraged Members to develop an understanding of what is behind this decline and what can be done to reverse this trend, and to share these findings with the AgMP. Congress requested Members to actively collaborate with the AgMP to develop and train future agricultural meteorologists in order to improve the provision of weather and climate information from their national Services to the agricultural community in their countries.

Partnerships

3.1.157 Congress expressed its appreciation for continued collaborative activities between WMO and a number of international and regional organizations in implementing the AgMP, such as the Convention on Biological Diversity (CBD), the United Nations Convention to Combat Desertification (UNCCD), FAO, the World Food Programme (WFP), GEO and the Global Agricultural Monitoring (GEOGLAM) project, the COST Actions of the European Science Foundation, World Farmer's Organization (WFO), the Regional Training Centre for Agrometeorology and Operation Hydrology and their Applications (AGRHYMET) and the African Centre of Meteorological Application for Development (ACMAD). Congress encouraged the continued linkages with these organizations to assist with the work of the AgMP and other WMO activities such as GFCS, WIGOS, and WIS.

3.1.158 Congress especially noted the establishment of the Global Alliance for Climate Smart Agriculture (GACSA) in September 2014 at the United Nations Climate Summit. Congress recognized that the work of CAgM contributes to the goals of GACSA and that CAgM could therefore effectively share its expertise with the GACSA. Congress agreed that WMO join the GACSA with CAgM as its main representative.

AgMP and CAgM contributions to GFCS

3.1.159 Congress appreciated the contribution of the president of the Commission and other CAgM members in developing the GFCS Agriculture and Food Security Exemplar. Congress supported the CAgM recommendation which created the User Interface Platform for Agriculture and Food Security (UIP-AFS) within the Capacity Development Focus Area of the CAgM structure and requested the Secretary-General to continue to collaborate with the various United Nations agencies on this UIP. Congress endorsed the organization of a UIP-AFS meeting in 2015/2016 to develop user requirements based on the needs of selected countries and update the workplan.

3.1.160 Congress noted that as requested by CAgM-16 (agenda item 5.1.4), a concept note on the Global Initiatives in Agricultural Meteorology (GIAM) has been developed. It also noted that GIAM correspond to each pillar of the GFCS and facilitate and support the contribution of CAgM and AgMP to the objectives of the GFCS. Congress agreed that these initiatives support and complement the work of CAgM. Congress requested the CAgM president and the Secretary-General to provide updates on GIAM as part of the CAgM workplan implementation. Congress appreciated that the KMA made a commitment to provide a coordination office for the better implementation of GIAM. Congress supported the efforts of the president to involve external

entities in the development of GIAM concepts and implementation plans, especially with Nanjing University of Information Science and Technology (NUIST). Therefore, Congress endorsed the GIAM concept note (see Annex V to the present report) and requested the Secretary-General to use the GIAM framework as a basis for aligning CAgM and AgMP support to GFCS.

WMO Strategic Plan

3.1.161 Congress requested the Secretary-General to take necessary actions, to the extent possible within available budgetary resources, to support Members in their efforts to implement, at the national level, the priority activities of the AgMP as described in the WMO Strategic Plan 2016–2019, including support for their efforts in the following:

(a) Improving service quality and service delivery;

(b) Advancing scientific research and its application, as well as the development and implementation of technology to support sustained services outcomes on all scales and especially to address the challenges of managing climate risks and adapting to climate variability and change;

(c) Strengthening capacity development through agricultural meteorological training at the regional, national and local levels;

(d) Building and enhancing partnerships and cooperation through working in collaboration with other WMO technical commissions and Members, United Nations agencies and other relevant organizations, to create synergies and to support improved agricultural production and economic development.

3.1.162 Congress noted that Resolution 22 (Cg-XVI) on the AgMP is still in force. It also decided to maintain AgMP for the period 2016–2019 as described in Annex II to the Report of the Sixteenth World Meteorological Congress and to implement the key priorities for the Programme as decided by CAgM-16 and informed by the WMO Strategic Plan.

Quality Management in Service Delivery – Current status and future development

3.1.163 Congress recalled that the WMO Quality Management Framework (QMF) was initiated at its fourteenth session in 2003 with the aim of promoting the implementation of quality management as a good practice for the NMHSs. The QMF was also intended as a response to the then new ICAO requirements for quality management of the meteorological information supplied to the aviation users.

3.1.164 Congress recalled further that, due to the cross-cutting nature of the QMF and the engagement of all technical commissions in its realization, EC-LVI (2004) established an Inter-Commission Task Team on Quality Management Framework (ICTT-QMF). The main tasks of the ICTT-QMF were to coordinate relevant Members' quality management activities and monitor progress, as a basis for development of WMO regulatory and guidance material. During the sixteenth financial period, following a recommendation by EC-LXIII (2011), the tasks of the ICTT-QMF have been transferred to a Task Team on Quality Management Systems (TT-QMS) under the Commission for Aeronautical Meteorology (CAeM) with a focus on assisting Members to achieve compliance with the requirements for QMS for aviation services that became ICAO and WMO standards in November 2012.

3.1.165 Congress appreciated the proactive work of the TT-QMS in assisting Members' implementation activities which resulted in a significant increase of the total compliance of WMO Members with the QMS requirements for the provision of services to aviation. Congress expressed its gratitude to the Members who had provided generic QMS material such as forms, processes and procedures, etc. for uploading onto the website for use by other Members to improve their QMS. Congress commended in particular the Bureau of Meteorology of Australia for their active support to the TT-QMS and for hosting a website with online resource material on QMS

(http://www.bom.gov.au/wmo/quality_management.shtml). Congress also appreciated the availability of QMS-related guidance on a "moodle" website hosted by the UK Met Office (http://www.caem.wmo.int/moodle/). These online resources proved to be very helpful to Members in developing their national quality management capacity.

3.1.166 Congress noted that, in addition to the aviation, other WMO application programmes have been addressing the quality management aspects of their service areas. The WMO Strategy for Service Delivery has recognized the implementation of a QMS as a vital tool in the continual enhancement of products and services provided by the NMHSs resulting in increased effectiveness, efficiency and customer/user satisfaction. The QMS is of particular importance in the provision of decision-supporting services to economic sectors and general public with the purpose of minimizing the weather-related risks, thus, the QMS is considered as an element of the wider risk- or safety-management of the respective organizations. Therefore, Congress encouraged further expansion and formalization of the QMS approach across such service areas and agreed that quality management should be established as a recommended function and managerial practice to be implemented by Members with regard to services provided in support of users' decisions with high economic and social impact.

3.1.167 Congress noted further the ongoing development of quality management aspects of other programme areas, like WIGOS and WIS, HWRP, WCP/WCSP, GFCS, DRR, GAW, etc. Several different expert bodies have been established by the technical commissions concerned to address quality management aspects of the respective programmes. However, it was understood that the quality management focus may vary from programme to programme, e.g., in some areas the main concern is about quality of observational data and related information derivatives, while in other areas the concern is on the availability of a recognized/certified QMS that warrants quality in accordance with a service level agreement. Therefore, Congress agreed that the WMO QMF should be further developed to streamline the quality actions of different programmes, technical commissions and expert bodies to ensure their consistency as part of the overarching organization-wide QM policy.

3.1.168 Congress appreciated the development and publication of the WMO *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100) which provided generic guidance on how to develop and implement a QMS to ensure and enhance the quality of products and services of the NMHSs. Congress acknowledged that a number of NMHSs have already implemented a QMS conformant with the ISO 9001 for the whole range of products and services they provide (e.g., in RA VI, about 50% of the NMHSs have implemented an organization-wide QMS in conformity with ISO 9001 standard). Congress strongly encouraged Members to consider the ISO 9001 certification as a best practice that adds to the credibility, visibility and competitiveness of their NMHSs.

3.1.169 Congress considered the regulatory aspects of the QMF as presented in the WMO *Technical Regulations, Volume IV, Quality Management* (WMO-No. 49, Vol. IV), and recommended a critical review of this material in view of raising its usefulness to Members and WMO Programmes. Congress also recommended a revision of the WMO Quality Policy adopted in 2007, as well as the development of a new document on the WMO QMF to cover in a holistic way the various aspects of the quality management being developed and implemented through different WMO Programmes. Such a generic QMF document should complement the WMO Strategic Plan, thus, promoting a long-term commitment to quality in all activities of Members and their NMHSs.

3.1.170 Congress endorsed the need for furthering the organization-wide QMF as a comprehensive and structured approach to organizational management that seeks to improve the quality of products and services through ongoing refinements in response to continuous feedback. Congress noted further that a new ISO 9001:2015 standard would become applicable from September 2015 bringing some significant changes, including a focus on leadership and risk management. All this would require development of further guidance to Members and capacity-building efforts supported by a suitable expert body, and by adequate resources within the Secretariat. Congress suggested that such new QM expert body should preserve the expertise and

experience gained by the previous bodies – ICTT-QMF and TT-QMS, and requested the Executive Council to consider establishment of such a body in its future work structure.

3.1.171 In this respect, Congress approved Resolution 7 (Cg-17) – WMO Quality Management Framework.

Amendment of Competency and Qualifications Provisions in the WMO *Technical Regulations*, Volume I (WMO-No. 49)

3.1.172 Congress recalled that the current edition of the WMO Technical Regulations Volume I (WMO-No. 49), contained provisions related to competencies and qualifications of aeronautical meteorological personnel. Congress welcomed advice that during this intersessional period a number of the technical commissions had acted upon the request of Cg-XVI to develop competency provisions in service domains. Congress recognized that in order to accommodate these and future competency provisions, typically as recommended practices within the Technical Regulations, it was necessary to restructure Chapter 5 of Volume I.

3.1.173 Congress agreed that in the restructuring of Chapter 5 it was necessary to define the terms “qualification”, “competency” and “operational personnel”. Congress noted the definition of operational personnel was adapted from that used within ICAO and this provided further consistency in this area between the two organizations. Congress further appreciated that in reviewing the general provisions for this chapter it was necessary to incorporate QMS principles related to Members record keeping and competency assessment programmes, and that these general provisions were introduced with due account to the local conditions, requirements and procedures in WMO Member States. Congress requested all Technical Commissions, particularly the Commission for Aeronautical Meteorology, to keep their qualification and competency requirements under review due to changes in science, technology and service requirements and to incorporate lessons learnt from the implementation of these practises. Congress adopted Resolution 8 (Cg-17) – Amendment of competency and qualification provisions in the *Technical Regulations* (WMO-No. 49), Volume I.

3.2 WMO disaster risk reduction services – Priority (agenda item 3.2)

Disaster Risk Reduction Programme

3.2.1 Congress reemphasized that reducing disaster risks from hydrometeorological hazards, such as strong winds and severe storms, tropical cyclones, flash floods, storm surges, droughts, wild fires, heat waves, landslides, sand and dust storms, marine and aviation hazards etc., is one of the strategic priority areas of WMO. Congress stressed that the protection of lives, livelihoods and property in society should be promoted through strengthening the capacities of the National Meteorological and Hydrological Services (NMHSs) in disaster risk reduction (DRR) at local, national, regional, and international levels. In this context, Congress recalled its decision to establish the cross-cutting DRR Programme through Resolution 29 (Cg-XIV), the vision and strategic priorities of which were underpinned by the Hyogo Framework for Action 2005−2015: Building the Resilience of Nations and Communities to Disasters (HFA) adopted by 168 countries at the Second World Conference on Disaster Reduction held in Kobe, Japan, in 2005.

3.2.2 Congress stressed that NMHSs need to provide products and services to a diverse group of DRR stakeholders, including government authorities, public and private sectors, non-governmental organizations (NGOs), the general public, the media, etc. Hence, the DRR Programme adopts a user-driven approach in the development of DRR products and services to provide support in thematic areas such as hazard and risk analysis, multi-hazard early warning systems (MHEWS), sectoral risk management, humanitarian planning and response, and disaster risk financing and financial risk transfer mechanisms (ref.: Resolution 8 (EC-64)).

3.2.3 Congress reiterated that the DRR Programme is cross-cutting and is inextricably linked to other WMO technical programmes, technical commissions (TCs), and regional associations (RAs). Hence, the activities of WMO constituent bodies, global operational and research networks,

as well as strategic partners, should be aligned with the DRR Programme when assisting NMHSs to implement an integrated approach to the development and delivery of weather, water, and climate services to DRR stakeholders and user communities. Therefore it is important for the DRR Programme to ensure careful coordination across the full range of WMO constituent bodies.

3.2.4 Congress noted that the Sendai Framework for DRR 2015–2030 was adopted at the Third United Nations World Conference on Disaster Risk Reduction (WCDRR) held in Sendai, Japan, from 14 to 18 March 2015. The new Framework addresses four priorities for action:

(a) Understanding disaster risk;

(b) Strengthening disaster risk governance to manage disaster risk;

(c) Investing in DRR for resilience; and,

(d) Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction;

and defines the role of stakeholders and of international cooperation and global partnership.

3.2.5 Congress further noted that WMO Members contribute with a number of activities to each priority for action of the Framework, especially for priority for action 4, referring to the Global Framework for Climate Services (GFCS) and hydrometeorological issues, and highlighted that its global target number 7, which reads "substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030", is particularly relevant to WMO (ref.: paragraphs 3.2.42–3.2.73).

Achievements and progress regarding disaster risk reduction service delivery

3.2.6 Congress acknowledged that nearly all RAs, TCs, and technical programmes contribute to the DRR priority and the DRR Programme's fundamental objective of assisting Members with the delivery of DRR products and services in a cost-effective and sustainable manner in support of the safety of life, livelihoods, and property. Congress noted in particular the outcomes and achievements of activities of different programmes in support of this objective as follows:

Progress in the implementation of multi-hazard early warning systems

(a) The publication Institutional Partnerships in Multi-Hazard Early Warning Systems containing seven good practices in MHEWS from Bangladesh, the megacity of Shanghai in China, Cuba, France, Germany, Japan, and the USA, with a sound foundation in risk assessment across multiple hazards being a fundamental part of each of the MHEWS in the seven countries;

(b) Better observation and monitoring of hazards, improved forecasting and warning services, and the rapid advances in technical capabilities to improve dissemination leading to advances in MHEWS;

(c) Emphasis on institutional commitment and effective coordination as the key to developing end-to-end user-oriented, impact-based warning systems for multiple hazards and the requirement for a strong political recognition of the importance of MHEWS;

(d) Improvement of MHEWS by incorporating impact and risk information related to extreme weather and climate change to forewarn and guide individuals, groups and communities at risk, as well as decision-makers, in taking appropriate action on preventing and reducing disaster losses (ref.: paragraphs 3.1.34–3.1.62);

(e) Implementation of standardized dissemination technologies such as the Common Alerting Protocol (CAP) in NMHSs as an effective tool for the dissemination of public warnings, and to register their alerting authorities in the WMO Register of Alerting Authorities (ref.: paragraphs 3.1.34–3.1.62);

Advances in forecasting hydrometeorological hazards and delivery of warning services

(f) Improving the ability of NMHSs to forecast severe weather events e.g. through the "Cascading Forecasting Process" (global to regional to national) which is being implemented through the WMO Severe Weather Forecasting Demonstration Project (SWFDP) (ref.: paragraphs 4.1.7–4.1.35) and through the Flash Flood Guidance Systems (FFGS); and enhancing the lead-time and reliability for warnings (ref.: paragraphs 3.1.34–3.1.62);

(g) Reducing vulnerability by improving operational forecasts and warning capability on the risks and probable impacts from coastal inundation, caused by storm surge, astronomical tides, waves, and sea surface elevation anomalies, through the WMO Coastal Inundation Forecasting Demonstration Project (CIFDP) (ref.: paragraphs 3.1.100–3.1.137);

Improving in flood and risk management

(h) Improved flood and flood risk management through the Associated Programme on Flood Management (APFM) (ref.: paragraphs 4.1.93–4.1.136), in collaboration with the Global Water Partnership (GWP), by compiling and producing guidance documents and tools in support of integrated flood and flood risk management;

Improving drought management

(i) Strengthened drought policy, monitoring, early warning and risk management, through the Integrated Drought Management Programme (IDMP) (ref.: paragraphs 4.1.49–4.1.92);

Storm surge watch scheme

(j) Increased utilization of Regional Specialized Meteorological Centres (RSMC) advisories through inclusion of storm surge information in the advisories by a number of RSMCs working on tropical cyclones (ref.: paragraphs 3.1.63–3.1.99);

Emergency Response Activities (ERA)

(k) Effective response to environmental emergencies associated with airborne hazards, for example, caused by nuclear accidents or events, volcanic eruptions, chemical accidents, smoke from large fires, and other events, which require emergency atmospheric transport and dispersion modelling (ATM) support (ref.: paragraphs 4.1.36–4.1.48).

DRR User-Interface Expert Advisory Groups (UI-EAGs)

3.2.7 Congress recalled the endorsement by EC-64 of four DRR User-Interface Expert Advisory Groups (UI-EAGs) in four DRR priority thematic areas, including:

(a) Hazard and risk analysis and assessment;

(b) MHEWS;

(c) Climate services for disaster risk financing;

(d) Hydrometeorological services for improved humanitarian planning and response.

These UI-EAGs were established to:

(a) Guide the documentation of good practices and the development of user needs and requirements for products and services to support thematic areas in DRR decision-making;

(b) Support the development of and provide feedback on the WMO DRR knowledge products;

(c) Support the implementation of the DRR Work Plan 2012–2015;

and the membership of these thematic UI-EAGs includes leading experts from the DRR user community (public and private sectors), United Nations and other international partner agencies from humanitarian and development communities, academia, as well as from the NMHSs and the DRR Focal Points of TCs and technical programmes (DRR FP TC-TP).

3.2.8 Recognizing the work of these UI-EAGs and their contribution to DRR-related activities of WMO, Congress encouraged the continuation of such user-driven approaches in the development of DRR knowledge products, science-based and risk-informed services, and in the implementation of demonstration projects. Congress requested the Secretary-General to develop a set of clear deliverables to allow progress to be tracked.

National DRR capacity development projects with regional cooperation frameworks

3.2.9 Congress noted the successful completion of the Costa Rica Early Warning Systems for Hydrometeorological Hazards Project in 2013 funded by the Global Facility for Disaster Reduction and Recovery (GFDRR). The purpose of the project was to develop an effective framework for an operational EWS, with the Sarapiquí River basin serving as a pilot area, and to strengthen coordination and cooperation among the National Meteorological Institute (IMN), the National Commission of Risk Prevention and Emergency Response (CNE), and the Instituto Costarricense de Electricidad (ICE). This collaboration among national government agencies and NGOs at the local level aimed at strengthening emergency preparedness and response, and included community participation in the implementation and development of this Project. Congress expressed its appreciation to IMN for its active collaboration in the implementation of this Project. Congress stressed the need to build on the lessons learnt from this Project and encouraged further expansion of such national DRR capacity development projects with regional cooperation frameworks.

3.2.10 Congress noted that a binational project between Ecuador and Peru in the Zarumilla River Basin for a flash flood system is being developed and will be implemented by WMO. Congress further noted that in RA III, Brazil (INMET) has developed, with initial financial support from the Ibero-American Cooperation Programme, the EWS called ALERT-AS for the Southern Part of South America. The system is operational in Brazil and will be extended to the NMHSs of Argentina, Paraguay, and Uruguay. The system uses as input different sources of meteorological information as well as information from civil protection on past extreme weather-related events and impacts. The dissemination of warnings is done through the Common Alert Protocol (CAP).

3.2.11 Congress noted that a Workshop on MHEWS for Urban Areas was held in December 2013 in Costa Rica in which a number of representatives from Central and South American as well as Caribbean countries participated. The focus of the workshop was on the development of MHEWS for weather-, climate-, and water-related hazards for medium to large cities. Within this context, the workshop highlighted the importance of a strong partnership between national disaster risk management (DRM) agencies, NMHSs, local governments, and civil society.

3.2.12 Congress noted with satisfaction that the second phase of the South-east European project Building Resilience to Disasters in the Western Balkans and Turkey, funded by the European Commission (Directorate-General for Enlargement), in cooperation with the United Nations Office for Disaster Risk Reduction (UNISDR), was completed in 2014. The Project considered seven beneficiary countries in the Western Balkans and Turkey which are exposed to a range of similar natural hazards. The project strengthened cooperation among national agencies and promoted regional cooperation. Congress supported the multi-national approach taken in this Project, including the project recommendations which include further actions in building a multi-

hazard early warning platform which will contribute to better collaboration and harmonization of warnings and advisories in the region.

3.2.13 Congress noted that during 2010–2011, WMO with support from regional and international partners, conducted an assessment of the institutional and technical capacities and needs of the Caribbean region to support MHEWS and risk assessment. The project included a number of MHEWS training workshops and meetings. Congress highlighted that these activities provide the foundation for future capacity development projects in the region.

3.2.14 Congress noted the progress made in rehabilitating the NMHS in Haiti following its destruction by the earthquake in 2010 (ref.: agenda item 5.3). The rehabilitation, funded by Environment Canada, has resulted in better working conditions for the staff; construction of a new hurricane-proof and earthquake-resistant building has commenced; and access to basic information and data has been secured. Collaboration with the World Bank Pilot Program on Climate Resilience (PPCR, to commence in June 2015) has been strong from the onset. Congress noted that challenges such as establishing the appropriate mechanisms for the access to data, timely payment of salaries, and ownership of equipment continue to exist, and requested the Secretary-General to continue to support the Haiti NMHS.

3.2.15 Congress urged the RAs, with support from the Secretariat, to document lessons learnt from the approach of the DRR Programme and the engagement of the RAs in the implementation of the DRR capacity development projects and to submit recommendations to EC on how the RAs can be effectively engaged in promoting this approach in other WMO Regions.

Knowledge products

3.2.16 Congress noted the efforts undertaken and underway to develop guidelines, standards, assessment reports, and training modules in the main areas of work of the DRR Programme that are consistent with Quality Management System (QMS) principles and that are to be demonstrated and further developed in the afore-mentioned capacity development projects. Effective service delivery to local, regional, and national stakeholders remains the principle focus of the NMHSs. Supporting knowledge of MHEWS, disaster risk financing, DRR and climate adaptation policies, institutional and financial planning, sectoral risk management and operations can also help inform NMHSs in respect of prioritized service delivery. Congress therefore requested the Secretary-General to provide further guidance to Members in this area.

3.2.17 Congress noted with appreciation the publication of several DRR knowledge products including:

(a) *Strengthening of Risk Assessment and Multi-hazard Early Warning Systems for Meteorological, Hydrological, and Climate Hazards in the Caribbean* (WMO-No. 1082, 2011);

(b) *Institutional Partnerships in Multi-Hazard Early Warning Systems: A compilation of seven national good practices and guiding principles* (WMO, 2012);

(c) *Strengthening Multi-Hazard Early Warning Systems and Risk Assessment in the Western Balkans and Turkey: assessment of capacities, gaps and needs* (DRR-SEE-1, 2012);

(d) *Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes* (1970–2012) (WMO-No. 1123).

3.2.18 Congress stressed the importance of DRR training materials, which can also help strengthen national institutional arrangements. Congress noted that a significant amount of training modules have been developed by Members and Regional Training Centres (RTCs) that could be extended and elaborated through the introduction of additional materials from partners such as the World Bank and other partner United Nations agencies. Congress requested the Secretary-

General to arrange for a review and regular updating of these training modules and programmes and to facilitate access to these materials as a contribution to WMO's Capacity Development Strategy. Congress requested the Secretary-General to include a review of DRR-related training materials as part of the WMO DRR Roadmap implementation.

Contribution of DRR-related programmes to the Global Framework for Climate Services

3.2.19 Noting that DRR is one of the priority areas of the GFCS and that the implementation of the DRR activities can demonstrate the value of climate services to risk-based DRR decision-making, Congress agreed that the UI-EAGs can contribute to the GFCS User Interface Platform (UIP), and that the deliverables of the WMO DRR Roadmap are relevant to strengthening of the UIP.

Coordination with technical commissions and technical programmes

3.2.20 Congress noted the establishment of the DRR FP TC-TP through nominations by the presidents of TCs (PTC) and relevant coordinating mechanisms of other technical programmes in 2013, and the progress underway to map the roles and relevant activities of TCs and RAs and to develop processes for their coordination in the implementation of the DRR Programme activities. Congress requested the DRR FP TC-TP to include DRR focal points of the regional associations.

3.2.21 Noting the recommendation of DRR FP TC-TP and subsequent recommendations of the meeting of the PTC in January 2014 to initiate a DRR demonstration project in South-East Asia that focuses on capacity development for risk analysis and MHEWS, Congress requested the Secretary-General, together with the PTC and with support from the DRR FP TC-TP, RA II, Members and partners, to facilitate the scoping of the proposal to complement existing relevant projects and activities in order to avoid duplication. Congress requested the Secretary-General to provide relevant information including the scoping of the proposal for consideration by EC.

3.2.22 Congress noted the work of the Commission for Basic Systems (CBS) Task Team on the Provision of Operational Meteorological Assistance to Humanitarian Agencies, through the Global Data-Processing and Forecasting System (GDPFS) and Public Weather Services (PWS) Programme, as a direct contribution from CBS to the DRR priority as an UI-EAG. Congress acknowledged the continued collaboration with the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) in the comprehensive review of the requirements for operational meteorological and hydrological products and services by humanitarian agencies, which would lead to the development of procedural arrangements for the provision of meteorological and hydrological assistance to humanitarian contingency planning, preparedness and early warning, and response and recovery activities. Congress therefore requested CBS, in collaboration with the Commission for Climatology (CCl) and the Commission for Hydrology (CHy), and in coordination with UNOCHA, to continue to work on the revision, with appropriate testing, of the Arrangements for the Provision of Meteorological Assistance to United Nations Humanitarian Missions, which are described in the *Manual on the Global Data-processing and Forecasting System* (GDPFS) (WMO-No. 485, Vol. I, Appendix 1-5).

Coordination with regional associations, national and regional Platforms for DRR and forums

3.2.23 Congress stressed the critical role of the RAs in the implementation of WMO DRR projects at national and regional levels by providing input on the needs and priorities of the Members and the Regions and encouraged the presidents of the RAs to facilitate collaboration with the regional inter-governmental DRM organizations. Congress urged the participation of NMHSs and RAs in the national, regional, and global DRR platforms as this will lead to strengthened partnerships and cooperation for the identification and implementation of DRR capacity development projects. Cooperation with civil protection and planning agencies in national and regional Platforms for DRR and forums are particularly important as long and short-term decisions are taken on that level. Congress stressed the importance of engaging the RAs, through their various DRR task teams or working groups, in DRR capacity development projects to provide

advice and expertise on implementation, review, and evaluation of the outcomes, and recommendations for improvements, sustainability, and scaling up of the projects.

Response to major disasters related to hydrometeorological hazards since Cg-XVI

3.2.24 Congress highlighted that there have been a number of disasters during the intersessional period. It particularly noted the devastation caused by the earthquake in Nepal in April 2015, super typhoon *Maysak* in the Federated States of Micronesia in April 2015, severe tropical cyclone *Pam* in Vanuatu on 14 March 2015, severe tropical cyclone Ian in Tonga in January 2014, the severe Balkan floods in 2014, the significant disaster that affected the Southern Africa Development Community (SADAC) countries in 2010, 2014 and 2015 such as the flooding in Zimbabwe in February 2014, typhoon *Haiyan* which devastated the central Philippines in November 2013, the Solomon Islands earthquake and tsunami in February 2013, and cyclone Evan which struck Fiji in 2012.

3.2.25 Congress noted with appreciation the efforts of the Secretariat to facilitate a coordinated response to NMHSs following these disasters. Noting that major disasters such as the earthquake in Nepal and floods in the Balkan peninsula have an international dimension and require coordinated response from a broader range of agencies and organizations and the need for improved and effective communication and the need for sustained public educational efforts to increase the awareness, understanding and preparedness of the public to the risks of the hazards and to take appropriate actions in response to the authoritative warnings, Congress requested the Secretary-General, in coordination with the TCs, RAs, RSMCs, and other operational centres to analyse the issue and develop a draft working arrangement that elaborates the roles and responsibilities for the coordination of WMO's response to Members' requests for assistance, noting that operational responsibility lies with the Members, and to report to EC for consideration.

Identifiers for cataloguing extreme weather and climate events

3.2.26 Regarding extreme weather and climate events and their reporting by Members, Congress noted the emphasis of the Sendai Framework for DRR 2015−2030 on the need for substantial reduction in disaster losses through the implementation of policies and practices for DRM based on an understanding of disaster risk in all its dimensions, including hazard characteristics. In this connection, Congress noted the need for systematic characterization and cataloguing of extreme weather and climate events in a form that allows data on losses and damage to be cross-referenced to these phenomena. In this regard, Congress recognized the Caribbean Climate Impacts Database (CCID) launched in Saint Lucia in May 2015, which archives impact information (including damage and loss information) associated with extreme weather and climate events in the Caribbean as a positive step in this direction.

3.2.27 Congress noted that several TCs including CCl, the Commission for Agricultural Meteorology (CAgM), CHy, CBS, the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), the Commission for Atmospheric Sciences (CAS), as well as RAs and relevant technical programmes are addressing different aspects of extreme events such as sector-specific indices, definitions of extreme weather and climate events, the development of extremes-related climate services, etc., and that this work needed to be consolidated.

3.2.28 Congress adopted Resolution 9 (Cg-17) – Identifiers for cataloguing extreme weather, water and climate events.

Partnerships for disaster risk reduction

3.2.29 Congress noted the partnership of WMO with global and regional organizations and international agencies in different regions that influence DRR policies, planning, funding, and institutional development, such as UNISDR, the International Federation of Red Cross and Red Crescent Societies (IFRC), United Nations regional economic groupings (e.g. the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)), development banks (World Bank in particular); and with academia and the private sector. By considering the necessity

and importance of NMHSs in all phases of the disaster risk management process not only for hydrometeorological disasters but also for all other types of disasters, Congress further noted that relations and partnerships with disaster risk management authorities, other national bodies and regional and global stakeholders should be improved for the efficient management of all disasters, including the reduction of risks and the prevention of creating new risks.

3.2.30 Congress noted that the Global Disaster Alert and Coordination System (GDACS), a cooperation framework between the United Nations (UNOCHA, the Operational Satellite Applications Programme of the United Nations Institute for Training and Research (UNITAR/ UNOSAT), the European Commission (through its Joint Research Centre (JRC)), and disaster managers worldwide to improve alerts, information exchange and coordination in the first phase after major sudden-onset disasters, is in the process for registering with the WMO Information System (WIS). Congress recalled the caution of EC-66 that the alerts and warnings from GDACS should not undermine the authoritative meteorological, hydrological and other environmental hazard warnings issued by NMHSs. Congress encouraged GDACS to use the authoritative information available through WIS and noted that information provided by GDACS through WIS could be helpful to Members in managing their preparations for and responses to disasters. Congress reminded all WIS Centres, including GDACS and other similar platforms, to take utmost care and ensure that any guidance they publish through WIS does not detract from warnings issued by registered alerting authorities. Congress therefore requested the Secretary-General to engage in a comprehensive dialogue with GDACS and other third-party service providers to facilitate improved cooperation and coordination of activities, while stressing the need to emphasize the mandated role of the NMHSs.

3.2.31 Congress requested the Secretary-General to further strengthen WMO partnerships with UNISDR and other relevant partners for the implementation of national and regional DRR projects in line with the Sendai Framework for DRR 2015–2030, including the partnerships of RAs, bodies such as the regional typhoon/hurricane committees which in many cases have existing DRR working structures, and WMO Regional Offices with regional bodies of international organizations and other partners.

WMO DRR Roadmap

3.2.32 Congress noted Resolution 8 (EC-66) requesting the Secretary-General to “urgently develop a WMO DRR Roadmap of prioritized and realistically achievable activities and deliverables, that are consistent with the WMO Strategic and Operating Plans, as well as the work plans for relevant WMO Programmes and projects”.

3.2.33 Congress emphasized that WMO DRR activities are based upon, and are in support of, the core work of NMHSs. Hence, the WMO DRR Programme should, in close collaboration with relevant technical programmes, and in particular the PWS Programme and Hydrology and Water Resources Programme (HWRP), facilitate efforts that promote delivery of authoritative forecast and warning information to decision-making authorities at local, national, regional, and global levels as well as provide relevant hazard and risk analysis and assessment to assist DRM.

3.2.34 Congress requested the Secretary-General to leverage existing guideline documents already created by expert teams within the TCs, gather lessons learned from NMHSs and disaster management partners, and identify existing gaps within the DRR Roadmap outline, which need to be filled. This will increase efficiency and minimize duplication of effort as the DRR Roadmap and other planning evolves.

3.2.35 Congress emphasized that all DRR work should proceed in consideration of all relevant guidelines and documents created by the expert teams within TCs, as well as input provided from NMHSs’ own DRR roadmaps, frameworks, and best practices.

3.2.36 Congress noted with appreciation that a draft WMO DRR Roadmap was prepared and sent to all the Members for their review and comments.

3.2.37 Congress noted that specific thematic areas to be addressed by the Roadmap should be closely interlinked with the priorities for action of the Sendai Framework for DRR 2015–2030, including the emphasis on a people-centred, multi-hazard approach to DRR underpinned by science and technology.

3.2.38 Congress noted that the Roadmap emphasizes the role NMHSs need to play across all timescales, including the provision of weather-specific early warnings with improved lead time, slower onset seasonal or climate-related information, and related hazard and risk information for planning and prevention purposes, including reducing existing risks and preventing the creation of new risks. In this context, the Roadmap:

(a) References developments in capabilities such as multi-hazard and impact-based forecasting; especially in dissemination and communication of early warnings to emergency managers, the general public, and other relevant stakeholders, with emphasis to support NMHSs of most vulnerable Members, specifically LDCs and SIDs;

(b) Provides a framework for WMO Members to enhance NMHSs' contributions to their national DRR efforts using in particular the possibilities of national and regional Platforms for DRR and forums, including forecasting, warning, service delivery, communication of forecasts and warnings to the public, and public education efforts;

(c) Provides a mechanism to enhance WMO Members' and programmatic collaboration in respect of DRR;

(d) Identifies both tactical and strategic opportunities to enhance the role of hydrometeorology and therefore NMHSs in global, regional, national, and sub-national DRR and climate change adaptation strategies;

(e) Provides mechanisms for engagement with the international DRR stakeholder community, e.g. the United Nations system, regional organizations and economic groupings, the private sector, and humanitarian agencies;

(f) Provides guidance and tools to NMHSs to strengthen linkages with emergency managers, decision makers in hydrometeorologically sensitive sectors, and the general public on reducing risk of weather, space weather, climate and water hazards.

3.2.39 Noting the enormous significance of the Sendai Framework for DRR 2015−2030 to the DRR priority of WMO and the need for assisting WMO Members in the effective implementation of this Framework through:

(a) Developing DRR knowledge products (e.g. guidelines, standards, training modules) in thematic areas such as hazard and risk assessment, MHEWS, humanitarian planning and response, and disaster risk financing;

(b) Assisting with the coordinated national and regional DRR capacity development activities and demonstration projects in these thematic areas;

(c) Promoting, engaging in, and facilitating multi-stakeholder partnerships in DRR on different levels.

3.2.40 In this regard, Congress requested the Secretary-General, in consultation with Members and collaboration with technical commissions and regional associations, to develop a final draft of the WMO DRR Roadmap for consideration and approval by the 68th Executive Council. It requested Executive Council to guide its further development and implementation, including monitoring and evaluation, and updating, in line with the Sendai Framework for DRR 2015–2030 adopted by 187 countries and other relevant international development frameworks (e.g. on sustainable development, climate change, humanitarian assistance, and urban issues).

3.2.41 Reemphasizing that the DRR Programme is a cross-cutting programme that coordinates the DRR services supported by various WMO Programmes, Congress requested EC to establish an appropriate governance mechanism to guide the implementation of the WMO DRR priorities through the DRR Programme with the aim to strengthen the capacities of Members, especially of their NMHSs, and the role of the WMO operational and research networks and designated entities assisting and cooperating with WMO, to deliver high-quality services for DRR towards building resilience at all levels.

Third United Nations World Conference on Disaster Risk Reduction (WCDRR)

3.2.42 Congress noted that the Third United Nations World Conference on Disaster Risk Reduction (WCDRR), held in Sendai, Japan, from 14 to 18 March 2015 was well attended with the participation of over 6,500 delegates, including 2,800 representatives from 187 governments, in the 150 intergovernmental and multi-stakeholder events and over 143,000 participants in the 350 side events organized in the public forum.

3.2.43 Congress was pleased to note that over 60 representatives of National Meteorological and Hydrological Services (NMHSs) from more than 42 countries (from all regional associations (RAs), and including 24 PRs with WMO) attended the conference, most of them being members of their respective national delegations. The NMHS representatives and staff members of the WMO Secretariat actively participated and contributed to the discussions during the sessions of WCDRR.

Sendai Framework for Disaster Risk Reduction 2015−2030

3.2.44 Congress acknowledged with satisfaction the adoption by 187 countries of the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015−2030 and WMO's extensive engagement in the various related consultations and preparatory processes between 2013 and 2015. SFDRR addresses four priorities for action: (1) understanding disaster risk; (2) strengthening disaster risk governance to manage disaster risk; (3) investing in disaster risk reduction (DRR) for resilience; and (4) enhancing disaster preparedness for effective response, and to "Building Back Better" in recovery, rehabilitation and reconstruction and defines the role of stakeholders and of international cooperation and global partnership.

Consultative process

3.2.45 Congress appreciated the participation and active involvement of Members, RAs, and the WMO Secretariat (including Regional Offices) in the consultative processes for the Post-2015 Framework for DRR facilitated by the United Nations Office for DRR (UNISDR), which included the session of the Global Platform for DRR in 2013, the Regional Platforms and Ministerial Conferences for DRR, and the three sessions of the Preparatory Committee for the WCDRR, as well as the open-ended informal consultative and negotiation meetings, held in 2014 and 2015. Congress appreciated the technical support WMO provided to the Informal Working Group on Targets and Indicators of the Preparatory Committee.

3.2.46 Congress noted the contribution of the WMO Secretariat Task Team for the Post-2015 Framework for DRR and WCDRR to ensure the active participation of WMO in the consultative processes leading to the adoption of the SFDRR and the organization processes leading to the conduct of the WCDRR. Congress further noted the close coordination of the Secretariat with other United Nations agencies through its active participation in the United Nations Inter-Agency Group (IAG) and the High-Level Committee on Programmes Senior Management Group for DRR and Resilience (HLCP-SMG) in the various preparations for the WCDRR.

Significance of SFDRR to WMO

3.2.47 Congress acknowledged the enormous significance of the SFDRR to the DRR Priority of WMO given the stated goal of SFDRR to "*prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and*

reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience."

3.2.48 Congress noted that WMO Members and their NMHSs contribute to a number of activities under each of the four priorities for action of the SFDRR and highlighted that global target number 7 of the framework which reads "substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030" is quite relevant to WMO.

3.2.49 Congress emphasized that among the provisions of SFDRR called for by and addressed to States, the following are primarily relevant to WMO:

(a) To enhance and strengthen multi-hazard early warning systems (MHEWS), to develop and invest in regional multi-hazard early warning mechanisms, to facilitate the sharing and exchanging of information across all countries, and to achieve the global target for MHEWS;

(b) To enhance and strengthen climatological aspects in the development of prevention activities together with other partners and governmental institutions;

(c) To strengthen and implement global mechanisms on hydrometeorological issues, in order to raise awareness and improve understanding of water-related disaster risks;

(d) To develop and apply methodologies to assess disaster risks, vulnerabilities and exposure to all hazards;

(e) To promote international cooperation for DRR and enhanced coordination of DRR strategies of United Nations and international and regional organizations and institutions;

(f) To maintain and strengthen in situ and remotely sensed Earth and climate observations;

(g) To promote the collection, analysis, management and use of relevant data and practical information and ensure its dissemination, taking into account the needs of different categories of users, as appropriate;

(h) To promote real-time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and use information and communications technology innovations to enhance measurement tools and the collection, analysis and dissemination of data;

(i) To have a more people-centred approach to DRR in addition to multisectoral-based and inclusive and accessible DRR practices.

WMO at WCDRR

Intergovernmental Segment and high-level events

3.2.50 Congress was pleased to note that the WMO Executive Management conveyed key messages on the role of NMHSs in disaster risk management (DRM) in the Intergovernmental Segment of WCDRR. The Secretary-General participated in the United Nations High Level Special Event "Uniting Nations, People and Action for Resilience". The Secretary-General also participated in the Ministerial Round Table "Public Investment Strategies for DRR" to discuss the importance of sustained investments in observation systems, scientific research and technology development. Furthermore, WMO provided the outcomes of the WMO Conference on Gender Dimensions of Weather and Climate Services to the organizers of the High-level Multi-Stakeholder Partnership Dialogue "Mobilizing Women's Leadership in DRR", and contributed to the conceptualization of the

Ministerial Roundtable “Reducing Disaster Risk in Urban Settings” and the High-level Multi-Stakeholder Partnership Dialogue “Inclusive DRM: Governments, Communities and Groups Acting Together”.

3.2.51 Congress appreciated that the WMO statement in the WCDRR Plenary Session articulated achievements, challenges and general commitments of WMO for DRR.

Multi-stakeholder Segment

3.2.52 The Multi-stakeholder Segment was comprised of 34 Working Sessions that addressed the experiences and progress of States in implementing the Hyogo Framework for Action (HFA) 2005–2015, emerging risks, commitments to implementing the post-2015 framework for DRR, and accelerating such implementation.

3.2.53 Congress appreciated the key role played by WMO in organizing the following Working Sessions of the Multi-stakeholder Segment:

(a) Early Warning (HFA Priority 2);

(b) Integrated Water Resource Management (IWRM);

(c) Applying Science and Technology to DRR Decision-making;

(d) Climate and Disaster Risk: Accelerating National and Local Initiatives;

(e) Food Security, Disaster-resilient Agriculture and Nutrition.

3.2.54 Congress was pleased to note that WMO also contributed to the preparations of, and the discussions during, other Working Sessions including those on “Underlying Risk Factors”, “Standards for DRR”, “Earth Observations and High Technology to Reduce Risks”, and “Lessons from Mega-Disasters”.

Public Forum

3.2.55 Congress noted with appreciation that WMO organized a symposium as well as showcased good practices in exhibitions during the Public Forum which was a significant part of WCDRR, promoting a shared responsibility of reducing risk and building resilience.

3.2.56 WMO organized the International Symposium on MHEWS and Service Delivery with the participation of 127 delegates including 19 Directors of NMHSs. The Symposium leveraged WCDRR to bring together MHEWS experts to take stock of the latest advancements in observation, seamless prediction of hazards, identification of their impacts and risks and the delivery of information and services, and to debate the future of DRR and the emerging role and challenges to NMHSs. The participants discussed how multi-stakeholder partnerships could make a difference in realizing the vision for MHEWS, and how the achievements NMHSs have made in building a more resilient society could be secured, sustained and strengthened further. The Symposium participants agreed that in order to do this, it would be essential to: (i) ensure access to the best possible science and optimum services for early warnings of hazards; (ii) build resilience in infrastructure systems and services; and (iii) provide for adequate catastrophe insurance.

3.2.57 The Congress welcomed the creation by WMO, the US National Weather Service and the US Agency for International Development (USAID) of the Weather-Ready Nations initiative. This initiative is a new programme to improve the understanding of high-impact weather, water, and climate events. Weather-Ready Nations, relying on best practices developed in many countries, will address this by offering to combine and share countries' experiences in developing initiatives that shift toward an impact-based forecasting and warning system which informs people about what impact the weather will have on users, rather than just expected conditions.

3.2.58 In collaboration with the Japan Meteorological Agency (JMA) and the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO/IOC), WMO organized a special exhibition booth on Building Weather and Climate Resilience. The booth made available to the public filmed messages and documentary videos of good practices in early warning systems, and public educational videos on typhoon hazards (produced by Hong Kong, China on behalf of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)/Typhoon Committee) shared by Members.

3.2.59 Congress was pleased to note that as part of the WMO communications plan for WCDRR, WMO prepared and distributed a brochure that highlighted the progress of Members in the delivery of weather and climate services, including for MHEWS. In addition, WMO coordinated closely with the UNISDR communications group on media affairs and a press conference.

3.2.60 Congress conveyed its sincere thanks to JMA for their active cooperation and support extended to WMO and its Members during WCDRR.

Follow-up actions

3.2.61 Congress emphasized that there are a number of key follow-up actions that need to be taken to ensure the best contribution of WMO to the SFDRR.

3. 2.62 Congress encouraged all Members to adopt a shared approach with relevant agencies and organizations at the national level to promote implementation of the SFDRR. In this regard, Congress noted that the United Nations Plan of Action on DRR for resilience was highlighted in the United Nations High Level Event in WCDRR and that it presents a strategy for integrating disaster risk reduction into United Nations country level operations. It is intended to all partners committed to reducing the risks that disasters pose and making our societies more resilient. Congress emphasized the need for a set of core commitments and actions to address the issue of resilience.

3.2.63 In response to the call of States in the SFDRR for advancing MHEWS at various levels, Congress emphasized that additional efforts are needed to institutionalize and strengthen multi-hazard, end-to-end, people-centred early warning systems (EWS) for all communities. Congress noted that international and regional collaboration as well as multi-stakeholder partnership at all levels is critically necessary, given the borderless nature of most hydrometeorological hazards.

3.2.64 Recognizing the increasing impact of disasters and their complexity in many parts of the world, the delegates to WCDRR declared their determination to enhance and strengthen the efforts to reduce disaster losses of lives and assets worldwide. Congress reiterated WMO's commitment to support DRR which is one of the strategic priority areas of WMO. Congress urged Members to proactively engage in their national DRM and take on a leading role in relevant areas such as early warning and/or multi-hazard early warning systems to assist the development of DRR Standard Operating Procedures (SOPs) for appropriate response to these warnings.

3.2.65 Congress noted that a number of partnerships were proposed and/or established during WCDRR such as for MHEWS, Earth observations and data and product sharing and exchange in support of national strategies for DRM, reducing landslide disaster risk, water resources management, coherence with climate change adaptation initiatives, and an international partnership of science and technology to support the implementation of the SFDRR. Congress encouraged WMO Members and the Secretariat to engage in relevant partnerships for effective implementation of SFDRR, and in particular to take on a leading role in the fields of MHEWS and in identifying/cataloguing extreme weather and its impacts, water and climate events in cooperation with all activities of the Global Framework for Climate Services (GFCS).

3.2.66 National and regional Platforms for DRR are mechanisms where NHMSs can take an active and leading role to bring in hydrometeorological perspectives in the timescale of early warnings, but also long-term planning and prevention aspects. The cooperation with other partners from public and the private sector are crucial for the advancement and implementation of SFDRR.

3.2.67 Congress requested the Secretary-General to extend full support to the Members in their efforts to implement SFDRR.

International Network on MHEWS and proposal for an International Conference on Multi-Hazard Early Warning Systems

3.2.68 Congress agreed that partnership and networking among relevant stakeholders and actors concerned are critical to advance and usher the next generation of EWS and service delivery for DRR and resilience building towards a multi-hazard approach that incorporates relevant impact and risk information.

3.2.69 Congress noted that during the Working Session on Early Warning (HFA Priority 2) in the Multi-Stakeholder Segment, a proposal was presented, developed jointly by WMO and other United Nations agencies and international organizations concerned, to establish an International Network on MHEWS (IN-MHEWS) (https://www.wmo.int/pages/prog/drr/documents/IN-MHEWSConceptPaper16415.pdf).

3.2.70 Congress was pleased to note that several organizations have expressed their intention to collaborate and to contribute to the initial activities of IN-MHEWS as Network Partners. These include United Nations Agencies and international organizations including WHO, UNDP, UNESCO-IOC, UNESCAP, UNISDR, UNOOSA/UN-SPIDER, ITU, and IFRC and National organizations i.e., GFZ (Helmholtz-Centre Potsdam – GFZ German Research Centre for Geosciences) and GIZ (German Development Corporation). Congress also noted that the establishment of the IN-MHEWS was supported by members of the national delegations of China, Ecuador, France, Germany, India, Indonesia, Italy, and the Philippines.

3.2.71 Congress noted that for more effective and wider implementation of MHEWS among the Members, it is important to document the good practices and other national experiences in implementing MHEWS and prepare guidelines on institutional coordination and cooperation and the role of NMHSs in implementing MHEWS. Congress noted the plans to organize an International Conference to address these issues and encouraged the organization of the International Conference on MHEWS in 2016, in collaboration with appropriate International, Regional and National agencies and institutions that have the mandates for other hazards such as for geophysical, biological, and human-induced hazards (a draft concept note is available at https://www.wmo.int/drr/ConceptNoteIntConfMHEWS).

3.2.72 Congress was pleased to note that the German Committee for Disaster Reduction (DKKV) informally conveyed its interest to contribute and co-organize the International Conference.

3.2.73 Congress adopted Resolution 10 (Cg-17) – Sendai Framework for Disaster Risk Reduction 2015−2030 and WMO participation in the International Network for Multi-hazard Early Warning Systems.

4. ADVANCING SCIENTIFIC RESEARCH AND APPLICATION, AS WELL AS DEVELOPMENT AND IMPLEMENTATION OF TECHNOLOGY (agenda item 4)

4.1 Data-processing and forecasting: weather, climate and water (agenda item 4.1)

Seamless data-processing and forecasting

Towards a Future Enhanced Integrated and Seamless Data-processing and Forecasting System

4.1.1 Congress recalled the decision by the Sixteenth World Meteorological Congress in 2011 (Cg-XVI) that the *Manual on the Global Data-processing and Forecasting System* (GDPFS) (WMO-No. 485) is the single source of technical regulations for all operational data-processing and forecasting systems of WMO Members. It noted that the Executive Council, in its sixty-fifth session

in 2013 (EC-65), reinforced that, similarly to the WIGOS and WIS, the GDPFS is an all-encompassing system, including data-processing and forecasting systems coordinated by CBS, jointly with other technical commissions and/or WMO Programmes, as well as with other international organizations. Congress also noted that the Commission for Basic Systems at its 2014 extraordinary session agreed that the GDPFS is at the heart of the WMO operational system. In order to support adequately the high priorities of WMO, the GDPFS needs also to evolve, be flexible and adaptable so that it can respond efficiently to current and emerging needs.

4.1.2 In this context, Congress recalled that the GDPFS is the worldwide network of operational centres systems operated by WMO Members, targeting mainly atmospheric weather forecasting by using Numerical Weather Prediction (NWP) and Ensemble Prediction System (EPS) techniques, thus providing services to a myriad of users. Congress also recalled that Cg-XVI adopted a Strategy for Service Delivery and EC-65 approved its Implementation Plan with new areas for consideration, such as the impact-based forecasting and risk-based warnings which imply that societal information or data need to be brought into the GDPFS environment for effective data-processing and forecasting for targeted services delivery. In addition, Congress noted that users' needs are becoming more sophisticated and varied while the technology is evolving rapidly, and also that climate change and variability are posing new challenges to National Meteorological and Hydrological Services (NMHSs) requiring them to produce information at various timescales.

4.1.3 Considering the conclusions of the first World Weather Open Science Conference (WWOSC-2014, Montreal, Canada, August 2014), organized by the World Weather Research Programme, Congress recognized that a seamless system spans multiple dimensions including:

(a) Timescales ranging from very short-range forecasts, including nowcasting, through weather forecasts for days and weeks ahead, to long-range forecasts on seasonal up to multi-annual scales;

(b) Multi-hazard forecasts, including coupled weather-related hazards such as hydrological (e.g. floods, inundation), marine and coastal (e.g. waves, storm surge), geophysical (e.g. landslides), air pollution episodes and sand and dust-storms, and also other similar hazards such as those induced by Space Weather disturbances. Under-pinning forecast systems will evolve from weather forecast systems, including probabilistic forecasts, to fully coupled and integrated Environmental Prediction Systems, coupling atmosphere, ocean, cryosphere and land with full representation of environmental parameters such as aerosols and pollutants affecting air quality; and

(c) Prediction of not only weather-related elements but also assessing likelihood and probabilities of impacts and risks associated with other hazards taking account of the vulnerabilities and exposure, and societal impact pathways to fully support risk-based decision-making.

4.1.4 Congress noted that with technological advances, new areas of research such as the use and propagation of NWP/EPS into high-impact weather forecasting and hazard risk management, and the post-THORPEX and other research projects (including Polar Prediction, Sub-seasonal to Seasonal Prediction, HIWeather, and Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)) will require transition to operations. Congress therefore agreed to initiate a process for the gradual establishment of a future enhanced integrated and seamless WMO Data-processing and Forecasting System, and adopted Resolution 11 (Cg-17) – Towards a future enhanced integrated and seamless WMO Data-processing and Forecasting System.

Revised Manual on the GDPFS

4.1.5 Congress recalled its decision to adopt the outline for a revised Manual on the GDPFS (WMO-No. 485) through Resolution 6 (Cg-XVI), wherein it agreed that this Manual is the single source of technical regulations for all operational data-processing and forecasting systems operated by WMO Members. Congress noted with appreciation that the revision of the Manual was

near completion, and acknowledged the active cooperation and enhanced coordination among the relevant technical commissions and partner organizations (e.g. IAEA and ICAO) in incorporating aspects related to all WMO data-processing and forecasting systems in the revised Manual on the GDPFS. Following the recommendation by the Commission for Basic Systems (CBS), at its 2014 extraordinary session, for a transition plan for the implementation of the new Manual (which will replace the current version) to manage the technical changes and the initial designation of the new GDPFS centres as defined in the new Manual, including WMCs and RSMCs, Congress adopted Resolution 12 (Cg-17) – Report of the extraordinary session (2014) of the Commission for Basic Systems concerning the introduction of the new *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485).

4.1.6 Congress recalled that the WMO Technical Progress Report on Global Data-processing and Forecasting Systems (GDPFS) and Numerical Weather Prediction (NWP) Research is a single source of information on operational NWP systems and relevant research activities. Congress agreed that the Report should be used as a basis to facilitate effective implementation of regular audits of RSMC compliance that would be introduced with the new Manual. Nevertheless, knowledge of the current status of GDPFS implementation by Members is essential for assessing the progress toward the future evolution of the GDPFS. Therefore, Congress requested CBS, in collaboration with CAS and assisted by the Secretary-General, to review the contents and the reporting method to facilitate the Members' contribution to the Report. It also encouraged CBS and the Secretary-General to explore the feasibility of using the WMO Country Profile Database to allow Members to access and update the information on the GDPFS in a timely fashion.

Weather issues

4.1.7 Congress recalled the many extreme weather events and their significant impacts on life and properties over the last few years, e.g. the 2012 flood event affected about 70% of the states in Nigeria resulting in the loss of 363 lives and damages worth $16.9 billion; Typhoon *Haiyan* in the Philippines in 2013 claiming over 6200 lives and destroying or damaging over one million homes; in 2014, heavy rainfall took the lives of 47 people and caused 2 million USD of infrastructure damage in Côte d'Ivoire; heavy downpours in 2014 caused floods and flash floods in India and Pakistan affecting close to 1000 villages and killing over 665 people; more recently in 2015, Mozambique and Malawi (January) suffered heavy rain causing floods and flash floods which claimed the life of 117 people and destroying over 11000 houses in Mozambique, and killing 48 people in Malawi; in March 2015 in two events, the United Republic of Tanzania suffered tornado like phenomena causing hailstones which claimed the lives of 47 people, injured 91, displaced 3500 and destroyed 634 houses, and heavy rain associated with flash floods took the life of 12 people; and a recent bitterly cold winter and heavy snow falls in eastern Canada and USA have made life difficult for inhabitants. In this context, Congress expressed its sympathy to all countries which had to cope with the high impacts from the extreme weather events and urged WMO Members, the Secretary-General and WMO constituent bodies to give high priority to the development and implementation of mechanisms to contribute to reducing the loss of life and property. In addition, Congress agreed that this would include enhancing the visibility, credibility and importance of NMHSs in their respective countries, thus facilitating increased support for NMHSs by their governments and partners. Congress noted with appreciation the contribution of WMO experts to Post Disaster Needs Assessments (PDNA) in affected countries.

4.1.8 Congress also recalled the discussions at the first World Weather Open Science Conference (WWOSC-2014, Montreal, Canada, August 2014) which resulted in the development of a White Paper on future challenges and opportunities related to weather issues. Congress urged the WMO Secretary-General and constituent bodies to exploit the recommendations of the White Paper once published.

Global Data-Processing and Forecasting System (GDPFS)

4.1.9 Congress recalled that the Global Data-processing and Forecasting System (GDPFS) includes the worldwide network of operational centres operated by WMO Members. Its primary purpose is, in operational conditions, to make available among all WMO Members, agreed

products and services from Numerical Weather Prediction (NWP) systems, including Ensemble Prediction Systems (EPS), for applications related to weather, climate, water and the environment. Congress acknowledged that the GDPFS enables scientific and technological advances made in meteorology and related fields to be shared as efficiently and effectively as possible among, and for the benefit of, WMO Members (including capacity-building in developing countries). Congress recognized that the activities, organizational structure and operations of the GDPFS are systematically designed in accordance with WMO Members' needs and their ability to contribute to, and benefit from, the system in an efficient manner, minimizing duplication. In this context, Congress recalled its decision to embark on an enhanced integrated and seamless WMO data-processing and forecasting system as part of the GDPFS (ref.: paragraphs 4.1.1–4.1.6), and agreed that this integrated and seamless approach would provide multi-dimensional forecasting capabilities to respond efficiently to current and emerging requirements from the services-application programmes, such as aeronautical, marine, agriculture, health, and public weather services, as well as requirements from a wide-range of hydrometeorological-related emergencies, or from implementing disaster mitigation strategies.

4.1.10 Congress highlighted that the GDPFS contributes to many of the WMO's high priorities through: (i) the use of NWP and Ensemble Prediction Systems (EPS) for severe weather forecasting, particularly through the Severe Weather Forecasting Demonstration Project (SWFDP) that contribute to disaster risk reduction, and capacity development of LDCs; (ii) the application of NWP/EPS to predict severe and high-impact weather events, including the propagation of the weather forecasts into impact models that contribute to disaster risk reduction; (iii) a network of centres that carry out global monthly and seasonal forecasts that are essential for the Climate Services Information System (CSIS) of the Global Framework for Climate Services (GFCS); and (iv) the provision of benefits to other socioeconomic sectors, including aviation, agriculture, marine safety, transport, tourism, and energy.

4.1.11 Congress acknowledged the significant progress made, since its last session, in many areas of GDPFS, such as: Severe Weather Forecasting (especially through the SWFDP), Ensemble Prediction Systems (EPS), Extended- and Long-range Forecasting, Very Short-range Forecasting, and Forecast Verification. In particular, Congress was pleased to note the productive work of CBS experts in relation to the Global Data-processing and Forecasting System (GDPFS), as well as the Emergency Response Activities (ERA), including collaboration with other relevant technical commissions that have resulted in Recommendation 2 (CBS-Ext.(2014)) to adopt amendments to the Manual on the GDPFS (WMO-No. 485) related to: (a) the designation of an RSMC for the Provision of Atmospheric Backtracking Products; (b) the regional and global arrangements for the provision of atmospheric transport model products for environmental emergency response, and atmospheric backtracking; and (c) the designation of Regional Climate Centres (RCCs). Congress adopted CBS Recommendation 2 through Resolution 13 (Cg-17) – Report of the extraordinary session (2014) of the Commission for Basic Systems concerning the Global Data-processing and Forecasting System and emergency response activities.

Operational Weather Forecasting Process and Support

4.1.12 Congress emphasized that NWP forecast verification activities are critical to quality assurance and management of the outputs of the GDPFS, and some "core" verification activities should be defined and considered as essential, and their results be made available for use by operational centres. In this context, Congress noted that the Commission for Basic Systems, at its fifteenth session (CBS-15, Jakarta, Indonesia, September 2012) provided a direction for the development of standard procedures for surface verification. Congress noted with satisfaction the progress achieved thus far and requested CBS to work towards its early completion. It requested the Secretary-General, in coordination with CBS, to promote the implementation of standard procedures for surface verification by WMO Members.

4.1.13 Congress commended the Lead Centres for forecast verification, including ECMWF for Deterministic NWP, JMA (Japan) for EPS, and BNOC (BoM, Australia) jointly with CMC (EC, Canada) for Long-range Forecasts, for coordinating the sharing of information on verification of upper-air forecasts. While recognizing that many operational centres running global NWP are

carrying out verification of upper-air forecasts, Congress noted limited compliance to the implementation of the standard procedures for upper-air verification as described in the Manual on the GDPFS (WMO-No. 485), and urged GDPFS Centres to adopt such standard procedures, as appropriate. Congress noted that Members are providing new observational data through WIS that may impact model performance. It therefore requested CBS, in collaboration with CAS, to carry out a study on the sensitivity of verification results to differences in observation availability and usage.

4.1.14 Congress recalled its request, at its sixteenth session (Cg-XVI, 2011), to the Secretary-General and CBS, to develop a strategy to assist Members in the implementation of improved high-resolution regional NWP including data assimilation. Congress noted that CBS has been developing an outline for the guidelines on high-resolution NWP. It stressed that the guidelines need to address the use and interpretation of high-resolution NWP models, the application of high-resolution NWP in forecasting severe weather, the implementation of (high-resolution) regional NWP model and data assimilation systems, and a mechanism to collect information and best practices. Congress also stressed the importance of this task to Members, and urged CBS to address this issue as a matter of priority and to work with the Secretary-General for the prompt dissemination of the guidelines to Members. Congress also requested CBS, in collaboration with CAS, to provide guidance on addressing scalability issues related to the development of improved high-resolution NWP, including data assimilation, for the optimal match between model code, hardware and efficient I/O, which are essential in developing disaster mitigation strategies.

4.1.15 Congress recognized that, while some of the Members have the capacity to run high resolution NWP models, many others do not. Congress noted the trend of regionalization of meteorological services such as aeronautical meteorological services, and the increasing demand of high resolution gridded weather forecasts in support of all areas of service delivery. It also noted that the development of high-resolution NWP with regional focus, taking advantage of the opportunity to assimilate the wealth of regional and local weather observational data into high resolution regional NWP models, would better support the regionalized delivery of services. To address these issues, Congress requested Members and RAs, with support as needed from CBS and the Secretary-General, to explore the possibility for setting up regional consortium for Limited Area Model (LAM) to facilitate access to high resolution NWP while building capacity of participating Members through training and development assignments. Congress noted the progress of the two pilot projects underway in RA II related to capacity development on NWP and provision of medium-range weather forecasts. It therefore requested CBS, RA II working groups and the pilot project coordinators to explore possible contributions to the guidelines on the use and interpretation of high-resolution NWP models.

4.1.16 Congress noted that a few Members have already engaged in impact-based forecasting and risk-based warnings and requested CBS to collect lessons learned for the benefit of all WMO Members and to provide guidance on the validation and verification of impact-based forecast and risk-based warnings. Congress recognized that the implementation of impact-based forecast and risk-based warning services by Members would be done at different paces depending on their state of readiness. It also recognized that the operationalization of this process requires the combination of the severity of the weather hazards with the vulnerability and exposure information which is not readily available to NMHSs. To address this issue, Congress requested the Secretary-General, in collaboration with CBS and other relevant technical commissions, and RAs, to build new partnerships and strengthen existing ones to facilitate the availability of societal information and its integration into operational forecasting systems.

4.1.17 Congress recalled that the Executive Council, at its sixty-fifth session (EC-65, 2013), discussed NMHSs' move towards impact-based forecasting and risk-based warnings in the provision of public forecasts and warning services in support of social resilience. It also recalled that PWS experts have prepared the WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services, to facilitate the implementation of this concept (ref.: paragraphs 3.1.63–3.1.99). In order to facilitate operational implementation at NMHSs, Congress requested CBS to consider the development of operational methodologies, tools and techniques as well as the identification of components of data-processing and forecasting systems that may require adjustment to facilitate the provision of impact-based forecast and risk-based warning services. Congress recognized that

impact-based forecast and risk-based warning services could be implemented through a demonstration phase in the well-established SWFDP, which would facilitate the introduction of these methodologies in many NMHSs of developing and least developed countries. It requested the Secretary-General, in collaboration with CBS and other relevant technical commissions, to develop related guidelines for the implementation of these methodologies.

4.1.18 Congress observed that technology is improving at a high pace and that some Members from developing countries are taking full advantage of it, in particular, by making available to forecasters a multitude of information to manipulate thus facilitating efficient and effective forecasting decision-making. Congress recognized that data volumes are growing with high quality datasets and ensemble models being provided from a variety of sources, with NMHSs and other partner organizations' data being shared in an interoperable manner. It also noted that the science behind the models is improving and the role of the forecaster is changing in some countries, with customer requirements moving towards more flexible, impact-based services based on integrated authoritative advice. In this context, Congress requested the Secretary-General and CBS, in collaboration with Members and partners, to explore ways for the development of appropriate forecaster systems meeting LDCs requirements as well as the changing way data is shared.

Severe Weather Forecasting Demonstration Project (SWFDP)

4.1.19 Congress noted with satisfaction the continuing effort through the SWFDP in building capacity of, and transferring skills to, NMHSs personnel in 41 least developed and developing countries with over 300 Forecasters and Public Weather Service (PWS) specialists trained. Congress underlined that such a success would not have been possible without the pioneering work and dedication of NMHSs of South Africa, Botswana, Madagascar, Mozambique, United Republic of Tanzania and Zimbabwe, global products centres at ECMWF, Met Office UK (Exeter), and NCEP-CPC (Africa Desk, USA), and RSMC Pretoria (South Africa), and RSMC-TC La Réunion (France), which embarked on this initiative in 2006. Congress noted with satisfaction the early implementation of the SWFDP in the South-west Pacific and in Eastern Africa, led respectively by RSMC Wellington (New Zealand) supported by RSMC-TC Nadi (Fiji), and RSMC Nairobi (Kenya) supported by RFSC Dar es Salaam (United Republic of Tanzania). Congress thanked the pioneers and urged the Secretary-General, in collaboration with these NMHSs and global and regional centres, to develop and make available lessons learned for the benefit of NMHSs of other countries about to join the SWFDP. In addition, Congress noted with appreciation that the SWFDP in Southern Africa was no longer a demonstration project, and has now been fully operational amongst all the southern African states since 2011. Congress noted that it might be appropriate to promote a forecasting demonstration project in South America associated with the field experiment RELAMPAGO and to develop capabilities at the local level related to nowcasting.

4.1.20 Congress also noted that forecast verification activities, including application of new verification methods, have been implemented through the SWFDP. Noting with satisfaction that guidelines have been developed on Forecast Verification for the African SWFDPs (WMO-No. 1132), Congress requested the Secretary-General, in collaboration with CBS, to promote the use of the forecast verification methods described in these guidelines in other SWFDP regional projects.

4.1.21 Congress expressed its appreciation to CBS for the coordination of the implementation and expansion of the SWFDP and its efficient cascading forecasting process, which put high value information in the hands of forecasters in developing countries, LDCs and SIDS, thus improving their abilities, particularly through training, to improve their forecast and warning services for efficient and effective decision-making.

4.1.22 Congress noted the request by the Regional Association I, at its sixteenth session (RA I-16, 2015), to CBS and the Secretary-General to expand the SWFDP to West Africa, then to the rest of Africa. Congress endorsed this request and was pleased to note that planning for the development of the SWFDP – West Africa has been initiated with seed funding provided by the Republic of Korea, to which it extended its appreciations.

4.1.23 Congress also noted that the SWFDP is running or being prepared to run in 5 geographical regions: Southern Africa, South Pacific, Eastern Africa, South-East Asia and Bay of Bengal. The proposed expansion of SWFDP in Africa as suggested by RA I-16 and the planned expansion in the Caribbean SIDS, Central Asia and South-East Europe would require significant increase of resources to support training, contributions by participating global products centres and RSMCs, and coordination functions by the WMO Secretariat. Congress recalled that it did recognize at its sixteenth session (Cg-XVI, 2011), that SWFDP expansion could only be realized with an appropriate and resourced Project Office at the WMO Secretariat, and extrabudgetary contributions to augment the regular budget allocations. Congress continued to support the SWFDP expansion, as indicated in the WMO budget proposal (ref.: agenda item 10.2).

4.1.24 In addition, Congress noted that, in subregions where the demonstration phase of the SWFDP had been concluded, it would be necessary to pass into the operational phase and to rename the project appropriately as an operational activity. It also noted that the operational phase would require a regional entity responsible for ensuring all countries achieve and maintain compliance and oversee project/programme management and related aspects with continuing support from the Project Office at the WMO Secretariat. Congress was pleased to note the productive work of CBS experts in relation to the overall SWFDP development, management and implementation, that have resulted in Recommendation 23 (CBS-Ext.(2014)) to adopt the establishment of an expanded mechanism to strengthen operational centres at global, regional and national levels, built upon the lessons learnt through the SWFDP (see Resolution 13 (Cg-17)).

4.1.25 Congress recalled its direction, at its sixteenth session (Cg-XVI, 2011), for the SWFDP to engage all WMO Programmes concerned with the real-time prediction of hydrometeorological hazards, through their respective technical commissions, from observations, to information exchange, to delivery of services, education and training, and to the transfer of relevant promising research outputs into operations. Consequently, Congress was pleased to note the collaboration between CBS and the Commission for Hydrology (CHy) for the integration of SWFDP with the Flash Flood Guidance System (FFGS) in Southern Africa and encouraged them to consider expansion of this approach to other regions, as appropriate. Congress agreed that such integration (including synergy with CIFDP – see paragraph 4.1.28) would facilitate implementation of operational support to Multi-Hazard Early Warning Systems.

4.1.26 Congress stressed the value of inter-commission collaboration in ensuring efficiency in the delivery of services to Members. To that end, it encouraged CBS, CHy and JCOMM to consider establishing synergies between the Coastal Inundation Forecast Demonstration Project (CIFDP) and the SWFDP so as to benefit from the well-established SWFDP, and the support and coordination by its Project Office. In addition, Congress invited CBS and CAS to establish synergies between the SWFDP and the High Impact Weather Prediction Project, which is led by WWRP, in particular for localized extreme winds and urban floods.

4.1.27 Congress noted that the Executive Council, at its sixty-fifth session (EC-65, 2013), acknowledged that, in the context of the implementation of the GFCS, Global Producing Centres (GPCs) for Long-range Forecasts (LRF), Regional Climate Centres (RCCs) and Regional Climate Outlook Forums (RCOFs) could also have a role in the SWFDP model, in support of developing seamless regional early warning systems. Congress supported EC-65 observations that in principle the SWFDP model could also be applied to prediction at longer-time scales, and therefore requested CBS and the Commission for Climatology (CCl) to explore ways to bridge the gap “weather/climate” at least from medium-range to sub-seasonal prediction to ensure seamless prediction across time-scale for at least up to 15 days.

4.1.28 Congress welcomed the Sustained Coordinated Processing for Environmental Satellite Data for Climate Monitoring (SCOPE) Nowcasting initiative under the WMO Space Programme, which exploits the capability of satellites to help with nowcasting, particularly in data sparse areas (ref.: paragraphs 4.2.4.1–4.2.4.34). It noted that SCOPE-Nowcasting generates satellite imagery, RGB composites and satellite-based precipitation estimates, using current and future imagers, to assist with the prediction of severe weather. Congress requested the Secretary-General, in

collaboration with CBS, to develop guidelines for operational implementation of SCOPE-Nowcasting products, particularly in SWFDP geographical regions.

Operational Predictions from sub-seasonal to Longer-Time Scales (OPSLS)

4.1.29 Congress noted the excellent collaboration between CBS and CCl through:

(a) The Joint CBS-CCl Expert Team on Operational Predictions from Sub-seasonal to Longer-time Scale (ET-OPSLS), which was established to support the development of operational production systems to provide information beyond the medium-range. Congress acknowledged that operational prediction in the forecast range of sub-seasonal to longer time scales is a significant contribution of CBS to the Climate Services Information System (CSIS) of the Global Framework for Climate Services (GFCS) and to the CCl development of the Global Seasonal Climate Update (GSCU);

(b) The establishment of the Joint CCl-CBS Expert Team on Regional Climate Centres (RCCs) to facilitate the inter-commission discussions on the designation of RCCs. Congress encouraged all Commissions to explore collaboration amongst themselves for consistency and efficiency.

4.1.30 Congress noted and encouraged new activities initiated in support of seamless forecasting including:

(a) A pilot activity, the purpose of which is the development and use of multi-model ensemble products including imagery for display, and standard procedures for verification of extended-range forecasts which could be used to support the operational exchange of these products. This could include the display of real-time sub-seasonal forecasts from GPCs making operational sub-seasonal forecasts. This exchange, coordinated by the Lead Centre for Long Range Forecast Multi-Model Ensemble (LC-LRFMME) is in close collaboration with the WWRP/ WCRP Sub-seasonal to Seasonal (S2S) project; and,

(b) In support of the GFCS, to continue the exchange of real-time multi-annual to decadal forecasts which is currently informally hosted by the UK Met Office. Noting the discussions by CCl-16 and CBS-Ext.(2014), and the work of the ET-OPSLS, Congress requested CBS and CCl, in close collaboration with WCRP, to assess the adequacy of real-time multi-annual to decadal forecasts for operational use, and, if appropriate, to make recommendations to CBS-16 on a new formal arrangement, for example through a new Lead Centre for multi-annual to decadal prediction, so that Members can benefit from this new prediction capability.

4.1.31 Congress noted with satisfaction that significant progress was made in the following areas: (a) continued development of GPC prediction systems; (b) development of forecast and verification products for the GSCU by the LC-LRFMME, using a common baseline; and (c) inclusion of verification of the multi-model ensemble at the LC-LRFMME website. Congress also expressed satisfaction on the generally well-established use of GPC and LC-LRFMME products by most RCCs and NMHSs, as well as RCOFs, stating that the mandatory and some recommended products are essential in fulfilling their own mandatory LRF functions. Congress noted, however, that partnerships between GPCs/RCCs/NMHSs need to be strengthened to facilitate provision of the data exchanges and support required to bring possible information on all timescales to WMO Members. Therefore, Congress requested CBS and CCl to explore ways to strengthen GPCs/RCCs/NMHSs partnerships (ref.: paragraphs 4.1.49–4.1.92).

4.1.32 Congress noted that, following the recommendation by the CBS-CCl Workshop on "Operational Long-range Forecasting: GPCs and RCCs, in support of NMHSs and RCOFs" (Brasilia, Brazil, November 2013), CBS and CCl have reviewed the availability of the GPCs' hindcast and forecast data on the LC-LRFMME website, in the context of understanding of each GPC's data policy, and recognized that there was a potential for improvement in data availability at

the LC-LRFMME website. In this context, Congress approved for implementation the amendment to the Manual on the GDPFS, Volume I, related to the access to GPC data and visualization products held by the LC-LRFMME, based on a recommendation by the presidents of CBS and CCl. Congress adopted the CBS and CCl presidents' recommendation in Resolution 14 (Cg-17) – Amendments to the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485).

Collaboration with Research

4.1.33 Congress recalled that the Executive Council, at its sixty-sixth session (EC-66, 2014) supported the WWRP led Aviation Research and Development Project (AvRDP), working in collaboration with CAeM, to further develop nowcasting capability and mesoscale modelling techniques in support of next generation aviation products and services (ref.: paragraphs 4.3.24–4.3.49). Congress requested CBS to coordinate closely with CAeM in monitoring potential applications of the research being undertaken.

4.1.34 Congress recalled the successful demonstration of nowcasting techniques by some Members at various international events such as the Olympic games and the World Exposition and requested the Secretary-General, in coordination with CBS and other related technical commissions, to gather lessons learned and best practices and develop guidelines on nowcasting techniques for the benefit of all WMO Members. Congress also noted that it would be a significant contribution to seamless data-processing and forecasting endeavour (ref.: paragraphs 4.1.1–4.1.6).

4.1.35 Congress recalled the two CAS/WWRP Strategic Projects endorsed by the Executive Council, at its sixty-sixth session (EC-66, 2014): the Sub-seasonal to Seasonal (S2S) Prediction Project and the Polar Prediction Project (PPP). It also noted the planned High Impact Weather (HIWeather) Prediction Project led by WWRP, which has five components: Localized extreme Wind, Wildfire, Urban Flood, Urban Heat/Air Quality and Disruptive Winter Weather (ref.: paragraphs 4.3.24–4.3.49). Congress acknowledged that the operationalization of these research results would necessitate significant implication of the GDPFS and recalled the importance of Research and Development Projects and of the Forecast Demonstration Projects (RDPs/FDPs) in ensuring smooth transition of science results into operations. Congress, therefore, requested CBS to work closely with CAS/WWRP to ensure that an operational forecast demonstration phase is established for each of these Projects following conclusive Research Development phase. It also requested the Secretary-General, in collaboration with CBS and CAS, to develop related guidelines for the implementation of new techniques.

Environmental related issues

4.1.36 Congress recognized that countries around the world have been facing an ever-growing need to cope with the increase in frequency of high impact hydrometeorological and environmental events and their human and economic consequences. It noted that this growing need is driven by the human dimension that includes the exponential growth of the world's population, changes in land use and demographic shifts that concentrate populations into urban locations, flood plains, coastal regions and other vulnerable areas. This has placed significant demands for focused hydrometeorological services which translated into the need to broaden the weather forecasting aspect to include environmental prediction (weather inferred consequences such as floods, avalanches, water management, air quality, transportation flow, agriculture, clean energy production), including effective communication and technology transfer. In addition, Congress noted the Climate-Resilient Green Economy (CRGE) initiative by Ethiopia, to protect the country from the adverse effects of climate change and to build a green economy that would help implement a new and sustainable growth model, and encouraged CBS and the Secretary-General to take this initiative into consideration in addressing environmental prediction issues.

4.1.37 Congress was informed on one of the objectives of the first World Weather Open Science Conference (WWOSC-2014, Montreal, Canada, August 2014) to explore the many applications of weather prediction to the natural environment as they are seen as an effective way to better address the socioeconomic demands for weather services. Congress noted that a number

of NMHSs of WMO Members, in some cases with partners, have been issuing air quality forecasts and other environmental related predictions to meet their users' needs. Congress noted that such predictions are developed through research projects performed by the World Weather Research Programme (WWRP) and the Global Atmosphere Watch (GAW) Programme, including large capacity-building elements. In this context, Congress stressed the need to share environmental prediction techniques among WMO Members, and therefore, urged Members to share their expertise gathered within these research projects. Members with expertise are encouraged to provide coaching to LDCs in adopting environmental predictions. Congress requested the Secretary-General, in collaboration with CBS and other relevant technical commissions, to compile lessons learned and develop guidelines on best practices on air quality forecasts and other environmental related predictions, for the benefit of all WMO Members.

4.1.38 Congress recognized that for many environmental and emergency environmental response issues, close links between NMHSs and relevant geophysical agencies are required. Examples of these issues include volcanic ashfall onto populated areas and crops, volcanic gases affecting infrastructure and human health, and meteorological interactions with disturbed environments, such as heavy rainfall on degraded hillsides which exacerbates erosion. In this regard, Congress encouraged Members to strengthen the relationship between NMHSs and relevant geophysical agencies, to help address these issues. In this context, Congress noted with appreciation the continued support and collaboration of the International Union of Geodesy and Geophysics (IUGG).

4.1.39 Congress acknowledged relevant research activities (ref.: paragraphs 4.3.24–4.3.49 and paragraphs 4.3.73–4.3.102) concerning environmental prediction (e.g. High Impact Weather – HIWeather, Sand and Dust Storm Warning Advisory and Assessment System – SDS-WAS GAW Urban Research Meteorology and Environment Project – GURME) and it noted the continuous need to include research into activities already transferred to operations. In addition it stressed the need to strengthen the capabilities of GDPFS centres in order to adopt environmental prediction. In this context, Congress urged Members to seek opportunity for strengthening their systems and requested CBS, in close collaboration with other relevant technical commissions, to ensure a quick transfer of research results into operations, along with the development of guidelines for their implementation by WMO Members.

Emergency Response Activities (ERA)

4.1.40 Congress recalled that the Emergency Response Activities (ERA) programme, implemented in close conjunction with the Global Data-processing and Forecasting System (GDPFS) (ref.: paragraphs 4.1.7–4.1.35), assists NMHSs and other relevant agencies of Members, as well as relevant international organizations, to respond effectively to environmental emergencies associated with airborne hazards, for example, caused by nuclear accidents or events, volcanic eruptions, chemical accidents, smoke from large fires, and other events, which require emergency atmospheric transport and dispersion modelling (ATDM) support. This programme is carried out through: (a) the provision of specialized GDPFS products and services by designated Regional Specialized Meteorological Centres (RSMC) for the provision of ATDM (for environmental emergency response and/or backtracking) hosted by WMO Members; (b) the development and implementation of efficient emergency procedures for the provision and exchange of specific data, information, and products related to the environmental emergency; (c) regular exercises; and (d) training for users.

4.1.41 Congress also recalled that activities related to airborne radionuclide hazards fall under two categories. First, nuclear accidents or radiological incidents fall under two International Conventions, one on Early Notification, and the second on Assistance, to which WMO is a Party along with other international organizations concerned under the overall coordination of the International Atomic Energy Agency (IAEA). Secondly, WMO collaborates with the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and provides specialized operational modelling support to the Treaty's Verification regime. In this context, Congress agreed that ERA contributes to the WMO's high priorities of Disaster Risk Reduction, and Capacity Development, through the use of and training on applications of NWP/EPS such as

atmospheric transport and dispersion modelling for environmental emergency response activities (ERA).

4.1.42 Congress noted that, following its request at the sixteenth session (Cg-XVI, 2011), CBS has reviewed the Environmental Emergency Response (EER) procedures to strengthen these aspects in the *Manual on the GDPFS* (WMO-No. 485) (ref.: paragraphs 4.1.7–4.1.35). In particular, Congress agreed that enhancements of the ATDM products were of uttermost importance, and noted that the calculation of Source Receptor Sensitivity (SRS) fields for backtracking purposes was successfully integrated in the Manual to support CTBTO in the event of anomalous radionuclide detections.

Atmospheric Transport and Dispersion Modelling

4.1.43 Congress noted the successful activities of CBS on Emergency Response Activities, and the work of the WMO Task Team on Meteorological Analyses for Fukushima Daiichi Nuclear Power Plant (NPP) Accident in elaborating enhanced procedures in the field of nuclear emergency response activities in the aftermath of the nuclear emergency in Japan (March, April 2011).

4.1.44 Congress recalled that WMO had actively participated in the activities of the UN system (in particular with the IAEA, as well as through the Inter-Agency Committee on Radiological and Nuclear Emergencies), following the Fukushima Daiichi NPP Accident, to review and assess emergency preparedness and response systems. Congress was pleased to note that the work of the WMO Task Team on Meteorological Analyses for Fukushima Daiichi Nuclear Power Plant (NPP) Accident had been completed, and the results were published: "Evaluation of Meteorological Analyses for the Radionuclide Dispersion and Deposition from the Fukushima Daiichi Nuclear Power Plant (NPP) Accident" (WMO-No. 1120). It noted that this contributes to the post-accident study undertaken by the UN Scientific Committee on Effects of Atomic Radiation (UNSCEAR) on the levels and effects of radiation released from the accident. Congress expressed its appreciation to the experts from several WMO Members, who actively participated in this work.

4.1.45 As part of its successful activities, the WMO Task Team on Meteorological Analyses for Fukushima Daiichi Nuclear Power Plant Accident examined in collaboration with research, the possibilities of the integration of methods to deal with unspecified source terms and to assist in the estimate of a source term, and the equivalent approach for forward calculations, and the additional high-resolution ATDM products in the local scale. Congress therefore encouraged enhancing the cooperation of WMO with other international organizations concerned, including IAEA and CTBTO, to seek ways to improve the availability of source term information for use by NMHSs for emergency response.

4.1.46 Congress noted that a user request survey on ATDM products would be instituted by the RA II Team Leader on ERA in association with the WMO Secretariat in 2015–2016 and encouraged Members to actively respond.

4.1.47 Congress noted that the Transfer Coefficient Matrix (TCM) method was explored and successfully tested in the framework of the work of the Task Team and that the introduction of the TCM methodology for nuclear emergency response activities would help to create a system that could support estimates of source terms of key nuclides in the event of a nuclear accident or emergency. Congress therefore requested CBS to continue to assess and, if appropriate, consider and plan how TCM methodology could be implemented into operations.

Ensemble approach to Atmospheric Transport and Dispersion Modelling

4.1.48 Congress noted the ongoing activities for assessing ensemble techniques and requested CBS to identify the steps necessary for the assessment and operational implementation of ensemble ATDM as soon as feasible.

Climate Issues

World Climate Programme

4.1.49 Congress recalled its decision, through Resolution 18 (Cg-XVI), to restructure the World Climate Programme (WCP) in close alignment with the Global Framework for Climate Services (GFCS). It further recalled that the sixty-fifth session of the Executive Council through Resolution 6 (EC-65) confirmed the inclusion of the Global Programme of Research on Vulnerability, Impacts and Adaptation (PROVIA), implemented by the United Nations Environment Programme (UNEP), as a component of the WCP. Congress noted with appreciation that this provides a comprehensive structure to the WCP, and adopted a consolidated Resolution 15 (Cg-17) – World Climate Programme – comprising the Global Climate Observing System (GCOS), the World Climate Research Programme (WCRP), a new World Climate Services Programme (WCSP) and PROVIA.

4.1.50 Congress reaffirmed the programme descriptions of the WCP and its components GCOS, WCRP and WCSP as adopted by Cg-XVI (included in Annex II of the report) and noted that the programme description of PROVIA is included under paragraphs 4.3.103–4.3.106. Congress noted that the issues relevant to GCOS are considered under paragraphs 4.2.5.1–4.2.5.24 and those relevant to WCRP are considered under paragraphs 4.3.10–4.3.23. Congress further noted that the issues relevant to WCSP are mostly considered in the present agenda item, but that the climate data aspects of WCSP are considered under paragraphs 4.2.3.1–4.2.3.21.

4.1.51 Congress noted that the four components of the WCP are being implemented in different streams with different sponsors and governing structures and recognized the need for their close collaboration and coordination to fully and effectively meet the vision and objectives of the WCP including its support to the implementation of the GFCS. Congress therefore requested the Executive Council to keep under review the overall coordination of the WCP components, and facilitate their collaboration through appropriate mechanisms.

Climate Coordination Activities

4.1.52 Congress noted that the EC considered overarching issues relevant to the World Climate Programme (WCP), its four components and their interaction with the GFCS in an integrated manner. It further noted the essential role of the WCP, since its inception, in climate science, research and modelling, observation, management of climate data, monitoring and in applications and services. Congress emphasized continued and enhanced support of the WCP for climate adaptation to benefit food security, water, health and other climate sensitive sectors.

4.1.53 Congress further recognized that in addition to providing coordinated support to the GFCS, close interaction among the four components of the WCP provides a strong basis for contribution to the implementation of other important initiatives within the United Nations Framework Convention on Climate Change (UNFCCC) such as Research and Systematic Observation, the Warsaw Mechanism for Loss and Damage Associated with Climate Change Impacts, National Adaptation Plans of Action (NAP) and the Lima Call for Climate Action. It requested the Secretary-General to continue his efforts in communicating the role and modalities of NMHSs in climate activities and to ensure that they participate in implementation of the afore-mentioned initiatives.

Sixteenth Session of Commission for Climatology (CCl-16)

4.1.54 Congress noted the outcomes of the sixteenth session of the Commission for Climatology (CCl-16) held from 3 to 8 July 2014 at Heidelberg, Germany, particularly its new working structure consisting of five Open Panels of CCl Experts (OPACEs). Congress adopted Resolution 16 (Cg-17) – Report of the sixteenth session of the Commission for Climatology.

Climate Monitoring and Assessment

Extreme Weather and Climate Events

4.1.55 Congress noted with appreciation the consideration given by CCl in its workplan and structure to the definition of extreme weather and climate events, particularly aiming at providing guidance on the definition and tools for monitoring extreme weather and climate events including heat waves, cold waves, heavy precipitations, dry spells, sand storms, etc. Such guidance would enable a harmonized monitoring of these extremes at national and regional level. Congress emphasized that this is critical for supporting Members' operational climate services including climate early warning/climate watches, climate prediction; for supporting research and studies on climate extremes, their attribution and impacts; and for supporting high-level policy processes such as the UNFCCC, the Post-2015 Framework for Disaster Risk Reduction and the Sustainable Development Goals. Congress urged early finalization of this important work with recommendations on and formulation of agreed definitions and tools for appropriate consideration to be included or referenced in the WMO Technical Regulations.

4.1.56 Congress was pleased to note the development of regional climate watch activities supported by the respective Regional Climate Centres (RCCs). In particular, Congress noted with appreciation that RCCs/RCC-Networks routinely provided, as part of their mandatory functions, climate watch-related products and made them available to the NMHSs during extreme events affecting large areas on an extended timescale beyond a week to several months.

4.1.57 Congress emphasized the importance for Members to use climate watch systems as a mechanism for extending the timescale of watches and warnings to cover large scale climate anomalies leading to, for example, heat waves, cold waves, floods and droughts, landslides, etc.

4.1.58 Congress noted the need for providing WMO technical guidance on climate watch systems for the NMHSs so that Members can issue climate watch advisories at national level in a timely manner. This should take into account Members infrastructure and experience in weather warnings, climate monitoring, and monthly and seasonal forecasting that could be effectively leveraged to support climate watch activities.

Climate Monitoring Products and Climate Indices

4.1.59 Congress noted that CCl had drafted a list of six templates for National Climate Monitoring Products (NCMPs) which were expected to be generated by Members on a voluntary basis, and proposed the establishment of national focal points on National Climate monitoring products to support Members' contribution to this activity. Congress also noted the importance of a careful and thorough review of the potential impacts of that initiative on Members' operational climate services.

4.1.60 Congress noted with appreciation the continued support given by CCl, JCOMM and the WCRP to the work of the joint CCl/WCRP-CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ET-CCDI), which has helped improve understanding and characterization of climate variability and change, which are essential for climate services development. Congress noted the need for enhanced collaboration of the Members to support the work of the ET-CCDI by establishing, regularly updating and sharing datasets of relevant climate indices.

4.1.61 Congress noted the request by EC-66 that the follow-through of the work of the ET-CCDI be reinforced through the establishment of focal points at NMHSs. These focal points should ideally have participated in the ET-CCDI workshops and would be responsible for updating the indices and communicating with the ET-CCDI.

4.1.62 Congress further emphasized the need for continued regional capacity-building for the monitoring of changes in extremes. It requested the ET-CCDI and the Secretariat, in collaboration with regional associations, to organize additional regional workshops and provide support to the Regional Climate Centres (RCCs) in this respect.

4.1.63 In view of above, Congress agreed that the concept of National Focal Points on National Climate Monitoring Products would help support the implementation of NCMPs and provide national input on climate indices for the global analysis of climate change and extremes.

WMO Climatological Standard Normals

4.1.64 Congress welcomed the active role undertaken by CCl in collaboration with other Commissions and Programmes to revisit the calculation of the WMO Climatological Standard Normals. Congress, through Resolution 16 (Cg-17), endorsed the recommendation of CCl-16 that the Climatological Standard Normal be calculated every 10 years at the start of every new decade having year digit 1; to serve as the updated official Climatological Standard Normal; that it applies to the most recent 30-year period, with 1981–2010 being the new current standard; and that for specific purpose of long-term climate change monitoring, the period 1961–1990 be retained as a reference period in perpetuity or until such time as a compelling scientific case to change it arises.

WMO Climate Statements and Publications

4.1.65 Congress noted with appreciation the increased contribution of Members to the WMO Annual Statement on the Status of the Global Climate, and the Secretariat efforts in its provision in the six WMO languages in a timely manner. It thanked the global climate data and analysis centres, RCCs and the NMHSs which actively contributed to the WMO Statements on a regular basis.

4.1.66 Congress noted with satisfaction that the WMO Annual Statement on the Status of Global Climate, widely highlighted through an advanced release at the UNFCCC Conference of Parties (COP 20) and press conferences led by the Secretary-General in Geneva and the Deputy Secretary-General in Lima, Peru, proved to be an important mechanism for delivering WMO's authoritative voice on the global climate on a yearly basis. Congress urged Members to continue and further enhance their contributions to this important publication and make best use of it by sharing its content with national policy and decision-makers. Congress further noted the efforts made by NMHSs in producing regular national climate assessments and encouraged their continuation.

4.1.67 Congress welcomed the publication 'The Global Climate 2001–2010, A Decade of Extremes', which received excellent attention by Members and the media. The publication provided an assessment of the state of the climate based on peer-reviewed high-quality global datasets in addition to the information provided by 139 Members based on a special survey. Congress noted with appreciation the partnership established during the process of elaboration of this report, with several agencies and institutions which helped in assessing extreme climate events and their socioeconomic impacts. Congress encouraged the preparation of the next report corresponding to the period 2011–2020, and requested that it be planned well in advance.

4.1.68 Congress welcomed the initiation of a five-year climate summary supported by the CCl Management Group, on the State of the Climate for the period 2011–2015. It stressed the importance of releasing an advanced version of this publication at the UNFCCC COP 21 in Paris in addition to the WMO Annual Statement, as it would provide a longer-term assessment.

Use of Satellite Products for Climate Monitoring and Assessment

4.1.69 Congress noted that there is a growing need for satellite products to complement the poorly documented areas currently based mainly on in situ data. Congress agreed that it is of particular importance for WMO to further enhance its climate monitoring and assessments of the climate system using satellite-based data to contribute to, inter alia, monitoring and assessment of temperature anomalies and trends, precipitation anomalies and its climatology, Arctic sea ice volume, snow cover, etc. Other products such as snow depth estimates and forest fire index, based on combined in situ and satellite data, could also be envisioned as a contribution to regional climate watch activities.

4.1.70 Congress noted with appreciation that the CCl established a task team on the use of remote sensing data and products in climate monitoring to promote the use and assess the suitability of space-based data in climate monitoring, and to work closely with the WMO Space Programme on developing guidance for NMHSs and other user entities to benefit from remote sensing data and products in climate monitoring and climate services.

4.1.71 Congress noted with appreciation the efforts by the WMO Space Programme in addressing, during the 42nd Meeting of the Coordination Group for Meteorological Satellites (CGMS-42), the WMO requirements for satellite data and products in support of WMO climate assessments. Congress encouraged increased collaboration between CCl and CGMS in climate monitoring and assessment at global and regional levels.

Climate Services Information System

4.1.72 Congress noted that WMO had already put in place, or identified, several entities to specifically support NMHSs climate operations, including the highly specialized centres designated by WMO based on standards and criteria. It further noted with satisfaction that these entities are appropriately highlighted in the GFCS implementation plan as part of its Climate Services Information System (CSIS) pillar, approved by the Intergovernmental Board on Climate Services (IBCS). Congress urged Members to enhance their contributions to the GFCS by strengthening the existing CSIS entities and also by identifying and filling gaps at global, regional and national levels.

4.1.73 Congress recalled Resolution 17 (Cg-XVI), establishing the CSIS under the World Climate Programme (WCP) with global, regional and national entities providing operational climate information, including data, monitoring, prediction and projection products within the GFCS. Congress further recalled its decision to close the Climate Information and Prediction Services (CLIPS) project by 2015 and transition its activities into the implementation of the GFCS, particularly through the CSIS. Congress therefore decided to formally close the CLIPS project on 31 December 2015.

4.1.74 Congress noted with appreciation the significant contributions of the CLIPS project, ever since its establishment in 1995, in developing the concept of climate services. In particular, Congress highlighted the success of the CLIPS project in developing and implementing the RCCs and Regional Climate Outlook Forums (RCOFs) and facilitating their support to the NMHSs. Congress emphasized the need to carry forward the CLIPS legacy into the implementation of the CSIS. Congress therefore complimented the CCl and WCRP for the successful organization of a Technical Conference with the theme “Climate Services – Building on CLIPS Legacy” (30 June–2 July 2014, Heidelberg, Germany), and noted its outcomes.

4.1.75 Congress also recalled its decision, through Resolution 17 (Cg-XVI), that the implementation of CSIS should be guided by the CCl in close collaboration with the Commission for Basic Systems (CBS). Congress noted with appreciation that CCl has given a high priority to the CSIS in its working structure and established an Implementation Coordination Team on CSIS. Congress supported the efforts of CCl in developing a CSIS Technical Reference Manual, Climate Services Toolkit, a National CSIS Focal Point Network, etc., and urged Members to actively contribute to the work of CCl in this regard. Congress requested the IBCS to ensure a tight nexus between the leadership role being played by the CCl in guiding the CSIS implementation and relevant mechanisms guiding GFCS implementation.

Operational Climate Prediction

4.1.76 Congress noted the rapid scientific advances in estimating future states of climate variability and change on different time and space scales, and the increasing recognition by Members of the importance of climate prediction and projection products in supporting climate adaptation and risk management, particularly for early warning systems and advance planning. Congress further noted that climate prediction and projection constitute high priority minimum functions identified for the CSIS in the implementation plan of the GFCS.

4.1.77 Congress noted with appreciation the strengthened collaboration between CCl and the Commission for Basic Systems (CBS) on operational climate prediction, facilitated by the joint CBS/CCl Expert Team on Operational Prediction on Sub-seasonal to Longer-time Scales (ET-OPSLS) and the CCl/CBS Expert Team on Regional Climate Centres (ET-RCCs). Congress noted with appreciation that a CBS/CCl Workshop on "Operational Long-range Forecasting: GPCs and RCCs, in support of NMHSs and RCOFs" was held in Brasilia, Brazil from 25–27 November 2013, to identify priorities for strengthening cooperation and enhanced exchange of data, methods and tools between Global Producing Centres of Long-range Forecasts (GPCs) and RCCs, and ways to improve operational practice in long-range forecasting, including in support of NMHSs and Regional Climate Outlook Forums (RCOFs). Congress noted the need for such interaction to be sustained on a regular basis.

Global Seasonal Climate Update

4.1.78 Congress recalled that the aim of Global Seasonal Climate Update (GSCU) would be to assist the NMHSs as well as RCCs and RCOFs. Congress noted that the CCl Task Team on GSCU progressed with the trial phase of the GSCU and that a number of updates have been produced to evaluate the content as well as operational requirements. Congress agreed that the GSCU development be continued as a collaborative effort between CCl and CBS, with a view to make it an operational product based on the guidance provided by EC-64.

Regional Climate Centres

4.1.79 Congress noted with satisfaction that RCCs have been recognized as key elements in the GFCS implementation plan, and that the coverage of RCCs is gradually expanding. Congress noted with appreciation that, during the last intersessional period, new RCCs had been designated and that demonstration phases of several RCCs/RCC Networks had commenced in different regions, in particular Central America and the Caribbean, Southern South America, North and Central Africa and South Asia. Congress noted with satisfaction that high-level engagement, including through meetings of Heads of States and Ministers, had facilitated progress towards the implementation of an RCC for Central Africa. Congress appreciated the close coordination of the concerned CCl and CBS joint entities in supporting the RCC designation process, and encouraged them to make concerted efforts with the relevant bodies of regional associations to ensure the establishment of RCCs in all Regions to meet the immediate needs of the GFCS implementation. Congress noted CCl efforts to pursue standardization of RCC products and services, and its ongoing role to provide guidance on this and other operational aspects of the RCCs. Congress urged the presidents of regional associations, CCl and CBS to closely work together to ensure successful establishment and operation of RCCs in all Regions and facilitate the effective use of their products and services by the NMHSs.

4.1.80 Congress further emphasized the importance of maintaining a high level of support given by the RCCs to the Members in the provision of regular climate products which help NMHSs in the development and provision of climate services to their national users. It urged Members to enhance their interaction with the RCCs by providing their feedback on the usefulness of the products delivered by the RCCs.

Regional Climate Outlook Forums

4.1.81 Congress recognized the role of RCOFs as effective platforms to bring together countries having common climatological characteristics and facilitate consistency in the access to and interpretation of the available information and to deliver a range of regional monitoring and outlook products. Congress further recognized that, in addition to the product generation, networking and capacity development opportunities the RCOFs provide to the Members, they also promote stakeholder awareness, feedback and decision-support oriented products. Congress noted with satisfaction the sustained operations of the existing RCOFs and the expansion of the concept to several other subregions. In that regard, Congress recognized the establishment or re-activation of a number of RCOFs around the world, in particular in Africa, South-East and South Asia, Central America and the Caribbean, South America, the Greater Mediterranean Region. The

RCOF process had assisted to build capacity in the NMHSs, particularly in how to make best use of the extensive information available from the GPCs. Congress noted with appreciation that CCl has set up a Task Team on RCOFs to enable a well-focused approach to enhance, strengthen and expand the RCOF process, improving technical inputs and methods, enhancing efficiencies and increasing user focus will augment the sustainability of RCOFs. Congress urged Members to actively support RCOF operations.

National Climate Outlook Forums (NCOFs)

4.1.82 Congress noted that National Climate Outlook Forums (NCOFs) and National Climate Forums (NCFs) are envisioned as key national platforms for promoting regular dialogue and inter-agency coordination in responding to climate variability and change, providing climate information at national level at relevant timescales through a regular and sustained multi-stakeholder dialogue between information provider(s) and users, and serve as an effective and sustained user interface platform for CSIS. Congress noted with appreciation that some Members have already started implementing NCOFs/NCFs, and requested CCl to provide the necessary technical guidance for their operational practices. Congress urged all Members to take up NCOF and NCF implementation as a key component of GFCS implementation at the national level, and requested the Secretary-General to facilitate the development of guidance to help NMHSs to set up and coordinate NCOFs and NCFs on a regular basis. Congress highlighted the importance of effective coordination of climate activities for coherent dissemination of information on climate and weather, and encouraged the development of frameworks for climate services at the national level.

Climate Information for Adaptation and Risk Management

4.1.83 Congress urged Members to support and promote user engagement through RCOFs, NCOFs, and NCFs by use or sector-driven climate forums (e.g., hydrological-, agricultural- or health-focused forums), demonstration projects, interdisciplinary workshops and training, and field activities including roving seminars, a notable success in climate services for the agriculture sector. Considering that the NCOFs and NCFs are likely to attract substantial participation of user sectors and are possible avenues for building the capacities of users of climate information, Congress agreed that NCOFs and NCFs could also be viewed as effective mechanisms for national implementation of both the User Interface Platform and Capacity Development pillars of the GFCS, offering excellent opportunities for NMHSs to interact with other stakeholders.

4.1.84 Congress recognized the need for improved practical application of Climate Risk Management (CRM) approaches at local levels, in order to reduce climate impacts and build resilience to climate variability and change. Congress appreciated CCl guidance on CRM, and urged Members to use the recommended CRM approaches, including development of case studies demonstrating good practices in CRM, and share the outcomes with CCl to help further improve the CRM concepts.

4.1.85 Congress noted with appreciation that a software package called “ClimPACT” was developed by the CCl Expert Team on Climate Risk and Sector-Specific Climate Indices (ET-CRSCI) with the aim of providing an easy and consistent way of generating sector-specific climate indices. Congress further appreciated that ET-CRSCI also demonstrated a workshop concept to provide subregional training and facilitate collaborative computation of sector-specific climate indices involving climate information providers as well as users. Recognizing the added value of application-oriented climate information, Congress highlighted the need of conducting such training workshops in all regions to promote wide use of the software.

4.1.86 Congress noted with appreciation the publication of the Guidance on Implementation of Heat Health early Warning Systems (HHWS), which is an outcome of collaborative efforts of experts from WMO and the World Health Organization (WHO). Congress recognized the critical importance of the Guidance in view of increased frequency and intensity of heat waves during the last decades and urged Members to use it to implement integrated HHWS.

Joint Expert Group on Climate, Food and Water (JEG-CFW)

4.1.87 Congress noted the work of the Joint CCl/CAgM/CHy Expert Group on Climate, Food, and Water (JEG-CFW) and its recommendations to the Executive Council. Congress supported the JEG-CFW recommendation to update the previous WMO Brochure on Weather, Climate, and Food security by adding water aspects to the theme. Congress was informed of the proposal for the establishment of an Intergovernmental Panel on Water made by Mexico at UNFCCC COP 20 in Lima, Peru. Congress encouraged that water related issues be further emphasized within the JEG-CFW. Congress further supported the use of simple rainfall observations made by volunteers and requested that CAgM, CCl, CHy, and CIMO work together to further develop and strengthen those observations, especially in developing countries.

Drought Initiatives

4.1.88 Congress noted with appreciation the successful organization of the High-Level Meeting on National Drought Policy (HMNDP), and complimented the collaboration of WMO, FAO and UNCCD and other partnering organizations. Congress noted the final HMNDP Declaration (see Annex VI to the present report) adopted by the High-level Segment of the meeting, which urged WMO, UNCCD, FAO, other related UN agencies, and programmes, as well as other concerned parties, to assist governments, especially the developing countries, in the development of National Drought Management Policies and their implementation. Congress encouraged all NMHSs to extend their full support and to urge relevant ministries and agencies in their countries to actively support the application of the Declaration. Congress noted with appreciation that a Special Issue on HMNDP was published by the *Weather and Climate Extremes* Journal. Congress thanked all the donors for their valuable support to the organization of HMNDP.

4.1.89 Congress noted that the Technical Support Unit (TSU) of the Integrated Drought Management Programme (IDMP) was established in August 2013 within the Climate and Water Department of WMO Secretariat. Congress was appreciative that the Global Water Partnership (GWP) seconded an expert to the TSU and that the Government of Canada has provided funds for the IDMP to start its work. Congress urged the Secretary-General to explore additional partners for the IDMP and to support its TSU. Therefore, Congress adopted Resolution 17 (Cg-17) – Integrated Drought Management Programme.

4.1.90 Congress noted that there is currently no global, authoritative, and consistent information on drought that is easily accessible to all users, including real-time assessments of ongoing drought and information on the understanding of the physical mechanisms and predictability of drought. With this in mind, Congress supported of the efforts of the WMO Secretariat, the TSU of the IDMP, the World Climate Research Programme, GEO, and the US NOAA to further develop the Global Drought Information System (GDIS).

4.1.91 Congress noted that the UN-Water Decade Programme on Capacity Development (UNW-DPC), WMO, CBD, UNCCD and FAO have collaborated on the National Drought Management Policies Initiative which has organized five regional workshops. Congress appreciated the efforts of these partners and noted that this specific initiative will end in 2015. Congress noted that this initiative was developed with the concepts of the HMNDP and therefore requested the Secretary-General to continue to harmonize the outcomes of this initiative and to liaise with these partners with regards to the IDMP.

4.1.92 Congress noted that there are other WMO activities which relate to drought issues such as the WMO Disaster Risk Reduction Programme Focal Points of Technical Commissions and Programmes and international activities such as the development of the Post-2015 Framework for Disaster Risk Reduction. Congress encouraged the Secretariat to liaise and coordinate with these activities to ensure that drought issues are adequately represented.

Water issues

4.1.93 Congress reviewed the Hydrology and Water Resources Programme on the basis of the reports by the president of Commission for Hydrology (CHy) and the Secretary-General, recording, among other things, the actions taken by CHy and the Secretariat in response to Resolution 12 (Cg-XVI) – Hydrology and Water Resources Programme; Resolution 13 (Cg-XVI) – Quality Management Framework – Hydrology; Resolution 14 (Cg-XVI) – World Hydrological Cycle Observing System; and Resolution 15 (Cg-XVI) – Establishment of an Advisory Group for the WMO Flood Forecasting Initiative.

Commission for Hydrology

4.1.94 Congress noted that the fourteenth session of the Commission for Hydrology (CHy-14), held in Geneva in November 2012 had adopted five thematic areas for the work of the Commission in its intersessional period 2013–2016:

(a) Quality Management Framework – Hydrology (QMF–Hydrology);

(b) Data Operations and Management;

(c) Water Resources Assessment;

(d) Hydrological Forecasting and Prediction; and

(e) Water, Climate and Risk Management.

4.1.95 Congress was informed that CHy had developed corresponding sets of activities and expected outputs and outcomes for each of these thematic areas and that these areas were supported by Open Panels of CHy Experts (OPACHEs).

4.1.96 Congress encouraged Members to nominate more experts to the Open Panels of CHy Experts (OPACHEs), which should include leading experts that actively work in one or more of the five priority thematic areas. It also encouraged Members to facilitate greater use of the CHy e-Board and CHy e-Forum by experts from their countries as mechanisms for strengthening communication and feedback amongst the Members on relevant items.

4.1.97 Congress was pleased to note that the Commission is undertaking an evaluation of the effectiveness of pre-session electronic discussions for some of its important documents. This approach is aimed at enabling participation of, and contributions from, experts without them physically joining the Commission sessions.

4.1.98 Congress gratefully acknowledged the many contributions of Dr Ödön Starosolszky (Hungary) to WMO, who had served as president of the Commission for Hydrology from 1984 to 1993. It noted that 3 June 2015 was the ninth anniversary of his passing, and expressed its appreciation for the important and enduring role Dr Starosolszky played in guiding the evolution of hydrology within WMO.

4.1.99 Congress adopted the Hydrology and Water Resources Programme as per Resolution 18 (Cg-17) – Hydrology and Water Resources Programme and the programme description given in Annex II to the Report of the Sixteenth World Meteorological Congress.

Quality Management Framework (QMF) – Hydrology

4.1.100 Congress was informed that CHy-14 had continued to support and implement a quality management approach in its actions and activities. In particular, Congress was informed that, in the framework of the cooperation with the International Organization for Standardization (ISO), the process for adoption of the WMO *Manual on Stream Gauging* Volumes I and II as a Technical Report under the category of other ISO deliverables was well under way, following the discussion

at the ISO/TC113 – Hydrometry meeting in May 2015 in Tokyo, Japan. Congress also supported actions taken to improve the accessibility of ISO standards related to hydrology for Members.

4.1.101 Congress was informed of the progress made by the CHy project "Assessment of the performance of flow measurement instruments and techniques" (Project X) in preparing guidance material on the estimation of uncertainty of the discharge measurements and determination, as well as on conducting and reporting results of instrument calibration and performance test on instruments and techniques. A community of practice has been established for the project Management Committee to facilitate sharing of documents and communications among participants.

4.1.102 Congress was pleased to note that a web page on the Quality Management Framework-Hydrology had been created within the Hydrology and Water Resources Programme website and urged Members to use the site to access information on quality management from a hydrological perspective.

4.1.103 Congress noted that the French, Russian and Spanish versions of the *Guide to Hydrological Practices* (WMO-No. 168) had been issued, and that the Chinese, French and Spanish versions of the *Manual on Flood Forecasting and Warning* (WMO-No. 1072) had also been produced, thanks to the contributions of China, France and Mexico. As for the *Manual on Stream Gauging* (WMO-No. 1044), it was decided to translate the abundant training material developed by two CHy experts, rather than to translate the manual itself (see also paragraph 4.1.32). WMO and UNESCO issued the third edition of the *International Glossary of Hydrology* in 2013.

Data Operations and Management

4.1.104 Congress noted the progress that had been made with respect to the application of WaterML 2.0. Congress was informed that WaterML2.0 is a significant multilateral effort that has resulted in its adoption by the Open Geospatial Consortium as an international standard for water data exchange and also contributed to the development of TimeSeriesML, which will be applicable to climate and meteorological data. Congress recalled that CHy, through Resolution 3 (CHy-14), had decided to start a process, including testing in pilot projects and operational applications, that could lead to the adoption of WaterML 2.0 as a WMO standard for information exchange. Congress was pleased to see the progress made, through a CHy designated expert, in the testing in a number of WMO Regions of a technical solution (open source software) that supports exchange of hydrological data using WaterML 2.0. Congress noted that this software is also being used to support the establishment of the WMO Hydrological Observing System (WHOS). It also noted the establishment of the WMO website with respect to WaterML 2.0. Congress encouraged CHy to further develop the material to support the introduction of WaterML 2.0 and agreed that the addition of case studies on the implementation of WaterML 2.0 would greatly assist Members.

4.1.105 Congress was informed of the recent establishment of the WMO Hydrological Observing System (WHOS) as the hydrological input to WIGOS. It noted that WHOS was being implemented in two phases, a short-term capability to access the hydrological data of NMHSs that are already freely and openly available online, which would be launched by July 2015, and a longer-term capability that was WIGOS and WIS compliant and makes use of a hydrological information system enabling data registration, data discovery, and data access. Congress welcomed that effort and urged the president of CHy to continue guiding WHOS to full implementation.

4.1.106 Congress was informed that within the framework of the EU funded project "Building Resilience to Disasters in Western Balkans and Turkey" WMO supported the International Sava River Basin Commission in developing a data exchange policy, based on the Resolution 25 (Cg-XIII) – Exchange of Hydrological Data and Products, and compliant with existing national policies. Congress encouraged the further promotion of Resolution 25 (Cg-XIII) in the water sector, as a way of enhancing cooperation in transboundary river basins.

4.1.107 Congress was informed that, as requested by CHy-14, a community of practice on database management systems had been established for the open source MCH (Meteorology, Climatology and Hydrology) system. The community of practice had been launched at a meeting in Madrid in December 2014 which made significant advances in charting the future of the MCH. MCH was originally developed in Spanish by Mexico, and adapted and installed in the Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Paraguay, Uruguay and the Bolivarian Republic of Venezuela by the Ibero-American Programme funded by Spain. At Cg-XVI, it was offered to WMO for use by Members, and has since been translated into English and French and installed in Ghana, Belize, Curaçao and Sint Maarten, Albania, Bosnia and Herzegovina, and the British Caribbean Territories. In all cases, NHS staff has been trained in the operation and management of the system. Congress encouraged other Members to take advantage of the availability of this open source software and noted that ad hoc routines/protocols had been developed to enable the transfer of data from CLICOM to MCH.

4.1.108 Congress agreed that the hydrological data collected by NMHSs and CHy's guidance in terms of hydrological data analysis could play a significant role in designing monitoring mechanisms for the Sustainable Development Goals (SDGs), especially the goals related to water and water-related disasters. Congress therefore encouraged the Secretary-General and CHy to actively participate in the discussions related to SDG monitoring through the framework provided by UN-Water. Congress noted also that, through the new Global Water Data Centre, Germany was contributing to this endeavour.

4.1.109 The Global Water Data Centre supports water management planning through its unique combination of freely available data on water quantity from the WMO Global Runoff Data Centre (GRDC) and data on water quality from the UNEP Global Water Quality Centre, both centres hosted at the Federal Institute of Hydrology in Koblenz, thus making use of the inherent synergies. Congress recognized the continued support of the government of Germany to the GRDC over the past 27 years and the preparedness of the Global Water Data Centre to provide additional services, especially in support of the development of WHOS, the GFCS and supply of hydrological information in support of SDG monitoring. In that regard, Congress called on Members to continue to improve the provision of streamflow data to the GRDC. Congress also recognized the active role of the GRDC in the development of data-sharing standards and practices.

4.1.110 Congress requested CHy to monitor progress in the area of data operations and management and report to the Executive Council with regard to the evolving role of the GRDC and other related data centres, such as IGRAC and HYDROLARE, and their relationship with WMO, inter alia, with respect to the monitoring and measurement of the achievement of the SDGs and their contributions to other CHy initiatives.

Water Resources Assessment

4.1.111 Congress was pleased to hear that advances were being made in the development of a Manual on Water Resources Assessment. Towards this end, CHy has published a report on Technical Material for Water Resources Assessment and organized two Expert Group meetings for experts in RA II in the Republic of Korea, and RA IV in Panama, and also set up a Task Team to finalize the Manual. The Task Team had met in May 2015 and had developed a workplan with the objective of having a version ready for peer review by the end of 2015 and a published version for CHy-15 in late 2016. Congress noted the importance of that particular Manual and urged all Members to contribute to its development as appropriate.

Hydrological Forecasting and Prediction

4.1.112 Congress was pleased to note that in response to Resolution 15 (Cg-XVI) establishing the Flood Forecasting Initiative Advisory Group (FFI-AG), the first meeting of the FFI-AG had been held in Geneva from 7 to 9 October 2013. Congress endorsed the approach taken by the FFI-AG of alignment of a range of projects being undertaken across WMO, including the Severe Weather Forecasting Demonstration Project (SWFDP), the Flash Flood Guidance System (FFGS) with global coverage and the Coastal Inundation Forecasting Demonstration Project (CIFDP). Congress

was also pleased to note that USAID/OFDA was supporting the integration of the SWFDP and the FFGS through a demonstration phase in the Southern African region, to enhance early warnings of hydrometeorological hazards. Congress requested the presidents of CAS, CBS, CHy and JCOMM to work together to enable improved linkages and interactions amongst the SWFDP, CIFDP and FFGS. In view of the several major flood events that South Asian countries had experienced in the recent past, Congress requested that consideration be given to the inclusion of the South Asia region in the demonstration phase for the integration of SWFDP and FFGS capabilities, as so doing would be an important contribution in the development of a robust prediction system for those heavy precipitation and flooding events. Congress further requested that when undertaking that initiative, particular attention be given to the Western Himalayas area.

4.1.113 Congress was informed of the efforts under way by CHy to prepare a report on the "Decision-support for the Selection of Flood Forecasting Models". Congress was pleased to learn that the guidance material would assist Members in the selection and application of flood forecasting models under different flood situations, as well as environmental and institutional settings, including a variety of professional capabilities in NHSs.

4.1.114 Recognizing the importance of effective flood forecasting services as a basic component of disaster risk reduction, Congress noted with interest the report on "Improving the Efficiency of Flood Forecasting Services – Development of a Framework for the Assessment of Service Delivery Capabilities of Hydrological Services" that had been developed in the framework of the WMO Strategy for Service Delivery. Congress requested CHy to establish a process to improve service delivery capabilities of NHSs for flood forecasting.

4.1.115 Congress was informed that, at CHy-14, Italy had offered to make the DEWETRA platform freely available to members of CHy. The DEWETRA platform is a real-time integrated system for hydrometeorological and wildfire risk forecasting, monitoring and prevention. It has the capability to ingest data from different sources and produce several types of integrated maps useful for risk-management decision-makers. A Cooperation Agreement between WMO and the Italian Department of Civil Protection (the "owner" of the software) has been signed and the first installation missions started in April and May 2014. Congress expressed its appreciation to the Government of Italy for making the DEWETRA platform available to its Members and encouraged Members to take advantage of this offer, as China, Croatia, Ecuador and the Philippines have already done.

4.1.116 Congress noted the work of CHy and CBS, as well as significant contributions by Members, leading to the extensive uptake of the FFGS. As called for in Resolution 21 (Cg-XV), and with financial support from USAID/OFDA, regional components of the global FFGS have been implemented or are under development in Central America, South-East Asia, Southern Africa, Black Sea and Middle East, Hispaniola, South-east Europe, South Asia and Central Asia. An initial Planning Workshop for FFGS in Central Asia had been held in early May 2015, in which Kazakhstan had offered to host the respective Regional Centre. An FFGS demonstration project has commenced for the Zarumilla River basin in South America, while the South-eastern Asia-Oceania Region FFGS project is under consideration. Nationally funded projects have also been implemented, or are proposed, in South Africa, Romania, Mexico and Oman. Through funding from the Swiss Agency for Development and Cooperation, Jordan has been added to the Black Sea and Middle East FFGS project. Congress was informed that a 10-year follow-on conference to the First International Conference on Flash Flood Forecasting is planned for 2016 and endorsed the proposal. Congress furthermore requested the Secretary-General to explore mechanisms to sustain the regional FFGS projects and the associated modelling systems.

4.1.117 Congress was informed that the Associated Programme on Flood Management (APFM), in partnership with the Global Water Partnership (GWP) and financially supported over the years by Switzerland, Japan, USA, Germany and Italy (currently only by Switzerland) continued to compile and produce guidance documents and tools in support of Integrated Flood Management. Congress welcomed the fact that eleven new publications had been published since Cg-XVI, providing references to specific topics related to flood management and made available through the APFM website. Congress noted that 33 requests for assistance were fulfilled through

the HelpDesk on IFM, a user friendly platform through which countries can get assistance in capacity-building, technical guidance, or policy formulation towards the implementation of flood management strategies. Congress noted the valuable input provided in the fulfilment of these requests by the 23 partner institutions forming the support base for the HelpDesk, and invited Member countries to make use of the resources available through the HelpDesk on IFM. Congress urged Members to financially and technically contribute to the APFM thereby increasing its ability to assist more countries.

4.1.118 Congress was informed that EC-65 had requested CHy to provide guidance for WMO's involvement in the Global Flood Partnership (GFP). Congress noted that the president of CHy had discussed the invitation from the GFP for WMO to be a partner with the CHy Advisory Working Group and agreed with his recommendation that WMO should not join the GFP as a partner, and furthermore encouraged CHy to continue interacting with the GFP to ensure consistency with the role and responsibilities of NMHSs in the delivery of flood forecasting and warning services at the national, regional and global levels. This decision reflected the current research focus, as opposed to operational capabilities, of the GFP.

Water, Climate and Risk Management

4.1.119 Congress was informed that CHy had made a major contribution to the GFCS through the Water Exemplar and that the WMO/GWP Associated Programme on Flood Management and the Integrated Drought Management Programme, being implemented in association with the GWP, FAO, WFP, and UNESCO, were contributions from the Hydrology and Water Resources Programme to the GFCS.

4.1.120 Congress noted that a range of activities had been undertaken in the area of Extended Hydrological Prediction, including a colloquium on seasonal forecasting – current challenges and potential benefits for decision-making in the water sector, in Koblenz, Germany in October 2014 and workshops involving experts from the water sector associated with Regional Climate Outlook Forums, in particular in RA II with the International Commission for Irrigation and Drainage. Congress was pleased to see the planned development of guidance material and case studies on the application of seasonal climate forecasts in hydrology and water resources and of Guidelines on the use of climate modelling and downscaling techniques in hydrological applications.

4.1.121 Congress agreed that integrated water resources management can play a key role in adaptation strategies for addressing climate change and variability, for advancing strategies to reduce loss of life and protect property and prosperity from flooding and droughts. Congress further noted that water management requires the integration of weather services, climate services, and hydrological services. Congress stressed that proper consideration should be given to advancing the implementation of integrated water resources management through the Global Framework for Climate Services (GFCS) and the ongoing global efforts on water-related disaster risk reduction.

Capacity Development (including WHYCOS)

4.1.122 Congress noted that the Strategy on Education and Training in Hydrology and Water Resources continued to be regularly updated and implemented by the Commission for Hydrology, agreeing that it provided an excellent framework for responding to the capacity development needs of the Members in this area.

4.1.123 Congress was pleased to note that a number of distance learning courses in Basic and Advanced Hydrological Sciences had been conducted for Asia and Africa. These courses are jointly organized by WMO, COMET, NOAA and a local WMO Regional Training Centre (RTC); the India National Water Academy (in the case of Asia) and the Institute for Meteorological Training and Research (IMTR) of Kenya (for Africa). In addition, Congress was pleased to note the online hydrology courses offered by the Caribbean Institute for Meteorology and Hydrology to regional and international communities. In particular, the course on Floodplain Mapping had been extremely well attended outside of the Caribbean region.

4.1.124 Congress was also pleased to note that the training material on the WMO *Manual on Stream Gauging* had been translated into French, Russian and Spanish and that a pool of instructors in the different languages is being formed. After courses in English for Indonesia and West Africa, a training-of-trainers session for Spanish-speaking instructors on stream gauging had been held in Mexico in November 2013, and a first course in French for African countries is scheduled for July 2015 in Benin, while the first course in Russian will be held in 2016. A community of practice of instructors in stream gauging had been developed and was activated in December 2014. Training material has also been developed for the *Manual on Flood Forecasting and Warning* and initial courses have been held in China and Turkey for the Western Balkans and Turkey. Congress noted the increased frequency of flood events in the African countries and requested that future training courses be extended to those countries.

4.1.125 Congress was informed that, following the request that had been made by Cg-XVI to CHy to review the definitions for hydrologists and hydrological technicians and their associated Basic Instruction Packages, and to develop competence standards for the core job-tasks in hydrology, a Joint Task Team with UNESCO, the International Association for Hydro-Environment Engineering and Research (IAHR) and the International Association of Hydrological Sciences (IAHS) had initiated its work on the subject, with the support of the EC Panel on Education and Training. The goal was to present the results of the work of the Task Force to CHy-15 in late 2016 for its endorsement.

World Hydrological Observing System (WHYCOS)

4.1.126 Congress was informed that the tenth session of the WHYCOS International Advisory Group (WIAG-10) was held in Geneva from 10 to 11 October 2013. The meeting discussed the follow-up to the 2011 WHYCOS Review and noted that the WMO Secretariat was taking action on the recommendations and was studying the best operational arrangements in the Secretariat to provide maximum support to the implementation of the programme and its components. Some of the recommendations had also been addressed in the review of the WHYCOS Guidelines. Congress was pleased to note that with the support of funding from the Swiss Agency for Development and Cooperation (SDC), a WHYCOS Office has been proposed to be established in the WMO along with a water innovation hub, focused on innovations in water resources measurement, monitoring and assessment. In that regard, Congress adopted Resolution 19 (Cg-17) – World Hydrological Cycle Observing System Office.

4.1.127 Congress noted that there had been progress over the past four years in a number of WHYCOS component projects, including Arctic-HYCOS, Carib-HYCOS, Congo-HYCOS, HKH-HYCOS, IGAD-HYCOS, Mekong-HYCOS, Niger-HYCOS and Volta-HYCOS. Congress was pleased to hear that there had also been increased activity concerning Lake Chad-HYCOS, Oyapock-HYCOS and Senegal-HYCOS and a further phase of HKH-HYCOS and SADC-HYCOS. The potential for a Nile-HYCOS was also being investigated with the relevant countries. Congress expressed its appreciation to development partners, notably the EU, France, the African Water Facility, among others, who support the implementation of various HYCOS components. Congress also took note of some unimplemented activities from previous phases in Volta-HYCOS and SADC-HYCOS that need the intervention of WMO for their completion. Congress noted that the WHYCOS Guidelines had been revised, updated and published and provided valuable guidance to the existing and evolving HYCOS components.

Cooperation in Water-related Issues

4.1.128 Congress took note that the activities of UN agencies, funds, programmes and offices with an interest in water matters continue to be effectively coordinated through UN-Water. Congress was pleased to note that in 2012 the Secretary-General of WMO had been appointed as the Chairperson of UN-Water and confirmed for a second term in 2014 and that, due to his dedicated and impartial leadership, this had raised the profile of WMO within the UN system on water-related activities, and of UN-Water among the various coordinating mechanisms of the UN system, in particular with respect to the developments associated with the post-2015 sustainable development agenda, including the establishment of SDGs and global efforts in disaster risk

reduction. Congress also recalled that WMO continues its lead role in coordination of the Water and Climate Change Thematic Priority Area.

4.1.129 Congress was pleased to note that WMO and UNESCO had re-affirmed their close working relationship through the signing of a Working Agreement on the long-term cooperation between UNESCO and the World Meteorological Organization in the field of hydrology and water resources (freshwater) and that the first Liaison Committee under this Working Agreement had been held in December 2014.

4.1.130 Congress also noted that WMO has continued cooperation with the United Nations Economic Commission for Europe (UNECE) providing technical backstopping for the pilot projects on climate change adaptation in the water sector and contributing to the publication of relevant case studies, and, through several of its Members, to addressing issues of surface water quality.

4.1.131 Congress further noted the ongoing cooperation with international non-governmental organizations and professional associations. WMO, in cooperation with IAHS and UNESCO, is organizing a session in the framework of the Conference “Our common future under climate change” ahead of the COP 21 of the UNFCCC in 2015. WMO and IAHS have developed the syllabus for a training programme for hydrologists for Philippines. WMO, UNESCO and IAHS have continued the process of awarding the International Hydrology Prize each year. IAHR and IAHS have cooperated with WMO in the organization of training courses on stream gauging based on WMO Manual. IAHR and IAHS are also members of the Management Committee of the project to assess the performance of flow measurement instruments and techniques. A tutorial on IWRM as an adaptation tool to climate change has been prepared in cooperation with Cap-Net.

4.1.132 Congress was informed that WMO continues to collaborate with the African Ministerial Council on Water (AMCOW) in UN-Water/Africa activities and actively participated in the 5th African Water Week in Dakar, Senegal at which the Secretary-General was the keynote speaker on Water. Congress also noted that WMO and AMCOW, together with the African Development Bank, continued to collaborate in implementing the African Water Facility that is providing financial support for hydrological activities, in particular support to HYCOS projects, in Member countries.

4.1.133 Congress thanked the Ibero-American NMHS Directors Conference (CIMHET) for its support to water-related education and training activities for the Ibero-American countries and requested the Secretary-General to explore the possibility of establishing closer ties with the Ibero-American Water Directors Conference (CODIA).

Regional Water-related Activities

4.1.134 All regional associations have re-established a Working Group on Hydrology and Water Resources (or a similar title). RA IV has established an online Virtual Hydrology Forum as a platform where issues and challenges related to the operation of hydrological networks and services can be discussed among experts of the Region’s NHSs. RA VI has established a regional forum to provide a mechanism where similar issues and challenges can be discussed within the hydrological community. Congress suggested that other Regions follow these examples. The working group of RA III has a very active web page, while in RA II, RA IV and RA V meetings have been dedicated to specific issues of regional interest. In RA I there is a proposal for revitalizing the Working Group on Hydrology (WGH), to among other things, complement the successful HYCOS projects in the Region. The activities of this WGH have suffered a slight delay due to the postponement of the RA I-16 session. Through the RA VI Working Group on Climate and Hydrology, WMO is also participating as an observer in the activities of the European Commission linked to the implementation of the Water Framework Directive and the Flood Directive.

Gender Issues

4.1.135 Congress noted with interest that the Conference on the Gender Dimensions of Weather and Climate Services, held in Geneva from 5 to 7 November 2014, had formulated the following sector-specific recommendations with respect to Water Resources Management:

(a) Target interventions at all levels, from children to youth to adults (in all capacities);

(b) Empower, through greater gender awareness, those at high levels to influence decision-making with respect to gender-related activities;

(c) Compile gender disaggregated indicators, as is being done by UN-Water's World Water Assessment Programme;

(d) Target those at greatest risk – the poor and disadvantaged – understand their perspective and needs;

(e) Develop partnerships and improve coordination among different stakeholders and different (especially already existing) projects;

(f) Disseminate information through the most appropriate means of communication (such as personal meetings, television, radio and infographics), keeping the message brief and simple;

(g) Ensure that information is made available in local languages to meet specific needs, with wider outreach for effective communication and feedback;

(h) Include indigenous knowledge together with scientific understanding – build trust;

(i) Provide schools with hands-on access to water and weather facilities, (e.g. a weather station), visits and career talks;

(j) Emphasize the societal value of scientific careers;

(k) Create and maintain networks of young women in water professions;

(l) Enable positive discrimination in hiring and promotion of equally qualified candidates – although it is just a start;

(m) Offer paid family leave for both mothers and fathers;

(n) Scan all policies and programmes through a gender lens.

4.1.136 Congress requested the Secretary-General and the president of CHy to ensure that the implementation of these recommendations is promoted among the NMHSs and in WMO water-related activities during the next intersessional period.

4.2 WMO Integrated Global Observing System and WMO Information System– Priority (agenda item 4.2)

4.2.1 World Weather Watch Programme (agenda item 4.2.1)

4.2.1.1 Congress recognized that the WWW continues to be the "core" operational infrastructure facility for all WMO Programmes, new initiatives, such as the Global Framework for Climate Services (GFCS) and the Global Cryosphere Watch (GCW), as well as for many international programmes of other agencies. Congress reaffirmed that the WWW Programme, with the evolving development of its observing, information, data-processing and forecasting components, continues to be the backbone Programme of WMO that also directly contributes to the WMO cross-cutting activities and to all WMO application programmes.

4.2.1.2 Congress re-affirmed that there is a need to further strengthen the components of this unique Programme of WMO, especially in developing countries, and invited the Secretary-General to make the necessary arrangements and encourage Members to provide the necessary resources.

4.2.1.3 Congress adopted Resolution 20 (Cg-17) – World Weather Watch Programme.

4.2.1.4 Congress noted that the Executive Council at its sixty first session (Resolution 7 (EC-LXI)) had delegated to the Commission for Basic Systems (CBS) procedures for approving some categories of changes to WMO-No. 306 *Manual on Codes* and that those procedures had proved to be effective. Congress recognized that changes required to support international civil aviation operations did not always fall into the category of change delegated to CBS, but that such changes would have undergone detailed scrutiny by affected Members during the approvals procedures within ICAO. Congress also noted that the effectiveness of the WWW would benefit from the application of similar procedures for updating aspects of other Manuals and Guides, and therefore adopted Resolution 21 (Cg-17) – Procedures for maintaining Manuals and Guides managed by the Commission for Basic Systems.

Global Observing System (GOS)

4.2.1.5 Congress recalled that the Global Observing System (GOS) had been recognized as the main component observing system of the WMO Integrated Global Observing System (WIGOS). GOS, through WIGOS and through the coordinated efforts of Members, continued to provide unique and sustainable observational data and information on the state of the Earth and its atmosphere to meet evolving requirements of various users. Congress recognized that further improvements had been achieved globally through the quality and availability of data produced by other components, notably marine and aircraft-based observations.

4.2.1.6 Congress reaffirmed that GOS should continue its fundamental mission in providing, through coordinated efforts of Members, timely, reliable and consistent meteorological data to meet the national, regional and global requirements. Emphasizing that GOS is one of the core component observing systems of the WIGOS and in view of the growing significance of the GOS and its impact on WIGOS operations, Congress adopted Resolution 22 (Cg-17) – Global Observing System.

Global Telecommunication System (GTS)

4.2.1.7 Noting that the Global Telecommunication System (GTS) continued as Part A of the WMO Information System (WIS), Congress emphasized the importance of national and international telecommunications and of GTS systems and applications to support the operational activities of Members. Congress therefore urged Members to ensure that their GTS connectivity was effective and met their own needs and, for those Members providing GTS services to other Members such as Regional Telecommunications Hubs, also met the needs of others.

4.2.1.8 Congress noted that providing impact-based forecasting and risk-based warning services required information that had not in the past been exchanged on the GTS, and that in providing such services Members would benefit from information provided by international agencies that were not themselves related to National Hydrological or Meteorological Services. Congress therefore encouraged the use of the GTS to convey such additional information that was relevant, of high importance and in need of prompt delivery to Members, provided adequate provision was made to make it clear that such information was advisory rather than authoritative. It further noted that where such information is outside of WMO's mandate of weather, climate and water, the Secretary-General should ensure coordination between those requesting the publication of such information and that the relevant authoritative body precedes exchange of such information on the GTS.

Global Data-processing and Forecasting System (GDPFS)

4.2.1.9 Congress reaffirmed the important role the GDPFS plays in supporting the priorities of WMO through integration of advances in NWP and EPS into operational forecasting and the use of new tools and techniques to provide high value hydrometeorological information for effective decision-making. Congress noted with satisfaction the contribution of SWFDP in capacity development and disaster risk reduction by putting in NMHSs hands, high quality information,

through the cascading process, thus allowing NMHSs to provide timely weather forecasts and warnings to the population they serve.

4.2.1.10 Congress concurred that the GDPFS has been performing well within the family of WWW Programmes. In particular, Congress noted the progress made with the Severe Weather Forecasting Demonstration Project (SWFDP) and its cascading process which put in the hands of Forecasters, from LDCs and SIDs, high quality NWP/EPS output products to build their skills in forecasting and to enhance their forecast and warning services to their users. Congress also noted that users' needs are becoming more and more sophisticated and varied, and that climate change and variability are imposing new challenges to National Meteorological and Hydrological Services (NMHSs) requiring them to produce a variety of information at various timescales. It concluded that the GDPFS needs to expand its services to encompass seamless data-processing and prediction services in order to be relevant to decision-makers and users. To that end, Congress requested the Secretary-General and CBS to develop plans and recommendations for Members towards implementing a modern, agile and more flexible GDPFS to meet emerging needs.

WWW Data Management (WWWDM)

4.2.1.11 Congress noted that Table Driven Code Forms (TDCF) had been introduced to allow new information content to be exchanged efficiently and effectively without the need to develop new software to handle the representation of each new type of data. TDCF were, for example, essential for extending the range of station identifiers for land-based stations. Congress further noted that TDCF were intended for machine-to-machine communication, that interaction with humans would be through a computer interface, and that modern meteorological workstations, telecommunications systems, and many observing systems were designed to use TDCF. Congress expressed concern that many Members were unable to use TDCF in their operations because this would increase the cost to those Members that were providing conversion services for others, and reduce the capability of Members to benefit from new information sources. It therefore urged Members to complete migration to TDCF, following the agreed regulations, so that they could provide all their services without reliance on Traditional Alphanumeric Codes.

WWW System Support Activity, including the Operational Information Service (OIS)

4.2.1.12 Congress requested the Commission for Basic Systems and the regional associations to continue identifying gaps in the implementation and operation of the WWW, and defining guidelines for the allocation of priorities in support of the implementation of WWW component systems to allow Members to provide required services to users. It noted the improved collaboration between the Commission for Basic Systems and the regional associations and requested that this be increased. Congress requested the Secretary-General, in collaboration with Members and funding agencies, to give a high priority to resource mobilization for supporting the implementation and operation of the WWW, in particular for mitigating the deficiencies observed.

4.2.1.13 Congress noted with appreciation that the technical advisory services provided in the form of expert missions, guidance materials and meetings in the framework of the WWW system support activities that contribute to the development and improvements of the WWW components. It stressed the importance to continue providing such technical advisory services.

4.2.1.14 The CBS software registry, published on the WMO web server, provided information to Members on the software packages offered by individual Members. Since the efficiency of the World Weather Watch was highly dependent on computer-based applications and systems for its operation, Congress invited WWW Centres to consider offering meteorological application software for free exchange among Members and to provide updates to the CBS software registry to ensure that it remained relevant. Congress requested the Secretary-General to investigate the voluntary inclusion of products by the private sector in the software registry.

4.2.1.15 Congress recalled that the objective of the WWW Operational Information Service (OIS) was to collect from, and distribute to, WMO Members and WWW Centres detailed and up-to-date information on facilities, services and products made available in the day-to-day operation of the

WWW. Congress was pleased to note that the updated operational information was available on the WMO server. Since the overall efficiency of the OIS depended on the prompt notifications of changes and updated information from NMHSs, Congress stressed the importance that all Members continue to review the operational information and update it as required.

Instruments and Methods of Observation Programme (IMOP)

4.2.1.16 Congress noted that quality and long-term stability of observations and measurements of meteorological and related environmental variables are paramount to the overall operation of the WWW. Congress stressed the importance of the Instruments and Methods of Observation programme in conducting relevant studies and developing appropriate guidance material for Members to enhance the effective and economic use of observing technology and systems to meet the requirements of operational and research applications, described in more detail in paragraphs 4.2.2.60–4.2.2.86.

Emergency Response Activities (ERA)

4.2.1.17 Congress noted with satisfaction the level of collaboration between WMO and IAEA during the Fukushima Daiichi nuclear accident (March 2011) and reaffirmed the important role WMO plays in the area of ERA. Congress requested the Secretary-General to continue to nurture the relationship with IAEA and its Incident Emergency Centre (IEC) to seek further enhancement to ensure effective preparedness and response to nuclear incidents/accidents.

4.2.1.18 Congress also noted the importance of addressing non-nuclear emergency (such as forest/chemical fires) and the progress made in this area by CBS. It encouraged CBS to develop a "users interpretation guide for non-nuclear ATM products".

WMO Antarctic Activities (WMOAA)

4.2.1.19 Congress noted that the Executive Council, through its Panel of Experts on Polar Observations, Research and Services (EC-PORS), had successfully coordinated the implementation and operation of the basic systems of the WWW in the Antarctic to meet the requirements for meteorological services and research activities in the Antarctic, including climate and environment monitoring.

4.2.1.20 Congress appreciated that through the collaboration with other international organizations, universities and programmes active in Antarctica, the Antarctic Observing Network (AntON) was maintained and data provided in a support of WMO and other international programmes. Recognizing difficulties to operate and maintain observing stations, platforms and observatories in the harsh Antarctic environment, Congress requested the Executive Council to investigate ways of further improving the collection of observational data, especially during the Antarctic winter.

4.2.2 WMO Integrated Global Observing System (agenda item 4.2.2)

Implementation of the WMO Integrated Global Observing System

4.2.2.1 Congress recalled its decision to implement WIGOS (Resolution 50 (Cg-XVI)) and was pleased to note the successful completion of the most critical activities for the WIGOS Framework to be implemented by 2015 in accordance with Resolution 10 (EC-64) – WIGOS Framework Implementation Plan (WIP). In this regard, Congress expressed its appreciation of the significant accomplishments since Cg-XVI and thanked all experts involved for their work, effort and time.

4.2.2.2 Congress appreciated the successful collective work of the Executive Council, its Inter-Commission Coordination Group on the WMO Integrated Global Observing System (ICG-WIGOS), Members, regional associations (RAs), technical commissions (TCs), partner organizations and the Secretary-General for implementing WIGOS.

4.2.2.3 Great appreciation was expressed to Members such as Australia, China, Germany, Norway, the United Kingdom of Great Britain and Northern Ireland, the United States of America, and other Members who had contributed to the implementation of WIGOS either via the WIGOS Trust Fund or in terms of secondments during the current financial period. In particular, the support from Switzerland for developing and providing IT infrastructure for the Observing System Capabilities Analysis and Review Tool (OSCAR) was noted with appreciation.

4.2.2.4 Congress further appreciated the progress achieved in the Regional WIGOS Implementation Plans (R-WIP). It was noted that all regional associations already adopted their R-WIP taking into account regional and subregional needs and priorities.

4.2.2.5 Congress noted that as part of its Regional WIGOS Implementation Plan, RA III is developing the WIGOS-SAS Project in the Southern Part of South America. NMHSs and Water/ Energy Agencies from Argentina, the Plurinational State of Bolivia, Brazil, Paraguay and Uruguay, in coordination with the regional Intergovernmental Coordination Committee for the Plata Basin (CIC), are combining their networks and systems, under the framework of WIGOS, to create homogeneous sets of observational data for optimized use by the meteorological, hydrological and climatological communities. Plans are to extend the scope of the project to include other Members of the Region.

4.2.2.6 Congress agreed with the Executive Council that the implementation of the WIGOS Framework had approached such a level of maturity where WIGOS enables the development and deployment of its component systems and that with the key initial building blocks of the WIGOS Framework in place by the end of 2015, the prerequisites are available for a Pre-operational Phase of WIGOS from 2016 to 2019.

WIGOS Regulatory Material

4.2.2.7 Congress noted with appreciation the revision of the WMO Technical Regulations carried out by ICG-WIGOS to reflect the requirements for the implementation of WIGOS. Congress urged Members to implement and operate their observing networks and systems in accordance with the WMO *Technical Regulations* (WMO-No. 49), Volume I, Part I – WIGOS and its Annex – Manual on WIGOS.

WIGOS Information Resource

4.2.2.8 Congress noted with appreciation the successful development and implementation of OSCAR. Congress recognized that Members will have to submit WIGOS metadata needed for OSCAR following the regulations specified in the Manual on WIGOS and it urged Members to nominate national focal points responsible for providing the required WIGOS metadata to OSCAR. It further urged Members to contribute to the WIGOS Trust Fund to support further development and subsequent sustainable operation and maintenance of OSCAR.

4.2.2.9 Congress further recognized that the remaining parts of the WIGOS Information Resource yet to be fully developed, e.g. the portal and the “Standardization of Observations” Reference Tool (SORT), are critical for WIGOS and will require substantial resources for their development and subsequent operation. It therefore urged Members to consider providing assistance for their development and future operations. Congress requested the Secretary-General to continue with the development of WIR.

4.2.2.10 Congress re-emphasized the need for Members to register all observing stations across all WIGOS component observing systems operating to WMO standards within their territories, providing the correct and complete coordinates of their observing stations, and to make their observations available in real-time. Congress also encouraged Members to make station identifiers available to potential non-NMHS contributors to WIGOS and to assist them operate their stations to WMO standards where possible.

Progress in WIGOS component systems:

(i) Global Observing System

4.2.2.11 Congress noted that while there have been some improvements in recent years, notably in the availability of RA III upper-air observations, the availability of reports from RA I Regional Basic Synoptic and Climatological Networks (RBSN/RBCN) remained low, and that a number of stations remain silent. It reaffirmed that a concerted effort by the international community is needed to assist RA I Members in the implementation and operation of RBSN/RBCN stations, noting that reduced availability of, especially, upper-air data over Region I has a negative impact on the quality of medium-range forecast products over all Regions, not just over Region I itself.

4.2.2.12 Congress noted that JCOMM had already started addressing many of the activities listed in WIP and in the legacy recommendations of the JCOMM Pilot Project for WIGOS, especially in the fields of interoperability of data, and the harmonization of standards and best practices. Specific actions included activities undertaken by Regional Marine Instrumentation Centres (RMICs) to promote best practices, intercalibration and capacity development, and workshops to establish an international forum for users of satellite communications, with the objective of establishing a basis for consolidated negotiation with commercial satellite service providers.

4.2.2.13 Congress recognized with concern that the implementation of marine meteorological and oceanographic observing systems as coordinated by JCOMM has not substantially evolved since the last Congress, and remains far from the initial implementation targets, in particular for some of its component observing networks. It requested Members to contribute to the JCOMM Observations Programme Area Implementation Goals and to sustain the marine meteorological and oceanographic observing system as a top priority. In particular, Congress requested Members to fund and install barometers on all newly deployed drifters.

4.2.2.14 Noting the ongoing development of the Tropical Pacific Observing System (TPOS) and related observing network design activities, Congress urged Members to enhance through partnership their contributions in support of the implementation and operations of the tropical moored buoy arrays, in particular in the Tropical Pacific Ocean, where data availability has dropped substantially in the last two years. Of particular interest is the provision of ship time to assist in the deployment and servicing of tropical moored buoys.

4.2.2.15 Congress recalled the importance of addressing the issue of ship security and piracy, which is impacting the implementation of the Voluntary Observing Ship Scheme and the deployment of instruments at sea and the importance of preventing vandalism to data buoys, and requested the Secretary-General to organize a second WMO-IMO high level meeting in the next two years to safeguard the buoys at sea. Recalling Resolution 25 (Cg-XVI), Congress further urged Members to follow the recommendations of the Data Buoy Cooperation Panel (DBCP) Technical Document No. 41, Ocean Data Buoy Vandalism – Incidence, Impact and Responses and appreciated the advances Member States have made in data buoy vandalism prevention.

4.2.2.16 Congress recognized the successful transition of programmatic responsibility for the AMDAR programme from the WMO AMDAR Panel to the WMO Technical Commissions, CBS and CIMO, and that the AMDAR Panel had ceased all activities in November 2012. In this regard, Congress acknowledged the work of the AMDAR Panel over its fifteen-year existence, recognizing its achievements in guiding the development and expansion of the AMDAR programme.

4.2.2.17 Congress, noting the WMO Aircraft Based Observations Programme Strategy and Implementation Plan developed jointly by CBS and CIMO, requested regional associations to collaborate with CBS and CIMO in developing, maintaining and implementing Regional Plans for the enhancement and expansion of aircraft-based observations and AMDAR under the respective Regional WIGOS Implementation Plans of each regional association. Congress also urged

Members to continue providing contributions to the AMDAR Trust Fund for the support of ongoing technical developments and capacity-building activities related to AMDAR.

4.2.2.18 Congress noted with appreciation, the work and contribution by the Turkish State Meteorological Service (TSMS) in establishing the WMO Weather Radar Database (WRD) and undertaking to maintain this facility for the benefit of all Members. While acknowledging that the WRD now contained metadata for nearly 1000 operational weather radars of around 80 WMO Members, Congress urged all Members to cooperate in the provision of their radar information through the nomination of focal points, thereby ensuring that the WRD could fulfil its vital role in the provision of metadata in support of WIGOS critical activities, such as the Rolling Review of Requirements, OSCAR, meteorological radio frequency protection, and public radar product availability advisement.

4.2.2.19 Congress requested Members, in collaboration with partner organizations, and identified agents in the new Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP), to address all actions listed in the Plan in order to address the identified observational gaps with regard to the observational user requirements of the WMO Application Areas.

4.2.2.20 Congress further requested Members who had not yet nominated their National Focal Points for the monitoring of progress on the actions listed in the EGOS-IP to do so by the end of December 2015. It requested CBS to find ways of improving the engagement of Members and Regions in completing the EGOS-IP actions and urged Members to mobilize resources to drive these activities forward.

4.2.2.21 Congress recommended enhanced contributions of Members to continue with the development and research of adjoint-based observation impact assessment tools as a complement to traditional Observing System Experiments (OSEs), to undertake OSEs for the optimization of regional composite networks, and to conduct OSEs and Observing System Simulation Experiments (OSSEs) to address the specific science questions proposed by the CBS.

4.2.2.22 Congress appreciated the steps being taken toward improved integration of the space-based component in WIGOS. Congress further welcomed the plans for full integration of the Global Satellite Inter-Calibration System (GSICS) in WIGOS, noting that this would further facilitate the use of satellite data by Members.

4.2.2.23 Congress underlined the importance of the continued development of the Architecture for Climate Monitoring from Space as a key WIGOS contribution to GFCS Observation and Monitoring component, and it requested the Executive Council and ICG-WIGOS to actively monitor and coordinate this development. Congress noted that WMO is an active member of the joint working group on climate established by CEOS and CGMS, with the major responsibilities for coordinating the development of the physical Architecture for Climate Monitoring from Space in the partnership with all relevant space agencies and satellite operators.

4.2.2.24 Congress recognized that there is a clear need to forge closer links between JCOMM and the satellite observation community. In particular, a better dialogue needs to be established concerning the requirements of the satellite community for in situ observations used for calibration and validation purposes. Congress noted the offer from CBS to JCOMM to collaborate on this issue, and requested that this be taken forward as a priority by both Commissions.

(ii) Global Atmosphere Watch (observing component)

4.2.2.25 Congress affirmed that the advantages of further integration of GAW within WIGOS will include improved visibility of observational requirements via OSCAR as well as promotion of extension of the GAW observing network, e.g. by encouraging Members to perform atmospheric composition measurements at existing synoptic stations. Congress noted the ongoing integration of the Global Atmosphere Watch Station Information System (GAWSIS) into OSCAR/Surface, and that this development had been made possibly by the synergy between the two databases.

Congress expressed its appreciation for this development and noted that it marked a further step toward realizing the vision for an integrated WMO observing system.

4.2.2.26 Congress acknowledged the work of the GAW Task Team on Observational Requirements and Satellite Measurements as regards Atmospheric Composition and Related Physical Parameters, and its definition of a new set of specific application areas that would replace the previous overarching “atmospheric chemistry” in the Rolling Review of Requirements (RRR). Congress appreciated the fact that this work had been done in collaboration with the CBS Expert Team on Satellite Systems (ET-SAT) and expressed its support for further work towards integration of GAW requirements and observing capabilities in the RRR.

4.2.2.27 Congress noted with appreciation that the GAW Programme had completed two WIGOS Pilot Projects: (1) Improvement of Interoperability of GAW World Data Centres with WIS and Establishment of Prototype Services to Facilitate User Access to GAW Data; and (2) Improvement of Dissemination of Ozone (total column, profiles and surface) and Aerosol observations through the WIS.

(iii) WMO Hydrological Observing System

4.2.2.28 Congress noted the proposed establishment of the WMO Hydrological Observing System (WHOS), the express purpose of which is to provide a portal to the near real-time and historical stream flow data (both water level and discharge) currently available online from those National Hydrological Services who choose to make such data available. Congress noted that WHOS will be an important step for the hydrological community toward meeting the WIGOS objective of an integrated, comprehensive and coordinated system, which is comprised of all WMO component observing systems.

4.2.2.29 Congress further noted a clear and compelling need for an easily accessible database of high-quality, continuous and real-time hydrological observations from around the world that could meet the need for inputs to WIGOS. Congress also recognized that WHYCOS will not be sufficient as the hydrological component of WIGOS. However, WHYCOS should be viewed as a platform for its further development.

(iv) Global Cryosphere Watch

4.2.2.30 Congress, while noting that WMO polar activities were addressed under agenda item 4.2.6, acknowledged the important contributions that CBS and other technical commissions provided in support of the WMO polar and high mountain activities and for the development of the Global Cryosphere Watch (GCW).

4.2.2.31 Congress agreed that an immediate priority for GCW is to establish the core standardized network of GCW surface-based measurement sites referred to as “CryoNet”, which is one of the four WIGOS component observing systems. Congress appreciated that, in parallel, GCW is identifying the best practices that will be applied in CryoNet and will be documented in the WIGOS regulatory material.

Pre-operational Phase of WIGOS (2016–2019)

4.2.2.32 Congress decided that the development of WIGOS will continue during its Pre-Operational Phase in the seventeenth financial period building upon and adding to those key building blocks of the WIGOS Framework that have already been implemented, while shifting the emphasis from the global level toward implementation activities at the regional and national levels. The goal is to have Members and their partners benefit from a fully operational system from 2020.

4.2.2.33 Congress further decided that the WIGOS Pre-Operational Phase will focus on: (i) complementing the WIGOS Regulatory Material with necessary guidance material providing Members with those technical details that are required for the implementation; (ii) further developing the WIGOS Information Resource (WIR), with special emphasis on the operational

deployment of the OSCAR/Surface database; (iii) development and implementation of the WIGOS Data Quality Monitoring System; (iv) concept development and initial establishment of Regional WIGOS Centres; and (v) national WIGOS implementation.

4.2.2.34 Congress recognized that Regional WIGOS Centres (RWCs) will play a critical role for the operational WIGOS. RWCs will provide regional coordination and support of WIGOS development and operations at regional and national levels, working closely with data providers to facilitate: (i) the collection of WIGOS metadata, and entry into OSCAR/Surface; (ii) regional performance monitoring of WIGOS networks, including follow-up with data providers in case of data availability or data quality problems; (iii) definition and coordination of regional/subregional WIGOS implementation projects; and (iv) advice to Members on the requirements for the regional network design. In this regard, Congress requested that detailed guidance on RWCs on their capabilities and performance evaluation be developed.

4.2.2.35 Congress acknowledged the key integrating role that NMHSs must play at a national level in the WIGOS implementation, both through strengthening their own national observing systems and by building national partnerships.

4.2.2.36 Congress recognized the essential role of WIGOS in the implementation of GFCS, weather and disaster risk reduction services, capacity development, aviation services and other WMO key priorities. Congress also affirmed that WIGOS, together with WIS, provide the essential infrastructure for acquisition and dissemination of observations, on which the capability of the Members to provide critical services to their citizens is built.

4.2.2.37 Congress reaffirmed the need to enhance existing observing networks and systems through an integrated effort of NMHSs and their partners. Particular attention should be given to the sustainability of observing systems at the national level, especially in less and least developed countries. Congress urged Members to follow the Observing Network Design principles specified in the Manual on WIGOS when designing and implementing their observing networks.

4.2.2.38 Congress requested the Executive Council to provide oversight of the further development of WIGOS as one of the key priorities of the Organization, to re-establish ICG-WIGOS, and to update its Terms of Reference accordingly.

Vision for WIGOS component observing systems in 2040

4.2.2.39 Congress acknowledged that EC-66 had requested CBS to take the lead in developing a Vision for WIGOS in 2040, which will include a “Vision for the WIGOS component observing systems in 2040” for its submission to Cg-18 in 2019.

WIGOS Data Management

4.2.2.40 Congress noted that existing WMO data policies and protocols in place for the Global Observing System (GOS) and other WIGOS components may not be adequate to fully cover the requirements of WIGOS. A particular concern relates to the integration of data from a broad range of external sources, some of which may impose restrictions on the use and further exchange of their data. While the WIGOS metadata standard acknowledges and accommodates potential restrictions on partner data, it remains unclear whether the technical implementation within the NMHS data management systems and WIS can adequately support such conditions. Therefore, Congress requested ICG-WIGOS to further explore this issue in conjunction with WIS and provide guidance to Members on best practices related to data agreements with WIGOS partners.

4.2.2.41 Congress further recognized that the effective management of data throughout its lifecycle is essential to ensuring that Members are able to extract full value from their observations and their observing systems. Hence, development of guidance on data management is important to the success of WIGOS and needs special focus and attention. Congress requested all relevant technical commissions, under the overall coordination by ICG-WIGOS, and in conjunction with CCl activities on climate data management, to be fully engaged in the development of data guidance,

which should include high-level principles and strategies for data management within the broader WMO context.

Resources

4.2.2.42 Congress stressed that WIGOS provides the essential observational foundation upon which Members build their services, and that commitment by Members to WIGOS is therefore also essential. Accordingly, Congress urged Members to fully support implementation of WIGOS in their Region, including providing sufficient resources.

4.2.2.43 Congress further agreed that the timely completion of the WIGOS Pre-operational Phase development activities in the seventeenth financial period directly depended on the available resources. Congress assigned a high priority to the proposed budget allocations for WIGOS activities. Congress also urged Members to continue to provide resources (e.g. in terms of seconded experts to the WIGOS Project Office and/or donations to the WIGOS Trust Fund) to help support the development of WIGOS.

Capacity development

4.2.2.44 Congress stressed that priority must be given to those activities that would assist Members in implementing their WIGOS national plans, with a special focus on the Least Developed Countries (LDCs), Landlocked Developing Countries (LLDCs) and Small Island Developing States (SIDS) where the needs are the highest.

4.2.2.45 In particular, the plan for the coming joint RA II/V Workshop on WIGOS for Disaster Risk Reduction was recognized as a very positive step in this direction, and the Secretary-General was requested to consider arranging similar events in other Regions.

Communications and Outreach

4.2.2.46 Congress stressed that Communications and Outreach should play key roles during the Pre-operational Phase of WIGOS. Internally to the WMO community, there is a growing need for interaction with Members as WIGOS matures, partly to keep them informed about WIGOS developments, partly to learn from their experiences with national and regional WIGOS implementation efforts. In this regard, Congress welcomed the WIGOS Newsletter as a practical vehicle for enhancing communication with Members. Externally, it is important to engage with partners, e.g. other international organizations, non-governmental organizations and commercial entities, both to keep them informed about WIGOS development and to foster the development of partnerships at all levels.

WIGOS Partnerships

4.2.2.47 Congress affirmed that a key principle of WIGOS is an inclusive approach to the integration of observations from a diverse range of observing systems, both NMHS and non-NMHS owned, into a composite set of observations to help Members improve their services across all WMO application areas.

4.2.2.48 Congress recognized the essential role of external (non-NMHS) observations in supporting WMO Programmes and the associated application areas, and the importance of establishing partnerships with non-NMHS entities to increase the overall volume of observational data available in WIGOS. Congress further emphasized the importance of the leadership of NMHSs in the building of WIGOS partnerships, and noted that this represents an opportunity for all Members, both to strengthen their national observing networks and to enhance their national leadership in relation to other WMO priority outcomes, such as GFCS and DRR.

4.2.2.49 Recognizing the need for assistance to Members concerning the establishment of partnerships and formal agreements with different data providers, Congress requested that guidance material on this matter be developed and included in the Guide to WIGOS.

4.2.2.50 Congress noted with satisfaction the increased involvement of co-sponsored observing systems such as GCOS and GOOS in WIGOS. Congress requested the GCOS Secretariat and GCOS Panels to continue to advise on the climate observing elements of WIGOS and to ensure that GCOS cooperates fully with WIGOS and WIS.

4.2.2.51 Congress reaffirmed the important role of external partners and cosponsors in WIGOS, and welcomed the initiative of ICG-WIGOS to engage the Group on Earth Observations (GEO) and the GCOS co-sponsors in its implementation activities. Congress emphasized the need to build on the synergies between the respective systems and mechanisms of GCOS, GOOS, GTOS and GEOSS, to develop constructive partnerships extending well beyond the immediate WMO stakeholder community, including the Association of Hydro-Meteorological Equipment Industry (HMEI), with the aim of supporting the GFCS Observations and Monitoring requirements across the target areas of food security, health, water, energy, and disaster risk reduction. Concerning the terrestrial observing systems, Congress re-emphasized their importance to WMO Programmes and strongly encouraged a revitalization of the effort to globally coordinate terrestrial observations, in collaboration with the other co-sponsors.

Conclusion

4.2.2.52 In conclusion, Congress agreed that WIGOS, supported by WIS, should continue as one of the WMO key priorities for the next financial period. Noting the difficulties in implementing WIGOS in some of the less and least developed countries, Congress agreed that increased priority be given to supporting the capacity development for WIGOS in these countries. It requested the Executive Council, RAs and TCs involved in the WIGOS implementation to give particular attention to work together in providing assistance and technical support to LDC, LLDC and SIDS Members.

4.2.2.53 Congress adopted Resolution 23 (Cg-17) – Pre-operational phase of the WMO Integrated Global Observing System.

4.2.2.54 Congress further adopted Resolution 24 (Cg-17) – Report of the extraordinary session (2014) of the Commission for Basic Systems relevant to WMO Technical Regulations concerning the WMO Integrated Global Observing System.

WMO* Technical Regulations *(WMO-No. 49), Volume I, Part I – WIGOS

4.2.2.55 Congress noted that the Commission for Basic Systems (CBS-Ext.(2014)) recommended that the Volume I, Part I – WIGOS of the WMO *Technical Regulations* (WMO-No. 49) be adopted by Cg-17.

4.2.2.56 Congress recognized the urgent need for accelerating the development of corresponding WIGOS guidelines and guidance material to facilitate the implementation of WIGOS technical regulations as specified in Volume I, Part I and the *Manual on WIGOS* (paragraphs 4.2.2.58–4.2.2.59) by Members. In order to assist Members to implement WIGOS regulations, Congress requested the Secretary-General to develop and publish a set of guidelines incorporated in an initial *Guide to WIGOS* to be provided to WMO Members by 1 July 2016, to be progressively revised and enhanced through the WIGOS Pre-operational Phase.

4.2.2.57 Congress adopted Resolution 25 (Cg-17) – *Technical Regulations* (WMO-No. 49), Volume I, Part I – WMO Integrated Global Observing System.

WMO* Technical Regulations *(WMO-No. 49) – Manual on WIGOS

4.2.2.58 Congress noted that the Commission for Basic Systems (CBS-Ext.(2014)) recommended that the Manual on WIGOS (as a future Annex to the WMO *Technical Regulations* (WMO-No. 49)) be adopted by the Cg-17.

4.2.2.59 Congress adopted Resolution 26 (Cg-17) – T*echnical Regulations* (WMO-No. 49) – Manual on the WMO Integrated Global Observing System.

Instruments and Methods of Observation Programme

4.2.2.60 Congress recognized that Members are facing numerous challenges in managing their observing systems to provide data of appropriate quality to meet user requirements. Congress expressed its appreciation to the Instruments and Methods of Observation Programme (IMOP) and the Commission for Instruments and Methods of Observation (CIMO) for their ongoing efforts to develop guidance for Members in operating their instrument systems and to support their continuous improvement.

4.2.2.61 In view of the importance of the Instruments and Methods of Observation Programme and its contribution to the WMO high priorities, Congress adopted Resolution 27 (Cg-17) – Instruments and Methods of Observation Programme.

4.2.2.62 Congress noted the report of the sixteenth session of CIMO and appreciated the considerable work achieved in strengthening capacity development, standardization of instruments and methods of observations, developing guidance material and increased collaboration with other technical commissions. Congress adopted Resolution 28 (Cg-17) – Report of the sixteenth session of the Commission for Instruments and Methods of Observation.

4.2.2.63 Congress noted that CIMO had long contributed to the global improvement in the quality and traceability of observational data from basic observational instruments, which had resulted mainly from the implementation of standardized calibration, maintenance and operational procedures, supported also by the establishment of the WMO Regional Instrument Centres and Regional Radiation Centres. Congress acknowledged CIMO reinforcement of these contributions through its co-leading role in the implementation of the WIGOS Framework. In the context of aircraft observations, similar improvements had been achieved through the AMDAR system.

Standardization of Weather Radar Practices and Procedures

4.2.2.64 Congress noted that weather radars are widely disseminated worldwide and that Members are investing very large amounts in this technology, including in developing countries, while significant deficiencies remain to ensure their overall data quality and their integration with other observing systems' data.

4.2.2.65 Congress noted the growing conflict between the operation of wind turbines and weather radar systems. The existing CIMO recommendations on separation distance between wind turbines and weather radar are based on advice from CIMO experts. Many Members need scientific justification to defend the undisturbed operation of their systems. CIMO is requested to coordinate scientific studies and work on more specific recommendations on the separation between wind turbines and weather radar systems.

4.2.2.66 Congress agreed to focus on harmonization of data quality processes and procedures where there is a clear benefit to the global user community and where this will not hamper innovation. In view of the need for a single international coordination mechanism for weather radar systems and their data and products, Congress agreed that a new initiative is required that utilizes existing bodies as far as possible, to achieve global weather radar data consistency. This would provide a key contribution to the WWW Global Observing System (GOS), the backbone component of WIGOS. Congress requested CIMO to establish a CIMO/CBS-led international coordination initiative for standardization of practices and procedures for weather radar systems, which should include all Members, partners and entities operating weather radar networks, capitalize on the positive experience achieved within regional cooperation mechanisms, such as OPERA and BALTRAD in Europe, and include a strong focus on capacity development to ensure coordinated weather radar data quality across regions.

Standardization of, and guidance on, other Surface-Based Observing Technologies

4.2.2.67 Congress requested that CIMO also explore options for improving standardization of other surface-based observing systems and techniques, particularly for remote-sensing systems

such as radar wind profilers and techniques such as water vapour retrieval using ground-based global positioning system receivers.

4.2.2.68 With regard to the variety of simple and sophisticated observing technologies available on the market, Congress recognized the challenges faced by small NMHSs in selecting suitable observing solutions fit for their purpose. Congress requested that CIMO develop additional guidance material to help Members in their procurement practices and in assessing the quality and suitability of observing systems, such as automatic weather stations.

4.2.2.69 Congress noted that some Members had had positive experiences in determining rainfall estimates from cellular communication networks. Congress noted that the density of precipitation gauge networks is declining throughout the world, and in some areas such measurements are very scarce, while, in contrast, cellular communication networks are being deployed widely, even in less developed countries, in all areas with significant population densities. Congress encouraged Members to liaise with mobile phone companies towards setting up arrangements with them to enable them to use the mobile phone signal attenuation data, which could support them in deriving precipitation maps for their country. Congress requested CIMO to develop guidance material to support Members in utilizing this technology for rainfall estimates.

4.2.2.70 Congress was pleased that CIMO and RA VI had agreed to collaborate on the observing challenges faced at mountain stations and encouraged collaboration between CIMO and regional associations in furthering implementation and operation of efficient observing technology in high mountain areas and the development of guidance for Members on best practice in this challenging area of observations.

Minamata Convention on Mercury

4.2.2.71 Congress noted that the Minamata Convention on Mercury (http://www.mercuryconvention.org/), developed by UNEP, is a global treaty to protect human health and the environment from the adverse effects of mercury, which is planned to enter into force in 2020. Congress recognized that this Convention would have a significant impact on Members still using mercury instruments and requested them to develop roadmaps to prepare themselves to introduce alternative instruments in their network and to ensure the continuity and quality of their observations, including carrying out parallel observations, as appropriate. Congress requested CIMO to support Members by developing appropriate guidance material and supporting the identification of appropriate replacement instruments. Congress urged Members having already transitioned away from mercury to publish their findings and share their expertise on a single platform that is accessible to all Members.

Regional Centres

4.2.2.72 Congress noted that all regional associations have put strong focus on the strengthening of Regional Instrument Centres (RICs), including increasing their support to Members of the Region, in their Regional WIGOS Implementation Plans (R-WIPs). Congress also noted that further improvement/modernization had taken place in some RICs. Congress welcomed the increased awareness of Members and their interest in the services that the RICs can provide through ensuring the traceability of reference standards used by Members and through capacity development and training related to instrument calibration and maintenance of instruments. Congress urged Members hosting RICs to continue their efforts to maintain and improve their capabilities, including pursuing accreditation under ISO 17025, and encouraged them to proactively reach out to the Members of their Region, thus supporting them in achieving the goals listed in the R-WIPs. Congress requested regional associations to monitor regional needs for RIC services, to ensure their RICs are regularly evaluated and to actively cooperate with CIMO and JCOMM in conducting training to meet the needs of their Members.

4.2.2.73 Congress welcomed the guidance material that had been developed to support RICs and Members' calibration laboratories to estimate calibration uncertainties and the plan to develop a training workshop on this matter. Congress noted the strong interest shown by Members for

training courses on instrument calibration and maintenance that had been held recently. Congress encouraged Members hosting Regional Training Centres and RICs to organize additional such courses to meet the demand of Members, and to improve traceability of observations to the International System of Units (SI) and their quality. Congress also recalled the outcome of the Workshop for Improving Surface-based Data Quality through Improved Standardization of Procedures, Langen, Germany (December 2014) that recommended that Members' calibration laboratories should actively pursue accreditation according to ISO 17025.

4.2.2.74 Congress noted with appreciation that the network of WMO-IOC Regional Marine Instrument Centres (RMICs), which currently comprises two centres in Mississippi, USA, and Tianjin, China, for Regional Associations IV and II respectively, has been effective in providing support in particular through specific instrument services, laboratory intercomparisons, and a series of instrument training workshops for Members in their respective Regions. Congress also noted the continued evaluation by JCOMM of the candidate RMIC Casablanca, Morocco, for Regional Association I.

WMO Regulatory Material

4.2.2.75 Congress was pleased that the WMO *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8, CIMO Guide, 2008 Edition, Updated in 2010), previously only available in English, had now also been published in French, Russian, and Spanish languages to support further improvements of the quality of observations and standardization of instrument performances worldwide. Congress expressed its thanks to those Members who had arranged for the translation and publication of the CIMO Guide into these languages. Congress noted that CIMO had actively cooperated with other technical commissions in developing a new edition (2014 Edition) of the CIMO Guide, which had been approved by CIMO-16 and which included a number of fully revised chapters and an extensive new part on satellite observations. Noting that this new material should also be translated in the official WMO languages so that all Members fully benefit from the new guidance material, Congress requested the Secretary-General to identify necessary resources for this purpose, and encouraged Members to continue their engagement in volunteering to translate the new edition of the CIMO Guide and/or to provide financial contributions for this work.

4.2.2.76 Congress was pleased that CIMO has taken steps in developing a new web-based edition of the *International Cloud Atlas (ICA) – Manual on the Observation of Clouds and Other Meteors* (WMO-No. 407, Volumes I and II) as a WIGOS-related document needed for the operation of NMHSs, particularly in developing countries. This activity will ensure that the ICA remains the world's authoritative, primary source of cloud classification, will be fully comprehensive and contain the most up-to-date information. Congress urged Members to make experts and resources available for this activity, and to consider developing and/or hosting the ICA web-based version. Congress acknowledged that the update of the *International Cloud Atlas* would need to be made by correspondence and delegated EC to approve the Atlas and ensure its prompt publication. Congress voiced support to fund that activity under RB to the extent possible within available resources.

Standards

4.2.2.77 Congress was pleased that the first common WMO-ISO standard had been approved based on the "Siting Classification for Surface Observing Stations on Land" originally developed by CIMO for WMO Members. It requested CIMO to collaborate with ISO on the second common WMO-ISO standard "Ground based remote sensing of wind by heterodyne pulsed Doppler lidar". Congress agreed that such synergies were beneficial to improve the standardization of observations according to WIGOS Framework implementation. In this regard, Congress recognized that common WMO-ISO standards should be considered when both WMO and ISO have a topic of common interest and similar goals. Congress requested CIMO to monitor and, if appropriate, contribute to the development of the weather radar standard that ISO has decided to develop.

4.2.2.78 Congress welcomed the ongoing collaboration between WMO and the International Bureau of Weights and Measures (BIPM) to ensure the maintenance of international scale and traceability of measurements that are particularly relevant to ensure data traceability to meet the goals of WIGOS and GFCS. Congress recalled that WMO maintains the World Radiation Reference that was recognized by BIPM and was informed on the apparent difference observed between the WRR and a new SI-traceable cryogenic radiometer. Congress requested CIMO to collaborate with BIPM in assessing the situation and determining whether a change of reference for solar irradiance would be needed to ensure the continuity of climate-relevant time series.

Instrument Intercomparisons

4.2.2.79 Congress agreed on the need to continue organizing International Pyrheliometer Intercomparisons (IPCs) at regular intervals to disseminate the WRR to Members and all interested stakeholders relying on this globally agreed reference and appreciated that the World Radiation Centre of Davos, Switzerland, would organize the Twelfth IPC from 28 September to 16 October 2015.

4.2.2.80 Congress also noted with appreciation the feasibility study being carried out towards an intercomparison of ground-based instruments for detection and quantification of volcanic ash/aerosols, and recognized its importance to the ongoing enhancement of aeronautical meteorological services for emergency responses to volcanic eruptions, demonstrating the close collaboration between CIMO, CAS and CAeM in application of science meeting societal needs.

4.2.2.81 Congress noted the significant costs associated with conducting and hosting instrument intercomparisons and that these resources are well invested for the benefit of Members. Congress expressed its thanks to those Members who have hosted past CIMO intercomparisons for the substantial in-kind contribution they had provided to the Organization. Congress encouraged CIMO to continue its intercomparison activities and Members to consider hosting them.

4.2.2.82 Congress was pleased that the presently ongoing WMO Solid Precipitation Intercomparison Experiment (SPICE) had attracted a wide interest from Members contributing 20 sites in 16 countries (Australia, Canada, Chile, Finland, France, Italy, Japan, Nepal, New Zealand, Norway, Poland, Republic of Korea, Russian Federation, Spain, Switzerland, United States of America) and in five regional associations. Congress was pleased that a number of WMO Programmes and initiatives had expressed interest in SPICE and encouraged all Members hosting a site, and interested stakeholders, to consider taking advantage of these sites to support other initiatives, such as the Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS), verification of models and radar calibration, ground validation of satellite data and to ensure the continuation of the measurements at these locations.

Training

4.2.2.83 In view of the strong interest of Members in courses related to instruments and methods of observation and their importance for ensuring data quality and the sustainability of observing networks, Congress encouraged CIMO to explore, in collaboration with the ETR Programme, the development of online training courses on instruments that could complement face-to-face training events. Congress also encouraged Members to share any such courses they have developed, so that they can be made widely available to all Members.

4.2.2.84 Congress recalled that at its sixteenth session it had requested the TCs to develop competency standards in the key areas of interest to each technical commission. Congress noted that CIMO was in the process of developing competency standards for personnel involved in undertaking weather observations, calibrating and maintaining equipment. Congress encouraged CIMO to finalize those competency frameworks and present them to EC for consideration and for inclusion in the WMO Technical Regulations as recommended practices.

Centennial Stations

4.2.2.85 Congress noted the support expressed by CIMO to the Commission for Climatology in developing a concept of establishing a recognition mechanism for centennial observing stations that would include designation criteria to protect well-sited long-term observing stations, with good quality time series of meteorological parameters, which is considered in further detail in paragraphs 4.2.3.22–4.2.3.33.

CIMO Trust Fund

4.2.2.86 Congress noted that resource allocated to IMOP will not be sufficient to achieve the high expectations from other WMO Programmes and high priority activities. Therefore, Congress urged Members to contribute to the CIMO Trust Fund to further facilitate timely conduct of IMOP activities to meet Members requirements. These include among others: regular update and further translation of the CIMO Guide, future intercomparisons, new edition of the International Cloud Atlas and strengthening of Regional Instrument Centres.

Radio-frequency coordination

4.2.2.87 Congress noted the progress on the preparation for the International Telecommunications Union (ITU) World Radiocommunication Conference 2015 (WRC-15). It expressed its appreciation to the CBS Steering Group on Radio-frequency Coordination (SG-RFC) for its continued diligence and efforts in managing the very specialist issue of radio-frequency coordination and for maintaining the WMO Position Paper on WRC-15 Agenda for the guidance of National Meteorological and Hydrological Services (NMHSs). It noted that the position paper had been submitted to the second WRC-15 Conference Preparatory Meeting as well as other WRC-15 related preparatory meetings.

4.2.2.88 Congress noted the potential impacts of WRC-15 decisions, in particular WRC-15 agenda item 1.1 related to additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications to facilitate the development of terrestrial mobile broadband applications. Congress urged WMO Members and regional associations to ensure that the WMO Position Paper on WRC-15 Agenda is brought to the attention of their national and regional radio-frequency spectrum managers and taken into consideration in the development of national and regional preparations for WRC-15. It also encouraged NMHSs to maintain close contact with respective national radio-frequency authorities during and after the WRC-15 process.

4.2.2.89 Emphasizing that radio-frequency coordination activities remained a matter of high priority as the demand on radio spectrum continues to increase, Congress adopted Resolution 29 (Cg-17) – Radio frequencies for meteorological and related environmental activities.

4.2.2.90 Noting that EC-64 had identified the need for a guide on radio-frequency coordination matters and the request of Resolution 9 (EC-65) for effective participation of NMHSs in national and international radio-frequency coordination processes, Congress adopted Resolution 30 (Cg-17) – Guide to National Meteorological and Hydrological Services' Participation in Radio-frequency Coordination. It encouraged all NMHSs and regional associations to make use of this guide to enhance their effectiveness in radio-frequency coordination matters at national, regional and global levels.

4.2.3 WMO Information System (agenda item 4.2.3)

Status of the WMO Information System

4.2.3.1 Congress expressed its appreciation for the contributions of China, Germany and Japan in implementing the new functionality of the WMO Information System (WIS) through provision of the first three operational Global Information System Centres (GISCs) so that WIS became operational on 1 January 2012. Congress noted that 11 of the 15 designated GISCs were

operational and that the remaining GISCs had been certified as WIS compliant by CBS and were in the process of going operational. Congress further noted, of the 375 centres identified for registration in WIS, 297 centres had been designated as WIS centres by Congress or the Executive Council. A further 28 centres were under review by CBS, 16 of which had been certified as WIS compliant and were to be included in the update of WMO-No. 1060 *Manual on the WMO Information System*. Congress further noted that the time made available to Members to have centres that were designated conditionally in Resolution 51 (Cg-XVI) certified by CBS as WIS compliant had been extended by Resolutions 12 (EC-64) and 13 (EC-65) and that these extensions had expired. Congress decided to continue the conditional designation of such centres until the sixteenth session of CBS, and urged all Members that had not implemented WIS or completed WIS Compliance procedures to do so as a matter of urgency for consideration by CBS at that session.

4.2.3.2 Congress strongly supported the clarifications proposed for the *Manual on the WMO Information System* by the Commission for Basic Systems (CBS) concerning the responsibility of GISCs to assist centres that nominated them as an associate or principal GISC that included ensuring that arrangements were in place for effective telecommunications connectivity for all centres in their area of responsibility defined by the GISC's Area Meteorological Data Communication Network (AMDCN). Congress emphasized that this included ensuring that appropriate back-up arrangements were in place to allow flow of information between centres in the AMDCN of the GISC and other WIS centres to continue in the event of a failure of the GISC. Congress expressed its appreciation to all GISCs that had implemented training and capacity development through the running of training and familiarization courses for Members likely to use their AMDCN. It noted that such training was an essential role of all GISCs if they are to ensure centres within their area of responsibility develop the competencies to be able to maintain effective communications with the GISC and to benefit from WIS. Congress stressed that the WIS was intended to extend data sharing far beyond that provided by the Global Telecommunications Systems (GTS), and emphasized the critical role of the GISCs in facilitating this, both through the provision of appropriate technical environments, and also through assisting Members to exchange routinely information that was not carried by the GTS.

Quality Management of the WMO Information System

4.2.3.3 Congress considered the tables in Annex 2 to Recommendation 20 (CBS-Ext.(2014)) and urged relevant Members to complete the WIS Demonstration Process as soon as possible, make operational those WIS centres identified and to ensure that the centres maintain compliance with required WIS functions. Congress welcomed the proposal by CBS to perform regular reviews of the compliance of WIS centres with WIS standards and practices in order to support the delivery of services that meet the needs of users of WIS. Congress requested CBS to further develop both near-real-time and after-the-event monitoring of the performance of the WIS with the aim of ensuring a high level of service, and noted that WIS monitoring would concentrate on how exchange of information was managed rather than on the content of the exchanged information.

4.2.3.4 Recognizing that requests for routine exchange of information through the WIS might exceed the capacity of the high-availability WIS Core network and other infrastructure that could be afforded by Members, Congress supported the proposal by CBS to develop procedures to make decisions on relative priorities for exchanging different types of information that took into account the impacts of sharing the information as well as the resources required to enable that exchange. Congress also noted the role of the Secretariat in facilitating coordination between contributors of content on WIS to ensure information is clearly differentiated between authoritative and ancillary sources through the utilization of Discovery Metadata and the Alerting Authorities Register.

4.2.3.5 Recalling that at its sixteenth session Congress had asked technical commissions to develop competencies for staff performing roles in support of operations, Congress reviewed the WIS competencies that had been recommended by CBS at its 2014 extraordinary session and considered how these should be recorded in Technical Regulations and WMO Guides. Congress concluded that, until a guide that covered competencies for all aspects of the operational activities

of Members was developed, details of the WIS competencies should be documented in the Manual on WIS and the Guide on WIS.

Operation of the WMO Information System

4.2.3.6 Congress noted with appreciation the strong leadership provided by ECMWF in migrating to a new supplier for the RMDCN, that supports the Main Telecommunications Network (MTN) and provides the WIS Core Network. Congress noted the significant progress in the regional networks, but it was concerned that serious shortcomings still existed in some WMO Regions. Congress emphasized the importance of continued improvement of the regional component of the Global Telecommunication System (GTS) to underpin the meteorological services of each Member, as well as to enable the implementation of WIS and other new initiatives of WMO, such as the Global Framework for Climate Services (GFCS). It urged Members and regional associations to sustain their commitment in this effort and to take effective actions to modernize their national and regional data-collection systems, especially to get as many NMCs as possible connected to the GTS. It encouraged the Secretary-General to focus on improvement of the GTS, especially in developing and least developed countries, when implementing capacity-building and disaster risk reduction actions for the next financial period. Congress highlighted the importance of regional oversight of the implementation of WIS and was pleased that by the end of 2014, Regions II, III, V and VI had WIS Implementation Plans (WIS IP) in place and Regions I and IV were working on their WIS IP. It noted with satisfaction that all regional WIS IP include the need to monitor WIS implementation.

4.2.3.7 Congress requested CBS to further refine the structure of the GTS, and to pursue a smooth evolution of networks and related applications, such as Automated Message Switching Systems, from the current point-to-point topology to the two-level managed data communication network service architecture. In particular, Congress requested CBS to explore further the potential efficiencies from additional technologies and services that were possible in the new architecture. Congress noted that innovative administrative and financial arrangements and partnership were required to share and take full benefit from those new network services, and invited NMHSs to work with their associated GISC and to be as flexible as possible in that regard, taking account of respective national policies.

4.2.3.8 Congress noted with appreciation that the satellite-based data distribution services continued to be an important component of GTS for the distribution of large volumes of information, and that there had been extensive implementation and significant technological upgrades. Furthermore it noted that some satellite systems also provided a data collection service. It urged NMHSs to consider taking advantage of this service in designing their new observing and warning systems. Congress expressed its gratitude to all Members and organizations operating satellite-based meteorological data distribution and collection systems for the benefit of all NMHSs. Congress considered the potential benefits of coordinating the efforts of users of satellite communications systems, and considered that these justified the estimated cost of CHF 10,000 a year to the Secretariat to coordinate the SATCOM forum proposed in Recommendation 9 (CBS-Ext.(2014)).

4.2.3.9 Congress noted that the Internet had continued to play an increasingly important role for access to and delivery of a wide-range of data and products and as a complement to dedicated circuits for the GTS, with particular importance for smaller NMHSs. Congress recalled the complementary role of the GTS dedicated circuits, GTS circuits implemented across the Internet and of the Internet itself to meet the various operational and other needs and to ensure overall robustness of the system. Noting the risks associated with use of Information Technology, Congress expressed its appreciation to CBS for having published WMO-No. 1115 Guide on IT Security and WMO-No. 1116 Guide on VPN via the Internet between GTS centres and requested CBS to continue to pay particular attention to Information Technology security and to continue to review and update related practices, procedures and guidelines, and in particular those related to ensuring that information was only available to those for whom access had been approved.

4.2.3.10 Congress adopted Resolution 31 (Cg-17) – Report of the extraordinary session (2014) of the Commission for Basic Systems centres and networks of the WMO Information System.

4.2.3.11 Congress noted the plans of CBS, with participation of relevant technical commissions, to further develop the WIS Discovery Metadata standard, formally known as the WMO Core Profile of the ISO 19115 metadata standard, to maintain consistency with the ISO 19115-1 and ISO 19115-2 and related standards, and to enhance its relevance to Members. Congress noted that there were still messages exchanged on the GTS that did not have corresponding metadata records, and that this would prolong the period when Members needed to maintain both Volume C1 and the WIS Discovery Metadata records. Congress emphasized the need to assist NMHSs in implementing metadata generation and exchange, and agreed that CBS should continue to develop recommended practices, procedures and guidelines for operation, including training.

4.2.3.12 Noting that several Regional Telecommunication Hubs had not implemented the maintenance of their parts of Volume C1 and/or had not provided updates of their routeing catalogue, and/or had not ensured that centres attached to them had supplied or updated WIS Discovery Metadata records, Congress urged Members operating these centres to fully implement the standard procedures for the maintenance of Volume C1 and the recommended practices for updating the routeing catalogues and WIS Discovery Metadata.

4.2.3.13 Noting the deficiencies in the updating and presentation of Volume C2 of WMO-No. 9 Transmission Programmes, Congress requested that WMO Members review the contents of Volume C2 and send amendments to the WMO Secretariat as required. Congress emphasized that failure to adhere to the agreed GTS practices negatively impacted on other NMHSs causing loss of data and products essential to their operations.

WMO data representations

4.2.3.14 Congress appreciated the development of a data representation in extensible mark-up language to support exchange of information in support of international air navigation to meet the needs of ICAO, and that the development had taken into the account the need to apply the same methodology to defining representations of other types of information. Congress was pleased to note that the data representation had been designed using a data modelling technique, and was based on standards developed by the Open Geospatial Consortium (OGC) and adopted by the International Standards Organization. Congress noted that the approach taken enabled interoperability of different data representation systems (e.g. XML-based, NetCDF, HDF) used, or planned to be used, for the exchange or access of weather, climate and water information within and outside the WMO community, and that interoperability with Table Driven Code Forms (TDCF) could be further simplified in future editions of the TDCF. Furthermore, Congress was pleased to note the ongoing development of new implementation specifications within the OGC Standards programme in response to requirements from WMO (e.g. the encoding of generic time-series information in XML), mediated through Member's participation in the OGC MetOcean Domain Working Group. Congress decided that an additional volume of WMO-No. 306 *Manual on Codes* was needed to document data representations designed using data modelling techniques.

4.2.3.15 Congress noted the significant effort made by many Members to successfully meet the deadline of migration to Table Driven Code Form (TDCF), and the significant support provided by CBS experts. It noted that the revised November 2014 target for migration of the data category 1 (SYNOP, TEMP, PILOT and CLIMAT) had not been fully met. It recognized that CBS had introduced measures to enable all WMO Members to continue to be able to access the observational data available on the GTS in the appropriate format.

4.2.3.16 Congress urged Members to make sure that they could use, as well as produce, information in TDCF because GFCS and WIGOS needed to implement features, such as reporting of snow depth and providing an extended range of station identifiers, that were not compatible with Traditional Alphanumeric Codes (TAC) and that could not be accommodated by parallel transmission of information. In support of the GFCS, Congress urged Members to exchange

information on rainfall accumulations in their reports that were distributed globally, rather than limiting this information to national or regional exchange. Congress stressed the continuing need for assistance to some developing countries in implementing the migration, and expressed its gratitude to those Members and organizations that had made available their TDCF converter software or contributed to relevant training workshops to complete this task.

4.2.3.17 Congress reviewed the recommendations of CBS-Ext.(2014) of relevance to WIS that included amendments to Technical Regulations, the Manual on WIS, the Guide to the WIS, the *Manual on the Global Telecommunication System*, and the *Manual on Codes*. Congress adopted Resolution 32 (Cg-17) – Report of the extraordinary session (2014) of the Commission for Basic Systems relevant to technical regulations concerning the Global Telecommunication System, data management and the WMO Information System.

Future of the WMO Information System

4.2.3.18 Congress recalled that at its fifteenth session Congress (WMO-No. 1026, paragraph 3.1.2.9) agreed that WIS be implemented in two parallel parts. Part A: continued evolution of the GTS and its extension to meet the operational requirements of all WMO programmes; and Part B: an extension of the information services through flexible data discovery, access and retrieval services to authorized users, as well as flexible timely delivery services. Taking into consideration the growing requirements from an increasing number of application areas, such as the Climate Services Information System pillar of the GFCS, WIGOS and research activities, for long-term management of information, for increased assurances about the provenance of information, and for using information from a wide variety of sources, Congress concluded that additional guidance and assistance was needed on data management issues.

4.2.3.19 Congress tasked the CBS to develop “Part C” of the WIS that would provide assistance to Members in matters concerning all stages of management of information. This should include guidance on best practice in the collection or creation of information (including ensuring that the information is fit for purpose), managing storage of information, sharing information (including the definition and enforcement of restrictions on use of the information), use of the information to deliver benefits from it, long-term preservation (archiving) of information, and disposing of information that is no longer required (including guidance on how decisions on disposal should be made). Congress also tasked CBS to develop auditable standards relevant to information management to be applied by data centres managing information on behalf of WMO Programmes where these would enhance the ability of Members to derive benefit from information, and to consider appropriate arrangements for long-term retention of information to meet the future needs of WMO Programmes.

4.2.3.20 Congress recognized the importance of maintaining an up-to-date vocabulary of well-defined terms that could be used unambiguously in technical regulations, descriptions of information and data, and technical documentation, and therefore asked CBS to prepare and implement a procedure for creating and maintain an authoritative set of definitions of terms for use in WIS and WIGOS, and for identifying those definitions as authoritative in the WMO METEOTERM application. Congress adopted Resolution 33 (Cg-17) – Report of the extraordinary session (2014) of the Commission for Basic Systems relevant to standardization of data management practices.

4.2.3.21 Congress noted that the rapid development of information technology presented both challenges to, and opportunities for, the capacity and models of operation and service delivery by NMHSs in such aspects as applying modern information technology, improving information quality, information standards, information management, and information security, expanding information sharing and applications, etc. The further implementation and enhancement of WIS will have essential bearing on all the strategic priority areas of WMO. Congress agreed that when developing future operating plans and activities under the strategic priorities, WIS related activities should be given high importance.

Climate Data Management and Applications

Climate Data Management Systems (CDMS)

4.2.3.22 Following results from a survey by the Commission for Climatology (CCl) on the status of Climate Data Management Systems (CDMSs), which includes the fact that almost half of WMO's Members do not have a proper CDMS in full operation, Congress urged Members and the Secretariat to continue the support being given to developing and least developed countries in implementing CDMSs. In this context, Congress took note of the existence of an increasing variety of CDMS solutions and appreciated the collaboration of CDMS developers with WMO and its Members. It welcomed the WMO CDMS Specifications publication as a powerful means to support future convergence of Members' climate data management practices. Congress noted relevant decisions taken during the sixteenth session of the Commission for Climatology (CCl-16) and the extraordinary session of the Commission for Basic Systems (CBS-Ext.(2014)) to reflect elements of the CDMS specifications in WMO *Technical Regulations* and adopted Resolution 34 (Cg-17) – Definition of standards for Climate Data Management Systems and their reference in the WMO Information System

Data Rescue

4.2.3.23 Congress noted that, despite ongoing efforts by CCl and the Secretariat to promote and guide climate data rescue, a large amount of efforts on data rescue work and digitization is still urgently required globally. Further, it recognized the need to better coordinate the numerous data rescue and digitization initiatives underway. Congress welcomed the CCl initiative to develop an International Data Rescue Portal (I-DARE, www.idare-portal.org) that will provide a central hosting point for coordinating information about climate data rescue initiatives globally, along with best-practice guidance on data rescue techniques. It strongly encouraged Members and the Secretariat to continue the support given to developing and least developed countries in implementing Data Rescue (DARE) initiatives, encouraged international collaboration with DARE projects, and welcomed improved collaboration with initiatives and organizations such as the Atmospheric Circulation Reconstructions over the Earth (ACRE) and the International Environmental Data Rescue Organization (IEDRO). Congress encouraged CCl and the Commission for Hydrology (CHy) to collaborate on rescuing hydrological data as well.

4.2.3.24 Congress emphasized the importance of continuously monitoring the progress made in Data Rescue activities and initiatives coupled with expert advice and knowledge sharing for the successful implementation of Data Rescue.

4.2.3.25 Congress welcomed the various regional DARE efforts, and strongly encouraged Members in the regions and across regions to collaborate on these initiatives to make use of, and share, their facilities and knowledge in order to optimize resources. Congress welcomed the international collaboration of Members for rescuing climate records belonging to territories previously administered by them. It further encouraged Members to continue this collaboration.

High-Quality Global Data Management Framework for Climate

4.2.3.26 Congress was informed of the CCl led inter-programme initiative to work towards the development of a High Quality Global Data Management Framework for Climate (HQ-GDMFC), through the newly established CCl Inter-Programme Expert Team on Climate Data Modernization Programme (IPET-CDMP). The aim of this initiative is to examine and make recommendations to improve existing practices in managing climate data and its quality control, as well as better harvesting the potential of other data forms to improve climate services, including those pertaining to remote sensing, climate models, third party data and volunteer observations. It will provide the opportunity for addressing inconsistencies and gaps in the definitions and procedures relevant to climate data management. Moreover, HQ-GDMFC will provide and publish best-practice guidance on methods and procedures, techniques as well as tools and infrastructure in relation to climate data rescue and preservation, archival, procedures for quality control and assurance, calculation of statistics and climate parameters, homogenization and adjustments, among others. This initiative

will collaborate closely with a wider cross-programme initiative aimed at modernizing WMO programmes' data management infrastructure and processes.

4.2.3.27 Congress emphasized the need to develop a Concept of Operations (ConOps) for the HQ-GDMFC, to be submitted for consideration by EC as a WMO contribution to the GFCS CSIS. It further requested CCl and the Secretariat to assess the benefit of linking this initiative to other international initiatives such as UN data initiatives (Big data, Data revolution, etc.) discussed under agenda item 9.1.

4.2.3.28 Congress emphasized the need for securing climate data homogeneity in the transition process from conventional to automatic observations. It appreciated the ongoing work by CCl and other technical commissions and programmes to guide Members on this aspect and looks forward to its accomplishment.

World Weather Records

4.2.3.29 Congress was informed of the successful implementation of the new approach for annual submission of the World Weather Records. It stressed the importance of providing and sharing these data sets for supporting global climate assessment studies and research and urged Members to submit their data in due time, i.e. after the end of the year but not later than June of the following year as described by Resolution 14 (EC-64). It stressed the importance of publishing these records as soon as possible for the benefit of the Members.

WMO Recognition of long-term observing stations

4.2.3.30 Congress recognized the importance of long-term observations, such as from centennial observing stations with good quality time series of meteorological parameters. These stations provide invaluable climate heritage for science and applications in climate change monitoring and adaptation.

4.2.3.31 Congress noted that some of these observing stations are being at risk of closure or losing minimum observational standards, due to significant changes in the surrounding environment (e.g. artificial structures) or due to enforced closure or relocation as a result of competing societal interests.

4.2.3.32 Congress recalled the request of the WMO Executive Council at its sixty-fifth session to the Commission for Climatology (CCl), jointly with GCOS and CIMO, to investigate existing site certification mechanisms, network criteria and monitoring principles and to set up an appropriate WMO mechanism for the recognition of centennial observing stations, based on a minimum set of objective assessment criteria. It welcomed the organization of a scoping meeting in June 2014 in Geneva involving experts from CCl, CIMO, CBS and GCOS to define a set of objective criteria for the recognition of centennial stations with at least 100 years of climate records.

4.2.3.33 Congress agreed to set up an appropriate WMO mechanism for the recognition of long-term observing stations. The mechanism can be expanded to cover 50 years, 75 years and over 100 years long-term observing stations, with certification levels such as bronze, silver and gold respectively. Congress adopted Resolution 35 (Cg-17) – WMO recognition of long-term observing stations.

Marine Climate Data System (MCDS)

4.2.3.34 Congress noted recent developments under JCOMM with regard to the Marine Climate Data System (MCDS), and the establishment of a network of Centres for Marine-Meteorological and Oceanographic Climate Data (CMOCs). Congress further noted with appreciation the successful evaluation by JCOMM of the application of the State Oceanic Administration (SOA) National Marine Data and Information Service (NMDIS) in Tianjin, China to become a CMOC, and adopted Resolution 36 (Cg-17) – Designation of the Centre for Marine-Meteorological and Oceanographic Climate Data in Tianjin, China, subject to a parallel approval by the Twenty-eighth

Session of the IOC of UNESCO Assembly. Congress thanked China for its commitment in this regard, noting the substantial benefits expected from the CMOCs to addressing the marine climate data requirements of the Global Framework for Climate Services (GFCS).

4.2.4 WMO Space Programme (agenda item 4.2.4)

Implementation of satellite programmes

4.2.4.1 Congress recalled the vital role of satellite observations across all WIGOS component observing systems to support WMO Programmes and applications, ranging from weather monitoring and prediction, nowcasting, climate and climate change monitoring, to applications related to atmospheric composition, hydrology, oceanography, cryosphere and environment monitoring, space weather, and including specific applications such as tropical cyclone forecasting, sand and dust storm or volcanic ash detection.

4.2.4.2 Congress thanked Members operating satellite systems in support of WMO Programmes. In particular, it commended the members of the Coordination Group for Meteorological Satellites (CGMS) for their response to the Vision for the Global Observing System (GOS) in 2025 and their agreement to maintain satellite missions on a long-term operational or sustained basis by adopting the CGMS Baseline for the Operational Contribution to the Global Observing System.

4.2.4.3 Congress expressed its congratulations to Members for the series of successful launches completed recently, which included, since early 2014: the Global Precipitation Measurement (GPM) Core Observatory by Japan and the United States of America (USA); Sentinel-1A, by the European Space Agency (ESA), ALOS-2 and Himawari-8 by Japan; Orbiting Carbon Observatory (OCO-2), DSCOVR and Soil Moisture Active Passive (SMAP) by the USA; Meteor-M2 by the Russian Federation; CBERS-4 by China and Brazil; and FY-2G by China. Congress noted with appreciation that Himawari-8, the first of the new generation of geostationary satellites, was planned to start its operational service on 7 July 2015 at 140°E. Himawari data will be distributed through a broadcasting service using a communication satellite, named HimawariCast, and an Internet-based service named HimawariCloud. These services already started in order to facilitate users' preparation and transition to operational use. Congress commended Japan for providing approximately 15 National Meteorological Services in RA II and RA V with HimawariCast receiving equipment, through the Japan Meteorological Agency in cooperation with the WMO Secretariat, and through the Japan International Cooperation Agency (JICA). Congress was pleased to note that FY-2G had been successfully commissioned and would start its operational service in June 2015 at 105°E.

4.2.4.4 Congress acknowledged the continuing plans from EUMETSAT and the USA to maintain and improve their polar-orbiting operational satellite missions in morning and afternoon orbits, respectively. It was pleased to note the measures taken by the USA to ensure continuity between Suomi-NPP and the JPSS spacecraft series on the mid-afternoon orbit. It expressed appreciation to EUMETSAT for the tandem operation of Metop-A and Metop-B on the mid-morning orbit and commended EUMETSAT and ESA for adopting the EPS Second Generation programme that will provide continuity after the EPS programme with considerable enhancements.

4.2.4.5 Congress commended China for confirming its plan to maintain a FY-3 satellite on the early-morning orbit starting with FY-3E. It emphasized that this plan was opening a new era for the space-based component of WIGOS since, for the first time, the constellation of atmospheric sounding capabilities in polar orbit would be distributed over three orbital planes as recommended in the WMO Vision for the GOS in 2025, thus improving temporal sampling of the atmosphere.

4.2.4.6 Regarding the geostationary constellation, Congress recalled the requirement for maintaining observation coverage of the Indian Ocean, an area which modulates climate over Africa and Australia, and is a source of severe weather systems impacting Indian Ocean islands, Southern Asia and Australia, and large parts of Eastern and Southern Africa. It noted that by the end of 2016 EUMETSAT will terminate the operations of Meteosat-7, since this satellite has to be

de-orbited. Congress expressed its high appreciation of the agreement reached at the 43rd meeting of CGMS on a multi-partner scenario involving China, India, the Russian Federation and possibly EUMETSAT, to secure Indian Ocean geostationary coverage after the decommissioning of Meteosat-7, as well as a roadmap for the timely implementation of this scenario. It was pleased to note that India's INSAT-3D was operational at 82°E, and that INSAT-3D data would be available to WMO Members and disseminated with the support of EUMETSAT by EUMETCast, that China would relocate the FY-2 E spacecraft at 86.5°E and ensure near real-time dissemination of FY-2 E data by CMACast, and that the Russian Federation would move Electro-L2 to 77.8°E after successful commissioning and provide Electro-L2 data to WMO Members. Congress welcomed the continued efforts of CGMS members to further improve the quality of Atmospheric Motion Vectors (AMVs) derived from geostationary imagery over this region.

4.2.4.7 Congress looked forward to the forthcoming launch of missions in highly elliptical orbit to consolidate coverage of the Arctic, and to the deployment of the two COSMIC-2/Formosat-7 constellations in 2016 and 2018 to expand radio-occultation measurements of atmospheric temperature, humidity and ionospheric electron density.

4.2.4.8 While it was pleased to note the increased level of coordination among satellite operators, Congress recalled that satellite missions were only contributing to WIGOS to the extent that data of suitable quality were available in a timely manner to the users. It encouraged China and India to collaborate with EUMETSAT towards near real-time dissemination of scatterometer data from HY-2 and from the future ScatSat respectively. Congress noted that data from Meteor-M2 were disseminated in L Band for local Direct Readout stations, and that the detailed characteristics of this service were published on the Planeta website; it encouraged the Russian Federation to also make global whole-orbit data from Meteor-M2 available to the WMO community in near real-time.

Future missions and preparation of users

4.2.4.9 Congress recalled Resolution 11 (EC-65) urging satellite operators to develop plans to fill gaps in essential space-based observations, and noted that several actions were taken in response to this resolution. It emphasized however that the coming years will see the termination of several R&D missions providing limb soundings, which are required for high-resolution vertical profile observations of temperature, humidity, wind, aerosol, ozone and other trace gases in the stratosphere and mesosphere. Congress welcomed the new Sentinel operational missions planned by the European Union, the European Space Agency (ESA) and EUMETSAT. For atmospheric monitoring of air quality and climate the first Sentinel will be the Sentinel-5-Precursor to be launched in the second quarter of 2016, succeeded by Sentinel-4 on MTG and Sentinel-5 on EPS-SG. The ADM/Aeolus mission of ESA and EarthCARE of ESA and Japan will achieve a new step forward for meteorology from space.

4.2.4.10 Congress noted that new-generation geostationary systems were being implemented in the 2014–2020 timeframe by Japan, China, the USA, the Republic of Korea, the Russian Federation and EUMETSAT; other new-generation systems were being developed for implementation in polar orbit and other orbit types in the coming decade. It pointed out that the transition to operations of these new systems would enable significant enhancements to satellite-based products and services delivered by WMO Members. The implementation of these systems in operational schemes would also have a major impact on user infrastructure, systems, applications and services, and require coordinated action at the scientific, technical, financial, organizational and educational levels. Congress appreciated that timely and careful preparation was essential to avoid any disruption of operations upon transition to these new systems, and to ensure that Members take advantage of the new capabilities as early as possible to provide a better service to users. It adopted Resolution 37 (Cg-17) – Preparation for new satellite systems, as recommended by the Commission for Basic Systems. It welcomed the implementation of the SATURN collaborative website hosting up-to-date information on the new systems.

4.2.4.11 Congress welcomed the effort initiated to devise the space-based component of a Vision of WIGOS component observing systems in 2040, which will provide guidance to WMO

Members for planning new satellite systems and applications. This new Vision shall take into account the anticipated maturity of emerging satellite applications (e.g. related to air quality, hydrology, and the cryosphere), expected advances in remote-sensing, satellite, and information technology, the diversity of orbits and mission concepts required for a robust space-based observing system, and the expanding community of satellite operators.

Global Space-based Intercalibration System (GSICS)

4.2.4.12 Congress confirmed the importance of GSICS for WIGOS, as a collaborative framework among satellite operators and science teams to develop, implement and share best practices, standards, procedures and tools to improve the calibration of environmental satellites throughout the WIGOS space-based component. It noted that GSICS was focusing on the systematic generation of in-orbit inter-calibration information of Level 1 satellite data. It encouraged GSICS to organize the continuous availability of well-characterized, on-orbit calibration reference standards, and to develop traceability to these references. Congress emphasized that GSICS was providing support on one hand to satellite operators, in assessing the uncertainty of calibration methods and sharing knowledge and tools, and on the other hand to satellite users, in enabling consistent, comparable, traceable data records. GSICS thus contributes to ensure interoperability within WIGOS and provides important support to climate applications.

4.2.4.13 Congress welcomed the collaboration initiated between GSICS, the GCOS Reference Upper-Air Network (GRUAN) and the radio-occultation community to join their expertise in providing highly accurate and better-characterized observations for weather and climate applications. In this regard, Congress noted the complementary nature of observations from satellite and ground-based observing systems, and stressed the relevance of high-quality ground-based observations for the validation of satellite-derived products.

Architecture for climate monitoring from space

4.2.4.14 Recalling Resolution 19 (Cg-XVI) – Development of an Architecture for Climate Monitoring from Space, Congress confirmed that the architecture should aim to provide a structured and comprehensive view of what Essential Climate Variable (ECV) Climate Data Records (CDRs) are available from Earth Observation satellites, to create the conditions for delivering further CDRs through best use of existing data holdings, and to optimize the planning of future satellite missions and constellations in order to expand existing and planned CDRs and address possible gaps. Congress recalled that the Architecture was an end-to-end approach spanning over several “pillars”, from remote sensing to climate data record creation and preservation and to climate applications in support of decision-making. The Architecture also provides a foundation for the Observations and Monitoring pillar of the Global Framework for Climate Services (GFCS), thus sustaining the provision of near real-time monitoring for climate services at the global, regional and national scales. Congress emphasized that the architecture was developed in collaboration between the space agencies, including CEOS and CGMS members, and WMO. It highlighted the particular role of WMO to promote free and open satellite data exchange, and to support the dialogue between space agencies and user communities for realizing economical and societal benefits through climate services. Congress underlined the linkage to the ongoing Climate Policy Framework as reflected in the conclusions of the Subsidiary Body for Scientific and Technological Advice of the UNFCCC (SBSTA-41, December 2014), which “noted the importance of continuing and sustaining satellite observations on a long-term basis and welcomed the efforts to develop an architecture for climate monitoring from space”.

4.2.4.15 Congress noted the effective collaboration among CEOS, CGMS and the WMO Secretariat which led to the Strategy towards the Development of an Architecture for Climate Monitoring from Space. It welcomed the establishment in 2013 of the CEOS-CGMS Joint Working Group on Climate, which includes WMO. It also appreciated the progress made by this group in developing an inventory for evaluating ECV satellite datasets.

4.2.4.16 As suggested by the Consultative Meetings on High-level Policy on Satellite Matters, Congress underscored the need for the satellite operators and the Secretariat to pursue the

development of the Architecture for Climate Monitoring from Space with a view to ensure seamless continuity of climate monitoring satellite programmes, comparability of measurements, provisions for continuity and contingency, and traceability to reference standards. Congress further encouraged satellite operators to pursue a dialogue with WCRP and GCOS in order to address the grand science challenges of WCRP in an end-to-end integrated approach.

4.2.4.17 Congress considered that advocacy for implementing and sustaining climate monitoring capabilities should be based upon the socioeconomic benefit of climate applications. In this respect it appreciated the report compiled by the Secretariat analysing the use of satellite-based climate information in support of decision-making for a range of case studies in GFCS priority areas and various geographical contexts.

Data access

4.2.4.18 Congress appreciated that user surveys among WMO Members were being made to monitor access to and use of satellite data and products, with focus on operational applications. It welcomed the initiative, presented to the CBS, to prepare a Satellite Data Dissemination Strategy as an update to the "Integrated Global Data Dissemination Strategy" (IGDDS). This update would take into account evolving needs and capabilities, to guide both users and providers towards the most effective use of satellites.

4.2.4.19 Congress encouraged special attention to the following elements in finalizing the updated strategy:

(a) Establishing regional groups on requirements for satellite data and exchange as requested by Resolution 12 (EC-65) is essential to capture and address the diversity of requirements of the different user communities in terms of data levels (e.g. raw data, high-level products), formats, or access means (e.g. broadcast, on-demand retrieval) depending on application and available technical infrastructure;

(b) Satellite data and products should be integrated into the WMO Information System, registered with standardized discovery metadata, and made available for international exchange in internationally agreed formats;

(c) Regional dissemination services based on Digital Video Broadcast from Satellite (DVB-S or DVB-S2) as recommended by CBS since nearly 15 years should continue to be regarded as a pillar of satellite data dissemination, be standardized, with interoperable catalogues, operated under agreements with satellite data providers (from meteorological and other relevant operational or R&D missions), and be integrated as far as possible for maximum efficiency;

(d) Space agencies should continue to act as redistribution hubs, through international partnership, for the delivery of third-party data to the user community through integrated interfaces according to end user needs;

(e) Direct Readout standards, which are particularly needed for Low Earth Orbit satellite systems, should be maintained and adapted as necessary to evolving data rates and bandwidth needs, and be supplemented when relevant with coordinated near real-time relay systems (such as the Direct Broadcast Network for Near Real-Time Relay of Low Earth Orbit Satellite Data (DBNet)); Direct Readout frequency bands should be protected;

(f) Online resources should continue to be maintained by the Secretariat, such as the Product Access Guide (PAG), and the Observing System Capability Analysis and Review/Space Module (OSCAR/Space) and associated webpages with information on satellite status and data access.

Applications

4.2.4.20 Congress welcomed the SCOPE-Nowcasting initiative, noting the critical importance of satellites for nowcasting applications, particularly in otherwise data-sparse areas. It invited Members to support the development of the four pilot projects and to provide assistance in their later operationalization, as appropriate and subject to progress review.

4.2.4.21 Congress welcomed progress in the SCOPE-CM initiative, aiming at elevating the maturity of climate data records as measured by a common metric, and now encompassing well-established community activities devoted to the generation and exploitation of satellite-based CDRs. It recommended that SCOPE-CM be responsive to the data requirements for operational climate monitoring, and become an integral part of the Architecture for Climate Monitoring from Space.

4.2.4.22 Congress stressed the critical importance of satellite imagery for disaster risk reduction in particular in the case of tropical cyclones. Congress reinforced the importance of maintaining an active dialogue between established WMO regional centres and the satellite community to ensure that advantage is taken of the latest satellite capabilities for issuing warnings on tropical cyclones. As a general guidance, Congress recommended that best practices be shared to ensure that key satellite data and products are available in critical situations. In this regard, Congress noted the planned WMO Joint RA II and RA V Workshop on WIGOS for Disaster Risk Reduction, to be convened in Jakarta, Indonesia, from 13–15 October 2015.

4.2.4.23 Congress stressed the importance of collaborating with, and supporting the WMO-sponsored international science groups on precipitation, sounding, winds, radio occultation, and clouds, in co-sponsorship with CGMS and other partners. These groups provide important inroads to the meteorological satellite user community, and their activities are essential for WMO applications development and for advancing the state-of-the-art in satellite data utilization.

User Awareness and Training

4.2.4.24 Congress welcomed the expansion of the WMO-CGMS Virtual Laboratory for Education and Training (VLab) to 13 Centres of Excellence, following the addition of a Centre hosted by DMN Morocco and sponsored by EUMETSAT. Congress urged the sponsoring satellite operators to renew and where possible augment their commitment to their affiliated Centres, to enable them to fully meet agreed expectations.

4.2.4.25 Congress welcomed the 2015–2019 strategy of the VLab to widen scope and audience by addressing the satellite-related capacity-building needs in meteorological, climate, and related environmental applications, in all WMO Regions and official languages. For implementing the VLab strategy, Congress welcomed partnerships such as with the Committee on Space Research (COSPAR) capacity-building activity, the European EUMETrain programme, and the COMET Program of the USA University Corporation for Atmospheric Research (UCAR).

4.2.4.26 Congress noted the critical need to ensure continued availability of a Technical Support Officer to the VLab. It therefore urged Members to provide regular financial contributions to the WMO VLab Trust Fund dedicated to this support and thanked Brazil, EUMETSAT, the Republic of Korea, and the USA for their financial contributions over the past years.

Regional Activities

4.2.4.27 Congress stressed the value of regional satellite user conferences to raise awareness of the user community on the new capabilities, to promote best practices in satellite applications focusing on regional needs and more generally to support the dialogue between satellite operators and users. Congress noted that such regional conferences are a privileged venue to collocate satellite training events and/or regional groups on requirements for satellite data and exchange, and other side-events. These events are thus an important contribution to the training strategy, to

the strategy to improve data access, to assist Members in planning and identifying the necessary resources for exploiting satellite data, and to the preparation of users for new satellite generations.

4.2.4.28 In this respect, Congress expressed its appreciation to EUMETSAT for convening an annual satellite user conference as well as a biennial User Forum in Africa and the information day for Eastern European and Caucasian countries. It was pleased to note the progress of the Monitoring of Environment and Security in Africa (MESA) project funded by the European Union and implemented by the African Union Commission with the support of EUMETSAT, and the adoption of the Benoni Statement on the Implementation of the Global Framework for Climate Services in Africa on 7 September 2014.

4.2.4.29 Congress also expressed particular appreciation for the collaboration developed among China, Japan, the Republic of Korea and Australia, who have hosted in turn the Asia Oceania Meteorological Satellite User Conferences (AOMSUC) with a growing success, and welcomed the intention of the Russian Federation to join this initiative. It encouraged Members and satellite operators to facilitate participation in such conferences. Congress invited the relevant satellite operators to use this framework to assist Members in addressing the challenges they are facing to access data from new satellites for daily operational purposes, in particular in the South West Asia Pacific region. Congress thanked the USA for organizing the NOAA Satellite Conferences, the last one having been held in Greenbelt, Maryland, from 27 April to 1 May 2015.

4.2.4.30 Congress noted the important role played by both NOAA and EUMETSAT to support the requirements of RA III and RA IV Members. Congress highlighted the importance of the dialogue established between NOAA, EUMETSAT and the Central and South American and Caribbean user community through the WMO Coordination Group on Satellite Data Requirements for Regions III and IV, which held its first meeting on the occasion of the 2015 NOAA Satellite Conference (http://www.wmo.int/pages/prog/sat/documents/RA-3-4-SDR-1_Final-Report.pdf). This group was recognized as an efficient framework to address the specific issues, challenges and opportunities, posed by the transition scenario to the new-generation GOES-R, the availability of the GEONETCast-Americas broadcast service, and the planned termination of the EUMETCast-Americas broadcast service. It was recalled that GOES-R, scheduled to replace GOES West or GOES East, was to be launched in March 2016. Then, after an extended product validation for a period of at least 6 months, it would start operational service in March 2017.

4.2.4.31 The presidents of RA III and RA IV thanked the USA for maintaining the GOES system which is essential for the daily operations of NMHS, and looked forward to the new generation GOES-R series of satellites. They stressed however that most Members would not be prepared to implement a GOES Re-broadcast (GRB) receiving station and that alternative solutions are needed to ensure continuous access to geostationary data. They pointed out that GEONETCast-Americas could be an affordable and efficient alternative, since several Members are already equipped and trained for its use, and such a system is scalable by design to accommodate evolving user needs. Existing EUMETCast-Americas receiving equipment provided by Spain through the Ibero-American cooperation Programme could be converted at very low cost into GEONETCast-Americas stations. RA III and RA IV Members welcomed the distribution of some GOES imagery and products by NOAA over GEONETCast-Americas, and the availability of Meteosat and other products over the EUMETCast-Americas service, taking particularly into account the importance of Meteosat data for meteorological operations of NMHSs in the Eastern part of South America. Being aware of the planned discontinuation of the EUMETCast-Americas broadcast service by EUMETSAT, the RA III and RA IV presidents:

(a) Encouraged the USA and potential partners to join their efforts to expand the GEONETCast-Americas service towards including the products currently distributed by EUMETCast-Americas, with a view to better fulfil regional user needs;

(b) Invited EUMETSAT Member States to reconsider the planned discontinuation of the EUMETCAst-Americas service and make best efforts to keep it in place until a satisfactory alternative dissemination as proposed in (a) be implemented.

4.2.4.32 Noting the needs expressed by RA III and RA IV Members, Congress urged Members to engage in the Coordination Group on Satellite Data Requirements for RA III and RA IV, in order to consider and implement partnership initiatives to ensure a smooth transition from EUMETCast-Americas to alternative data distribution mechanisms such as GEONETCast-Americas.

Socioeconomic benefits

4.2.4.33 Congress noted that CM-12 and CBS-Ext.(2014) had discussed the socioeconomic benefits of satellite programmes. It was pointed out that one aspect of the benefit is the reduction of cost to society in disaster situations. As many WMO Members and their space agencies have to manage priorities in an increasingly resource-constrained environment, it is highly important to evaluate and document these socioeconomic benefits in order to assist the decision process on new satellite programmes. In particular, socioeconomic benefit assessments should provide an objective basis to inform the transition of mature research and development capabilities to an operational status, and to secure sufficient resources to support the development of applications. Recalling the highly successful series of WMO Impact Workshops (e.g. Sedona 2012), Congress encouraged broadening the assessment of the impact of observing systems on user applications beyond numerical weather prediction.

4.2.4.34 Congress noted the ongoing development of the European Union Copernicus user services based on satellite data, starting with the Atmosphere Monitoring Service, Marine Monitoring Service, and Climate Change Service. These are important steps forward to enhance the societal benefits of satellite data, which are all of direct relevance to WMO.

WMO Coordination of Space Weather Activities

4.2.4.35 Congress recognized the increasing societal demand for space weather services as a result of growing dependence on technologies impacted by space weather, including radio-communications, and observation and navigation satellites. Procedures are being developed by a number of countries to manage the risks of severe space weather events as part of a multi-hazard Disaster Risk Reduction approach. Space weather services are regularly used by commercial airlines, satellite industry, drilling and surveying operations, power grid operators, pipeline designers and users of satellite-based navigation systems. It is anticipated that this demand will expand with broader awareness of the impact of space weather events, increasing exposure of the society, and greater maturity of space weather products and services.

4.2.4.36 of primary importance for WMO are the requirements for space weather information emerging from international air navigation, as discussed by the Conjoint ICAO/WMO MET Divisional Meeting in July 2014, which requested further work on establishing criteria for the designation of global and regional space weather centres, the assessment of their capabilities and appropriate governance as well as cost recovery arrangements. Congress noted that this work should result in a respective amendment to ICAO Annex 3/WMO *Technical Regulations* Volume II that would enable the commencement of operational space weather services in 2018.

4.2.4.37 Space weather phenomena are best monitored through coordinated efforts of multiple nations. They are triggered by events occurring on the Sun and in interplanetary space, are ranging in size from the global to the regional scale, are potentially affecting a global community and require extensive observation capabilities on Earth and in space. In spite of valuable international initiatives, there is no global coordination mechanism addressing the whole range of activities required to ensure sustainable, operational, space weather services meeting the expressed needs.

4.2.4.38 Congress noted that space weather, as a discipline in geophysical sciences, is related to meteorology through the physical connection of the ionosphere, magnetosphere, and solar processes to the neutral atmosphere. It underlined that opportunities for integration of meteorological and space weather observing systems should be explored in accordance with the vision of WIGOS and the ICAO System-Wide Information Management (SWIM). When space weather is addressed by institutions which are distinct from the NMHS, WIGOS provides a

framework facilitating agreements between the NMHS and the relevant institutions. Furthermore, in the WIS structure, space weather centres which are not NMHSs can become, for example, Data Collection or Production Centres.

4.2.4.39 Congress agreed that WMO should undertake international coordination of operational space weather monitoring and forecasting with a view to support the protection of life, property and critical infrastructures and the impacted economic activities, in an optimized overall effort. In providing a global intergovernmental framework, WMO would facilitate international commitments and enable the establishment of operational space weather services, in particular in the context of the support to ICAO. Congress requested that just as space weather observation requirements have been developed within the Rolling Review of Requirements, space weather observations be integrated into WIGOS. An integrative approach should also be used as concerns data sharing and management within the WIS, data processing within the Global Data Processing and Forecasting System (GDPFS) and decision support services within our Services Delivery and Disaster Risk Reduction activities. Congress adopted Resolution 38 (Cg-17) — Four-year Plan for WMO Coordination of Space Weather Activities.

4.2.4.40 Congress acknowledged the progress made with Space Weather activities including space weather observing requirements, an assessment of gaps in observing systems, the establishment of a space weather product portal, coordination with the International Civil Aviation Organization on space weather information for global aviation and the development of a draft four year plan. Congress expressed its appreciation to ICTSW and to the Secretariat for this outcome. It noted that this work was accomplished to date using modest Secretariat support, including staff and travel funding. It requested that EC and Members consider adequate resourcing be provided for the activity including extrabudgetary resources through voluntary contributions to the Space Weather Trust Fund and supplemental in-kind contributions.

4.2.4.41 Congress noted that the expression “space weather” was understood as the “*physical and phenomenological state of the natural space environment, including the sun, the solar wind, the magnetosphere, the ionosphere and the thermosphere, and its interaction with the Earth*”, and was also commonly designating the associated discipline. It noted furthermore that the current WMO definition of “space meteorology” is a source of confusion between “space weather” and “satellite meteorology”. Congress therefore decided that the definitions of “space weather” and “space meteorology” be clarified in Meteoterm, in order to avoid confusion between “space weather” and “satellite meteorology” in all WMO official languages.

4.2.5 **Global Climate Observing System** (agenda item 4.2.5)

Review of the GCOS Programme

4.2.5.1 Congress noted that at its 19th session in 2011, the Steering Committee had welcomed an independent review of the GCOS programme, requested by its four sponsoring organizations WMO, the Intergovernmental Oceanographic Commission (IOC) of UNESCO (United Nations Educational, Scientific and Cultural Organization), United Nations Environment Programme (UNEP) and the International Council for Science (ICSU), and appreciated the willingness of WMO to take the lead.

4.2.5.2 Congress recognized that new developments in the Earth observing programme community have required a review of the GCOS programme objectives and mandate. The new developments include the establishment of the Global Earth Observation System of Systems (GEOSS), and the increased attention countries are now giving to adaptation. The GCOS programme will also be affected by the development and implementation of the Global Framework for Climate Services (GFCS), WMO Integrated Global Observing System (WIGOS), and the findings of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5). The recent changes in the climate observation landscape have led to an evolving framework for climate services also for the other sponsoring organizations programmes including Future Earth, Blue Planet, and Programme of Research on Climate Change Vulnerability, Impacts and. Adaptation (PROVIA). In addition, the Subsidiary Body for Scientific and Technological Advice

(SBSTA) of the United Nations Framework Convention on Climate Change (UNFCCC) has considered the timing of future contributions of GCOS to SBSTA that will assess the adequacy of climate observing systems, evaluate progress, and update implementation planning.

4.2.5.3 Congress was informed that the review focused on assessing the added value the GCOS programme is giving to the Members of its sponsors and to the closely affiliated Earth Observation Community with respect to climate science research and climate policies. The programme review provided the basis for revising the GCOS Memorandum of Understanding (MoU).

4.2.5.4 Congress noted with appreciation the key outcomes of the review, which is the general recognition of the normative work of GCOS in defining guidelines and setting principles, and of the significance of the programme in general. Based on the full report, the review board prepared 18 recommendations to assist the sponsors in their considerations of further action to support the GCOS programme.

4.2.5.5 Congress commended the GCOS Steering Committee for evolving the programme on the basis of the review, which entails also the evolving explanation of accuracy requirements and the reinforcing to mend the weaknesses in the global observing systems.

GCOS Status Report and new GCOS Implementation Plan

4.2.5.6 Congress was pleased to note that at the 37th session of SBSTA in November 2012, GCOS was invited to submit a report on the assessment of the adequacy of the global observing systems for climate. A Status Report will be prepared for submission to GCOS' sponsoring organizations and Parties to the UNFCCC, in 2015. It will review the overall status of each Essential Climate Variable, assess progress against the GCOS Implementation Plan and identify gaps. This report will be submitted to the 43rd session of the SBSTA, at UNFCCC`s Conference of the Parties, COP 21, to be held in December 2015, in Paris.

4.2.5.7 Congress also noted that in parallel with the Status Report, GCOS has started drafting a new Implementation Plan which requires that GCOS will consider new developments, systems and frameworks, such as the GFCS and GEOSS. It will also need to take into account the findings of the IPCC AR5, the Future Earth, the Blue Planet, and the PROVIA initiatives. The new GCOS Implementation Plan, to be published at the end of 2016, will be a milestone that will influence the agenda for climate observations on a global and regional scale. GCOS is planning to submit the Implementation Plan to the 45th session of SBSTA, at the 22nd meeting of COP, in 2016.

4.2.5.8 Congress recommended that the Status Report and Implementation Plan should be submitted for review to relevant WMO Technical Commissions and the appropriate Expert Teams, before formal submission to the UNFCCC.

GCOS supporting the Global Framework for Climate Services

4.2.5.9 Congress noted with appreciation the outcome of the GCOS Workshop on Observations Adaptation to Climate Variability and Change held from 26–28 February 2013, in cooperation with UNEP, the IOC of UNESCO and the Department of Energy and Climate Change (DECC) of the United Kingdom, at the headquarters of the German Meteorological Service (DWD) in Offenbach, Germany.

4.2.5.10 Congress again expressed its appreciation for the findings of the joint workshop of GCOS and the Global Observations for Forest Cover and Land Dynamics (GOFC-GOLD) on Observations for Climate Change Mitigation, Geneva, Switzerland, 5–7 May 2014.

4.2.5.11 Congress was further pleased to note the report on the GCOS workshop Enhancing observations to support preparedness and adaptation in a changing climate – Learning from the IPCC 5th Assessment Report, which had been held in collaboration with UNFCCC and IPCC, from 10–12 February 2015, in Bonn, Germany.

4.2.5.12 Congress commended GCOS for its successful initiatives which have been effectively supporting the GFCS in addressing the need for observation requirements for climate change adaptation and mitigation. Congress requested that GCOS should continue to identify observational needs for climate services and recommended that the GCOS Secretariat should cooperate closely with the GFCS Office to ensure that the necessary resources are made available to further strengthen the Observation and Monitoring Pillar of the GFCS.

GCOS Experts Panels for Land, Atmosphere and Oceans

4.2.5.13 Congress recognized the fundamental work accomplished by the three GCOS expert panels: Terrestrial Observation Panel for Climate (TOPC), Atmospheric Observation Panel for Climate (AOPC) and the Ocean Observations Panel for Climate (OOPC) with regard to the evolving WMO Integrated Global Observing System (WIGOS) and the global observing systems for climate supported and operated by other organizations. All three panels are co-sponsored by WCRP, and OOPC is also one of three panel (physics and climate, with sister panels for biogeochemistry and biology) within the IOC-led Global Ocean Observing System (GOOS). OOPC coordinates ocean input to GCOS in consultation with the GOOS Biogeochemistry and Biology panels. All GCOS panels have been reviewing the current list of ECVs specified for each physical domain and for cross-cutting topics. The panels will consider the draft of the Status Report prior to its release for public review, and also the outcomes of dedicated workshops, to be held in 2015 and 2016 in preparation of the new Implementation Plan.

4.2.5.14 Congress expressed its appreciation that GCOS and GOOS, through its joint panel OOPC, strongly supported the developing and improving of the sustained observing system in the Tropical Pacific: The Tropical Pacific Observing System, 2020 Project.

4.2.5.15 Congress further expressed its appreciation for the support given to the implementation of GCOS Reference Upper-Air Network (GRUAN) by the AOPC, as GRUAN is a WIGOS Implementation Project. The AOPC will continue to work on cross-calibration requirements and further discuss reference networks for surface observations.

4.2.5.16 Congress appreciated that GCOS fully stepped up to sponsor the TOPC so that this panel could continue to assess the progress in the terrestrial domain, and how the terrestrial observing systems design has developed. Congress noted with concern that a framework for terrestrial observation is still missing, caused by the absence of support for the inactive Global Terrestrial Observing System.

4.2.5.17 Congress noted the importance of enabling globally coordinated space-based observations for climate monitoring. Congress commended GCOS on its close liaison with space agencies on dedicated space-based observations for climate, in particular through the Committee on Earth Observation Satellites (CEOS), the Coordination Group for Meteorological Satellites (CGMS) and their Joint CEOS/CGMS Working Group on Climate, the WMO Space Programme and the development of the architecture for climate monitoring from space.

4.5.2.18 Congress encouraged the GCOS Secretariat to remain engaged in the next stages of development and implementation of the architecture and to continue to report back to its sponsoring organizations on how the space agencies will respond to the Status Report and Implementation Plan.

The GCOS Cooperation Mechanism – Activities in WMO Regions

4.2.5.19 Congress noted that managing the impacts of climate change have and will present major challenges for all countries, particularly for developing and least developed countries. The information needed to design effective policies for mitigating the effects of – and adapting to – climate change and facilitating sustainable development fundamentally depends on the availability of climate observations. However, such observations must be of a high quality, have a long period of operations and be incorporated in a network of sufficient density to be useful in decision-making. Meeting these challenging requirements will be difficult for many developing countries unless they

are provided with sustained assistance and own national investments. The GCOS Cooperation Mechanism directly contributes to meeting some of the repeated requests of NMHSs to provide financial and technical support to developing countries to improve their climate observing systems.

4.2.5.20 Congress noted that successful GCOS Cooperation Mechanism implementation projects include the renovation of surface observing stations, the implementation of new upper-air observing systems, replacing and installing new generation hydrogen generators, improved telecommunication infrastructure and hosting technical workshops. Since Cg-XVI, the GCOS Cooperation Mechanism continued to focus on the GCOS upper-air and surface observing networks, working to improve the overall performance of these important baseline networks through direct renovation projects, the recent activities of the WMO Commission for Basic Systems (CBS) Lead Centres for GCOS, and various training workshops.

4.2.5.21 Congress expressed serious concern at the continuing difficulty in establishing adequate sustained climate observing networks, particularly in developing countries. It was pleased, however, to note that some progress had been made in tackling implementation, planning and coordination activities throughout all domains and involving all sponsoring organizations and partners.

4.2.5.22 Congress expressed appreciation for the voluntary contributions of Germany, the UK, Switzerland, Japan and Greece (through GFCS) to the GCOS Cooperation Mechanism since Cg-XVI, which had enabled a number of deficiencies in the functioning of in-situ meteorological networks to be addressed. In spite of these improvements though, it is increasingly evident that technical issues, failures in key hardware and re-supply of consumables are resulting in significant downtimes for many of the GCOS Surface network (GSN) and GCOS Upper-Air Network (GUAN) stations. Thus Congress stressed the urgent need for ongoing Member investments and additional support to improve the availability and quality of data across the GSN, GUAN, and other networks.

4.2.5.23 Congress noted the continued work to improve climate observing networks in developing regions and Small Island Developing States, primarily through the work of the GCOS Implementation Manager. Congress recognized and appreciated the significant number of cooperation mechanism projects that have benefited these priority regions, and the direct engagement of GCOS at a national and regional level, which not only publicized the performance, and associated challenges, of the observing networks, but also offered support and advice for those Members that requested it.

4.2.5.24 Congress adopted Resolution 39 (Cg-17) – Global Climate Observing System.

4.2.6 WMO polar and high mountain activities (agenda item 4.2.6)

4.2.6.1 Congress noted the significant increase in economic activities such as tourism, shipping, energy development, fishing and mining in the Polar Regions. These activities are highly sensitive to weather and climate conditions. Congress also noted that global weather and climate patterns are influenced by polar processes resulting in, for example, perturbations in the polar jet stream that influence storm tracks and intensity in lower latitudes. Congress noted with appreciation the great effort of all Members who undertake research and operational activities in the Polar and High Mountain Regions and recognized that Polar Regions are extremely important in terms of their global impacts on weather, climate and water. It appreciated the efforts of the Executive Council (EC) and its Panel of Experts on Polar Observations, Research and Services (EC-PORS) to integrate operational and research networks in Polar and High Mountain Regions and to improve predictive capability in these Regions through engagements with WMO Members, technical commissions, regional associations and relevant research and international organizations.

4.2.6.2 Congress recognized the cross-cutting nature of polar activities and the importance of cryosphere data and products that support the development and delivery of climate, weather and water services by Members, including the priority Global Framework for Climate Services (GFCS) areas of food security, water, health, and disaster risk reduction.

4.2.6.3 Congress recognized the importance of integrating the operational and research observing networks in Polar and High Mountain Regions within the framework of the WMO Global Integrated Observing System (WIGOS) and the WMO Information System (WIS), and that cryosphere-related variables are also included. It acknowledged that the Global Cryosphere Watch is a major contribution to this objective.

4.2.6.4 Recognizing that requirements for observations in Polar and High Mountain Regions cannot be fully met through surface-based observing sites, Congress appreciated the work accomplished by the Polar Space Task Group (PSTG) and its subsidiary group the Synthetic Aperture Radar (SAR) Coordination Working Group (SAR-CWG) in coordinating, across research and operational agencies, the planning, processing and archiving of Earth observation datasets to support the continuation of these efforts. The requirements of a polar space programme are canvassed from a wide stakeholder group, including the science community and end users (including hydrology). Congress requested EC, through its EC-PORS, to reflect on how to align PSTG strategies with GCW and the Global Integrated Polar Prediction System (GIPPS).

4.2.6.5 Congress noted with appreciation the accomplishments made in several Polar and High Mountain activities namely: (i) the maintenance of the Antarctic Observing Network (AntON); (ii) the implementation of GCW, (iii) the development of GIPPS; and (iv) the implementation of the International Polar Partnership Initiative (IPPI).

4.2.6.6 Congress recognized the importance of observations, research and services components in the high Asian (Tibetan Plateau) cryosphere environment. It noted that 45% of the world's population dwells in or near this region and depends on the water supply of the eight large rivers originating there. Congress requested EC to coordinate High Mountain Activities in this region with the relevant international science programmes, such as the Third Pole Environment (TPE) and consider supporting studies of the 'water-ice-air-ecosystem-human' interaction through the collection and provision of data from the GCW observing network. With respect to the high Asian cryosphere, there is a need to fully document the observing network in this vast region and GCW should support this activity. Congress also requested EC to coordinate high mountain activities in the Tropical regions.

4.2.6.7 Congress acknowledged the strengthened cooperation of EC with international organizations and bodies active in Polar Regions. It requested EC to continue interacting with the Arctic Council and the Antarctic Treaty Consultative Meeting (ATCM) to ensure objectives are aligned and for mutual recognition. Specific tasks have been identified with the Council of Managers of National Antarctic Programs (COMNAP), the International Association of Antarctic Tour Operators (IAATO) and the International Ice Charting Working Group (IICWG). Congress acknowledged a number of positive relationships that have developed over the last four years with, inter alia, the Scientific Committee on Antarctic Research (SCAR), the International Arctic Science Committee (IASC), the International Association of Cryospheric Sciences (IACS), the Forum of Arctic Research Operators (FARO), the International Centre for Integrated Mountain Development (ICIMOD) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. These collaborations are seen as essential for strengthening WMO's technical and scientific capabilities in Polar and High Mountain Regions. Members are urged to support these collaborative efforts whenever and wherever possible.

4.2.6.8 Congress also recognized the importance of joint research between developed and developing countries, especially for Members in the tropics, to have the opportunity to study polar condition and its interaction with tropical regions.

4.2.6.9 Congress agreed that the delivery of effective services is an important driver that anchors the work of WMO Polar and High Mountain Activities. It appreciated that EC has completed an initial inventory of existing weather, climate, water and cryosphere services that are currently provided in the Polar Regions and agreed that further consultations to validate user requirements should be conducted, such as the survey provided to COMNAP and IICWG. Congress noted with appreciation the progress made on behalf of EC by the EC-PORS Task Team on Services in developing a Services White Paper and mapping service requirements for target

regions (Arctic, Antarctic, Third Pole). In addition, it agreed that the WMO Strategy for Service Delivery should become a guiding document when developing the scope of non-operational climate services of any Polar Regional Climate Centres and Polar Regional Climate Outlook Forums.

4.2.6.10 Congress emphasized the importance of Regional Climate Centres (RCCs) and Regional Climate Outlook Forums (RCOFs) and acknowledged the effort made by EC-PORS to develop a collaborative mechanism for creating sustained, practical, and operational products and services in Polar Regions. It requested EC-PORS, in cooperation with CBS, to support CCl in developing Polar Regional Climate Centres (PRCCs) and Polar Regional Climate Outlook Forums (PRCOFs).

4.2.6.11 Congress, noting that Polar and High Mountain Regions are recognized as one of the seven key priorities of WMO, requested EC to improve operational meteorological and hydrological monitoring and prediction services in these Regions and beyond by: (i) operationalizing the Global Cryosphere Watch (GCW); (ii) better understanding the implications of changes in these regions on global weather and climate patterns; and (iii) advancing Polar weather and climate predictions under the Global Integrated Polar Prediction System (GIPPS). Congress noted that EC-PORS activities to date have been funded predominantly from the PORS Trust Fund and it encouraged Members to continue providing support to WMO's Polar and High Mountain Activities through this Trust Fund. Congress adopted Resolution 40 (Cg-17) – WMO polar and high-mountain activities.

4.2.6.12 Congress acknowledged that, on behalf of EC, oversight for WMO Antarctic responsibilities is provided by EC-PORS and its Antarctic Task Team (ATT). Congress acknowledged the contribution of the British Antarctic Survey (BAS) as a dedicated monitoring centre for the WMO Antarctic Observing Network (AntON) as the CBS Lead Centre for GCOS. Congress also extended its appreciation to other organizations, such as the U.S. National Science Foundation, which currently funds the University of Wisconsin (USA) to maintain and operate over half of these stations.

4.2.6.13 Congress recognized the effort of the ATT in maintaining the list of AntON stations, working with other organizations to increase data availability, encouraging Member States to deposit their metadata and contributing to WMO regulatory material within WIGOS. These efforts are essential for keeping the observing system operating in this harsh environment. Congress appreciated that all Antarctic networks that were integrated into AntON comprise operational and/or research stations, all of which should produce climate messages, and adopted Resolution 41 (Cg-17) – Antarctic Observing Network.

4.2.6.14 Congress requested EC to continue its regulatory responsibilities with respect to Antarctica and focus on how best to ensure AntON is well situated in WIGOS and WIS given the unique requirements of this region. Congress also reaffirmed the importance of building synergy with the Antarctic Treaty Consultative Meeting mechanisms and that further developments, such as encouraging ships to join the VOS scheme are critical to success.

4.2.6.15 Congress noted that EC-PORS reviewed the practices for Antarctic observing included in the *Manual on the Global Observing System* (WMO-No. 544) and adopted Resolution 42 (Cg-17) – Amendments to the *Manual on the Global Observing System* (WMO-No. 544), Volume II, Regional Aspects – The Antarctic.

Global Cryosphere Watch

4.2.6.16 Congress noted that in the light of Resolution 60 (Cg-XVI) – Global Cryosphere Watch (GCW), the Executive Council (EC) requested the EC Panel of Experts on Polar Observations, Research and Services (EC-PORS) to steer and monitor these activities. EC-PORS provided general direction in developing GCW and established the GCW Steering Group to provide detailed guidance and direction on GCW implementation, its further development, and oversight and management of the newly established GCW working structure.

4.2.6.17 Congress acknowledged the accomplishments made in the development of GCW and noted that following the request of Cg-XVI, the Global Cryosphere Watch Implementation Plan (GCW-IP) has been developed. Congress requested EC to implement GCW according to this Plan and to continue steering and monitoring the GCW implementation. Congress adopted Resolution 43 (Cg-17) – Global Cryosphere Watch.

4.2.6.18 Congress, referring to the WMO Strategic Plan 2016–2019, noted that Polar and High Mountain Regions activities, including the operationalizing of GCW, is one of the seven WMO Priorities. Congress requested EC, in consultation with all WMO and co-sponsored programmes, to mainstream GCW into the WMO Programme structure. It also requested the Secretary-General to establish a GCW Project Office to support all GCW activities, including coordination with partners, monitoring of its implementation, reporting and follow-up actions and to provide support for the Office through a combination of regular and matching extrabudgetary resources.

4.2.6.19 Congress agreed that an immediate priority for GCW is to establish the core standardized network of GCW surface-based measurement sites referred to as “CryoNet”, which is one of the four WIGOS component observing systems. It appreciated that, through extensive collaboration with partners, more than 100 sites have been proposed for CryoNet of which 36 will be used for the pre-operational testing phase (see Annex VII to the present report). Noting the importance of CryoNet for WIGOS and other WMO and co-sponsored Programmes, Congress requested EC-PORS and the GCW Steering Group to continue evaluating these and any new sites, in particular in the marine environment in cooperation with JCOMM, and to submit the list of CryoNet sites for approval by EC in 2016. Noting the importance of thorough cryosphere research over the globe, Congress welcomed the initiative taken by Indonesia to propose Papua New Guinea as the candidate site for CryoNet.

4.2.6.20 Congress noted that the GCW high-level practices were included in the WIGOS section of the WMO *Technical Regulations* and Manual on WIGOS. It requested CBS to collaborate with the GCW Steering Group and its Working Groups in developing best observing practices for CryoNet and GCW contributing sites and include them in the further updates of the Manual on WIGOS.

4.2.6.21 Congress noted with appreciation the efforts of the Norwegian Meteorological Institute in developing a WIS compliant GCW Data Portal to allow for easy access to cryospheric data and information. With this in mind, Congress agreed with plans for the GCW Data Portal to become a WIS DCPC. It stressed the need for GCW to accommodate historical data and make sure that such data could be accessible through the GCW Data Portal.

4.2.6.22 Congress noted with appreciation that the GCW website has been developed and implemented by the United States of America with a view of providing a centralized point of access to all information on GCW development and implementation. It recognized that a number of initial products, such as “snow anomaly trackers” for snow equivalent, are already available on the GCW website and requested EC to further expand the scope of GCW products and to provide guidance for the future “authoritative” products.

4.2.6.23 Congress noted that GCW is truly cross-cutting through weather, climate and water and that it is a total system from observations to services. It requested EC to ensure the active participation and representation of the principal bodies concerned and also the participation, as appropriate, of technical experts and representatives of agencies undertaking observing and research initiatives relevant to the cryosphere. In addition to NMHSs themselves, the majority of current stakeholders come from the research community, therefore it is important to recognize that GCW will facilitate the transition from research to operations when and where feasible. It agreed that for the implementation of GCW, a close partnership between research institutions and operational agencies is imperative.

4.2.6.24 Congress stressed that GCW should support prediction projects, such as the Global Integrated Polar Prediction System (GIPPS) which includes the WWRP Polar Prediction Project

(PPP) and the WCRP Polar Climate Predictability Initiative (PCPI), through collaboration on data needs and applications. This interaction is reflected in both the GCW-IP and on the GCW website.

4.2.6.25 Congress recognized the need for communicating the importance of GCW to Members, noting that cryosphere activities often extend beyond NMHSs to other national agencies and institutions. Communication with the Permanent Representatives (PRs) of Member countries with WMO needs to draw their attention to the importance of GCW activities to, for example, water resources, climate services and the modelling communities.

4.2.6.26 Congress agreed that cryosphere data and products support the development and delivery of climate, weather and water services by Members, including in the Global Framework for Climate Services (GFCS) priority areas of food security, water, health, and disaster risk reduction. In this regard, GCW should provide information for decision-making and policy development related to climate, water and weather, for use in real-time, for climate change adaptation and mitigation, and for risk management. In this way, GCW will provide foundational support to the GFCS, as well as other WMO and international programmes.

4.2.6.27 Congress requested EC to ensure that GCW is supported by effective capacity development activities to respond to the needs at national and regional levels. For developing and the least developed countries this should ensure access to, and effective utilization of, observations, data and products, related technologies and new knowledge.

The Global Cryosphere Watch Implementation Plan

4.2.6.28 Congress noted that in the light of Resolution 60 (Cg-XVI) – Global Cryosphere Watch, the Executive Council's Panel of Experts on Polar Observations, Research and Services (EC-PORS) and the GCW Steering Group developed the Global Cryosphere Watch Implementation Plan (GCW-IP) (see Annex VIII to the present report). It agreed that the GCW-IP should be the guiding document for the implementation of the GCW.

4.2.6.29 Congress underlined the importance of close linkages between GCW-IP with the implementation plans of other major activities/programmes, especially with those of WIGOS, WIS, GCOS and GFCS. In adopting the GCW Implementation Plan, Congress requested the Executive Council to keep the Plan under regular review and to update and monitor the progress in the implementation of the Plan and to report to the eighteenth World Meteorological Congress on progress achieved.

4.3 Research (agenda item 4.3)

An integrated WMO research approach in support of future seamless services

4.3.1 Congress noted that the WMO research activities are represented by:

(a) The World Climate Research Programme (WCRP) which under the joint sponsorship of the International Council for Science (ICSU) and the World Meteorological Organization (WMO), and, since 1993, also by the Intergovernmental Oceanographic Commission (IOC of UNESCO), facilitates analysis and prediction of Earth System variability and change on climate timescales for use in an increasing range of practical applications of direct relevance, benefit and value to society;

(b) The World Weather Research Programme (WWRP), a WMO Programme aimed at advancing society's ability to cope with high impact weather through research focused on improving the accuracy, lead time and utilization of weather prediction and the methods to integrate observations into assimilation systems; and

(c) The Global Atmosphere Watch (GAW) Programme of WMO which is a partnership involving WMO Members, contributing networks and collaborating organizations and bodies which provides reliable scientific data and information on the chemical

composition of the atmosphere, its natural and anthropogenic change, and helps to improve the understanding of interactions between the atmosphere, the oceans and the biosphere.

4.3.2 Congress acknowledged that humanity will, in the 21st Century, face new challenges as it adapts to rapid change, both in the physical environment and related to socioeconomic dynamics. Congress noted that, since its sixteenth session in 2011, WCRP in October 2011, and WWRP in August 2014, held successful open science conferences. The WCRP Open Science Conference and the World Weather Open Science Conference have established that significant scientific progress has been made in weather and climate science in recent decades. Furthermore, these conferences provided a clear pathway for the future work of WCRP and WWRP, aligned to the needs of society. The GAW Programme celebrated its 25th year anniversary in 2014, highlighting the considerable progress made in establishing a global high-quality observing network on atmospheric composition and showcasing GAW contribution towards advancing environmental knowledge, and supporting conventions and policy through science.

4.3.3 Congress agreed that a growing and progressively urbanizing global population will be constrained by limited resources and will face the consequences of climate change and variability as manifested through high-impact weather and environmental events. The growing vulnerability of urban populations holds a considerable threat to safety and wellbeing.

4.3.4 Congress agreed that new and improved science, applications and services tailored to the requirements of users and provided in a seamless fashion will be required towards sustainable societies (seamless services/seamless approach forges weather and related environmental forecasting and climate change studies into a single framework, contiguous across time and spatial scales and transparent to the end user). Such services will greatly benefit from an integrated approach to the underlying science (across disciplines) and delivery systems (catering for all spatial and temporal scales) and this approach will require new partnerships between Members, and between the National Meteorological and Hydrological Services (NMHSs), academic and other institutions and the private sector. In this regard Congress requested the Commission for Atmospheric Sciences (CAS), the WCRP Joint Scientific Committee and the Commission for Basic Systems (CBS) to establish a mechanism that will ensure that research results are translated to operations in a timely manner. Congress welcomed the EU Copernicus programme for operational user services in the fields of atmospheric composition and climate change, as a new step towards user-oriented services. Congress requested CBS and CAS to review together their structure to identify synergies and remove redundancies, thereby ensuring that integrated operational and research activities are realized inside CBS and CAS respectively.

4.3.5 Congress acknowledged that the complexity of weather, air quality and climate modelling and prediction systems naturally concentrate the expertise required to maintain and improve such systems in a circumscribed number of forecast production centres globally. In this respect WMO has an important role to play to ensure that Members are prepared to deal with this emerging reality in a manner where all Members contribute to and benefit from the forecasts and predictions generated at production centres. The experience gained through THe Observing system Research and Predictability EXperiment (THORPEX), which was concluded after 10 years in 2014, and its Global Interactive Forecast System (GIFS), THORPEX Interactive Grand Global Ensemble (TIGGE) hold important lessons. Similarly, the Severe Weather Forecast Demonstration Project (SWFDP) provides examples of the type of cascading partnerships that could be further refined to ensure equitable contributions, participation and capacity development.

4.3.6 Congress noted the establishment of the WCRP Grand Challenges focusing on regional climate information; sea-level rise and regional impacts; cryosphere in a changing climate; changes in water availability; clouds, circulation and climate sensitivity, and science underpinning the prediction and attribution of extreme events. These themes represent major areas of scientific research, modelling, analysis and observations for WCRP and its affiliate projects in the ensuing decade.

4.3.7 Congress also noted that the Commission for Atmospheric Sciences had, at its sixteenth session in November 2013, identified six focus research areas in the coming decade. These are high-impact weather and its socioeconomic effects in the context of global change; water: modelling and predicting the water cycle for improved disaster risk reduction and resource management; an Integrated Greenhouse Gas Information System: serving society and supporting policy; aerosols: impacts on air quality, weather and climate; urbanization: research and services for megacities and large urban complexes, and evolving technologies: their impact on science and their use.

4.3.8 Congress agreed that improved understanding and enhanced predictive skill related to the Earth System provides new opportunities to Members and that the weather, climate and atmospheric composition research communities have a growing number of research topics that can best be addressed in a collaborative fashion. Congress thus encouraged close collaboration between GAW, WCRP and WWRP in order to build on the synergies between the activities that have commonalities. Congress recommended also for the WMO research programmes to increase collaboration with projects addressing biosphere processes, for example with the new Interdisciplinary Biomass Burning Initiative (IBBI) of the International Global Atmospheric Chemistry (IGAC) initiative and the Integrated Land Ecosystem Atmosphere Process Study (iLEAPS).

4.3.9 Congress noted that three new research initiatives on subseasonal to seasonal prediction (jointly between WWRP and WCRP), polar prediction and predictability (strong links and cooperation between WWRP and WCRP) and high-impact weather (WWRP but with relevance to WCRP and GAW) has been established since Cg-XVI. Congress encouraged WCRP, WWRP and GAW to actively seek areas of cooperation to realize a seamless science approach in support of the emerging weather, climate, water and related environmental issues. Congress urged Members to actively support and to engage in the WMO research activities as a collective investment in preparing for the knowledge and service requirements of society in the 21st Century.

World Climate Research Programme

4.3.10 Congress noted with satisfaction the achievements of the World Climate Research Programme (WCRP) since Sixteenth Congress. Particular advances under the Programme's two objectives, improving climate prediction and enhancing understanding of human interactions with climate, included conducting a well-attended Open Science Conference in 2011, developing six climate science Grand Challenges through a wide community consultation process, successful completion of the Climate Model Intercomparison Project (CMIP5), substantial progress on regional climate research and information, and contributions to the research, modelling and prediction component of the GFCS.

4.3.11 Congress was pleased to note the success of the WCRP Open Science Conference in October 2011 on the theme 'Climate Science in Service to Society' and the emergence from that conference of increasing WCRP focus on "actionable" science, subsequently embodied in WCRP Grand Challenges, and of enhanced attention to training and developing the next generations of climate scientists and decision-makers through deliberate integration of recruitment and capacity-building into all WCRP-sponsored activities. Congress particularly noted WCRP's leadership and support for enhanced synergy between WCRP global initiatives and regional activities and capacities as an outcome of the WCRP Conference for Latin America and the Caribbean: Developing, Linking and Applying Climate Knowledge (March 2014, Montevideo, Uruguay) and through continuing partnership with the Africa-led initiative Climate Research for Development (CR4D) following a successful Africa Climate Conference (October 2013, Arusha, United Republic of Tanzania). Congress also acknowledged the successful Climate Symposium (October 2014, Darmstadt, Germany) organized in close cooperation with EUMETSAT and other partners to define requirements and further the development of an efficient and sustained international space-based Earth observing system.

4.3.12 Congress noted the successful international collaborations and very strong positive impact of CMIP5 products and processes, which developed new but now widely-used

representative concentration pathways as input to Atmosphere-Ocean Global Circulation Model (AOGCM) as well as Earth System Model (ESM) experiments. Congress noted that CMIP5 outcomes provided the fundamental modelling basis for the entire IPCC 5th Assessment Report (AR5), permeated many chapters of the Working Group I report and continue to enable a very wide range of climate research and analysis. Congress welcomed WCRP's broad-ranging planning efforts for a CMIP6 process composed of a research-driven set of climate diagnosis, evaluation and characterization experiments accompanied by standardization, coordination, infrastructure, and documentation functions to allow all simulations and their main characteristics performed under CMIP to be made available to a broader community. Congress emphasized the positive aspects of the proposed CMIP/CMIP6 structure to allow anyone at any time to download model data for analysis, with user friendliness, and welcomed the excellent record of international collaboration and participation as CMIP6 proceeds.

4.3.13 Congress noted the emergence of high-impact and widely used products from WCRP's Coordinated Regional Climate Downscaling Experiment (CORDEX) project and the growing availability of the CORDEX climate products for research, analysis, validation, and inter-comparison of regional climate data over many of the world's land areas. Congress welcomed the initiative and support of the Swedish Meteorological and Hydrological Institute to establish a new International Project Office for CORDEX and looked forward to substantial progress and advancement of CORDEX specifically and regional climate modelling generally.

4.3.14 Congress took particular note of progress on WCRP's six Grand Challenges as a mechanism to certify and focus WCRP's attention on urgent and actionable issues. The six challenges – Water Availability; Regional Sea Level Rise; Changes in Cryosphere; Clouds, Circulation and Climate Sensitivity; Climate Extremes and Regional Climate Information – move through stages of visioning, definition and implementation, with several already submitting large-scale multinational proposals to external funding sources. Congress appreciated the role of the Grand Challenges within WCRP to help identify areas for significant progress and especially to recognize and prioritize cross-cutting limitations – in fundamental modelling skill, for example. Congress noted that all the challenges fit a paradigm of global processes with regional and local impact and recognized additional positive impact as the WCRP Grand Challenges propagate into the organizing structures of climate conferences and workshops and into the planning processes of funding agencies.

4.3.15 Congress appreciated recent scientific outcomes from and accomplishments of the WCRP Projects, including notable efforts at recruitment and capacity-building for their respective areas or science, and drew attention to the ongoing need to ensure adequate funding for effective conduct of their activities. The WCRP Projects stimulate and coordinate timely and essential activities in the four essential compartments – land, ocean, ice, atmosphere – of the Earth's climate system. Congress appreciated the variety of exchanges, partnerships, and co-sponsorships through which the WCRP Projects maintain close and vital mutual interactions and recognized the growing need for shared activities such as the joint CLIVAR/GEWEX science and steering group meetings in 2014. Congress recognized the emergence of a plan for a planetary 'diagnosis', building on and extending existing widely-used meteorological data reanalyses, as an integrating factor across WCRP Projects and activities with potential to stimulate very wide improvements in climate data access and exchange. Congress expressed sincere appreciation to present – Norway for CliC, USA for GEWEX, Switzerland for SPARC – and new – China and India for CLIVAR – national contributions for welcome and essential support to the WCRP International Project Offices.

4.3.16 Congress expressed appreciation that WCRP maintains effective partnerships with WMO co-sponsored programmes and technical commissions including the Global Climate Observing System (GCOS) through shared membership on the GCOS science panels for ocean, atmosphere and land (OOPC, AOPC and TOPC, respectively) and through mutual interest in the development and definition of climate observing networks and essential climate variables, the Commission for Climatology through the CLIVAR/CCl/JCOMM/GEWEX Expert Team on Climate Change Detection and Indices (ETCCDI), and the World Weather Research Programme (WWRP) specifically and the Atmospheric Research and Environment Branch (ARE) generally, through

mutually planned, implemented and sponsored research on sub-seasonal to seasonal prediction, high-impact weather and polar prediction. Congress particularly welcomed WCRP and WWRP mutual development of scientific and modelling focus on coastal megacities. Congress noted with satisfaction that WCRP represents 'resources close at hand' with respect to GFCS and WCRP's willingness to cooperate on and contribute to mutually developed tasks toward the common goal of reliable climate information. Congress requested the Secretary-General to ensure that support for climate research is maintained to that effect.

4.3.17 Congress acknowledged with appreciation WCRP's effort in leading the development of the Research, Modelling, and Prediction Annex to the GFCS Implementation Plan, which was endorsed by the first session of IBCS in July 2013. WCRP is committed to conduct effective research in areas of mutual priority with the GFCS and to continue making the wealth of climate research information widely available. In this regard, Congress welcomed WCRP cooperation with WMO constituencies involved in the development of the GFCS, with special mention to the joint WCRP-CCl deliberation on their joint efforts on research and operational support to climate services which emerged from the WMO Technical Conference on Climate Services held in Heidelberg, Germany, July 2014.

4.3.18 Congress noted with appreciation WCRP's continued, positive and effective relationships with its co-sponsoring organizations, the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the International Council for Science (ICSU). Congress appreciated the positive impacts of a formal declaration of partnership between WCRP and the emerging programme Future Earth sponsored by the Science and Technology Alliance for Global Sustainability.

4.3.19 Congress welcomed continued oversight of WCRP by the Joint Science Committee nominated and supported by WMO, ICSU and IOC, including guidance of the development and implementation of the WCRP Grand Challenges and effective promotion of geographic and gender diversity in the steering committees and organizing groups of WCRP Projects, Working Groups and Grand Challenges. Congress noticed with appreciation the recent Lessons Learnt Workshop with respect to the recently published IPCC Fifth Assessment Report (AR5) conducted by the JSC working closely with Working Group I of the Intergovernmental Panel on Climate Change (IPCC), which recorded the good match between goals of the WCRP Grand Challenges and AR5 uncertainties. Congress encouraged the JSC to develop and guide plans to promote progress and collaboration on actions identified by the Workshop as needed, for additional progress within the WCRP Grand Challenges including attention to ocean heat and carbon uptake, the need for greater emphasis on understanding natural variability and forced change on annual to decadal timescales, the need for better descriptions and incorporation of aerosols into climate scenarios and predictions, and the growing need to incorporate interactive components of the carbon cycle, including terrestrial and oceanic geochemical and ecological sources and sinks, into analyses and models.

4.3.20 Congress noted with appreciation the collaboration between WCRP and the WMO Commission for Climatology, and particularly the outcomes of the joint CCl-WCRP session held in Heidelberg in 2014 in which the programmes affirmed the need for joint efforts to comprehensively address rapidly emerging societal needs for climate services for adaptation and risk management.

4.3.21 Congress noted with interest the WCRP Polar Challenge initiative (http://www.wcrp-climate.org/polarchallenge) to stimulate technological innovation towards a new paradigm for long-term under-ice observations and a cost-effective, autonomous and scalable ocean monitoring network for the Polar Regions. Congress welcomed the development of the WCRP's Polar Climate Predictability Initiative and WCRP's intention to collaborate closely with relevant WMO polar programmes and efforts including the Polar Prediction Project and especially the Year of Polar Prediction, covering a number of issues of high relevance for global prediction, such as the variability of polar vortex.

4.3.22 Congress noted the updated description of the WCRP functions and structure as contained in Annex IX to the present report. Congress recalled Resolution 15 (Cg-17) to

reconstitute the World Climate Programme (WCP) taking into account WCRP and other climate observations/services components of WMO, and agreed that WCRP should play the central role for climate research in WCP. It agreed that WMO should continue its strong support for and guidance to the WCRP, and urged all Members to actively participate in the research initiatives of WCRP and other partner programmes. Congress also invited ICSU and IOC to take note of and to endorse Resolution 15 (Cg-17), and to consider enhanced support to the WCRP implementation.

4.3.23 Congress took note that WCRP research initiatives of a cross-cutting nature with WWRP and GAW are reflected in more detail under WCRP, WWRP and GAW Joint Research Activities below.

The World Weather Research Programme

4.3.24 Congress noted the development of the World Weather Research Programme (WWRP) implementation plan for the period 2016–2023 (https://www.wmo.int/wwrp). It further recommended that in the development of the WWRP implementation plan, the WMO priorities approved by Congress are taken into consideration. Congress noted with appreciation the emphasis within the programme on research activities in order to deliver, evaluate and apply new generation models and tools for environmental prediction, and to provide a common modelling framework between weather, climate and air-quality communities.

4.3.25 Congress acknowledged the significant role that THe Observing system Research and Predictability EXperiment (THORPEX) played to increase the understanding of the high-impact weather predictability and to foster the improvement of weather prediction models, data-assimilation methods and ensemble techniques in the 10 years until its conclusion at the end of 2014. Congress expressed its satisfaction for the contribution by THORPEX to increase the preparedness of least developed and developing countries to high-impact weather events and extended its appreciation to all Members that have actively participated and contributed resources to the experiment.

4.3.26 Congress noted the development of three major projects based on the THORPEX experience: ‘polar prediction project’ (PPP), ‘subseasonal to seasonal’ project (S2S) and ‘high-impact weather’ project (HIWeather), aligned to the needs of Members as reflected through the WMO strategic priorities and supported through voluntary contributions. Congress urged Members to actively engage and support these projects.

4.3.27 Congress expressed its satisfaction for the organization of the World Weather Open Science Conference (WWOSC) in Montreal, Canada, from 16 to 21 August 2014. It noted that the overarching theme of the conference was “Seamless Prediction of the Earth System: from minutes to months”. Congress highlighted the role of the conference in reviewing recent advances in weather science and in the science and practice of weather prediction. Congress appreciated the development of a publication summarizing the conference outcomes, which will be an important guidance document for Members and for the further development of the WWRP scientific and implementation plans. Congress recognized the effort to involve early-career scientists in WWOSC and their role in providing input to the publication. Congress requested the Secretary-General to promote the dissemination of WWOSC outcomes among Members and relevant international organizations. Congress further suggested that WWRP should investigate the feasibility of follow-up open science conferences with an appropriate regularity and to consult with WCRP and GAW in this regard.

4.3.28 Congress noted the emerging role of the seamless prediction approach to better predict and to be prepared for high-impact weather events. In this context WWOSC established that an Earth System approach for environmental prediction, should encompass the atmosphere and its chemical composition, the oceans, sea-ice, and other cryosphere components, the land-surface, including surface hydrology, wetlands, and lakes. Congress recognized the importance to go towards kilometre-scale prediction in order to improve the forecast of short time-scale phenomena and cross-scale interaction to provide better products at local scale (urban environments, coastal

regions, etc.). Congress requested WWRP, WCRP and GAW to continuously collaborate towards the development of a seamless approach.

4.3.29 Congress noted the establishment of HIWeather and its trust fund. Congress recognized that HIWeather plays a key role to integrate multiple factors over multiple timescales. Congress was reminded that these factors cover multiple hazards including floods, landslides, bushfires and air pollution episodes. Congress noted the need to apply new knowledge and developments in information content, language, format, public awareness and dissemination to increase public confidence. Congress highlighted the role of HIWeather to foster research activities on the impacts of extreme events on urban areas, and to provide a strong link with user-defined applications. Congress noted that HIWeather research activities could determine critical thresholds and tipping points beyond which society will experience severe impacts. Congress highlighted the relevance of this project in order to establish multi-hazard early warning systems and stress-test tools to benchmark adaptation options. Congress appreciated the contributions of Germany and the United Kingdom of Great Britain and Northern Ireland to the Trust Fund and encouraged other Members to also contribute to the trust fund in support of the successful implementation of the project.

4.3.30 Congress noted that several panel discussions during WWOSC have focused on the role of the private sector as an important player in providing weather-related information. It was also informed of several voluntary observations initiatives, which provide an opportunity to increase the monitoring and observation of the Earth System state. Congress recognized that although all these initiatives increase the availability of weather products and services for the citizens, there is a fundamental need to ensure their accuracy, continuity and trustworthiness, and to clarify issues related to authority. Congress further recognized that the potential benefits offered by voluntary observations depend on them being exchanged together with the necessary information to enable use. Congress suggested that WMO should act at the forefront of this issue, promoting the development of a worldwide framework to ensure that products and services are safe, reliable and of good quality and recognized the need to exchange third party observations according to the WMO Integrated Global Observing System (WIGOS) principles on Observing System Network Design.

4.3.31 Congress recognized the significant role of Research and Development Projects (RDPs) and Forecast Demonstration Projects (FDPs) to transfer research outcomes into operational applications and to provide Members a bottom-up opportunity to benefit from the expertise within WWRP. Congress expressed its satisfaction for the collaboration between the Commission for Atmospheric Sciences (CAS) and the Commission for Basic Systems (CBS) to promote the Earth-System modelling approach towards environmental prediction throughout RDPs and FDPs. Congress requested CAS and CBS to:

(a) Encourage the planning of demonstration projects by Members in two linked phases, where appropriate, a research improvement phase, and a pre-operational pilot-test phase;

(b) Integrate impact models into the RDP/FDP planning and implementation, as appropriate, and to collect possible impact related observations; and

(c) Promote model and observational data availability to the scientific community in order to ensure the optimal benefit from scientific and operational advancements;

and it also encouraged Members engaged in RDPs/FDPs to establish project archives with appropriate websites to collect and disseminate RDP/FDP observational and modelling data and pre-operational products/tools.

4.3.32 Congress noted the establishment of two new working groups under WWRP based on the experience of THORPEX. The Predictability, Dynamics and Ensemble Forecasting (PDEF), and the Data Assimilation and Observing Systems (DAOS) working groups will foster international research in fundamental areas to foster model development and utilization. Congress

acknowledged the development of the terms of reference for these working groups and requested CAS to ensure that these working groups will join the other WWRP working groups in supporting the three major WWRP projects (S2S, PPP and HIWeather) as well as RDPs/FDPs as appropriate.

4.3.33 Congress noted the CAS-16 decision to merge the Nowcasting Research and Mesoscale Weather Forecasting Research working groups and the adjusted terms of references for this new working group. The motivation for the merger is related to the emerging requirements for higher skill levels in 1–6 hour predictions and warnings utilizing the fast development in kilometre-scale NWP. Congress recognized the role of the new working group on Nowcasting and Mesoscale Weather Forecasting Research in supporting several RDPs and FDPs.

4.3.34 Congress noted the role of the Working Group on Tropical Meteorology Research (WGTMR) in improving the understanding of high-impact tropical weather events, such as tropical cyclones, and in the bridging of knowledge between researchers and forecasters. Congress requested CBS and CAS to prioritize the recommendations made by the WGTMR, on warning and advisory communication, and on improving the prediction of tropical cyclones through coupled modelling with a special focus on sub-seasonal to seasonal time-scale. Congress recommended Members to incorporate these improvements into operations at the six Tropical Cyclone Regional Specialized Meteorological Centres (RSMCs) and the six Tropical Cyclone Warning Centres (TCWCs) when ready. Congress also noted that the project “Experiment on Typhoon Intensity Change in the Coastal area (EXOTICA)” was being taken forward by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) / WMO Typhoon Committee with a view to improving the operational analysis and forecasting techniques of tropical cyclone (TC) intensity, understanding of the mechanisms of TC intensity and structural changes, and identifying key scientific issues of TC related disaster prevention and mitigation, and further coordination with the WGTMR would be expected.

4.3.35 Congress noted the recommendation from the Eighth International Workshop on Tropical Cyclones (IWTC-VIII) that consideration be given by WMO for new topics for future workshops. Such topics could include societal impacts for the advancement of the Total Warning System concept and for the sharing of relevant experiences. In addition, in view of the continuing need, previous topics such as Satellite Analysis of Tropical Cyclones, Extratropical Transition of Tropical Cyclones, should also be taken into account. Congress requested the Executive Council and the Secretary-General to support future workshops along these lines.

4.3.36 Congress noted the efforts made by some Members in the research and operational practice of weather modification, and that some Members have formulated their future weather modification development plans, aiming to reduce the risks of high-impact weather and to enable meteorological services to better support socio-economic development, safeguard people’s livelihood and serve major social events. Congress further suggested that measurements gathered during weather modification experiments be shared and published.

4.3.37 Congress recognized the activities of the CAS Expert Team on Weather Modification promoting the scientific activities in weather modification research and providing guidelines for the conduct of weather modification experiments. Congress requested that the status and guidance documents on weather modification be kept under review and updated as necessary and once revised by CAS, be submitted to EC for further considerations and eventual approval. Congress encouraged Members and stakeholders to contribute to the Weather Modification trust fund to maintain the above activities of the Expert Team.

4.3.38 Congress noted the role of the Working Group on Societal and Economic Research and Applications (SERA) in fostering social and interdisciplinary science and its relation to the weather enterprise more broadly. Congress recognized the SERA activities in order to strengthen the social components of the three strategic projects (PPP, S2S and HIWeather). Congress welcomed the initiative for SERA to move beyond providing a liaison or “advisory” service to WWRP activities towards the development of specific research studies within the context of the three major WWRP research projects.

4.3.39 Congress recognized the role of the Joint Working Group on Forecast Verification Research in developing and promoting verification methods. Congress noted that the future challenges related to environmental and kilometre-scale prediction requires development of new verification methods and a multi-disciplinary approach. Congress concurred with CAS for the Joint Working Group on Forecast Verification Research to address these issues through a stronger link with the three major projects (PPP, S2S and HIWeather).

4.3.40 Congress noted the development of the Aviation Research and Development Project (AvRDP) led by WWRP as a joint project between CAS, CBS and the Commission for Aeronautical Meteorology (CAeM). Congress appreciated the proactive role of Hong Kong, China in the development of this project. Congress noted the new requirements from the International Civil Aviation Organization (ICAO) concerning the Global Aviation Navigation Plan (GANP), and recommended that several airports and several nowcasting systems with different technologies should participate in the project to validate and to quantify the prediction capabilities as well as to show the benefits of such new products and services to aviation users.

4.3.41 Congress acknowledged that all Members will have to respond to the GANP (see agenda item 9.2) requirements and develop further their systems for the provision of aviation weather services. In light of this, it requested Members participating in AvRDP to:

(a) Support the planning of the project by the provision of expertise in both aviation weather nowcast/forecast systems, verification and in air traffic management systems;

(b) Participate by the provision of observations, technologies and aviation nowcast systems;

(c) Participate by the provision of air traffic management data for validation of the benefits of the nowcast/modelling systems; and

(d) Support capacity development by providing of suitable trainers in the planned training workshop.

4.3.42 Congress strongly recommended that the AvRDP should also, when appropriate, demonstrate the expeditious transfer of scientific and research results into the operational practice. Congress suggested that the design of the project should envisage an immediate second phase aimed at developing, in close coordination with the air traffic management (ATM) user community, of methods and procedures to facilitate the technological transfer. Congress also noted that this work should go in parallel with the development of appropriate regulatory amendments.

4.3.43 Congress adopted Resolution 44 (Cg-17) – Aviation Research and Development Project.

4.3.44 Congress noted the additional potential benefits of better collaboration between the Nowcasting and Mesoscale Weather Forecasting Research working group and the aeronautical meteorology community related to the use of atmospheric forecasting for improved meteorology services to aviation, especially in relation to volcanic ash monitoring and forecasting (reference to paragraphs 3.1.13–3.1.33).

4.3.45 Congress noted the importance to strengthen the warning services of the East African Community members to save life and property within the Lake Victoria Basin. It supported the WWRP Lake Victoria RDP focusing on the development of a severe weather warning nowcasting system based on satellite, lightning, NWP and local observations, and including four components: nowcasting system, links with Severe Weather Forecast Demonstration Project (SWFDP), a field campaign, and capacity development. Congress requested Members to:

(a) Support the Lake Victoria RDP by the provision of global satellite data and products, lightning data, high-resolution numerical weather prediction products (4km or better) for the Lake Victoria Basin in the initial phase and all of Africa in future phases;

(b) Support this initiative by the provision of expertise for planning, design, implementing, technology transfer and capacity development (both research and operations); and

(c) Support funding proposals.

4.3.46 Congress noted the importance of the RELAMPAGO (Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations) Research Development Project which will conduct a field experiment in central Argentina to advance the scientific understanding of some of the most severe mesoscale systems and thunderstorms in the world. Congress noted that the weather and hydrological systems in the La Plata Basin affect many countries in South America and that the results of RELAMPAGO will be the foundation for the development of a severe weather nowcasting/forecasting system that will strengthen regional NMHSs. Congress requested that Members support the RELAMPAGO RDP by the provision of expertise in the planning of the project, the provision of logistic support for potential field sites and the provision of in situ and satellite related observations.

4.3.47 Congress noted the emerging cross-commission initiatives, including the Commission for Atmospheric Sciences (CAS), the Commission for Hydrology (CHy) and the Commission for Basic Systems (CBS) inter-commission research, development and forecasting demonstration project (RDP/FDP) Coupled Hydrology-Atmospheric Modelling and Prediction (CHAMP). This initiative will be implemented on a regional basis where the coupling of hydrological and atmospheric predictive systems is crucial to delivery of new advanced services and/or enhance predictive capabilities. A first possible regional research and development project, to serve as a case study, would be in the Laurentian Great Lakes St Lawrence River of North America. Congress requested that CAS, through WWRP, coordinates with CHy and CBS in order to advance the CHAMP project and to individuate other potential case studies.

4.3.48 Congress took note that WWRP research initiatives of a cross-cutting nature with WCRP and GAW are reflected in more detail below under Joint Research Activities.

4.3.49 Congress adopted Resolution 45 (Cg-17) – World Weather Research Programme, which reflects major aspects of the WWRP Programme.

The Global Atmosphere Watch Programme

4.3.50 Congress noted the development of the GAW Implementation Plan for the period 2016–2023 (www.wmo.int/gaw). It recommended that the WMO priorities approved by Congress are taken into consideration in the development of the GAW Implementation Plan. Congress noted with pleasure that the programme development is aimed at delivery of enhanced products and services to Members through cross-cutting application areas.

4.3.51 Congress recognized that the GAW observing network continues to play an important role as a tool underpinning research and service delivery. Congress noted that substantial regional gaps still exist in this network. It urged Members to establish stations or provide resources to cover those spatial gaps with observations. Congress encouraged Members to extend observational programmes at active stations to include more parameters related to atmospheric composition, including those currently only performing meteorological observations. Congress stressed that GAW observations contribute to the WMO Integrated Global Observing System and that the network evolution should follow the Rolling Review of Requirements process. Congress invited Members to provide contributions to trust funds dedicated to supporting GAW in developing countries.

4.3.52 Congress recognized that much better integration between ground-based, aircraft and satellite observations using comprehensive modelling tools is required to address atmospheric composition application areas. Congress acknowledged contributions of the In-service Aircraft for a Global Observing System (IAGOS) project to atmospheric composition observations for the past 20 years and appreciated the link established between IAGOS and the global Aircraft Meteorological DAta Relay (AMDAR) programme for near real-time chemical data delivery.

Congress requested Members to contribute with aircraft observations to the GAW Programme using the quality assurance principles laid down in the Programme. Congress urged Members involved in the operation of satellites to take into consideration the needs for atmospheric composition observations and encouraged them to share data with minimal delays. Congress encouraged Members to get more actively involved in atmospheric composition and deposition modelling coordinated through the GAW Programme to tackle environmental issues.

4.3.53 Congress took note of the decline in data submission of several GAW parameters and it urged Members to submit observational data to WMO Data Centres in a timely fashion, as specified in the GAW Implementation Plan. Congress appreciated efforts of Members supporting WMO/GAW World Data Centres. Congress noted that the GAW Station Information System (GAWSIS, http://www.meteoswiss.ch/gawsis) supported by MeteoSwiss will in the future distinguish active from silent stations based on their data submission status as outlined in the GAW Implementation Plan. GAWSIS with all its contributing data centres also supports the WIGOS platforms. Congress appreciated the efforts of the GAW Expert Team on World Data Centres to link metadata and data collected within GAW to the WMO Information System (WIS).

4.3.54 Congress noted that several applications require near real-time data submission. Congress requested Members to ensure that observations are made available with minimum delay for such applications (such as atmospheric composition forecast verification and data assimilation in numerical weather prediction (NWP)).

4.3.55 Congress noted that GAW established an ad hoc team to review user requirements for atmospheric composition and related needs for satellite measurements following a request made by Cg-XVI (abridged final report, paragraph 3.2.3). Congress appreciated the proposed substitution of the “atmospheric chemistry” application area with more specific application areas related to “atmospheric composition forecasting”, “atmospheric composition analysis and monitoring” and “urban services”. Congress agreed that atmospheric composition observations are required in a number of WMO application areas (http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html), including Global NWP, high resolution NWP, Nowcasting and Very Short-Range Forecasting, subseasonal to longer predictions, aeronautical meteorology, agricultural meteorology and climate applications.

4.3.56 Congress stressed that increased modelling capacity is required in GAW to address different applications areas. Congress supported the recommendation of the Environmental Pollution and Atmospheric Composition Scientific Steering Committee (EPAC SSC) to extend the scope of the GAW Expert Team on Near-real-time Chemical Data Transfer to cover atmospheric composition forecasting on regional and global scales. Congress agreed that the revised group will be referred to as the Scientific Advisory Group on Near-Real-Time applications.

4.3.57 Congress noted that changes in atmospheric composition have numerous two-way links with agriculture. Congress urged Members to establish joint activities between agrometeorological and GAW activities, especially in the context of the agriculture and food security priority area of the Global Framework for Climate Services.

4.3.58 Congress encouraged stronger collaboration between GAW, the World Weather Research Programme (WWRP) and the World Climate Research Programme (WCRP) in addressing cross-cutting applications. Congress stressed that model based services can benefit substantially from integrated atmospheric composition modelling especially when addressing high impact weather and climate events and related air pollution episodes. Congress agreed that the Working Group on Numerical Experimentation (WGNE), established by the Commission for Atmospheric Sciences and WCRP, provides an ideal platform to foster such collaboration. Congress appreciated the ongoing collaboration between WWRP and GAW on WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) and GAW Urban Research Meteorology and Environment (GURME) project. Congress requested that similar joint research be undertaken in support of the development of biomass burning services.

4.3.59 Congress recognized that the rapid urbanization currently taking place requires new types of services making best use of science and technology. Congress appreciated the contribution of GURME projects to urban services. Congress encouraged Members to establish GURME pilot projects in those areas with potential high exposure of the population to air pollution. GURME and urban related cross-cutting activities with WHO, and other programmes are reflected under paragraphs 4.3.73–4.3.102 and agenda item 9.8.

4.3.60 Congress noted the ongoing development of the Implementation Plan for an Integrated Global Greenhouse Gas Information System (IG^3IS) (see: www.wmo.int/gaw). Congress agreed that IG^3IS can become an important science-based tool for independent quantification of GHG sources and sinks, both natural and anthropogenic, delivering actionable information to help Members understand and manage greenhouse gas budgets on enhanced temporal and spatial scales. Congress further noted that the implementation of IG^3IS can provide new and innovative services in support of the Global Framework on Climate Services (GFCS). Congress urged Members to undertake efforts related to the development of observational networks and modelling tools in support of IG^3IS. Congress requested Members to report by the next Congress on the efforts undertaken in this direction in individual countries and regions. To this end Congress adopted Resolution 46 (Cg-17) – Integrated Global Greenhouse Gas Information System.

4.3.61 Congress recognized that aerosol observations and analysis are critical for weather, climate, human health and aviation security. Congress encouraged Members to take note of the recommendations made in GAW Report No. 207 “Recommendations for a Composite Surface-Based Aerosol Network”. It requested Members to establish observations that allow estimates of aerosol parameters following GAW recommendations. Congress appreciated developments of the GAW Lidar Observational Network (GALION) especially in support of volcanic ash observation and verification of satellite products. Congress welcomed the important steps taken by EARLINET and the EUMETNET E-PROFILE programme towards an integrated monitoring approach and operational use of ceilometer and lidar data in Europe. Congress encouraged stronger collaboration between GAW and other aerosol observation networks seeking synergies and complementarities to enhance specific model and satellite atmospheric applications.

4.3.62 Congress acknowledged, in view of the IPCC AR5 report, the importance of aerosols and reactive gases (NO_x, VOCs, tropospheric ozone) as short-lived climate forcers/pollutants (SLCFs/SLCPs). Congress urged Members to undertake observations of SLCF in their countries. Congress noted that WMO has joined the Climate and Clean Air Coalition (CCAC) as a partner. Congress reminded that WMO could participate in a number of relevant initiatives, in particular through provision of observations of SLCFs, and to nominate a person for the roster of the Scientific Advisory Panel.

4.3.63 Congress appreciated the publication of the Global Precipitation Chemistry Assessment. Congress agreed that total atmospheric deposition is a more critical parameter for understanding biogeochemical cycles and ecosystem effects than wet deposition alone. Congress encouraged Members to take further steps in developing their capacity to observe and model total atmospheric deposition. Congress supported the recommendation of EPAC SSC to extend the scope of the GAW Scientific Advisory Group on Precipitation Chemistry to cover total deposition. Congress agreed with the proposed change of name of this expert group to the Scientific Advisory Group on Total Atmospheric Deposition (SAG-TAD).

4.3.64 Congress noted the activities of Working Group 38 (Atmospheric Input of Chemicals to the Ocean) of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) of the United Nations. Congress highlighted that collaboration within GESAMP is very important in the context of total atmospheric deposition analysis. Congress confirmed that WMO will continue sponsorship of WG 38 and encouraged Members to contribute to the WMO GESAMP Trust Fund.

4.3.65 Congress took note of the publication of the WMO/UNEP Scientific Assessment of Ozone Depletion and stressed the importance of long-term continuous time series of total ozone as well as vertical ozone profiles for the detection and attribution of the expected ozone recovery

during coming decades. Congress urged Members to maintain their observations of stratospheric ozone and other parameters relevant to ozone depletion. Congress encouraged Members to take note of the recommendations made by the Ninth Meeting of the Ozone Research Managers of the Parties to the Vienna Convention for the Protection of the Ozone Layer. Congress noted with satisfaction that the Vienna Convention Trust Fund for Research and Systematic Observations was prolonged until the end of 2020. Congress encouraged Members to contribute to this Trust Fund.

4.3.66 Congress recognized that future changes in surface ultra-violet (UV) radiation, that have potential detrimental and beneficial impacts on human health and the environment, depend on other factors in addition to ozone, such as cloud cover and type, surface albedo and atmospheric aerosol load. Congress therefore requested Members to include observations of parameters that influence surface UV radiation in their programmes. Congress urged GAW to make such data available in a format appropriate for medical and biological users. Congress recommended that Members should ensure participation in intercomparison campaigns to improve data quality in the global GAW UV network. Congress recommended that Scientific Advisory Group on UV Radiation (SAG UV) should address the growing issue of low levels of UV radiation in many populated areas in the world by working jointly with other organizations such as World Health Organization (WHO) and International Commission on Illumination (CIE).

4.3.67 Congress recognized that quality assurance and quality control (QA/QC) of observational data constitutes one of the cornerstones of high-quality product delivery and that GAW has established a WMO benchmark in this regard. Congress requested Members to implement the *WMO Quality Management Framework* (WMO-No. 1100) for atmospheric composition measurements. Congress appreciated Members efforts that support GAW Central Facilities in their countries. Congress noted the increasing cooperation with the International Bureau of Weights and Measures (BIPM) and appreciated the involvement of the GAW community in BIPM activities through joint workshops and projects.

4.3.68 Congress appreciated the efforts on capacity development and collaboration activities by Finland, France, Germany, Spain and the United States of America, especially in relation to observational capacity-building in South America, Africa and Asia. Congress noted with satisfaction the contribution of Switzerland in the global observational capacity development through the Capacity-building and Twinning for Climate Observing Systems (CATCOS) project. Congress encouraged Members with advanced capacity to enter into partnerships with less developed Members to address the gaps in observational networks.

4.3.69 Congress expressed its appreciation to Germany for their efforts since 2001 in support of the GAW Training and Education Centre (GAWTEC). Congress recognized that this training plays an important role in the building of GAW-related technical expertise of Members and in establishing international networks among experts. Congress encouraged Members to take advantage of GAWTEC training and it invited WMO Regional Training Centres to consider the hosting training courses on atmospheric composition.

4.3.70 Congress expressed its satisfaction with the number and quality of GAW publications and with the timely preparation of the annual Greenhouse Gas Bulletin that provides important science-based evidence on the fundamental causes of climate change. Congress appreciated the publication of the WMO Antarctic Ozone Bulletins during the Antarctic ozone hole season and urged Members to support this publication through data submission and analyses. Congress noted the publication of the Aerosol Bulletin in 2013 and urged the GAW community to pursue its continuation. Congress appreciated the publication of the special brochure dedicated to the celebration of the 25th anniversary of GAW highlighting the achievements of the Programme. Congress recommended that more publications in support of WMO application areas related to atmospheric composition be delivered by the GAW Programme.

4.3.71 Congress took note that GAW research initiatives of a cross-cutting nature with WCRP and WWRP are reflected in more detail in subsequent section below.

4.3.72 Congress adopted Resolution 47 (Cg-17) – Global Atmosphere Watch Programme, which reflects major aspects of the GAW Programme.

WCRP, WWRP and GAW Joint Research

4.3.73 Congress acknowledged the existence of a number of joint research activities between the World Climate Research Programme (WCRP) and the Global Atmosphere Watch (GAW) Programme and the World Weather Research Programme (WWRP), both under the Commission for Atmospheric Sciences (CAS), to address the complex feedbacks between atmospheric composition, and weather and climate processes. Congress strongly encouraged the Programmes and CAS to explore further integration of their objectives and programmatic components where applicable, and to request CAS to report to EC on activities that enhance the collaboration between WCRP, WWRP and GAW.

Working Group on Numerical Experimentation

4.3.74 Congress recognized the role of the Working Group on Numerical Experimentation (WGNE) to foster cooperation on model development and model evaluation across timescales between CAS and WCRP. Congress noted the importance of the WGNE project led by the Environment Canada and focusing on the treatment of surface drag in models to compare the parameterized and physics components of modelled surface stress. The WGNE aerosol project, led by Centro de Previsão de Tempo e Estudos Climáticos (CPTEC) in Brazil, to evaluate aerosols impacts on weather and climate predictions, and the grey zone project to evaluate model capabilities at the 1–10 km resolution range are two further important WGNE research areas aimed at improving models and predictions. Congress encouraged Regional and Global NWP Centres to actively participate in these WGNE activities.

4.3.75 Congress noted with satisfaction the progress made by the WGNE Madden-Julian Oscillation (MJO) Task Force in the six sub-projects on: process-oriented diagnostics and metrics; boreal summer monsoon intraseasonal variability; the analysis of CMIP5 model capabilities on intraseasonal variability; the vertical structure of the MJO and diabatic processes; air-sea interactions; and the MJO over the Maritime Continent.

4.3.76 Recognizing the importance of the two-way interaction between atmospheric composition and weather/climate processes, Congress solicited WCRP and CAS to further fully integrate GAW research on atmospheric composition into the work of WGNE. Congress supported the idea to establish a dedicated task force on seamless/coupled meteorology-chemistry modelling within WGNE.

4.3.77 Congress particularly recognized the importance of land-surface interactions with atmospheric chemistry, and encouraged the development of appropriate coupled models designed for short-term weather and climate studies. Congress encouraged WGNE to foster the development of a seamless prediction system for this topic in close coordination with WWRP and WCRP and GAW. Congress supported the idea that a first research priority could be on biomass burning and wild fires prediction and on the development of pre-operational products.

Sub-seasonal to Seasonal Prediction

4.3.78 Congress noted that substantial progress was made since its sixteenth session on the establishment of the Sub-seasonal to Seasonal (S2S) prediction research project, a joint initiative between WCRP and WWRP. Congress agreed that the sub-seasonal to seasonal timescale (2 weeks to 3 months ahead) is, from a user perspective, a particularly important time range. Congress recognized that improvements in the predictive skill and in the use of sub-seasonal to seasonal predictions would benefit shorter-range weather and longer-range climate predictions as well as support improved climate services within the context of the Global Framework for Climate Services (GFCS). Congress invited the Intergovernmental Board on Climate Services to acknowledge and support this important contribution to the GFCS.

4.3.79 Congress noted the establishment of the S2S Steering Group and supported the developing five sub-projects focusing on extreme weather, monsoons, MJO, Africa, and verification. Congress noted the collaboration between CAS and the Commission for Agricultural Meteorology (CAgM) in order to support the agriculture sector and food security through the exploitation of the S2S database. Congress recommended the support of these activities by GFCS, and encouraged the development of links with international agencies, such as the Food and Agriculture Organization of the United Nations (FAO) and the World Food Programme (WFP).

4.3.80 Congress, in acknowledging that S2S has been set up initially as a five year project with the possibility for extension, solicited WWRP and WCRP to ensure a thorough review of progress during the initial period in order to objectively decide on the continuation of the project.

4.3.81 Congress appreciated the establishment of the International Coordination Office hosted by the Korea Meteorological Administration (KMA) at the National Institute of Meteorological Research in Jeju, Republic of Korea in November 2013. Congress extended its appreciation to the European Centre for Medium-Range Weather Forecasts (ECMWF) and the China Meteorological Administration (CMA) to undertake the S2S database archiving and to provide related data services to support research. Considering the importance of the sub-seasonal to seasonal (S2S) timescale to many user sectors, Congress requested the centres to make near real-time S2S forecasts routinely available to NMHSs. Congress further appreciated the contributions of Australia, United Kingdom of Great Britain and Northern Ireland and United States of America to the S2S Trust Fund and urged more Members to contribute to the Trust Fund to support the successful implementation of the project.

Year of Tropical Convection and Year of the Maritime Continent

4.3.82 Congress recognized that the Year of Tropical Convection (YOTC) project (http://yotc.ucar.edu/), which is a joint WCRP–WWRP THe Observing system Research and Predictability EXperiment (THORPEX) project, has resulted in significant advances in understanding and modelling of tropical convection and its organization into complex multi-scale precipitation systems with particular emphasis on the Madden-Julian Oscillation (MJO).

4.3.83 Congress recalled that the YOTC project and THORPEX were both concluded at the end of 2014, and that relevant research activities on tropical processes would continue as part of the WGNE MJO Task Force, in particular, focusing on MJO interactions with the Maritime Continent. Congress urged WCRP and CAS to task WGNE to ensure a continued focus on the understanding and modelling of organized convection at the intersection of weather and climate timescales (sub-seasonal to seasonal) aimed at improving operational weather and climate predictions.

4.3.84 Congress noted that the joint research plan for the Year of the Maritime Continent (YMC), involving researchers from Australia, Indonesia, Japan, Malaysia, Philippines, Singapore, USA and other countries in the Maritime Continent, was endorsed at the sixteenth session of Regional Association V. YMC aims to improve the understanding of the role of the Maritime Continent in the local, regional and global weather-climate continuum with a focus on the Madden–Julian Oscillation (MJO), the Indonesian Through Flow (ITF) transport dynamics and ocean-atmospheric interaction of the marginal seas, and troposphere-stratosphere interactions, among others. An intensive YMC campaign is planned from July 2017 to July 2019 with several observational periods focusing on specific topics. Following the kick off meeting in Jakarta on 5 September 2014 and the First International Science and Planning Workshop in Singapore from 27 to 30 January 2015, the YMC implementation plan workshop will be held in November 2015 in Jakarta. YMC will contribute towards better seasonal and sub-seasonal prediction over the Maritime Continent and beyond. Congress requested YMC to closely coordinate its activities with the MJO Task Force and the S2S project.

The Research Contribution to the Global Integrated Polar Prediction System

4.3.85 Congress noted the significant progress made since its sixteenth session related to the implementation of the 10-year WWRP Polar Prediction Project (PPP), guided by the PPP Steering

Group. Congress requested WWRP and WCRP to ensure close collaboration between PPP and the WCRP Polar Climate Predictability Initiative (PCPI).

4.3.86 Congress noted the progress in the implementation of the Year of Polar Prediction (YOPP) planned for 2017–2019 and its strong links with other related activities. Congress encouraged Members to engage in the planning process and to use this as an opportunity to strengthen polar observing networks, science initiatives required to improve predictive skill and services in these regions.

4.3.87 Congress, in acknowledging that the observational and modelling campaign of YOPP coincides with the period of the YMC campaign, suggested that their supporting observations and modelling studies be closely coordinated. Such coordination will facilitate a better understanding of the teleconnection between the tropics and Polar Regions considering that the energy from the tropics is distributed to Polar Regions through the oceans and atmosphere.

4.3.88 Congress adopted Resolution 48 (Cg-17) – Global Integrated Polar Prediction System, in support of overall polar research activities conducted by WCRP and WWRP, and Resolution 49 (Cg-17) – Year of Polar Prediction, in support of this major initiative of WWRP conducted in close collaboration with WCRP.

4.3.89 Congress extended its appreciation to the Alfred Wegener Institute for Polar and Marine Research (AWI), Germany, for hosting the International Coordination Office (ICO) for the project. Congress further appreciated the contributions of Canada, Norway, United Kingdom of Great Britain and Northern Ireland and United States of America to the PPP Trust Fund but urged more Members to contribute to the Trust Fund to support the successful implementation of the project.

Sand and Dust Storm Warning Advisory and Assessment System

4.3.90 Congress agreed that sand and dust storms have considerable impacts on Members, especially those in, around and downwind from arid and semi-arid regions. Congress appreciated that the Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS), a joint activity between GAW and WWRP, has raised awareness and has contributed to a better understanding of the phenomena. Congress agreed that the SDS-WAS “Science and Implementation Plan: 2015–2020” formed the basis for the implementation of the research component of the project.

4.3.91 Congress noted with satisfactions that regional research nodes for SDS-WAS have been established in Asia (hosted by China), the Northern Africa-Middle East-Europe (hosted by Spain) and the Americas (hosted by the United States of America), with an additional potential regional node in West Asia in collaboration with the United Nations Environment Programme (UNEP). Congress also noted the designation by EC-65 of the SDS-WAS regional centre in Barcelona, Spain, as the Regional Specialized Meteorological Centre (RSMC) – Atmospheric Sand Dust storm Forecasts (ASDF) for Northern Africa (north of Equator), the Middle East, and Europe. Congress acknowledged the offer by China to establish another RSMC-ASDF based in Beijing, China, for the region consisting of Asia and the Central Pacific. Congress further noted that the fourth SDS-WAS Asian Regional Steering Group (RSG) Meeting which was held in Beijing from 10 to 11 March 2015 adopted the SDS-WAS Technical Report on Asian Regional Centre. Congress invited the Commission for Basic Systems (CBS) to look into this matter in consultation with CAS based on the outcomes of regional consultation on this matter.

Aerosol Impacts

4.3.92 Considering that the detection of volcanic ash requires collaboration between different WMO Programmes and activities, Congress agreed that the Volcanic Ash Scientific Advisory Group (VASAG) (see: https://www.wmo.int/aemp/vasag) established between WMO and the International Union of Geodesy and Geophysics (IUGG) provides a suitable platform for CAS, CBS, the Commission for Instruments and Methods of Observations (CIMO), the Commission for Aeronautical Meteorology (CAeM) and other relevant bodies to work together on cross-cutting

volcanic ash-related issues. Congress urged VASAG to improve collaboration with the WWRP and GAW research community that has a broad experience in atmospheric transport processes.

GAW Urban Research Meteorology and Environment Project

4.3.93 Congress acknowledged the progress made in the GAW Urban Research Meteorology and Environment (GURME) for enhancing the capabilities of Members to address meteorological and air quality (AQ) aspects of urban pollution, and related weather-sensitive public health threats, from research through operations to services and products. Congress recognized that these activities need to be carried out in collaboration with relevant WMO Programmes and groups, and international organizations and initiatives. In particular, GURME should contribute, together with the WCRP coastal cities initiative and the WWRP HIWeather project, to a larger WMO Urban Initiative (discussed under agenda item 9.8). Congress recommended the implementation of GURME as a joint initiative between GAW and WWRP, in order for the meteorological aspects of GURME to be strengthened.

4.3.94 As pilot projects have played a major role in GURME activities and are important for capacity development, Congress encouraged that these be continued. Congress was pleased to note that several pilot projects have been established in India and China. Congress recommended that similar pilot projects be established in South American, African and Middle-East cities that would include observations, modelling and forecasting.

4.3.95 Congress recognized the value of collaboration with the World Health Organization (WHO) within the Climate and Clean Air Coalition (CCAC), where an Urban Health Initiative is being established in collaboration with several CCAC Partner organizations and countries. Congress encouraged for GURME to be an active Partner in this initiative, recognizing further the importance of collaboration with WHO as currently it is estimated that globally seven million people are dying prematurely annually due to poor air quality.

4.3.96 Congress noted that the WHO Member States at the 68th World Health Assembly in May 2015 passed a ground-breaking resolution A68.8 “Addressing the health impact of Air Pollution” (http://apps.who.int/gb/ebwha/pdf_files/WHA68/A68_R8-en.pdf). Congress recognized the integral value of its programmes and services for Members to respond to this socioeconomic priority. The collaboration between WHO and WMO will be essential for Members of both organizations to implement the suggested activities within this resolution, notably to better understand, monitor, model, forecast, and inform action to reduce hazardous air quality. Congress requested the WHO/WMO Joint Office and GAW, including GURME, to ensure effective collaboration and implementation regarding this matter.

4.3.97 Congress appreciated the GURME support for attendance of young scientists, especially women from developing countries, in international meetings and conferences and encouraged GURME to continue these actions.

Joint WG on Forecast Verification Research

4.3.98 Congress recognized the relevant activities of the Joint Working Group on Forecast Verification Research and encouraged WCRP, WWRP and GAW to further explore synergies for a seamless and consistent approach to forecast verification across scales and disciplines. Such an approach to forecast verification will address the needs of the CAS and WCRP projects and assist in the development of new verification methods required for operational services.

Climate Engineering

4.3.99 Congress noted the growing interest in climate engineering, also referred to as geoengineering, and its proposed application as a potential strategy for limiting climate change. Congress acknowledged that climate engineering covers a wide spectrum of technologies, each with a different level of complexity, uncertainty and associated risk. Congress considered that there could be unintentional consequences associated with large-scale climate engineering and the fact

that it could also be used by some countries as a reason to lessen their resolve and/or efforts to counter anthropogenic climate change. In this regard Congress noted the interest of Members in developing a science-based assessment on climate engineering, specify the gaps in scientific understanding and promote specific research activities to fill such gaps.

4.3.100 Congress noted that several scientific bodies and academic institutions have developed statements and other documents on climate engineering/geoengineering – including the American Meteorological Society (AMS) and the University of Oxford, UK, and that a growing number of scientific papers on climate engineering have appeared in the peer-reviewed literature.

4.3.101 Congress noted that CAS, at its sixteenth session held in Antalya, Turkey, in November 2013 stated that further research is needed to adequately understand the potential feasibility, the effectiveness and risks associated with various climate engineering techniques. Congress further noted that CAS agreed to contribute to a comprehensive assessment of the state of knowledge, science capacity and understanding of information gaps and to identify appropriate research to address these gaps. Congress requested CAS to coordinate its contribution to such an assessment in close cooperation with International Maritime Organization (IMO), Intergovernmental Oceanographic Commission (IOC) of UNESCO, Intergovernmental Panel on Climate Change (IPCC), WCRP and other relevant international, academic and science bodies.

4.3.102 Congress requested CAS to keep the Congress and the Executive Council updated on any significant developments in climate engineering of relevance to WMO, in order to enable decisions on the appropriate level and the nature of involvement of WMO in climate engineering.

Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA)

4.3.103 Congress noted that PROVIA represents an interface between the research community, decision-makers and other stakeholders to improve policy-relevant research on vulnerability, impacts and adaptation (VIA), allowing scientists to coordinate and facilitate the dissemination and practical application of their research. It further noted that following the inclusion of PROVIA in the World Climate Programme (WCP), PROVIA has been actively engaging with the Executive Council Working Group on Climate and related Weather, Water and Environmental Matters (ECWG-CWE), the WCRP Joint Scientific Committee (JSC), the GCOS Steering Committee, the Commission for Climatology (CCl) and coordination mechanism for implementation of the GFCS. In that context, Congress recommended that the GCOS Secretariat and GCOS Scientific Steering Committee, as well as the WCRP Joint Planning Staff and GCOS Joint Scientific Committee, should liaise with the PROVIA Secretariat and the PROVIA Scientific Steering Committee to extend collaboration on joint research interests and share lessons learnt in establishing a fully operational programme under the WCP. The scope and objectives of PROVIA are given in Annex X to the present report. Congress took note of those, while clarifying that the inclusion of PROVIA in WCP did not imply that PROVIA would be funded from the WMO regular budget.

4.3.104 Congress noted that PROVIA has released the 'PROVIA Guidance on Assessing Vulnerability, Impacts and Adaptation to Climate Change' dedicated to climate adaptation planners and encouraged its translation into other WMO official languages. The guidance report provided a wide array of approaches, methods and tools with a focus on practical implications to the development of specific, sectoral or place-based approaches with case studies and good practices for effective adaptation. It further noted that PROVIA has provided technical support to assist countries to advance their National Adaptation Plans (NAPs) under the United Nations Framework Convention on Climate Change (UNFCCC) and lead nationally driven NAP processes to facilitate effective medium- to long-term planning for adaptation to climate change in Least Developed Countries (LDCs) and strengthen institutional and technical capacities for iterative development of comprehensive NAPs in LDCs. Congress underscored the need to do that in cooperation with NMHSs. Congress requested PROVIA to include capacity-building for impact modellers and adaptation planners, particularly in countries with less developed scientific capabilities, to equip them to make better use of the increasingly complex climate predictions and other available information.

4.3.105 Congress welcomed the PROVIA Young Researcher Fellowship, which was launched in 2014. Congress noted that the Fellowship Programme specifically aimed to contribute to the capacity-building of young scientists especially from developing and least developed countries to carry out scientific assessments of climate change vulnerability and impact assessment and enhances its societal benefits. In that aspect, it deemed great benefits in building synergies between the Fellowship Programme and capacity-building efforts within the implementation of the GFCS.

4.3.106 Congress appreciated the role of PROVIA as a founder of the biennial International Adaptation Futures Conference. It noted that the third such Conference was held in Fortaleza, Brazil in May 2014. Another PROVIA related conference was the ECCA conference held in May 2015 in Copenhagen. It involved 850 participants mainly from universities and agencies all working in the field of PROVIA. Congress recognized that the Conference brings together research scientists, policymakers and practitioners from developed and developing countries to share knowledge on adaptation challenges and opportunities. Congress further noted that the fourth International Adaptation Futures Conference will be held in Rotterdam, the Netherlands in May 2016 and will be co-hosted by PROVIA, the Government of the Netherlands and the European Commission. In preparation for the Rotterdam Conference, the Dutch Government also had commissioned the organization of a workshop in November 2015 involving European Union NMHSs, national policymakers, EU policymakers, and data providers. Congress requested the Secretary-General to ensure active participation of WMO in the Conference through involvement of relevant programmes and bodies such as the Commission for Climatology (CCl), as appropriate.

5. STRENGTHENING CAPACITY DEVELOPMENT (agenda item 5)

5.1 Capacity development strategy (agenda item 5.1)

Overview

5.1.1 Congress was informed that during the intersessional period, Expected Result 6, Capacity Development, was carried out as a cross-cutting priority activity. It noted that Members were assisted in strengthening their NMHSs through a wide variety of mechanisms under the coordination of WMO. During the period, assistance in building human capacity was provided through the Education and Training Programme (ETRP), in addressing deficiencies in infrastructure through the Voluntary Cooperation Programme (VCP), the Regional Programme (RP) and technical programmes. Congress appreciated the attention given by the Secretariat in advocating regional and national support for NMHSs as well the substantial assistance offered in project development, mobilizing resources and strengthening development partnerships. Congress appreciated the efforts of the technical commissions to advise on matters relating to NMHS compliance with WMO requirements and the work of regional associations for their renewed focus on regional centres and the political support needed for development of NMHSs. Congress also recognized the significant technical assistance Members afforded each other through bilateral or multilateral means for the development of NMHSs and encouraged Members to continue their efforts, highlighting the importance of initiatives for the coordination and information of such activities, such as the Informal Planning Meeting of the WMO Voluntary Cooperation Programme (IPM).

Capacity Development Strategy

5.1.2 Congress recalled that through Resolution 49, Cg-XVI requested the Executive Council to prepare a WMO Capacity Development Strategy (CDS) and an associated CDS Implementation Plan (CDSIP). It further recalled that the request was based on the need for a cohesive and coordinated approach to capacity development to maximize the outcome of capacity development activities and to ensure sustainable development of NMHSs. In this regard, Congress recognized with appreciation that the CDS and CDSIP had been prepared as requested and subsequently approved at EC-64 (Resolution 18) and EC-65 (Resolution 16) respectively.

5.1.3 Congress was pleased to note the initial progress since EC-65 towards the six Strategic Objectives of the CDS through the activities of the Secretariat, WMO constituent bodies and WMO Programmes.

5.1.4 Congress was informed of the efforts of the EC Working Group on Capacity Development (ECWG-CD), which led to the Executive Council approval of the CDS and assisted the Executive Council in consideration of a number of issues relating to capacity development activities including, resource mobilization and strategic partnerships; service delivery to NMHSs; interaction with the EC Panel on the Education and Training on needs of Members; volunteerism; and the preparation of the CDS. Congress noted the importance of providing guidance and oversight during implementation of the CDS and agreed that the Executive Council could continue to play such a role. In particular, Congress noted the efforts of the ECWG-CD on the Country Profile Database (CPDB) and on the Categorization of NMHSs by level of service provision. To build on and continue this work, Congress requested the Council to make appropriate arrangements to assist in the oversight of the CDS.

5.1.5 Congress thanked the Executive Council for its leadership in WMO capacity development efforts. It encouraged the Executive Council to further refine the capacity development implementation activities of the WMO during the financial period 2016–2019.

Capacity Development Programme

5.1.6 Congress recalled that much of the WMO's capacity development activity was under the umbrella of the Technical Cooperation Programme (TCOP). The TCOP, created by Congress as part of the WMO Second Long-Term Plan (Resolution 25 (Cg-X)), managed technical cooperation activities to assist developing countries in maintaining observation equipment and telecommunications systems, in providing specialized training, and to assist NMHSs provide relevant services at national level. TCOP assistance also included provision of emergency assistance for the repair and maintenance of basic World Weather Watch (WWW) facilities and equipment and for NMHSs and Regional Specialized Centres to provide tailored, user friendly products and regional guidance products.

5.1.7 Following the creation of the TCOP in 1987, a Technical Cooperation Department was created with staff and projects funded primarily by a UNDP sectoral contribution of approximately USD 12 million annually. The Technical Cooperation Department worked in parallel with the Education and Training Department, the Regional Offices and the scientific and technical departments. Since 1997, when the annual UNDP sectoral contribution ended, much of the work of the TCOP was taken up through other funding or mainstreamed into the activities of the technical and scientific departments. In 2007 the TCOP activities were reorganized along with the VCP, the Education and Training Programme (ETRP) and the Regional Programme (RP) into what is now called the Development and Regional Activities Department (DRA). Resource mobilization was included in DRA since extrabudgetary funding and development partnerships were also considered key to finding new and innovative ways of increasing technical support to developing country NMHSs. The TCOP was not renewed as a particular Programme by Cg-XVI, noting that the Executive Council was requested to incorporate the activities of the TCOP into the CDS.

5.1.8 Congress appreciated efforts by the Secretary-General to concentrate the efforts of Expected Result 6 by various departments under coordination of a single department to take advantage of synergies and to improve efficiency. Congress also recognized that the CDS incorporated the activities of the TCOP. However, Congress agreed that WMO capacity development activities could benefit from a similar level of consolidation at the programme level especially with regard to those programmes more closely associated with Expected Result 6, Capacity Development, i.e., Least Developed Countries Programme (LDCP), Voluntary Cooperation Programme (VCP), ETRP and RP. Such a consolidation would be consistent with efforts to improve internal collaboration and consistency of the development efforts within the Organization, including efforts by RAs, TCs and WMO Programmes, and across all departments within the Secretariat.

5.1.9 Congress also noted that the mechanisms identified in the CDS should further promote improvements in coordination among these Programmes and thus better contribute to building NMHSs in developing countries, in particular those with economies in transition, LDCs and SIDSs, according to their needs and requirements. Congress felt that new aspects of the CDS should serve to guide capacity development efforts. In particular, WMO priorities and the goal of sustainable NMHS development and interaction with technical and scientific programmes should have a prominent place in the capacity development programmatic activities. Congress stressed that capacity development should have more focus on compliance with WMO Technical Regulations, efficient implementation of high-priority WMO programmes and projects such as WIGOS, WIS, DRR and GFCS at the national and regional levels, knowledge-based gap analysis, national strategic planning, regional political support, development partnerships at regional level, advocacy, project assistance, project development at the national and regional levels and focused fellowships/training in priority areas, the management and modernization of NMHSs, and increased involvement of developing countries in research.

5.1.10 To this end, Congress welcomed the recommendation of EC-66 to incorporate under a new WMO Capacity Development Programme those activities formerly related to the TCOP with emphasis on broader programmatic linkages and the objectives of the CDS. Congress adopted Resolution 50 (Cg-17) – Capacity Development Programme for the creation of the Capacity Development Programme.

5.2 Education and Training Programme (agenda item 5.2)

Overview

5.2.1 Congress was informed that during the intersessional period, the Education and Training Programme (ETRP) assisted WMO Members through the provision of a wide range of guidance and advisory services on the education, training, qualification and competence requirements for personnel of National Meteorological and Hydrological Services (NMHSs), particularly those associated with aeronautical meteorological personnel. Congress appreciated the collaboration between the ETRP and the technical commissions particularly in relation to competence standards. Activities included organizing short-term training events in specialized subjects; organizing the Twelfth WMO Education and Training Symposium; awarding and implementing long- and short-term fellowships for basic and specialized training; facilitating communication and exchange of information training and learning materials, experts and other training resources between Members; promoting distance learning and alternative training approaches through activities such as seminars and focus group discussions for trainers and forecasters; and promoting school and popular education in weather, climate and water subjects.

5.2.2 Congress thanked the Executive Council for its strong leadership in education and training matters. Congress encouraged the Executive Council to further refine the timing of the WMO Education and Training Symposium to facilitate input into the budget and planning processes for the 2020–2023 financial period. Congress noted that in the 2012–2015 financial period the Executive Council had prompted three new WMO publications on education and training to assist Members. The WMO Fellowship Manual had also been reviewed in the same period. Additionally, the Executive Council had overseen the development of a trainer competency framework following the guidance of Cg-XVI. Congress thanked the Executive Council and the contributors for WMO Publications WMO-No. 1104, *Guidelines for applying for a WMO Fellowship*, WMO-No. 1083, *Manual on the Implementation of Education and Training Standards in Meteorology and Hydrology*, Volume I and WMO-No. 1114, *Guidelines for Trainers in Meteorological, Hydrological and Climate Services*. Congress noted that WMO-No. 1083 officially replaced WMO-No. 258 on 1 December 2013 as the main guidance for education and training of meteorologists and meteorological technicians in accordance with Resolution 32 (Cg-XVI). Congress recalled that Volume II of WMO-No. 258 addressed the education and training of hydrological personnel. Congress noted that the Commission for Hydrology anticipated replacing this publication in the 2016–2019 financial period with a new Volume to WMO-No. 1083. Congress noted that the name of WMO-No. 1083 would change to *Guide on the Implementation of Education and Training Standards in Meteorology and Hydrology*, Volume I on 1 January 2016. The small

change in title was necessary for consistency with WMO regulatory material. The publication number would remain the same.

5.2.3 Congress noted the work undertaken by the WMO Education and Training Office to capture Member information regarding the staffing numbers and staff profiles of their NMHSs. Congress further noted that the data was incomplete and that the staff numbers in areas such as hydrology, climate and environmental monitoring are probably under-reported on a national basis as these activities can be carried out under agencies other than the NMHS. Congress considered that even with the limitations noted above this data was very useful for planning, prioritization and monitoring purposes and requested that a follow-up survey be taken in the 2016–2019 financial period. Congress was advised that the Caribbean Institute of Meteorology and Hydrology (CIMH) was collecting similar data for the British Caribbean Territories and would share this with the Secretariat. Congress was further advised that CIMH were offering to share the database structure with Members and other WMO Regional Training Centres to enable more consistent reporting. Congress encouraged the Regional Association Management Groups to gather such information and to report to the Education and Training office as an important element of their regional monitoring and evaluation responsibilities. This is particularly important for the least developed countries that are under-represented in the current statistics and potentially require the most assistance.

5.2.4 Congress recalled its discussions on resource mobilization and development partnerships during this session (agenda item 5.5) and noted its deep appreciation to Members for their direct and indirect contributions to the Education and Training Programme under the Voluntary Cooperation Programme. Congress noted with pleasure that this funding continued to include South–South and East-West funding as well as the more traditional North–South funding. Congress recognized the significant support received from the Governments of Canada and Norway for education and training under their GFCS trust funds that have assisted many countries in Africa, the Caribbean, South-East Asia and the South-West Pacific with short-term training in climate service areas as well as instrument calibration and maintenance. Whilst this level of voluntary support was heartening, Congress recognized that even more voluntary support would be required in the seventeenth financial period to assist Members, particularly those from developing and least developed countries, to address the education and training issues associated with the high priority areas and implementation of WMO Strategies such as Gender Mainstreaming, Service Delivery and Capacity Development. Congress called upon Members and the Secretary-General to work with aid agencies and other bodies in their region and countries to attract this additional support, particularly encouraging the development agencies to enable the NMHSs to directly execute the funds. Congress encouraged donors to work with WMO Regional Training Centres to offer fellowships at those RTCs. Congress noted that under CLIMANDES project phase I (2012–2015) between the National Meteorological Service of Peru (SENAMHI), MeteoSwiss, the Swiss Development Corporation and WMO funds had been identified to provide fellowship support to fellows at the RTC in Peru (UNALM) and that discussions were underway for further fellowship support under a proposed phase II project for 2016–2018.

Education and Training Programme

5.2.5 Congress reviewed the Programme activities proposed in the WMO Operating Plan and budget for 2016–2019, and agreed that during the seventeenth financial period the ETRP should continue to be given high priority by the Organization, in order to pursue its support to Member countries in human resources development of their NMHSs under Expected Result 6 (ER 6).

5.2.6 Congress recommended that particular emphasis should be placed on the following approaches which will support each of the high-priority areas identified for the next financial period:

(a) Providing increased assistance to least developed countries (LDCs) and small island developing States (SIDS) in planning, management and implementing human resources development (HRD) activities in their NMHSs;

(b) Promoting international cooperation in order to more efficiently utilize the wealth of education and training resources available worldwide in multiple languages and different formats; and supporting distance and e-learning activities in meteorology, climatology, hydrology and other relevant topics;

(c) Encouraging quality education by stimulating national/international accreditation of training institutions and programmes, and professional certification of NMHS personnel;

(d) Supporting school and popular education in meteorology, climatology and hydrology, and contributing to the increase of public awareness on disaster risk reduction, prevention and mitigation as well as climate change science, adaptation and mitigation options. Promoting careers in weather, water and climate, particularly for women;

(e) Preparing programme or project oriented training programmes and packages, in collaboration with technical commissions and regional associations, to assist the capacity development activities and improvements in the technical infrastructure of NMHSs;

(f) Improving cooperation and exchange of the experts among the RTCs and establishing a database of qualified lecturers on particular subjects for required training activities.

5.2.7 Noting the amended description of the Education and Training Programme (see Annex XI to the present report) Congress adopted Resolution 51 (Cg-17) – Education and Training Programme.

WMO Regional Training Centres

5.2.8 Congress recalled that the concept of WMO Regional Training Centres (RTCs) was more than 50 years old with the network of RTCs growing from a small number in the early 1960s to 26 RTCs composed of 38 institutions in 2014. Congress noted that these 38 institutions in 26 different countries included universities, NMHS training institutes, training institutes in other government departments and regional bodies such as the Caribbean Institute of Meteorology and Hydrology in Barbados and AGRHYMET and EAMAC in Niger. The common element to all of them is that they have all offered, and most do, to provide specialist education and training to address the needs of WMO Members in their Region and beyond. Congress appreciated that EC-64 had undertaken a review on the future role and operation of RTCs and that EC-66 had subsequently updated the EC Criteria for the recognition and reconfirmation of RTCs on the basis of the review. In light of the need for continuous improvement, service delivery and quality management, Congress supported EC's decision to make renewal of RTCs dependent upon performance. Congress also agreed with EC's decision that each regular regional association session consider whether to recommend renewal of the RTCs in the Region. Noting that a number of the RTCs not only address the needs of their home regional association but actively contribute to the needs of other regional associations, Congress requested that the regional associations take this cross-regional support into account when considering reconfirmation of RTCs located in their Region based on recommendations and/or advice from the Secretary-General. Congress acknowledged that for the RTCs to be aware of, and be able to address, regional education and training needs there needed to be regular communication and close coordination between the regional association, the host country and the RTC and its components. Without this integration and support Congress noted that it would be very difficult for the RTCs to be effective which could negatively impact upon Members, particularly the least developed countries and small island developing States. Congress welcomed the development of a handbook that would assist all parties involved in an RTC to know and carry out their obligations. Congress further noted that the handbook should be published before the end of 2015.

5.2.9. In addition to the traditional areas covered by university based RTCs or RTC components Congress recognized the need for RTCs to cover specialized areas related to priority activities such as aviation, climate services, disaster risk reduction, the cryosphere and urban meteorology. Congress noted that the RTC in Kenya was now offering post-graduate studies in

specialized fields such as aeronautical meteorology and emerging areas such as climate change and encouraged other RTCs not offering specialist courses in these areas to follow suit.

5.2.10 Congress recalled that EC-64, noting the review into the future roles and operations of RTCs, had limited the duration of reconfirmation of RTCs decided during this financial period to 31 December 2015. This was to allow for any changes in the RTC review, recognition and reconfirmation processes. Noting that future reconfirmations of existing RTCs could not occur until at least the EC session after each regional association session, Congress agreed to extend the reconfirmation of the RTCs in China, India and Uzbekistan to 31 December 2017, the RTCs in Indonesia, Israel, the Russian Federation and Turkey to 31 December 2018, and the RTC in Kenya to 31 December 2019. Congress was advised that the EC Panel of Experts had considered the reports on the nomination from the Republic of Korea for a new WMO RTC, the reconfiguration of the RTC in Brazil, the possible addition of the Department of Hydrology in the Indian Institute of Technology (Roorkee) as a new component to the RTC in India and the review of the RTC in Niger with two components based at EAMAC and AGRHYMET. Congress noted that the EC Panel of Experts on Education and Training recommended the recognition of the Republic of Korea as an RTC, the addition of a new component to the RTC in India, reconfiguration of the RTC in Brazil and reconfirmation of the RTC components in Niger. Congress further noted that the EC Panel had identified a number of items that each of the RTCs would need to address prior to subsequent consideration for reconfirmation. Congress adopted Resolution 52 (Cg-17) – Recognition and reconfirmation of WMO Regional Training Centres.

Competence Standards and Requirements

5.2.11 Congress appreciated the work being undertaken in the technical commissions and ETRP to develop competence standards and requirements for the core job-tasks in meteorology, climatology and hydrology (summary available at https://www.wmo.int/pages/prog/dra/etrp/competencies.php). Congress noted that specific recommendations related to competence standards and requirements for WIS, PWS, marine meteorology and climate were discussed under appropriate agenda items in this session. Congress requested that all technical commissions continue to make this a high priority activity and incorporate regular reviews of their competency frameworks into their work programmes.

5.2.12 Congress noted that the ETRP, in partnership with technical commissions such as the Commission for Aeronautical Meteorology, plan to provide more detailed guidance to assist Members to adapt, implement and assess the top-level competence standards and requirements through a Guide for Competency Development and Assessment that will support the implementation of the competency requirements in the Technical Regulations. Congress noted the need for such a document to assure consistent assessment of the competency of operational staff, particularly those involved in the provision of meteorological services to international air navigation. Congress requested the Executive Council to progress this publication as a high priority activity and to continue their assistance to the technical commissions in the development and update of competence standards and requirements.

Fellowship Activities

5.2.13 Congress was informed about the continuing measures taken in the Secretariat to enhance fellowship activities and to improve their effectiveness and transparency. Ongoing reform measures included: increased communication with Members, fellows and training institutions; more timely processing of requests for fellowships; monitoring and evaluation of fellows during and after the completion of studies; reviewing the policies and procedures for nomination and selection of WMO fellows. Congress was pleased to note the satisfactory collaboration of the training institutions in the monitoring and evaluation of the fellows studying in those institutions, but expressed concern that despite increased surveillance from the Secretariat there is still a relatively low-level of response from some beneficiary countries in providing feedback on the fellows' performance upon their return home. The Congress restated its support for the decision taken by EC-LVIII (June 2006) that no further fellowship awards would be considered for the Members

whose Permanent Representatives did not provide the required post-fellowship reports and requested the Secretary-General to enforce this decision for the 2016–2019 financial period.

5.2.14 Congress noted that the Executive Council had reviewed its criteria for selection of fellows during the current financial period. Congress further noted that the revised criteria included addressing the request from the last Congress that some consideration be given to providing support for fellows to study in their own country. Given the high demand for fellowships, Members are encouraged to seek all means to contribute towards cost sharing of fellowship expenses in an effort to stretch the limited resources further. Congress appreciated that the WMO Fellowship Manual had been updated and a new publication WMO-No. 1104, *Guidelines for applying for a WMO Fellowship*, had been produced in English, French, Russian and Spanish to assist Members better understand the processes and requirements. Congress requested the Secretary-General to investigate options for translating WMO-No. 1104 into Arabic and Chinese within available budget resources. Congress further appreciated that an online application process for fellowships was under development and would be available in the near future.

5.2.15 Congress expressed the need for additional funding for the fellowships programme to meet the increasing demand. It noted with appreciation the generous contributions of VCP and other donor countries in providing support for fellowships, and appealed to all Members to further increase their contributions.

WMO Global Campus Feasibility Study

5.2.16 Congress recalled Resolution 31 (Cg-XVI) related to the WMO Education and Training Programme. Congress in particular recalled its decision that the work of the ETRP should be carried out via collaboration with national and international partners and that special emphasis should be placed on promoting and supporting the exchange and sharing of training resources and expertise, including e-learning. Congress further recalled that Resolution 31 (Cg-XVI) requested EC to further elaborate on the proposal for a consortium of RTCs, NMHSs and other institutions to develop an accredited online course that would meet the Basic Instruction Package – Meteorology requirements. Congress noted that the WMO Global Campus feasibility study endorsed by EC-66 was a first step towards these goals. Congress further noted that the purpose of the WMO Global Campus is to provide a framework or mechanism for the many WMO affiliated institutions (particularly RTCs) involved in providing education and training support to Members to learn from each other, coordinate courses and training resources and collaborate to develop and deliver courses in multiple languages for Members. Congress also noted that the concept of a WMO Global Campus had been first discussed at the WMO Education and Training Symposium in Toulouse in September 2013 and was included in the recommendations of an EC Panel of Experts on Education and Training task force looking at the future roles and operations of WMO RTCs in 2014. Congress appreciated the effort taken by the Executive Council, through its Panel of Experts on Education and Training and the steering committee it has formed on the feasibility study, to fully involve the WMO education and training community in the development of the WMO Global Campus proposal. Congress also appreciated that the feasibility study was reaching out to new partners whose input could complement those provided by institutions such as RTCs and support WMO Members and their NMHSs in developing further capability in the high priority areas for the 2016–2019 financial period.

5.2.17 Congress noted with pleasure that the Brazil proposal recommended by RA III during its sixteenth session was an example of the WMO Global Campus proposal but on a national scale. Congress further recognized that the RTC recommended by RA II at its sixteenth session for the Republic of Korea would contribute an accredited online BIP-M course to the WMO Global Campus feasibility study as part of its RTC activities. Congress further recognized the Spanish language blended learning course offered by Spain through AEMET to address the BIP-M qualification requirements of the Ibero-American countries as another example of an activity that could fall within the concept of the WMO Global Campus.

5.2.18 Congress was advised that in October 2014 in Geneva the WMO Global Campus concept had been further elaborated by more than 20 representatives in the WMO education and

training community (RTC Directors, heads of national training institutions and representatives from WMO partner organizations such as EUMETSAT, EUMETNET and UNESCO-IOC) and more recently it has been the focus of a meeting of RTC Directors (Langen, Germany, March 2015). The outcomes from the October 2014 meeting included many of those present offering activities to support the feasibility study and, following an active and lengthy debate, an endorsement of the name WMO Global Campus. In March 2015 the RTC Directors discussed the concept at length, identifying potential benefits for the Members and challenges in implementing the concept. Congress further noted that the RTC Directors had made suggestions to the WMO Global Campus steering committee regarding the desirable features for a phase one implementation and prioritized the challenges that the WMO Global Campus steering committee should investigate in order to deliver the desired features for phase one which could occur in the financial period following Cg-18 in 2019. The WMO Global Campus steering committee also agreed on a set of guiding principles for involvement of WMO RTCs and WMO affiliated institutions in the WMO Global Campus. The EC Panel of Experts on Education and Training will further discuss the guiding principles at their next session.

5.2.19 Congress was advised that the WMO Global Campus steering committee subsequently endorsed the suggestions from the RTC Directors regarding the desirable features for a phase one implementation of the WMO Global Campus and these recommendations were subsequently accepted by the Chairperson of the EC Panel of Experts on Education and Training. Congress further noted that the WMO Global Campus steering committee had recommended the development of three demonstration activities prior to EC-70 in 2018 as part of the extension of the feasibility study: a searchable online calendar that brought together in one website as many as possible education and training activities offered by WMO RTCs and WMO affiliated institutions to assist Members in identifying education and training opportunities for the staff of their NMHSs; further development and delivery of teaching and learning resources that would result in a course or courses supporting aeronautical meteorological personnel competencies in multiple languages suitable for face-to-face and/or online delivery; and, commence the development of a course or courses supporting climate services in multiple languages suitable for face-to-face and/or online delivery. The climate services course or courses, initially focusing on climate and adaptation issues would build upon the lessons learnt from the existing collaborative developments, further enhancement of the aeronautical meteorological course(s) and outcomes from the Commission for Climatology regarding competencies for personnel involved in the provision of climate services. Congress noted that the WMO Global Campus steering committee anticipated that these activities would be funded through focusing of activities already planned under the WMO regular budget and supplemented by voluntary resources where possible.

5.2.20 Congress recognized that whilst the feasibility study was already showing positive benefit for WMO and its Members, further work was needed before the introduction of a WMO Global Campus could be formally considered. Congress thanked those Members who had conducted activities in the feasibility study, particularly the United Kingdom of Great Britain and Northern Ireland for the contribution of a seconded officer to support this work. Congress thus decided that the feasibility study should continue and its progress be monitored and reviewed by the Executive Council with the view of a fully developed proposal being considered at the Eighteenth World Meteorological Congress in 2019. Congress adopted Resolution 53 (Cg-17) – WMO Global Campus feasibility study.

School and Popular Education

5.2.21 Congress noted the long-term importance of promoting knowledge and awareness of meteorology, climatology and hydrology to students at different educational levels and the population at large to not only ensure a public able to use the services from the NMHSs but to also attract new people to careers in weather, water and climate. Congress welcomed the recommendations from the Gender Dimensions of Weather and Climate Services Conference hosted by WMO in Geneva in November 2014 calling for particular attention to be paid to attracting and supporting women in careers in weather, water and climate.

5.2.22 Congress recognized that attracting youth, particularly women, to careers in science was an issue shared with many other scientific and technical organizations. Congress further recognized that within the limited budget envelope for the next financial period, advancements in this area would come about primarily through the activities of the Members at their national level engaging their Ministry of Education and professional societies to cooperate in promoting and incorporating meteorology, climatology and hydrology into school and university curricula. Congress requested the Secretary-General to continue to work with other UN organizations such as UNESCO, to promote and highlight science in general to the students and the public, particularly careers options in weather, water and climate. Congress further requested Members and the Secretary-General to continue their engagement with groups such as the Globe Project to ensure consistency of approach and content in their promotion of scientific awareness and literacy through their global networks.

5.3 Programme for the Least Developed Countries, Small Island Developing States and Member Island Territories (agenda item 5.3)

Least Developed Countries

5.3.1 Congress recalled that the Least Developed Countries (LDCs) are a group of countries that have been classified by the UN as “least developed” in terms of their low gross national income (GNI), their weak human assets and their high degree of economic vulnerability. There are 34 LDCs in Africa (Angola, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, South Sudan, Sudan, Togo, Uganda, United Republic of Tanzania and Zambia), eight in Asia (Afghanistan, Bangladesh, Bhutan, Cambodia, Lao People’s Democratic Republic, Myanmar, Nepal and Yemen), five in the Pacific (Kiribati, Timor-Leste, Tuvalu, Vanuatu and Solomon Islands) and one in the Caribbean (Haiti), making a total of 48 LDCs. Moreover, nine Small Island Developing States (SIDS) are LDCs and of the 31 Landlocked Developing Countries (LLDCs), 16 are classified as LDCs.

5.3.2 Congress further recalled that the Least Developed Countries are characterized by extreme poverty, inadequate institutional and productive capacity, and other vulnerabilities and constraints. The LDCs constitute the weakest segment of the international community and their economic and social development represents a major challenge for themselves as well as for the international community.

5.3.3 Congress noted that since the Sixteenth Congress assistance has been provided to many NMHSs of the LDCs through the WMO Programme for the LDCs and other regular and extrabudgetary activities of the Organization. However, considering the obstacles and constraints encountered in addressing the special needs of the LDCs, it was recognized that further efforts were required to enhance the capacities of most of the NMHSs concerned to enable them to contribute effectively in the sustainable development of their respective countries. In this respect, Congress requested the Secretary-General to take all the necessary measures through all WMO scientific and technical programmes to give higher and visible priority to LDCs, particularly in their assistance and capacity development activities.

5.3.4 Noting the importance of the WMO Programme for the LDCs and the high priority to be continually attached to it, Congress reiterated the specific objectives of the programme of Action for the LDCs for the decade 2011–2020 with the aim of enabling half the number of LDCs to meet the criteria for graduation by 2020, including the following objectives that require contribution and support from WMO and NMHSs:

(a) Build viable national productive capacity in all sectors, particularly infrastructure, energy, transport, and other weather, climate and water sensitive sectors;

(b) Promote agriculture, food security and rural development strategies that strengthen support for smallholder farmers and contribute to poverty eradication;

(c) Invest in basic services for health, education, water and sanitation;

(d) Strengthen the resilience of LDCs by reducing their vulnerability to economic, natural and environmental shocks and disasters, as well as climate change and, enhancing their ability to meet these challenges, particularly climate change adaptation and mitigation;

(e) Promote science and technology for peaceful and development purposes, including strengthening national and regional institutions, as appropriate and in line with LDCs national development priorities;

(f) Strengthen the global partnership and public-private partnerships for inclusive economic growth and sustainable development of LDCs.

5.3.5 During the Ministerial Conference on New Partnerships for the Development of productive Capacities in LDCs organized by the UN Office of the High Representative for Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (OHRLLS) held in Cotonou, Benin from 28 to 31 July 2014, the Ministers adopted “Cotonou Agenda for productive capacity-building in LDCs” where they call for enhanced support to LDCs to achieve the overarching goal, set out in the IPoA, of enabling half of them to meet the criteria for graduation by 2020.

5.3.6 In this connection, Congress appealed its Members to provide special assistance to LDCs, including contribution to the WMO Trust Fund for the NMHSs of LDCs.

5.3.7 Congress noted that the Regional Workshop on the Implementation of Weather and Climate Services in LDCs in Asia was organized by WMO in Thimphu, Royal Kingdom of Bhutan from 9 to 11 September 2014. The Workshop brought together participants from the NMHSs of the eight Asian LDCs and provided an opportunity to share experiences and identify common challenges that can be tackled adopting a regional approach. Immediate priorities include the improvement in quality and availability of observations, the provision of tailored weather forecasts and warnings and climate prediction to support decision-makers, establishing national frameworks for weather- and climate-related services, enabling better linkages with users, improving forecast products and public weather services as well as implementing the recently published WMO Strategy for Service Delivery (SSD) using its Implementation Plan.

5.3.8 Congress noted that the Secretariat is supporting LDCs in a numbers of ways. One of the most important assistance rendered since the Sixteenth Congress was through the award of fellowships. About 90% of LDCs benefited from fellowships, with beneficiaries from those countries constituting 46% of the total number of awards globally.

5.3.9 Congress encouraged the Secretary-General and Members to continue to support initiatives in LDCs in integration of NMHSs activities and products into socioeconomic development frameworks, strategies and priorities at national and regional level, thereby raising their profile.

5.3.10 Congress noted that the fourth United Nations Conference on the LDCs (Istanbul, Turkey, May 2011) adopted a New Programme of Action for the LDCs for the Decade 2011–2020. The Programme, known as the Istanbul Programme of Action (IPoA) contains many references of direct interest to the World Meteorological Organization (WMO) and the National Meteorological and Hydrological Services (NMHSs). In response to the Istanbul Declaration which urged United Nations organizations and Governments to renew and strengthen global partnership for the development of LDCs, the Sixteenth World Meteorological Congress in May–June 2011 decided to continue and enhance the WMO Programme for the LDCs to address the obstacles and constraints limiting NMHSs in LDCs to provide relevant weather, water and climate information and

services and to strengthen their capabilities to meet the demands and requirements of the priority areas for action in IPoA.

5.3.11 Noting the efforts made by the Secretary-General and Members in the implementation of the WMO Programme for LDCs, Congress decided to continue and support the WMO Programme for LDCs (see updated Programme Description given in Annex XII to the present report) and further decided that the Resolution 33 (Cg-XVI) shall remain in force in the seventeenth financial period.

Small Island Developing States (SIDS) and Member Island Territories

5.3.12 Congress recalled that since 1970, more than 650 hydrometeorological disasters have impacted Small Island Developing States (SIDS) and Member Island Territories, affecting more than 35 million people and causing approximately US$ 34 billion in damage. While many SIDS are already enhancing their weather and climate services in their respective countries, they remain isolated geographically and are highly exposed to risks from extreme weather events and other adverse impacts of climate change and in need of support for further sustainable modernization of services.

5.3.13 Congress was informed of the outcomes of the Third International Conference on Small Island Developing States (SIDS Conference) which took place in Apia, Samoa from 1 to 4 September 2014, whose outcome was the "Samoa Pathway" – a sustainable development strategy for SIDS.

5.3.14 During the SIDS Conference WMO launched a partnership for strengthening weather and climate services in SIDS. WMO plans to contribute to the implementation of the "Samoa Pathway" through engagement with the UN Implementation Matrix and through the SIDS partnership.

The following results are expected from the partnership through to 2019:

(a) Improved delivery of weather and climate information services;

(b) Enhanced human and technical capacities at national and regional climate centres;

(c) Increased range of products and services delivery to stakeholders;

(d) South-South/North-South Cooperation fostered;

(e) Expansion of the infrastructure required for weather and climate research and services.

5.3.15 Congress noted that WMO already has significant actions underway in support of enhanced weather and climate services in SIDS.

5.3.16 In this regard, Congress approved the creation of a programme and adopted Resolution 54 (Cg-17) – Programme for WMO Small Island Developing States and Member Island Territories.

5.4 Regional Programme, including cooperation with regional bodies (agenda item 5.4)

Regional activities and regional offices

Regional activities

5.4.1 Congress reviewed the progress of the Regional Programme (RP), during the sixteenth financial period, as well as the actions taken by the Secretary-General as follow-up to its decisions and those of the Executive Council and regional associations (RAs) related to the Programme. It noted that the Regional Programme, implemented by the six RAs and supported by the Secretariat including WMO Regional Offices and WMO Offices in the Regions, continued to implement

relevant resolutions of Congress, the Executive Council and regional associations and coordinate Members' activities in their respective Regions.

5.4.2 Congress was pleased to note that all RAs have developed and implemented their Regional Strategic/Operating Plans during the sixteenth financial period, contributed to the WMO Strategic Plan 2016–2019 and developed their Operating Plans 2016–2019, which are part of the WMO-wide Operating Plan 2016–2019.

5.4.3 Congress noted that RAs have promoted and supported the implementation of the WMO priorities and various WMO Programmes, through their subsidiary bodies and in collaboration with technical departments, Regional Offices and technical commissions including development/implementation of Regional WIGOS/WIS Implementation Plans, organization of Climate Outlook Forums and implementation of Regional Climate Centres, organization of tropical cyclone body sessions and various training events.

5.4.4 Congress noted that the RP contributed to strengthening NMHSs and improving their capacity to provide better products and services. Relevant information on the attained results and identified priorities and challenges by the regional associations is provided under agenda item 2.4.

5.4.5 Congress noted that the Meetings of Presidents of Regional Associations and the Executive Council considered and agreed to the proposal for the better definition of the role and responsibilities of RAs: organizing and coordinating regional activities; identifying and addressing needs of Members; establishing requirements for regional networks and facilities; regional planning and monitoring as part of the WMO integrated planning process; establishing adequate regional subsidiary structure, and building and promoting regional partnerships, as provided under agenda item 13.3.

5.4.6 Congress noted that meetings of Directors of NMHSs were held by economic groupings in Africa (such as Economic Community of Western African States (ECOWAS); Economic and Monetary Community of Central Africa (CEMAC); Economic Community of Central African States (ECCAS); Southern African Development Community (SADC) through the Meteorological Association of Southern Africa (MASA); Intergovernmental Authority on Development (IGAD) and East Africa Community (EAC)), the League of Arab States (LAS), the Gulf Cooperation Council (GCC), the Association of Southeast Asian Nations (ASEAN), the Commonwealth of Independent States (CIS), the Pacific Meteorological Council (PMC), Ibero-American countries and Western/Central/South-Eastern Europe, to discuss issues specific to NMHSs in their subregions.

5.4.7 Congress noted that high-level meetings were held in the Regions that served to promote the role and operation of NMHSs and to bring the institutional support of decision-makers for the effective participation of NMHSs in the development of their respective countries and for their visibility during the sixteenth financial period.

5.4.8 Congress noted that the Second and the Third Sessions of the African Ministerial Conference on Meteorology (AMCOMET) were successfully held in Zimbabwe in October 2012 and in Cabo Verde in February 2015, respectively, jointly by WMO, the African Union Commission (AUC) and the Governments of host countries with the financial support from the several partners.

5.4.9 Congress noted that AMCOMET discussed and approved the Integrated African Strategy on Meteorology (Weather and Climate Services) which was endorsed by the African Union Summit of Heads of State and Government. AMCOMET-3 approved the Praia Ministerial Statement, the Constitution and Rules of Procedures of AMCOMET and the Implementation and Resource Mobilization Plan for the Integrated African Strategy on Meteorology (Weather and Climate Services). AMCOMET also discussed a number of priority matters as reported under agenda item 2.4.

5.4.10 Congress noted that ministerial conferences on meteorology were also held during the intersessional period by the Caribbean Meteorological Council (November 2012, 2013 and 2014) and the League of Arab States (March 2012 and April 2015). Congress also was pleased to note

the First Meeting of Ministers Responsible for Meteorology in the Pacific Region was planned as part of the Secretariat of the Pacific Regional Environment Programme (SPREP) Officials Meeting (July 2015).

Regional Offices

5.4.11 Congress reaffirmed the important role of the Regional Offices as focal points for information on regional activities and for assisting Members develop their NMHSs, and commended the continued efforts by the Regional Offices in supporting the work of the RAs, their presidents and subsidiary bodies, as well as in providing assistance to Members in implementing the various technical and scientific programmes in the Regions.

5.4.12 Congress was informed that at the request of Cg-XVI, the Secretary-General undertook a review of Regional Office locations. The review was undertaken in consultation with Members of RA I (Africa), RA II (Asia) and RA V (South-West Pacific), with a special focus on efficient and effective management and operation of the Offices for Africa and LDCs (AFLDC) and the Regional Office for Asia and the South-West Pacific (RAP Office).

5.4.13 Congress expressed its deep appreciation to the Governments of India, Indonesia, Philippines, Qatar and Singapore for their offers to host the RAP Office and to the Governments of Egypt, Ethiopia, Kenya, Nigeria and Tunisia for their offers to host AFLDC Offices.

5.4.14 Congress commended the review conducted by the Secretariat on the relocation of Regional Offices and encouraged the presentation of a plan on the modalities of the relocation during the intersessional period. Congress noted that Kenya appreciates being considered to host the AFLDC Offices since it hosts other UN Offices including UNEP, the WMO Office for Eastern and Southern Africa, the IGAD Climate Prediction and Application Centre (ICPAC), the Climate Change Secretariat, IGAD HYCOS, MESA for IGAD Region, Regional Air transport hub, including provision for free office space, utilities and security, among others. Congress noted that Nigeria, which hosts the WMO Office for Northern, Central and West Africa (NCWA Office), expressed its willingness to host the AFLDC Offices and the effectiveness and cost-saving due to the colocation of the AFLDC and NCWA Offices. Congress noted that Indonesia expressed its appreciation for the site visit of the WMO evaluation team to Jakarta and reiterated the strong support of its Government for the relocation of the RAP Office to Jakarta. Congress also noted that the Philippines expressed its willingness to host the RAP Office.

5.4.15 Congress recognized that the Secretary-General organized and conducted a comprehensive evaluation of candidate locations for the RAP and AFLDC Offices, which was carried out using evaluation procedures and methodology as well as the criteria for the assessment of the candidate locations that were agreed by the Management Groups of RA I, RA II and RA V. Recognizing the advantages of the location of the Office being in the Region, in particular in terms of efficiency and cost-effectiveness, while also recognizing the need to ensure coordination with the WMO Secretariat in Geneva, Congress requested the Secretary-General to expedite the review and selection of AFLDC Offices and the RAP Office locations, including consultation with regional presidents, as appropriate, with a view to gaining benefits for the Regions within available resources during the next financial period.

5.4.16 Congress noted with appreciation the ongoing process towards establishment of an Eurasian Office in Minsk, Belarus based on the initiative of the Interstate Council on Hydrometeorology of the Commonwealth of Independent States (CIS/ICH). Congress was further encouraged by RA VI and RA II consultations on the support for WMO activities that this Office could provide for Members in RA VI and RA II, noting that these consultations were supported by EC-66 (para. 2.4.43). Congress welcomed the readiness of Belarus to provide in-kind support for a WMO Eurasian office and requested the Secretary-General to pursue with Belarus and CIS, without delay, the possible arrangements for this cooperation, with the understanding that no regular budget funding would be provided during the seventeenth financial period.

5.4.17 Congress noted with appreciation that the Secretary-General assigned the function of regional coordination to a dedicated officer within the Development and Regional Activities Department (DRA) to improve coordination among Regional Offices and particularly among technical departments in Geneva and the WMO Offices in the Regions. Congress also appreciated the recently implemented improvements in video-conferencing and remote access by the WMO Offices in the Regions to WMO's financial and administrative management system that would further improve coordination and efficiency.

5.4.18 Congress felt that the WMO Regional Offices and the WMO Offices in the Regions should be reinforced within available resources to increase their efficiency and effectiveness in enhancing the visibility of NMHSs and adequately address the expectations and priorities of the Regions, and requested the Secretary-General to consider adapting the activities of these Offices to address the expanding needs of NMHSs in the Regions, to increase efforts building institutional support, to assist in extrabudgetary resource mobilization and to support Members in the implementation of regional projects in key priority areas.

5.4.19 Congress noted that the presidents of RA III and RA IV expressed their concern about the retirement of the heads of the WMO Offices in Paraguay and Costa Rica at the same time in the coming year and requested the Secretary-General to take appropriate measures to ensure continuity of staff in these Offices.

5.4.20 Congress noted that some Members expressed their concerns about the limited staff and resources allocated to the Regional Offices leading to the limited services provided to Members in the responsible Regions and suggested some measures, including the possible secondment of staff by Members.

5.4.21 Congress noted the recommendations of Cg-XV and the discussions of Cg-XVI on networks of advisers to Permanent Representatives on international cooperation and external relations (INTADs) and the potential role which these INTADs could play in promoting greater efficiency of Members and teamwork with the Regional Offices. Congress also noted with concern the limited progress made by the INTADs in many Regions to promote international cooperation and communication during the intersessional period. In this regard, Congress, taking note of the benefits being accrued by those NMHSs with INTADS in operation, recommended:

(a) The designation of INTADs in those NMHSs which have yet to do so;

(b) The provision of advice and guidance to the INTAD activities by the Cabinet and External Relations Department and Regional Offices;

(c) Training sessions for INTADs within available resources;

(d) Facilitation of "online" sharing of knowledge and best practices amongst INTADs.

WMO Country Profile Database

5.4.22 Congress recalled that Cg-XV requested that a County Profile Database (CPDB) be developed to consolidate information collected by individual WMO Programmes and departments/ offices and which ultimately could assist WMO and development partners follow the status of and needs of NMHSs. Congress also recalled that Cg-XVI reviewed the process towards the development of the CPDB and stressed that it is important that Members have access to the information contained in the database, especially with regards to their own NMHSs and that the mechanism for reviewing and updating the CPDB information and requirements would require regular feedback from Members.

5.4.23 Congress was pleased to note that the Initial Operating Capacity of the CPDB had been released following EC-66. Congress noted that CPDB (which can be accessed at https://www.wmo.int/cpdb/) provides the geographical/organizational information (e.g. WMO-No. 5 – Permanent Representatives), the institutional information (e.g. questionnaire survey results),

programmatic and technical information (e.g. national observation network), the information on capacity-building (e.g. training, modernization projects), and information on monitoring and evaluation (e.g. WIS operational statistics), consolidating various data-sources available at the Secretariat.

5.4.24 In this regard, Congress requested Members to keep under review the CPDB with regard to ensuring the accuracy and completeness of data and to maintain and update their country information through the appointment of national CPDB Focal Point(s) and with the assistance of the WMO Regional Offices. Congress requested the Secretary-General to ensure that the capability of CPDB will be further enhanced and maintained as part of the WMO IT architecture within available resources. Congress encouraged the regional associations and technical commissions to make use of the Country Profile Database to monitor progress of Members' implementation of planned programmes and activities with a view to identify gaps impeding their timely implementation, and to address these gaps including the provision of assistance to Members in need, in a timely manner.

Regional Programme in the seventeenth financial period

5.4.25 Congress agreed that the Regional Programme should be continued in the seventeenth financial period recognizing that it contributes to all Expected Results of the WMO Strategic Plan and Operating Plan 2016–2019 adopted under Resolution 69 (Cg-17), with particular focus on Priority: “Capacity Development”, and Expected Result 6: “Strengthened Capacity Development – Enhanced capabilities of Members’ NMHSs, in particular in developing and least developed countries and Small Island Developing States, to fulfil their mandates”.

5.4.26 Congress adopted Resolution 55 (Cg-17) – WMO Regional Programme.

5.5 Resource mobilization and development partnerships (agenda item 5.5)

Office for Resource Mobilization and Development Partnerships

5.5.1 Congress welcomed and strongly supported the various measures taken by the Secretary-General during the sixteenth financial period, as follow-up to its decisions and those of the Executive Council and regional associations related to the strengthening of resource mobilization activities. In particular Congress appreciated the re-designation of the Resource Mobilization Office as Office for Resource Mobilization and Development Partnerships (RMDP) to give more emphasis to the importance of leveraging on, and influencing the investments of the projects and programmes of development partners such as World Bank and UN Agencies as well as sourcing direct financing for WMO Programmes and NMHS development.

5.5.2 Congress noted the continuing enhancement of project management processes within the Secretariat. In particular, Congress appreciated the improved project management governance architecture put in place, with its various components: the Project Management Board (PMB) chaired by the Assistant Secretary-General and composed of Directors, and the Project Coordination Unit (PCU) with the recent recruitment of the Head of the PCU. Congress took note of the fact that through the PCU, with the strategic guidance and oversight by the PMB, more transparent, effective and efficient project management, including monitoring, reporting and coordination, has started rapidly evolving in the Secretariat.

5.5.3 Noting that WMO is significantly increasing its project-based activities regionally and globally, Congress also recognized that WMO will need to continue to enhance resource mobilization and project management capacities both in Geneva and in the Regional Offices.

5.5.4 Acknowledging that the WMO institutional infrastructure, WMO being a non-resident UN Agency, is less well suited to country by country project implementation than other development actors with strong in-country presence, Congress requested the Secretary-General to focus project-based activities on specific global and regional priorities, on demonstration projects with potential for upscaling and replication, on projects opening up new areas of service delivery and on

projects piloting innovative technology. Congress furthermore emphasized the need for improved coordination at the national and regional levels through the strengthening of Regional Offices and involvement of the advisers to Permanent Representatives on international cooperation and external relations (INTADs).

5.5.5 Congress felt that the WMO Regional Offices and the WMO Offices in the Regions should be reinforced to increase their efficiency and effectiveness in enhancing the visibility of NMHSs and to adequately address the expectations and priorities of the Regions, and requested the Secretary-General to consider adapting the activities of those Offices to address the expanding needs of NMHSs in the Regions, to increase efforts building institutional support, to assist in extrabudgetary resource mobilization and to support Members in the implementation of regional projects in key priority areas. In that connection, Congress called on Members to second experts to the WMO Regional Offices in various disciplines for agreed periods to assist the work of the RMDP on resource mobilization and project implementation at the regional and national levels.

Resource Mobilization

5.5.6 Congress commended the Secretary-General on the implementation of the RMDP Office and the Resource Mobilization Strategy 2012–2015. It welcomed the focus of the RMDP and RM Strategy on supporting the Technical Programmes, Regional Offices and National Meteorological and Hydrological Services to enhance the level of support and funding to activities aimed at development of NMHSs to reach the levels of services needed to support the protection of life, property and food security, with particular emphasis on the developing countries, Least Developed Countries (LDCs) and Small Island Developing States (SIDS) and in keeping with the Regional Strategic/Operating Plans and Strategic Development Plans.

5.5.7 Congress recognized that many Members benefited from extrabudgetary financed activities which covered a wide spectrum of development support, including the assessment and evaluation of the status of the National Meteorological and Hydrological Services, support for institutional development, infrastructure upgrades, strengthening regional networks and the preparation of national meteorological development plans, and enhancement of service delivery.

5.5.8 Congress noted that projects totalling some CHF 85 million in support of capacity enhancement of NMHSs were underway in West, Sub-Saharan and East Africa, South Eastern Europe, Central and South-East Asia, Pacific-Caribbean-Indian Ocean SIDS and the Americas.

5.5.9 Additionally Congress noted that voluntary contributions were also supporting the core activities of WMO technical programmes including the Agricultural Meteorology Programme, African Ministerial Conference for Meteorology, Coastal Inundation Forecast Demonstration Programme, Flash Flood Guidance, Least Developed Countries Programme, Small Island Developing States Partnership, Polar activities, Public Weather Service Programme, Severe Weather Forecast Demonstration Project, World Hydrological Observing System, Global Framework for Climate Services, and the joint WMO-WHO and WMO-WFP Offices for GFCS.

5.5.10 Congress welcomed the broad range of financing partners including Canada, China, European Commission (various Directorates), Finland, Germany, Greece, Italy, Ireland, Japan, Kingdom of Saudi Arabia, Norway, Qatar, Republic of Korea, Spain, Switzerland, United Kingdom, USA) and the scope of ongoing initiatives aimed at development and modernization of NMHSs and weather, climate and water services and the fact that all most all WMO Regions were benefitting.

Voluntary Cooperation Programme

5.5.11 Congress noted with satisfaction the achievements of the Voluntary Cooperation Programme (VCP), the NMHS to NMHS cooperation programme of the WMO community in particular the number of NMHSs of LDCs and developing countries supported during the period 2012–2015 and that projects were supported in many Member countries. More than 80 per cent of all the requests received during the period were supported. The streamlining of the VCP process has allowed the VCP to support projects through the Trust Fund and through coordinated efforts

with partner NMHSs and respond to the requests in shorter timeframes. Regions I and V benefited most from VCP projects during the financial period.

5.5.12 Congress noted that during this financial period, direct, in-kind and bi-lateral support through VCP amounted to an average financial equivalent of CHF 33–35 million per year across the WMO community (see annual Informal Planning Meeting reports at https://www.wmo.int/pages/prog/dra/vcp/eventsandmeetings.php). The contributions supported mainly expert services, short-term fellowships and training activities, surface observing stations, improvement of telecommunication systems, climate database management systems and other climatological activities, operational hydrological activities, and emergency assistance activities.

5.5.13 Congress expressed its appreciation to VCP donor Members for their valuable efforts in supporting the Programme and for their willingness to continue to do so. Noting further the continued and increased needs of Members for this type of support, Congress encouraged Members to expand this network by creating more linkages among NMHSs, bringing more Members in to support the VCP Programme and strengthening the spirit of cooperation within the WMO through more active participation in the Programme.

5.5.14 Considering that the demands on the VCP remain high, Congress urged Members to contribute to the VCP Trust Fund to ensure that the VCP can continue to provide this “quick time” response support to address immediate needs of Members in developing countries, LDCs and SIDS.

Partnerships

5.5.15 Congress welcomed the launch at the Third International Conference on SIDS (Samoa, September 2014) of a partnership for strengthening weather and climate services in Small Island Developing States. The new partnership will reinforce the capacity of SIDS to cope with weather-, climate-, and water-related extreme events. It will strengthen preparedness and multi-hazard early warning systems, and improve access to timely and user-friendly weather and climate information. The partnership will seek to do this in a systematic manner, rather than through a series of stand-alone projects. Congress welcomed the establishment and WMO engagement in the Task Force to coordinate with the Africa-Caribbean-Pacific European Development Fund (ACP-EDF) to finance this programme.

5.5.16 Congress in particular took note that, in addition to projects undertaken directly by WMO, there are increasingly significant global and regional investments in NMHS and weather, climate and water services by other entities including the World Bank (Pilot Programme for Climate Resilience (PPCR) and Global Facility for Disaster Risk Reduction (GFDRR)) covering 28 countries across most WMO Regions; the UNDP GEF/LDCF support for EWS to the National Meteorological Services and other line ministries (including disaster management, agriculture and water) in 10 countries in Africa; the proposed WMO-WB-GFDRR-Africa HydroMet Cooperation Framework Programme for which WMO has entered into a specific Partnership arrangement with the GFDRR to support implementation, to name the key ones.

5.5.17 Congress noted the participation of MMOP in the joint IHO/IMO/WMO/IOC/International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA)/International Atomic Energy Agency (IAEA) capacity development discussions within the United Nations system. Congress requested the Secretary-General and JCOMM to continue to share information and work closely with other UN agencies to effectively utilize joint resources in the delivery of marine/ocean-related capacity-building.

5.5.18 Congress welcomed the signing during Congress of a Memorandum of Understanding between WMO and the International Bank for Reconstruction and Development (IBRD) titled “A Collaboration Framework to Strengthen Climate and Disaster Resilience by enhancing Regional Meteorological and Hydrological Centres and Meteorological and Hydrological Services (NMHS) in Sub-Saharan Africa”.

5.5.19 Congress noted with appreciation China's contribution to capacity development activities, especially the ongoing meteorological aid projects to seven African countries under the initiative proposed at the Fifth Ministerial Conference of the Forum on China–Africa Cooperation.

WMO Support to National Investments in Weather, Climate and Hydrological Services

5.5.20 Considering the above, Congress requested the Secretary-General to strengthen the role of WMO as a provider of technical support and quality assurance for the investments of development agencies engaged in NMHS development projects and to formalize respective institutional arrangements with WB, GEF, UNDP and others as relevant to ensure that the mandate and core competencies of the WMO are leveraged to ensure effectiveness and sustainability of these investments in the longer term and to assist Members optimize the benefits of these investments.

5.5.21 Moreover, Congress considered that supporting NMHS to put in place medium- to long-term (5 to 10 years) strategic development plans for weather, climate and hydrological services would greatly enhance Members capacity to integrate the external investments directed towards modernization of NMHSs, and their observations and communications networks. Congress urged the Secretary-General to make this a priority for the next financial period and establish a specific process/facility to support this through training, guidance materials, twinning arrangements and advisory services.

5.5.22 Congress agreed with the recommendation of the Executive Council that in order to ensure sustainability of the investment in modern observation systems these should be recognized as Information and Communication Technology (ICT) items and integrated with ICT systems to be able to provide reliable information that is of vital importance to preserve human lives and livelihoods with high efficiency.

5.5.23 Congress also stressed the importance to provide adequate financing in order to assure the sustainability of the observing systems/networks especially in developing and least developed countries. In particular, Congress strongly recommended to donors and/or funding bodies taking an end-to-end approach to include in the projects, besides the initial investments in acquisition, installation, maintenance and training, adequate operational funds to ensure the sustained operation of observing systems and supporting activities for the period of at least 10 years.

5.5.24 In order to maximize sustainability, Congress requested that the Secretary-General should pay appropriate attention to this critical issue when considering any donation and/or funding from major development partners to investments in the observing systems of WMO Members. The Congress strongly recommended that the World Bank, the Asian Development Bank and other development partners take such actions to ensure the sustainability of investments.

5.5.25 Congress also acknowledged that WMO has a comparative advantage in bringing forward the needs and priorities of its Members for weather, climate and hydrological services into the global post-2015 development agenda linked to climate change adaptation and DRR. Since weather, water and climate services have strong development implications, it is paramount that WMO and its Members' NMHSs become key stakeholders in national development planning processes and in particular taking a strong strategic and pro-active approach with respect to the United Nations Development Assistance Framework (UNDAF) processes considering that 40 LDCs are embarking on UNDAF development currently and in the National Adaptation Plan (NAP) processes. In this regard, Congress noted that WMO was in the process of accreditation with the Green Climate Fund which would facilitate resourcing of weather and climate services.

5.5.26 Congress acknowledged the JCOMM capacity development activities to support Members in the conduct of marine meteorological and oceanographic observations, marine monitoring and the provision of services in support of marine safety.

6. BUILDING AND ENHANCING PARTNERSHIPS AND COOPERATION (agenda item 6)

6.1 Cooperation with the United Nations system and other international organizations (agenda item 6.1)

Cooperation with the UN System

WMO involvement in UN structures

6.1.1 The Congress noted the actions taken by the Secretary-General to strengthen cooperation with the United Nations system. These actions have been facilitated by activities of the WMO representative to the United Nations at the WMO Liaison Office in New York and achieved through the active participation of WMO senior officials in the sessions of the sixty-eighth session of the United Nations General Assembly and associated Committees. WMO officials have been deeply involved in the Task Team and Open Working Group for Sustainable Development Goals related to the post-2015 development agenda and have also contributed to the discussions at the Environmental Management Group (EMG), the High Level Committee on Programmes (HLCP), the High Level Committee on Management (HLCM), and the United Nations Development Group (UNDG). Continued efforts to promote the GFCS have also been made through targeted WMO senior level briefings to New York-based Missions and the World Bank in Washington DC.

WMO and the post-2015 development agenda

6.1.2 The Congress also acknowledged the critical importance of WMO engagement in consultations on the development of the post-2015 agenda within the Open Working Groups (OWGs) and noted that WMO had co-led the thematic Issue Brief on Climate and Natural Disasters with UNISDR and other UN partners. The Congress also welcomed the role played by the WMO Secretariat in contributing to other Issue Briefs, including in the areas of Poverty Eradication; Desertification, Land Degradation and Drought; Sustainable Agriculture; Health and Sustainable Development; Population Dynamics; Social Protection; Energy; Means of Implementation; Science, Technology and Innovation, Knowledge-sharing and Capacity-building; Sustainable Cities and Human Settlements; Sustainable Transport; Biodiversity; Forests; Gender Equality and Women's Empowerment; and Oceans and Seas. WMO prepared a proposal to the Environmental Management Group (EMG) which has focused on data provision to the Sustainable Development Goals (SDG's), particularly focusing on the nexus issues, such as food security, water, energy and climate change. WMO has also been closely involved in the discussions on the establishment of a High Level Political Forum (HLPF) replacing the Commission for Sustainable Development. Congress encouraged the Secretary-General to engage in mechanisms to strengthen the science/ policy dialogue and the future activities of this new body.

UN Climate Summit

6.1.3 Congress noted with satisfaction that the UN Secretary-General invited WMO, along with key partners UNESCO and UNITAR, to organize a thematic session on Climate Science at the Global Climate Summit in September 2014. This successful session, co-chaired by two Heads of State, the Presidents of Guyana and Mongolia, outlined the importance of scientific data and observations underpinning actions and decision-making by national governments and the international community in climate change. WMO has made major contributions to the climate summit through the provision of simulated TV forecasts showing the potential effects of climate change in 2050. These forecasts were delivered by a group of international weather presenters from developed and developing countries. Congress noted with appreciation that the WMO representative to the United Nations co-chaired a special interagency task team with the Secretary-General's climate change support team. This team examined the quantifiable impacts of the Climate Summit commitments across the various thematic areas of cities, energy, transportation, agriculture, and finance, etc. The final recommendations of this task team have been utilized by the Executive Office of the Secretary-General (EOSG) and other UN agencies to determine key outcomes of the Climate Summit.

United Nations Development Group (UNDG)

6.1.4 Congress was informed that there is a request for cost-sharing across all UN entities of the UN Resident Coordinator system managed by the United Nations Development Programme (UNDP), mostly in relation to the future post-2015 development agenda and that WMO had been invited by the UNDP Administrator to enter into an agreement with the United Nations Development Group (UNDG) in this regard.

6.1.5 Congress acknowledged that WMO enjoys the support of the UN Resident Coordinator system at the country level for a range of purposes, including security of personnel while on mission, assistance with procurement and customs clearance, assistance with financial transfers to support in-country activities and other matters.

6.1.6 Noting also that WMO participation in the UNDG is beneficial to Members and provides a platform to advocate for the role of NMHSs in development, and that participation to the Chief Executives Board for coordination (CEB) also provides an avenue for engagement with UN system partners at the highest levels, Congress considered the request for cost-sharing as formulated by the UNDG chairperson in November 2014, and agreed with the continued participation of WMO in the UNDG and authorized a contribution from WMO to the UN Resident Coordinator system at a level of USD 100,000 per annum for the financial period to the extent possible within budgetary resources for the financial period.

6.1.7 Congress requested Permanent Representatives of Members, subject to the approval of their respective governments, to maintain contact with the United Nations Resident Coordinator located in their countries on matters concerning the work of WMO to facilitate due consideration of WMO priority needs in United Nations country programmes.

UN GA and ECOSOC Resolutions

6.1.8 Congress took note of the resolutions of the sixty-eighth session of the UN General Assembly addressed to the UN specialized agencies and relevant to WMO, as referenced in the circular letter sent to the Permanent Representatives. Some 33 UN resolutions adopted during the 68th session have been identified to contain some relevance and linkages to existing WMO priorities and activities in areas including climate, water and food security, DRR as well as partnership and capacity development activities, among others. WMO has also followed and contributed to the important debates and resolutions of ECOSOC (Economic and Social Council) with a number of areas of relevance such as Science and Technology for Development.

Climate Change and UNFCCC

6.1.9 Congress conveyed its support for the actions taken to further strengthen the role of WMO in the UN system coordinated response to climate change, its contribution to the UNFCCC process, especially link the WMO GFCS with the UNFCCC Climate Adaptation Committee, and its proactive engagement in global climate activities through the UN inter-agency mechanism HLCP Working Group on Climate Change chaired by the WMO Assistant Secretary-General. Congress noted with satisfaction that a system-wide publication on actions on climate change was prepared for the UN Climate Summit and terms of reference of the group had been agreed by the HLCP and CEB.

UNCC: Learn

6.1.10 The Congress noted that WMO had been contributing to the work of the One UN Training Service Platform on Climate Change (UNCC: Learn) of UNITAR, a partnership of 33 multilateral organizations which supports Member States, UN agencies and other development partners in designing and implementing results-oriented and sustainable learning to address climate change. It noted that WMO contributed to the science section of an Introductory Learning Module (ILM) on Climate Change, covering six modules including climate science, policy, adaptation, mitigation, finance and planning. The modules provided interactive e-learning facility

and a mix of different approaches including visuals, explanatory text, videos, and quiz questions. The Congress welcomed this initiative, which marked the partnership between WMO and UNCC:Learn and supported expansion of the cooperation on producing an Advanced Learning Module (ALM), planned by the UNCC:Learn.

UN Water and WMO Chairmanship

6.1.11 Congress noted that the WMO Secretary-General had been appointed for two consecutive two-year terms starting in January 2012 as chairperson of UN-Water, the coordination mechanism of UN that has a water programme. Congress acknowledged the importance of the work of UN-Water at the international level and the visibility and added value that the WMO Secretary-General brings to these activities in his current capacity as chairperson. Congress also noted the added visibility that activities such as the International Year of Water Cooperation (2013), the annual celebrations of World Water Day and World Toilet Day, as well as high level events held at the UN Headquarters on water and disasters, sanitation and water for all, the definition of a Sustainable Development Goal and related targets on water, have brought WMO to the forefront of the international water community and beyond. This is reflected in the increased requests of cooperation WMO has received from UN entities, IGOs and NGOs and has contributed to an increase in resource mobilization for WMO in water-related and other projects.

Cooperation with other international organizations

6.1.12 Congress noted with satisfaction the actions taken by the Executive Council and the Secretary-General regarding the establishment and entry into force of: (i) a Memorandum of Understanding between WMO and the International Renewable Energy Agency (IRENA) to cooperate with a view to support the widespread and increased adoption and sustainable use of all forms of renewable energy; (ii) a Memorandum of Understanding between WMO and the World Federation of Engineering Organizations (WFEO) aiming at improving delivery of WMO climatic information and services to the engineering community; (iii) a Memorandum of Understanding between WMO and the World Farmers Organization (WFO) to cooperate in the fields of weather and climate applications for farmers, climate change impacts on agriculture, and promoting interactions between the agricultural and meteorological communities; (iv) a Memorandum of Understanding between WMO and the International Mobile Satellite Organization (IMSO) on cooperation in the field of maritime communication for safety and efficiency of navigation at sea; (v) a Memorandum of Understanding between WMO and the International Federation of Red Cross and Red Crescent Societies (IFRC) to extend their cooperation and joint activities under appropriate arrangements to achieve, inter alia, the main goal of the Global Framework for Climate Services (GFCS), which is to enable better management of the risks of climate variability and change and adaptation to climate change, through the development and incorporation of science-based climate information and prediction into planning, policy and practice on the global, regional and national scale; (vi) a Memorandum of Understanding between WMO and the International Union for Conservation of Nature and Natural Resources (IUCN) in the area of institutional, scientific and technical collaboration to define and meet the needs of the IUCN for Climate Information; (vii) a Memorandum of Understanding between WMO and Abdus Salam International Centre for Theoretical Physics (ICTP) to cooperate in the fields of weather, climate and water, with particular regard to research and modelling for understanding and predicting, and capacity-building in environment-related issues, especially in developing countries; and (viii) WMO has recently signed an agreement with the International Office for Migration (IOM). The WMO and IOM share mutual goals in contributing to the safety and welfare of humanity and the protection of life and property. In support of these goals, both WMO and IOM have a mutual interest and commitment to define the types and formats of climatic information products needed to perform their work. A close connection with GFCS will be established.

6.1.13 Congress acknowledged that an important agreement on water cooperation between WMO and UNESCO in the context of UN-Water and the two organizations' hydrological activities was signed at the UN Headquarters in New York on the sidelines of the General Assembly.

6.1.14 Congress noted that following the 2010 international BIPM–WMO workshop on Measurement Challenges for Global Observation Systems for Climate Change Monitoring: Traceability, Stability and Uncertainty and the signature of the Mutual Recognition Arrangement signed between WMO and the International Committee of Weights and Measures (CIPM), three laboratories had been designated to represent WMO in CIPM activities.

6.2 Report of the Chairperson of the Intergovernmental Panel on Climate Change (agenda item 6.2)

6.2.1 Congress expressed its appreciation to the former Chairperson of the IPCC, Dr Rajendra K. Pachauri, the Acting Chairperson of the IPCC Mr Ismail A.R. El Gizouli and the co-chairs of the IPCC Working Groups and the Task Force on National Greenhouse Gas inventories, for their work at the IPCC, and warmly thanked Mr Ismail A.R. El Gizouli, for his report on the current status of the work of the Panel. Congress also expressed its appreciation to Mrs Renate Christ for her work as Secretary of the IPCC until the date of her retirement on 31 May 2015.

6.2.2 Congress expressed its continued appreciation of the key role of the IPCC in preparing and disseminating high quality assessments in support of national and international policy formulation on climate change-related issues and reiterated WMO's commitment to assist IPCC in delivering its work programme, including through financial, administrative and operational support to the extent possible.

6.2.3 Congress welcomed the highly successful completion and release of the Fifth Assessment Report (AR5) of the IPCC, which was produced by over 830 scientists and released over a period of 13 months, the Working Group I contribution entitled Climate Change 2013: the Physical Science Basis, the Working Group II contribution entitled: Climate Change 2014: Impacts, Adaptation, and Vulnerability, the Working Group III contribution entitled: Climate Change 2014: Mitigation of Climate Change and the Synthesis Report in November 2014. The AR5, being the most comprehensive assessment of climate change ever undertaken, provided important conclusions for the benefit of Members and the international community as a whole. Congress expressed appreciation to all scientists and experts who contributed to the writing and review of the IPCC reports and stressed the importance of scientists and experts from developing countries being involved in the work of the IPCC.

6.2.4 Congress welcomed the release of the Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) in November 2011, which provided an unprecedented level of detail regarding observed and expected changes in weather and climate extremes.

6.2.5 Congress appreciated the work of the IPCC Task Force on National Greenhouse Gas Inventories and welcomed the release of the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands* and of the *2013* Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.

6.2.6 Congress expressed appreciation at the progress made on the implementation of the IPCC Scholarship Programme and expressed its gratitude to donors for their support. It welcomed the call for applications for the third round of awards for the period 2015–2017 for scholars from Developing and Least Developed Countries.

6.2.7 Congress noted that the United Nations Framework Convention on Climate Change (UNFCCC) reiterated the crucial role of IPCC assessment reports for its future work in decisions taken at the 18th, 19th and 20th sessions of the Conference of the Parties (COP 18, 19 and 20) and encouraged the IPCC to continue to respond to requests from the UNFCCC.

6.2.8 Congress welcomed the decisions taken by the Panel at its 41st Session (Nairobi, 24–27 February 2015) on future work of the IPCC and the structure of the IPCC Bureau by increasing the representation of African and Asian countries on the IPCC Bureau. The number of IPCC Bureau members increased to 34 from 31.

6.2.9 Congress expressed gratitude and appreciation to all members of the IPCC Bureau and of the Bureau of the Task Force on National Greenhouse Gas Inventories for successfully guiding the activities of their respective Working Groups and Task Force during the fifth assessment cycle, and to the IPCC Secretariat for the administrative support.

6.2.10 Congress expressed its appreciation to the WMO Members who actively participated and contributed to the work of the IPCC, through direct financial contributions to the WMO/UNEP Trust Fund or by supporting Technical Support Units (TSUs); to UNEP for its continued co-sponsorship of the IPCC; and to the scientists and experts who contributed to the writing and review of the IPCC reports.

6.2.11 Congress recognized the important role of and contributions from the WMO Members and National Meteorological and Hydrological Services (NMHSs) in the areas of climate variability and climate change and towards the work of the IPCC; noted with appreciation that substantial benefits flow to NMHSs and the IPCC through the active involvement of scientists and experts from NMHSs, especially those from developing countries, in the activities of the IPCC and strongly encouraged NMHSs, especially those of developing countries, to be involved in activities related to climate change and to continue supporting the efforts of the IPCC.

6.2.12 Congress noted the increasing IPCC workload for the scientists and the NMHSs, the need for regional assessments and the increasing communication demands. IPCC was invited to address these concerns and demands when preparing for the 6th Assessment Reports.

6.2.13 Congress reaffirmed that the IPCC should continue its fundamental mission for providing scientific-technical assessments of available factual information on issues related to climate change and adopted Resolution 56 (Cg-17) – Intergovernmental Panel on Climate Change.

6.3 WMO and the Global Earth Observation System of Systems (agenda item 6.3)

6.3.1 Congress noted the actions taken by the Executive Council and WMO Members to reinforce the guidance issued by Cg-XVI regarding participation in the Group on Earth Observations (GEO). Congress was informed of the benefits resulting from WMO's contribution to the Global Earth Observation System of Systems (GEOSS) including, but not limited to, collaboration on data sharing and data dissemination and on radio-frequency coordination. Congress noted that WMO contributes programmatically to the (GEOSS) 10-year Implementation Plan (2005–2015) through the World Weather Watch (WWW), including the GDPFS, and through WIS and WIGOS, including the WMO Space Programme activities. Examples include the contributions of the WMO Programmes and co-sponsored Programmes under WIGOS, i.e. GOS, GCOS, WWRP, GAW and GCW, to the agriculture, climate, water and weather Societal Benefit Areas (SBAs) of GEO.

6.3.2 Congress encouraged WMO Members to continue to engage fully with national GEO coordination mechanisms in order to reinforce the central national, regional and global role – and the recognition of this by GEO – of the NMHSs in the specification, acquisition and dissemination of observations to support a broad range of weather, climate and water applications. Recognizing that the number of Members joining GEO continues its increase, Congress called on Members to closely coordinate their national activities related to observations and their contributions to regional global GEOSS activities and encouraged NMHS Directors to work closely with GEO Principals at the national level.

6.3.3 Congress was informed that in order to ensure interoperability with the GEOSS Common Infrastructure (GCI), the WMO Information System (WIS) had maintained close coordination with the GCI by providing access to observational data and information collected by NMHSs. In this regard, Congress noted with satisfaction that data in WIS could now be discovered in GEOSS, and vice versa, thanks to Germany, Japan and the Republic of Korea providing WMO metadata to the GEOSS Common Infrastructure through the GEOSS Open Modeller. This was seen as an important step toward making both GEOSS and WIGOS observations available through both WIS and GCI, as requested by Cg-XV.

6.3.4 Congress welcomed the Geneva Declaration adopted by the GEO Ministerial Summit in January 2014, by which the mandate of GEO was renewed until 2025. It noted the strengthened relationships between WMO and GEOSS through the implementation of the Global Framework on Climate Services (GFCS), reflecting the alignment with some GEO SBAs of the four GFCS priority areas, in particular agriculture and food security, water, health and disaster risk reduction. Congress encouraged similar close collaboration with the emerging energy priority area and the GEO energy SBA. In addition Congress noted the good collaboration between WMO and GEO on initiatives such as GEO's Global Agricultural Monitoring (GEOGLAM), Global Carbon Observation and Analysis (GEO Carbon), Cold Regions activities and Global Urban Observation and Information efforts.

6.3.5 Congress urged GEO to ensure that the contributions of WMO to GEOSS through its programmes, technical commissions, NMHSs etc. be properly recognized and acknowledged in publications, strategic documents and plans. Congress acknowledged the steps being taken by GEO to address its governance structure to give proper recognition to the role of UN agencies as being distinct from that of their programmes.

6.3.6 Congress noted the initiation of the AfriGEOSS initiative and encouraged it to build on the complementary efforts by WMO, in particular WIGOS, and to engage with WMO Members in Region I (Africa) especially through their NMHSs in this activity. Congress urged GEO to give proper recognition to WMO's contribution in Africa, and noted with satisfaction the increased collaboration between WMO, through WIGOS, and AfriGEOSS in Region I, as encouraged in the Praia Ministerial Declaration issued by AMCOMET-3 in Cabo Verde, February 2015.

6.3.7 Concerning radio-frequency coordination, Congress noted with satisfaction that GEO had contributed to a WMO Position Paper on the importance of protecting the 5350–5470 MHz frequency band, and that it had prepared a GEO Position Paper, both of which had been submitted to the Joint Task Group meeting in preparation for the 2015 World Radiocommunication Conference. Congress further expressed its appreciation of the fact that the GEO-X Plenary had highlighted the need to preserve the 5350–5470 MHz frequency range, which is of high importance to the Copernicus Sentinel-series satellites and other Earth Observation (EO) missions providing benefits to WMO Members and Programmes.

6.4 Future Earth (agenda item 6.4)

6.4.1 Congress appreciated the presentation on Future Earth by the Executive Director of ICSU at EC-66, highlighting the potential partnerships and cooperation to be further developed with WMO and associated programmes such as WCRP, WWRP and GAW.

6.4.2 Congress noted the decision of EC-66 by which WMO became a member, rather than observer, in the Science and Technology Alliance for Global Sustainability (the Alliance) and endorsed the goals and terms of WMO's participation.

6.4.3 Congress appreciated the role of the WMO co-sponsored WCRP as a full and independent and strategic partner of Future Earth and thanked the Executive Directors of ICSU, the co-chairs of the Alliance (ICSU and UNESCO), the Chairs of the WCRP Joint Scientific Committee and the Future Earth Science Committees for establishing positive and pro-active agreements.

6.4.4 Congress noted the proposal by the Science and Technology Alliance for Global Sustainability to possibly become the Governing Council for Future Earth. Congress appreciated that WMO and WCRP played useful roles in both the Alliance, in the Transition Team of Future Earth including in the design of the Future Earth, its secretariat, and its various governance mechanisms. It noted the complexity of the new Programme, its innovative emphasis on co-design and co-production of research, its emphasis on multi-disciplinary research in its areas of research and considered these complimentary to the Research, Modelling and Prediction pillar of the Global Framework for Climate Services (GFCS). Considering the evolving nature of Future Earth, Congress encouraged the Secretary-General to exercise vigilance and prudence in WMO's

engagement as member of the Alliance and to safeguard against decisions that would be contrary to Congress decisions and WMO's mission, including financial commitments.

6.4.5 Congress welcomed the inclusion of a Dynamic Planet theme in Future Earth to which WCRP, WWRP, GAW and MMOP would make a significant contribution as well as new initiatives emerging from WCRP, Future Earth and IOC particularly as they relate to health and well-being of the ocean and oceanic applications including operational modelling and forecasting for coastal and high-sea areas, end-to-end data management and observations. Congress therefore encouraged WWRP, GAW and MMOP to join WCRP in WMO's Future Earth related efforts, taking into account the role of extreme weather and climate events in a changing climate, the critical research and infrastructure resources that weather research can mobilize for accomplishing objectives, and the need to avoid replication of efforts and optimizing WMO contributions.

6.5 International Polar Partnership Initiative (agenda item 6.5)

6.5.1 Congress noted with appreciation the efforts of the Interagency Steering Group to develop the concept of a long-term cooperative international polar initiative. Congress agreed with the conclusions of the Steering Group that the changes witnessed in Polar Regions have a strong influence on the Earth system and that due to the harsh polar environment and relatively high cost of operations there, no nation or organization is able to effectively achieve the objectives of their polar activities without strong cooperation with partners. Congress further agreed that improved understanding of polar weather and climate requires a coordinated multi-agency effort to develop and maintain observing networks, productive research, and the transformation of observations and research into products of high societal value.

6.5.2 Congress noted the Concept of the International Polar Partnership Initiative (IPPI), developed by the IPPI Steering Group. Congress agreed that the IPPI has the potential to provide a framework for cooperation in polar activities that would lead to improved polar observations, create opportunities to seek funding for polar research and enhance the provision of user-tailored services. In this context, Congress encouraged the Steering Group to further develop a clear framework of the Partnership, to be reviewed by the Executive Council in 2016 and thereafter in view of defining WMO's roles in and contributions to the future IPPI framework.

6.5.3 Congress indicated that WMO initiatives such as the Global Integrated Polar Prediction System (GIPPS), Global Cryosphere Watch (GCW), the Antarctic Observing Network (AntON), polar activities of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) and of the co-sponsored World Climate Research Programme (WCRP), and other WMO polar activities would contribute to the IPPI and would strongly benefit from contributions by partner organizations. Therefore, Congress endorsed participation of WMO in IPPI and adopted Resolution 57 (Cg-17) – Participation of WMO in the International Polar Partnership Initiative.

6.6 Other partnerships (agenda item 6.6)

Cooperation with regional organizations

Partnership with the European Commission

6.6.1 Congress welcomed and encouraged initiatives by the Secretary-General to capitalize on and enhance the partnership with the European Commission. It agreed that with the start of the new European Union legislature and with the new structure of the Commission, such efforts should be reinforced, in order to strengthen collaboration on different EC policy areas and to increase the attention devoted to the potential role and added value of the meteorological community with the aim of aligning the European Commission initiatives in weather, climate and water with those of WMO, in particular, those in RA VI, in order to avoid duplication and optimize synergies. European Commission initiatives such as Copernicus, Single European Sky or, more recently, the development of a market for Climate services are related to many WMO Programmes and initiatives, including WMO's contribution to the GFCS, aeronautical meteorology, disaster risk

reduction and marine services. Congress also recommended that the role of WMO and its Members, through their NMHSs, should be highlighted regarding European Commission international cooperation. The exchange of staff with the European Commission in this field is particularly welcomed.

Partnership with organizations representing the meteorological community at large

6.6.2 Congress noted with appreciation development of cooperation agreements within the European region, including: (i) a Memorandum of Understanding (MOU) signed between WMO and the Association of Private Meteorological Services (PRIMET); (ii) a Memorandum of Understanding between WMO and the Economic Interest Grouping of European Meteorological Organizations, EUMETNET EIG, which formalizes their cooperation in areas such as observations, climate services, forecasting and training, early warning systems, disaster risk reduction, aviation meteorology and protection of radio frequencies need for meteorological purposes; and (iii) a Memorandum of Understanding between WMO and the Economic Interest Grouping for National Meteorological and Hydrological Services in Europe (ECOMET).

6.6.3 Congress expressed appreciation for development of cooperation agreements in other parts of the world, including: (i) a Memorandum of Understanding between WMO and the Secretariat of the Pacific Regional Environment Programme (SPREP); (ii) a Memorandum of Understanding between WMO and the Secretariat of the Cooperation Council for the Arab States of the Gulf (GCC); (iii) a Memorandum of Understanding between WMO and the United Nations Economic Commission for Africa (UNECA), Africa Climate Policy Centre (ACPC) concerning the implementation of the Climate Research for Development (CR4D) agenda in Africa; and (iv) a Memorandum of Understanding signed on 3 September 2014 between WMO and the Indian Ocean Commission (IOC).

Cooperation with national organizations

6.6.4 Congress welcomed the development of cooperation agreements with national entities, including: (i) a Memorandum of Understanding between WMO and the State Meteorological Agency of Spain (AEMET); (ii) a Memorandum of Understanding between WMO and the International Commission on Irrigation and Drainage (ICID – India); (iii) a Memorandum of Understanding between WMO and Korea Institute of Civil Engineering and Building Technology (KICT) – River Experiment Centre (REC – Republic of Korea); and (iv) a Memorandum of Understanding between WMO and the International Environmental Data Rescue Organization (IEDRO – USA).

6.6.5 Congress also noted the efforts made to strengthen cooperation with national meteorological and hydrological professional societies, and encouraged the Secretary-General to take further measures to support and cooperate with them.

Cooperation with funding entities

6.6.6 Congress welcomed the growing collaboration with other international organizations, such as the World Bank, and Regional Development Banks noting, particularly, the importance of ongoing cooperation in support of DRR national and regional initiatives leading to the modernization of National Meteorological and Hydrological Services and on the estimation of their role in the development of the national economy. Congress encouraged the Secretary-General, as well as the Officers of the Organization, to continue high-level dialogue with other international organizations so as to strengthen cooperation in order to further benefit WMO and National Meteorological and Hydrological Services.

Consolidation and development of partnerships

6.6.7 Congress was informed of the achievements made by the Executive Council to enhance and re-establish cooperation with those organizations with which cooperation had been dormant for several years. It requested the Secretary-General to continue enhancing and

strengthening their implementation to the benefit of WMO and National Meteorological and Hydrological Services. Congress noted with appreciation the work entailed to review the status of all cooperation agreements and encouraged the Secretary-General to continue re-establishing cooperation during the seventeenth financial period with those organizations whose cooperation remained dormant, should this be of the interest of the Organization.

6.6.8 Congress authorized the Executive Council to consider, when appropriate, the advisability of concluding formal working arrangements and consultative status, as might be necessary, with other international organizations, subject to the provisions of Article 26 of the Convention of the World Meteorological Organization.

6.6.9 Congress noted with satisfaction that the visibility of WMO and awareness on its work, as well as that of NMHSs, had improved through representation at, and contribution to, sessions of other international organizations. Congress invited Members to continue their efforts in ensuring representation of WMO and National Meteorological and Hydrological Services, where possible, in events of relevance to the development of meteorology and hydrology and to their application to sustainable development. Congress urged the Secretary-General to continue efforts in ensuring that WMO plays a leading role in areas falling within its mandate and in developing relevant projects with specialized agencies, intergovernmental organizations and non-governmental organizations in accelerating the implementation of the Millennium Development Goals, in support of the United Nations Conference on Sustainable Development (Rio+20) outcomes, of the Third World Conference on Disaster Risk Reduction, and the Post-2015 Development Agenda and its related Sustainable Development Goals as well as other relevant regional and global strategies and plans of action.

6.6.10 Congress requested the Secretary-General to further strengthen and support the external relations activities in line with the WMO's strategic priorities and within the approved maximum expenditure for the seventeenth financial period, so as to strengthen cooperation with other organizations, including regional and national meteorological/hydrological professional societies.

7. STRENGTHENING GOOD GOVERNANCE (agenda item 7)

7.1 Oversight of the Organization (agenda item 7.1)

Report of the Audit Committee

7.1.1 Congress noted with appreciation the continued excellent work of the Audit Committee that contributed to the considerable progress made over the last four years in effective oversight and Enterprise Risk Management.

7.1.2 Congress noted the valuable reports of the Audit Committee to the FINAC and the Executive Council at its sixty-forth, sixty-fifth and sixty-sixth sessions, including the recommendations on the various issues under the Audit Committee's mandate which informed decisions of the Executive Council.

7.1.3 Congress requested the Executive Council to continue to review the functioning and membership of the Audit Committee. It endorsed the request of FINAC that the reports from the Audit Committee to the Council and Congress should provide more details without duplicating information contained in other reports, for example from the External Auditor. It further requested the Audit Committee to continue to assess and monitor the enterprise risks involving the Organization, particularly the risks related to the liability associated with After-Service Health Insurance (ASHI). In that respect, it kept in force Resolution 38 (Cg-XV) on the Audit Committee.

Annual Accountability Report of the Internal Oversight Office

7.1.4 The Congress considered the annual accountability report of the Internal Oversight Office containing the summary of oversight findings, recommendations and actions taken in response, and D/IOO's opinion on adequacy of governance, risk management and internal control processes for the year 2014. The Congress also took into account the report of the Audit Committee in considering the report of IOO.

7.1.5 The Congress expressed its satisfaction on the work done by the Internal Oversight Office in the sixteenth financial period in contributing to good governance in the Organization and commended the efforts of the Secretary-General in building a strong oversight culture in the Organization.

Implementation of Recommendations of the Joint Inspection Unit

7.1.6 The Congress noted with appreciation the work done by the Joint Inspection Unit on strengthening good governance in the United Nations system.

7.1.7 Recalling the WMO procedures on follow-up on JIU reports, approved by the fifty-fourth session of the Executive Council in 2002, the Congress noted with appreciation the progress made by the Secretariat in the implementation of recommendations relevant to WMO.

7.1.8 The Congress requested the Secretary-General to continue providing support to the work of the Joint Inspection Unit and provide due consideration to the recommendations of the Unit in accordance with the established procedures.

7.2 Monitoring and evaluation (agenda item 7.2)

7.2.1 Congress recalled its decision at the sixteenth session agreeing that full implementation of the WMO Monitoring and Evaluation (M&E) System should start in 2012. Congress noted with appreciation that the M&E System was fully implemented covering all the Expected Results and that the Secretariat conducted two surveys to assess the impacts of achieved results on Members, with the first survey aimed at setting baselines and targets for the reformulated Key Performance Indicators (KPIs). It further noted with appreciation the progress made in achieving the Expected Results as presented in the Mid-Term Monitoring and Performance Evaluation Report prepared by the Secretariat for the first biennium of the financial period (January 2012–December 2013).

7.2.2 Congress agreed with the recommendations of the sixty-sixth session of the Executive Council (EC-66, paragraph 4.8.2.2) on the continued improvement of the M&E System. It noted challenges experienced in measuring key outcomes due to the low and fluctuating levels of responses to the surveys on Impacts of Achieved Results on Members. In this respect, Congress encouraged Members to respond to surveys conducted by the Secretariat to provide regular, accurate and comprehensive information that would help the Organization identify priority actions to better address Members' needs. It appreciated the roles of regional associations and technical commissions in facilitating data collection and in monitoring the implementation of their respective operating plans.

7.2.3 Congress requested the Executive Council and the Secretary-General to use the lessons learned from the first years of implementation of the M&E System to make necessary adjustments and further improvements.

7.3 Risk management (agenda item 7.3)

7.3.1 Congress noted that following its decisions to approve the WMO Strategic Plans and Results-based Budgets for the periods 2008–2011 and 2012–2015, the Secretariat had implemented the Enterprise Risk Management (ERM) as an integral part of Systems of Internal Control and Results-based Management (RBM). Congress noted that the Executive Council had approved the WMO Risk Management Policy, which together with the WMO Risk Management

Framework, formed the basis for the implementation of ERM. Congress appreciated the progress made by the Secretariat in implementing ERM and the maturity of the system, as observed by the Audit Committee and Executive Council. The risk management was integrated into the WMO strategic and operational planning, and monitoring and evaluation process.

7.3.2 Congress encouraged Members to make use of the WMO Risk Management Policy (Resolution 22 (EC-66)) and *WMO Risk Management Framework* (WMO-No. 1111) when developing their respective risk management frameworks. It requested the Executive Council to keep under review high risks of the Organization and provide guidance on actions as required.

7.4 Conference services (agenda item 7.4)

7.4.1 The Congress noted that during 2012–2015, WMO modernized the infrastructure of the WMO Conference Centre and Services. This enabled the Secretariat to manage more efficiently the delivery of conference services, both in Geneva and abroad. The most significant change was the transition to paperless sessions and electronic session management introduced for all constituent bodies and other major sessions; video-conferencing facilities allowed more virtual meetings and enabled off-site participation of staff and experts in meetings. Thanks to a careful upstream planning of the daily agenda of constituent body sessions, the Secretariat, in consultation with the presidents of regional associations and of technical commissions and coordination committees of the sessions, optimized the cost of interpretation services. These measures resulted in significant savings of resources and reduced environment impact.

7.4.2 In the seventeenth financial period, the multilingualism and the excellence of conference services will remain the high priority of WMO. Pursuing this principle, it is expected that interpretation into Portuguese could be provided at several sessions as in the past.

7.4.3 Congress noted that 18 constituent body sessions and 980 other meetings were held during the sixteenth financial period, both in and away from Geneva. It examined the information submitted by the Secretary-General on the invitations extended by Members for hosting sessions of constituent bodies during the seventeenth financial period (2016–2019). In that context, Congress established a provisional programme of constituent body sessions for those meetings, as given in Annex XIII to the present report. The potential hosts of WMO sessions will be required to adhere with this programme as well as with a standard WMO host country agreement, as given in Annex XIV to the present report.

7.4.4 Conference Services will direct their efforts toward optimizing the cost of sessions through enhancement of IT web applications and those that facilitate the use and processing of session documentation in all languages, participants' registration and increase possibilities for their active online participation.

7.5 Languages and publications (agenda item 7.5)

7.5.1 The Congress noted that during 2012–2015, WMO successfully implemented Resolution 35 and published all planned titles in various WMO languages. While the resources from the regular budget were focused on these publications which were a priority, there were additional publications produced by WMO and approved by other constituent bodies, amounting to 104 titles, which were issued in various language versions, thus bringing the total number of publications to 388. By upgrading its computer-assisted translation tools and streamlining its printing equipment, WMO enhanced the processing of requests for language and publication services. Since 2013, WMO has been focusing its efforts on consolidating the quality management framework of its language services. This is being done by re-profiling language work functions and strengthening the in-house language resources (translators, editors and language support teams), which are the core group indispensable for ensuring the high quality of a variety of multilingual products and services that Members expect from WMO. In addition, in the case of highly technical publications that are crucial for the NMHS's operational work, WMO benefited from the close collaboration of experts coming from several NMHSs. Their contribution to the validation of multilingual terminology and the translations of recommended practices provided in the *Guide to*

Meteorological Instruments and Methods of Observation (WMO-No. 8) was an example of the successful cooperation of linguists and technical experts.

7.5.2 Noting the significant contribution made by language and publishing services to the achievement of Expected Result 8 – An Effective and Efficient Organization, Congress welcomed the progress in electronic publishing and distribution of WMO publications, documents and correspondence. It encouraged the Secretary-General to pursue the efforts to enhance WMO publications by producing new titles using interactive and dynamic content and different formats, such as HTML, e-publications and similar, to be read on different mobile devices or in printable form. Congress adopted Resolution 58 (Cg-17) – Publications for the seventeenth financial period.

7.5.3 It was pointed out that interpretation, translation and publishing services are essential for efficient communication and dissemination of information. In this regard, the efforts of the Secretariat to support constituent body sessions and to produce publications in as many WMO languages as feasible within the available budget were praised. In a multilingual world, language and publishing services underlie the WMO commitment to promote cooperation and collaboration in scientific endeavours, and the application of meteorology to issues of public concern worldwide.

7.5.4 Congress noted that the side event that launched the book *Seamless Prediction of the Earth System: from Minutes to Months* was very well attended. In view of the great interest generated by this synthesis of the many papers and discussions that took place at the World Weather Open Science Conference (Montreal, summer 2014), Congress noted the importance of providing this publication in languages other than English. Congress noted that the Publications Trust Fund could be used for producing this book in all WMO languages and invited Members to contribute to it.

7.6 Information technology support (agenda item 7.6)

7.6.1 Congress noted the significant developments and proposed strategy in the areas of information technology as well as the building and related facilities.

7.6.2 Congress also noted augmented focus on the IT needs of the WMO departments and Member community and the associated opportunities to leverage IT solutions to improve efficiency and effectiveness of WMO activities, as well as on the needed investments that are deemed necessary to sustain the WMO headquarters building whilst exploiting opportunities to render the building carbon neutral.

7.6.3 Congress noted that priorities in the area of both IT and the facility management of the WMO Secretariat had been identified and that a corresponding workplan has been designed for implementation during the seventeenth financial period.

7.7 Continuous improvement of WMO processes and practices (agenda item 7.7)

7.7.1 Congress recalled its decisions at the sixteenth session requesting the Executive Council to continue to work on, and implement as appropriate, continuous improvement of WMO processes and practices to increase the efficiency and effectiveness of WMO constituent bodies and the overall efficiency of the Organization.

7.7.2 Congress noted with appreciation the progress made by the Executive Council, regional associations, technical commissions and the Secretary-General to implement various measures to improve WMO processes and practices, which resulted in improved efficiency and cost savings. It requested the Executive Council to continue to introduce specific measures for improvement of WMO processes and practices and also to undertake a holistic review of the Organization, including its processes and working practices, in implementing the Strategic Plan 2016–2019.

7.7.3 Congress requested the Executive Council to provide recommendations to the Eighteenth Congress on constituent body constructs, as appropriate, including possible new structures for TCs, RAs, EC, and also to provide recommendations on rules, procedures,

processes, working mechanisms, and duties, of constituent bodies, WMO Officers (President, vice-presidents, PRAs and PTCs) and the relationship between them and the WMO Secretariat to enhance the efficiency and effectiveness of the Organization and good governance.

Towards a climate neutral WMO

7.7.4 Congress took note of the objective set by the UN Secretary-General for the UN system to become climate neutral by 2020 at the latest and to consider accelerating this effort, in order to reach climate neutrality already by the end of 2015.

7.7.5 Congress took note of the actions already implemented and planned by the Secretariat to achieve the objective of climate neutrality.

7.7.6 Congress supported the initiative to create a dedicated Trust Fund to finance a project leading to the installation of a photovoltaic solution for electricity generation at the WMO headquarters building and invited Members to contribute to it.

7.7.7 Congress supported the proposal of offsetting WMO residual carbon emissions through purchasing of Certified Emission Reductions (CERs).

7.7.8 Congress requested the Secretary-General to continue to work towards a carbon-neutral WMO, through identifying the key sources and reducing of greenhouse gas emissions by WMO.

7.8 Gender mainstreaming (agenda item 7.8)

7.8.1 Congress welcomed the outcomes of the Conference on the Gender Dimensions of Weather and Climate Services (Geneva, 5–7 November 2014). It commended the Permanent Representatives of India, Italy, South Africa and the United States of America, the Deputy Administrator of the China Meteorological Administration, as well as senior representatives of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Office for Disaster Risk Reduction (UNISDR), the United Nations Entity for Gender Equality and the Empowerment of Women (UN Women), the World Bank, the World Health Organization (WHO), and the International Union for Conservation of Nature (IUCN) for their participation in the International Steering Committee for the Conference. It praised the Secretariat for its leadership role in building a multi-stakeholder partnership. Congress further recognized the voluntary contributions of China, Finland, Greece, India, Norway, the Republic of South Africa, Switzerland, the United Kingdom of Great Britain and Northern Ireland, the United Republic of Tanzania, the United States of America, FAO, UNESCO, UN Women, the World Bank and Swiss Re.

7.8.2 In reviewing the outcomes of the Conference, Congress acknowledged the need to ensure equitable access to, interpretation of, and use of weather and climate information by both women and men. Congress noted the Conference Statement and endorsed the recommendations and proposed actions in the areas of disaster risk reduction, public health, water resources management, agriculture and food security, and careers for women, as formulated in the Statement and its Annex. It requested the Executive Council, technical commissions and regional associations to take action on these recommendations in relevant programmes and projects.

7.8.3 Congress noted with appreciation the creation of a comprehensive gender database containing sex-disaggregated information on the gender composition of all WMO bodies and the gender balance at all constituent body meetings. It commended the development of monitoring indicators for measuring progress in implementation of the WMO Policy on Gender Mainstreaming. Noting the importance of collecting sex-disaggregated data and conducting gender analysis, Congress requested the Secretariat to maintain the gender database and continue conducting regular surveys. It further advised regional associations, technical commissions and Members to collect relevant statistics systematically and to provide the Secretariat with such information on a regular basis. Congress noted that 58 Members and several technical commissions and regional

associations had designated gender focal points. It encouraged expansion of the network of focal points to facilitate policy implementation and data collection.

7.8.4 Congress noted with appreciation the first Progress Report on Implementation of the WMO Policy on Gender Mainstreaming prepared by the Secretariat. In reviewing the report, it recognized that women's participation in the activities of WMO had modestly increased but that the rate of improvement had been slow. Congress was pleased that professional staff at the Secretariat was approaching parity. However, it remarked that women were still significantly underrepresented in the working structures of technical commissions, regional associations and in the Executive Council, as well as among the senior management of NMHSs and the Secretariat. Congress advised regional associations and technical commissions to make gender mainstreaming a standing item on their agenda, to monitor continuously progress in implementation of the WMO Policy on Gender Mainstreaming, and to report regularly to the Executive Council.

7.8.5 Congress noted with appreciation that the EC Advisory Panel of Experts on Gender Mainstreaming contributed to the development of monitoring indicators, the analysis of statistical data, the update of the WMO Policy on Gender Mainstreaming, and the outcomes of the Conference.

7.8.6 Congress recalled that Cg-XV had approved the WMO Policy on Gender Mainstreaming. It further recalled Resolution 54 (Cg-XVI) – WMO Gender Mainstreaming. It strongly encouraged Members to continue to promote and facilitate equal opportunities for women and men in meteorology, including training, employment, careers and participation in WMO activities, as well as in the delivery of weather, water and climate services. Congress decided to amend the Policy to incorporate the outcomes of the Conference on the Gender Dimensions of Weather and Climate Services, address gaps and deficiencies identified in the Progress Report, and reflect existing good practice. Congress adopted Resolution 59 (Cg-17) – Gender equality and empowerment of women. It requested the Executive Council to develop an action plan and to oversee its implementation.

7.8.7 Congress recognized that the effectiveness of the Policy and the outcomes of the Conference were contingent upon the availability of human and financial resources. To this effect, it urged Members to provide voluntary contributions for gender activities in the Organization.

7.9 Role and operation of National Meteorological and Hydrological Services – An update on the WMO Statement for Decision-makers (agenda item 7.9)

7.9.1 Congress recalled its decision at the sixteenth session endorsing the WMO Statement on the Role and Operation of NMHSs for Directors and requesting the Executive Council to review the Statement with a view to more clearly reflect their crucial role in the implementation of the GFCS (Cg-XVI, Annex XI) and Resolution 48 (Cg-XVI) – Implementation of the Global Framework for Climate Services. Congress noted with appreciation that the Executive Council at its sixty-fifth session adopted the revised WMO Statement on the Role and Operation of NMHSs for Directors that reflected the crucial role of NMHSs in the implementation of the GFCS (EC-65, Annex II).

7.9.2 Congress further recalled the Executive Council 2005 Statement on the Role and Operation of NMHSs for decision-makers that was intended to urge their support for NMHSs by demonstrating relevance and benefits of the services provided by NMHSs to meeting societal needs and to national sustainable development (EC-LVII, Annex VII). Congress considered and approved the revised Statement for decision-makers as given in Annex XV to the present report.

7.9.3 Congress agreed that Statements for Decision-Makers and Directors be normally reviewed every four years to reflect and to align Statements with the adopted WMO Strategic Plans, evolving roles of NMHSs unless there is an emerging issue of significance to the Organization that merits their immediate review or alignment.

8. GLOBAL FRAMEWORK FOR CLIMATE SERVICES (agenda item 8)

8.1 Implementation of the Global Framework for Climate Services (agenda item 8.1)

8.1.1 Congress recognized the significant progress achieved in the implementation of the Global Framework for Climate Services (GFCS). Congress noted with appreciation the efforts undertaken towards implementation of the GFCS relative to the deliverables and targets, along the 2-, 6-, and 10-year time frames, as they were decided by Congress. In this regard, this report is presented in a way to show the progress made towards achieving the milestones for the first two years, as indicated in the Implementation Plan (IP).

Implement the agreed governance structure of the Framework, including establishing a secretariat in support thereof

8.1.2 Congress welcomed the efforts of the WMO Secretary-General in establishing, at the technical level, a Project Oversight Board (POB) as an informal structure to contribute to effective ways of cooperation and coordination between the organizations of the UN system and key international agencies that are directly involved in the planning and implementation of GFCS-related activities in alignment with their mandates and priorities to advance the application of climate services in the initial four priority areas. The POB has contributed considerably to the planning and development of the GFCS activities. It met regularly on a monthly basis providing a platform for sharing of information on GFCS-related activities and updates on the overall status of GFCS implementation. The chairperson of the POB rotated among its members with WFP being its last chair. The POB ceased to exist with the operationalization of the Partner Advisory Committee.

8.1.3 Congress also welcomed the initiative of the WMO Secretary-General in establishing, at management level, an Interagency Coordination Group (ICG) as an informal mechanism to ensure engagement and ownership of the key partners involved in the GFCS initiative across UN bodies and organizations. The ICG involves so far only UN agencies, namely: the Food and Agriculture Organization of the United Nations (FAO), WFP, the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Development Programme (UNDP), the United Nations International Strategy for Disaster Reduction (UNISDR), the World Bank (WB), the World Health Organization (WHO) and WMO.

8.1.4 Congress noted with appreciation that the Partner Advisory Committee (PAC) is now operational (see agenda item 8.5) with the United Nations Institute for Training and Research (UNITAR) as its initial Chairperson and the World Food Programme (WFP) as its Vice-Chair, who would serve for a period of one year.

Initiate a reporting structure that enables national, regional and global entities to report on their efforts to meet near-term targets and address gaps in current climate services capabilities

8.1.5 Congress noted with appreciation that the WMO Secretary-General had invited Members and Partners to designate their projects and activities to be recognized as contributing to the GFCS should they comply with a set of criteria as approved by the IBCS. Congress was pleased to note that a web-based platform had been developed that would allow Members and Partners to designate activities. To access the platform, Members and Partners were requested to nominate a focal point who would receive the credentials to upload the information on the platform. So far 45 focal points were designated by Members and Partners. These focal points are providing data that will be used to build a database of projects that is being displayed on the GFCS website. In this regard, Congress urged Members to contribute to this initiative by designating focal points to upload information on relevant projects and activities.

Design and implement a set of projects that demonstrate the value of climate services, primarily in climate vulnerable developing countries, to ensure sustained and expanding interest on the part of the donors

Project 1 (IP): Establish frameworks for climate services at national level in developing countries

8.1.6 Congress noted with appreciation that, to facilitate the establishment of frameworks for climate services at national level as flagships, activities were initiated since 2012 in Burkina Faso, Chad, Mali and Niger through the organization of national consultations. In these countries, following the consultations the GFCS Office is facilitating the development of action plans to address the gaps and needs identified at the national consultations. Partners such as WB and UNDP have been engaged in the development of the actions plans, which have been used to inform their investments in these countries. Linkages were also established with the UN Framework Convention on Climate Change (UNFCCC) to consider the integration of these action plans into National Adaptation Plans (NAPs) processes that are currently underway in several countries around the world. In addition, using a facility provided by the Norwegian Refugee Council (NRC) through its Norwegian Capacity Programme (NORCAP), the GFCS has deployed a regional coordinator in the Office of FAO in Dakar (Senegal) to support these countries with implementation of the GFCS.

8.1.7 Congress also noted that the GFCS Office had been supporting and facilitating national consultations around the world to identify gaps and priorities as well as to establish the internal coordination mechanisms needed to ensure effective implementation of the Framework at the national level. National consultations were held in Belize, Dominica, Malawi, Senegal, South Africa and United Republic of Tanzania in addition to the ones underway as flagship activities in Burkina Faso, Chad, Mali and Niger. Plans are underway for conducting similar consultations in Tonga, Kiribati, Papua New Guinea, Suriname and Maldives, among others (see http://gfcs.wmo.int/events). The outcomes of these consultations are being used to develop guidelines that will help Members in establishing Frameworks at the national level. In addition, regional consultations were organized in Thailand for the Least Developed Countries in Asia, in Trinidad and Tobago for the Caribbean, in Cook Islands for Pacific Small Island Developing States (SIDS), in Costa Rica for Latin America and in Turkey for South Eastern Europe. Additional consultations are planned for North Africa and the Middle East (dates to be decided). These consultations are facilitating identification of regional priorities which are essential for the expansion or update of the projects contained in the compendium of initial GFCS projects and activities to ensure that the compendium responds to the evolving needs of Members for projects at the regional and national levels. Congress noted that the Government of Indonesia, through the Agency for Meteorology, Climatology and Geophysics of the Republic of Indonesia (BMKG), held a Workshop on the Implementation of the GFCS in RA V in Citeko, Indonesia, on 26–27 November 2014.

8.1.8 A number of countries are making progress in implementing frameworks for climate services at national level. These countries are building on their experiences in providing weather forecasts to provide seamless weather and climate information products and services. Engagement of users has been a key characteristic in these countries for the provision of tailored climate services. Examples of countries where national frameworks have been developed include China, Germany, Switzerland and Nigeria. Belize, Samoa and South Africa have initiated the establishment of their national frameworks with the support of the GFCS. In addition, Armenia, Bhutan, Nepal, the Republic of Moldova and Serbia have expressed interest in establishing their national frameworks with the support of the GFCS.

8.1.9 Congress noted the implementation of the “Climate Services Adaptation Programme in Africa”, a partnership aimed at co-designing and co-producing climate services involving WMO and partner agencies. This first multi-agency initiative implemented under the GFCS with funding from Norway was launched in October 2013. The programme will build capacities of producers and users of climate information and products to develop and apply information and knowledge to support decision-making in the priority areas of agriculture and food security, health and DRR with Malawi and the United Republic of Tanzania as the two focus countries. Consultation meetings to

define national structures for the management and implementation of the programme were held in the United Republic of Tanzania (7–9 May 2014) and in Malawi (9–11 June 2014). The project hinges on multi-agency collaboration involving the following agencies: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS); Centre for International Climate and Environmental Research – Norway; Chr. Michelsen Institute – Norway; IFRC including the Netherlands Red Cross and Red Cross/Red Crescent Climate Centre; WFP; WHO and WMO.

8.1.10 Congress noted that WFP, WHO and IFRC Country Offices in Malawi and the Republic of Tanzania are supporting the relevant ministries and institutions to establish management and action plans that will build capacity, integrate climate services into decision-making, and pilot test climate services to understand the linkages of climate with food security, health and DRR. These activities are actively coordinated with the national GFCS project development team.

Project 2 (IP): Strengthening capacity for disaster risk reduction and early warnings

8.1.11 Congress noted with satisfaction that the "Climate Services Adaptation Programme in Africa", under implementation in Malawi and the United Republic of Tanzania, has as one of its key objectives the improvement of DRR through building technical capacity for effective development and communication of early warnings. The project will contribute to building the capacity for the production of early warning information and its application for DRR.

8.1.12 Congress noted the work currently being undertaken in the Caribbean by the Caribbean Institute for Meteorology and Hydrology (CIMH) with funding from the US Higher Education Development programme and the International Research Institute for Climate and Society (IRI) programme at Columbia University to develop a Caribbean Climate Impacts Database. The database will record impacts data from climate sensitive sectors in the region and will support climate-based damage and loss analyses, risk forecasting and risk reduction activities in the region. Congress noted that the Caribbean region, with funding from the European Commission, will support a range of DRR activities and CIMH intends to apply for some of these funds to extend DRR activities under the GFCS.

8.1.13 Congress was informed of WHO plans to publish a collection of global case studies for Climate Services for Health; guidance on Heat Health Early Warning Systems; Principles and Practices of Health Early Warning Systems, along with a series of technical fact sheets.

8.1.14 Congress was also informed of the support of Canada to Haiti (6.5 million CAD) that will provide essential support to re-establish weather, climate and hydrological forecasting activities in Haiti under the coordination and management of WMO.

8.1.15 Congress recalled with appreciation the achievements under the "GFCS – Adaptation and DRR in Africa", particularly under the module that supports technical capacity development and service delivery. This module aims at increasing human and technical capacities of the National Hydrological and Meteorological Services (NMHS) to provide timely and accurate severe weather forecasts. It also includes support for Data Rescue, Fellowships, the Severe Weather Forecast Demonstration Project, Public Weather Service and Meteorological Services for Agriculture.

8.1.16 Congress noted the work towards the development of the concept of a Seamless Weather and Climate Watch for operational monitoring and forecasting of extreme meteorological events, and the plans for the demonstration of its effectiveness in Eastern Africa, by developing synergies with and taking the advantage of the well-established Severe Weather Forecasting Demonstration Project (SWFDP) that is being implemented by the WMO in that geographical region. Such "seamless" service would match with the user needs for early warning information.

Project 3 (IP): Improving communications between the climate and agriculture and food security communities

8.1.17 Congress was informed that a pilot on National Climate Outlook Forum (NCOF) for Mozambique was kick-started with a meeting in March 2014 in Maputo. The meeting provided an

opportunity to identify specific user needs that could benefit from the use of climate services through a participatory process. It also agreed on user interface mechanisms to strengthen the interaction of the NMHSs and users to ensure feedback and improvement of service provision. Similarly NCOFs were conducted in Belize, the Maldives, Papua New Guinea and Trinidad and Tobago.

8.1.18 Congress noted that the METAGRI and METAGRI OPS projects, funded mainly by Spain and Norway, have trained more than 12,000 farmers in 17 Western Africa countries in the use of climate and weather information for decision-making at final user level. The project METAGRI has been implemented in Mauritania, Senegal, Cabo Verde, Gambia, Mali, Niger, Burkina Faso, Guinea-Bissau, Guinea, Ghana, Côte d'Ivoire, Benin, Togo and Nigeria. In addition the METAGRI OPS is also being implemented in Liberia, Chad and Sierra Leone. Roving Seminars have created a practical link between experts in climate and farmers, shepherds and fishermen bridging the gap between them. The use of mobile phone and local radio messages as communication tools and simple plastic raingauges to measure precipitation and to provide information for decision-making such as the right seeding time and crop variety selection showed a practical example of simple and cost effective User Interface Platform (UIP) elements. Roving seminars for fishermen were performed for the first time in December 2014 in Senegal. Congress encouraged the continuation of the development of those practices in Western Africa and to expand or increase them into other African regions and other continents. Congress also expressed the need to strengthen capacity-building on the use and application of technical tools as remote sensing products, crop modelling and Geographical Information Systems (GIS) to support agricultural climate services.

Project 4 (IP): Partnering climate services and water resources management

8.1.19 Congress noted that the Associated Programme on Flood Management (APFM) is a joint initiative of the WMO and the Global Water Partnership (GWP) and it contributes to GFCS. Whilst it was founded in 2001 with the objective to promote the concept of Integrated Flood Management (IFM) as an alternative approach in dealing and living with floods, it has, since the establishment of the GFCS, incorporated an additional emphasis on climate services related to floodplain management. To this end, it facilitates dialogue and provides governmental agencies (in particular NMHSs) with multi-disciplinary guidance on flood management for the implementation of IFM national strategies. Congress further noted that APFM activities include the provision of guidance on flood management policy, strategy, and institutional development for countries that want to adopt the IFM concept. Users have the possibility either to request custom-made technical support through the Get Help function or to find flood management solutions by themselves using the literature in the Help Yourself section.

8.1.20 Congress noted with appreciation that over its period of activity APFM has implemented various field demonstration projects, developing strategies for flood management either at the national level (e.g. Kenya, Zambia, and Thailand) or at the local scale (e.g. India, Bangladesh) through community-based flood management approaches. Funding has been provided by the Swiss Federal Office for Environment and USAID, with in-kind contributions from Germany and Italy.

8.1.21 Congress was informed that based on the APFM experience in service delivery, during the High-Level Meeting on National Drought Policies in March 2013 WMO and GWP launched the Integrated Drought Management Programme (IDMP). The scope of the Programme is to contribute to national efforts for poverty alleviation in drought-affected regions of the world through an integrated approach to drought management cutting across sectoral, disciplinary, and institutional jurisdictions. IDMP is currently working on the set up of a HelpDesk on Drought Management, while in the meantime various projects have been launched at the regional level through the GWP network (e.g. the IDMP Central and Eastern Europe, the IDMP West Africa and the IDMP Horn of Africa), or in support to NMHSs for the development of national strategies through the WMO network (e.g. in Mexico, supporting the CONAGUA PRONACOSE – national programme against droughts; or in Turkey, supporting the establishment of a national drought policy and providing

international expertise). Funding has been provided by Canada and the Danish International Development Agency (DANIDA), with in-kind contributions from WMO and GWP.

Project 5 (IP): Developing National Climate and Health working groups

8.1.22 Congress noted that WMO had assisted Madagascar to form a National Climate and Health Working Group (NCHWG) engaging the Meteorological Service of Madagascar (DGM) and the Ministry of Health. Activities had also been initiated to form a similar Working Group in the United Republic of Tanzania. The main aim of the Working Groups is to provide national institutional mechanisms for collaboration between climate and health actors and to develop capacity for health and climate institutions to collaborate more effectively in the delivery of climate and health services. Congress further noted that through the same project in which WMO collaborated with the IRI, several objectives had been met in Madagascar and the United Republic of Tanzania including: the installation of IRI Data Library and development of Map rooms; training of staff of the Meteorological Services of both countries; and holding of a workshop for stakeholders to introduce new climate and health products and services to the public. Congress agreed that this was a good contribution to the UIP of GFCS and encouraged continued implementation of similar projects for Members in all Regions, as needed.

Project 6 (IP): Improving decision-making processes concerning climate-related risks

8.1.23 Congress emphasized that improved climate information is an incentive to mainstream and adopt new methods or concepts. A “Weather index-based financing scheme” was piloted by the German Red Cross and the Red Cross and Red Crescent (RCRC) Climate Centre in Uganda and Togo. This initiative aims to bridge the funding gap between disaster response and long-term DRR and adaptation taking into account that response to disasters has been the mode of operation of various agencies. Practical science-based methodologies have been developed that help identify which early actions should be triggered by which forecasts.

8.1.24 Congress was pleased to learn that the Red Cross Global Disaster Preparedness Centre and the RCRC Climate Centre have initiated a research partnership to catalogue and analyse the costs and benefits of early actions that could be taken based on forecasts at different timescales in ten countries, namely Guatemala, Kenya, Philippines, India, Mali, Ethiopia, USA, Netherlands, Argentina and Uganda. The results will feed into forecast-based financing and impact analyses of DRR investments.

Project 7 (IP): Strengthening regional systems for providing climate services

8.1.25 Congress noted that the organization of regional consultations is facilitating the identification of priorities for GFCS implementation at regional level. At regional level, based on the consultations the Pacific Regional Implementation Roadmap for Strengthened Climate Services was developed for the Pacific Islands as well as an action plan for the Latin America and Caribbean countries. Congress stressed the need of better engagement of regional associations in the implementation of the various projects under the GFCS at regional and national levels.

8.1.26 Congress recalled that the GFCS three-pronged approach is hinged on a cascading process from global to regional to national levels in support of provision of climate services. The regional component is ensured by the operationalization of RCCs. Currently a number of candidate centres have started a demonstration phase to demonstrate their abilities to perform the mandatory functions of a RCC. Congress was pleased to learn that RCC Africa hosted by the African Centre for Meteorological Applications for Development (ACMAD) and RCC-WCSA hosted by CIIFEN were recently recommended for formal designation as WMO RCCs, through a Commission for Climatology (CCl)/Commission for Basic Systems (CBS) mechanism.

8.1.27 Congress noted that Canada is providing support through the Programme for Implementing the GFCS at Regional and National Scales that includes support to strengthening RCCs and organization of Regional Climate Outlook Fora (RCOF) (6.2 million USD). The

programme also supports the development of capacities of SIDS in the Indian Ocean, Caribbean and Pacific regions, as well as central and south-east Asia and Polar Regions.

8.1.28 Congress was informed of the support of the US Government to the Caribbean region through the CIMH and WMO. In particular, the US has provided more than USD 5 million to: (i) support the establishment and initial operation of the WMO RCC for the Caribbean SIDS; (ii) strengthen the CIMH to improve its delivery of training services; (iii) strengthen regional and international participation in the Caribbean Climate Outlook Forum; and (iv) support the establishment of the Caribbean Centre for Climate and Environmental Simulations. In addition, CIMH will utilize funding under the Strategic Programme for Climate Resilience (SPCR) component of the Pilot Programme for Climate Resilience (PPCR) for the Caribbean to support a range of GFCS-related activities including strengthening of the NMHSs in the Caribbean region to enable them to develop and deliver climate services and products for national stakeholders.

8.1.29 Congress noted with appreciation that building from the Climate Services Adaptation Programme in Africa a joint programmatic approach is being pursued with FAO for the Sahel. A comprehensive programme to implement the GFCS in the Sahel with the involvement of other UN agencies with regional and national components is being developed. Congress was informed that this programme is being facilitated by a GFCS regional coordinator for the Sahel deployed to the FAO Office in Dakar (Senegal) through a partnership with the Norwegian Refugee Council. The coordinator provides system-wide substantive leadership to effectively coordinate the mainstreaming and use of climate services in different sectors and high-level policy and technical advice on using climate services to the countries in the Sahel. Additional experts will be deployed at national level to support the Sahelian countries where GFCS pilot projects are being implemented.

8.1.30 Congress took note of the organization of a regional workshop on the proposed establishment of a RCC for Central Africa, in N'Djamena (Chad) from 22 to 24 October 2014. Organized by the Economic Community of Central African States (ECCAS) in collaboration with the Economic and Monetary Community of Central Africa (CEMAC) and the Government of the Republic of Chad, the workshop helped to review and adopt the feasibility study for the proposed establishment of the RCC for Central Africa, to develop a roadmap for the implementation of this centre, together with relevant recommendations addressed to the next meeting of Ministers of Central Africa in charge of Meteorology for the adoption of this project.

Project 8 (IP): Large-scale data recovery and digitization

8.1.31 Congress noted the organization of an International Workshop on the Recovery and Digitization of Climate Heritage in the Indian Ocean Rim Countries and Islands, in Maputo, Mozambique in April 2014. The workshop developed an implementation plan for an Indian Ocean Data Rescue Initiative (INDARE) that will accelerate identification of data that need to be rescued and digitized, including historical records that are not held in the participating countries. As a follow-up to the meeting, the Steering Committee for the INDARE initiative met in Geneva from 29 September to 1 October 2014 and finalized its Implementation Plan and also approved the Work Plan for 2014–2015. At this meeting, Kenya was elected the Chairperson and India as the Co-Chairperson to steer the process during this period. Congress noted with appreciation that WMO had developed a template to assist Member countries submit project proposals on Data Rescue for potential funding.

8.1.32 Congress welcomed the support of Australia to SIDS in the Pacific in establishing climate database management systems and supporting efforts for the rescue of data under risk of degradation or loss given the poor state in which the data are kept. Despite these efforts additional support is needed to accelerate data rescue.

8.1.33 Congress further emphasized the need for undertaking this activity with the required synergy and sustainability keeping in view the need for such activities to be based on internationally agreed standards and best practices. It agreed that WMO should continue playing

its leadership role in coordinating and guiding the international efforts in data rescue and the implementation of related Climate Data Management Systems and analysis tools.

Other activities

8.1.34 Congress welcomed the initiative of the Secretariat for convening an ad hoc group of experts on 13 June 2014 to scope out an Energy Exemplar. In addition, on 23–24 March 2015, WMO convened a Private Sector Partnership Forum on Energy in Geneva which provided additional elements for the development of the Energy Exemplar. The Exemplar explains how improved climate services can benefit the Energy Sector and illustrates a vision as to how the development and application of targeted climate products and services through the GFCS can help improve efficiency and reduce risk associated with hydrometeorological hazards of energy systems. Congress decided on the IBCS recommendation on the energy priority of GFCS as provided in paragraph 8.3.1 (d).

8.1.35 Congress recalled joint activities with the World Health Organization (WHO), through which in 2012 the Atlas of Health and Climate was jointly developed and launched at the extraordinary session of the World Meteorological Congress. New technical publications underway include a collection of global case studies for Climate Services for Health; guidance on Heat-Health Early Warning Systems; Principles and Practices of Health Early Warning Systems, along with a series of technical fact sheets and promotional materials. A Health and Climate Services web-portal is planned as a main instrument of the Health UIP to share technical information, link end users to WMO resources, and build awareness and capacity of health actors to make climate-smart decisions.

8.1.36 Congress recognized that one of the long-term objectives for the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) Strategy (2012–2017) refers to: “the coordination of the development, enhancement and delivery of climate services related to the marine atmosphere and coastal and deep oceans, based on the core competencies within the Commission in marine meteorology and oceanography, as a contribution by JCOMM to the Global Framework for Climate Services (GFCS)”. Therefore, Congress was informed that JCOMM will consider the inclusion of ocean-related activities to the GFCS implementation.

8.1.37 Congress noted the efforts to advance implementation of the research component of the GFCS Implementation Plan with the development of the Climate Research for Development Agenda for Africa (CR4D) following the Africa Climate Conference 2013 (October 2013) and the ongoing efforts for the development of the regional climate research priorities for Latin America and the Caribbean, following the WCRP Conference for Latin America and the Caribbean (17–21 March 2014).

8.1.38 Congress took note of relevant data aspects accommodated in the GFCS Implementation Plan Annex ‘Observing and Monitoring component’. Congress recalled the overall importance of these aspects, including but not limited to implementation of the WMO Integrated Global Observing System (WIGOS), implementation of the WMO Information System (WIS), implementation of the Global Climate Observing System (GCOS), data rescue, data management, quality control and assurance, data homogenization, data analysis as an integral part of a modern climate data management, which links observations and monitoring to climate products and services.

8.1.39 Congress noted the importance of liaising closely with space agencies on dedicated space-based observations for climate, in particular through the Committee on Earth Observation Satellites (CEOS), the Coordination Group for Meteorological Satellites (CGMS) and their Joint CEOS/CGMS Working Group on Climate, the WMO Space Programme and the development of the architecture for climate monitoring from space, as a key component of WIGOS. A first element of developing an end-to-end system is an Essential Climate Variables (ECV) inventory, which provides information on the physical representation of the Architecture. Congress requested the WIGOS and GCOS to remain actively engaged in the next stages of development and implementation of the architecture.

8.1.40 Congress was pleased to note that at this stage of implementation, WIGOS is ready to fully support and contribute to the implementation of the GFCS. It also noted the request of the sixty-sixth session of the WMO Executive Council that better understanding and more concrete specification of the WIGOS role to the Observation and Monitoring Pillar, and contribution from ICG-WIGOS, is needed from the GFCS community.

8.1.41 Congress agreed on the need to integrate observations supporting a broad range of application areas from a large and heterogeneous variety of sources, both NMHS and non-NMHS owned, into the WIGOS framework and on the importance of the free and unrestricted exchange of such observations. It agreed that addressing these issues is critical for the success of WIGOS as one of the key WMO priorities serving the GFCS, and consequently for the effective and successful implementation of GFCS.

8.1.42 Congress noted that urbanization is rapidly becoming a dominant feature of the societal dynamics in the 21st Century and welcomed the IBCS-2 decision on the inclusion of urban activities related to climate as a specific cross-cutting element within the priority areas of the GFCS.

8.1.43 Congress noted that cryosphere data and products support the development and delivery of weather, climate and water services by Members, including in the four priority areas of the GFCS. Congress agreed that the Global Cryosphere Watch (GCW) will provide information for decision-making and policy development related to weather, climate and water, for use in real-time, for climate change adaptation and mitigation, and for risk management. In this way, GCW will provide foundational support to the GFCS, as well as other WMO and international programmes. Furthermore, GCW should be considered as a contributing project to the GFCS. Congress encouraged Members to support cryosphere-related projects linked to the GFCS including the need to advance Polar RCOFs to engage stakeholders and to improve our understanding of the connections between changes in polar climate and their impacts on the Earth system including temperate and equatorial regions.

8.1.44 Congress recalled the publication “Climate ExChange” which documented good practices and lessons learned in the production and application of climate services worldwide, launched at the Dialogue on Climate Services (Geneva, 26–27 October 2012) organized prior to the extraordinary session of the World Meteorological Organization (Geneva, 29–30 October 2012). The publication provided examples on how climate services can help food production, disaster risk reduction, health, transport, energy and water management.

8.2 The WMO policy for the international exchange of climate data and products to support the implementation of the Global Framework for Climate Services (agenda item 8.2)

8.2.1 Congress noted that, prior to 1995, there had been a range of bi-lateral and multilateral arrangements and the business models for making data available ranged from free and unrestricted to fully commercial arrangements. The change in business model in the 1990s, which differentiated roles and responsibilities of the private sector and governments, necessitated emergence of data policies to help regulate this change. Furthermore, the issue of the use of the data for commercial purposes was causing considerable angst amongst many Members.

8.2.2 In 1995, Congress adopted Resolution 40 (Cg-XII) – WMO policy and practice for the exchange of meteorological and related data and products including guidelines on the relationships in commercial meteorological activities – following widespread agreement that the exchange of meteorological data at the global level was essential for improvements in weather forecasting through data assimilation and ingestion into Numerical Weather Prediction models. It further noted that all WMO Members have benefited from this decision through enriched accuracy of forecasts and improved forecast lead times and that this amply shows the value of global free and unrestricted exchange of data. In response to the concerns concerning the commercial use of the data, Resolution 40 (Cg-XII) has annexes which address both Guidelines for relations among National Meteorological or Hydrometeorological Services (NMHSs) regarding commercial activities

and Guidelines for relations between National Meteorological or Hydrometeorological Services (NMSs) and the commercial sector.

8.2.3 Congress agreed that, similarly, through Resolution 25, adopted by Cg-XIII in 1999, the exchange of hydrological data between countries had been enhanced, especially in shared (transboundary) river basins. It noted that such data exchange greatly enhances the shared and sustainable management of water resources and in times of flood threat improves the capability of nations to provide much required flood forecasting and warning services. This shows the benefits of neighbour to neighbour exchange of data.

8.2.4 Congress noted the discussions at EC-64, EC-65 and EC-66 regarding the proposed WMO Policy for the International Exchange of Climate Data and Products to Support the Implementation of the GFCS and in particular agreed that the benefits realized from climate data and products are greatly enhanced when combined with socioeconomic information. Linking physical and social science information enables a wide range of societal benefits and enhances decision support. Sources of this socioeconomic information may be from other UN-sponsored or –related programmes. Furthermore, several countries possess visualization, forecast, and decision-support capabilities that could be shared to the benefit of all. The value of these tools and capabilities is traceable directly to practices of free and open data and products exchange. The greater the availability and sharing of the data, the greater the applicability and accuracy of these tools and capabilities, which for society supports ready, responsive, and resilient communities. Congress noted that EC-66 had adopted a value proposition for the international exchange of climate data and products (see Annex XVI to the present report) to support the implementation of the GFCS and recommended a draft resolution on this topic for consideration by Congress.

8.2.5 Congress recalled its discussion under agenda item 4.2 about the challenges faced by some Members in establishing Climate Data Management Systems and the support needed for developing and least developed countries.

8.2.6 Accordingly, Congress adopted Resolution 60 (Cg-17) – WMO policy for the international exchange of climate data and products to support the implementation of the Global Framework for Climate Services.

8.2.7 Congress requested the Executive Council to support the implementation of the Policy.

8.3 Congress response to the report of the Intergovernmental Board on Climate Services (agenda item 8.3)

8.3.1 Congress welcomed the report by the Chairperson of the Intergovernmental Board on Climate Services (IBCS) including the summary of progress and achievements in the implementation of the GFCS. Congress considered the recommendations of the Chairperson of the IBCS under agenda item 2.6 with the following considerations and decisions:

(a) **Recommendation 1 on *Frequency of IBCS and its Management Committee sessions***: Congress supported the proposal of the IBCS and adopted Resolution 61 (Cg-17) – Governance of the Global Framework for Climate Services;

(b) **Recommendation 2 on Relationship and interaction between IBCS and WMO constituent bodies**: Congress strongly encouraged direct linkage between the IBCS and the constituent bodies of WMO. In particular, Congress requested direct linkage of the IBCS with the Executive Council and a strengthened collaboration with regional associations. Congress adopted Resolution 62 (Cg-17) – Relationship and interaction between the Intergovernmental Board on Climate Services and WMO constituent bodies;

(c) **Recommendation 3 on *GFCS governance resource requirements***: Congress decided to include the costs of conference services for IBCS sessions as reflected in Resolution 61 (Cg-17) in the WMO regular budget subject to availability of funds;

(d) **Recommendation 4 on *Energy as an additional priority area of the GFCS***: Congress supported the inclusion of Energy as a fifth priority area of the GFCS. Congress also recognized the role of Energy in supporting the initial four priority areas and a low carbon development path. However, given that implementation of the GFCS activities is in its initial stages, some Members expressed concerns about the timeliness and availability of resources to adopt Energy as an additional priority of the GFCS. Concerns related to the risk of diverting resources from the initial four priority areas to the new priority. Congress indicated the need for resource mobilization in support of the Energy Exemplar implementation which could come from the Energy sector itself through effective engagement with relevant stakeholders. In this regard, Congress adopted Resolution 63 (Cg-17) – Energy as an additional priority area of the Global Framework for Climate Services. With regards to other areas such as tourism and transportation, Congress noted the relevance of IBCS considering them in the future and recommended that additional prioritization on these be taken at regional and national levels. Congress encouraged Members to inform the Secretary-General of cases where implementation of the GFCS focuses on such areas such as the case of the Caribbean which decided on Energy as a priority;

(e) **Recommendation 5 on *the approach in implementing GFCS***: Congress endorsed the recommendation of the IBCS to focus on the development of a Proof of Concept in the first years so as to facilitate the development of guidelines to support further implementation of the GFCS by Members and partners.

8.3.2 Congress further considered these decisions in its discussion of WMO contribution to the GFCS (agenda item 8.4).

8.4 WMO contribution to the Global Framework for Climate Services (agenda item 8.4)

8.4.1 Congress acknowledged the specific support provided by WMO to the GFCS Office to cover the costs of staff (Director and one administrative assistant) and the functioning of the Office. It further recognized that WMO support also included in-kind support services (language and publication services) and administrative services (budget, finance, human resources, and common services).

8.4.2 Congress recalled with appreciation the many contributions of WMO Members, technical commissions and programmes towards GFCS implementation to date. Congress further noted that virtually all WMO technical commissions and regional associations have outlined in their abridged session reports, often in detail, many additional planned contributions to GFCS implementation during their current intersessional periods. Furthermore, Congress highlighted that, in addition to the work of these bodies, ongoing activities in the WMO Programmes considerably add to WMO GFCS implementation support capacity.

8.4.3 Congress also recognized the growing role and importance of partner activities in this regard and commended partners for their active participation. Congress nonetheless emphasized the need for continued complementary efforts by GFCS partners, noting that WMO's support for GFCS, while central, does not provide full coverage of all areas of the GFCS Implementation Plan, notably the exemplars. Congress noted that, although the agriculture and food security and water exemplars are supported by technical commissions focused on those areas, full support for these sectors requires partnership with entities mandated and competent to support climate services implementation sector-wide to address areas outside the manageable interest of WMO and its Members. Congress appreciated the support WMO provides for implementation of the health and disaster risk reduction exemplars but emphasized that, in the absence of dedicated technical commissions, partnerships focused on these areas are even more essential. Congress therefore underscored the need for WMO to continue to clarify and define the nature and scope of its support vis-à-vis that of the other GFCS partners.

8.4.4 Taking account of the results of the GFCS Meeting on Implementation Coordination in September 2014, which documented over 100 projects directly contributing to country-level climate services implementation in 16 countries, with a combined budget of over USD 700 million, Congress recognized that the investment already being made in climate services is significant. Congress anticipated that the emphasis on climate and climate risk management in high-level policy dialogues and frameworks such as the United Nations Framework Convention on Climate Change, Sustainable Development Goals, and the Sendai Framework for Disaster Risk Reduction 2015–2030, will only further boost the visibility of these issues and the demand for climate services implementation support.

8.4.5 Congress noted the priority accorded to supporting GFCS implementation in the WMO Strategic Plan 2016–2019. In light of the above developments, Congress emphasized that WMO should continue its work – complementing, enhancing and supporting that of other GFCS partners – to:

(a) Build and strengthen the global and regional infrastructure and knowledge base for supporting GFCS implementation at country level;

(b) Leverage the considerable and growing complementary efforts of the GFCS and international partners engaged in supporting country-level implementation through the strengthened provision of WMO technical guidance and advisory services.

8.4.6 Congress agreed that aligning WMO efforts towards these ends across its technical commissions, regional associations and programmes would be facilitated by putting in place a results-based framework specifying the expected collective outputs and outcomes of these efforts over the coming financial period. Congress remarked that such a framework would assist in achieving synergies, identifying overlaps and filling gaps across WMO working structures with respect to GFCS support, especially in light of the decentralized nature of these structures and the multiplicity of their subsidiary bodies. Congress requested the Executive Council to oversee WMO's further contribution to GFCS implementation as guided by a results-based framework and to establish an appropriate mechanism for that purpose.

8.4.7 Congress adopted Resolution 64 (Cg-17) – Development of a results-based framework for WMO support to the implementation of the Global Framework for Climate Services.

8.5 Global Framework for Climate Services partnerships (agenda item 8.5)

8.5.1 Congress recognized the importance of partnerships for the successful implementation of the Global Framework for Climate Services (GFCS), which are critical for:

(a) Ensuring coordination of initiatives of various actors, their integration, establishing synergies among relevant initiatives and maximizing the benefits of investments and resources currently being applied in support of the production and application of climate services;

(b) Ensuring a multidisciplinary approach to the co-design and co-production of climate services with the involvement of users and relevant stakeholders;

(c) Ensuring effective provision and use of expertise available through partner agencies and networks in support of development and application of climate services;

(d) Effectively mainstreaming GFCS in partners' agendas and activities.

8.5.2 Congress welcomed the approach being pursued under the GFCS with respect to partnerships which focuses on ensuring the above critical elements with a view to maximize potential synergies in support of the production and application of climate services. In addition, Congress noted that the modalities for contribution to the GFCS by Members and partners which consist in direct contributions to the GFCS Trust Fund; selection of activities in the implementation

plan of the GFCS for direct implementation by Members and partners; and designation of activities as contributing to the GFCS should they comply to a set of criteria approved by the Intergovernmental Board on Climate Services (IBCS) offer ample opportunities for partnerships. In this regard, Congress was pleased to note that the WMO Secretary-General had invited Members and partners to designate their projects and activities to be recognized as contributing to the GFCS. A web-based platform had been developed that would allow Members and partners to designate activities. This approach will promote sharing of information that would lead to minimum duplication of efforts and opportunities for alignment and coordination.

8.5.3 Congress welcomed the statements made by GFCS partners namely, the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), the International Union of Geodesy and Geophysics (IUGG), the World Bank Group (WB), the World Food Programme (WFP), the United Nations Institute for Training and Research (UNITAR); and video messages from the European Commission (EC) and the Global Water Partnership (GWP). These partners submitted reports containing their specific contributions to the GFCS.

8.5.4 Congress was pleased to note efforts to enhance the engagement of partners and stakeholders and promote alignment and synergy of their activities with those planned or under implementation through the GFCS. The IBCS offers a good platform for partnerships in particular through the Partner Advisory Committee (PAC). The PAC is currently comprised of EC, EUMETSAT, FAO, GWP, IUGG, UNEP, United Nations International Strategy for Disaster Reduction (UNISDR), UNITAR, the World Business Council for Sustainable Development (WBCSD), WB, WFP, the WMO and the International Federation of Red Cross and Red Crescent Societies (IFRC). Congress also noted the expressed intention of WHO to join the PAC during the year.

8.5.5 Congress was also pleased to note that partnerships are being strengthened with the United Nations Economic Commission for Africa (UNECA) through its ClimDev Programme, the Green Climate Fund, United Nations Development Programme (UNDP) and the UN Framework Convention on Climate Change (UNFCCC) to ensure that their initiatives and investments are informed by GFCS priorities and needs. The Green Climate Fund in particular is a possible funding mechanism that would enable knowledge generation for adaptation. Through selected national projects the GFCS is supporting the integration of climate services in the National Adaptation Plans (NAPs) processes that are currently underway in several countries around the world.

8.5.6 Congress welcomed the strategy of establishing joint offices with partners with a mandate in the priority areas of GFCS to lead the coordination implementation in those areas. In this regard, Congress was pleased to note that a joint WMO/WHO Climate & Health Project Office was established under the GFCS Office to lead implementation of the GFCS Health Exemplar. Similarly, a joint office with GWP was established under the Climate and Water Department of WMO supporting the Associated Programme on Flood Management (APFM) and the Integrated Drought Management Programme (IDMP). In addition, a WFP Climate Services Advisor to the GFCS has been located within the GFCS Secretariat to support linkages between WFP projects and the GFCS, including the GFCS Climate Services Action Programme for Africa. The WFP Advisor will support specific areas of global GFCS implementation in food security, disaster risk reduction and humanitarian response.

8.5.7 Congress noted with appreciation that a partnership with the Norwegian Refugee Council (NRC), through the Norwegian Capacity Programme (NORCAP), is supporting country level implementation of the GFCS. In August 2014, the NRC had deployed a regional coordinator in the Office of FAO in Dakar (Senegal) to support the implementation of GFCS flagship activities in five Sahelian countries, namely Burkina Faso, Chad, Mali, Niger and Senegal. Moreover, GFCS and WMO are in discussion with NRC to further support the initiative by deploying programme and technical staff at national level.

8.5.8 Congress noted with appreciation that a partnership for strengthening weather and climate services in Small Island Developing States (SIDS), in the Caribbean, South Pacific, Indian Ocean and other regions, was launched at the Third International Conference on SIDS. It aims to strengthen the capacity of SIDS to cope with weather-, climate-, and water-related extreme events.

8.5.9 Congress noted that regional and national GFCS consultation processes have been supported and benefited from active participation of partner agencies such as FAO, IFRC, UNISDR, WFP, WHO, UNESCO and various regional and national organizations. In August 2014, a National GFCS Consultation in Dominica was hosted by the Ministry of Health and the Pan American Health Organization PAHO/WHO. This represented the first GFCS consultation to be initiated and led by a user-sector, in this case, the health sector. This dialogue identified the need to conduct a baseline study on the impacts of climate and weather on the health sector, and take steps to develop an integrated database, as the foundation for future programmatic and policy related activities.

8.5.10 Congress was pleased to note that the WB is increasing its investments in support of weather, climate and hydrological service modernization projects for National Meteorological and Hydrological Services (NMHSs), which are informed by the GFCS priorities and needs, contribute to its goals, and are being increasingly aligned with the activities of GFCS partners. This is exemplified by the cases of Burkina Faso and Niger where Action Plans developed to address gaps and needs identified as part of the implementation of the GFCS are being used to plan WB future investments in these countries. Investments focus on the activities needed to strengthen service delivery, emphasizing the strengthening of relationships between information providers and users, and building capacity to both, produce and use climate, weather and hydrologic information for decision-making across time-scales. As an example, in Africa the WB, together with the African Development Bank and WMO, is launching a regional framework programme for strengthening hydrometeorological services. The GFCS Office is participating in the development of this initiative, both through coordination meetings and participation in preparation missions.

8.5.11 Congress noted that a Meeting on the Implementation Coordination of the GFCS recognized that effective responses to user needs for climate services can be addressed through enhanced partnerships and coordinated approaches by governments, international and regional organizations, and stakeholders implementing activities that contribute to enhanced development and application of climate services at national, regional, and local levels. The Meeting reviewed over 100 projects ongoing in 16 illustrative countries whose components directly support implementation of GFCS thematic pillars (User Interface Platform; Climate Services Information System; Observation and Monitoring; Research, Modelling and Prediction; and Capacity Development) and priority areas (agriculture and food security, water, health and disaster risk reduction), with a combined budget of over USD 700 million. This survey of country-level programmes brought into sharp focus a clear need on coordination among climate services-related activities at global to national levels through appropriate partnerships.

8.5.12 Congress also noted that despite the progress made by various actors in implementing GFCS-related activities, coordination to ensure planning, exchange of information and linkage of initiatives to more effectively develop and apply climate services for decision-making worldwide remains a challenge. At the global level, the PAC offers a good platform for strengthening partnerships. At regional and national levels, Congress noted that there is a need to strengthen efforts and collaboration especially with regional associations and regional partners. At the national level for instance, where investments are made by partners and activities take place, there is a need to have appropriate platforms that promote partnerships. The frameworks for climate services that are being established by Members as coordination mechanisms that bring together various stakeholders to address issues related to the production and application of climate services can play a critical role in ensuring coordination, exchange of information and promotion of partnerships at national level. In this regard, Congress stressed that the GFCS should promote opportunities to link and align initiatives in ways that enhance partnerships that increase cost-effectiveness, leverage partner investments, respond to user needs, promote exchange of information across sectors, and to more effectively share available technical expertise and climate knowledge.

9. FUTURE CHALLENGES AND OPPORTUNITIES (agenda item 9)

9.1 Emerging data challenges for WMO stakeholders (agenda item 9.1)

9.1.1 Under this agenda item, Congress discussed issues and opportunities related to the task of gathering, storing and exchanging 'Big Data', the collection and sharing of crowd-sourced data, working with information through social media channels, as well as emerging and future data challenges and how these impact WMO Members. In particular, Congress noted that:

(a) Members are faced with challenges with respect to the access, exchange, and processing of data. With the expansion of mobile phones and other devices, satellite data, observing system data, and numerical weather prediction data, real-time digital data is ever increasing in volume and speed of delivery and is derived from a greater diversity of sources. Traditional methods of data access, exchange, and processing may not be adequate or appropriate;

(b) As the quantity and volumes of these data types and datasets increase, there is a need to find appropriate ways through which the meteorological community can benefit, while striving to adhere to standards for timeliness, quality, and transparency;

(c) In August 2014 UN Secretary-General Ban Ki-moon asked an Independent Expert Advisory Group to make concrete recommendations on bringing about a data revolution in sustainable development. The report indicates that diverse, integrated, and timely information can lead to better decision-making and real-time citizen feedback;

(d) This and other initiatives are bringing the issues of access, data exchange and use of these emerging data to the forefront and will require special attention from the meteorological and hydrological communities;

'Big Data'

(e) 'Big Data' is an all-encompassing term for the collection and sharing of datasets so large and complex that they become difficult to process using traditional data processing applications. The challenges include analysis, capture, curation, search, sharing, storage, transfer, visualization, and protection of privacy. The data requirements for many operational activities of NMHSs are considered by some to be 'Big Data'. There are various definitions of 'Big Data', however;

(f) Big "scientific" data are formally collected, structured data. Examples include NWP and climate model-related data, radar and satellite data. These have associated information about the data (metadata) that is relevant to the application area, such as quality information or a description of how the data were derived. Key challenges with this type of data include storing, processing in a short time, moving the information, and in delivering to users only the components relevant to them;

(g) Big "opportunity" data are informally collected and unstructured. Examples include messages on social media and measurements obtained from instruments that are deployed for non-meteorological purposes (such as sensors in mobile telephones). There is often only poor knowledge about the technical and environmental characteristics of these data, or a weak link between the data and the meteorological information that might be derived. Here the challenges are in extracting relevant and useful information from the data; the meteorological information will often only be derived using aggregation and statistical approaches which may be driven by marketing or other non-meteorological purposes. Through 'big data analytics', valuable information on access to data and products (where, when, what, how) can provide valuable tools for fine-tuning delivery of services, designing new services and targeting products at specific user groups;

Crowd-Sourcing

(h) 'Crowd-sourcing' is the process of obtaining data, services, ideas, or content by soliciting or capturing contributions from a large group of people, and especially from an online community. While crowd-sourcing will not replace high quality observations, especially for climate and where traceability and accountability is important, it is potentially an innovative way to collect large amounts of data and non-conventional observations such as impact reports, particularly during significant events;

(i) It may require novel approaches to gain access to crowd-sourced data, as well as new approaches to process and use the data to enhance hydrometeorological services;

Social Media

(j) 'Social media' allows people to create, share or exchange information in virtual communities and networks. Social media provide a wealth of environmental observations and information that could be used for supplementing meteorological forecasts and warnings. Challenges may arise with regarding how NMHS data processing systems can accept and process these novel types of data. Mobile phones and other devices will provide an ever-growing source and volume of real-time digital data;

(k) Social media will create new data sources and datasets that may be used in new ways to support operational meteorology. Techniques such as ‘data analytics’ and ‘data mining’ will provide intelligence on user access patterns and preferences as well as locally observed weather phenomena and impacts;

Future/Emerging Data Sources, Opportunities, Challenges and Risks

(l) Additional sources and types of data will continue to increase and this presents both opportunities and risks to WMO activities. Our ability as a community to address the growing number of data sources through traditional means may not serve us well in the future. The challenge will be to develop approaches to deal with the emerging opportunities to access and utilize these data and to manage the complexity of processing, use, distribution and security as well as laws concerning privacy and propriety;

(m) An important underlying issue is the need for sound practices, policies and capabilities within individual meteorological institutions in relation to the lifecycle management of data, to ensure that Members are able to manage their observations and data efficiently and effectively, to extract the value from the data in support of their services, and to integrate observations and data from diverse platforms and from external sources. In order to assist Members in meeting these challenges, and especially to extract the greatest value from their investment in designing and operating their national observing systems, the WMO Integrated Global Observing System (WIGOS) and the WMO Information System (WIS) are placing a key focus on effective lifecycle management of data and on building effective data partnerships as part of the WIGOS Preoperational Phase;

(n) 'Big data' provides an opportunity to combine large volumes of environmental information and innovative processing technologies while still maintaining timely service. There is a need to find appropriate ways through which the meteorological and hydrological community can benefit from enhancements in the access, exchange and use of data beyond what can be achieved by existing methods. Data which is crowd-sourced or data-mined from the Internet, social networks, and other sources, could provide new information for NMHSs to evaluate the public’s perception and opinion concerning NMHS performance in public weather forecasting and warning services, as well as new information that may be used in social science studies related to the

services provided by NMHSs. NMHSs should be proactive in engaging with the relevant stakeholders to foster partnerships with data providers and users to derive new information and value from the data to achieve the maximum benefits for society;

(o) Crowd-sourcing of meteorological data provides opportunities for NMHSs to engage the public in observing weather, climate and extreme weather events for the benefit of forecasting and warning processes, and for educating the public on weather and climate based on a "learning by doing" approach. To make Big Data useable for forecasting and warning services, crowd-sourcing should be supported by new guidance material on quality assurance and availability of necessary metadata;

(p) As regards future-proofing existing WMO systems and services in the Big Data environment, it is recognized that the World Weather Information Service (WWIS) and the Severe Weather Information Centre (SWIC) are essentially collecting authoritative weather reports, forecasts and warnings for dissemination to the public and international media. These WMO systems and services could potentially be further developed into a more effective meteorological data and information sharing platform utilizing crowd-sourced data from the Internet and social networks, e.g. observations and reports of weather, disasters, to supplement the authoritative weather information. This would bring greater benefits to society and increase the visibility of NMHSs.

9.1.2 Consequently, Congress adopted Resolution 65 (Cg-17) – Towards a WMO approach to emerging data challenges.

9.2 Integrated meteorological services for future air traffic management – WMO response (agenda item 9.2)

ICAO Global Air Navigation Plan (GANP)

9.2.1 Congress strongly supported the position of EC-66 regarding the ICAO Global Air Navigation Plan (GANP) and related Aviation System Block Upgrades (ASBU) methodology as a key development for the coming decades, imposing enormous challenges but also offering opportunities to Members to modernize and rationalize the meteorological services provided to aviation. Congress welcomed the recognition that the meteorological information, through its integration to the System-Wide Information Management (SWIM), would become a key enabler for the realization of the future Global Air Traffic Management concept.

9.2.2 Congress expressed full support to the objectives of the GANP and its forward looking vision for a safe, sustained growth of the air transport sector with increased efficiency and responsible environmental stewardship that societies and economies globally now require.

9.2.3 Congress noted further that the GANP, as a rolling fifteen-year strategy that will guide complementary and sector-wide air transport improvements over the period from 2013 to 2028, would require substantial regional and national planning for the implementation of its meteorological components incorporated in the ASBU. Congress emphasized the need for WMO to adopt an inclusive approach to encompass all Members, with appropriate assistance and guidance by the CAeM and other relevant technical commissions, and with strong engagement of the regional associations, to ensure a coherent approach in addressing related technological enhancement, evolving institutional developments and related capacity development needs at all levels.

Conjoint MET DIV 2014 Outcomes

9.2.4 Congress expressed its appreciation to the highly successful outcome of the ICAO/WMO Meteorology Divisional Meeting (MET DIV 2014) conducted conjointly with the fifteenth session of the Commission for Aeronautical Meteorology (CAeM-15) in July 2014 in Montreal, Canada. Congress expressed its satisfaction on the excellent cooperation between WMO and ICAO in organizing and conducting this meeting that resulted in a firm commitment of the two

Organizations to continue their traditional coordinated and collaborative approach in meeting the challenges stemming from the foreseen future developments of aeronautical meteorology in line with the GANP and ASBU.

9.2.5 Congress acknowledged that the MET DIV 2014 adopted 29 recommendations which form the basis for the alignment of the future fully integrated aeronautical meteorology services in the GANP and ASBU. Congress endorsed the WMO engagement, in close collaboration with ICAO, in the follow-up action on 22 of these recommendations, as indicated in the Report of the MET DIV 2014 (http://www.icao.int/Meetings/METDIV14/Pages/default.aspx). Congress requested the Secretary-General, assisted by the president of the CAeM, to ensure adequate representation of WMO in the relevant ICAO and WMO expert bodies tasked to follow-up on the MET DIV 2014 recommendations, including the necessary resources for the effective participation of WMO experts in the work of those bodies. Congress also requested Members to actively support the forthcoming work on the MET DIV 2014 recommendations by assigning appropriate experts and to coordinate closely towards convergent WMO positions, as necessary.

Institutional and regulatory aspects

9.2.6 Congress noted that the envisaged measure towards enhanced efficiency and quality of services in the GANP and ASBU would imply increased multi-national, regional and global approach to operational services. Technological and, in some regions – institutional developments (e.g., the Single European Sky legislation in Europe), would lead to cross-border operational coordination, merging airspaces, consolidating control systems, all of which would stimulate regionalized service provision based on bilateral or multilateral agreements between Member States. Congress noted in particular Recommendation 2/9 (MET DIV 2014) on the implementation of a phenomenon-based regional advisory system for en-route hazardous meteorological conditions aiming at resolving long-standing deficiencies in the provision of SIGMET service. Noting that this was a user-driven development expected to enhance the provision of safety-related SIGMET information and facilitate its integration into the SWIM, Congress also recognized the concerns expressed by some Members that such regionalization might negatively affect the national service providers. Therefore, Congress supported the need for ICAO and WMO to develop, well in advance of the targeted implementation dates, a roadmap including adequate provisions and guidance on the related institutional arrangements, governance, regulatory and cost recovery frameworks, taking into account the sustainability of the supporting infrastructure established and maintained by Members. Congress agreed that the envisaged establishment of regional hazardous weather advisory centres (RHWAC) should be based on regional agreement, should be pursued as a priority in regions where national capacities for provision of SIGMET information have proved insufficient, and should satisfy long-standing requirements from users, such as airlines. Therefore, the presidents of the regional associations should work towards a consolidated regional position on the RHWAC and establish coordination with the respective ICAO Planning and Implementation Regional Groups (PIRGs) in this regard.

9.2.7 Congress considered Recommendation 4/1 (MET DIV 2014) on the Review of the Working Arrangements between ICAO and WMO. Congress acknowledged that these Working Arrangements established the necessary foundation for effective inter-agency collaboration and partnership in the field of aeronautical meteorology over several decades, and agreed on the need for a thorough review and updating to reflect the evolving roles and responsibilities of the two Organizations in view of the intensive work envisaged in the GANP and ASBU framework. Congress also agrees that the review of the Working Arrangements should in principle be carried out by the Secretariats of the two Organizations who could seek assistance by CAeM, Members and relevant stakeholders, as necessary. In this regard, Congress acknowledged the proactive approach of the WMO Secretary-General who had already initiated with the ICAO Secretary-General a consultative process and designation of focal points. Congress noted the target date of November 2016 for the completion of the review and update of the Working Arrangements and their submission for approval by the respective governing bodies. In view of this tight schedule, Congress requested the Secretary-General to ensure the necessary resources for the effective participation of the WMO in the forthcoming collaborative work with the ICAO.

9.2.8 Congress endorsed the Recommendation 4/2 (MET DIV 2014) calling for ICAO and WMO to further clarify the notion of meteorological authority through appropriate amendments to the relevant ICAO and WMO provisions and supporting guidance material. Congress recalled that similar requests had already been formulated by its previous sessions and so reaffirmed the importance and urgency of a common definition and understanding of the roles and responsibilities of the national bodies tasked with regulatory, oversight and service provision functions. Congress recognized that this issue has become even more important in view of the inevitable significant changes in the provision of services to aviation. Recognizing further that the majority of the NMHSs were designated as the national MA, Congress expressed concern that in many cases there was inadequate supporting national legislation to allow them to effectively discharge their authoritative role. In view of this, Congress requested the Secretary-General, assisted by the president of CAeM, to accord high priority on the follow-up of the above recommendation taking due account of the needs of the NMHSs that are also designated as MAs of their States.

9.2.9 With regard to Recommendation 5/2, Reorganization of provisions relating to aeronautical meteorology, Congress noted the plan for developing a new structure of the ICAO and WMO regulatory material contained in the ICAO Annex 3/WMO Technical Regulations, Volume 2, in order to provide a better delineation between the provisions specifying service requirements and respective obligations of Members and service providers, to be retained in Annex 3, and the means to comply with those requirements, to be included in a new ICAO document – Procedures for Air Navigation Services — Meteorology (PANS-MET). While agreeing with the rationale and benefits of such restructuring of the regulatory material, Congress noted that WMO did not have an analogue of PANS-MET in its current regulatory framework. Therefore, as part of the follow-up of the above recommendation, Congress requested the president of CAeM, assisted by the Secretariat, to duly observe the WMO role in the development of the international regulations for the provision of aeronautical meteorological services and that the related WMO Technical Regulations are fully aligned with those promulgated by ICAO. Congress also advised that the restructuring of the ICAO Annex 3/WMO Technical Regulations, Volume II, should also be considered in the context of the evolving Working Arrangement discussed in paragraph 9.2.7.

9.2.10 Congress appreciated that the new structure of the CAeM, adopted at its fifteenth session, included two expert teams; ET on Governance (ET-GOV), and ET on Communication, Coordination and Partnership (ET-CCP), whose work programmes cover the follow-up of the many aspects of evolving institutional arrangement stemming from the GANP and ASBU, including changes to the business models for service delivery and cost recovery mechanisms, related risk analysis and assessments of impacts on Members. Congress requested the president of CAeM, assisted by the Secretariat, to ensure an organization-wide consultation process involving Members, regional associations and technical commissions concerned on those institutional aspects in view of their crucial importance for the future aeronautical meteorological service provision.

Technology development and operational enhancement in service delivery

9.2.11 Congress noted the wide range of recommendations by the MET DIV 2014 on the planned performance enhancement in aeronautical meteorology through utilization of new and improved technology and service delivery improvements. Congress noted further that these enhancements were targeted at meeting the evolving service requirements by users. Congress commended the important contributions by experts and expert bodies of CAeM and CBS in the development of proposals for new methodologies in data management, observing and forecasting practices, based on advancements in technology, including long-term roadmaps and concepts of operations.

9.2.12 Congress acknowledged that a core new concept in the ICAO GANP was the System-Wide Information Management (SWIM) that would create an interoperable global air traffic management (ATM) environment through which the meteorological information would be integrated and made available to various groups of users. Thus, SWIM also determines a service delivery paradigm from "product-centric" to "data-centric". Congress appreciated in this regard that the Recommendation 3/2 MET DIV 2014, Inclusion of aeronautical meteorological information in

the future SWIM-enabled environment, provided a broad framework for ICAO and WMO, through appropriate expert bodies, to address the wide range of technological and operational issues and develop respective provisions enabling and guiding the evolution towards an information management environment. Congress agreed that WMO and ICAO should work together in establishing a roadmap for the transition to SWIM including related data policies, a transparent system of governance and risk mitigation actions.

9.2.13 Congress considered that the ICAO SWIM concept contained a similar vision and technological solutions already in place in the WMO Information System (WIS) and recommended that WMO should offer to share operational plans, experience and lessons learned in the implementation of the WIS with the SWIM stakeholders. Congress stressed that from the point of view of the WMO Members, the interoperability of the WIS with SWIM would be of paramount importance in order to ensure cost-effectiveness. Therefore, Congress requested the presidents of CAeM and CBS, supported by the Secretariat, to establish appropriate liaison with the respective ICAO expert bodies and investigate possible solutions ensuring the interoperability and standardization of the data management and exchanges within the WIS and SWIM environments.

9.2.14 Congress noted further that, as part of the SWIM development, the next financial period (2016–2019) would be a period of intensive work towards the migration from the traditional alphanumeric codes to a XML/GML-based exchange format for METAR, SPECI, TREND, TAF and SIGMET through implementing the ICAO meteorological information exchange model (IWXXM). The timeline for this transition includes specific target dates when the respective ICAO and WMO technical provisions would become applicable, initially as recommended procedures (November 2016), and then as standard procedures (November 2018). Congress stressed the need for a highly coordinated action plan for this transition between the ICAO and WMO Secretariats, Members, appropriate regional stakeholders, and industry, in order to ensure the timely and ordered transition to the XML/GML-coded operational meteorological information. It urged the presidents of CAeM and CBS to coordinate closely on those aspects of the transition under WMO responsibility, including an assessment of the Members capacity needs in terms of technology and training. Congress requested the Secretary-General to ensure that appropriate resources are available to support such capacity development actions during the next financial period.

9.2.15 Congress expressed its satisfaction of the decision by the MET DIV 2014, taking into account the advice of the WMO through the Inter-Programme Coordination Team on Space Weather (ICTSW), that ICAO and WMO should work closely in developing further the service requirements and operational procedures for a space weather information service for international air navigation, including development of criteria and procedures for designation of global and regional space weather centres. It was envisaged that the system of global and regional centres for space weather would become operational through the inclusion of appropriate provisions in Annex 3/Technical Regulations, Volume II, in 2018. Congress requested the presidents of CAeM and CBS, the Members actively engaged in space weather activities, and the Secretary-General, to work in close coordination and provide full support to the inter-agency effort for putting into operation the space weather service that is expected to bring tangible safety and efficiency benefits to aviation stakeholders.

9.2.16 Congress noted that the GANP and ASBU envisaged that future ATM performance improvements would need the development of improved and enhanced meteorological services. This would be achieved through the planned gradual improvements of the established international systems, such as the World Area Forecast System (WAFS) and the International Airways Volcano Watch (IAVW), and also through the development of specifically designed new services for ATM procedures that would be crucial for achieving the safety, efficiency and environment goals of the GANP. Among those are meteorological services for the terminal area (Recommendation 2/10 MET DIV 2014 refers), and services for the "Trajectory-Based Operations" (TBO) (Recommendation 3/1 MET DIV 2014 refers). Congress requested the CAeM, through its Expert Team on Information and Services for Aviation (ET-ISA), to ensure broad coordination and information sharing between Members, technical commissions concerned, relevant bodies of ICAO

and ATM stakeholders, in developing relevant background material, methodology and implementation guidance.

9.2.17 Congress emphasized that WMO should play a lead role in the development of such new services to ATM through an accelerated transfer of the research and technology achievements into operational practice. In this regard, Congress welcomed the establishment of a joint Aviation Research Demonstration Project (AvRDP) aimed at demonstrating the capability of modern nowcasting techniques to provide information and products for enhanced air traffic management in the terminal areas of large and busy airports. Congress noted that AvRDP would also demonstrate a strong partnership approach through the engagement of several WMO Programmes (AEMP, WWRP, GDPFS) and several technical commissions (CAeM, CAS, CBS), and WMO Members (Canada, China, France, Hong Kong, China and South Africa, committed to participate in the first research phase). Congress fully endorsed the idea that the research phase of AvRDP could be followed by a second phase focused on preparing the necessary procedural and regulatory basis together with the supporting guidance material for the transfer of the research results into operational practice. Congress requested the Secretary-General to provide further support to the AvRDP; it also requested the EC to follow the AvRDP developments through annual progress reports from the implementing parties.

Conclusion

9.2.18 Congress agreed that the future development of the aeronautical meteorological service, at a global, regional and national level, should be fully aligned with the ICAO GANP and the related ASBU approach with a horizon of 2028 and beyond. Congress further agreed that the envisaged changes in the institutional arrangements, business models and technology were far reaching and would have a significant impact on all Members, in particular, on those NMHSs tasked through the national legislation with the functions of meteorological authority and/or meteorological service provider. In view of this, Congress welcomed the actions already initiated by the CAeM, supported by the Secretariat and other relevant WMO bodies, to build a strong WMO response to the challenges through a concerted effort and wide partnership.

9.2.19 Congress further noted that the envisaged performance improvements of the ATM system would require in turn a new high performance level of the meteorological service provision, ensuring accurate, timely, high resolution and fit for purpose information suitable for integration into the SWIM environment. Congress agreed that WMO should continue playing a vital role in the development of such "service of the 21st century" in close coordination and collaboration with ICAO, user organizations and other aviation stakeholders. Special attention should be given to the changing institutional arrangements and business models, including the trends towards liberalization and commercialization, and increased multi-national service delivery.

9.2.20 Congress noted the concerns expressed by some Members that in a future highly competitive service delivery environment, many NMHSs, in particular in the developing and least developed countries, would face the risk of losing vital revenues from the aviation sector with a potential negative impact on the sustainability of national infrastructures and availability of core meteorological data. Therefore, Congress urged the president of the CAeM, in close coordination with the Secretariat, regional associations and Members, to pay special attention to measures accounting for the sustainability of the national infrastructures for provision of core meteorological data, promoting the role of the NMHSs in this regard, and assessing the associated risks at the different stages of implementation of the ASBU modules that would allow the NMHSs to develop relevant national actions. In addition, Congress also urged Members to work proactively towards closer partnerships between the NMHSs and the respective national civil aviation authorities, air navigation service providers, airport authorities, airlines and any other relevant aviation stakeholders, in order to ensure their firm commitment for the realization of the required performance improvements. Congress encouraged further strengthening of regional and subregional cooperative mechanisms that bring improved efficiency and quality to the meteorological services provided to international air navigation.

9.2.21 Congress acknowledged the need for an organization-wide campaign to raise Members awareness to forthcoming changes in the provision of meteorological service related to GANP and ASBU, and their inter-linkages with the broader evolution of the air navigation services and the air transport sector as whole. In this regard, Congress welcomed the decisions by several regional associations to hold regional and subregional conferences on aviation meteorology in the next couple of years and requested the Secretary-General to support, to the extent possible within the available resources, such regional events during the next financial period.

9.2.22 Taking into consideration the above deliberations, Congress adopted Resolution 66 (Cg-17) – WMO support to evolving aeronautical meteorological services.

9.3 Post-2015 United Nations development agenda (agenda item 9.3)

9.3.1 Congress noted with appreciation the involvement of the WMO Members and of the WMO Secretariat in the process put in place by the Secretary-General of the United Nations following the Rio+20 outcome declaration "The Future We Want". In particular, it welcomed that the following messages have been factored consistently in the various consultations, namely:

(a) Climate, water, climate change, disaster risk management and resilience building should be accounted for in all climate-sensitive sectors;

(b) Decisions with middle- and long-term time horizon should be science-based;

(c) Human and technical infrastructures are pivotal to maintain, strengthen and develop capacities to analyse and monitor the consequences of the implementation of any measure taken in support of the post-2015 development agenda;

and Congress also recognized that, as part of these messages, the Global Framework for Climate Services (GFCS) had been promoted.

9.3.2 Congress indicated that it would be important for WMO to define its objectives for the coming years to manage its action with respect to the Sustainable Development Goals (SDGs). In this respect, Congress recognized that WMO will act in accordance with the strategy and budget, as approved by its seventeenth session. Congress encouraged WMO to use the Chief Executives Board for coordination (CEB) and its associated process as well as its role in UN coordination mechanisms such as UN-Water to ensure that the above messages be consistently instilled in UN debates, in order to increase the WMO recognition as a reference scientific and technical organization for weather, climate and water. Congress urged Members to get involved, especially through their Permanent Representatives with WMO, to support WMO messages and promote competence and objectives at the local, regional and global levels, and welcomed the continuous efforts of the Secretary-General to engage the Permanent Missions and Governments representatives.

9.3.3 Congress noted the creation of the Scientific Advisory Board (SAB) established by the UN Secretary-General as an outcome of recommendations by the High Level Panel on Global Sustainability in which Dr Bedritskiy, WMO President Emeritus, as well as Zheng Guoguang, Permanent Representative of China with WMO, served. Congress welcomed that this SAB mission is, inter alia, to expand the assessment of the Earth System beyond the physical climate in a more integrate fashion, and to identify knowledge gaps. In this regard, Congress appreciated that the Secretary-General was invited by Irina Bokova, Director General of UNESCO and Secretary of the SAB, to participate in the first session from 30–31 January 2014 in Berlin, and expressed the interest of the WMO community that the Secretary of the SAB continues to extend such invitations to the Secretary-General in the future.

9.3.4 Recalling that the High-Level Panel of Eminent Persons on the Post-2015 Development Agenda report, which laid the basis for the Post-2015 UN Sustainable Development Agenda, advocated for a data revolution and stressed the need for five fundamental transformative changes, including a new global partnership, Congress considered how best WMO could take an

active and rewarding part in the ongoing construction of the post-2015 development agenda. In particular, Congress urged its Members to include the need for meteorological and hydrological infrastructure in projects eligible for funding by mechanisms in place in the broad context of climate adaptation and mitigation and resilience building, as well as by major donors. Congress thus recommended that opportunities be created to convene high-level meetings at ministerial level, such as AMCOMET, in order to demonstrate WMO's competence and increase understanding and recognition of WMO activities, including NMHSs role in serving national priorities.

9.3.5 Congress stressed the importance of the role of its Members, especially through their NMHSs, in providing data and products to contribute to the monitoring of the Post-2015 UN Development Agenda's implementation, in particular its related SDGs. Congress thus encouraged Members to sustain investments in their national human, scientific and technical infrastructure related to WMO activities to ensure the delivery of appropriate parameters to document the targets and indicators in SDGs in which the weather, climate, including ocean and water dimensions are relevant.

9.3.6 Reflecting on the arrangements in place for the adoption by a UN Summit in September 2015 of the post-2015 development agenda, Congress urged Members and requested the Secretary-General to coordinate their inputs in the various consultations that will lead to this Summit as well as at the Summit itself, to better anchor the WMO Strategic Plan 2016–2019 and beyond in this new international agenda.

9.4 Holistic approach to service provision – concept (agenda item 9.4)

9.4.1 Congress recognized that a more uniform approach for service development and delivery had been initiated through "The WMO Strategy for Service Delivery", and that the Strategy and its Implementation Plan provide an adaptable tool and comprise an initial step for Members and WMO constituent bodies to move towards a more structured approach to service delivery (ref.: paragraphs 3.1.1–3.1.12). Congress acknowledged the definition of service as "a product or activity that meets the needs of a user or can be applied by a user" and related attributes, as defined in the Strategy and considered it useful to also define some generic principles applicable to all types of services provided by Members and guided by various WMO Programmes. Such principles would imply that services should be: (a) science-based; (b) quality-assured; and (c) user-oriented. Congress further noted that science-based services would require direct involvement of research in the service delivery process. Congress encouraged that services development should be carried out through a continuous and strong collaboration with research on the topics specified by users' needs. Congress requested to integrate services development with the seamless weather and environmental prediction systems developed under Global Atmosphere Watch (GAW) and the World Weather Research Programme (WWRP).

9.4.2 Congress appreciated the developments towards a more holistic approach to service delivery and emphasized that the broadcast media continued to play a supportive role as one key channel to the public for the communication of weather and climate related information, forecasts and warnings. It agreed that at the national level, the broadcast media's main connection was with the PWS component of the NMHSs and that a holistic approach to service delivery by NMHSs would also help to justify the underpinning investment in national meteorological infrastructure.

9.4.3 Congress agreed that this approach needed to be complemented with a products and services development and delivery process that would incorporate: (a) identification and prioritization of the target users; (b) establishment of working arrangements; (c) understanding the target users' needs and requirements; (d) development of products and technical support to meet those needs and requirements; (e) development of the proper service delivery model appropriate for each target user group; (f) delivery of the service; and (g) establishment of feedback mechanisms for improving products and/or identifying new products with the target user. All activities should be grounded in sound social science techniques from inception. The expected benefits of such a holistic approach for NMHSs are: (a) increased effectiveness and efficiency with a low-cost approach; and (b) improved service quality and institutional capacity. The benefits for the end users would be: timely and easy access to services, as well as greater quality and value

obtained from those services; and focus on their primary needs, efficiency and affordability in their operations.

9.4.4 In order to progress towards a coherent organization-wide service delivery approach within each NMHS, Congress endorsed a set of directions for enhancing service delivery capabilities as presented in Annex XVII to the present report.

9.4.5 Congress recalled its decision to initiate a process for the gradual establishment of an enhanced integrated and seamless WMO data-processing and forecasting system as part of the GDPFS, which would provide multi-dimensional forecasting capabilities to respond efficiently to the emerging requirements from a holistic service delivery methodology. Congress also recalled the Cascading Forecasting Process, being implemented through the SWFDP, could facilitate the introduction of such methodologies in many NMHSs of developing and least developed countries.

9.4.6 Congress considered the importance of assisting Members in the implementation of "The WMO Strategy for Service Delivery" through its application to particular thematic areas such as land transportation, integrated services for urban areas, energy and health. The requirements of users in these thematic areas need to be identified and accordingly impact-based forecasts and risk-based warnings be developed to respond to those requirements. This will lead to improved service delivery which will in turn show the benefits of the work of NMHSs for different societal applications. Congress noted that such development may require unique information as provided by sector-specific partners and may lie outside the NMHS purview, and agreed that establishing and/or strengthening partnerships was a key element of this process.

9.4.7 As an example of this process, as indicated in paragraph 9.4.5 above, Congress considered the recent initiatives within WMO on the improvement of service delivery to the land transport (road and rail) as a sector which could benefit from a coherent service delivery approach (ref.: sixty-sixth session of the WMO Executive Council (EC-66)). It noted that a meeting of an Ad hoc Working Group on Meteorological Services for Land Transportation comprising a number of representatives from NMHSs, research institutions, as well as private sector representatives, had taken place in January 2015 in Geneva. The meeting discussed the needs and opportunities for service delivery for land transport with a focus on how WMO could provide Members with guidance on observations, data management, data processing and forecasting, based on user requirements. It concentrated on how to leverage the investments already made by Members and NMHSs in improving the standards of observations, and in particular investments in the WMO Integrated Global Observing System (WIGOS), the WMO Information System (WIS), as well as in forecasting and service delivery, which are all taken into consideration and applied in improving the land transportation services, as well as those developed by related transportation communities for this purpose.

9.4.8 Congress agreed that the first step should be the identification of the users of the services and the requirements of each user group, including the requirements of the travelling public through the provision of information on the condition of the roads affected by fog, snow, ice and floods, among other hazards. Specialized services are also important to local authorities, highways agencies and gritting contractors in reducing operational expenditure, ensuring efficient flow of traffic, reducing the impact of weather on operations, and minimizing exposure to risk. In this context, Congress noted that provision of specialized services may or may not be appropriate for NMHS' based upon their partnership policies with the private sector. Congress also highlighted the need to identify differences between the needs in the developing and developed Members, with regard both to their meteorological capacity and their road/rail infrastructure. In this regard, Congress agreed with the proposal of the meeting that gathering case studies with a view to identifying good practices among those Members who had experience with service provision to land transport sector would be a helpful tool in this first step. Congress suggested involving the High Impact Weather project, under the World Weather Research Programme, in order to advise on the case studies and on the development of impact databases that are specific to the needs of each NMHS. Congress considered that the following step could be to identify emerging trends in observing and forecasting methods, including impact-based forecasts and warnings, and technologies relevant to land transport.

9.4.9 Congress concluded that it would be beneficial to develop a roadmap to address land transportation and requested that the Executive Council initiate a process for this purpose and to report back to Congress with recommendations on a mechanism for potential improvements to the current situation, where required and applicable.

9.5 Building new partnerships (agenda item 9.5)

9.5.1 Congress defined 'partnership' as *working with international agencies, other organizations, academia, the media and the private sector to improve the range, quality and delivery of critical environmental information and services*. The present WMO partnerships, some of which were formed decades ago, are also in concert with the role of partnerships as outlined in the WMO Strategic Plan 2012–2015 and the WMO Strategic Plan 2016–2019, in which Expected Result 7 that addresses "Strengthened Partnerships" reads: "New and strengthened partnerships and cooperation activities to improve NMHSs' performance in delivering services and to demonstrate the value of WMO contributions within the United Nations system, relevant regional organizations, international conventions and national strategies". Congress recognized that these partnerships also support the delivery of other expected results.

9.5.2 Congress reviewed the present WMO partnership arrangements with a wide variety of partners including UN bodies, non-UN intergovernmental organizations, NMHSs, bilateral donor agencies, research institutes, academia, foundations and the media. These working arrangements are governed by/documented in instruments that include UN inter-agency coordination mechanisms, cooperation agreements, memoranda of understanding and letters of agreement. Congress considered the possibilities offered to WMO should the Organization become more active in, and leverage the synergies created by, various new forms of partnership. These "new partnerships" that are now growing in importance include alliances, coalitions, initiatives, public-private partnerships and civil society partnerships.

9.5.3 Congress noted that many UN organizations are engaged in public-private partnerships, and that international best practices and standards are being developed to govern public-private partnerships in support of UN development objectives, in particular, as follow-up to the International Private-Public Partnerships Summit (15–16 September 2006, Ankara, Turkey) held under the auspices of the UN Global Compact.

9.5.4 Congress took note that "civil society" is defined for the purposes of this document as non-state actors including non-governmental organizations, community-based organizations and professional organizations. Congress observed that civil society organizations are active at all levels of society.

9.5.5 Congress noted that WMO is presently deepening its engagement in a variety of programmes/activities, whose success will require the Organization and its Members to enter into new forms of partnership at the national, regional and global levels. Such WMO Programmes/ activities include those relating to the GFCS, WIGOS, seamless predictions, impact-based forecasts, risk-based warnings in support of Disaster Risk Reduction, Earth system science and the Sustainable Development Goals.

9.5.6 Congress, cognizant of the premature nature of that issue, given the relevance of the matter of "new partnerships", entrusted the Executive Council to explore the issue in greater depth, in particular the associated benefits, obligations and risks. Congress also entrusted the Executive Council to guide the Secretary-General in engaging WMO as a participant or member in alliances, coalitions, initiatives and public-private partnerships.

9.6 Future role of the private sector in meteorology (agenda item 9.6)

9.6.1 Congress acknowledged the growing involvement of entities which can be identified as belonging to the "private sector" (private companies, citizen's associations, bloggers, etc.) in weather, climate, water and related environmental matters, and that these entities are active to a varying extent in the full value chain of activities, starting with observations; extending to data

acquisition tools and technologies, information generation and processing technologies; and culminating in product dissemination and services. Congress thus recognized this part of the private sector as a set of stakeholders in end-to-end service delivery supporting the WMO vision, mandate and objectives. But Congress recognized also the need to set guidelines for action regarding the part of the private sector that is composed of for-profit institutions so that WMO could secure new forms of funding coordinated with the trade development or public service provision policies of the NMHSs, thereby helping to meet the growing interest from such institutions in all areas relating to meteorology, climate, water and related environmental matters. Congress however noted that in future discussion on the subject, it would be useful to make a distinction between private companies which have commercial interests, and the other part of the private sector which does not, since commercial interests could lead to different behaviour and outcomes in delivery of weather information and services, e.g. whether the weather information could be delivered as is, or exaggerated to attract attention and business.

9.6.2 Congress highlighted the different, and at times, complementary roles and responsibilities of NMHSs, academic institutions, research and technological agencies, and the private sector. Congress agreed that closer interactions between the public and private sectors could stimulate innovation and facilitate cross-fertilization, ultimately benefitting the achievement of the WMO Strategic Plan and Expected Results. Congress noted that WMO has a unique opportunity to initiate this interaction and emphasized that inaction may limit the benefits to be derived for the users. Congress noted that, on the other hand, such activities could also lead to proliferation of non-authoritative weather and climate information which could challenge the NMHSs mandate to disseminate authoritative weather information and warnings to the public, media and disaster management authorities. Congress therefore encouraged the development of specifications and service level agreements by NMHSs in order to ensure accuracy, traceability and delivery of quality services to their end users.

9.6.3 Whilst Congress recognized that the private sector initiatives do increase the availability of weather services for the citizens, it was of paramount concern to ensure the sustainability of NMHSs over time. In particular, Congress appreciated efforts by Members to become a "weather and climate ready society", including opening the dialogue to establish common goals with varying responsibilities among their national stakeholders, namely, the public, private, academic, non-governmental and user sectors. Congress suggested that WMO should act at the forefront of this issue, promoting the development of guidance to ensure that products and services are safe, reliable, consistent, coherent and of good quality, whilst maintaining the NHMSs as the authoritative sources of weather information, forecasts and warnings at the same time, and promoting sustainability as well. Congress requested that regional associations and technical commissions identify opportunities for dialogue with the private sector in their workplan, highlight best practices for partnership, and establish an appropriate mechanism to study the findings on those matters and advise the Executive Council accordingly.

9.6.4 With regard to warnings of severe weather, Congress noted that some Members may wish to improve the reach of NMHSs warnings to the public, including inter alia, utilizing the latest communication technology such as mobile applications, improved liaison with digital and broadcast media, provided that they utilize the authoritative weather information and warnings issued by NMHSs and give appropriate credit to the NMHSs as the issuing authority. Congress reiterated that the NMHSs are the national authority for the issuance of warnings of severe weather, and should be given appropriate credit to all intents and purposes as far as the establishment of mechanisms for effective cooperation is concerned.

9.6.5 Mindful of the budgetary context experienced by the NMHSs of many Members, in particular of developing and least developed countries, Congress urged Members to keep investing in their national meteorological, climatological and hydrological infrastructures. Whether fully funded through the public part of a NMHS budget or with complements brought by revenues from cost-recovery mechanisms or commercial activities, including ones that a commercial branch of a NMHS is statutory authorized to conduct, Congress stressed that the finance flowing to support NMHS core operations should be at the appropriate amount. In this regard, Congress invited Members to ensure that appropriate legislation and fiscal directives allow directing part of

the benefits made by the private sector using data and products from NMHSs back to their national infrastructure based on appropriate, internationally recognized guidelines of cost recovery.

9.6.6 Imbalances in the access to markets, including data and other relevant information, by different economic actors may result in difficulties for the most vulnerable in capturing benefits that can accrue from the private sector, markets and economic activities. In this regard, particular attention has to be paid to gender equality and the role of women and to account for the gender dimensions of weather and climate services to serve WMO objectives as concluded by the WMO Conference on Gender Dimension of Weather and Climate Services (Geneva, 5–7 November 2014). Congress invited WMO Members and the Secretary-General to seek to develop services, goods and opportunities for both women and men.

9.6.7 The synthesis report of the Secretary-General of the United Nations on the post-2015 sustainable development agenda – "The Road to Dignity by 2030: Ending Poverty, Transforming all Lives and Protecting the Planet" – stressed the importance of the private sector at the global level in supporting future development financing, as well as in using available funds efficiently, noting that the private sector should not be considered only as a finance provider, but also as a beneficiary of funding. Congress recognized that WMO guidance on engagement with the private sector will enable NMHSs to keep pace with the activities at the national and international levels and enhance efficiency and service delivery, including in support of the development of observational and communication infrastructures at the local and regional level. To this end, Congress encouraged the development of WMO guidance on partnerships with the private sector and adopted Resolution 67 (Cg-17) – WMO guidance on partnerships with the private sector.

9.7 Socioeconomic impacts of meteorological and hydrological services and their communication to decision-makers and users (agenda item 9.7)

9.7.1 Congress recognized that the rapidly growing demand for meteorological and hydrological services around the world presented major scientific, operational and public policy challenges for the NMHSs that maintain and operate most of the global infrastructure on which the quality and value of these services ultimately depends. Congress acknowledged that it had long been understood that investment in NMHSs provided countries with an important quantifiable return in economic benefits, in addition to the vitally important, but less quantifiable, contribution to human safety and well-being. However, the investments, both globally and for individual countries, have now reached such a level that NMHSs are required to demonstrate and justify the value of the continued public investment necessary to support the level of meteorological and hydrological services expected by their governments and national communities.

9.7.2 While the experience of the past decade suggests that it is possible to maintain the overall stability of the international meteorological and hydrological systems, many NMHSs have found that at a national level, they are in urgent need of:

(a) A clearer demonstration of the necessity of continued support for the observational and data processing infrastructure, and their capacity to provide essential public information, forecast and warning services to their national communities;

(b) More rigorous and widely understood demonstration of the socioeconomic benefits of the services they provide to the governments, public and private sectors; and

(c) A more systematic basis for prioritizing the use of available funding for infrastructure and service development and improvement.

9.7.3 A key milestone in the development of Socioeconomic Benefit (SEB) studies was the international conference in Madrid 2007 on "Secure and Sustainable Living: Social and Economic Benefits of Weather, Climate and Water Services". The Madrid Conference Statement and the Madrid Action Plan (MAP) set out a comprehensive five-year strategy for enhancement of the applications and benefits of meteorological and hydrological services around the world including a

specific call, through its Action 11, for the development and application of improved methodologies for evaluating the benefits from the operation of NMHSs.

9.7.4 Congress recalled that the sixty-fourth session of the Executive Council (EC-64, Geneva, June-July 2012), through Resolution 7 (EC-64) – Social, Economic and Policy Impacts of Weather, Climate and Water Services, had requested WMO to collaborate with the World Bank in preparing an authoritative publication on methodologies for assessing the socioeconomic benefits of meteorological and hydrological services and to assist NMHSs in communicating these benefits to their governments and other decision-makers. The result of this effort is a joint book published by WMO in 2015, entitled, "Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services." Congress commended the World Bank and the Climate Services Partnership (CSP), which provided support in the preparation of the book and in organizing a number of regional seminars and training workshops for NMHSs, in regional associations RA I, RA IV, RA V and RA VI, on all aspects of designing SEB studies. Recognizing that this initiative would help accelerate the use of the book and facilitate a new generation of SEB studies, Congress requested that these series of workshops should continue in all WMO Regions and that pilot projects be developed for testing the methodologies.

9.7.5 Congress recalled that the Executive Council discussed the possibility of holding a follow-up conference (Madrid+10) to the Madrid 2007 Conference, which could be held in 2017, which could focus on the following issues:

(a) Current assessment of the economic value of weather and climate services;

(b) The benefits of Government investment in the infrastructure and human resources of NMHSs;

(c) The opportunity for NMHSs to demonstrate the continued and improved/enhanced benefits of their services;

(d) Guidance on communicating these benefits to the governments and other decision-makers;

(e) Assessment of methodologies for analysing socioeconomic benefits of NMHSs services; and

(f) The opportunity for policymakers to understand the importance of continued funding of weather, water and climate services for the national benefits.

9.7.6 Congress noted that a follow-up conference would, in addition, provide a forum for exchanging views and experiences on how to accelerate the capacity development of NMHSs and to encourage partnerships for the effective and efficient delivery of their services to society. The Conference would also examine how increasing the socioeconomic benefits from meteorological, hydrological and climatological services would contribute to achieving the relevant goals of the Post-2015 Framework for Disaster Risk Reduction and the Post-2015 Development Agenda. Congress recommended that the lessons being learned through the implementation of the World Weather Research Programme (WWRP) High Impact Weather Project, in which the socioeconomic value of a number of environmental prediction applications will be studied, be thoroughly considered.

9.7.7 Congress noted that one of the major needs identified in the process leading up to the World Climate Conference 3 (WCC-3) that established the Global Framework for Climate Services (GFCS) and the first years of the implementation of the GFCS is related to the need to develop appropriate tools to evaluate the benefits and monitor effective and cost-effective use of climate information for sector decisions, as well as taking into account the benefits of improved risk communication designed to bridge the gap between information and action. Congress also noted that the new working structure of the Commission for Climatology (CCl), adopted at CCl-16, is closely aligned with the GFCS implementation with a clear focus on user-targeted climate services

including through tailored information, sector-specific climate indices, climate risk management and user interface, addressing some key aspects of the assessment of socioeconomic benefits of climate services.

9.7.8 Congress therefore requested CCl work be effectively integrated into the planning of Madrid+10. Congress further noted that the Conference would present a comprehensive assessment of the outcomes of the Madrid Conference Statement and Action Plan since its adoption in 2007. Many initiatives may have taken place without the Madrid Action Plan "MAP" label, but there is considerable value in identifying, summarizing and disseminating this information.

9.7.9 After careful reflection on the feasibility and benefits, of an international conference on socioeconomic benefits, Congress decided that there was merit in holding a second conference, and requested the Secretary-General to make the necessary preparations to hold it in 2017, using extrabudgetary resources. Congress invited Members and partner organizations to voluntarily contribute resources to enable holding a Madrid+10 Conference.

9.8 Integrated approach to WMO urban activities (agenda item 9.8)

9.8.1 Congress recognized that urbanization is rapidly becoming the dominant feature of societal dynamics. More than half the global population now lives in cities and this percentage is expected to increase to approximately 70% by 2050. The urban environment is complex and sensitive and relatively small environmental perturbations can have large impacts. Considering the ongoing urbanization and expectations of more weather and climate extremes, an urgent need exists to enhance the resilience of cities and their inhabitants.

9.8.2 Congress recalled past actions and international developments in this area. Sixteenth Congress requested for WMO to look at the challenges faced by megacities; the sixteenth session of the Commission on Atmospheric Sciences (CAS-16) in 2013 included "Urbanization: research and services for megacities and large urban complexes" among the six emerging challenges and opportunities for the decades to come; the sixty-sixth session of the Executive Council (EC-66) addressed urban issues; and the Intergovernmental Board on Climate Services (IBCS) agreed that urban activities related to climate be included as a specific cross-cutting element within the priority areas of the Global Framework for Climate Services (GFCS) (Resolution 3 (IBCS-2)). Within the United Nations system, urban issues are likely to feature prominently in the post-2015 development agenda. The United Nations Conference on Housing and Sustainable Development, HABITAT-III, will take place in 2016, and in this connection a new United Nations Urban Agenda is being developed.

9.8.3 Congress emphasized that integrated urban services will be relevant for urban resilience and sustainable development, city planning, transportation, power supply, food safety, climate change adaptation and mitigation, the anticipation and mitigation of natural hazards, including flooding and droughts, reducing the vulnerability of the urban poor to natural hazards, and the health of the citizens, amongst others. Congress stressed that WMO and its Members can make a tangible positive impact on the urban environment by providing forecasts and integrated services that are targeted to the wide-ranging needs of urban authorities and population. New service delivery models, including the role of the private sector as a partner, need to be developed to ensure that services, products and warnings do in fact have the intended impact. Congress pointed out that clearly the contribution to sustainable cities and urban sustainable development requires integration of cross-cutting initiatives between WMO Members and between WMO Programmes, constituent bodies, and activities, between research and operational applications, and with other agencies and organizations involved in urban matters.

9.8.4 Congress was pleased to note that CAS, in collaboration with the Commission for Basic Systems (CBS), had provided leadership for addressing the emerging concerns regarding megacities as requested by Cg-XVI.

9.8.5 Regarding climate in relation to urban issues, Congress agreed that activities that are needed are the identification of criteria to capture the influence of urban growth on observing stations as regards climate data and monitoring; identification of observational data sets from urban conglomerations for urban climatology studies, model evaluation and services; and consideration of climate characteristics of specific impacts of climate anomalies on urban conglomerations for climate service provision.

9.8.6 Congress recognized that in addition there are many ongoing activities within the Commission for Climatology (CCl) that do not have an explicit urban focus but that are relevant for urban settings, and requested CCl to consider addressing these from the urban point of view in line with the WMO Strategic Plan 2016–2019. Congress foresees that climate services for renewable energy and urban planning (hazard data and climate trends for risk assessments) and operations (such as water management and drainage systems), heat wave health early warning systems and climate-smart urban infrastructure (including buildings and urban spaces) are likely to be in increasing demand and requested for CCl to consider addressing these in its work.

9.8.7 Congress noted that the activities of the Commission for Agricultural Meteorology (CAgM) are mostly focused on increasing food production and that urban agriculture needs to be considered as an important contribution to this goal. In addition, Congress recognized that drought has a significant impact on the water resources management for urban areas especially where there are competing uses such as irrigation water for agricultural production. Congress acknowledged that the ongoing activities on drought within CAgM and the Integrated Drought Management Programme should be taken into consideration with regards to urban issues.

9.8.8 In considering urban areas and climate-related research, Congress noted that the main topics of interest are those signifying climate-related risks, including sea level rise, extreme climate events and intensification of storms and storm surges. Congress agreed that the World Climate Research Programme (WCRP) Working Group on Regional Climate will need to consider extending its efforts to address climate information for urban communities due to the increased demand for climate information in megacities.

9.8.9 Congress acknowledged that WCRP and the World Weather Research Programme (WWRP) need to work together to address urban population and environment needs in an effective and coordinated manner, especially as regards hourly-to-decadal time and regional geographic scales and seamless coupled weather-climate modelling capabilities. In particular, for major cities along coastal zones, more reliable information should be provided for water resourcing, extreme storm event and climate trend predictions, to support sound local decisions including those on investments, town planning and infrastructure design.

9.8.10 Concerning climate-related observations, Congress recommended developing a scoping study to evaluate and prioritize observation-related needs for understanding and predicting urban climate, based on the Global Climate Observing System (GCOS) principles.

9.8.11 Congress recalled that the Commission for Instruments and Methods of Observations (CIMO) Guide (WMO-No. 8) has a chapter on Urban Observations that provides Members with guidance on siting, exposure and metadata requirements for instrumentation for urban meteorology. However, as the urban environment varies greatly, and siting depends on purpose, the measurements should be revisited, including consideration of unconventional methods, such as mobile phone network signals (wet delay) for rainfall estimation. Mobile sources, such as phones and cars, may have particular relevance for urban meteorology as the densities of usage are very high.

9.8.12 Congress noted that the WMO Integrated Global Observing System (WIGOS), the WMO Information System (WIS) and the Global Data-processing and Forecasting System (GDPFS) need to ensure that those Programmes undertaking research and development for urban activities are fully aware of what WIGOS, WIS, GDPFS and Emergency Response Activity (ERA) are offering and enabling. Congress recognized that on the other hand CBS will need to fully understand users' needs to make sure standards can meet these needs and integrate, or at least

be interoperable with, the tools and needs of urban stakeholders. In addition, understanding decision-making processes is important for ensuring that provided services meet the requirements of and feed into these processes. By understanding urban needs, WIS service providers will be better able to fine-tune their systems to be able to meet the needs of these specialist users. Congress reminded that the consideration of these standards and practices needs to be brought early on into the process of developing urban applications.

9.8.13 Congress agreed that a major element of WIS has been the framework development for bringing together data from various stakeholders. In the urban sense, this would include the various infrastructure suppliers as well as emergency services and other crucial urban components between which cooperation would need to be enhanced. With the infrastructure of WIS and the collaboration framework of WIGOS, NMHSs, once appropriately trained, should be able to implement these frameworks and practices required to make independent partners work as if in an integrated unit.

9.8.14 Concerning satellite observations, mapping of urban areas (land cover use, terrain elevation, air quality, land surface temperature) is important for pre-disaster exposure assessment, and post-disaster recovery, for assessing climate change adaptation measures, for monitoring health hazards, and for tracking emission sources. Partnerships beyond WMO should be established for these applications. Congress recommended an assessment of current mechanisms to provide and use this type of satellite data; here collaboration with the Group on Earth Observations (GEO) could be useful.

9.8.15 Congress reminded that satellite observations are also important for the meteorological, climatological and air quality forecasting applications for use in urban areas.

9.8.16 Congress recalled the vital role of NMHSs in the provision of effective public weather services (PWS) in support of the delivery of user-targeted meteorological and hydrological services in urban areas. Congress recommended for NMHSs to take advantage of the emerging high technology communication systems, including mobile applications and social network platforms, which may require private sector collaboration that can provide NMHSs with the opportunity for continuous and tailored provision of authoritative public forecasts and warnings to the urban population, especially location-specific and targeted weather information for people on the move. Congress highlighted the importance of using these multi-channel systems especially in cities where severe weather can be a source of the so called “domino effect” and lead to great challenges, complications and disruptions in the lives of the city population and for city authorities. Congress stressed the importance of the provision of impact-based forecasts and warning services in urban areas, where a variety of institutional, governmental, and specialized users and the public need tailored and targeted services (agenda item 3). Congress agreed that service delivery for urban settings should be given focused consideration.

9.8.17 Regarding the Disaster Risk Reduction (DRR) Programme in relation to urban phenomena, Congress noted that cities are made up of complex interrelated systems and can be points of convergence of many risks, making them particularly vulnerable to cascading impacts of multiple hazards and to the amplification of risks up to global scales through interconnections between cities and further between regions. Congress thus stressed that an urgent need exists to reduce disaster impacts in urban settings, for enhancing the resilience of cities to natural hazards, and for improving the urbanization process, including urban planning.

9.8.18 Congress recognized that the implementation of the Congress-approved WMO Strategy for Service Delivery will provide tools to be applied especially to the provision of improved services in urban areas. Congress remarked that CBS-16 provides an opportunity for urban service, observations and data processing needs to be addressed and requested the president of CBS to make CBS expert groups aware of the cross cutting nature of urban issues within the strategic plan so appropriate consideration may be given in the preparatory work for the sessions.

9.8.19 Congress acknowledged that the Associated Programme on Flood Management (APFM) is an advocacy for integrated flood management, i.e., increasing preparedness and

resilience to floods through a multidisciplinary approach encompassing flood forecasting, early warning, flood mapping, land-use planning and structural and non-structural measures. Congress recognized that APFM is already heavily involved with urban flood management, having developed training manuals and tools on integrated urban flood management, that provide best practice concepts and applications in view of integrated and cooperative approaches in water management. These manuals and tools are directed at decision-makers, professionals of various fields of knowledge, working in the urban environment as administrators, legislators, engineers, architects, geologists, biologists and others, integrating expertise from different disciplines. Congress agreed that this approach could serve as an example to other WMO Programmes on addressing urban problems.

9.8.20 Congress recognized that urban flooding would need to continue to be of great importance in the APFM agenda because of the high impact that flood events have on the urban environment and because of the need for more detailed information regarding modelling and assessment of flood impacts in human settlements. Events in informal settlements are especially destructive as these settlements are particularly vulnerable. Reducing disaster risks and increasing the resilience of people living in these areas would also be crucial for minimizing loss of life and maximizing net benefits from the use of floodplains and would work towards achieving the post-2015 UN sustainable development agenda.

9.8.21 Congress also recognized the importance of the Integrated Drought Management Programme (IDMP) in building resilience to drought through a multidisciplinary approach, addressing the issue specifically in urban settings.

9.8.22 Congress recognized that urbanization in coastal areas combined with climate change and possibly in some cases poor governance can lead to significant increase in the risk of local pluvial flooding coinciding with high water levels in rivers and high tide or storm surges from the sea, posing a greater risk of devastation in coastal communities. These areas may also be susceptible to multiple hazards, from for instance tropical cyclones. Congress noted that the WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) and the WMO Commission for Hydrology (CHy) have initiated the Coastal Inundation Forecasting Demonstration Project (CIFDP) to facilitate the development of efficient warning systems to protect communities from coastal inundation in disaster-prone countries. Congress recommended for APFM, the World Climate Services Programme, DRR, the Marine Meteorology and Oceanography Programme, PWS, the Tropical Cyclone Programme, GDPFS, WCRP, and WWRP to build upon the lessons learned from CIFDP by jointly working together to address issues faced by coastal cities.

9.8.23 The WMO GAW Urban Research Meteorology and Environment (GURME) addresses air pollution and related questions in urban areas, and Congress recognized that these are an integral part of urban research and services and recommended for these activities to be considered jointly with other urban applications. Congress agreed that a good example of such joint WMO-wide work has been the Multi-hazard Early Warning System (MHEWS) that was developed for Shanghai for the World EXPO 2010. Congress further agreed that public information and warnings about air quality (pollution as well as pollen) can help urban dwellers adjust their level of exposure to elements that are harmful to them.

9.8.24 Considering the above, Congress stressed that it is important for WMO activities related to urban services to be addressed in an integrated manner in order to provide efficient and effective services, going from research to operational applications, to assist in urban planning processes and to minimize risks and damages. Congress requested the concerned technical commissions to address urban issues in their work and regional associations to include urban activities in their programmes. Congress recognized that a dedicated focal point is needed to consolidate WMO urban activities and coordinate the above efforts and requested the Secretary-General to take appropriate action and to report to Eighteenth Congress on the progress.

9.8.25 Congress adopted Resolution 68 (Cg-17) – Establishing a WMO cross-cutting urban focus.

10. WMO STRATEGIC PLAN AND BUDGET (agenda item 10)

10.1 WMO Strategic Plan 2016–2019 (agenda item 10.1)

10.1.1 Congress recalled its decisions on strategic planning (paragraphs 8.5.1–8.5.5 and Resolutions 36 and 38 (Cg XVI)) and noted that the strategic planning for the period 2016–2019 represented the third phase of the Results-based Management (RBM) Strategic Planning Framework for WMO and builds upon the previous long-term planning process and the experience and lessons learnt in RBM during the 2008–2011 and 2012–2015 periods that had enabled it to respond to the changing needs of Members and society in general.

10.1.2 Congress noted with appreciation the work accomplished by the Executive Council (EC) through its Working Group on Strategic and Operational Planning in preparing the Strategic Plan. Congress also noted that the WMO Strategic Plan (SP) for the period 2016–2019 is directed at addressing three broad global societal needs through implementation of seven priorities to advance the achievement of Expected Results. The priorities identified reflected the inputs from all WMO constituent bodies and in particular the six regional associations.

10.1.3 Congress appreciated the active involvement of regional associations, technical commissions and the Secretariat, including Secretariats of co-sponsored programmes, in the development of the WMO Strategic Plan 2016–2019, which ensured that the document reflected the collective view of all WMO constituent bodies.

10.1.4 Congress reaffirmed the importance of the Strategic Plan for the WMO RBM as the foundation for the planning of activities and resource allocation in the seventeenth financial period as reflected in the WMO Operating Plan (OP) and Results-based Budget (RBB) for the period 2016–2019.

10.1.5 Congress agreed that, although its primary focus was on the Seventeenth WMO financial period (2016–2019), the Strategic Plan takes into consideration the challenges beyond the period that may influence the achievement of Expected Results. The Plan should direct collective and coordinated activities of regional associations, technical commissions and the Secretariat through well-defined Programmes, projects and initiatives, as well as guide and motivate activities of Members and their National Meteorological and Hydrological Services.

10.1.6 In that connection, Congress adopted Resolution 69 (Cg-17) – WMO Strategic Plan 2016–2019.

WMO Operating Plan 2016–2019

10.1.7 Congress noted the draft WMO-wide Operating Plan (2016–2019) as a component of the WMO's Result-based Management (RBM) framework. Congress noted that the draft WMO Operating Plan (2016–2019) provided details on expected results, key outcomes, deliverables and time-bound activities, which have been used to guide resource estimates and allocations in the Secretary-General's budget proposal for the seventeenth financial period. Congress appreciated the contributions of the technical commissions and regional associations to the development of the WMO Operating Plan 2016–2019.

10.1.8 Congress requested the Secretary-General to finalize the WMO Operating Plan taking into account all the decisions of the Seventeenth Congress, particularly Resolution 70 (Cg-17) – Maximum expenditure for the seventeenth financial period (2016–2019), and to make the final version of the Plan available online for use by all management groups, the Executive Council and the Secretariat.

10.2 Budget for the seventeenth financial period (2016–2019) (agenda item 10.2)

10.2.1 Congress considered the budget proposal from the Secretary-General for the seventeenth financial period (2016–2019) and decided on the maximum expenditure and the eight

Expected Results. The detailed discussions of various activities and Programmes, and the decisions of Congress thereon, were recorded under their respective agenda items.

10.2.2 Congress stressed the importance to maintain a close alignment between the budget proposal for the seventeenth financial period and the corresponding WMO Strategic Plan, as well as the Operating Plan. Several Members expressed the view that due to affordability constraints at the national level, they had difficulties accepting any regular budget increase, and that further efficiencies and savings should be achieved. They also stated that extrabudgetary resources should be used more extensively for activities currently funded from the regular budget. Other Members could support a moderate increase of the assessed contributions over and above the Zero Nominal Growth level to address emerging priorities, and expressed their concern about the risks associated with extrabudgetary resources, including lack of stable funding and unpredictable availability, and the fact that these funds are often provided for specific purposes.

10.2.3 Congress noted with satisfaction the efficiency and savings measures introduced since 1996 and those planned for the coming financial period, and stressed that efforts aimed at reviewing internal operations of WMO and identifying further efficiency gains and savings should be continued and reinforced to allow priorities identified by Congress to be realized within approved resources. Congress also noted the need to consider re-scoping activities and Programmes to ensure WMO resources are aligned with the priorities identified in the Strategic Plan 2016–2019.

10.2.4 To this end, Congress requested the Executive Council, in close cooperation with the Secretariat, to establish required mechanisms in order to review WMO activities and Programmes and to consider additional efficiencies and savings, re-scoping of activities and the use of programme support costs associated with voluntary contributions, as well as the associated risks and opportunities. Congress requested that the Executive Council report to Eighteenth Congress on the results of the review and their implementation. To ensure more informed decision-making on the results-based budget of WMO, Congress also requested the Secretary-General to include information on the costs of the WMO activities and Programmes and the detail of costs by object of expenditure in the budget proposals for the second biennium (2018–2019) of the seventeenth financial period and the eighteenth financial period (2020–2023).

10.2.5 Congress also recognized the need for additional resources and their management which are deemed necessary for the timely implementation of activities addressing the priorities included in the WMO Strategic Plan 2016–2019, as well as for the maintenance of the WMO headquarters building.

10.2.6 After discussion, Congress agreed to a maximum level of expenditure for the seventeenth financial period (2016–2019) of CHF 266,220,000, which also corresponds to the expected level of assessed contributions for the same financial, by adopting Resolution 70 (Cg-17) – Maximum expenditure for the seventeenth financial period (2016–2019).

10.3 Preparation of the Strategic and Operating Plans 2020–2023 (agenda item 10.3)

10.3.1 Congress reiterated the importance of the strategic planning process and the WMO Strategic Plan 2016–2019 for the appropriate and coordinated implementation of the WMO Programmes in the forthcoming financial period. It saw the need to put in motion a mechanism for the preparation of the Strategic and Operating Plans for the eighteenth financial period taking into consideration the need to have stable Strategic Plans that focus beyond the planning period.

10.3.2 Congress noted that the WMO Strategic Plan sets the direction and priorities to guide the activities of all WMO constituent bodies to enable all Members improve their core information, products and services, maintain necessary infrastructures, and to directly benefit from advancements in science and technology. The Strategic and Operating Plans provide the foundation for developing the WMO Results-based Budget (RBB), which identifies regular resources that are needed to implement the Operating Plan, as well as voluntary resources for project initiatives that enhance key outcomes in priority areas.

10.3.3 Congress agreed that the Global Societal Needs (GSNs) identified by the Organization based on post-2015 sustainable development goals, and which form the solid basis for the Strategic Plan for the period 2016–2019 and the Expected Results (ERs), represent relevant issues and directions that could still influence the focus of the Organization beyond the period 2016–2019, and should form the basis for the WMO Strategic Plan for the period 2020–2023.

10.3.4 Congress further agreed that the strategic and operational planning for the period 2020–2023 should:

(a) Follow the overall integrated planning process, taking into account the evolution of the societal and economic needs of the Members, relevant international initiatives, and the challenges of climate variability and change;

(b) Build on programme and management-related experiences gained in the implementation of the three phases of strategic planning (2008–2011, 2012–2015 and 2016–2019) and from the strategic planning process as a whole; and

(c) Improve the Key Performance Indicators to facilitate efficient monitoring and evaluation of the progress to achieve Expected Results;

(d) Take advantage of various regional association management groups to identify the needs and priorities of Regions given the differences in the cycles of sessions of regional associations.

10.3.5 In light of the above, Congress adopted Resolution 71 (Cg-17) – Preparation of the Strategic and Operating Plans 2020–2023.

11. RESOURCE MANAGEMENT (agenda item 11)

11.1 Financial matters (agenda item 11.1)

Financial Report of the Secretary-General for the sixteenth financial period

11.1.1 Congress examined the financial situation of the Organization for the sixteenth financial period (2012–2015). In particular, Congress noted the financial situation with regard to assessments, outstanding contributions, status of budgetary appropriation, revenue and surplus. In addition, the Congress noted information on programme support cost arrangements, Working Capital Fund (WCF), Trust Funds, Joint WMO/ICSU/IOC Climate Research Fund (JCRF), WMO/UNEP Intergovernmental Panel on climate Change (IPCC) Fund and the Global Climate Observing System (GCOS).

11.1.2 Congress was satisfied that the Secretary-General was taking all the necessary steps to administer the financial resources made available to the Organization in a manner consistent with the provisions of the Financial Regulations and the decisions of Sixteenth Congress (2011) and the Executive Council.

11.1.3 Congress also noted that the financial situation was regularly reviewed on an annual basis by the Executive Council, the Audit Committee, and the Financial Advisory Committee.

11.1.4 Congress noted with satisfaction the payment by some Members of their long-outstanding contributions. It nevertheless noted with much concern that in some cases, Members were delaying the settlement of their assessed contributions for unduly long periods, which deprived the Organization of cash resources required to implement the programmes.

11.1.5 Congress further noted that programme and budget performance during the first three years (2012–2014) of the sixteenth financial period was carried out on the basis of the approved budget for the sixteenth financial period.

11.1.6 Congress requested that future financial statements present more clarity when presenting differences between IPSAS accrual based figures and cash based figures, as was previously presented under UNSAS.

11.1.7 Congress agreed to suspend Financial Regulation 9.1 during the seventeenth financial period only, with respect to the distribution of any cash surplus that might result from the sixteenth financial period, and to delegate to the Executive Council the allocation of such cash surplus to priority activities, and adopted Resolution 72 (Cg-17) – Use of cash surplus arising from the sixteenth financial period (2012–2015).

Proposal for Funding the Liability for After-Service Health Insurance (ASHI)

11.1.8 Congress noted that WMO has a contractual obligation to finance medical care by subsidizing medical insurance premiums for retired employees, in accordance with Article 6.2 of the Staff Regulations.

11.1.9 Congress noted that WMO's liability for After-Service Health Insurance (ASHI) amounted to CHF 53.0 million at 31 December 2014, and that this reflected an increase of 42% over the four years ending 31 December 2014. Congress noted that this increase resulted primarily from a decrease of the discount rate, the change of the normal retirement age from 62 to 65 for staff joining the Organization on 1 January 2014 or later, and a change in membership of the insurance plan. Congress also noted that, during the same (four-year) period, the number of retirees increased at nearly twice the rate of increase of active staff.

11.1.10 Congress noted that the Organization is funding these liabilities on a pay-as-you-go plan, which was established by the Executive Council, and that the balance in the reserve created for this purpose was CHF 2.4 million at 31 December 2014. Congress noted that this balance was sufficient to cover annual premiums for two years.

11.1.11 Congress noted that the plan covers the short- to medium-term liabilities related to employee benefits, but it does not cover the liabilities over the long term.

11.1.12 Congress noted that the Executive Council considered this issue at its sixty-sixth session and requested the Secretary-General to submit the proposal to Seventeenth Congress which should take into account: (i) the recommendations that may arise from the ongoing UN system exercise on reviewing the liabilities for After-Service Health Insurance (ASHI); (ii) reflect on possible measures to contain and reduce ASHI liability; (iii) the possibility of applying future potential surpluses at the end of a financial period – in total or in part – to this liability, beginning in the seventeenth financial period; and (iv) a reflection on the possibility of adopting measures to increase the cost-effectiveness of the health insurance scheme.

11.1.13 Noting that the UN system exercise was expected to be completed after its seventeenth session and that the United Nations General Assembly (UNGA-70) would consider the results and recommendations arising from the exercise during its seventieth session (2015), Congress requested the Secretary-General to submit a proposal to the Executive Council that will take into account the decision of UNGA-70, and authorized the Executive Council to take a decision.

11.1.14 Noting the risks associated with the long-term liability for ASHI, Congress adopted Resolution 73 (Cg-17) – Plan for funding liability for after-service health insurance.

Benefits realized from adoption of International Public Sector Accounting Standards (IPSAS)

11.1.15 Congress recalled that during its sixteenth session (May–June 2011), it requested the Secretary-General to fully exploit IPSAS in continuing to improve the efficiency, effectiveness and financial management of the Organization, and to report to Cg-17 on the benefits achieved.

11.1.16 Congress reviewed the Secretary-General's report on the Organization's experience with IPSAS following the adoption of IPSAS from 1 January 2010, noting the benefits realized as well as the challenges encountered.

11.1.17 Congress noted that the external auditor's opinions on the IPSAS-compliant financial statements have been unqualified.

11.1.18 Recognizing that some difficulties existed in issuing donor reports on a cash basis, Congress requested the Secretary-General to continue to work toward exploiting IPSAS to improve the efficiency, effectiveness and financial management of the Organization.

Proposed Revision to Resolution 31 (Cg-XIII) – Short-term borrowing authority

11.1.19 Congress noted that Resolution 31 (Cg-XIII) authorizes the Secretary-General, if the cash balance of the Working Capital Fund proves to be temporarily inadequate for financing the approved budget, to borrow funds on a short-term basis from the Voluntary Cooperation Fund and from the Publications Fund to the extent that such borrowing does not affect the activities financed under these funds.

11.1.20 Congress noted that the Publications Fund was closed at the end of the thirteenth financial period, in accordance with Resolution 42 (Cg-XV) and that this limited the Secretary-General's authority for internal borrowing to only one fund.

11.1.21 Congress further noted that WMO is currently managing a significant number of projects funded with voluntary contributions in addition to the Voluntary Cooperation Fund.

11.1.22 Congress considered and approved the recommendation of the Executive Council (Resolution 24 (EC-66)) that the Secretary-General's short-term borrowing authority be expanded to include voluntary contributions and adopted Resolution 74 (Cg-17) – Short-term borrowing authority.

Report of the Secretary-General on the surplus or deficit from the fifteenth financial period (2008–2011)

11.1.23 Congress examined the statement of surplus or deficit for the fifteenth financial period (2008–2011) and noted that the Organization started that period with a cash surplus of CHF 9.2 million from the fourteenth financial period (2004–2007), which was applied to the budget for the fifteenth financial period, in accordance with Resolution 35 (Cg-XV). Congress further noted that, during the fifteenth financial period, WMO received payments of assessed contributions from Members amounting to CHF 243.4 million and receipts of other regular income (rental income, programme support cost income, interest, and other income) of CHF 16.0 million. Congress also noted that, after liquidation and cancellation, in the sixteenth financial period, of open obligations at 31 December 2011, cash expenditure of the regular budget amounted to CHF 275.9 million, resulting in a cash deficit of CHF 7.3 million at the end of the period.

11.1.24 Congress noted that the expenditure of CHF 275.9 million was within the maximum of CHF 279.0 million authorized by Congress in Resolution 35 (Cg-XVI), CHF 269.8 million funded with assessed contributions and other regular sources and CHF 9.2 million with the surplus from the fourteenth financial period.

11.1.25 Congress noted that it was not possible for the Secretariat to present to the Sixteenth Congress (May 2011) a reasonable projection of the cash situation at the end of the fifteenth financial period because the Secretariat was transitioning from the United Nations System Accounting Standards (UNSAS) to International Public Sector Accounting Standards (IPSAS) during 2010 and most of 2011.

11.1.26 Congress noted that the cash deficit of CHF 7.4 million was carried forward to the sixteenth financial period (2012–2015), as shown in paragraphs 11.1.1–11.1.7.

11.2 Proportional contributions of Members (agenda item 11.2)

Sixteenth financial period

11.2.1 Congress noted that the Republic of South Sudan and Tuvalu had become Members during the sixteenth financial period, bringing the Membership of the Organization to 191.

Scale of assessment of contributions

11.2.2 Congress recalled its decision under Resolution 39 (Cg-XVI) – Assessment of proportional contributions of Members for the sixteenth financial period, that the latest United Nations scales to be approved by the United Nations General Assembly should be adopted as the basis for the calculation of the WMO scales of assessments, duly adjusted for differences in membership.

11.2.3 Congress noted that the United Nations scale of assessments for the years 2016–2018, which will be approved by the seventieth UNGA at the end of 2015, will be available too late for application to WMO's scale of assessments for 2016. Congress also noted that the United Nations scale of assessments for the years 2019–2021, which will be approved by the seventy-third UNGA at the end of 2018, will be available too late for application to WMO's scale of assessments for 2019.

11.2.4 Congress decided that the minimum rate of assessment of 0.02%, as adopted for the sixteenth financial period, be retained as the minimum assessment rate for the seventeenth financial period.

11.2.5 Congress authorized the Executive Council to base the WMO scale of assessments for: (a) the year 2016 on the already approved scale of assessments for 2015; and (b) the years 2017, 2018 and 2019 on the United Nations scale of assessments to be adopted by the United Nations General Assembly at its seventieth session in the year 2015. Corrections should be made to ensure that no Member's rate of assessment would increase to a level which would exceed 200% of the WMO scale for 2015.

11.2.6 Congress adopted Resolution 75 (Cg-17) – Assessment of proportional contributions of Members for the seventeenth financial period, and requested the Secretary-General to calculate the advances due to the Working Capital Fund from any new Members joining the Organization after 1 January 2016 on the basis of the scale of contributions for the year 2016 as provided for in Financial Regulation 9.3.

Working Capital Fund

11.2.7 Congress recalled its decisions under Resolution 42 (Cg-XV) – Working Capital Fund, to: (a) fix the capital of the Working Capital Fund at CHF 7.5 million; (b) freeze the advances of existing Members then at the level for the fourteenth financial period; and (c) fund the unfunded capital of CHF 2.5 million at the time with savings expected from the consolidation of off-budget funds into the regular budget as of 1 January 2008. Congress further noted that the consolidation resulted in savings of CHF 1,326,000, reducing the shortfall to CHF 1,174,000.

11.2.8 Congress noted that the capital of the Working Capital Fund earned interest amounting to CHF 278,000 by 31 December 2014, bringing the capital of the Fund to CHF 6,604,000.

Risks of the negative interest rate policy

11.2.9 Congress noted that there was a need to assess the risks of the negative interest rate policy as introduced by the Swiss National Bank and implemented by all major banks in Switzerland. Congress noted that comparison of policies adopted by other UN organizations in that regard might be beneficial.

11.2.10 Congress requested the Audit Committee to look at that area with a view to advising the Secretary-General in mitigation actions. It also requested the Executive Council to monitor and assess the impact of a negative interest rate policy and to keep the matter under review.

11.2.11 Congress adopted Resolution 76 (Cg-17) – Working Capital Fund, maintaining the Working Capital Fund at CHF 7.5 million for the seventeenth financial period and continuing to fund the remaining unfunded capital of CHF 896,000 with interest income to be earned by the Fund during the seventeenth financial period.

11.3 Staff matters (agenda item 11.3)

11.3.1 The president of the Staff Association (SA), on behalf of the staff, expressed appreciation for having the opportunity to address Congress, in compliance with Staff Regulation 8.1. Congress acknowledged the value of the participation of staff in the discussions relating to their conditions of service.

Effective support to WMO Members by WMO staff

11.3.2 Congress reaffirmed that an efficient and motivated Secretariat work force is an essential asset for the Organization in meeting the needs of its Members. Staff should be enabled in the most efficient way to carry out the scientific, technical and administrative work required to achieve the goals of the Organization. Hence Congress recommended that WMO management, in consultation with staff, strive to reinforce and enhance the ability of the Secretariat staff to address existing and new challenges, through increased training opportunities also in view of career development, efficiency of the administrative processes and enhanced protection of staff well-being, also by making available adequate resources.

Role of the Staff Committee

11.3.3 Congress recalled that, based on Staff Rule 181.1, a Staff Committee is established, which is regularly consulted and involved on matters relating to staff welfare and administration, including policies on appointment, promotion and termination, benefits and allowances. This consultation is exercised through the participation of members elected by the staff or nominated through the Staff Committee in several internal committees (Joint Consultative Committee (JCC) for administrative matters, and specialized committees for appeals, reclassification, grievance and disciplinary matters, etc.). Travel policy, including lump sum for home leave, flexible working hour arrangements, development of a car parking fee structure linked to greenhouse emission, and WMO greening, were among the specific topics discussed at JCC.

11.3.4 Congress was informed of the continuing difficulties faced by the members of the Staff Committee to allocate sufficient time to deal with the substantial issues related to representation of the WMO staff, as the time devoted by members of the Staff Committee to staff matters is in addition to the time devoted to normal Secretariat work responsibilities. The Congress noted that the President of the Staff Committee is entitled to a 50% release from his/her regular duties.

Follow-up to 2012 Staff Survey

11.3.5 Congress noted that, as had been requested at its sixteenth session, a Staff Survey was conducted in 2012 to capture information on health, well-being and work satisfaction of WMO staff members. In comparison to a similar survey carried out in 2008, this most recent survey indicated a general increase in staff satisfaction regarding overall management of the Organization and clarity of procedures, but also revealed a persistent dissatisfaction concerning career management and related opportunities for staff career development. In addition, 25–33% of staff members reported frequent stress at work, with workload and inadequate management by supervisors figuring prominently among the reported causes of stress.

11.3.6 Congress was informed that following EC-65, WMO management and staff engaged, through the ad hoc Working Group on Staff Survey Follow-up, in a consultative process aimed at

addressing issues that were identified by the Staff Survey, in particular, matters that eroded work satisfaction. Congress noted that the Staff Committee appointed an Informal Consultative Group to provide input to the working group that was formed by the JCC.

11.3.7 The Working Group on Staff Survey Follow-up made four key recommendations:

(a) The induction process for new staff members should be improved and strengthened;

(b) Staff training and development activities should continue to be enhanced and increased, with particular focus on management, leadership and knowledge sharing on office procedures;

(c) Information flow and open, two-way communication throughout the Organization should be encouraged and increased in order to promote and support, inter alia, team work and develop a better understanding of cultural differences. In particular, the suggestion was made that consideration be given to the holding of a quarterly meeting between DSG/ASG and their Directors and Chiefs; and

(d) Enhancement of the PAR so as to introduce a 360-degree component in order that all staff members better understand how they are perceived by their colleagues. A 360-degree PAR is a type of performance appraisal in which subordinates, co-workers, and managers all rate a staff member. As implemented by some organizations, the appraisals of the subordinates and co-workers are anonymous. The 360-degree information is incorporated into the staff member's PAR.

11.3.8 Congress noted that the JCC had agreed to act on recommendations (a) to (c) of the working group; while recommendation (d) (360-degree PAR) was considered but not acted on. Thus, in this framework, a series of “soft skills” training courses focusing on supervisory, writing, presentation and administrative skills was implemented. As recommended by Cg-XVI, management and supervisory experience and skills are now included in the job descriptions for advertised posts and the revised Performance Appraisal System also places more emphasis on supervisory skills. Congress encouraged the Secretary-General to continue the implementation of the working group recommendations so that the WMO Secretariat may continue to be a healthy, efficient and productive workplace.

11.3.9 Congress encouraged the Secretary-General to continue with the practise of conducting a survey once every four years and to report the outcomes and actions taken to the Executive Council.

Other Human Resources matters

11.3.10 Congress was informed that training modules have been developed and provided to staff for better use of information systems and secretarial tools, including Oracle, IPSAS and the Google Applications suite, as well as on Ethics. An induction programme was developed for newly appointed staff, including a newcomer pamphlet and an introduction video. This material covers a range of topics from the organization of the Secretariat to entitlements, financial and budget procedures, occupational health and safety, etc. The updating of the WMO Standing Instructions, Chapter 4, on Human Resources management was regularly carried out, after consultation with the Staff Committee.

Administrative measures

11.3.11 Congress also noted with pleasure that appropriate insurance coverage against malicious acts, and a policy to prevent retaliation against staff representatives, have been put in place.

11.4 Secretary-General's contract (agenda item 11.4)

11.4.1 Congress decided that, with retroactive effect from 1 January 2015, the net annual salary of the Secretary-General should be US$ 166,846 (at dependency rate) taking into account the salaries of the Executive Heads of other comparable agencies. Congress also decided to authorize the Executive Council to carry out any readjustment of salary which might become necessary if, during the seventeenth financial period, changes in the salary of comparable United Nations staff should occur.

11.4.2 Congress further decided that during the seventeenth financial period the representation allowance for the Secretary-General should be established in Swiss francs at a level of CHF 29,000 per year.

11.4.3 Congress adopted, in that connection, Resolution 77 (Cg-17) – Secretary-General's contract, to which the contract to be signed by the President of the Organization and the Secretary-General for the seventeenth financial period was attached.

Salaries and allowances of other ungraded officials

11.4.4 With retroactive effect from 1 January 2015, Congress set the net annual salaries of the Deputy Secretary-General and the Assistant Secretary-General at US$ 153,150 and US$ 140,699 per annum, respectively. Those were the levels which applied to Deputy and Assistant Executive Heads of comparable specialized agencies of the United Nations. Congress further decided that during the seventeenth financial period, the representation allowances for the Deputy Secretary-General and the Assistant Secretary-General should be established at CHF 14,500 per annum. In that connection, Congress decided to authorize the Executive Council to carry out any adjustment of salary which might become necessary if, during the seventeenth financial period, an increase in the salaries of comparable United Nations staff should occur.

Pensionable remuneration of ungraded officials

11.4.5 Congress further noted that, in accordance with the provisions of Article 54(b) of the Regulations of the United Nations Joint Staff Pension Fund, the scale of remuneration for the Professional and higher categories must be adjusted with the same effective date and by the same percentage as the net remuneration increase. Congress noted that the ICSC had promulgated the consequent revised scale of pensionable remuneration applicable to those categories of staff and that comparable United Nations agencies (ITU and UPU) had consequently adjusted the pensionable remuneration of their ungraded officials. Congress therefore decided also to apply with retroactive effect from 1 February 2013 the following levels of annual pensionable remuneration:

Secretary-General	US$ 336,941
Deputy Secretary-General	US$ 311,400
Assistant Secretary-General	US$ 288,180

11.5 Amendment to the Staff Regulations (agenda item 11.5)

11.5.1 Congress noted the amendment of the mandatory age of separation by decision of the United Nations General Assembly A/RES/67/257 and decided that the amendment of Staff Regulations Article 9 paragraph 9.5 shall apply, commencing retroactively on 1 January 2014. Congress adopted Resolution 78 (Cg-17) – Amendment to the Staff Regulations.

11.5.2 Congress also noted the amendment to Staff Regulations Article 4 paragraph 4.2 driven by the WMO Gender Equality Policy adopted by the Congress (Resolution 59 (Cg-17)) and decided that the amendment shall apply as of 1 July 2015.

12. COMMUNICATIONS AND PUBLIC AFFAIRS (agenda item 12)

12.1 Congress appreciated the activities undertaken through the Information and Public Affairs (IPA) programme during the sixteenth financial period. It recognized that effective communications and public outreach are vital to leveraging WMO's strategic and operational plans. Greater public awareness of the contribution that WMO and NMHSs make to human safety and well-being and to sustainable development is fundamental to attracting financial resources, political support and a new generation of young professionals to NMHSs. The Congress therefore decided that the IPA programme shall be continued in the seventeenth financial period, with the support of experts from WMO Members and WMO Secretariat staff, and with regular guidance from the Executive Council.

12.2 Congress emphasized the role that the WMO Secretariat can play in promoting the contribution that WMO and NMHSs make to issues that are at the top of the global agenda. The WMO community's operational and scientific expertise in weather, climate and water supports national and international decision-making on sustainable development, climate change, disaster risk reduction, food security, public health, natural resource management and much more. As a UN specialized agency, WMO is well positioned to integrate its activities into the work of the broader UN system. A key part of this includes communicating the value that NMHSs bring to national and international decision-making on humanity's most profound challenges.

12.3 The mandate for national weather information and prediction belongs to the Members, which continue to strengthen and improve their ability to communicate to decision-makers and the public about the value and availability of weather products and services. Congress noted that the Secretariat complements these efforts by raising international awareness of the benefits and advances of weather science and global cooperation on data sharing and research. For example, WMO supported Members' outreach efforts on weather through the 2013 World Meteorological Day theme of "Watching the weather to protect life and property," and it collaborated with partners to promote awareness of the emerging science at the 2014 World Weather Open Science Conference.

12.4 From climate observations to research, modelling and assessment, WMO and NMHSs are responsible for a great deal of the global community's climate knowledge. Congress appreciated that WMO regularly communicates about the outputs of the Intergovernmental Panel on Climate Change, the Global Framework for Climate Services, the World Climate Research Programme, the Global Atmosphere Watch programme, the Regional Climate Outreach Forums, and other WMO-related climate bodies and activities. For example, WMO supported press outreach for the IPCC's Fifth Assessment Report and produced a series of outreach videos for the GFCS. It ensured wide press coverage of WMO's annual GHG Bulletin and its Statements on the Status of the Global Climate. WMO has a regular presence at the annual conferences of the UNFCCC, where it interacts with the press, issues statements, participates in side events and exhibits its materials and reports.

12.5 Congress urged NMHSs and the Secretariat to continue working with partners from other sectors as the most effective way of integrating WMO's expertise on weather, climate and water into sustainable development, climate adaptation and other cross-cutting concerns. Raising awareness of WMO's role in major events such as the Rio+20 Summit, the UN Climate Summit and the World Conference on Disaster Risk Reduction has provided a useful way of raising WMO's profile and strengthening its influence.

12.6 Congress recognized that the IPA programme's network of communications Focal Points is a valuable tool for promoting WMO's messages and information products. In addition to building contacts with journalists, educators, and other communicators at the national level, IPA Focal Points coordinate with one another internationally to ensure that WMO can speak with one voice on issues of common concern. The Secretariat disseminates information to the Focal Points about World Meteorological Day, press coverage of WMO, and so forth, while receiving updates and information from the network for posting on the WMO website. Congress encouraged Members to seek opportunities to further strengthen the communications network and its

effectiveness. With regard to World Meteorological Day, Congress noted that the yearly event needed a new impulse or re-design. World Meteorological Day was meant to attract the attention of the general public to meteorology, and the media were very much needed to achieve that. Therefore, themes that more easily attracted the attention of the media needed to be chosen for that day.

12.7 Congress expressed appreciation for the continued strong impact that WMO reports and activities have in the international press. As a result of this positive media coverage, WMO and NMHSs are increasingly recognized as a valuable source of insights and information on a wide range of subjects, including climate variability and change, atmospheric pollutants, early warning, and droughts, floods and storms.

12.8 Congress welcomed WMO's increasing focus on engaging with weather presenters, including as climate change communicators. It encouraged the Secretariat to maintain and expand these efforts, and it thanked the donors who have made this work possible.

12.9 Congress appreciated the recent advances in improving the WMO website, starting with the new Youth Corner and Media sections, and it urged WMO to advance further with modernizing the entire site. It also welcomed the excellent progress that has been made in expanding WMO's social media footprint, and it welcomed the Secretariat's plans to continue this effort.

12.10 Congress invited Members to contribute further to promoting the role and activities of WMO.

13. GENERAL AND LEGAL MATTERS (agenda item 13)

13.1 Questions concerning the Convention (agenda item 13.1)

Number of seats in the Executive Council

13.1.1 Congress considered the report of the sixty-sixth session of the Executive Council regarding the number of seats in the Executive Council.

13.1.2 Congress noted the request of Regional Association II (Asia) for one additional seat for the Region in the Executive Council.

13.1.3 Congress also noted the positions of the Regional Associations I (Africa), III (South America), IV (North America, Central America and the Caribbean), V (South-West Pacific) and VI (Europe) in reaction to this request and considered the decisions taken by Congress in the past in relation to a change in the number of seats in the Executive Council.

13.1.4 Congress analysed the matter of the number of seats in the Executive Council and their regional distribution and discussed the context for any change including in the context of (i) the various challenges faced by the Organization as well as the benefits, (ii) costs of one or more additional seats, and (iii) the adequate representation of WMO Members and its importance for EC to fulfil its mandate. Congress acknowledged that in the spirit of continuous improvement, the functioning of the Executive Council should be reviewed during the next intersessional period.

13.1.5 Based on the foregoing, Congress decided to refer the matter of "the number and the distribution of seats of the Executive Council" to the Executive Council, with the aim to maintaining efficiency and effectiveness and requested the Executive Council to review the practices and operations including the selection process of members of the Executive Council and elaborate proposals to amend the Convention and related General Regulations, for submission to the eighteenth session of Congress.

13.2 Membership of the Organization (agenda item 13.2)

13.2.1 Congress noted with appreciation that the Governments of Tuvalu and South Sudan had deposited instruments of accession to the Convention of the World Meteorological Organization with the Government of the United States of America on 23 August 2012 and 14 November 2012, respectively, in accordance with Articles 3 (b) and 33 of the Convention of the World Meteorological Organization. In accordance with Article 35 of the Convention, the Governments of Tuvalu and South Sudan became Members of the Organization on 22 September 2012 and 14 December 2012, respectively.

13.2.2 Congress congratulated and warmly welcomed Tuvalu and South Sudan, bringing the total Membership of WMO to 191, comprising 185 Member States and 6 Member Territories.

13.2.3 Congress noted the Statement by South Sudan will be included in Part II of the abridged final report with resolutions of Seventeenth Congress.

13.3 Revision of the General Regulations (agenda item 13.3)

Terms for the Secretary-General

13.3.1 Congress considered the report of the Executive Council on its discussion on the terms for the Secretary-General. Congress noted the proposal of the Executive Council to consider two options regarding Regulation 198 of the General Regulations which defines the number of terms of the Secretary-General.

Option (a): Keep the current Regulation 198 on the number of terms of the Secretary-General unchanged, that is maximum of three four-year terms;

Option (b): Reduce the number of terms for the Secretary-General to a maximum of two four-year terms and amend Regulation 198.

13.3.2 Congress expressed the view that Option (b) is the better option for the Organization for the future.

13.3.3 In view of the above, Congress adopted Resolution 79 (Cg-17) – Amendments to the General Regulations of the World Meteorological Organization – Limitation of the number of terms of office of the Secretary-General.

General terms of reference of regional associations

13.3.4 Congress was informed that the proposal for a better definition of the role and responsibilities of the regional associations had been discussed in a series of meetings of presidents of regional associations and sessions of the Executive Council.

13.3.5 Recognizing the need to ensure consistency across the constituent bodies, particularly in developing and documenting a WMO integrated planning and implementation process and that the WMO General Regulations do not describe in detail this specific role and responsibilities of the regional associations, Congress agreed to a structure and a text for the amendment to Regulation 162 and Annex II of the General Regulations which were recommended by the Executive Council at its sixty-sixth session in 2014.

13.3.6 Congress adopted Resolution 80 (Cg-17) – General terms of reference of regional associations, containing the added text to Regulation 162 and the general terms of reference of regional associations to be included in Annex II to the General Regulations.

13.4 Amendments to the Technical Regulations – Consolidated report (agenda item 13.4)

13.4.1 Congress appreciated the work carried out by the Executive Council, regional associations, technical commissions and the Secretary-General on the improvement of, and compliance with, the Technical Regulations as part of a broader action aimed at an enhanced compliance with the international regulatory framework established according to its mission defined in the WMO Convention.

Amendments to the Technical Regulations

13.4.2 Congress noted amendments to the *Technical Regulations* (WMO-No. 49), its annexes (Manuals) and related Guides approved by the Executive Council since its Sixteenth Session. Congress re-affirmed the authority delegated to the Executive Council to approve amendments to the Technical Regulations through Resolution 45 (Cg-XVI).

13.4.3 Congress requested the Secretary-General to consolidate all amendments to the Technical Regulations adopted by its seventeenth session, to ensure editorial consistency and to publish 2015 editions of the *Technical Regulations* and respective Manuals.

Improved standard-making

13.4.4 Congress noted with appreciation various measures taken by the Executive Council and the Secretary-General to ensure consistency and quality of the *Technical Regulations* as follows:

(a) The *Guidelines on the Preparation and Promulgation of the WMO Technical Regulations* (WMO-No. 1127) had been developed and published. The document provides a logical framework of the standard-making process to ensure consistency and alignment of all WMO regulatory documents, as well as measures and recommendations to enhance Members' compliance;

(b) A set of procedures for keeping the regulatory documents up-to-date in a systematic manner had been included in the General Provisions of Volume I;

(c) A full set of WMO regulatory documents had been consolidated on a dedicated webpage "Standards (Technical Regulations)";

(d) Members had been increasingly engaged in the development and pre-approval phase of new and amended standards and recommended practices;

(e) Traceability of amendments had been improved, in particular for Volume I of the *Technical Regulations* with a new "edition" to be published after each Congress, and subsequent "updates" upon approval by the Executive Council during the intersessional period; documents revision track records had been included in each Volume and Manual;

(f) The *Technical Regulations* are being published in a priority order;

(g) Measures are being taken to build the standard-making capacity of experts in technical commissions and Secretariat staff in order to ensure the consistency and quality of the regulatory material across different disciplines and documents.

13.4.5 Congress welcomed the decision of the Executive Council to reorganize Volume I – *General meteorological standards and recommended practices*, in order to structure regulatory documents in line with the evolving technology and operational practices of Members and to accommodate emerging systems and services. Congress requested the Executive Council, technical commissions and the Secretary-General to continue their efforts to reorganize Volume I

in an optimal structure and in a flexible modular format that will facilitate the implementation of the standard and recommended practices and procedures by Members through their transposition into respective national legal and regulatory frameworks.

13.4.6 In order to build and maintain required competence in standard-making, Congress encouraged technical commissions to designate experts responsible for regulatory documents and invited the Secretary-General to provide appropriate training. Congress further requested the presidents of the technical commissions to enhance the coordination mechanism in preparing regulatory and related guidance material to ensure their consistency, relevance and usefulness.

Promulgation and compliance with the Technical Regulations

13.4.7 Congress reinstated that achieving compliance with the Technical Regulations of the Organization was fundamental for a global standardization and interoperability of systems, networks, methods and related services provided at global, regional and national level. Therefore, enhanced compliance with regulations and provisions of the WMO Convention should be built and promoted among Members and throughout the Organization.

13.4.8 Congress concurred with a set of concrete measures provided in the new Guidelines (WMO-No. 1127) aimed at enhancing technical compliance. These measures include:

(a) Reinstating the requirements for systematic notification of compliance and non-compliance (deviation) by Members pursuant to the Article 9 of the Convention and General Regulation 128;

Regulation 128: "… Members shall specifically notify the Secretary-General in writing of their intention to apply the "standard practices" of the Technical Regulations except for those for which they lodge specific deviations. Members shall also inform the Secretary-General, at least three months in advance, of any change in the degree of their implementation of a "standard practice" as previously notified and of the effective date of the change."

(b) Vigorous monitoring of Members' compliance with the *Technical Regulations'* provisions with regard to establishment and performance of relevant systems, networks and services promulgated through various WMO Programmes;

(c) Establishment of a central compliance database (preferably as part of the Country Profile Database);

(d) Establishment of a mechanism for identification and timely resolution of critical deviations (deficiencies);

(e) Prioritizing the capacity development activities to assist Members in eliminating identified deficiencies.

"Critical deviations" are those that seriously affect either: (a) the provisions of safety-related services nationally or internationally; or (b) the overall performance of required regional or global services and facilities, thereby affecting other Members depending on the services of those facilities.

13.4.9 Congress appreciated that the Executive Council (EC-66) had advised the Secretary-General to establish appropriate mechanisms that would allow the Secretariat to monitor the compliance with the *Technical Regulations* in a systematic and coordinated manner throughout all relevant technical programmes, and requested that this be consistent with the Monitoring and Evaluation process already agreed and approved by Congress.

13.4.10 Congress noted that the actual implementation of the WMO *Technical Regulations* at the national level should be done through transposition of the WMO standard practices and procedures (considered mandatory requirements in the spirit of Article 9 of the Convention) and

recommended practices and procedures (considered desirable requirements) into appropriate national legislation or regulation. In this regard, Congress expressed concern that, apart from aviation, Members were normally lacking a designated national meteorological "regulator" (authority) responsible for the enforcement of the international meteorological regulations at the national level. Congress requested the Executive Council to consider the issue of a better definition of national meteorological regulatory functions and responsibilities needed for effective implementation of the WMO regulations including the respective role of the NMHSs.

13.4.11 Congress further urged Members to report on compliance with a view to identify the root causes for non-compliance, recognizing that Members should be guided to develop their systematic compliance evaluation procedures.

13.4.12 Congress called on technical commissions: (a) to complement their regulatory material with necessary guidance material to assist Members with the implementation of the Technical Regulations; (b) to monitor compliance through system performance/monitoring mechanisms (such as WIS monitoring and performance mechanism and WIGOS Data Quality Monitoring System, as part of the WMO Monitoring and Evaluation System); (c) to provide related technical expertise, assistance and advice to Members and the regional associations; and (d) to perform regular reviews of the compliance of specialized centres.

13.4.13 Congress emphasized that the regional associations should play a major role in the identification of critical deficiencies in their Regions and engaging their Members in concerted effort for their resolution, as provided in their terms of reference set in force through Resolution 80 (Cg-17).

13.4.14 Congress requested the Executive Council and the Secretary-General to actively pursue actions to enhance compliance with the *Technical Regulations* throughout the Organization.

Promulgation of WMO technical requirements though other international regulatory frameworks

13.4.15 Congress recalled that the *Technical Regulations Volume II – Meteorological Service for International Air Navigation* is fully aligned with the *Annex 3 to the Convention on International Civil Aviation – Meteorological Service for International Air Navigation*. Congress noted the plans by ICAO to introduce a shorter two-year cycle of amendments to Annex 3 and requested the president of the Commission for Aeronautical Meteorology and the Secretary-General to undertake appropriate measures to ensure respective forward planning for the related amendments to the *Technical Regulations Volume II*.

13.4.16 Congress appraised, under agenda item 4.2.2, the first common WMO-ISO standard approved on the basis of the "Siting Classification for Surface Observing Stations on Land" originally developed by CIMO for WMO Members.

13.5 Financial Regulations (agenda item 13.5)

13.5.1 Congress considered the revisions to the WMO Financial Regulations proposed by the Secretary-General to ensure compliance with IPSAS.

13.5.2 Congress approved the proposed revisions to the relevant Financial Regulations, with retroactive effect from 1 January 2010, the effective date of implementation of IPSAS at WMO, and adopted Resolution 81 (Cg-17) – Financial Regulations of the World Meteorological Organization.

13.6 Preview of previous resolutions of Congress (agenda item 13.6)

In accordance with General Regulation 136 (17), Congress examined its previous resolutions in order that those which no longer had a purpose or which had been replaced by new decisions should not remain in force. Congress accordingly adopted Resolution 82 (Cg-17) – Review of previous Congress resolutions.

14. ELECTIONS AND APPOINTMENTS (agenda item 14)

14.1 Appointment of the Secretary-General (agenda item 14.1)

14.1.1 Congress appointed Prof. Petteri Taalas as the Secretary-General of the Organization for the seventeenth financial period.

Tribute to the Secretary-General

14.1.2 Congress noted the outstanding services rendered to the Organization by the retiring Secretary-General, Mr Michel Jarraud, and decided to accord him at the conclusion of his contract as Secretary-General, on 31 December 2015, the honorary title of "Secretary-General Emeritus". Congress accordingly adopted Resolution 83 (Cg-17) – Tribute to the Secretary-General.

14.2 Election of the President and Vice-Presidents of the Organization (agenda item 14.2)

14.2.1 Congress unanimously re-elected Mr David Grimes, Permanent Representative of Canada with WMO, as President of the Organization.

14.2.2 Congress unanimously re- elected Dr Antonio Divino Moura, Permanent Representative of Brazil with WMO, as First Vice-President of the Organization.

14.2.3 Congress unanimously re-elected Prof. Mieczyslaw S. Ostojski, Permanent Representative of Poland with WMO, as Second Vice-President of the Organization.

14.2.4 Congress unanimously re-elected Mr Abdalah Mokssit, Permanent Representative of Morocco with the WMO, as Third Vice-President of the Organization.

14.3 Election of members of the Executive Council (agenda item 14.3)

Congress elected the following Directors of National Meteorological or Hydrometeorological Services of Members of the Organization as members of the Executive Council in accordance with the provisions of Article 13 (c) of the Convention.

Prof. Gerhard ADRIAN	Germany
Dr Anthony C. ANUFOROM	Nigeria
Dr Mamadou Lamine BAH	Guinea
Mr Juan Manuel CABALLERO GONZÁLEZ	Mexico
Dr Alexander FROLOV	Russian Federation
Dr Laura K. FURGIONE (Ms)	United States of America
Dr Ayman Salem GHULAM	Saudi Arabia
Mr Ismail GÜNES	Turkey
Dr Agnes KIJAZI (Ms)	United Republic of Tanzania
Dr KO Yunhwa	Republic of Korea
Mr Daouda KONATE	Côte d'Ivoire
Mr Ravind KUMAR	Fiji
Mr Jean-Marc LACAVE	France
Mr Miguel Angel LOPEZ GONZALEZ	Spain
Dr Linda MAKULENI (Ms)	South Africa
Col. Dr Leonardo MUSMANNO	Italy

Dr Guillermo NAVARRO	Chile
Mr Noritake NISHIDE	Japan
Mr Richard PHILIPPE	Cameroon
Dr Laxman Singh RATHORE	India
Prof. Andrea Celeste SAULO (Ms)	Argentina
Mr Tyrone SUTHERLAND	British Caribbean Territories
Mr Fetene TESHOME	Ethiopia
Mr Robert VARLEY	United Kingdom of Great Britain and Northern Ireland
Dr Robert VERTESSY	Australia
WONG Chin Ling (Ms)	Singapore
Dr ZHENG Guoguang	China

15. SCIENTIFIC LECTURES AND DISCUSSIONS (agenda item 15)

15.1 The IMO Lecture was delivered at Seventeenth Congress by Dr Alexandre Bedritskiy (Russian Federation), laureate of fifty-ninth IMO Prize, on the subject “WMO’s role in global socio-economic development: Present and Future”.

15.2 Congress thanked Dr Bedritskiy for his lecture, and requested the Secretary-General to arrange for the appropriate publication of the lecture in the WMO *Bulletin* series.

15.3 Congress agreed that, in continuation of the tradition, an IMO Lecture at Eighteenth Congress should be delivered by a laureate of the IMO Prize, selected by the Executive Council in 2018.

15.4 Following guidance by the Executive Council, the lecture “Post-2015 UN Sustainable Development Agenda” was presented by Ms Amina J. Mohammed, Special Advisor of the UN Secretary-General on Post-2015 Development Planning.

15.5 Congress thanked Ms Mohammed for her insightful lecture. It noted that the extended summary of the lecture would be published in a suitable form and requested the Secretary-General to take appropriate action.

15.6 Congress also decided that a programme for scientific and/or other relevant discussions should be arranged for Eighteenth Congress and requested the Executive Council to select themes for that purpose and the Secretary-General to make the necessary arrangements.

16. DATE AND PLACE OF EIGHTEENTH CONGRESS (agenda item 16 and 17)

The Congress agreed that Cg-18 will be held in Geneva from 18 May to 7 June 2019.

17. CLOSURE OF THE SESSION (agenda item 16 and 17)

The Seventeenth Congress closed at 12.45 p.m. on 12 June 2015.

RESOLUTIONS ADOPTED BY THE SESSION

Resolution 1 (Cg-17)

REPORT OF THE FIFTEENTH SESSION OF THE COMMISSION FOR AERONAUTICAL METEOROLOGY, INCLUDING REVISED TERMS OF REFERENCE OF THE COMMISSION

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the report of the president of the Commission for Aeronautical Meteorology, the proposed changes to the terms of reference of the Commission, and resolutions and recommendations adopted by the Commission at its fifteenth session,

Expressing concern of recent weather-related aircraft accidents highlighting the need for better understanding of the impact of meteorological hazards on aviation and for enhanced services in support of safe and efficient operations of international air navigation,

Noting the *Abridged Final Report with Resolutions and Recommendations of the Fifteenth Session of the Commission for Aeronautical Meteorology* (WMO-No. 1139),

Decides to take the following actions on the recommendations:

Recommendation 1 (CAeM-15) – Terms of reference of the Commission for Aeronautical Meteorology

(a) Adopts the revised terms of reference for the Commission, as given in the annex to the present resolution, in place of the terms of reference put in force by Resolution 43 (Cg-XVI) – Terms of reference of the technical commissions;

(b) Requests the Secretary-General to arrange for the respective amendment to the WMO General Regulations, Annex III – Structure and terms of reference of technical commissions, contained in *Basic Documents No. 1* (WMO-No. 15);

Recommendation 3 (CAeM-15) – Review of relevant resolutions of the Executive Council based on previous recommendations of the Commission for Aeronautical Meteorology

(a) Requests the Executive Council to take into account this recommendation.

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Note: This resolution replaces Resolution 53 (Cg-XVI), which is no longer in force.

Annex to Resolution 1 (Cg-17)

TERMS OF REFERENCE OF THE COMMISSION FOR AERONAUTICAL METEOROLOGY

Commission for Aeronautical Meteorology (CAeM)

The terms of reference of the Commission for Aeronautical Meteorology shall be:

(a) To contribute, in close collaboration with ICAO, to furthering the international standardization of meteorological service provision to international air navigation and provide assistance to Members to achieve compliance with those standards;

(b) To promote and facilitate, in collaboration with relevant WMO bodies, the international sharing of implementation experience, exchange of technology and research uptake, including appropriate pilot projects, to meet evolving user requirements for aeronautical meteorological information and services;

(c) To participate, in close collaboration with ICAO and other relevant stakeholders, in the planning and development of enhanced aeronautical meteorological services in support of the future Air Traffic Management system;

(d) To coordinate development of guidance, training material and learning opportunities in collaboration with other WMO bodies and ICAO, to ensure Members' compliance with the competency and qualification requirements for aeronautical meteorological personnel;

(e) To review and respond to Members' aeronautical meteorology prioritized needs and support capacity development activities, in cooperation with regional associations, aimed at enhancing the delivery of quality aeronautical meteorological services, especially by developing and least developed Members;

(f) To promote good governance and efficiency, in cooperation with ICAO, regional bodies and Members, including enhanced regional and subregional cooperation in aeronautical meteorological service delivery and development of related cost-recovery mechanisms;

(g) To maintain existing and develop further partnerships with relevant aviation user and stakeholder organizations and collaborate on issues related to aeronautical meteorology.

Resolution 2 (Cg-17)

IMPLEMENTATION OF THE WMO STRATEGY FOR SERVICE DELIVERY

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) That the WMO Strategic Plan 2016–2019 has recognized "Improved service quality and service delivery" as an Expected Result of the Organization,

(2) That the Sixteenth World Meteorological Congress approved the WMO Strategy for Service Delivery (*Abridged Final Report with Resolutions of the Sixteenth World Meteorological Congress* (WMO-No. 1077)),

(3) That the Executive Council at its sixty-fifth session endorsed the Implementation Plan for the Strategy through Resolution 4 (EC-65) – Implementation Plan of the WMO Strategy for Service Delivery,

(4) That the Strategy and its Implementation Plan were cross-cutting and could be applied in the development of weather and warning services, climate and hydrological services,

(5) That the Strategy and its Implementation Plan were published in March 2014,

Noting further:

(1) The need to identify critical areas of focus in implementing the Strategy,

(2) The need to identify a mechanism to coordinate and guide the implementation of the Strategy as provided in its Implementation Plan,

Having considered:

(1) That Members, through regional associations, technical commissions and various WMO activities, had expressed a need for improved service delivery to the public, to the disaster community and to social and economic sectors,

(2) That service delivery related priorities of Members are fully catered for in the Strategy and its Implementation Plan,

Decides:

(1) To request the Commission for Basic Systems to develop a mechanism to focus on service delivery to coordinate and guide the implementation of the Strategy as provided for in its Implementation Plan;

(2) To support the further development of service delivery by Members in the area of impact-based forecasting and risk-based warning;

Requests the Secretary-General:

(1) To provide support for the implementation of this decision within available resources;

(2) To facilitate and monitor the implementation of the WMO Strategy for Service Delivery;

Requests the constituent bodies to support the implementation of the Strategy by Members;

Requests Members to implement the WMO Strategy for Service Delivery as provided in its Implementation Plan and to share their experiences and best practices.

Resolution 3 (Cg-17)

AERONAUTICAL METEOROLOGY PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 53 (Cg-XVI) – Aeronautical Meteorology Programme,

(2) The *Abridged Final Report with Resolutions and Recommendations of the Fifteenth Session of the Commission for Aeronautical Meteorology* (WMO-No. 1139),

(3) The *Abridged Final Report with Resolutions of the Sixty-sixth Session of the Executive Council* (WMO-No. 1136), Annex XV – Executive Council position taken at its sixty-sixth session related to the Conjoint ICAO/WMO Meteorology Divisional Meeting,

(4) The report of the International Civil Aviation Organization (ICAO)/WMO Meteorology Divisional Meeting 2014,

(5) The reports of all regional associations during the intersessional period 2011–2015,

Considering:

(1) That the seventeenth intersessional period 2016–2019 will be a period of significant developments in aeronautical meteorology as part of the Aviation System Block Upgrades of the ICAO Global Air Navigation Plan,

(2) The need to provide further assistance to Members in enhancing their compliance with the WMO and ICAO regulations, in particular those related to the implementation of quality management systems, and competency and qualification of aeronautical meteorological personnel,

(3) The challenges and opportunities for Members regarding the envisaged changes in the service delivery and business models for the provision of aeronautical meteorological service, and the need to assess the related risks and impacts,

Decides:

(1) That the Aeronautical Meteorology Programme shall continue to be a high-priority programme and suitably resourced to enable it to maintain the role and the position of WMO in the international collaborative governance of aeronautical meteorological service provision;

(2) That the Programme should continue to provide targeted assistance to Members in need to achieve the required level of compliance with the international requirements promulgated by WMO and ICAO;

(3) To align the Programme with the new developments in the field of meteorological service for international air navigation;

Requests the Secretary-General:

(1) To apply, in coordination with the president of the Commission for Aeronautical Meteorology, a longer-term planning approach to the Aeronautical Meteorology Programme consistent with the ICAO Global Air Navigation Plan and its Aviation System Block Upgrades methodology and timeline (2013–2028), with special consideration on building capacity of subregions and Members with long-standing deficiencies in their service provision to civil aviation;

(2) To continue the rigorous monitoring of the compliance of Members with the WMO Technical Regulations related to aeronautical meteorology, in particular the implementation of the quality management system and the aeronautical meteorological personnel competency and qualification requirements, and to address identified deficiencies thereof;

(3) To collaborate closely with the Secretary-General of ICAO in undertaking appropriate measures in view of facilitating the implementation of cost recovery by Members in order to provide foundation for sustainable implementation of the ICAO and WMO requirements for quality management systems, and competency and qualification of aeronautical meteorological personnel;

Urges Members:

(1) To consider establishing longer-term national plans for the development of aeronautical meteorological services, taking due account of the Global Air Navigation Plan and Aviation System Block Upgrades timelines and in consultation with the national aviation stakeholders;

(2) To strive to enhance their compliance with the international requirements, in particular those related to the implementation of quality management systems, and competency and

qualification of aeronautical meteorological personnel, including through bilateral and multilateral arrangements, such as twinning and mentoring;

Requests the regional associations, through their appropriate regional subsidiary bodies, to define the needs for and facilitate the provision of assistance to their Members in resolving identified deficiencies in the provision of aeronautical meteorological services, and to support, monitor and report on capacity development activities in this regard.

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Note: This resolution replaces Resolution 53 (Cg-XVI), which is no longer in force.

Resolution 4 (Cg-17)

REPORT OF THE EXTRAORDINARY SESSION (2014) OF THE COMMISSION FOR BASIC SYSTEMS RELEVANT TO TECHNICAL REGULATIONS CONCERNING PUBLIC WEATHER SERVICES COMPETENCIES

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No.1140), in particular, Recommendation 1 (CBS-Ext.2014) – Competency Framework for Public Weather Services Forecasters and Advisers,

Decides to take the following actions on the recommendation:

Recommendation 1 (CBS-Ext.(2014)) – Competency Framework for Public Weather Services Forecasters and Advisers

(a) Approves the Public Weather Services (PWS) forecasters and advisers top-level competency requirements to take effect from 1 December 2017, as follows:

Fundamental WMO competency requirements for a PWS forecaster

(i) Analyse and monitor continually the evolving meteorological and/or hydrological situation;

(ii) Forecast meteorological and hydrological phenomena and parameters;

(iii) Warn of hazardous phenomena;

(iv) Ensure the quality of meteorological and hydrological information and services;

(v) Communicate meteorological and hydrological information to internal and external users.

Competency requirements for weather broadcasters and communicators

(i) Oral, written and graphical communication via media;

(ii) Use of appropriate tools and systems for the delivery of meteorological and, where appropriate, hydrological information to end users;

(iii) Self-management and team-working within a media environment.

Competency requirements for PWS advisers engaged in user interaction, media liaison and outreach activities

(i) Oral and written communication;

(ii) Use of appropriate tools and systems required for the delivery of meteorological and hydrological information to end users;

(iii) User interaction;

(iv) Self-management and team-working in a media environment;

Competency requirements for a disaster prevention and mitigation weather adviser

(i) Communicate warnings and associated information, including uncertainties and confidence levels, to users;

(ii) Develop products, procedures and services to meet user needs;

(iii) Develop and manage disaster prevention and mitigation stakeholder relationships;

(iv) Promote and implement impact assessments and community outreach;

(v) Ensure the quality of information, services and procedures;

Competency requirements for persons engaged in the innovation, improvement and delivery of meteorological and hydrological services and products

(i) Knowledge of meteorology and hydrology, as well as models and systems used in operational forecasting;

(ii) Ability to apply existing and new technologies effectively;

(iii) Knowledge of user requirements for applications of meteorological and hydrological information;

(b) Requests the Secretary-General:

(i) To make the necessary amendment, as required, for the incorporation of the PWS Competency Framework and top-level competency requirement into the Technical Regulations (WMO-No. 49);

(ii) To publish guidelines for Members on the implementation of the PWS forecasters and advisers competency requirements based on the PWS Competency Framework as given in the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No 1140);

(c) Requests the Commission for Basic Systems, in coordination with the Secretariat, to develop appropriate training material on the competency assessment of PWS forecasters and advisers;

(d) Urges Members to consider timely implementation of the recommended practices on the competency of PWS forecasters and advisers.

Resolution 5 (Cg-17)

PUBLIC WEATHER SERVICES PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 20 (Cg-XVI) – Public Weather Services Programme,

(2) The *Abridged Final Report with Resolutions of the Sixty-sixth Session of the Executive Council* (WMO-No. 1136),

(3) Resolution 40 (Cg-XII) – WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities,

Considering:

(1) That the Public Weather Services (PWS) Programme constitutes the main conduit connecting National Meteorological and Hydrological Services (NMHSs) to the public, media, disaster management authorities, communities affected by weather-related disasters, and social and economic user sectors,

(2) The continuing need to strengthen the capability of Members to deliver high-quality services for the safety of life and livelihood, the protection of property, and for contributing to sustainable development,

(3) That it is critical for decision-makers to understand and translate meteorological information and especially warnings into effective actions,

(4) The progress and accomplishments made by the World Weather Information Service (WWIS) and the Severe Weather Information Centre (SWIC) in strengthening the recognition of NMHSs by providing a centralized and authoritative source of official weather forecasts, climatological information and weather warnings to the public and the media,

Decides:

(1) That the substance of the PWS Programme shall be as indicated in the WMO Strategic and Operating Plans (2016–2019) adopted under Resolution 69 (Cg-17);

(2) That the WMO Strategy for Service Delivery should guide the implementation of the PWS Programme;

(3) That the information content of WWIS, including the official weather forecasts and climatological information for worldwide cities, should be made available on a free and unrestricted basis;

Requests the Commission for Basic Systems:

(1) To continue to provide assistance to the technical planning and further development of the PWS Programme in accordance with the WMO Strategic and Operating Plans;

(2) To enhance its crucial support to the Programme in the delivery of services to the public and to socioeconomic sectors;

(3) To provide further guidance to Members in enhancing their city forecasts with longer lead time, higher spatial and temporal resolutions, and additional weather elements, and in converting weather warnings into Common Alerting Protocol (CAP) format;

(4) To provide technical guidance to Members, as needed, for the use of CAP format in the dissemination of information contained on the WWIS and SWIC websites;

Invites the regional associations:

(1) To continue to be actively engaged with the PWS Programme;

(2) To promote the implementation of the Competency Framework for PWS Forecasters and Advisors in their respective Regions;

(3) To establish requirements in the light of the evolving needs of Members and technical developments in the delivery of services;

Requests the Executive Council to take all necessary actions to guide the PWS Programme and to enable it to meet the needs of Members in service delivery and thus to achieve its objectives under the WMO Strategic and Operating Plans (2016–2019);

Urges Members:

(1) To take all possible measures to continue to support the implementation of the PWS Programme;

(2) To take all possible steps to strengthen their national PWS through ensuring effective service delivery to user communities and stakeholders, and raising the level of public awareness of, and response to, these services through effective communication and public education efforts;

(3) To participate in PWS capacity development activities;

(4) To evaluate the effectiveness of PWS in the delivery of services to users;

(5) To assess the contribution of PWS to the social and economic benefits provided to users through the work of NMHSs, and demonstrate such benefits to governments with the aim of securing due support for NMHSs, and further strengthening their capacity to deliver quality service;

(6) To support initiatives aimed at provision of impact-based services;

(7) To contribute more city forecasts with longer lead time, higher spatial and temporal resolutions, current weather observations and additional weather elements to WWIS;

Requests the Secretary-General:

(1) To support Members, as necessary, in their efforts to implement PWS activities at the national level in accordance with the WMO Strategy for Service Delivery;

(2) To collaborate closely with Members to ensure the further development and implementation of the PWS Programme and to establish clear performance metrics so that the Programme is enabled to contribute fully to the realization of Expected Result 1 – Improved service quality and service delivery;

(3) To propose projects for the further development of key PWS components;

(4) To promote collaboration between PWS Programme and other relevant WMO Programmes;

(5) To liaise with the Member that hosts the SWIC website to carry out the enhancement necessary to enable the website to disseminate weather warnings that would be provided in CAP format by Members;

(6) To promote collaboration with relevant national and international organizations.

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Note: This resolution replaces Resolution 20 (Cg-XVI), which is no longer in force.

Resolution 6 (Cg-17)

COMPETENCE REQUIREMENTS FOR MARINE WEATHER FORECASTERS

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The request of the Sixteenth World Meteorological Congress to the technical commissions to make the development of competence standards for personnel a priority,

(2) The *Abridged Final Report with Resolutions and Recommendations of the Fourth Session of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology* (WMO-No. 1093), general summary, paragraphs 8.4.1 to 8.4.10 and Recommendation 5 (JCOMM-4) – Quality Management Implementation for JCOMM,

(3) The *Abridged Final Report with Resolutions of the Sixty-sixth Session of the Executive Council* (WMO-No. 1136), general summary, paragraph 4.1.63,

Considering that the Secretary-General distributed the draft Marine Weather Forecaster (MWF) Competence Requirements to members of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) for review and approval for submission to Seventeenth Congress,

Considering further that JCOMM members supported the submission of the Marine Weather Forecaster Competence Requirements for adoption by Seventeenth Congress,

Approves the inclusion of Competence Requirements for Marine Weather Forecasters in the *Technical Regulations* (WMO-No. 49), Volume I, Part II, Chapter 5, as recommended practices and procedures;

Requests the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology:

(1) To finalize the amendment to the *Technical Regulations*, with assistance from the Secretariat, in time for publication of the 2015 edition;

(2) To develop relevant guidance material to support the implementation of the competency requirements, in particular practical guidance on the MWF competency assessment, similar to the guidance prepared for the competency of aeronautical meteorological personnel, and make it available to Members;

Requests the presidents of regional associations to consider the needs of their Members for training in the competency assessment of Marine Weather Forecasters;

Encourages Members concerned to prepare competency assessment programmes for their MWF personnel and, as appropriate, include this as part of their quality management arrangements.

Annex to Resolution 6 (Cg-17)

COMPETENCY REQUIREMENTS FOR MARINE WEATHER FORECASTERS

Note: These are the minimum competency requirements to effectively perform the duties of a Marine Weather Forecaster (MWF). National personnel qualification requirements for MWF may be set at a higher level, e.g., to be also degree qualified.

Note: The marine environment includes the open and coastal seas (including the surf zone), estuaries, large lakes, rivers and their interfaces with the land and the atmosphere.

The MWF should have successfully completed the Basic Instruction Package for Meteorologists (BIP-M) or relevant parts thereof.

Within the context of these conditions:

- For the area of responsibility refer WMO-No. 558, *Manual on Marine Meteorological Services*, Volume 1 – Global Aspects and Volume II, Regional Aspects;
- In consideration of the impact of meteorological phenomena, variables and parameters on marine operations; and
- In compliance with marine user requirements, international regulations, local procedures and priorities.

The MWF should be able to (competence requirements):

1. Analyse and monitor continually the marine weather situation;
2. Forecast marine weather phenomena, variables and parameters;
3. Warn of hazardous marine meteorological phenomena;
4. Ensure the quality of marine meteorological information and services;
5. Communicate marine meteorological information to internal and external users.

Note: As these competency requirements are recommended and generic to all providers of marine weather forecast and warning services, no priority is stated to either the phenomena or parameters. Any priorities are established by the Marine Meteorological Service.

Resolution 7 (Cg-17)

WMO QUALITY MANAGEMENT FRAMEWORK

THE WORLD METEOROLOGICAL CONGRESS,

Noting Resolution 26 (Cg-XVI) – WMO Quality Management Framework,

Noting further:

(1) The work related to the development of the WMO Quality Management Framework (QMF) carried out since the Fourteenth World Meteorological Congress, including the reports and

recommendations of the quality management expert bodies – the Intercommission Task Team on Quality Management Framework and the Task Team on Quality Management Systems,

(2) The progress in implementing the quality management system (QMS) for the provision of meteorological service to international air navigation,

(3) The ongoing development of quality management aspects of relevant WMO Programmes,

Recognizing:

(1) The QMF as an expression of the WMO long-term commitment to the quality of information, products and services delivered to society,

(2) The added value of QMS in the delivery of information, products and services in an increasingly competitive service provision environment,

(3) The need to streamline the quality management aspects of all WMO Programmes and in the activities of the technical commissions,

Decides to further the development of the WMO QMF with focus on:

(1) Coordinating the activities of the technical commissions and their relevant expert bodies to ensure that the quality management issues are complementary and consistent with the overarching WMO QMF;

(2) Developing further the WMO regulatory and guidance material on quality management contained in different documents and domains, including updated guidance on the transition to the new International Organization for Standardization (ISO) 9001:2015 quality management standard;

(3) Review and actualization of the WMO Quality Policy as an organization-wide policy complementing the WMO Strategic and Operating Plans;

(4) Continuing support to Members in implementing QMS, in particular for achieving compliance with relevant international requirements;

Encourages Members that have not yet implemented a QMS to strengthen the quality management of their National Meteorological and Hydrological Services and other relevant service providers on the basis of the ISO 9001 quality standards;

Requests the presidents of technical commissions to continue developing the quality management aspects relevant to their activities in a coordinated way under the overarching WMO QMF;

Requests the presidents of regional associations to consider cooperation activities to assist Members in the implementation of QMF with focus on those Members lacking national capacity, where twinning or mentoring projects and other forms of regional cooperation should be utilized;

Requests the Executive Council to establish an appropriate mechanism of promoting and guiding the further development and implementation of QMF;

Requests the Secretary-General to continue the support to the development and implementation of the QMF within the available resources.

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Note: This resolution replaces Resolution 26 (Cg-XVI), which is no longer in force.

Resolution 8 (Cg-17)

AMENDMENT OF COMPETENCY AND QUALIFICATION PROVISIONS IN THE *TECHNICAL REGULATIONS* (WMO-No. 49). VOLUME I

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 17 (EC-65) – Competency requirements for providers of education and training to meteorological, hydrological and climatological services, that incorporated competency provisions for education and training providers into the *Technical Regulations* (WMO-No. 49), Volume I,

(2) Resolution 6 (EC-66) – Amendment to the *Technical Regulations* (WMO-No. 49), Volume II – Meteorological Service for International air navigation, and related guidance material,

(3) Resolution 3 (Cg-17) – Aeronautical Meteorology Programme,

Recalling the request of the Sixteenth World Meteorological Congress to technical commissions to assign high priority to the development of job competency standards within the area of responsibility of each of the commissions,

Recognizing:

(1) That incorporation of new competency provisions in the *Technical Regulations*, Volume I, Part II, Chapter 5 would require restructuring of the chapter,

(2) The need to define the terms qualifications, competency and operational personnel,

(3) The need to incorporate quality management system principles into record-keeping and competency assessment,

(4) The need to take due account of the local conditions, regulations and procedures of Members,

Approves the amended text of the *Technical Regulations*, Volume I, Chapter 5, as annexed to the present resolution, for inclusion in its 2015 edition;

Urges Members to implement the standard and recommended practices and procedures contained in this amendment in a timely manner;

Requests the presidents of technical commissions concerned to continue the development and update of the competency provisions in their domains, including implementation guidance;

Requests the Executive Council to continue monitoring the compliance of Members with the competency provisions and act upon identified deficiencies thereof;

Requests the Secretary-General:

(1) To incorporate the amendment defined in the annex to the present resolution in the 2015 edition of the *Technical Regulations* (WMO-No. 49), Volume I;

(2) To bring the present resolution to the attention of Members and constituent bodies.

Annex to Resolution 8 (Cg-17)

AMENDMENT OF COMPETENCY AND QUALIFICATION PROVISIONS IN THE *TECHNICAL REGULATIONS* (WMO-No. 49). VOLUME I

Qualification. The minimum core knowledge, usually acquired through education, required to enter a profession.

Note: Qualifications are frequently based on successful completion of a formal course of study or examination through an institution endorsed for such purposes at the national level (for example, a university).

Competency. The knowledge, skills and behaviours required to perform specific tasks in the fulfilment of a job responsibility.

Note: Competencies are often acquired and assessed on the job or through a variety of training opportunities.

Operational personnel. Personnel involved in producing and providing services and decision support information (e.g. meteorological, hydrological, climatological and / or related services) to users including the general public.

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5. QUALIFICATIONS AND COMPETENCIES OF PERSONNEL INVOLVED IN THE PROVISION OF METEOROLOGICAL, HYDROLOGICAL AND/OR CLIMATOLOGICAL SERVICES

5.1 General

5.1.1 The qualifications and competencies required of personnel involved in the provision of (operational) meteorological, hydrological, climatological and/or related services should be as described below, in sections 5.2–5.7.

Notes:

1. A specific qualification is typically acquired once and remains valid throughout a person's career.

2. Qualifications and competencies for personnel in additional service areas will be developed in due course and subsequently included in this chapter.

5.1.2 **Members should keep records of the qualifications of all personnel involved in the provision of (operational) meteorological, hydrological, climatological and/or related services.**

5.1.3 Members should decide, based on their national circumstances, whether higher or more specific qualification requirements than those described below should be established for certain categories of operational personnel.

5.1.4 Competency should be demonstrated through job performance and assessed through competency assessment procedures, as appropriate.

Note: Guidance on competency development and assessment procedures is provided in Guide for the Development and Implementation of Competency-based Frameworks in Support of Meteorological, Hydrological and Climatological Services (in preparation).

5.1.5 Members should establish competency assessment programmes for different categories of operational personnel; competency assessments should be repeated at regular intervals defined by the quality management practice of each Member.

5.1.6 Members should implement WMO global-level competency provisions taking due account of their local conditions, regulations, requirements and procedures.

5.1.7 Members should ensure that their operational personnel undertake continuous professional development to maintain competence.

5.2 Personnel involved in the provision of aeronautical meteorological services

5.2.1 Qualifications

5.2.1.1 Members, taking into consideration the area and airspace of responsibility, the impact of meteorological phenomena and parameters on aviation operations, aviation user requirements, international regulations and local procedures and priorities, should ensure that an Aeronautical Meteorological Forecaster has successfully completed the Basic Instruction Package for Meteorologists as defined in Appendix D.

Note: This provision, which defines the required qualifications, will become a standard practice on 1 December 2016.

5.2.1.2 Members should decide whether their national circumstances require specific qualifications of Aeronautical Meteorological Observers.

5.2.2 Competencies

Note: The Competence Standards of Aeronautical Meteorological Personnel are maintained by the Commission for Aeronautical Meteorology.

5.2.2.1 Members shall ensure that for the area and airspace of responsibility, given the impact of meteorological phenomena and parameters on aviation operations, and in compliance with aviation user requirements, international regulations and local procedures and priorities, an Aeronautical Meteorological Forecaster is able to:

(a) Analyse and monitor continually the weather situation;

(b) Forecast aeronautical meteorological phenomena and parameters;

(c) Warn of hazardous phenomena;

(d) Ensure the quality of meteorological information and services; and

(e) Communicate meteorological information to internal and external users.

5.2.2.2 Members shall ensure that for the area and airspace of responsibility, given the impact of meteorological phenomena and parameters on aviation operations, and in compliance with aviation user requirements, international regulations and local procedures and priorities, an Aeronautical Meteorological Observer is able to:

(a) Monitor continually the weather situation;

(b) Observe and record aeronautical meteorological phenomena and parameters;

(c) Ensure the quality of system performance and of meteorological information; and

(d) Communicate meteorological information to internal and external users.

5.3 Personnel involved in the provision of education and training for meteorological, hydrological and climate services

5.3.1 Qualifications

5.3.1.1 Members should define, based on their national circumstances, the specific qualifications required of personnel engaged in education and training in meteorology, hydrology and climatology.

5.3.2 Competencies

Note: The Competency Standards for Providers of Education and Training for Meteorological, Hydrological and Climate Services (March, 2014) are maintained by the Executive Council Panel of Experts on Education and Training.

5.3.2.1 Members should ensure that institutions providing education and training for meteorological, hydrological and climatological services have the personnel and resources to:

(a) Analyse the organizational context and manage the training processes;

(b) Identify learning needs and specify learning outcomes;

(c) Determine a learning solution;

(d) Design and develop learning activities and resources;

(e) Deliver training and manage the learning event;

(f) Assess learning and evaluate the learning process.

Note: The performance criteria and knowledge requirements that support the competencies should be customized based on the particular context of an organization.

5.4 Personnel supporting the WMO Information System (WIS) (in preparation)

5.5 Personnel providing marine meteorological services (in preparation)

5.6 Personnel involved in the provision of public weather services (in preparation)

5.7 Personnel involved in the provision of climate services (in preparation)

Resolution 9 (Cg-17)

IDENTIFIERS FOR CATALOGUING EXTREME WEATHER, WATER AND CLIMATE EVENTS

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The increasing frequency and magnitude of extreme weather, water and climate events and their impacts on different socioeconomic sectors, lives and livelihoods,

(2) The calls for reducing the losses associated with extreme events in the Sendai Framework for Disaster Risk Reduction 2015−2030, the United Nations Framework Convention on Climate Change Warsaw international mechanism for loss and damage associated with climate change impacts, and the United Nations draft sustainable development goals,

Noting further:

(1) That developing identifiers for cataloguing weather, water and climate extreme events in cooperation with institutions having competences about possible impact of those weather events can provide an unambiguous reference for associated losses and damages and can promote consistency in the characterization of extreme events,

(2) That more consistent event characterization in terms of type of event, location, duration, magnitude and timing would allow for better evaluation of the types of losses and damages associated with different types of events, and the most damaging events and thresholds, and trends,

Considering:

(1) That many National Meteorological and Hydrological Services have developed and are maintaining historical catalogues of extreme events,

(2) That many countries have established disaster loss and damage accounting systems that could help in monitoring the implementation of the Sendai Framework and other international policies,

(3) That technical commissions, regional associations and technical programmes are at different stages in addressing the different aspects of extreme weather, water, climate and space weather events such as methodologies and standards for defining the events, indices, and creating web portals for event databases, and that there is a need for better understanding their roles in addressing this issue,

(4) That an identifier and cataloguing system is an important prerequisite for the Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes and the United Nations Office for Disaster Risk Reduction Global Assessment Reports on Disaster Risk Reduction, and that it could greatly assist the Global Framework for Climate Services by bringing a standardized approach of National Meteorological and Hydrological Services to the analysis and recording of extreme hydrometeorological events in national databases, and by supporting the international exchange and validation of these data,

Decides to standardize weather, water, climate, space weather and other related environmental hazard and risk information and develop identifiers for cataloguing weather, water and climate extreme events;

Requests the Executive Council to provide oversight on the standardization of hazard information for loss and damage assessment;

Requests the Commission for Basic Systems to develop, in collaboration with all technical commissions and regional associations, a proposal on standardized identifiers for cataloguing hazardous events for consideration by the Executive Council;

Requests the Secretary-General to take the necessary actions, within the available budgetary resources, to facilitate the work on this important issue.

Resolution 10 (Cg-17)

SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION 2015−2030 AND WMO PARTICIPATION IN THE INTERNATIONAL NETWORK FOR MULTI-HAZARD EARLY WARNING SYSTEMS

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The need to assist Members in implementing the Sendai Framework for Disaster Risk Reduction 2015–2030 through provision of guidance, capacity-building and facilitating implementation of projects at the national level,

(2) The need for a holistic and integrated multi-hazard approach to early warning systems as a strategy to streamline such systems, to apply lessons learned from their operations, and to contribute effectively to disaster risk reduction,

Noting further:

(1) That the Sendai Framework calls for the necessity of enhancing multi-hazard early warning systems (MHEWS) and that the Member States of the United Nations called for

strengthened regional and international cooperation to develop science-based methodologies and tools to support MHEWS,

(2) The emphasis placed by the United Nations Plan of Action on Disaster Risk Reduction for Resilience on the need for cooperation and coordination between various United Nations agencies and other international organizations,

(3) The need for a multi-stakeholder partnership at various levels forged through voluntary commitment to foster and enhance cooperation, collaboration and networking on improving early warning systems with a multi-hazard approach,

(4) The concept for the establishment of the International Network for Multi-hazard Early Warning Systems (IN-MHEWS), developed by the organizing team of the United Nations World Conference on Disaster Risk Reduction Working Session on Early Warning, presented during the Conference, and the support this received from the Working Session and a number of key stakeholders,

(5) That IN-MHEWS would involve a number of appropriate international, regional and national partner agencies and institutions that have the mandates for the monitoring, forecasting and warning of natural and human-induced hazards,

(6) That WMO is planning to conduct an International Conference on MHEWS in 2016 in collaboration with Members, technical commissions, regional associations, and partners that have expressed commitment to IN-MHEWS and other international bodies and stakeholders,

Requests the Executive Council, working with regional associations and relevant technical commissions, to guide the WMO contribution to the development of the hydrometeorological elements of IN-MHEWS, including possible governance mechanisms, operating modalities and appropriate monitoring and evaluation procedures;

Requests the Secretary-General:

(1) To proactively and continuously assist Members in their efforts to implement the Sendai Framework;

(2) To ensure relevant stakeholders in hydrometeorological aspects are actively engaged in the planning meetings of IN-MHEWS in 2015 to develop its collaborative arrangements and integrated plan of action;

(3) To keep Members informed about the progress in the establishment of IN-MHEWS and its activities;

Requests the regional associations to assist with the development of IN-MHEWS and to cooperate with the regional organizations and regional bodies to strengthen partnerships and support WMO Regional Centres to promote the implementation of the Sendai Framework, in particular MHEWS;

Requests the technical commissions:

(1) To assist with the development of IN-MHEWS, in particular the development of science-based methodologies and tools to support MHEWS;

(2) To develop appropriate training modules to enhance the capacity of National Meteorological and Hydrological Services in implementing the Sendai Framework, in particular MHEWS, and climatological aspects of extreme weather impacts for planning and prevention;

Requests Members to adopt a shared approach with relevant agencies and organizations at the national level to promote implementation of the Sendai Framework.

Resolution 11 (Cg-17)

TOWARDS A FUTURE ENHANCED INTEGRATED AND SEAMLESS DATA-PROCESSING AND FORECASTING SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Article 2 of the Convention of the World Meteorological Organization,

(2) Resolution 36 (Cg-XVI) – WMO Strategic Plan (2012–2015) approving the Plan, as contained in the *WMO Strategic Plan 2012–2015* (WMO-No. 1069), and Resolution 69 (Cg-17) – WMO Strategic Plan 2016–2019, approving the Plan for 2016–2019,

(3) The *Abridged Final Report with Resolutions of the Sixteenth World Meteorological Congress* (WMO-No. 1077), Resolution 6 (Cg-XVI) – Revised *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), and general summary, paragraphs 3.1.3.1 to 3.1.3.29,

(4) The *Abridged Final Report with Resolutions of the Sixty-fifth Session of the Executive Council* (WMO-No. 1118), general summary, paragraphs 4.3.1 to 4.3.14 and Resolution 4 (EC-65) – Implementation Plan of the WMO Strategy for Service Delivery, and the *Abridged Final Report with Resolutions of the Sixty-sixth Session of the Executive Council* (WMO-No. 1136), general summary, paragraphs 4.3.1 to 4.3.15,

(5) The *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140), general summary, paragraphs 4.4.1 to 4.4.20,

(6) The *Abridged Final Report with Resolutions of the Fourth World Meteorological Congress* (WMO-No. 142), general summary, paragraphs 5.3.1.3 and 5.3.1.4,

(7) The *Abridged Final Report with Resolutions of the Fourteenth World Meteorological Congress* (WMO-No. 960), general summary, paragraphs 3.1.3.1 to 3.1.3.27, and the *Abridged Final Report with Resolutions of the Fifteenth World Meteorological Congress* (WMO-No. 1026), general summary, paragraphs 3.1.3.1 to 3.1.3.31,

(8) Resolution 2 (Cg-17) – Implementation of the WMO Strategy for Service Delivery,

Recalling:

(1) That the General Assembly of the United Nations in 1961 unanimously adopted Resolution 1721 (XVI) – International cooperation in the peaceful uses of outer space, and WMO was called upon to study measures to advance the state of atmospheric science and technology and to develop existing weather forecasting capabilities,

(2) That the result of the above task had led to the establishment of the World Weather Watch by the Fourth World Meteorological Congress in 1963, which included the Global Data-processing System, the Global Observing System and the Global Telecommunication System operated by Members for the collection, analysis and dissemination of meteorological data and processed products,

(3) That Fourteenth Congress in 2003 included the function of forecasting into the definition of the Global Data-processing System to become the Global Data-processing and Forecasting System (GDPFS),

Noting further that the Commission for Basic Systems at its extraordinary session in 2014 requested its Management Group to initiate a process for the development of a long-term vision for the GDPFS,

Considering:

(1) That all WMO constituent bodies and numerous subsidiary expert level groups provide a complex framework for coordination and collaboration in which a large number of decision-makers and experts from virtually all Members and partner organizations address matters related to the Data-processing and Forecasting System,

(2) That emerging requirements from the services-oriented programmes, such as aeronautical, marine, agriculture, health and public weather services, as well as requirements from a wide range of hydrometeorological-related emergencies, or from implementing disaster mitigation strategies, require an enhanced integrated, holistic and seamless Data-processing and Forecasting System in order to be relevant to users' decision-making,

(3) That an enhanced integrated, holistic and seamless Data-processing and Forecasting System could have the potential to lead to important benefits for Members and their National Meteorological and Hydrological Services and the Organization as a whole,

Recognizing that the integration of the technical support to meet the ongoing and emerging requirements from different sectors of society in a single system, in a multidimensional and multidisciplinary approach, would be more cost-effective and relevant to decision-makers and users,

Recognizing further:

(1) That working towards an enhanced integrated and seamless WMO Data-processing and Forecasting System would be a major undertaking, which would be designed to improve the capability of Members to effectively provide a widening range of services to end users,

(2) That this endeavour would have an impact on the work of the technical commissions and WMO Programmes,

(3) That the integration process would be a complex undertaking that would stretch over several years and require the full support of all Members to be successful,

Decides to initiate a process for the gradual establishment of a future enhanced integrated and seamless WMO Data-processing and Forecasting System, in the light of the conclusions of the first World Weather Open Science Conference held in Montreal, Canada in August 2014, in particular that a seamless system encompasses several dimensions including timescales, multiple weather related hazards and societal impacts;

Urges Members and invites partner organizations and WMO constituent bodies to collaborate actively in and give all possible support to the development and implementation of this initiative;

Requests the Executive Council:

(1) To formulate terms of reference for this process, and a description of the set of products the system should produce, and to steer the activity accordingly;

(2) To ensure the active participation and representation of the constituent bodies concerned and also the participation, as appropriate, of technical experts and representatives of partner agencies;

(3) To strengthen the link between the research activities on seamless prediction and the development of downstream related services;

(4) To submit a comprehensive report on the integrated and seamless WMO Data-processing and Forecasting System to Eighteenth Congress;

Requests the technical commissions to include this activity in their work programmes, as appropriate depending on the guidance from the Executive Council, in order to fully accommodate the cross-programme nature of the integration initiative;

Requests the Secretary-General to strengthen coordination and collaborate closely with relevant partner organizations in pursuing this endeavour.

Resolution 12 (Cg-17)

REPORT OF THE EXTRAORDINARY SESSION (2014) OF THE COMMISSION FOR BASIC SYSTEMS CONCERNING THE INTRODUCTION OF THE NEW *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-No. 485)

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140), concerning the introduction of the new *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

Noting Recommendation 3 (CBS-Ext.(2014)) – Introduction of the new *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

Noting further that the new Manual introduces a number of changes to the current procedures,

Considering the Manual as the single source of technical regulations for all operational data-processing and forecasting systems of Members, including their designated meteorological centres,

Recalling that the Sixteenth World Meteorological Congress adopted the outline for a revised Manual through Resolution 6 (Cg-XVI) – Revised *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

Decides to approve Recommendation 3 (CBS-Ext.(2014)), which includes the request for the World Meteorological Congress:

(1) To adopt the roadmap for the introduction of the new Manual;

(2) To authorize the Executive Council to adopt the new revised Manual, as it will be completed after the time of Seventeenth Congress and before Eighteenth Congress, noting that the revised Manual would not compromise the operation and further development of the Global Data-processing and Forecasting System (GDPFS);

to take effect from 1 July 2015;

Invites Members:

(1) To review the draft version of the new Manual and provide their comments to the Secretariat by e-mail, in order to facilitate the review process of the new Manual, prior to its consideration by a WMO constituent body;

(2) To collaborate in, and give all possible support to, the introduction and implementation of the revised Manual, following the roadmap given in the annex to Recommendation 3 (CBS-Ext.(2014));

Affirms the authority of the Executive Council to adopt the new revised Manual as it will be completed after the time of Seventeenth Congress and before Eighteenth Congress, noting that the revised Manual would not compromise the operation and development of the GDPFS;

Noting that deferring the adoption of the new Manual until Eighteenth Congress would represent a significant delay in the implementation of important quality management processes and the revised designations of Data-processing and Forecasting System centres, including a delay of the designation of centres under the new framework until Nineteenth Congress in 2023,

Requests the Secretary-General:

(1) To ensure coordination with other components of the World Weather Watch, primarily with the WMO Integrated Global Observing System and the WMO Information System, so that the observational and data management aspects related to the GDPFS are included in relevant regulatory documentation;

(2) To arrange for coordination among Programmes and relevant technical commissions to ensure that all WMO relevant operational centres that provide weather, climate, hydrological and environmental products are included in the Manual;

(3) To keep and maintain the current version of the Manual in force until the completion of the new revised Manual;

(4) To arrange for the implementation of the transitional plan for the introduction of the new Manual, which will replace the current version, in order to manage the technical changes and the initial designation of the GDPFS centres as defined in the new Manual;

(5) To arrange for the revision of the Manual to be continued so as to achieve its earliest possible completion, subsequent adoption by a WMO constituent body and publication in all WMO official languages.

Resolution 13 (Cg-17)

REPORT OF THE EXTRAORDINARY SESSION (2014) OF THE COMMISSION FOR BASIC SYSTEMS CONCERNING THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM AND EMERGENCY RESPONSE ACTIVITIES

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140), concerning the Global Data-processing and Forecasting System and emergency response activities,

Noting Recommendation 2 (CBS-Ext.(2014)) – Amendments to the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485) and Recommendation 23 (CBS-Ext.(2014)) – Proposed mechanism to strengthen operational centres, built upon the lessons learned through the Severe Weather Forecasting Demonstration Project,

Decides on each of the recommendations as follows:

Recommendation 2 (CBS-Ext.(2014)) – Amendments to the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485)

(a) Approves this recommendation, which includes amendments to the Manual related to:

(i) The designation of National Meteorological Centre Washington as a Regional Specialized Meteorological Centre for the Provision of Atmospheric Backtracking Products;

(ii) The regional and global arrangements for the provision of atmospheric transport model products for environmental emergency response and atmospheric backtracking;

(iii) The designation of Regional Climate Centre (RCC) Africa hosted by the African Centre of Meteorological Applications for Development (Regional Association I (Africa)) and RCC Western South America hosted by the International Research Centre on El Niño (Region Association III (South America));

to take effect from 1 July 2015; and authorizes the Secretary-General, in consultation with the president of the Commission for Basic Systems, to make the necessary editorial amendments to the Manual;

Recommendation 23 (CBS-Ext.(2014)) – Proposed mechanism to strengthen operational centres, built upon the lessons learned through the Severe Weather Forecasting Demonstration Project

(a) Endorses this recommendation, which includes the establishment of an expanded mechanism to support operational centres at the global, regional and national levels for the sustainability of the Cascading Forecasting Process, developed through a set of Severe Weather Forecasting Demonstration Project (SWFDP) regional projects and sustained with the support of a coordination office within the Secretariat;

Requests the Secretary-General:

(1) To incorporate the amendments in the Manual;

(2) To make the appropriate arrangements for the implementation of the proposed mechanism to strengthen operational centres, built upon the lessons learned through SWFDP, in the light of the budget for the seventeenth financial period (2016–2019), and for these centres to support the disaster risk reduction roadmap once adopted;

Requests the Commission for Basic Systems to continue to guide the expansion of SWFDP and take the leadership role in the implementation of the mechanism to strengthen operational centres;

Requests Members, technical commissions and regional associations to fully collaborate with the Secretary-General and the Commission for Basic Systems to facilitate the implementation of the mechanism;

Requests the Executive Council to guide the cross-programmatic integration in SWFDP and the mechanism to strengthen operational centres.

Resolution 14 (Cg-17)

AMENDMENTS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-No. 485)

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140), concerning the Global Data-processing and Forecasting System (GDPFS) and emergency response activities,

Noting the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485),

Noting further Recommendation 15 (CBS-Ext.(2014)) – Procedures for maintaining Manuals and Guides managed by the Commission for Basic Systems,

Considering the urgent need to review the access to the Global Producing Centre data and visualization products held by the Lead Centres for Long-range Forecasting Multimodel Ensemble (*Manual on the Global Data-processing and Forecasting System*, Volume I, Global Aspects, Attachment II.12, Item 6), jointly managed by the Commission for Basic Systems and the Commission for Climatology,

Decides to take action as follows:

(1) Approves the amendment to the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), Volume I, Global Aspects, Attachment II.12, item 6, as contained in the annex to the present resolution, to take effect from 1 July 2015;

(2) Authorizes the Secretary-General, in consultation with the president of the Commission for Basic Systems, to make the necessary editorial changes, and requests the Secretary-General to incorporate the amendment in the *Manual on the Global Data-processing and Forecasting System.*

Annex to Resolution 14 (Cg-17)

PROPOSED AMENDMENTS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING AND FORECASTING SYSTEM* (WMO-No. 485), VOLUME I, GLOBAL ASPECTS, ATTACHMENT II.12, ITEM 6, RELATED TO ACCESS TO GLOBAL PRODUCING CENTRE DATA AND VISUALIZATION PRODUCTS HELD BY THE LEAD CENTRES FOR LONG-RANGE FORECASTING MULTI-MODEL ENSEMBLE

6. ACCESS TO GPC DATA AND VISUALIZATION PRODUCTS HELD BY THE LEAD CENTRES FOR LRFMME

(a) Access to GPC data and graphical products from LC-LRFMME Websites will be password protected.

(b) Digital GPC data will be only redistributed in cases where the GPC data policy allows it. In other cases, requests for GPC output should be referred to the relevant GPC.

(c) Formally designated GPCs and RCCs, NMHSs and institutions coordinating RCOFs are eligible for password-protected access to information held and produced by the LC-LRFMME. Entities which are in demonstration phase to seek designation as GPCs or RCCs are also eligible for password protected access to information held and produced by

the LC-LRFMME, provided a formal notification has been issued in this regard by the WMO Secretary-General.

(d) Institutions other than, but providing contributions to, those identified in (c) above, may also request access to LC-LRFMME products. These institutions, referred to as "supporting institutions" and including research centres, require endorsement letters from: (1) the Permanent Representative of the country where they are hosted; and (2) the executive manager of the entity they wish to provide contributions to (i.e., RCCs, Institutions coordinating RCOFs and NMHSs). The use of LC-LRFMME products by supporting institutions is restricted to assistance of the organizations identified in (c) in their production of official forecast outputs. Supporting institutions may not use LC-LRFMME products to generate and display/disseminate independent forecast products. Supporting institutions must agree with these restrictions to be eligible for access. Prior to access being granted to an applicant supporting institution, the LC-LRFMME will refer the application to the CBS-CCl Expert Team on Operational Prediction from Subseasonal to Longer-time Scales (ET-OPSLS) through the WMO Secretariat, for final consultation and review. Decisions to allow access must be unanimous. The Lead Centre will be informed by the WMO Secretariat of such new users accepted for access.

(e) A list of users provided with password access will be maintained by LC-LRFMME and reviewed periodically by the CBS-CCl ET-OPSLS, to measure the degree of effective use and also to identify any changes in status of eligible users, and determine further necessary follow-up.

Resolution 15 (Cg-17)

WORLD CLIMATE PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Recalling Resolution 18 (Cg-XVI) – World Climate Programme,

Noting:

(1) The *Abridged Final Report with Resolutions of the Fifteenth World Meteorological Congress* (WMO-No. 1026), Resolution 8 (Cg-XV) – World Climate Programme and its coordination, Resolution 12 (Cg-XV) – World Climate Data and Monitoring Programme and Resolution 13 (Cg-XV) – World Climate Applications and Services Programme, including the CLIPS project,

(2) That the Sixteenth World Meteorological Congress agreed to the request of the United Nations Environment Programme (UNEP) to formally close the World Climate Impacts and Response Strategies Programme (WCIRP), which was part of the erstwhile structure of the World Climate Programme (WCP), and recommended to UNEP that relevant WCIRP activities be taken up within the UNEP Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA),

(3) That PROVIA has been recognized and encouraged by the Governing Council of UNEP at its twenty-seventh session,

(4) The *Abridged Final Report with Resolutions of the Sixty-fifth Session of the Executive Council* (WMO-No. 1118), Resolution 6 (EC-65) – Restructuring of the World Climate Programme: inclusion of the Programme of Research on Climate Change Vulnerability, Impacts and Adaptation as an additional component,

Recognizing:

(1) The fundamental role of the World Climate Programme in climate science, research and modelling, observations of climate, management of climate information, climate monitoring, and climate applications and services,

(2) The continuing importance of the WCP and its associated activities in making an effective contribution to the Intergovernmental Panel on Climate Change, the United Nations Framework Convention on Climate Change and the United Nations Convention to Combat Desertification, as well as to the successor framework to the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters, and the United Nations sustainable development goals expected to be confirmed by the end of 2015,

(3) The emergence of the Global Framework for Climate Services (GFCS) and new coordination mechanisms for inter-agency cooperation on climate activities,

(4) The need to refocus WCP, inter alia, to respond to the needs of GFCS and to ensure its effective implementation,

(5) The effective long-term partnership and contribution of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, the World Health Organization, the Food and Agriculture Organization of the United Nations, UNEP, the International Council for Science, and a growing number of other United Nations agencies, funds and programmes, and other international organizations to WCP,

(6) The scope and objectives of WCP and its components that would be consistent with its contributions in particular, and those of WMO in general, to GFCS,

Decides:

(1) To reconstitute the World Climate Programme to serve the strategic goals of the Organization;

(2) To structure the Programme to be composed of the Global Climate Observing System (GCOS), the World Climate Research Programme (WCRP), the World Climate Services Programme (WCSP) and the Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA);

(3) That the Commission for Climatology will guide the implementation of WCSP in collaboration with other technical commissions and co-sponsored entities;

(4) To invite the co-sponsors of WCRP, GCOS and PROVIA to support this structure;

Requests the Commission for Climatology, the WCRP Joint Scientific Committee and the GCOS Steering Committee to ensure close cooperation with each other for the effective implementation of the Programme;

Requests the Intergovernmental Board on Climate Services to ensure that WCP, including all its components, is a key programme in the delivery of GFCS;

Requests the Executive Council to ensure effective coordination among all the bodies responsible for the implementation of WCP, including through setting up of appropriate mechanisms therefor;

Requests the Secretary-General:

(1) To ensure coherent planning and implementation of WCP;

(2) To promote WCP at high levels and to foster engagement of the United Nations system in its implementation in close alignment with GFCS;

(3) To appropriately review and update the relevant memorandums of understanding with the co-sponsoring partners of various components of WCP, in accordance with their revised scope and objectives;

Urges Members, regional associations and technical commissions:

(1) To ensure the implementation of WCP activities that fall within their areas of competency and responsibility;

(2) To support the required capacity development, particularly in developing and least developed countries;

(3) To strive to increase support for global, regional and national climate-related activities, including through Global Producing Centres, Regional Climate Centres and National Meteorological and Hydrological Services, and to promote increased use of climate products and information for societal benefit;

(4) To make all possible efforts to support operational activities for the generation and dissemination of products required for the implementation of the Climate Services Information System pillar of GFCS.

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Note: This resolution replaces Resolution 18 (Cg-XVI), which is no longer in force.

Resolution 16 (Cg-17)

REPORT OF THE SIXTEENTH SESSION OF THE COMMISSION FOR CLIMATOLOGY

THE WORLD METEOROLOGICAL CONGRESS,

Noting the *Abridged Final Report with Resolutions and Recommendations of the Sixteenth Session of the Commission for Climatology* (WMO-No. 1137),

Decides:

(1) To note the report;

(2) To note Resolutions 1 to 3 (CCl-16);

(3) To take action on each of the following recommendations as follows:

Recommendation 1 (CCl-16) – Reflecting Climate Data Management System specifications in WMO Technical Regulations

(a) Approves this recommendation;

(b) Requests the Commission for Basic Systems to work closely with the Commission for Climatology to identify the relevant parts of the Climate Data Management System specifications publication for possible inclusion in the WMO Technical Regulations;

Recommendation 2 (CCI-16) – Calculating climatological standard normals every 10 years

(a) Approves this recommendation;

(b) Approves the proposed amendments to the *Technical Regulations* (WMO-No. 49), Volume I, with respect to the definition of Climatological Standard Normals as follows:

- Climatological Standard Normals: Averages of climatological data computed for the following consecutive periods of 30 years: 1 January 1981–31 December 2010, 1 January 1991–31 December 2020, and so forth;
- WMO Reference Period for long-term climate change assessment: The consecutive period of 30 years from 1 January 1961 to 31 December 1990;

(c) Authorizes the Secretary-General to make any consequent purely editorial amendments;

Recommendation 3 (CCI-16) – Establishing a list of national focal points on national climate monitoring products

(a) Approves this recommendation;

(b) Requests the Commission for Climatology to define the terms of reference for the work of the national focal points on national climate monitoring products;

(c) Urges Members to collaborate with the Commission and the Secretariat on the implementation of this recommendation;

Recommendation 4 (CCI-16) – National Climate Outlook Forums and National Climate Forums

(a) Approves this recommendation;

(b) Urges Members to foster partnerships and collaborations between National Meteorological and Hydrological Services and national user groups, through National Climate Outlook Forums (NCOFs) and National Climate Forums (NCFs) or other national user-focused mechanisms;

(c) Requests the Secretary-General to facilitate wider dissemination of the NCOF and NCF concepts and relevant guidance;

Recommendation 5 (CCI-16) – National focal points of the Climate Services Information System

(a) Approves this recommendation;

(b) Requests the Commission for Climatology to define the terms of reference for the work of the national focal points of the Climate Services Information System (CSIS);

(c) Urges Members to establish national focal points of CSIS and facilitate their work in close collaboration with the relevant technical commissions, the Secretariat and the entities of the Global Framework for Climate Services;

(d) Requests the Secretary-General to support the provision of the necessary guidance, tools and training for the national CSIS focal points;

Recommendation 6 (CCI-16) – Review of resolutions of the Executive Council based on previous recommendations of, or concerning, the Commission for Climatology

(a) Approves this recommendation.

Resolution 17 (Cg-17)

INTEGRATED DROUGHT MANAGEMENT PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The increasing impacts of droughts on national and global economies and the potential benefits of improved weather, climate and hydrological information and products in the mitigation of these impacts,

(2) The need to move from a reactive to proactive approach to drought management, based on risk management principles as stated in the Final Declaration of the High-Level Meeting on National Drought Policy,

(3) The development of an Integrated Drought Management Programme (IDMP) concept note by WMO and the Global Water Partnership (GWP),

(4) The success of the Associated Programme on Flood Management, a joint WMO/GWP initiative, over the past 10 years in promoting and supporting the concept of integrated flood management through comprehensively addressing the scientific, engineering, environmental, social, institutional and legal aspects of flood management,

(5) Resolution 1 (CAgM-16) – Integrated Drought Management Programme,

Noting further:

(1) That the goal of IDMP is to support stakeholders at all levels by providing them with policy and management guidance through globally coordinated generation of scientific information and sharing of best practices and knowledge in support of integrated drought management,

(2) That IDMP is based on four key principles:

   (a) Shifting from a reactive (crisis management) approach to proactive and programmatic measures through mitigation, vulnerability reduction and preparedness,

   (b) Integrating the vertical planning and decision-making processes at the regional, national and community levels into a framework of horizontally integrated sectors and disciplines, such as water, land, agriculture, ecosystems and energy,

   (c) Promoting the evolution of a knowledge base and establishing mechanisms for sharing it with stakeholders across sectors at all levels,

   (d) Building on the existing capacity of the various stakeholders at all levels,

Decides to support the principal goal of IDMP to develop a global coordination of efforts to strengthen drought monitoring, risk identification, drought prediction and early warning services;

Recommends that IDMP liaise and coordinate with other drought initiatives in order not to duplicate activities;

Encourages Members to use the resources available under IDMP, including the Help Desk, in developing proactive drought management actions;

Requests the Secretary-General:

(1) To facilitate the work of the IDMP Technical Support Unit, Management Committee and Advisory Committee and to report regularly to the Executive Council on the progress of its implementation;

(2) To work with the Global Water Partnership and other potential partners to secure extrabudgetary funding to resource the activities of the IDMP in the Secretariat.

Resolution 18 (Cg-17)

HYDROLOGY AND WATER RESOURCES PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 12 (Cg-XVI) – Hydrology and Water Resources Programme,

(2) Resolution 7 (CHy-14) – Work programme and structure of the Commission for Hydrology,

(3) Resolution 7 (EC-65) – Report of the fourteenth session of the Commission for Hydrology,

(4) Resolution 5 (CHy-14) – Establishment of an Integrated Drought Management Programme,

(5) The WMO Strategic Plan 2016–2019,

(6) The report of the president of the Commission for Hydrology to the Seventeenth World Meteorological Congress,

(7) Resolution 25 (Cg-XIII) – Exchange of hydrological data and products,

Considering the continuing importance of sustainable water resources management in a variable and changing world and the need to ensure that weather-, climate- and hydrological-related information, products and services reach their intended users,

Urges Permanent Representatives to appoint Hydrological Advisers, even in those countries where the National Meteorological Service and National Hydrological Service are part of the same institution, giving due consideration to the fact that hydrological activities are undertaken by various institutions within countries;

Decides to maintain the Hydrology and Water Resources Programme for the period 2016–2019, as described in the *Abridged Final Report with Resolutions of the Sixteenth World Meteorological Congress* (WMO-No. 1077), Annex II – WMO Programme descriptions;

Requests the Executive Council and Secretary-General to take all the necessary actions:

(1) To arrange for the implementation of the Hydrology and Water Resources Programme and to assist the Commission for Hydrology and all bodies concerned in its implementation;

(2) To ensure that WMO continues playing an active role in UN-Water, the inter-agency coordination mechanism of the United Nations system on water-related issues;

(3) To continue to provide support to regional activities of the Programme;

(4) To support the cooperation between WMO and other governmental and non-governmental organizations on hydrology and water resources management;

Requests the president of the Commission for Hydrology:

(1) To promote cross-technical commission and cross-programme cooperation in areas of concern to the Commission, including, inter alia, with the presidents of the Commission for Atmospheric Sciences, the Commission for Basic Systems and the Joint WMO/IOC Commission for Oceanography and Marine Meteorology to ensure improved linkages and interactions between the Severe Weather Forecasting Demonstration Project, the Coastal Inundation Forecast Demonstration Project and the Flash Flood Guidance System;

(2) To encourage and support active collaboration between the Commission and the regional associations, in particular their groups related to hydrology and water resources management;

(3) To engage, as appropriate, with the governance and implementation of the Global Framework for Climate Services;

(4) To ensure that the Commission takes an active part in facilitating the active role of National Hydrological Services and National Meteorological Services in the user interface component of the Global Framework for Climate Services, to promote the development and delivery of user-oriented climate information and prediction services meeting the needs of the water sector;

(5) To continue to coordinate the activities of the Hydrology and Water Resources Programme with the International Hydrological Programme of the United Nations Educational, Scientific and Cultural Organization and to collaborate with other UN-Water agencies in areas of common interest;

(6) To continue to implement the WMO Strategy on Education and Training in Hydrology and Water Resources, as given in the annex to Resolution 6 (CHy-14) – Capacity-building in hydrology and water resources management;

(7) To contribute to the implementation of the WMO Strategy for Service Delivery with a view to improve effectiveness of service delivery capabilities of National Hydrological Services;

(8) To ensure that the implementation of the recommendations from the Conference on the Gender Dimensions of Weather and Climate Services, held in Geneva from 5 to 7 November 2014, are promoted among the National Meteorological and Hydrological Services and in WMO water-related activities during the seventeenth intersessional period;

(9) To ensure that WMO contributes, as appropriate, to the development, measurement and monitoring of the water-related United Nations sustainable development goals;

Requests the regional associations to continue to take into account, while deciding on the structure of their subsidiary bodies, the benefits of regional Working Groups on Hydrology as a platform for hydrologists within a Region to discuss matters of common concern;

Reaffirms Resolution 25 (Cg-XIII) as an essential cornerstone in the efforts to seamlessly address weather, climate and hydrology activities from scientific research to policy development and operational implementation;

Urges Members to comply with relevant data policy resolutions, such as Resolution 40 (Cg-XII) – WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities and Resolution 25 (Cg-XIII), and thus to jointly address the challenges facing societies with regard to climate variability and change, integrated water resources management and flood forecasting in international basins;

Invites Members to participate in, and contribute to, technical cooperation activities in hydrology and water resources management also by contributing to the Hydrology and Water Resources Trust Fund in support of water-related activities, including the Associated Programme on Flood Management, the Integrated Drought Management Programme and the World Hydrological Cycle Observing System.

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Note: This resolution replaces Resolution 12 (Cg-XVI), which is no longer in force.

Resolution 19 (Cg-17)

WORLD HYDROLOGICAL CYCLE OBSERVING SYSTEM OFFICE

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 14 (Cg-XVI) – World Hydrological Cycle Observing System, requesting the Secretary-General to carry out an independent external evaluation of the System,

(2) Resolution 25 (Cg-XIII) – Exchange of hydrological data and products,

(3) The *Comprehensive Review of the World Hydrological Cycle Observing System* (2011) prepared by independent external experts and the recommendations therein,

(4) Resolution 4 (CHy-14) – World Hydrological Cycle Observing System, containing the responses prepared by the Commission for Hydrology to the recommendations of the external evaluation,

(5) Resolution 8 (EC-65) – World Hydrological Cycle Observing System, containing the responses by the Executive Council to the recommendations of the external evaluation,

Recognizing:

(1) The growing importance of hydrological data and information and effective institutions in support of sustainable water resources management, in particular with respect to the measurement and monitoring of the United Nations sustainable development goals,

(2) That the World Hydrological Cycle Observing System (WHYCOS) has proven in the past decade a useful means for mobilizing resources to support the strengthening of National Meteorological and Hydrological Services and their regional cooperation,

(3) The positive impacts of implemented Hydrological Cycle Observing System components on the strengthening of technical and institutional capacities of National Hydrological Services in a number of countries, including improved international cooperation in transboundary and international rivers basins,

(4) That the visibility earned by WMO in the field of hydrology-related activities is also due to WHYCOS,

(5) The recommendation in the *Comprehensive Review of the World Hydrological Cycle Observing System* for the establishment of a dedicated WHYCOS Office,

(6) The kind offer by the Swiss Agency for Development and Cooperation to fund the initial scoping study and initial operations of a dedicated WHYCOS Office in association with an innovation hub for water resources measurement and monitoring,

Aware and concerned that shortcomings still exist in the implementation of WHYCOS, in particular with respect to the sustainability of the systems installed, which may affect both ongoing components and the potential to implement new ones,

Reaffirms the importance of WHYCOS as a priority activity within the Hydrology and Water Resources Programme;

Requests Members and funding agencies to support, as appropriate, the ongoing operations of the WHYCOS Office;

Requests the Secretary-General to establish the WHYCOS Office, to be funded by voluntary contributions;

Requests the president of the Commission for Hydrology, as chairperson of the WHYCOS International Advisory Group, to oversee the implementation of the WHYCOS Office through the Advisory Group and report back to the Executive Council on progress made.

Resolution 20 (Cg-17)

WORLD WEATHER WATCH PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Article 2 of the Convention of the World Meteorological Organization,

(2) Resolution 1 (Cg-XVI) — World Weather Watch Programme for 2012–2015,

(3) Resolution 69 (Cg-17) – WMO Strategic Plan 2016–2019,

Noting further:

(1) The *Abridged Final Report with Resolutions of the Sixteenth World Meteorological Congress* (WMO-No. 1077), general summary, agenda item 3.1,

(2) The *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

(3) The *Abridged Final Report with Resolutions and Recommendations of the Sixteenth Session of the Commission for Instruments and Methods of Observation* (WMO-No. 1138),

(4) The *Abridged Final Report with Resolutions and Recommendations of the Fifteenth Session of the Commission for Basic Systems* (WMO-No. 1101),

Expresses:

(1) Its satisfaction that progress has been made in the further improvement of the operation of the World Weather Watch (WWW) Programme during the period 2012–2015;

(2) Its concern that deficiencies remain in the implementation of the Programme in some areas;

(3) The need for intensified and coordinated activities for the operation and maintenance of the Programme in support of other WMO Programmes and high-priority areas to meet the objectives of the WMO Strategic Plan and maximize the benefits available to all Members;

Confirms:

(1) That the WWW Programme has the highest priority as the basic WMO Programme on which all other Programmes of the Organization depend and provides the basis for the operations of National Meteorological and Hydrological Services;

(2) That the Programme continues to provide an effective mechanism for the application of science and technology in operations;

(3) That the Programme contributes to the WMO Strategy for Service Delivery;

(4) That the Programme should be used only for peaceful purposes, due account being taken of the national sovereignty and security of Member States and Territories, in accordance with the provisions of the Charter of the United Nations and the spirit and tradition of the Convention of the World Meteorological Organization;

Considering:

(1) The absolute importance of weather, climate and hydrological observations for determining the current state of the atmosphere, for weather forecasting, including severe weather forecasting and warning services, for monitoring climate variability and climate change, for climate prediction and as a fundamental underpinning of the Global Framework for Climate Services,

(2) That advanced technology for improving the technical systems of the WWW Programme calls for special efforts in the provision of technical guidance, specialized training and capacity-building,

Decides that the WWW Programme shall be aligned with the WMO Strategic Plan 2016–2019 and high priorities of WMO;

Stresses the role to be played by regional associations in coordinating WWW Programme implementation, identifying deficiencies, specifying requirements, and planning system support projects, on a regional scale;

Invites the regional associations to promote the coordinated implementation of the WWW Programme and to keep under continuous review related regional requirements;

Requests the Executive Council:

(1) To ensure that the further development of the WWW Programme is carried out in accordance with the WMO Strategic Plan;

(2) To adjust the Programme as necessary, particularly in the light of the recommendations made by the Commission for Basic Systems, the Commission for Instruments and Methods of Observation and the regional associations;

(3) To assist Members in all possible ways in meeting their respective responsibilities within the Programme;

(4) To promote the establishment of cooperative arrangements for the implementation, operation and maintenance of Programme system components, as appropriate;

Requests the Commission for Basic Systems:

(1) To pursue the technical planning and further development of the WWW Programme in accordance with the WMO Strategic Plan, taking into account any adjustments and directives from the Executive Council;

(2) To take a leading role, together with the Commission for Instruments and Methods of Observation, in the technical development and implementation of the Global Observing System (GOS), as the key component of the WMO Integrated Global Observing System (WIGOS), to meet, in an optimal way, the requirements of all WMO and co-sponsored Programmes;

(3) To pursue its leading role in the technical implementation and operation of the WMO Information System (WIS), including the Global Telecommunication System as its core network, for the collection and sharing of information for all WMO and related international programmes;

(4) To pursue its leading role to enhance the implementation of the Global Data-processing and Forecasting System through increased lead time and reliability of forecasts and warnings, and its critical support to the delivery of services to the general public as well as to all relevant socioeconomic sectors;

(5) To maintain close liaison with the other technical commissions, the regional associations, other relevant international organizations, and international programmes, in particular the Global Climate Observing System, with a view to ensuring that their relevant requirements and recommendations are taken in due consideration;

Urges all Members, especially donor countries, individually and through appropriate multinational arrangements, to cooperate actively in the further development and operation of the World Weather Watch, and in particular:

(1) To continue, to the best of their ability, to further develop, implement, operate and maintain the WWW Programme component systems (observation, information, data-processing and forecasting components) and to ensure the requirements of Members for the provision of services and products are fully met;

(2) To contribute to the implementation and operation of WIGOS and WIS;

(3) To coordinate and pool their national efforts and resources, in order to establish realistic goals, minimize the implementation and operational costs, and avoid duplication of Programme activities as far as possible;

(4) To participate in the deployment and use of new systems and techniques, including appropriate capacity-building activities, and, individually or collectively, to evaluate their effectiveness and their integration in the Programme;

(5) To keep the Secretary-General informed about their plans and activities regarding the implementation of the Programme;

Requests the Secretary-General:

(1) To keep Members informed of progress and developments in the planning and implementation of the WWW Programme;

(2) To further improve the monitoring of the operation of the Programme and the publication of results;

(3) To assist Members, as necessary, in overcoming difficulties that may arise in the implementation of the Programme during the seventeenth financial period;

(4) To propose projects and priorities for the consolidation and further development of key Programme facilities;

(5) To assist the Executive Council, the regional associations, the Commission for Basic Systems and the Commission for Instruments and Methods of Observation in the implementation of the present resolution;

(6) To bring the present resolution to the attention of all concerned;

(7) To submit a report to the Eighteenth World Meteorological Congress on the implementation of the WWW component systems during the seventeenth financial period together with proposals for further development of the World Weather Watch.

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Note: This resolution replaces Resolution 1 (Cg-XVI), which remains in force only until 31 December 2015.

Resolution 21 (Cg-17)

PROCEDURES FOR MAINTAINING MANUALS AND GUIDES MANAGED BY THE COMMISSION FOR BASIC SYSTEMS

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

Noting:

(1) Resolution 1 (Cg-XV) – Technical Regulations of the World Meteorological Organization,

(2) Resolution 1 (Cg-XVI) – World Weather Watch Programme for 2012–2015,

(3) The *Technical Regulations* (WMO-No. 49), Volume I – General Meteorological Standards and Recommended Practices, Part I, section 2.3,

(4) Resolution 4 (Cg-XVI) – Report of the extraordinary session (2010) of the Commission for Basic Systems relevant to Technical Regulations concerning the Global Telecommunication System, data management and the WMO Information System,

(5) That amendments to the *Technical Regulations* (WMO-No. 49), Volume II – Meteorological Service for International Air Navigation, may require changes to the *Manual on Codes* (WMO-No. 306),

(6) Recommendation 5 (CBS-Ext.(2014)) – Authorizing use of the procedure for amending Manuals between sessions of the Commission for Basic Systems in response to amendments to Annex 3 to the Convention on International Civil Aviation,

(7) Recommendation 15 (CBS-Ext.(2014)) – Procedures for maintaining Manuals and Guides managed by the Commission for Basic Systems,

Recalling that the Executive Council at its sixty-first session delegated to the Commission for Basic Systems the authority to approve low-risk changes to the *Manual on Codes*,

Decides to take action as follows:

Recommendation 5 (CBS-Ext.(2014)) – Authorizing use of the procedure for amending Manuals between sessions of the Commission for Basic Systems in response to amendments to Annex 3 to the Convention on International Civil Aviation

(a) Approves this recommendation, with effect from 1 January 2016;

(b) Requests the Secretary-General to add the following phrase to the end of paragraph 1.4.1 (Scope) of Annex 1 to Recommendation 15 (CBS-Ext.(2014)): "…, or that are required to implement changes in the *Technical Regulations* (WMO-No. 49), Volume II – Meteorological Service for International Air Navigation", and to add to the end of paragraph 1.4.2 (Approval of draft recommendations) the sentence "In the case of recommendations in response to changes in the *Technical Regulations* (WMO-No 49), Volume II – Meteorological Service for International Air Navigation, the president of the Commission for Basic Systems shall consult with the president of the Commission for Aeronautical Meteorology.";

(c) Authorizes the Secretary-General to make any consequent purely editorial amendments;

Recommendation 15 (CBS Ext.(2014)) – Procedures for maintaining Manuals and Guides managed by the Commission for Basic Systems

(a) Approves this recommendation, with effect from 1 January 2016;

(b) Requests the Secretary-General to make the amendments, as given in Annexes 1 and 3 to that recommendation, to the *Technical Regulations* (WMO-No. 49), Volume I;

(c) Requests the Secretary-General to make the amendments, as given in Annex 2 to that recommendation, to the *Manual on Codes* (WMO-No. 306) and the *Manual on the WMO Information System* (WMO-No. 1060);

(d) Authorizes the Secretary-General to make any consequent purely editorial amendments.

Resolution 22 (Cg-17)

GLOBAL OBSERVING SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Article 2 of the Convention of the World Meteorological Organization,

(2) Resolution 3 (Cg-XVI) – Global Observing System,

(3) Resolution 69 (Cg-17) – WMO Strategic Plan 2016–2019,

(4) Resolution 20 (Cg-17) – World Weather Watch Programme,

(5) Resolution 23 (Cg-17) – Pre-operational phase of the WMO Integrated Global Observing System,

Noting further:

(1) The *Abridged Final Report with Resolutions of the Sixteenth World Meteorological Congress* (WMO-No. 1077), general summary, paragraphs 3.1.1–3.1.1.11,

(2) The *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

(3) The *Abridged Final Report with Resolutions and Recommendations of the Fifteenth Session of the Commission for Basic Systems* (WMO-No. 1101),

Considering:

(1) That the Global Observing System (GOS) is a unique international observing system, owned and operated by Members, which provides unique and sustainable observational data and information on the state of the Earth and its atmosphere to meet evolving requirements of various users,

(2) That GOS, as a core component of the World Weather Watch Programme also contributing to co-sponsored programmes, is a backbone for the implementation of other WMO observational programmes and projects, including CryoNet, the observing component of the Global Cryosphere Watch and the Global Climate Observing System (GCOS) surface network (GSN) and upper-air network (GUAN),

(3) That GOS, with its integrated approach to surface and space-based components, is the core component observing system of the WMO Integrated Global Observing System (WIGOS), and that its evolution will be closely linked with the evolution of WIGOS,

(4) That investments of Members to the sustainable operation of the evolving GOS have ensured a provision of operational data for a wide range of basic services that they provide to the user community, such as weather and climate analysis, forecasts and warnings at the national, regional and global levels,

(5) That GOS ensures a continuous acquisition of the majority of Essential Climate Variables for the monitoring and prediction of climate changes, for the Global Framework for Climate Services, as well as for other international initiatives,

Reaffirms:

(1) That sustainable operation of GOS has a vital role and highest priority for WMO in providing observational data to meet the requirements of several WMO application areas, such as global numerical weather prediction (NWP), high-resolution NWP, nowcasting and very short-range forecasting, aeronautical meteorology, ocean and climate applications;

(2) The need for strengthening GOS to meet the evolving requirements of various users and, in particular, provision of timely and reliable information for natural disaster prevention and mitigation;

(3) That GOS, through the coordinated efforts of Members, should continue its fundamental mission in providing timely, reliable and consistent meteorological data, including marine meteorological data, to meet the requirements of various users worldwide;

Urges Members:

(1) To provide all possible support to the implementation of national observational programmes contributing to GOS, including where appropriate through partnerships with other organizations;

(2) To ensure sustainable operation of GOS and encourage activities with respect to the optimization of observing elements and development and deployment of the advanced composite system, with priority given to projects in the following order:

   (a) Projects aiming at restoring and improving the existing sites, as well as building the new upper-air observational capabilities of the Regional Basic Networks, with emphasis on GSN/GUAN stations, especially to fill the gaps over data-sparse areas;

   (b) Projects aiming at expansion and enhancement of aircraft-based observations, with special attention to developing countries to supplement scarce upper-air observations or to provide a cost-effective alternative to countries that cannot afford costly upper-air sounding systems;

   (c) Projects related to the improvement of data quality, regularity and coverage of surface observations of the Regional Basic Networks;

   (d) Projects related to the use of new observing equipment and systems including, where cost-effective, surface-based remote-sensing systems (weather radars, wind, temperature and humidity profiles and lightning systems), automatic weather stations, Automatic Meteorological DAta Relay (AMDAR), the Automated Shipboard Aerological Programme and drifting buoys;

   (e) Projects related to increasing the synergies between space-based and surface-based observing systems, and the integration of in situ and satellite data;

(3) To follow guidelines and recommendations contained in the new *Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)*, WIGOS Technical Report No. 2013-4, and nominate or update a national point of contact responsible for reporting progress and plans in their country related to EGOS-IP;

(4) To continue providing contributions to the AMDAR Trust Fund for the support of technical developments and capacity-building related to AMDAR;

Encourages Members:

(1) To communicate metadata from their stations to the WMO systems, at present *Weather Reporting* (WMO-No. 9), Volume A – Observing Stations and in future the Observing Systems Capability analysis and Review tool;

(2) To communicate historical data and metadata from their GSN/GUAN stations to Commission for Basic Systems Lead Centres for GCOS;

(3) To increase the use of automatic weather observing systems where they enable cost-effective real-time measurements, compatible with data from conventional systems, of quality and reliability suitable to all climate conditions;

Invites the regional associations to promote the coordinated implementation of GOS in the Regions through sustainable functioning of the regional observing networks and to keep under continuous review related regional requirements;

Requests the Commission for Basic Systems and the Commission for Instruments and Methods of Observation:

(1) To pursue their leading role in the technical planning and development of GOS in close collaboration with relevant technical commissions in support of all WMO and related international programmes and initiatives;

(2) To assist Members and regional associations in continued evolution of their observing systems;

(3) To develop a mechanism to assess the performance of Observing System Experiments and Observing System Simulation Experiments undertaken by Members and to communicate the benefits earned thereby to other Members;

Requests the Secretary-General:

(1) To assist Members, within the budgetary resources available, in the implementation of the Global Observing System during the seventeenth financial period;

(2) To keep Members informed of progress and developments in the planning and implementation of the Global Observing System.

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Note: This resolution replaces Resolution 3 (Cg-XVI), which is no longer in force.

Resolution 23 (Cg-17)

PRE-OPERATIONAL PHASE OF THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Article 2 of the Convention of the World Meteorological Organization,

(2) Resolution 50 (Cg-XVI) – Implementation of the WMO Integrated Global Observing System,

(3) Resolution 69 (Cg-17) –WMO Strategic Plan 2016–2019,

Noting further:

(1) That with the key initial building blocks of the WMO Integrated Global Observing System (WIGOS) Framework in place by the end of 2015, the prerequisites are available for a pre-operational phase of WIGOS from 2016 to 2019,

(2) The critical role of WIGOS to the implementation of the Global Framework for Climate Services, weather and disaster risk reduction services, capacity development, aviation services and other WMO priority areas,

Recognizing:

(1) That WIGOS is one of the key priorities and objectives of the Organization,

(2) That WIGOS together with the WMO Information System (WIS) provides the essential infrastructure for acquisition and dissemination of observations, on which the capability of Members to provide critical services to their citizens is built,

(3) That WIGOS is essential for all Members and that their commitment to WIGOS is therefore essential,

(4) That National Meteorological and Hydrological Services (NMHSs) play a leading role at the national level in the implementation and further development of WIGOS, both via strengthening and integrating their national observing systems and via the establishment of national partnerships,

(5) That the success of WIGOS depends on full integration and sharing of observations from both NMHSs and non-NMHS sources,

(6) That the timely completion of the WIGOS pre-operational phase implementation activities in the seventeenth financial period directly depends on the available resources,

Decides that the development of WIGOS will continue during its pre-operational phase in the seventeenth financial period with the aim of having Members benefit from a fully operational WIGOS from 2020 onward;

Decides further:

(1) That the highest priorities for the WIGOS pre-operational phase will be:

(a) National WIGOS implementation;

(b) WIGOS regulatory material complemented with necessary guidance material to assist Members with the implementation of the WIGOS technical regulations;

(c) Further development of the WIGOS Information Resource, with special emphasis on the operational deployment of the databases of the Observing Systems Capability Analysis and Review tool;

(d) Development and implementation of the WIGOS Data Quality Monitoring System;

(e) Concept development and initial establishment of Regional WIGOS Centres;

(2) That special priority must be given to those activities that will assist Members in implementing their WIGOS national plans, with a special focus on the least developed countries, landlocked developing countries and small island developing States where the needs are the highest;

(3) That high priority should be given to strengthening the capacity of developing and least developed countries, through the provision of guidance on best practices and procedures in the area of integration of automatic weather stations in their observing networks;

(4) That high priority should be given to the development of a strategy to mitigate risk posed by integration of data operated by organizations other than NMHSs;

Requests the Executive Council:

(1) To provide oversight of the further development of WIGOS;

(2) To approve the draft Plan for the WIGOS pre-operational phase;

(3) To re-establish the Intercommission Coordination Group on the WMO Integrated Global Observing System with strengthened regional representation to monitor and guide WIGOS development and implementation;

Requests the regional associations:

(1) To assign high priority to the implementation and further development of WIGOS in their Regions, including at the national level;

(2) To update their Regional WIGOS Implementation Plans in accordance with the decisions of the World Meteorological Congress and the Executive Council;

(3) To strengthen their role in managing and supervising the implementation and further development of WIGOS in accordance with these Plans;

(4) To coordinate WIGOS implementation activities with the implementation of WIS and other WMO key priorities in their operating plans and work programmes;

(5) To collaborate on the development of the concept and establishment of Regional WIGOS Centres;

(6) To provide regional support to Members in accordance with the Regional WIGOS Implementation Plan and in a response to their requests, subject to availability of resources or funds;

(7) To continue to promote capacity development, communications and outreach activities to assist Members in the implementation of WIGOS;

Requests the technical commissions:

(1) To develop technical guidelines and related guidance material incorporated in the Guide to WIGOS, to assist Members in implementing and operating their observing networks and systems in accordance with the WMO Technical Regulations;

(2) To develop, in collaboration with partner organizations and programmes, technical standards to support WIGOS and propose, as needed, related updates to the WIGOS regulatory material;

(3) To provide technical expertise, assistance and advice to Members and the regional associations on WIGOS;

(4) To continue to provide the technical lead for WIGOS through the Commission for Basic Systems and the Commission for Instruments and Methods of Observation;

Urges Members:

(1) To develop their national observing strategies and National WIGOS Implementation Plans;

(2) To establish national WIGOS governance, coordination and implementation mechanisms, and to nominate their national WIGOS focal points;

(3) To implement and operate their observing networks and systems in accordance with the WMO Technical Regulations;

(4) To coordinate their WIGOS implementation activities with the implementation of WIS and other WMO key priorities;

(5) To provide experts to participate in the WIGOS-related work of the Regions and relevant technical commissions;

(6) To support regional and global WIGOS implementation activities and projects, including providing sufficient resources;

(7) To keep the Secretary-General informed about their WIGOS implementation progress and achievements;

Requests the Secretary-General:

(1) To provide the necessary assistance and Secretariat support for the further development of WIGOS through its pre-operational phase, within available resources;

(2) To actively reach out to and establish agreements with potential partner organizations with observing system activities relevant to WIGOS;

(3) To collaborate and coordinate WIGOS activities with relevant United Nations system and other international organizations and programmes;

Invites partners to participate in relevant WIGOS implementation activities and further development of WIGOS during its pre-operational phase.

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Note: This resolution replaces Resolution 50 (Cg-XVI), which is no longer in force.

Resolution 24 (Cg-17)

REPORT OF THE EXTRAORDINARY SESSION (2014) OF THE COMMISSION FOR BASIC SYSTEMS RELEVANT TO WMO TECHNICAL REGULATIONS CONCERNING THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

Noting:

(1) Recommendation 11 (CBS-Ext.(2014)) – Revised *Manual on the Global Observing System* (WMO-No. 544),

(2) Recommendation 17 (CBS-Ext.(2014)) – Enhancement and expansion of aircraft-based observations,

(3) Recommendation 18 (CBS-Ext.(2014)) – Support of Members to the implementation of the marine meteorological and oceanographic observing system in support of numerical weather prediction,

Decides to take action on each of the above recommendations as follows:

Recommendation 11 (CBS-Ext.(2014)) – Revised *Manual on the Global Observing System* (WMO-No. 544)

(a) Approves this recommendation with the same effect as for the Manual on the WMO Integrated Global Observing System;

(b) Requests the Secretary-General to make the amendments, as given in the annex to this recommendation, to the *Manual on the Global Observing System*;

(c) Authorize the Secretary-General to make any subsequent purely editorial amendments;

Recommendation 17 (CBS-Ext.(2014)) – Enhancement and expansion of aircraft-based observations

(a) Approves this recommendation;

(b) Requests the Secretary-General:

(i) To invite the regional associations to consider further development of aircraft-based observations, primarily through wider implementation of the Automatic Meteorological DAta Relay (AMDAR) programme;

(ii) To invite the regional associations to develop, maintain and implement regional plans for the enhancement and expansion of aircraft-based observations and AMDAR;

(iii) To provide support for the coordination of the development and maintenance of these planning and implementation activities through appropriate promotion to Members and at each regional association session;

Recommendation 18 (CBS-Ext.(2014)) – Support of Members to the implementation of the marine meteorological and oceanographic observing system in support of numerical weather prediction

(a) Approves this recommendation;

(b) Requests the Secretary-General:

(i) To invite Members to contribute to the Implementation Strategy of the Data Buoy Cooperation Panel (DBCP), and commit appropriate resources to the barometer drifter and the tropical moored buoy arrays;

(ii) To invite National Meteorological and Hydrological Services to collaborate with partner organizations, and use the opportunity of the DBCP barometer drifter upgrade scheme;

(iii) To bring this recommendation to the attention of Members.

Resolution 25 (Cg-17)

TECHNICAL REGULATIONS **(WMO-No. 49), VOLUME I, PART I – WMO INTEGRATED GLOBAL OBSERVING SYSTEM**

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

Noting:

(1) Articles 2 (a), 2 (c) and 8 (d) of the Convention of the World Meteorological Organization,

(2) Resolution 45 (Cg-XVI) – Technical Regulations of the World Meteorological Organization,

(3) Resolution 50 (Cg-XVI) – Implementation of the WMO Integrated Global Observing System,

(4) Resolution 26 (EC-64) – Amendments to the Technical Regulations,

(5) Recommendation 16 (CBS-Ext.(2014)) – Regulatory material of the WMO Integrated Global Observing System,

(6) Resolution 23 (Cg-17) – Pre-operational phase of the WMO Integrated Global Observing System,

(7) Resolution 26 (Cg-17) –*Technical Regulations* (WMO-No. 49) – Manual on the WMO Integrated Global Observing System,

Recalling:

(1) That the Sixteenth World Meteorological Congress emphasized that the implementation of the WMO Integrated Global Observing System (WIGOS) must be reflected in the revised *Technical Regulations* (WMO-No. 49), documenting the WIGOS concept of operations and contributions of all observing components,

(2) The decision of the Executive Council at its sixty-fourth session on revision of the *Technical Regulations* in line with the up-to-date and emerging WMO systems and services,

(3) The decision of the Executive Council at its sixty-fifth session on the adjustment of the structure of the *Technical Regulations*, Volume I, Part I, agreed at its sixty-fourth session,

(4) That the Executive Council at its sixty-sixth session agreed that Volume I, Part I – WMO Integrated Global Observing System could be approved and promulgated effectively by Seventeenth Congress,

Considering the draft Part I recommended by the Commission for Basic Systems for adoption by the World Meteorological Congress,

Noting that the draft Part I was circulated to all Members and their comments were incorporated accordingly,

Decides to approve Part I, as provided in the annex to the present resolution, with effect from 1 July 2016;

Affirms the authority of the Executive Council to approve any amendments to Part I if required before the time of Eighteenth Congress;

Decides that the Commission for Basic Systems, in collaboration with other technical commissions, shall act as the lead technical commission for managing changes to the *Technical Regulations*, Volume I, Part I – WIGOS;

Requests the Secretary-General:

(1) To incorporate Part I – WIGOS in the *Technical Regulations* (WMO-No. 49), Volume I, 2015 edition, and to publish it in all official WMO languages;

(2) To ensure the editorial consistency of the relevant documents;

(3) To ensure the revision of the regulatory documents in a systematic manner and ensure that the published versions of the regulatory documents are consistent and include provisions that can be used within a nationally implemented quality management system;

(4) To bring the present resolution to the attention of all concerned.

Annex to Resolution 25 (Cg-17)

***TECHNICAL REGULATIONS* (WMO-No. 49), VOLUME I, PART I –**
WMO INTEGRATED GLOBAL OBSERVING SYSTEM

WORLD METEOROLOGICAL ORGANIZATION

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

Technical Regulations

VOLUME I – General Standards and Recommended Practices (2015 edition)

PART I. WMO Integrated Global Observing System (WIGOS) (Version 0.9)

WMO-No. 49

VERSION CONTROL

Version	Summary of change	By	Date
0.1	First full compilation of (mostly) completed and reviewed sections, for presentation to ICG-WIGOS-3	Chairperson TT-WRM	2014-02-06
0.2	Comments & changes for consideration	I. Zahumensky, T. Goos, L. Nunes	2014-03-13
0.3	Review	Russell Stringer, I. Zahumensky, T. Goos, L. Nunes	2014-04-03
0.4	Final editorial	I. Zahumensky	2014-04-09
0.5	Feedback from all TCs, EC-PORS, TT-WQM, Secretariat	R. Stringer, T. Goos, L.P. Riishojgaard, I. Zahumensky	2014-08-07
0.6	Minor editorial	I. Zahumensky	2014-08-08
0.7	Feedback from Secretariat, and editorial	R. Stringer, M. Ondras, L.P. Riishojgaard, I. Zahumensky	2014-08-27
0.8	Feedback from CBS-Ext.(2014)	L.P. Riishojgaard	2014-09-11
0.9	Feedback by Members, and editorial	WIGOS-PO	26-01-2015

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TECHNICAL REGULATIONS

GENERAL PROVISIONS

VOLUME I – General Standards and Recommended Practices (2015 edition)

PART I WMO Integrated Global Observing System (WIGOS)

TECHNICAL REGULATIONS

GENERAL PROVISIONS

Note: These sections will be provided in the overall Volume I.

DEFINITIONS

Note 1: Other definitions may be found in the *Manual on Codes* (WMO-No. 306), *Manual on the Global Data Processing and Forecasting System* (WMO-No. 485), Volume I, *Manual on the Global Telecommunication System* (WMO-No. 386), Volume I and other WMO publications.

Note 2: These definitions will be added to the definitions provided by other Parts to the full definition set for Volume I.

The following terms, when used in the Volume I of the Technical Regulations, have the meanings given below.

Aircraft meteorological station. Meteorological station situated aboard an aircraft.

Antarctic Observing Network. Comprises all operational networks in Antarctica.

Calibration (rating).

- Experimental determination of the relationship between the quantity to be measured and the indication of the instrument, device or process which measures it.
- Process of relating the indicated response of an instrument to its actuating signal, or to the true value obtained independently; it is usually carried out at several points in the instrument's measurement range.

Climatological station. (1) Station from which climatological data are obtained. (2) Surface station at which observations of specified elements are made primarily for climatological purposes.

Compatibility. A state in which two things are able to exist and be used together without problems or conflict.

Cryosphere. Component of the Earth System that includes solid precipitation, snow cover, sea ice, lake and river ice, glaciers, ice caps, ice sheets, permafrost, and seasonally frozen ground.

Note: While elements of the cryosphere are often defined to contain frozen water, permafrost can be “dry”. The Global Cryosphere Watch (GCW) definition includes elements of the cryosphere that occur on or beneath the Earth’s surface, or that are measured at the surface in the case of solid precipitation. It therefore excludes ice clouds.

Global Cryosphere Watch (GCW) Observing Network. Comprised of GCW sites with varying capabilities built on existing observing programmes and promoting the addition of standardized cryospheric observations to existing facilities. It covers all components of the cryosphere: glaciers, ice shelves, ice sheets, snow, permafrost, sea ice, river/lake ice, and solid precipitation.

CryoNet. The core of the GCW observing network that applies GCW agreed observing practices. It comprises sites in cold climate regions, on land or sea, operating a sustained, standardized programme for observing and monitoring as many cryospheric variables as possible. CryoNet is being structured in two different classes of observational sites: Basic Sites and Integrated Sites. CryoNet Sites contain one or more CryoNet Stations: Primary Stations and Baseline Stations.

Discovery metadata. Metadata consistent with the standard that is used within WMO Information System (WIS) for discovery of information shared through WIS.

Framework. A set of principles, ideas, guidelines and provisions to enable decisions, judgments and operations.

Geostationary Earth Orbit (GEO). Satellites in geostationary Earth orbits are often referred to as GEOs.

Geostationary satellite. Meteorological satellite orbiting the Earth at an altitude of approximately 36 000 km with the same angular velocity as the Earth and within the equatorial plane, thus providing nearly continuous information in an area within a range of about 50° from a fixed sub-satellite point at the Equator.

Global Climate Observing System (GCOS). A long-term, user-driven operational system capable of providing the comprehensive observations required for:

- Monitoring the climate system,
- Detecting and attributing climate change,
- Assessing impacts of, and supporting adaptation to, climate variability and change,
- Application to national economic development,
- Research to improve understanding, modelling and prediction of the climate system.

Instrument. Device used for making measurements, alone or in conjunction with one or more supplementary devices.

In situ observation. Observation made by a device that is in physical or direct contact with the object or phenomenon under study.

Interoperability. The ability of diverse systems to work together (inter-operate).

Low Earth Orbits (LEO). An orbit with an altitude between 160 kilometres (99 mi), with a period of about 88 minutes, and 2,000 kilometres (1,200 mi), with a period of about 127 minutes.

Meteorological observation. Evaluation or measurement of one or more meteorological elements.

Meteorological observing network. A group of meteorological observing stations spread over a given area for a specific purpose.

Meteorological observing station (Meteorological station). Place where meteorological observations are made with the approval of the WMO Member or Members concerned.

Meteorological report (Report). Statement of observed meteorological conditions related to a specific time and location.

Near-polar orbiting satellite. A meteorological satellite with a nearly circular, nearly polar orbit. The combination of satellite motion and the Earth’s rotation beneath the orbit provides overlapping strips of satellite data covering swaths (up to 3000 km) from pole to pole. The satellite's altitude can be chosen within a wide range (600 to 1500 km) in order to provide data over the entire globe twice a day.

Observation. Evaluation of one or more elements of the physical environment.

Note: Observations are level II data and may be obtained directly or derived, as defined in the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485, 2010 edition), Volume I – Global Aspects

Observational data. The result of the evaluation of one or more elements of the physical environment.

Observational Metadata. Descriptive data about observational data; information that is needed to assess and interpret observations or to support design and management of observing systems and networks.

Observation network. One or more sensors, instruments or types of observation at more than one station or platform, acting together to provide a coordinated set of observations.

Observing station/platform. A place where observations are made; it refers to all types of observing stations and platforms, whether they are surface-based, or space-based, on land, at sea/lake/river, or in the air, fixed, or mobile (including in the air), and making in-situ or remote observations.

Note: The owner and operator of an observing platform may be a National Meteorological and/or Hydrological Service, another agency or organization (either governmental, non-governmental or commercial) or an individual.

Observing (or Observation) system. A coordinated system of methods, techniques and facilities for making observations using one or more sensors, instruments or types of observation at one or more stations and platforms, acting together to provide a coordinated set of observations.

Near-real-time observation. An observation which is available to a user soon after the observation is completed.

Note: The time-lags considered to be “real-time”, “near-real-time” or "non-real-time" are different in different situations and depend on several factors. A near-real-time observation is essentially a real-time observation with an identifiable delay which reduces its value to some users.

Non-real-time observation. An observation which is not available to a user immediately or soon after the observation is completed, but at some later time. It informs the user of conditions that prevailed at an earlier time.

Note: The time-lags considered to be “real-time”, “near-real-time” or "non-real-time" are different in different situations and depend on several factors. Factors include the user application, the dissemination method, intervening quality control or other processing steps, the frequency and sampling time of the observation, and the variability of the physical element observed.

Real-time observation. An observation which is available to a user immediately after the observation is completed. It informs the user of the current conditions.

Note: The time-lags considered to be “real-time”, “near-real-time” or "non-real-time" are different in different situations and depend on several factors. A key factor is the requirement of the user application, such that an observation not available quickly enough for immediate operational use (within seconds, or minutes, or hours, or for some applications days) might not be regarded as real-time for that application. Some other factors are whether the dissemination method used is the most direct and rapid possible, whether quality control or other processing steps delay availability, whether the time lag is reasonably proportionate to the frequency of observation or the sampling time taken to collect the observation, and whether the time lag is reasonably proportionate to the variability of the physical element observed.

Remote sensing. Observation made by a device that is not in physical or direct contact with the object or phenomenon under study.

Satellite systems. A space system using one or more artificial satellites orbiting the Earth.

System. Assembly of objects, processes or concepts, most often interacting with each other, which are focused on or result in a specific outcome.

WMO Observing station/platform. Any observing station/platform currently issued with a valid WMO identifier.

WMO Observing system/observations network. An observing system/observations network consisting of WMO stations and platforms.

WMO Observation. An observation made at a WMO observing station/platform.

1. INTRODUCTION TO WIGOS

1.1 Purpose and Scope of WIGOS

1.1.1 The WMO Integrated Global Observing System (WIGOS) shall be a framework for all WMO observing systems and the contributions of WMO to co-sponsored observing systems in support of all WMO Programmes and activities.

Note: The co-sponsored observing systems are the WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS), the WMO-IOC-UNEP-ICSU Global Ocean Observing System (GOOS) and the WMO-IOC-UNEP-ICSU Global Terrestrial Observing System (GTOS).

1.1.2 The WIGOS shall facilitate the use by WMO Members of observations from systems that are owned, managed and operated by a diverse array of organizations and programmes.

1.1.3 The principal purpose of WIGOS shall be to meet the evolving requirements of Members for observations.

Note: The assessments of requirements and plans to meet them are achieved through the application of the Rolling Review of Requirements (RRR) process according to the Manual on WIGOS (WMO-No. XXXX), section 2.2.

1.1.4 Within WIGOS, Members shall collaborate to advance the state of observing systems, their compatibility and the worldwide exchange of observations.

Note: Additional benefits will emerge as the concept is adopted by entities beyond WMO itself and its partner organizations.

1.1.5 Members should enhance collaboration and cooperation amongst meteorological, hydrological, marine, oceanographic and other related academic and research institutions and services at the national level, in order to meet the goals listed in 1.1.3.

1.1.6 The WIGOS framework shall focus on the integration of governance and management functions, mechanisms and activities to be accomplished by contributing observing systems on a global, regional and national level.

1.2 WIGOS component observing systems

1.2.1 The component observing systems of WIGOS shall comprise the Global Observing System (GOS) of the World Weather Watch (WWW) Programme, the observing component of the Global Atmosphere Watch (GAW) Programme, the WMO Hydrological Observing System (WHOS) of the Hydrology and Water Resources Programme (HWRP) and the observing component of the Global Cryosphere Watch (GCW), including their surface-based and space-based components.

Note: The above component systems include all WMO contributions to the co-sponsored systems, as well as the WMO contributions to the Global Framework for Climate Services (GFCS) and Global Earth Observation System of Systems (GEOSS).

1.2.1 Global Observing System of the World Weather Watch

1.2.1.1 The Global Observing System (GOS) shall be a coordinated system of networks of observing stations and platforms, together with methods, techniques, facilities and arrangements for making observations on a worldwide scale and defined as one of the main components of the World Weather Watch Programme.

1.2.2 Global Atmosphere Watch (observing component)

1.2.2.1 The Global Atmosphere Watch (GAW) shall be a coordinated system of networks of observing stations, methods, techniques, facilities and arrangements encompassing the many monitoring and related scientific assessment activities devoted to the investigation of the changing chemical composition and related physical characteristics of the global atmosphere.

1.2.3 WMO Hydrological Observing System

1.2.3.1 The WMO Hydrological Observing System (WHOS) shall comprise hydrological observations, initially focusing on water level and discharge, and shall include the World Hydrological Cycle Observing System programme (WHYCOS) intended to improve basic observation activities, strengthen international cooperation and promote the free exchange of data in the field of hydrology.

Note: The composition of WMO hydrological observations is provided in Volume III – Hydrology, Chapter D.1.2 of the WMO *Technical Regulations* (WMO-No. 49).

1.2.3.2 The purpose of the WHOS shall be to provide real time streamflow data (both water level and discharge) from participating National Hydrological Services.

1.2.3.3 Members providing hydrological observations to the WHOS shall operate in accordance with the procedures and practices set out in the following sections (2, 3, 4 and 7) of Volume I, Part I.

1.2.4 Global Cryosphere Watch (observing component)

1.2.4.1 The Global Cryosphere Watch (GCW) shall be a coordinated system of networks of observing stations, methods, techniques, facilities and arrangements encompassing monitoring and related scientific assessment activities devoted to the investigation of the changing Cryosphere.

1.2.4.2 The GCW observing network and its standardized core network (CryoNet) shall build on existing observing programmes and promote the addition of standardized cryospheric observations to existing facilities.

Note 1: The GCW Implementation Plan available at: http://globalcryospherewatch.org/reference/documents/ provides more information.

Note 2: Existing Cryosphere observing programmes include cryospheric observational programmes within WMO Programmes (including the Joint WMO/IOC Technical Commission on Oceanography and Marine Meteorology (JCOMM)), the co-sponsored Programmes (GCOS, GTOS, GOOS) and including, but are not limited to, observational programmes of the International Permafrost Association (IPA), the World Glacier Monitoring Service (WGMS), a service of the International Association of Cryospheric Sciences (IACS), the Scientific Committee for Antarctic Research (SCAR), and the Global Precipitation Climatology Centre (GPCC), and the US National Snow and Ice Data Center (NSIDC).

1.3 Collaboration with partners responsible for co-sponsored and non-WMO observing systems

1.3.1 Members shall support the collaboration between the WMO and its international partners responsible for the co-sponsored and non-WMO observing systems.

1.3.2 Members shall implement similar cooperation and coordination arrangements among National Meteorological and Hydrological Services (NMHSs) and through national mechanisms for GFCS, GCOS, GOOS, GTOS, and GEOSS.

1.4 Governance and management

Note: WIGOS implementation is an integrating activity for all WMO and co-sponsored observing systems: it supports all WMO Programmes and activities. The Executive Council and regional associations, supported by their respective working bodies, have a governing role in the implementation of WIGOS. Technical aspects of WIGOS implementation are guided by the technical commissions, with leadership provided through CBS and CIMO.

1.4.1 Members shall implement and manage their national observing systems in accordance with the provisions of the Technical Regulations, Volume I, Part I, and the Manual on WIGOS (WMO-No. XXXX).

2. COMMON ATTRIBUTES OF WIGOS COMPONENT SYSTEMS

2.1. Requirements

2.1.1 Members shall establish, operate and maintain their national observing systems to address observational requirements in an integrated, coordinated and sustainable manner.

2.1.2 Members shall convey their observational user requirements, for each of the WMO application areas, to the Rolling Review of Requirements (RRR) process.

Note: Details on the Rolling Review of Requirements (RRR) process and the WMO application areas are given in the Manual on WIGOS (WMO-No. XXXX), section 2.2.

2.2. Design, Planning and Evolution

2.2.1 General

2.2.1.1 Members, both directly and through the participation of their experts in the activities of regional associations and technical commissions, shall contribute to the Rolling Review of Requirements (RRR) process.

2.2.1.2 Members should implement the plans published by WMO for evolution of WIGOS component observing systems when planning and managing their observing systems.

2.2.1.3 Members shall maintain close coordination with their national telecommunication authorities to register their frequencies for adequate protection and to defend the availability of frequencies for all WIGOS component observing systems.

2.3. Instrumentation and Methods of Observation

2.3.1 General

Note: Standard and recommended practices and procedures with respect to instruments and methods of observation across and within all WIGOS component observing systems are specified in the *Technical Regulations* (WMO-No. 49), Volumes I – III, and detailed in the Manual on WIGOS (WMO-No. XXXX).

2.4 Operations

2.4.1 General Requirements

2.4.1.1 Members shall install, operate and maintain their WIGOS component observing systems in accordance with the *Technical Regulations* (WMO-No. 49, Volumes I-IV), and the Manual on WIGOS (WMO-No. XXXX).

2.4.1.2 Members shall ensure the continuity of operation and availability of observations generated by the observing systems under their responsibility.

2.4.1.3 Members shall ensure that proper safety practices and procedures for operation of observing systems are specified, documented and utilized.

Note: Safety practices and procedures are those that are concerned with assuring the welfare of staff while promoting overall efficiency and effectiveness of the NMHS and responding to national laws, regulations and requirements for occupational health and safety.

2.4.2 Observations

2.4.2.1 Members shall ensure overall availability of observations for all WMO Application Areas in accordance with these Technical Regulations and the Manual on WIGOS (WMO-No. XXXX).

Note 1: The WMO Application Areas are detailed in section 2.1 of the Manual on WIGOS (WMO-No. XXXX).

Note 2: Special focus is to be given to meet the requirements of numerical weather prediction since many application areas depend on it.

Note 3: Special focus is to be given to climate monitoring, including the observational requirements of the Global Framework for Climate Services, which is one of the priority areas for WMO.

2.4.2.2 Members should ensure timely, quality-assured, quality-controlled, and well-documented compatible long-term observations in accordance with the practices and procedures specified in these Technical Regulations and the Manual on WIGOS (WMO-No. XXXX).

Note: Technical specifications and details are given mainly in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), *Guide to Climatological Practices* (WMO-No. 100), *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information, *Guide on the Global Data-Processing Systems* (WMO-No. 305), and *Guide to the Global Observing System* (WMO-No. 488).

2.4.3 Performance

2.4.3.1 Members shall continuously monitor the performance of their observing systems.

2.4.3.2 Members should maintain records of the performance monitoring as part of their Quality Management System, for auditing purposes, where appropriate, in accordance with section 2.6 of these Technical Regulations and the Manual on WIGOS (WMO-No. XXXX).

Note: Technical specifications and details are given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), *Guide to Climatological Practices* (WMO-No. 100), *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information, and *Guide to the Global Observing System* (WMO-No. 488).

2.4.4 Quality Control

2.4.4.1 Members shall implement quality control for all observations for which they are responsible.

Note: Minimum set of standards of quality control for meteorological data are specified in the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), Volume I.

2.4.4.2 Members not capable of implementing quality control should establish agreements with an appropriate national, regional or global organization or centre to perform the necessary quality control.

2.4.5 Calibration

2.4.5.1 Members shall perform calibration of their systems and instruments traceable to an international standard in accordance with the Manual on WIGOS (WMO-No. XXXX).

2.5. Observational Metadata

2.5.1 Members shall record, retain and make available internationally the observational metadata as specified in the Manual on WIGOS (WMO-No. XXXX), section 2.5.

2.6. Quality Management

2.6.1 Members shall comply with the standard and recommended practices and procedures with regard to the quality of WIGOS observations and observational metadata, as detailed in these Technical Regulations and in the Manual on WIGOS (WMO-No. XXXX).

Note: Provisions relating to the WMO Quality Management Framework are provided in the *Technical Regulations* (WMO-No. 49), 2011 edition, Volume IV – Quality Management (WMO-No. 49), 2011 edition.

2.7. Capacity Development

2.7.1 General

2.7.1.1 Members should undertake efforts in capacity development to ensure that their observing systems comply with the standard and recommended practices and procedures specified by the WMO *Technical Regulations* (WMO-No. 49).

Note: Guidance on approaches for capacity development is found in the *WMO Capacity Development Strategy* (WMO-No. 1092) and its *Implementation Plan* (WMO-No. 1118). Such guidance includes consideration of various types of capacity: institutional, infrastructural, procedural and human resources.

2.7.2 Training

2.7.2.1 Members shall ensure that their personnel involved in WIGOS-related activities are educated and trained to comply with the WIGOS standard and recommended practices and procedures.

Note: Extensive provisions applicable to the education and training of personnel are defined in Part V and Part VI of these Technical Regulations, and the *Manual on the Implementation of Education and Training Standards in Meteorology and Hydrology* (WMO-No. 1083), Volume I.

2.7.3 Infrastructural Capacity Development

2.7.3.1 Members should regularly review their observing infrastructure and pursue capacity development activities to upgrade them, as required to address the priorities for evolution of observing systems identified through the Rolling Review of Requirements process as well as any additional national priorities.

Note: The Rolling Review of Requirements process and the resulting priorities for evolution of observing systems are described in section 2.2 above.

3. ATTRIBUTES SPECIFIC TO THE SURFACE-BASED SUB-SYSTEM OF WIGOS

3.1. Requirements

3.1.1 General

3.1.1.1 The WIGOS surface-based sub-system shall be composed of stations and platforms within the component networks (i.e. GOS, GAW, GCW, and WHOS) as described in the Manual on WIGOS (WMO-No. XXXX).

3.1.1.2 Members should establish and operate their surface-based sub-system as a single composite system of observing stations and platforms.

3.1.2 Observational requirements

3.1.2.1 Members shall establish, operate, and maintain surface-based observing systems to meet the requirements of the WMO Application Areas, in accordance with section 2.1 of the Manual on WIGOS (WMO-No. XXXX).

3.2. Design, planning and evolution

3.2.1 General

3.2.1.1 Members shall plan, implement, operate and maintain national networks and observing programmes based on the standard and recommended practices and procedures as stated in the WMO Technical Regulations, including the Manual on WIGOS (WMO-No. XXXX).

Note: Members are urged to take into account various plans and strategies developed by WMO for WIGOS and the component observing systems.

3.2.1.2 Members should cooperate to address regional implementation of observing networks or systems.

3.2.1.3 Members should adopt a composite network approach to their networks and include observations from a range of sources, including NMHSs and other government agencies, academic and research institutes, the commercial sector and the public.

Note 1: The composite network approach here means the use of various types of observing systems or sources of observations to deliver a combined set of observations.

Note 2: In all cases users are to judge the suitability of observations for their intended application, through assessment of available metadata, which includes the identification of the source. Section 2.5 of the Manual on WIGOS (WMO-No. XXXX) describes the required metadata.

3.3. Instrumentation and Methods of Observation

3.3.1 General

Note: Standard and recommended practices and procedures with respect to instruments and methods of observation for all WIGOS surface-based sub-systems are specified in the *Technical Regulations* (WMO-No. 49), Volumes I – III, and detailed in the Manual on WIGOS (WMO-No. XXXX).

3.4. Operations

3.4.1 General

3.4.1.1 Members should ensure that operators of observing systems comply with the WMO *Technical Regulations* (WMO-No. 49, Volumes I-IV) and the Manual on WIGOS (WMO-No. XXXX).

Note: System operators are generally NMHSs or other organizations within WMO Member countries but are sometimes other entities.

4. ATTRIBUTES SPECIFIC TO THE SPACE-BASED SUB-SYSTEM OF WIGOS

4.1 Scope, purpose and operation of the space-based sub-system

4.1.1 General

Note: Space-based observations, i.e. data obtained from satellite systems, are a fundamental asset for meteorology, climatology and hydrology, both for operational and research applications.

4.1.2 Observational requirements

4.1.2.1 Satellite operators shall establish, operate, maintain and ensure the continuation of satellite systems, providing observational information as specified in the Manual on WIGOS (WMO-No. XXXX).

Note 1: The term “satellite operators” is used in Vol. I. Part I to refer to “Members or a coordinated group of Members operating environmental satellites”.

Note 2: A coordinated group of Members operating environmental satellites is a group of Members acting jointly to operate one or more satellites through an international space agency such as the European Space Agency or EUMETSAT.

4.1.2.2 To ensure global coverage, contingency support and to meet further requirements as stated in the Manual on WIGOS (WMO-No. XXXX), satellite operators shall cooperate and arrange an optimal constellation of satellite systems, including but not restricted to near-polar-orbiting and geostationary platforms.

Note: These requirements are compiled through the Rolling Review of Requirements (RRR) process (see the Manual on WIGOS (WMO-No. XXXX), section 2.2.), and are expressed in terms of coverage, continuity, resolution, uncertainty, frequency and observational variables.

4.1.2.3 Satellite operators shall process observational data up to a level as required by the Manual on WIGOS (WMO-No. XXXX) and shall do so in a timely manner for dissemination in near real-time.

4.1.2.4 Satellite operators shall report data as observed variables, defined in the Manual on WIGOS (WMO-No. XXXX) and expressed by environmental quantities in International Standards (SI) units.

5. ATTRIBUTES SPECIFIC TO THE GLOBAL OBSERVING SYSTEM OF THE WORLD WEATHER WATCH

5.1 The purpose of the Global Observing System (GOS) shall be to provide the meteorological and related environmental observations from all parts of the globe that are required by Members for operational and research purposes.

5.2 The Global Observing System shall be constituted as a coordinated system of methods, techniques and facilities for making observations on a worldwide scale and defined as one of the main components of the World Weather Watch.

5.3 The Global Observing System shall be composed of integrated sub-systems: the surface-based sub-system and the space-based sub-system.

5.4 The surface-based sub-system shall be composed of the regional basic synoptic networks and the Antarctic Observing Network of surface and upper-air stations, climatological stations, Global Climate Observing System stations, aircraft meteorological stations, and other types of stations and special stations as detailed in the *Manual on the Global Observing System* (WMO-No. 544), Volume I.

5.5 The space-based sub-system shall be composed of three elements: (a) a space segment with: (i) operational satellites on Geostationary Earth Orbit (GEO); (ii) operational satellites on distributed, sun-synchronous, Low Earth Orbits (LEO); (iii) other operational or sustained satellites or instruments on appropriate orbits; (iv) research and development (R&D) satellites; (b) an associated ground segment for data reception, dissemination, and stewardship; and (c) a user segment.

5.6 The Global Observing System shall be established and operated in accordance with the provisions set out in the *Manual on the Global Observing System* (WMO-No. 544), Volume I, Manual on WIGOS (WMO-No. XXXX), and in the *International Cloud Atlas* (WMO-No. 407), Volume I – *Manual on the Observation of Clouds and Other Meteors*.

6. ATTRIBUTES SPECIFIC TO THE OBSERVING COMPONENT OF THE GLOBAL ATMOSPHERE WATCH

6.1 The purpose of the Global Atmosphere Watch (GAW) shall be to:

(a) Reduce environmental risks to society and meet the requirements of environmental conventions;

(b) Strengthen capabilities to predict climate, weather and air quality;

(c) Contribute to scientific assessments in support of environmental policy.

through:

(a) Maintaining and applying global, long-term observations of the chemical composition and selected physical characteristics of the atmosphere;

(b) Emphasizing quality assurance and quality control;

(c) Delivering integrated products and services of relevance to users.

6.2 The Global Atmosphere Watch observational network shall be developed and implemented in accordance with the provisions set out in the Manual on WIGOS (WMO-No. XXXX).

6.3 The Global Atmosphere Watch observations shall be carried out in accordance with the provisions set out in the Manual on WIGOS (WMO-No. XXXX) and the *Manual on the Global Observing System* (WMO-No. 544), Volume I.

Note 1: Members may perform observations of any of the parameters included in the GAW focal areas: ozone, greenhouse gases, reactive gases, aerosols, UV radiation and precipitation chemistry, using observation modes such as in situ, vertical distribution and total column.

Note 2: Members may use different platforms or their combinations, e.g. fixed stations, mobile platforms and remote sensing to perform atmospheric composition measurements.

6.4. Members shall register their contribution in the GAW Station Information System (GAWSIS), and submit their observations to the relevant GAW Data Centre.

Note: GAW Data Centres are listed at: http://www.wmo.int/gaw and http://gaw.empa.ch/gawsis.

7. ATTRIBUTES SPECIFIC TO THE WMO HYDROLOGICAL OBSERVING SYSTEM

7.1 The purpose of the WMO Hydrological Observing System (WHOS) shall be to provide the hydrological observing component in fulfilment of the WIGOS objective by facilitating online access to already available real-time and historical data, drawing from the water information systems of Members that make their data available on a free and unrestricted basis.

7.2 The WMO Hydrological Observing System shall be constituted as a coordinated system of methods, techniques and facilities for making hydrological observations on a worldwide scale.

7.3. The WMO Hydrological Observing System and the practice of obtaining hydrological observations shall be developed and implemented in accordance with the provisions set out in the Manual on WIGOS (WMO-No. XXXX).

8. ATTRIBUTES SPECIFIC TO THE OBSERVING COMPONENT OF THE GLOBAL CRYOSPHERE WATCH

8.1 The purpose of the Global Cryosphere Watch (GCW) shall be to provide data and other information on the cryosphere from a local to the global scale to improve understanding of its behaviour, interactions with other components of the climate system, and impacts on society.

8.2 The observing component of the Global Cryosphere Watch shall be a coordinated system of observing stations, facilities and arrangements encompassing monitoring and related scientific assessment activities devoted to the Cryosphere.

8.3 The development of the GCW observing network and its core network (CryoNet) that applies GCW agreed practices and standards shall build on existing observing programmes and promote the addition of standardized cryospheric observations to existing facilities.

8.4 The Global Cryosphere Watch observing network shall be developed and implemented in accordance with the provisions set out in the Manual on WIGOS (WMO-No. XXXX)

Note 1: Members may perform observations of any of the parameters describing the state of the GCW cryospheric components (snow, solid precipitation, permafrost, glaciers and ice caps, ice sheets, sea ice, lake and river ice).

Note 2: Members may use different platforms or their combinations (fixed stations, mobile platforms, virtual sites and remote sensing) to perform cryospheric measurements.

8.5 For all stations and platforms which provide GCW observations, Members shall register the station in the GCW station information system at the GCW website (www.globalcryospherewatch.org), and submit those observations to the GCW Portal.

Resolution 26 (Cg-17)

TECHNICAL REGULATIONS (WMO-No. 49) – MANUAL ON THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

Noting:

(1) Articles 2 (a), 2 (c) and 8 (d) of the Convention of the World Meteorological Organization,

(2) Resolution 45 (Cg-XVI) – Technical Regulations of the World Meteorological Organization,

(3) Resolution 50 (Cg-XVI) – Implementation of the WMO Integrated Global Observing System,

(4) Resolution 26 (EC-64) – Amendments to the Technical Regulations,

(5) Recommendation 11 (CBS-Ext.(2014)) – Revised *Manual on the Global Observing System* (WMO-No. 544), and the synchronization of revisions with those in the Manual on the WMO Integrated Global Observing System (WIGOS), leading to the eventual phasing out of the *Manual on the Global Observing System*,

(6) Recommendation 16 (CBS-Ext.(2014)) – Regulatory material of the WMO Integrated Global Observing System,

(7) Resolution 23 (Cg-17) – Pre-operational phase of the WMO Integrated Global Observing System,

(8) Resolution 25 (Cg-17) –*Technical Regulations* (WMO-No. 49), Volume I, Part I – WMO Integrated Global Observing System,

Recalling that the Sixteenth World Meteorological Congress emphasized that the implementation of WIGOS must be reflected in the revised *Technical Regulations*, documenting the WIGOS concept of operations and contributions of all observing components,

Considering the draft Manual on the WMO Integrated Global Observing System recommended by the Commission for Basic Systems for adoption by the World Meteorological Congress,

Noting that the draft Manual was circulated to all Members and their comments were incorporated accordingly,

Decides to approve the Manual, as provided in the annex to the present resolution, with effect from 1 July 2016;

Affirms the authority of the Executive Council to approve any amendments to the Manual if required before Eighteenth Congress;

Further decides:

(1) That the Commission for Basic Systems, in collaboration with other technical commissions, shall act as the lead technical commission for managing changes to the Manual;

(2) That the simple, standard and complex procedures defined in Recommendation 15 (CBS Ext.(2014)) – Procedures for maintaining Manuals and Guides managed by the Commission for Basic Systems, shall also apply to maintaining the Manual;

Requests the Secretary-General:

(1) To publish the Manual in all WMO official languages;

(2) To ensure the editorial consistency of the relevant documents;

(3) To bring the present resolution to the attention of all concerned.

Annex to Resolution 26 (Cg-17)

TECHNICAL REGULATIONS (WMO-No. 49), MANUAL ON THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM

WORLD METEOROLOGICAL ORGANIZATION

MANUAL ON THE WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

Annex IX to the WMO Technical Regulations

(2015 edition)

(Version 0.11)

WMO-No. XXXX

VERSION CONTROL

Version	Summary of change	By	Date
0.1	first full compilation of (mostly) completed and reviewed sections, for presentation to ICG-WIGOS-3	Chair TT-WRM	2014-02-06
0.2.0	Review of 2.6	T. Goos, L. Nunes	2014-02-19
0.2.1	Comments on the review of 2.6	I. Zahumensky	2014-02-25
0.2.2	Review	T. Goos, L. Nunes	2014-03-10
0.2.3	Final review	I. Zahumensky	2014-03-13
0.2.4	Review	I. Zahumensky, T. Goos, L. Nunes	2014-03-21
0.3	Review	R. Stringer, I. Zahumensky, T. Goos	2014-04-04
0.3.1	Re-attached draft content for Appendix 2.3 (clearly labelled as “indicative only – final draft pending”)	R. Stringer	2014-04-06
0.4	Revised version	R. Stringer, I. Zahumensky, T. Goos, L. Nunes	2014-04-09
0.5	Updated Appendix 2.3; “WIGOS Core Metadata” was replaced by “WIGOS Metadata Standard” in the whole document; Provision 2.5.1.1, Note 2	WIGOS-PO	2014-06-30
0.6	Minor editorial	WIGOS-PO	2014-07-15
0.7	Feedback from all TCs, EC-PORS, TT-WQM, Secretariat	R. Stringer, T. Goos, L.P. Riishojgaard, I. Zahumensky	2014-08-07
0.8	Minor editorial	I. Zahumensky	2014-08-08
0.9	Feedback from Secretariat (DPMU, OBS) and editorial	R. Stringer, M. Ondras, L.P. Riishojgaard, I. Zahumensky	2014-08-27
0.10	Feedback from CBS-Ext.(2014)	L.P. Riishojgaard	2014-09-11
0.11	Feedback by Members, and editorial	WIGOS-PO	26-01-2015

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INTRODUCTION

PURPOSE AND SCOPE

1. The Manual is designed:
(a) To specify obligations of Member countries in the implementation and operation of the WIGOS;
(b) To facilitate cooperation in observations between Member countries;
(c) To ensure adequate uniformity and standardization in the practices and procedures employed in achieving (a) and (b) above.

2. The Manual is an Annex to the WMO Technical Regulations and should be read in conjunction with the four Volumes and the set of Annexes which together comprise the Technical Regulations. In particular the *Manual on the GOS* (WMO-No. 544) is closely related and will over time disappear as its content is progressively moved into this Manual.

3. Members will implement and operate their observing systems in accordance with decisions of Congress, the Executive Council, the technical commissions and regional associations. Where those decisions are technical and regulatory in nature, they will in due course be documented in the Technical Regulations.

4. This is the first edition of the Manual on the WMO Integrated Global Observing System (WIGOS), developed following the decision of the Sixteenth World Meteorological Congress to proceed with the implementation of WIGOS, approved by the Seventeenth World Meteorological Congress and issued as the 2015 edition.

5. The Manual was developed by the Executive Council through its Inter-Commission Coordination Group on WIGOS (ICG-WIGOS), specifically its Task Team on WIGOS Regulatory Material (TT-WRM). This represents a collaborative approach involving all interested technical commissions under the technical leadership provided through CBS and CIMO.

6. Gradually, all technical regulations for all WMO component observing systems will be included under the identity of WIGOS. For reasons of practicality, the *Manual on the GOS* (WMO-No. 544) is a companion to this Manual during a certain period. However all the practices will over time be described in this Manual.

7. In essence, the Manual specifies what is to be observed, following what practices and procedures, in order to meet the relevant observational requirements of Members. These requirements may arise directly at a national level or collectively through WMO Programmes at global or regional levels, and are expressed through the Application Areas of the Rolling Review of Requirements process. A number of other Manuals and Guides provide more practices and procedures on the operation of observing systems including stations and platforms, instruments and methods of observation, and the reporting and management of observation and observational metadata.

TYPES OF REGULATION

8. The Manual comprises ***standard*** practices and procedures (**standards**), and ***recommended*** practices and procedures (**recommendations**). The definitions of these two types are as follows:

9. The ***standard*** practices and procedures:
(a) Are those practices and procedures which it is ***necessary*** that Members follow or implement; and therefore
(b) Have the status of ***requirements*** in a technical resolution in respect of which ***Article 9 (b)*** of the Convention is ***applicable***; and
(c) Are invariably distinguished by the use of the term ***shall*** in the English text and by suitable equivalent terms in the Arabic, Chinese, French, Russian and Spanish texts.

10. The ***recommended*** practices and procedures:

(a) Are those practices and procedures which it is ***desirable*** that Members follow or implement; and therefore

(b) Have the status of ***recommendations*** to Members to which ***Article 9 (b)*** of the Convention ***shall not be applied***; and

(c) Are distinguished by the use of the term ***should*** in the English text (except where specifically otherwise provided by decision of Congress) and by suitable equivalent terms in the French, Russian and Spanish texts.

11. In accordance with the above definitions, Members shall do their utmost to implement the standard practices and procedures. In accordance with Article 9 (b) of the Convention and in conformity with the provisions of Regulation 128 of the General Regulations, Members shall formally notify the Secretary-General, in writing, of their intention to apply the "standard practices and procedures" of the Manual, except those for which they have lodged a specific deviation. Members shall also inform the Secretary-General, at least three months in advance, of any change in the degree of their implementation of a "standard practice or procedure" as previously notified and of the effective date of the change.

12. In the case of hydrological observations, there is not a widely implemented base of global exchange and global standard practices and procedures. Technical Regulations Volume III - Hydrology provides Members with predominantly recommended practices and procedures to be followed. In order to help ensure the quality and comparability of observations within WIGOS, Members making their hydrological observations available through the WMO Hydrological Observing System (WHOS) are requested to comply with the provisions specified within this Manual. For this reason, a number of provisions listed herein which are recommended practices and procedures for hydrology in Technical Regulations Volume III – Hydrology have become standard practices and procedures, similar to efforts made by Members for the other WIGOS component observing systems. It is recognized that some of the WIGOS standard practices and procedures might not easily be widely and quickly implemented by all Members for their hydrological observations. Nonetheless, Members are urged to make their best efforts to implement the WIGOS standard practices and procedures in the collection and exchange of hydrological observations and to make such observations available through WHOS.

13. With regard to the recommended practices and procedures, Members are urged to comply with these, but it is not necessary to notify the Secretary-General of non-observance.

14. In order to clarify the status of the various regulatory material, the standard practices and procedures are distinguished from the recommended practices and procedures by a difference in typographical practice, as indicated in the Editorial note.

APPENDICES

15. Material presented in Appendices has full status as part of the Technical Regulations. Appendices are used where a set of provisions on a single topic might, due to their detailed nature and length, otherwise interrupt the flow of the relevant section of this Manual. Also, Appendices are used to facilitate the ongoing review and update process by identifying sub-sections which fall under the specific responsibility of a particular group.

NOTES AND ATTACHMENTS

16. Notes and Attachments are included in the Manual for explanatory purposes. They do not have the status of WMO Technical Regulations.

17. The words "shall" and "should" in any notes and attachments have their dictionary meanings and do not have the regulatory character of standard and recommended practices and procedures mentioned above.

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DEFINITIONS

Note 1: Other definitions related to observing systems may be found in the Volume I of the WMO Technical Regulations and the *Manual on the GOS* (WMO-No. 544). Definitions are not duplicated between Manuals hence it is important to consult all documents.

Note 2: Further definitions may be found in the *Manual on Codes* (WMO-No. 306), *Manual on the Global Data Processing and Forecasting System* (WMO-No. 485), Volume I, *Manual on the Global Telecommunication System* (WMO-No. 386); Volume I, and other WMO publications.

Note 3: Definitions, terminology, vocabulary and abbreviations used in relation to quality management are those of the ISO 9000 family of standards for quality management systems, in particular those identified within ISO 9000:2005, Quality Management Systems – Fundamentals and vocabulary.

The following terms, when used in the *Manual on WIGOS* (WMO-No. XXXX), have the meanings given below.

Accuracy. The extent to which the results of the readings of an instrument approach the true value of the calculated or measured quantities, supposing that all possible corrections are applied.

Accreditation. The formal recognition by an independent body, that the staff has been trained and have mastered the processes to meet the requirements. Accreditation is not mandatory but it adds another level of confidence, as 'accredited' means the certification body has been independently checked to make sure it operates according to international standards.

Acoustic Doppler Current Profiler (ADCP). Hydroacoustic current meter to measure the velocity of water over a range of depths in a column using the Doppler Effect, with the overall depth of water usually being measured simultaneously.

Acoustic Velocity Meter. System that uses the difference in travel time of acoustic (ultrasonic) pulses between transducers in a stream to determine the mean velocity on the signal path.

Adaptive maintenance. Modification of an instrument, software etc. performed after installation to keep the product usable in a changed or changing environment.

Bank. (1) Rising land bordering a river, usually to contain the stream within the wetted perimeter of the channel. (2) Margin of a channel at the left-hand (right-hand) side when facing downstream.

Cableway. Cable stretched above and across a stream, from which a current meter or other measuring or sampling device is suspended, and moved from one bank to the other, at predetermined depths below the water surface.

Calibration (rating) Tank. ***(Straight Open Tanks)*** Tank containing still water through which a current meter is moved at a known velocity for calibrating the meter.

Catchment Area. Area having a common outlet for its surface runoff.

Certification. The provision by an independent body, generally known as an accreditation body, of written assurance (a certificate) that the product, service or system in question meets specific requirements.

Compliance. May be an internal code of conduct where employees follow the principles of one of the Quality Management Standards series (such as the ISO standards) or other internationally recognized practices and procedures. It may also represent an external stamp of approval by an accreditation firm when customers or partners request documented proof of compliance.

Confidence Level. Probability that the confidence interval includes the true value.

Control. Physical properties of a channel which determine the relationship between stage and discharge at a location in the channel.

Control Structures. Artificial structure placed in a stream such as a low weir or flume to stabilize the stage-discharge relation, particularly in the low flow range, where such structures are calibrated by stage and discharge measurements taken in the field.

Co-sponsored observing system. An observing system from which some but not all observations are WMO observations

Cross-section. Section perpendicular to the main direction of flow bounded by the free surface and wetted perimeter of the stream or channel.

Current meter. Instrument for measuring water velocity.

Current meter, propeller type. A current meter the rotor of which is a propeller rotating around an axis parallel to the flow.

Data archiving. Storage of data on a set of catalogued files which are held in some backup storage medium and not necessarily permanently online.

Data compatibility. The capacity for two systems to exchange data without having to be altered to do so including making any changes in data formats.

Data processing. Treatment of observational data until they are in a form ready to be used for a specific purpose.

Data quality objectives. Define qualitatively and quantitatively the type, quality and quantity required of primary data and derived parameters to yield information that can be used to support decisions.

Discharge. Volume of water flowing through a river (or channel) cross-section per unit time.

Drainage basin. (See Catchment area)

Elevation. Vertical distance of a point or level, on or affixed to the surface of the ground, measured from mean sea level.

Estuary. Broad portion of a stream near its outlet to a sea, lake or sabkha.

Flood. (1) Rise, usually brief, in the water level of a stream or water body to a peak from which the water level recedes at a slower rate. (2) Relatively high flow as measured by stage height or discharge.

Flood-proofing. Techniques for preventing flood damage in a flood-prone area.

Gauge boards (Staff Gauge). Graduated vertical scale, fixed to a staff or structure, on which the water level may be read.

Gauge datum. Vertical distance between the zero of a gauge and a certain datum level.

Gauging station. Location on a stream where measurements of water level and/or discharge are made systematically.

GAW Station Information System (GAWSIS). The official catalogue for monitoring sites/platforms/stations operating within Global Atmosphere Watch (GAW) as well as related programmes providing station metadata and serving as the clearing house for unique station identifiers. GAWSIS represents the metadata source for OSCAR for GAW observations.

Hydrograph. Graph showing the variation in time of some hydrological data, such as stage, discharge, velocity and sediment load.

Hydrological Forecast. Estimation of the magnitude and time of occurrence of future hydrological events for a specified period and for a specified locality.

Hydrological observation. Direct measurement or evaluation of one or more hydrological elements, such as stage, discharge and water temperature.

Hydrological observing station. Place where hydrological observations or climatological observations for hydrological purposes are made.

Hydrological warning. Emergency information on an expected hydrological event which is considered to be dangerous.

Hydrometric station. Station at which data on water in rivers, lakes or reservoirs are obtained on one or more of the following elements: stage, streamflow, sediment transport and deposition, water temperature and other physical properties of water, characteristics of ice cover and chemical properties of water.

Intercomparison. A formalized process to assess the relative performance of two or more systems (observing, forecasting, etc.).

Moving-Boat Method. Method of measuring discharge which uses a boat to traverse the stream along the measuring section and continuously measure velocity, depth and distance travelled.

Quality. The degree to which a set of inherent characteristics fulfils requirements.

Quality Assurance. That part of quality management focused on providing confidence that quality requirements will be fulfilled.

Quality Control. That part of quality management focused on fulfilling quality requirements.

Quality Management. The coordinated activities to direct and control an organization with respect to quality.

Rating curve. Curve showing the relation between stage and discharge of a stream at a hydrometric station.

Recession. Period of decreasing discharge as indicated by the falling limb of a hydrograph starting from the peak.

Registration. Certification is very often referred to as registration in North America.

Reservoir. Body of water, either natural or man-made, used for storage, regulation and control of water resources.

River. Large stream which serves as the natural drainage for a basin.

Stage. See water level.

Stage-discharge relation. Relationship between water level and discharge for a river cross-section, which may be expressed as a curve, a table or an equation.

Streamflow. General term for water flowing in a watercourse.

Uncertainty. Estimate of the range of values within which the true value of a variable lies.

Upstream. Direction from which a fluid is moving.

Verification. The process of establishing the truth, accuracy, or validity of something.

Water level. Elevation of the free water surface of a water body relative to a datum level.

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1. INTRODUCTION TO WIGOS

1.1 Purpose and Scope of WIGOS

1.1.1 The WMO Integrated Global Observing System (WIGOS) shall be a framework for all WMO observing systems and the contributions of WMO to co-sponsored observing systems in support of all WMO Programmes and activities.

Note: The co-sponsored observing systems are the WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS), the WMO-IOC-UNEP-ICSU Global Ocean Observing System (GOOS) and the WMO-IOC-UNEP-ICSU Global Terrestrial Observing System (GTOS).

1.1.2 The WIGOS shall facilitate the use by WMO Members of observations from systems that are owned, managed and operated by a diverse array of organizations and programmes.

1.1.3 The principal purpose of WIGOS shall be to meet the evolving requirements of Members for observations.

1.1.4 The interoperability (including data compatibility) of WIGOS component observing systems shall be achieved through their common utilization and application of internationally accepted standards and recommended practices and procedures. Data compatibility shall also be supported through the use of data representation standards.

1.2 WIGOS component observing systems

1.2.1 The component observing systems of WIGOS shall comprise the Global Observing System (GOS) of the World Weather Watch (WWW) Programme, the observing component of the Global Atmosphere Watch (GAW) Programme, the WMO Hydrological Observing System (WHOS) of the Hydrology and Water Resources Programme (HWRP) and the observing component of the Global Cryosphere Watch (GCW), including their surface-based and space-based components.

Note: The above component systems include all WMO contributions to the co-sponsored systems, as well as the WMO contributions to the Global Framework for Climate Services (GFCS) and Global Earth Observation System of Systems (GEOSS).

1.2.1 Global Observing System of the World Weather Watch

1.2.1.1 The Global Observing System (GOS) shall be constituted as a coordinated system of observing networks, methods, techniques, facilities and arrangements for making observations on a worldwide scale and defined as one of the main components of the World Weather Watch.

1.2.1.2 The purpose of the Global Observing System shall be to provide the meteorological observations from all parts of the globe that are required by Member countries for operational and research purposes through all WMO and co-sponsored programmes.

1.2.1.3 The Global Observing System shall consist of: (i) a surface-based sub-system composed of regional basic networks of stations and platforms, and other networks of stations and platforms; and (ii) a space-based sub-system composed of: (a) an Earth observation space segment; (b) an associated ground system for data reception, dissemination and stewardship; and (c) a user segment.

1.2.1.4 The Global Observing System shall comply with the provisions specified in the sections 1, 2, 3, 4 and 5.

1.2.2 Global Atmosphere Watch (observing component)

1.2.2.1 The Global Atmosphere Watch (GAW) shall be a coordinated system of observing networks, methods, techniques, facilities and arrangements encompassing the many monitoring and related scientific assessment activities devoted to the investigation of the chemical composition and related physical characteristics of the atmosphere.

Note: The GAW Programme has six focal areas: ozone, greenhouse gases, reactive gases, aerosols, UV radiation and total atmospheric deposition. GAW stations in addition to measuring one or more of the parameters related to these areas may also measure ancillary variables, like radiation, radio nuclides, and persistent organic pollutants.

1.2.2.2 The purpose of the Global Atmosphere Watch shall be to provide data and other information on the atmospheric chemical composition and related physical characteristics of the background, unpolluted atmosphere, as defined in section 6, from all parts of the globe, required to reduce environmental risks to society and meet the requirements of environmental conventions, strengthen capabilities to predict the state of climate, weather and air quality, and contribute to scientific assessments in support of environmental policy.

1.2.2.3 The observing component of GAW shall consist of a surface-based system composed of networks for observation of specified variables, complemented by space-based observations.

1.2.3.4 The observing component of the Global Atmosphere Watch Programme shall be operated in accordance with the provisions specified in the sections 1, 2, 3, 4 and 6.

1.2.3 WMO Hydrological Observing System

1.2.3.1 The WMO Hydrological Observing System (WHOS) shall comprise hydrological observations, initially focusing on water level and discharge.

Note: The composition of the WMO hydrological observing systems is provided in the Volume III – Hydrology, Chapter D.1.2 of the *WMO Technical Regulations* (WMO-No. 49).

1.2.3.2 The WMO hydrological observing systems shall expand to include other elements identified through the application of the Rolling Review of Requirements (RRR) process (specified in section 2.2.4 and Appendix 2.3) at the national, regional and global levels.

1.2.3.3 The purpose of the WHOS shall be to provide real time stream data (both water level and discharge) from participating Members.

1.2.3.4 Members making their hydrological observations available through the WMO Hydrological Observing System (WHOS) shall comply with the provisions specified in the sections 1, 2, 3, 4 and 7.

Note: Volume III – Hydrology, the *Guide to Hydrological Practices* (WMO-No. 168), and the *Manual on Stream Gauging* (WMO-No. 1044) and the *Manual on Flood Forecasting and Warning* (WMO-No. 1072) provide the necessary information to operate hydrological stations to prescribed standards.

1.2.4 Global Cryosphere Watch (observing component)

1.2.4.1 The Global Cryosphere Watch (GCW) shall be a coordinated system of observing networks, methods, techniques, facilities and arrangements encompassing monitoring and related scientific assessment activities devoted to the investigation of the Cryosphere.

1.2.4.2 The purpose of the Global Cryosphere Watch shall be to provide data and other information on the cryosphere, from a local to the global scale, to improve understanding of its behaviour, interactions with other components of the climate system, and impacts on society.

1.2.4.3 The GCW observing network and its standardized core network (CryoNet) shall build on existing observing programmes and promote the addition of standardized cryospheric observations to existing facilities.

1.2.4.4 The observing component of the Global Cryosphere Watch shall comply with the provisions specified in the sections 1, 2, 3, 4 and 8.

1.3 Governance and Management

1.3.1 Implementation and Operation of WIGOS

1.3.1.1 Members shall be responsible for all activities connected with the implementation and operation of WIGOS on the territories of their individual countries.

1.3.1.2 Members should, as far as possible, use national resources for the implementation and operation of WIGOS, but, where necessary and so requested, assistance may be provided in part through:

(a) The WMO Voluntary Cooperation Programme (VCP);

(b) Other bilateral or multilateral arrangements including the United Nations Development Programme (UNDP) which should be used to the maximum extent possible.

1.3.1.3 Members should participate voluntarily in the implementation and operation of WIGOS in regions outside the territories of individual countries (e.g. outer space, oceans, the Antarctic), if they desire and are able to contribute by providing facilities and services, either individually or jointly.

1.3.2 WIGOS Quality Management

Note 1: Provisions relating to the WMO Quality Management Framework, WMO QMF, are provided in the *Technical Regulations* (WMO-No. 49), Volume IV – Quality Management, 2011 edition).

Note 2: Within the WMO Quality Management Framework, WIGOS provides the procedures and practices with regard to the quality of observations and observational metadata that should be adopted by Members in establishing their quality management system for the provision of meteorological, hydrological, climatological and other related environmental observations.

Note 3: Section 2.6 provides detailed provisions on WIGOS Quality Management.

1.3.3 WIGOS High Level Processes

1.3.3.1 Members should adopt a process-based approach to the management of WIGOS observing systems as described in Attachment 1.

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ATTACHMENT 1

WIGOS High Level Processes

Many of the WIGOS activities may be represented together as a series of high-level processes.

Figure 1 provides a schematic description of the processes (horizontal bars), the collaborating entities (vertical columns) and those having primary involvement in each process (marked by solid circles). In reality the processes have more complex interrelationships and sequences than shown by the arrows – the most extreme case is the capacity development (including training) process which is not shown as a step in the sequence since it has important inputs to most of the other processes.

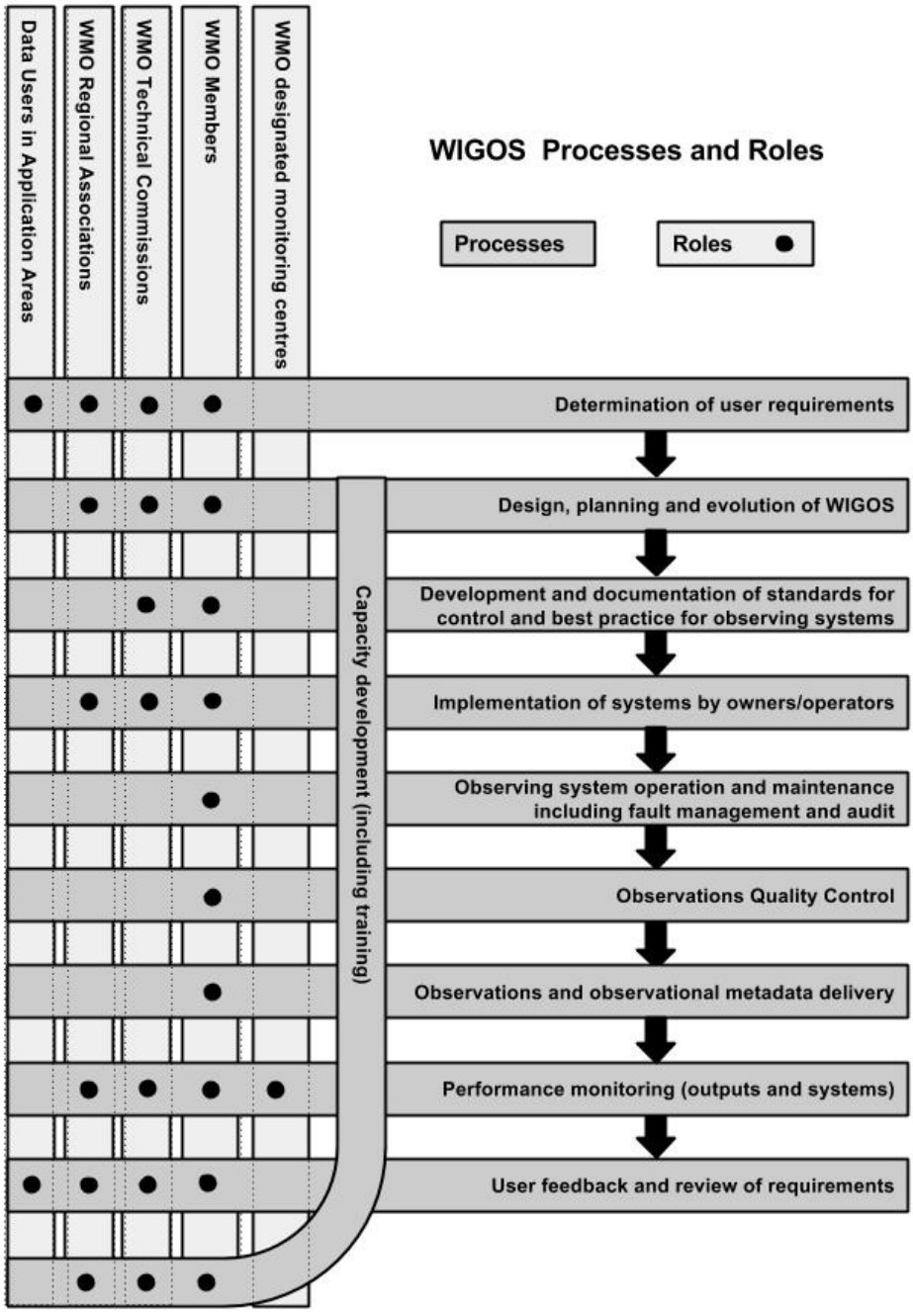

FIGURE 1. Schematic diagram of WIGOS high-level processes (horizontal bars), the collaborating entities (vertical columns) and those having primary involvement in each process (marked by solid circles)

These processes are carried out by Members through one of the following modes of collaboration:

- Data Users in Application Areas: Members collaborate by selectively contributing Application experts and information to provide the capability to undertake the relevant WIGOS process(es),
- WMO regional associations: Members collaborate by working together in a geographical grouping, and by selectively contributing experts for regional teams, to undertake the relevant WIGOS process(es),
- WMO technical commissions: Members collaborate by selectively contributing technical experts for global teams to undertake the relevant WIGOS process(es),
- WMO Members: as individual operators and managers of observing systems, Members directly undertake the relevant WIGOS process(es),
- WMO designated Centres for performance monitoring (including Lead Centres, and Monitoring Centres): individual Members or groups of Members operate a WMO centre designated for performance monitoring, including Lead Centres or Monitoring Centres, to undertake the relevant WIGOS process(es).

In the case of WIGOS processes being undertaken by the WMO Secretariat or other entities funded by WMO Programmes, the mode of collaboration is through the overall operation of the WMO.

The following example illustrates the relation between the WIGOS high-level processes and the structure of the regulatory material. In section 2 the standard and recommended practices and procedures relevant to each WIGOS process can be found in the following sub-sections:

- Determination of user requirements: 2.1, 2.2
- Design, planning and evolution of WIGOS: 2.2
- Development and documentation of standard and recommended practices and procedures for observing systems: 2.3
- Implementation of observing system by owners and operators: 2.3, 2.4
- Observing system operation and maintenance including fault management and audit: 2.4
- Observation quality control: 2.4, 2.6
- Observations and observational metadata delivery: 2.4, 2.5
- Performance monitoring: 2.4, 2.6
- User feedback and review of requirements: 2.2, 2.6
- Capacity development (including training): 2.7

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2. COMMON ATTRIBUTES OF WIGOS COMPONENT SYSTEMS

2.1 Requirements

2.1.1 Members shall take steps for collecting, recording, reviewing, updating, and making available their observational user requirements.

2.1.2 Members shall convey their observational user requirements, for each of the WMO application areas, to the Rolling Review of Requirements (RRR) process specified under 2.2.4 and Appendix 2.3.

2.2 Design, Planning and Evolution

2.2.1 General

2.2.1.1 The WIGOS shall be designed as a flexible and evolving system capable of continuous improvement.

Note: Factors which drive the evolution of WIGOS component observing systems include technological and scientific progress and cost-effectiveness, changes in the needs and requirements of WMO, WMO co-sponsored programmes and international partner organizations at national, regional and global levels, and changes in the capacity of Members to implement observing systems. It is important to identify the impact on all users before a change is made.

2.2.1.2 Members shall plan and operate their networks in a sustainable and reliable manner utilizing WIGOS standard and recommended practices and procedures, and tools.

Note: Sustainability over at least a ten year period is recommended; however, this depends on paying sufficient attention to maintenance and operations following the original establishment.

2.2.2 Principles for Observing Network Design and Planning

2.2.2.1 Observing Network Design Principles

2.2.2.1.1 Members should follow the principles specified in Appendix 2.1 when designing and evolving their observing system networks.

2.2.2.1.2 Members should conduct network design studies which address national, regional and global scale questions about the optimum affordable mix of components to best satisfy the requirements for observations.

2.2.2.2 GCOS Climate Monitoring Principles

2.2.2.2.1 Members designing and operating observing systems for monitoring climate should adhere to the principles specified in Appendix 2.2.

Note: Fifty Essential Climate Variables (ECVs) have been identified for GCOS, which are required to support the work of the United Nations Framework Convention on Climate Change (UNFCCC) and the Inter-governmental Panel on Climate Change (IPCC). The ECVs cover the atmospheric, oceanic and terrestrial domains, and all are technically and economically feasible for systematic observation. Further information about the ECVs is in the "Implementation Plan for the Global Observing System for Climate in support of the UNFCCC (2010 Update)" (GCOS-138, also identified as WMO-TD/No.1523).

2.2.3 Vision for WIGOS Observing Systems

2.2.3.1 Members shall take into account the "*Vision for the global observing system in 2025"* when planning the evolution of their observing networks.

Note 1: The "*Vision for the global observing system in 2025*" provides high-level goals to guide the evolution of the WMO integrated global observing systems in the coming decades. The Vision is updated on a multi-year time scale (typically decadal).

Note 2: The "*Vision for the global observing system in 2025*" is available at: http://www.wmo.int/pages/prog/www/OSY/gos-vision.html

2.2.4 The Rolling Review of Requirements (RRR) Process

2.2.4.1 Members, both directly and through the participation of their experts in the activities of regional associations and technical commissions, shall contribute to the Rolling Review of

Requirements (RRR) process and assist the designated Points of Contact (PoCs) for each Application Area in performing their roles in the RRR.

Note: Appendix 2.3 provides further details on the RRR process.

2.2.5 Observation Impact Studies

2.2.5.1 Members, or groups of Members within regions, should conduct and/or participate in observation impact studies and related scientific evaluations to address WIGOS network design questions.

2.2.5.2 Members should provide expertise for synthesizing the results of impact studies and making recommendations on the best mix of observing systems to address the gaps identified by the RRR process.

Note: Impact studies using Observing System Experiments (OSEs), Observing System Simulation Experiments (OSSEs), Forecast Sensitivity to Observations (FSO) studies and other assessment tools are used to assess the impact of the various observing systems on Numerical Weather Prediction model analyses and predictions, hence their value and relative priority for addition or retention for these Application Areas.

2.2.6 Evolution of WIGOS Observing Systems

2.2.6.1 Members should follow the plans published by WMO for evolution of WIGOS component observing systems when planning and managing their WIGOS observing systems.

Note1: The planning and coordination of the evolution of WIGOS observing systems is steered by the Executive Council and undertaken by Members individually and through regional associations, technical commissions and relevant steering bodies of WMO co-sponsored observing systems.

Note 2: The current WMO plan for the evolution of WIGOS observing systems was published as the "*Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)*" (WIGOS Technical Report No. 2013-4). It contains guidelines and recommended actions to be undertaken by Members, technical commissions, regional associations, and satellite operators and other relevant parties in order to stimulate cost-effective evolution of the WMO observing systems to address in an integrated way the requirements of WMO Programmes and co-sponsored programmes.

Note 3: The WMO plan for the evolution of WIGOS observing systems is regularly updated and new versions are published on a multi-year time scale (typically decadal), taking into account the Vision for the WIGOS observing systems, and the advice of technical commissions and regional associations, concerned and relevant WMO co-sponsored observing systems, and international experts in all application areas.

2.2.6.2 Members shall coordinate the activities by agencies within their country including the National Meteorological and Hydrological Services (NMHSs) and other relevant agencies, in addressing relevant actions of the WMO plans for evolution of WIGOS observing systems.

2.2.6.3 In the cases where Member countries cover small areas and are geographically close or already have established multilateral working relationships, Members should consider a sub-regional or transboundary river basin approach, in addition to national, to WIGOS observing systems planning.

2.2.6.4 In this case, Members concerned should work in close cooperation to prepare sub-regional or transboundary river basin reviews of requirements to be used as a basis for detailed planning at that scale.

2.2.6.1 Monitoring the Evolution of WIGOS Observing Systems

2.2.6.1.1 Members should contribute to the monitoring of the evolution of WIGOS observing systems by providing their national progress reports on a yearly basis through nominated national focal points.

Note: The Commission for Basic Systems, in collaboration with other technical commissions, regional associations, and co-sponsored programmes, regularly reviews progress of actions of the plan for evolution of WIGOS observing systems, and provides updated guidance to Members regarding the evolution of global observing systems.

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APPENDIX 2.1

Observing System Network Design (OSND) Principles

1. SERVING MANY APPLICATION AREAS

Observing networks should be designed to meet the requirements of multiple application areas within WMO and WMO co-sponsored programmes.

2. RESPONDING TO USER REQUIREMENTS

Observing networks should be designed to address stated user requirements, in terms of the geophysical variables to be observed and the space-time resolution, uncertainty, timeliness and stability needed.

3. MEETING NATIONAL, REGIONAL AND GLOBAL REQUIREMENTS

Observing networks designed to meet national needs should also take into account the needs of the WMO at the regional and global levels.

4. DESIGNING APPROPRIATELY SPACED NETWORKS

Where high-level user requirements imply a need for spatial and temporal uniformity of observations, network design should also take account of other user requirements, such as the representativeness and usefulness of the observations.

5. DESIGNING COST-EFFECTIVE NETWORKS

Observing networks should be designed to make the most cost-effective use of available resources. This will include the use of composite observing networks.

6. ACHIEVING HOMOGENEITY IN OBSERVATIONAL DATA

Observing networks should be designed so that the level of homogeneity of the delivered observational data meets the needs of the intended applications.

7. DESIGNING THROUGH A TIERED APPROACH

Observing network design should use a tiered structure, through which information from reference observations of high quality can be transferred to and used to improve the quality and utility of other observations.

8. DESIGNING RELIABLE AND STABLE NETWORKS

Observing networks should be designed to be reliable and stable.

9. MAKING OBSERVATIONAL DATA AVAILABLE

Observing networks should be designed and should evolve in such a way as to ensure that the observations are made available to other WMO Members, at space-time resolutions and with a timeliness to meet the needs of regional and global applications.

10. PROVIDING INFORMATION SO THAT THE OBSERVATIONS CAN BE INTERPRETED

Observing networks should be designed and operated in such a way that the details and history of instruments, their environments and operating conditions, their data processing procedures and other factors pertinent to the understanding and interpretation of the observational data (i.e. metadata) are documented and treated with the same care as the data themselves.

11. ACHIEVING SUSTAINABLE NETWORKS

Improvements in sustained availability of observations should be promoted through the design and funding of networks that are sustainable in the long-term including, where appropriate, through the transition of research systems to operational status.

12. MANAGING CHANGE

The design of new observing networks and changes to existing networks should ensure adequate consistency, quality and continuity of observations across the transition from the old system to the new.

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APPENDIX 2.2

GCOS Climate Monitoring Principles

Effective monitoring systems for climate should adhere to the following principles:

(a) The impact of new systems or changes to existing systems should be assessed prior to implementation;

(b) A suitable period[1] of overlap for new and old observing systems is required;

(c) The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e., metadata) should be documented and treated with the same care as the data themselves;

(d) The quality and homogeneity of data should be regularly assessed as a part of routine operations;

(e) Consideration of the needs for environmental and climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities;

(f) Operation of historically uninterrupted stations and observing systems should be maintained;

(g) High priority for additional observations should be focused on data-poor regions, poorly observed parameters, regions sensitive to change, and key measurements with inadequate temporal resolution;

(h) Long-term requirements, including appropriate sampling frequencies, should be specified to network designers, operators and instrument engineers at the outset of system design and implementation;

(i) The conversion of research observing systems to long-term operations in a carefully planned manner should be promoted;

(j) Data management systems that facilitate access, use and interpretation of data and products should be included as essential elements of climate monitoring systems;

Furthermore, operators of satellite systems for monitoring climate need to:

(a) Take steps to make radiance calibration, calibration-monitoring and satellite-to-satellite cross-calibration of the full operational constellation a part of the operational satellite system; and

(b) Take steps to sample the Earth system in such a way that climate-relevant (diurnal, seasonal, and long-term interannual) changes can be resolved.

Thus satellite systems for climate monitoring should adhere to the following specific principles:

(k) Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained;

(l) A suitable period of overlap for new and old satellite systems should be ensured for a period adequate to determine inter-satellite biases and maintain the homogeneity and consistency of time-series observations;

(m) Continuity of satellite measurements (i.e. elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured;

(n) Rigorous pre-launch instrument characterization and calibration, including radiance confirmation against an international radiance scale provided by a national metrology institute, should be ensured;

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[1] a suitable period of dual operations, under the same climatic conditions, of the current and new observing systems, which is adequate to identify and record any impact of the change

(o) On-board calibration adequate for climate system observations should be ensured and associated instrument characteristics monitored;

(p) Operational production of priority climate products should be sustained and peer-reviewed new products should be introduced as appropriate;

(q) Data systems needed to facilitate user access to climate products, metadata and raw data, including key data for delayed-mode analysis, should be established and maintained;

(r) Use of functioning baseline instruments that meet the calibration and stability requirements stated above should be maintained for as long as possible, even when these exist on decommissioned satellites;

(s) Complementary in situ baseline observations for satellite measurements should be maintained through appropriate activities and cooperation;

(t) Random errors and time-dependent biases in satellite observations and derived products should be identified;

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APPENDIX 2.3

The RRR Process

The WMO Rolling Review of Requirements (RRR) process compiles information on Members evolving requirements for observations in the application areas that directly use observations; the extent to which current and planned WIGOS observing systems satisfy those requirements; guidance from experts in each application area on the gaps and the priorities for addressing the deficiencies and opportunities in WMO observing systems; and hence plans for the future evolution of WIGOS observing systems.

The Application Areas are:

- Global numerical weather prediction (GNWP);
- High-resolution numerical weather prediction (HRNWP);
- Nowcasting and very short range forecasting (NVSRF);
- Seasonal and inter-annual forecasting (SIAF);
- Aeronautical meteorology;
- Atmospheric chemistry;
- Ocean applications;
- Agricultural meteorology;
- Hydrology;
- Climate monitoring (as undertaken through the Global Climate Observing System, GCOS);
- Climate applications;
- Space weather.

Note 1: A detailed and up-to-date description of the RRR process is available on the WMO website at http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html.

In addition, observational requirements for WMO polar activities and the Global Framework for Climate Services (GFCS) are also being considered. The observational needs of the former application area "Synoptic meteorology" are now captured and reviewed along with those for NVSRF.

An expert is identified for each Application Area to be the Point of Contact (PoCs). That expert has a very important role as the conduit to the RRR for input and feedback from the entire stakeholder community for that Application Area.

The nominated Point of Contact should coordinate with their Application Area community (technical commission, or programme or co-sponsored programme as appropriate) as needed in order to perform the following tasks:

(1) Investigate whether it is appropriate to represent the Application Area in several sub-applications;

(2) Submit the quantitative observational user requirements to the OSCAR/Requirements database (see http://www.wmo.int/oscar), review and keep up-to-date these requirements, and make changes as needed (the PoCs are provided with the required access rights);

(3) Produce, review and revise the Statement of Guidance for the Application Area;

(4) Review how requirements for cross-cutting activities (e.g. Cryosphere, climate services) are taken into account in the user requirements database and in the Statement of Guidance for the Application Area.

Note 2: The observational user requirements compiled through the RRR process are stored and made available by the WIGOS Operational Information Resource (WIR) (OSCAR/Requirements database) as described in detail in Attachment 2.2.

The RRR process consists of four stages:

(1) A review of technology-free (that is, not constrained by any particular type of observing technology) users requirements for observations, within each of the WMO Application Areas (see section 2.1);

(2) A review of the observing capabilities of existing and planned observing systems, both surface- and space-based;

(3) A Critical Review, a comparison of requirements with the observing system capabilities; and

(4) A Statement of Guidance providing a gap analysis with recommendations on addressing the gaps for each Application Area.

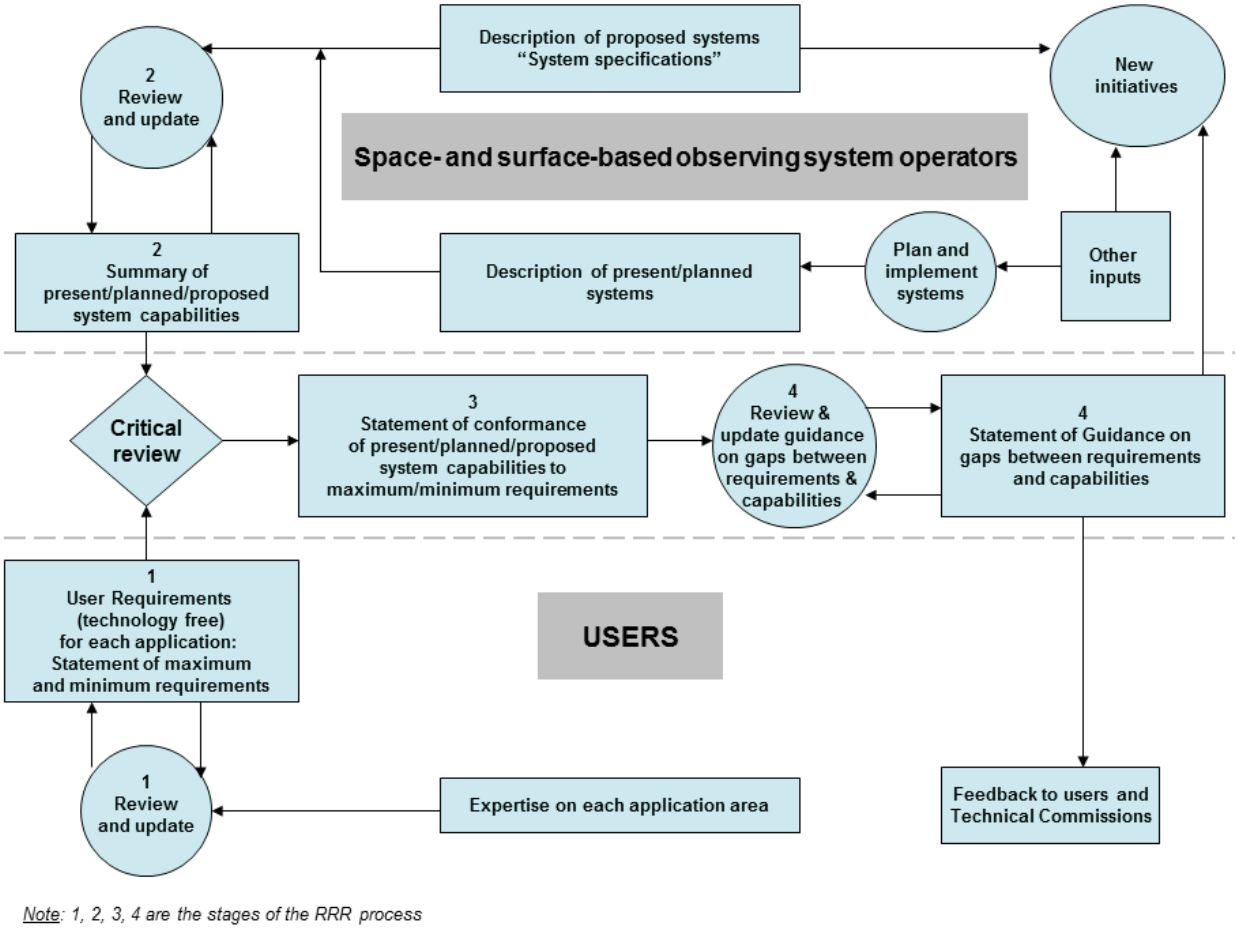

Figure 2. Schematic representation of the steps included in the Rolling Review of Requirements process

1) Review of observational user requirements

Note 1: This stage of the RRR is described briefly in section 2.1.

Note 2: Regional associations examine and provide to PoCs additional details for the compiled user requirements, taking into account the particular requirements of the Region and transboundary river basin authorities.

2) Review of current and planned observing systems capabilities

Members shall take steps for collecting, reviewing, recording, and making available current and planned capabilities of observing systems.

Note: Information on observing system capabilities is in the form of metadata and is to be made available for global compilation according to the provisions of section 2.5.

3) The critical review

Note: This WMO Programme activity proceeds with assistance from the PoCs of the Application Areas. It compares the quantitative observational user requirements of each Application Area with the observing systems capabilities.

4) Statements of Guidance

Note 1: The Statement of Guidance interprets the output of the critical review as a gap analysis and identifies priorities for action – the most feasible, beneficial and affordable initiatives to close the identified gaps or shortcomings in WMO observing systems for an Application Area. This draws on the subjective judgement and experience of the PoC and all of the experts and other stakeholders they consult within their Application Area.

Note 2: This stage of the RRR requires the Application Area PoCs to coordinate with their Application Area community and stakeholders as needed in order to produce, review and revise the Statement of Guidance for the Application Area.

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2.3 INSTRUMENTATION AND METHODS OF OBSERVATION

2.3.1 General Requirements

Note: Details are provided in the *Technical Regulations* (WMO-No. 49), Volume III: Hydrology, the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), *Weather Reporting* (WMO-No. 9), Volume D – Information for Shipping, and the *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information.

2.3.1.1 Members should ensure that observations and observational metadata are traceable to International Standards (SI), where these exist.

Note: Traceability to International Standards (SI) is an area where concerted effort is required to increase-improve compliance.

2.3.1.2 Members should employ properly calibrated instruments and sensors that provide observations satisfying at least measurement uncertainties that meet the specified requirements.

Note 1: Achievable measurement uncertainty is specified in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1 (1.6.5.2), Annex 1.D.

Note 2: A number of operational, financial, environmental and instrumental issues may cause the system to not always satisfy the specified requirements, e. g. Annex 1.D (the column „achievable“) provides a list of the achievable and affordable measurement uncertainties which in some cases might not satisfy specified requirements.

2.3.1.3 Members should describe uncertainty of observations and observational metadata as specified in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1 (1.6).

Note 1: The corresponding text from the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1 (1.6) will be included as an Appendix in a future edition.

Note 2: The definition of uncertainty in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter1 (1.6) is consistent with international standards approved by the International Committee for Weights and Measures (CIPM).

2.3.1.4 Members should follow the definitions and specifications for the calculation of derived observations specified in the WMO Technical Regulations.

Note 1: Further methods provided or referenced by the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) and the *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information could be also considered.

Note 2: Such derivations can take many forms, such a statistical processing of average or smooth values, or multivariate algorithm to determine streamflow discharge.

Note 3: The corresponding text from the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) will be included as an Appendix in a future edition.

2.4 Operations

2.4.1 General Requirements

Note: Provision 2.4.1.1, Volume I, Part I of the *Technical Regulations* (WMO-No. 49) applies.

2.4.1.1 WMO observing stations and platforms shall be uniquely identified by a WIGOS station identifier.

Note: The structure of WIGOS station identifiers is specified in Attachment 2.1.

2.4.1.2 Members shall issue WIGOS station identifiers for observing stations and platforms within their geographic area of responsibility that contribute to a WMO or co-sponsored programme and shall ensure that no WIGOS station identifier is issued to more than one station.

Note: Members may issue WIGOS station identifiers for observing stations and platforms within their geographic area of responsibility that do not contribute to a WMO or co-sponsored programme, provided that the operator has committed to providing and maintaining WIGOS metadata.

2.4.1.3 Before issuing a station identifier, Members should ensure that the operator of a station or platform has committed to providing and maintaining WIGOS metadata for that station or platform.

Note 1: In circumstances when a WIGOS identifier is required for a station or platform to support a WMO or co-sponsored programme and no Member is in a position to issue one (e.g. Antarctica), the Secretary-General may issue a WIGOS station identifier for that station or platform provided that its operator has committed to:

(a) Providing WIGOS metadata; and

(b) Conforming to relevant Technical Regulations.

Note 2: In circumstances where a WIGOS identifier is required for a station or platform to support a WMO or co-sponsored programme and a Member is not able to issue a WIGOS identifier, the Secretary-General will work with the Member concerned to issue a WIGOS station identifier for that station or platform provided that its operator has committed to:

(a) Providing WIGOS metadata; and

(b) Conforming to relevant Technical Regulations.

2.4.1.4 Members shall make available to WMO the updated metadata each time a new station identifier is issued.

2.4.1.5 Members shall operate their observing systems with properly calibrated instruments and adequate observing and measuring techniques.

Note 1: Detailed guidance on observing practices of meteorological observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

Note 2: Detailed guidance on observing practices of hydrological observing systems and instruments is given in the *Guide to Hydrological Practices* (WMO-No. 168); the Manual on Flood Forecasting and Warning (WMO-No. 1072), and the *Manual on Stream Gauging* (WMO-No. 519).

Note 3: Detailed guidance on observing practices of GAW observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8).

2.4.1.6 Members should address the requirements for uncertainty, timeliness, temporal resolution, spatial resolution, and coverage which result from the RRR process specified in section 2.2.4 and in accordance with the details provided by other sections as appropriate.

2.4.1.7 Members shall ensure that proper safety procedures are specified, documented and utilized in all its operations.

Note: Safety practices and procedures are those that are concerned with assuring the welfare of staff while promoting overall efficiency and effectiveness of the NMHS and responding to national laws, regulations and requirements for occupational health and safety.

2.4.2 Observing Practices

2.4.2.1 Members should ensure that their observing practices are adequate to comply with the observational user requirements.

Note: Observing practices is inclusive of station operation, data processing practices and procedures, applied calculation rules, documentation on calibration practices and associated metadata.

2.4.3 Quality Control

2.4.3.1 Members shall ensure observations provided through their WIGOS component observing systems are quality controlled.

2.4.3.2 Members shall implement real-time quality control prior to exchange of observations via the WMO Information System.

Note 1: Quality control of observations consists of examination of observations at stations and at data centres to detect errors so that observations may be either corrected or flagged. A quality control system should include procedures for returning to the source of observations to verify them and to prevent recurrence of errors. Quality control is applied in real time, but it also operates in non-real-time, as delayed quality control. Observations quality depends on the quality control procedures applied during observations acquisition and processing and during preparation of messages, in order to eliminate the main sources of

errors and ensure the highest possible standard of accuracy for the optimum use of these observations by all possible users.

Note 2: Quality control on a real-time basis also takes place in the Global Data-Processing and Forecasting System, prior to the use of the meteorological and climatological observations in data processing (i.e. objective analysis and forecasting).

Note 3: Recommended minimum standards of quality control of the meteorological and climatological observations at the level of the National Meteorological Centre are given in the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), Volume I – Global Aspects, Appendix II-1, Table I. The *Guide on the Global Data-processing System* (WMO-No. 305) should be consulted for more detailed guidance.

Note 4: Recommended practices and procedures for quality control of hydrological observations are given in the *Manual on Flood Forecasting and Warning* (WMO-No. 1072), Chapter 6 and the *Guide to Hydrological Practices* (WMO-No. 168).

Note 5: Recommended practices and procedures regarding the quality of observations for GAW requirements are formulated in Measurement Guidelines through Data Quality Objectives.

2.4.3.3 Members not capable of implementing these standards should establish agreements with an appropriate Regional Meteorological Centre or World Meteorological Centre to perform the necessary quality control.

2.4.3.4 Members shall also perform quality control of observations on a non-real-time basis, prior to forwarding the observations for archiving.

2.4.3.5 Members should develop and implement adequate quality control processes.

Note 1: Quality control processes include (but are not necessarily limited to): (a) validation; (b) cleaning; (c) monitoring.

Note 2: Further guidance is available in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), *Guide to Climatological Practices* (WMO-No. 100), *Guide to Hydrological Practices* (WMO-No. 168), Volume I: Hydrology – From Measurement to Hydrological Information, and *Guide to the Global Observing System* (WMO-No. 488).

2.4.4 Data and Metadata Reporting

2.4.4.1 Members shall report and make available observations in standard formats specified by the *Manual on Codes* (WMO-No. 306).

2.4.4.2 In the case of GAW observations, Members shall report and make available observations in standard formats as advised by GAW data centres, in accordance with the provisions in section 6.

Note: Members are to report and make available up-to-date WIGOS metadata as specified in section 2.5.2.

2.4.5 Incident Management

2.4.5.1 Members should implement incident management to detect, identify, record, analyse and respond to any incident for restoring a normal observing system operation as quickly as possible, minimizing the negative impact, and preventing a future re-occurrence.

2.4.5.2 Members shall implement procedures to detect, analyse and respond to system faults and human errors at the earliest stage possible.

2.4.5.3 Members should record and analyse incidents as appropriate.

2.4.6 Change Management

2.4.6.1 Members should carefully plan and control changes to ensure continuity and consistency of observations and record any modification related to the observing system.

Note: This requirement relates to any change in the observing system, including an observing station, observing programme, instruments, methods of observation, etc.

2.4.6.2 In the case of significant changes in instruments or methods of observation used or the location in which observations are made, Members should ensure a sufficiently long period (to capture all expected climatic conditions) of overlap with dual operation of old and new systems to identify biases, inconsistencies and inhomogeneities.

2.4.7 Maintenance

2.4.7.1 Members shall ensure that each observing system is rigorously maintained.

2.4.7.2 Members shall perform regular preventive maintenance of their observing systems including their instruments.

Note: Carefully organized preventive maintenance of all system components is recommended to minimize corrective maintenance and to increase the operational reliability of an observing system.

2.4.7.3 Members shall determine the frequency and timing (schedule) of the preventive maintenance taking into account the type of the observing system, environmental and climate conditions of the observing site and platform, and the instrumentation installed.

2.4.7.4 Members shall perform corrective maintenance in case of observing system component fault as soon as practically possible once the problem has been detected.

2.4.7.5 Members shall employ adaptive maintenance that satisfies the requirements for stability, continuity and consistency of observations through time.

Note: Detailed guidance on maintenance of observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) including all of the GAW measurement guides as referenced in Chapter 16 of the Guide, the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

2.4.8 Inspection

2.4.8.1 Members shall arrange periodic inspection of their observing systems.

Note: Such inspection could be undertaken directly or remotely as necessary to monitor correct functioning of observing platform and instruments.

2.4.9 Calibration procedures

2.4.9.1 Members shall ensure that measurement systems and instruments are calibrated regularly in accordance with adequate procedures for each type of system and instrument, as described in the relevant sections.

Note 1: Where international or national standards are not available, the basis for calibration is defined or supplied by the manufacturer or by the Scientific Advisory Groups for GAW observations.

Note 2: Detailed guidance on calibration procedures is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

Note 3: In the GAW Programme, World Calibration Centres perform the audit of the stations and require that every laboratory is traceable to the single network standard.

2.4.9.2 Members shall ensure that the measuring devices they use are:

(a) Calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards. Where no such standards exist, the basis used for calibration or verification shall be recorded.

(b) Adjusted or readjusted as necessary, but at the same time safeguarded from adjustments that would invalidate the measurements;

(c) Identified, enabling the calibration status to be determined; and

(d) Protected from damage and deterioration during handling, maintenance and storage.

Note: Details regarding the hydrological observations are given in the WMO *Technical Regulations* (WMO WMO-No. 49), Volume III – Hydrology; guidance is available in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

2.4.9.3 When the equipment is found not to conform to requirements, the Member shall assess and record the validity of previous measuring results, and take appropriate action on the equipment and the products affected.

2.4.9.4 Members shall record and maintain the results of calibration and verification.

ATTACHMENT 2.1

Structure of WIGOS Station Identifiers

The structure of the WIGOS Identifier is shown in Figure 1. The meaning of the components of the WIGOS identifier is given in Table 1.

WIGOS Identifier series	Issuer of Identifier	Issue Number	Local Identifier

Figure 1. Structure of WIGOS identifier

Table 1. Allocating the component parts of a WIGOS station identifier

Component	Description	Initial Range – series 0 (Stations)
WIGOS Identifier Series	This is used to distinguish between different systems for allocating identifiers. It allows future expansion of the system so that entities do not have to be issued with new identifiers if the structure of the WIGOS identifiers proves unable to meet future requirements. Different values of the WIGOS Identifier Series may correspond to different structures of the WIGOS identifier. Initial permitted range: 0-14	0
Issuer of Identifier	A number that is used to distinguish between identifiers issued by different organizations. It is allocated by WMO to ensure that only one organization can create a given WIGOS station identifier.	0-65534
Issue Number	An identifier that an organization responsible for issuing an identifier may use to ensure global uniqueness of its identifiers. For example, allocating one issue number for hydrological stations and another for voluntary climate observing stations would enable the managers of the two networks to issue Local Identifiers independently without needing to check with each other that they were not duplicating identifiers.	0-65534
Local Identifier	This is the individual identifier issued for each entity. An organization issuing identifiers must ensure that the combination of Issue Number and Local Identifier is unique; in that way global uniqueness is guaranteed.	16 characters

Notes:

(1) The structure of WIGOS station identifiers has been designed to be general enough to identify other entities, such as individual instruments; however, this has not yet been implemented.

(2) Although the table proposes initial ranges of permitted values of the components that make up a WIGOS identifier, future changes in requirements may result in these ranges being increased. IT systems must, therefore, be designed to process identifiers whose components are of arbitrary length. BUFR encodings will need to be prepared for WIGOS identifiers to allow efficient representation and these may use code lists to represent components of the WIGOS identifier that are shared by many entities. Currently, station identifier = 0.

Notation for the WIGOS identifier

The convention for writing the WIGOS identifier (in the context of WIGOS) is:

<WIGOS Identifier series>-<Issuer of Identifier>-<Issue Number>-<Local Identifier>

Note: as an example the WIGOS Identifier

WIGOS Identifier series	Issuer of Identifier	Issue Number	Local Identifier
0	513	215	5678

would be written as 0-513-215-5678.

Representing the WIGOS identifier in contexts outside WIGOS

The following conventions should be used to represent the WIGOS identifier in contexts outside WIGOS or to show the relationship between the WIGOS identifier and an identifier that has been defined in a different context.

int.wmo.wigos	WIGOS identifier	WIGOS supplementary identifier

Figure 2. Structure of an extended WIGOS identifier. Both the int.wmo.wigos and the WIGOS supplementary identifier elements are optional.

int.wmo.wigos

The first component of the extended WIGOS identifier (int.wmo.wigos) allows the identifier to be recognized as a WIGOS identifier when used in contexts where it may be ambiguous as to what type of identifier is being used. This is optional and need not be represented in BUFR, because the entries for the WIGOS identifier provide this information.

WIGOS identifier

The second component (WIGOS identifier) is defined above. Within a WIGOS context it is the only component of the WIGOS identifier that is always required.

WIGOS supplementary identifier

The final component of the extended WIGOS identifier (WIGOS supplementary identifier) is optional and is used to associate identifiers issued using other systems to be associated with the WIGOS unique identifier. A single WIGOS identifier may be associated with many WIGOS supplementary identifiers (such as an observing site that is used for both synoptic and aviation reporting), and a WIGOS supplementary identifier may be associated with many WIGOS unique identifiers (such as a World Weather Watch drifting buoy identifier that has been issued to many drifting buoys). In BUFR, this would be specified through a specific table entry (such as IIiii for World Weather Watch station identifier).

Note: if above example of a WIGOS identifier (0-513-215-5678) was also associated with an identifier (MYLOCATION) issued by another authority, a valid extended WIGOS identifier would be int.wmo.wigos-0-513-215-5678-MYLOCATION.

2.5. Observational Metadata

2.5.1 Purpose and scope

Note 1: Observational metadata are essential as they enable users of observations to assess their suitability for the intended application and managers of observing systems to monitor and control their systems and networks. WMO Members benefit from sharing observational metadata which describe quality of observations and provide information about stations and networks used to collect those observations.

Note 2: Discovery metadata, defined in the *Manual on the WMO Information System* (WMO-No. 1060), are concerned with discovering and accessing information, including observations and their observational metadata. Requirements for discovery metadata are specified in the *Manual on the WMO Information System* (WMO-No. 1060) and are not considered further here.

2.5.1.1 For all WIGOS observations they make available internationally, Members shall record and retain the observational metadata specified as mandatory in the WIGOS Metadata Standard defined in Appendix 2.4.

Note 1: The WIGOS Metadata Standard defines a common set of requirements for elements to be provided in observational metadata. It includes a detailed list of mandatory, conditional and optional metadata.

Note 2: A record of “not available”, "unknown" or "not applicable" are valid values for many elements of the WIGOS Metadata Standard. This assists Members to achieve compliance with the standard, particularly in a transitional step towards capability to report actual values.

2.5.1.2 For all WIGOS observations they make available internationally, Members shall record and retain the observational metadata specified as conditional in the WIGOS Metadata Standard in Appendix 2.4 whenever the related condition is met.

2.5.1.3 For all WIGOS observations they make available internationally, Members should record and retain the observational metadata specified as optional in the WIGOS Metadata Standard in Appendix 2.4.

Note 1: Further requirements for observational metadata beyond the WIGOS Metadata Standard are stated in the following sections. In the case of the Global Observing System, as noted in section 5, the *Manual on the GOS* (WMO-No. 544) provides further provisions for GOS metadata.

Note 2: Further guidance on metadata, and on sound metadata practices, is provided in Guides and guidance documentation associated with the individual observing system components.

2.5.2 Exchanging and archiving observational metadata

2.5.2.1 Members shall make available internationally and without restriction, those mandatory and conditional (whenever the condition is met) observational metadata supporting observations that are made available internationally.

2.5.2.2 Members making observations available internationally shall retain and make available, without restriction, observational metadata for at least as long as they retain the observations described by the observational metadata.

2.5.2.3 Members making available internationally archived observations shall ensure that all WIGOS metadata describing the observations remain available, without restriction, for at least as long as the observations are retained.

2.5.2.4 Members making available internationally archived observations should ensure that any additional observational metadata describing the observations remain available, without restriction, for at least as long as the observations are retained.

2.5.3 Global compilation of observational metadata

2.5.3.1 Members shall make available to WMO for global compilation those components of the WIGOS metadata that are specified as mandatory or conditional (whenever the condition is met).

Note: Global compilations of WIGOS metadata are held in several databases. The Observing Systems Capabilities Analysis and Review tool (OSCAR) database of the WIGOS Operational Information Resource (WIR) is the key source of information for WIGOS metadata. Other global compilations of specific components of WIGOS metadata include elements of the GAWSIS, the JCOMMOPS database and others. Purposes and management of WIGOS Operational Information Resource (WIR) and OSCAR are described in Attachment 2.2.

2.5.3.2 For all WIGOS component observing systems they operate, Members shall keep the relevant WMO observational metadata databases updated with the required WIGOS metadata.

2.5.3.3 Members shall routinely monitor the content of WIGOS metadata databases, and provide feedback to WMO Secretariat on identified discrepancies, possible errors, and required changes with respect to the WIGOS component observing systems they operate.

2.5.3.4 Members shall designate their national focal points responsible for making available metadata and monitoring content of WMO observational metadata databases, and inform the Secretariat accordingly.

2.5.3.5 Members delegating the responsibility of the national focal point for all or part of the observing networks they operate to a global or regional entity shall inform the Secretariat accordingly.

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APPENDIX 2.4

The WIGOS Metadata Standard

General

This Appendix refers to the "*WIGOS Metadata Standard*", which consists of the set of observational metadata elements to be made available internationally. They are required for the effective interpretation of observations from all WIGOS component observing systems by all observational data users, allowing them to access important information about why, where, and how an observation was made, along with how the raw data has been processed and the quality of the data. Note that WIGOS metadata which is required from specific components or sub-systems is detailed in the sections 3–8.

The table below presents categories (or groups) of metadata, each containing one or more elements. Each element is classified (using the same terminology as is used by ISO) as either mandatory (M), conditional (C), or optional (O).

The definition of each metadata element, together with notes and examples, as well as the explanation of the condition to apply to the conditional elements are specified in the WIGOS Metadata Standard , Attachment to this Appendix.

Members' obligations

Mandatory metadata elements shall always be made available. The content of the corresponding fields shall never be empty, either the metadata "value" or the reason for no-value, shall be made available.

Conditional metadata elements shall be made available when the specified condition or conditions are met, in which case the content of the corresponding fields shall never be empty, either the metadata "value" or the reason for no-value, shall be made available.

Optional metadata elements should be made available, as they provide useful information that can help to better understand an observation. These elements are likely to be important for a particular community, but less so for others.

Adoption through a Phased Approach

Making available WIGOS metadata will generate substantial benefits for Members, but developing the capacity to make available these metadata also requires a substantial effort on the part of (meta)data providers. To help Members comply with reporting obligations, guidance material will be developed and provided.

Moreover, reporting obligations will be enforced in phases, in order to allow Members sufficient time to develop the capacity to comply. Balancing the effort required to generate and make available individual elements, and the need to have this information to make adequate use of observations, implementation will proceed through three phases as shown in the table below. Importantly, elements required by the end of **Phase I** are either the mandatory elements in WMO Publication No. 9, Vol. A or are of critical importance for the Observing Systems Capability Analysis and Review (OSCAR) tool of the WIR, and are considered of benefit for all WMO Application Areas. **Phase II** adds elements recognized to be more challenging for Members, but the knowledge of which is still of rather immediate need for the adequate use of observations, in particular for assessing quality of observations. **Phase III** adds the remaining elements specified in this version of the standard.

Elements emerging as being important for specific application areas or observing programmes will be added to the standard as it evolves.

List of elements specified in the WIGOS metadata standard and the phases for Members implementation

Category	Phase I	Phase II	Phase III
	2016	2017–2018	2019–2020
1. Observed variable	**1-01 Observed variable – measurand (M)**	1-05 Representativeness (O)	
	1-02 Measurement unit (C)		
	1-03 Temporal extent (M)		
	1-04 Spatial extent (M)		
2. Purpose of observation	**2-01 Application area(s) (M)**		
	2-02 Programmes/Network affiliation (M)		
3. Station/Platform	*3-01 Region of origin of data (C)*	**3-04 Station/platform type (M)**	**3-05 Station/platform model (M)**
	3-02 Territory of origin of data (C)	3-08 Data communication method (O)	
	3-03 Station/platform name (M)		
	3-06 Station/platform unique identifier (M)		
	3-07 Geospatial location (M)		
	3-09 Station status (M)		
4. Environment		4-04 Events at Station/platform (O)	*4-01 Surface cover (C)*
		4-05 Site information (O)	*4-02 Surface Cover classification scheme (C)*
			4-03 Topography or Bathymetry (C)
5. Instruments and Methods of Observation	**5-01 Source of observation (M)**	5-11 Maintenance party (O)	5-04 Instrument operating status (O)
	5-02 Measurement/observing method (M)	*5-12 Geospatial location (C)*	*5-06 Configuration of instrumentation (C)*
	5-03 Instrument specifications (M)	*5-15 Exposure of instrument (C)*	*5-07 Instrument control schedule (C)*
	5-05 Vertical distance of sensor (C)		*5-08 Instrument control result (C)*
			5-09 Instrument model and serial number (C)
			5-10 Instrument routine maintenance (C)
			5-13 Maintenance Activity (O)
			5-14 Status of observation (O)
6. Sampling	6-03 Sampling strategy (O)	**6-05 Spatial sampling resolution (M)**	6-01 Sampling procedures (O)
	6-07 Diurnal base time (M)		6-02 Sample treatment (O)
	6-08 Schedule of observation (M)		**6-04 Sampling time period (M)**
			6-06 Temporal sampling interval (M)
7. Data Processing and Reporting	**7-03 Temporal reporting period (M)**	7-02 Processing/analysis centre (O)	7-01 Data processing methods and algorithms (O)
	7-04 Spatial reporting interval (C)	7-06 Level of data (O)	7-05 Software/processor and version (O)
	7-11 Reference datum (C)	**7-09 Aggregation period (M)**	**7-07 Data format (M)**
		7-10 Reference time (M)	**7-08 Version of data format (M)**
			7-12 Numerical resolution (O)
			7-13 Latency (of reporting) (M)
8. Data Quality		*8-01 Uncertainty of measurement (C)*	
		8-02 Procedure used to estimate uncertainty (C)	
		8-03 Quality flag (M)	
		8-04 Quality flagging system (M)	
		8-05 Traceability (C)	
9. Ownership and Data Policy	**9-02 Data policy/use constraints (M)**	**9-01 Supervising organization (M)**	
10. Contact	**10-01 Contact (Nominated Focal Point) (M)**		

ATTACHMENT 2.2

The WIGOS Information Resource (WIR)

Purpose of the WIR

The WMO Integrated Global Observing System (WIGOS) Information Resource (WIR) is a tool designed to provide WIGOS stakeholders (observing network decision makers, managers, supervisors, implementation coordination groups, observational data users) with all relevant information on the operational status and evolution of WIGOS and its observing components, the operational requirements of WIGOS, including standard and recommended practices and procedures, best practices and procedures used in the WIGOS framework, and their capabilities to meet observational user requirements of the WMO Application Areas. The WIR serves a number of purposes, and brings the following benefits to WMO Members:

(i) To provide general information on WIGOS, its benefits to Members, and the impacts on Members of addressing WIGOS requirements;

(ii) To provide an overall description of the WIGOS component observing systems that are currently in place (list of observing networks, stations, their characteristics (metadata) including information on observational products they deliver);

(iii) To monitor the evolution of the observing systems and compare this with the plans, to ascertain progress;

(iv) To outline existing national and regional plans for evolution of WIGOS component observing systems;

(v) To assist Members and those in charge of observing network design and implementation to understand the requirements for the relevant observing systems, including standard and recommended practices and procedures, and observational user requirements, in order for them to make appropriate decisions;

(vi) To assist Members to identify observational gaps through critical review and to conduct network design studies, in order for them to address those gaps;

(vii) To assist Members to understand the full potential of the current observing systems with regard to the WMO Application Areas, including those systems operated by partner organizations, to enhance: (a) the scope and availability of observations made by specific observing stations; (b) collaborations; (c) data sharing; and (d) data exchange;

(viii) To provide data users with immediate access to the list of WIGOS component observing systems, with a basic set of observational metadata for each (specified by WMO Technical Regulations), and with links to the appropriate national databases where more detailed information is available in those cases where such databases exist;

(ix) To provide developing countries with guidance on observing network implementation, and tools they can readily use to document their own observing systems (e.g. by using the OSCAR tool of the WIR, they could avoid the need to develop a database nationally); and

(x) To provide a mechanism for matching specific needs (capacity building, gaps, etc.) with resources (via knowledge sharing, donor contributions etc.).

Note 1: Observing stations refer to all types of observing sites, stations and platforms relevant to WIGOS, whether they are surface-based, or space-based, on land, at sea, lake, river, or in the air, fixed, or mobile (incl. in the air), and making in-situ or remote observations.

Note 2: Gaps are expressed in terms of required space, and time resolution, observing cycle, timeliness, and uncertainty for the WMO Application Areas.

The Observing Systems Capabilities Analysis and Review tool (OSCAR)

The Observing Systems Capabilities Analysis and Review tool (OSCAR) of the WIR is a key source of information for WIGOS metadata. The surface- and space-based capabilities components of the OSCAR is intended to record observing platform/station metadata according to the WIGOS metadata standard described in the *Manual on WIGOS* (WMO-No. XXXX), and to retain a record of the current and historical WIGOS metadata.

Management of OSCAR

The management of OSCAR (i.e. functional specifications and their evolution, and information content management) and its components is overseen by the WMO Secretariat in liaison with relevant expert groups and bodies, and in accordance with the WIGOS agreed upon standard and recommended practices and procedures.

OSCAR content management

The OSCAR will be managed to provide the availability needed to address its purpose. WIGOS metadata is maintained under the authority of the Permanent Representatives with WMO.

The operator of OSCAR will collect feedback from Members on noted discrepancies, possible errors, and required changes, so that the OSCAR information content reflects the reality of the surface and space-based capabilities of the observing platforms/stations they operate, including instrument, and platform/station metadata.

The WMO Secretariat is responsible to coordinate management of the information content of OSCAR, with assistance from designated experts and focal points.

Current information can be seen at: http://www.wmo.int/oscar.

2.6. Quality Management

Note 1: The *Technical Regulations* (WMO-No. 49), Volume IV – Quality Management, 2011 edition, provides provisions relating to the WMO Quality Management Framework, WMO QMF.

Note 2: Detailed guidance on how to develop and implement a quality management system (QMS) to ensure and enhance the quality of NMHS products and services is provided in the *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100), 2013 edition).

Note 3: Definitions, terminology, vocabulary and abbreviations used in relation to quality management are those of the ISO 9000 family of standards for quality management systems, in particular within ISO 9000:2005, Quality Management Systems – Fundamentals and vocabulary.

Note 4: A QMS can only be implemented by the body which has the resources and the mandate to manage the observing system. While for consistency with the WMO QMF, it is Members who are urged to follow the standard and recommended practices and procedures associated with implementation of a QMS, in practice it is one or more organizations within the Member's country that own and operate observing systems and provide observations and observational metadata, most notably the NMHSs. In practice, then, implementation of the WMO QMF relies on the Member making arrangements for such organizations to implement a QMS.

Note 5: The term "observations" include also "observational metadata" everywhere in the section 2.6.

2.6.1 Scope and Purpose of WIGOS Quality Management

Note: WIGOS practices and procedures enable Members to comply with the WMO QMF in relation to the quality of observations.

2.6.2 WIGOS Component of the WMO Quality Management Framework

2.6.2.1 Quality Policy

2.6.2.1.1 In the establishment and maintenance of WIGOS observing systems, Members should ensure optimum affordable quality for all observations.

2.6.2.1.2 Members should, through a process of continual improvement, pursue effective and efficient management and governance of observing systems.

2.6.2.2 Application of the eight Principles of Quality Management

2.6.2.2.1 Members should apply the eight Principles of Quality Management to the implementation of WIGOS as specified in Appendix 2.5.

Note: The eight principles of QM are specified in Volume IV of WMO the *Technical Regulations* (WMO-No. 49).

2.6.3 WIGOS Quality Management Processes

Note: The processes and roles of various entities are described in Attachment 1.

2.6.3.1 Determination and Maintenance of User Requirements

Note: The WMO RRR process for compiling observation user requirements is described in section 2.2.4 and Appendix 2.3.

2.6.3.2 Development and Documentation of Observing Systems Standards and Recommendations

2.6.3.2.1 Through involvement in the work of technical commissions, Members should participate in the development of observing system standard and recommended practices and procedures.

2.6.3.3 Training of Personnel and Capacity Development

2.6.3.3.1 Members should ensure appropriate planning and implementation of training and capacity development activities.

2.6.3.4 Performance Monitoring

2.6.3.4.1 Members should use and respond to the results, advice and reports of designated monitoring centres and any subsequent advice of expert groups.

2.6.3.5 Feedback, Change Management and Improvement

2.6.3.5.1 Members should ensure that inconsistencies (problems) identified by WIGOS Lead and Monitoring Centers are rectified in a timely manner and that a process for their documentation and rectification is implemented and maintained.

2.6.3.5.2 Members should, upon identification or notification of observation quality related inconsistencies, and problems analyze the detected problem and implement necessary improvements to operational practices and procedures so as to minimize their negative impacts and prevent their future reoccurrence.

2.6.3.5.3 Members should ensure that changes to operational practices and procedures are accordingly documented.

2.6.4 WIGOS aspects of the Development and Implementation of the QMS of Members

Note: This section specifies requirements for the integration of WIGOS practices and procedures into the QMS of Members. The requirements are based on the eight clauses of the ISO 9001 standard. The *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100) 2013 edition provides extensive explanatory notes about the eight clauses. The five subsections which follow correspond to the last five of the clauses, providing further details about the elements required in a QMS.

2.6.4.1 General requirements for the content of a QMS

2.6.4.1.1 Members should identify their high level processes and their interactions that lead to the provision of observations.

Note: In addition to WIGOS specific provisions, there are many other general requirements for the content of a QMS which are not unique to WIGOS observations hence are not repeated here.

2.6.4.2 Requirements related to management and planning

2.6.4.2.1 Members should clearly demonstrate and document their management commitment to the integration of WIGOS quality management practices within their QMS.

2.6.4.2.2 Members should carefully identify and routinely review user requirements for observations prior to attempting to meet user needs.

2.6.4.2.3 Members should ensure that their published quality policy is consistent with the WIGOS quality policy.

2.6.4.2.4 Members should establish and make known objectives for their future provision of observations so as to provide guidance to stakeholders, users and clients on the expected evolution of and changes to the observing systems that they operate as a contribution to WIGOS.

Note: The objectives referred to in this provision constitute the WIGOS quality objectives.

2.6.4.2.5 Members should appoint a quality manager.

2.6.4.3 Requirements related to resource management

2.6.4.3.1 Members should determine and provide the resources needed to maintain and continuously improve the effectiveness and efficiency of their processes and procedures.

2.6.4.3.2 Members should define the competencies required for staff involved in the provision of observations.

2.6.4.3.3 Members should take steps to rectify any competency shortcomings identified for new or existing employees.

2.6.4.3.4 Members should implement policies and procedures to maintain the infrastructure required for the provision of observations.

2.6.4.4 Requirements related to the provision of observations

2.6.4.4.1 Members should undertake sound planning for the provision of observations.

Note: Such planning includes the following activities and processes:

- Determination and continuous review of user and client requirements;
- The translation of user and client requirements into objectives and targets for observations and observing system design;
- Initial and ongoing allocation of adequate resources for all aspects of the design, implementation and maintenance processes of observing systems;
- Implementation of design processes and activities, including communication strategies and risk management, that will ensure and confirm the development and implementation of observing systems that meet objectives and user and client requirements; and,
- Appropriate and ongoing documentation of planning processes and their results.

2.6.4.4.2 Members should identify their users and establish and document their users' requirements for observations.

Note: The means for doing this include:

i. The WMO Rolling Review of Requirements (RRR) process, described in sections 2.2.4 and Appendix 2.3;

ii. Other processes to establish user requirements within WMO Programmes through the activities of WMO technical commissions;

iii. Regional processes through the activities of WMO regional associations and other multi-lateral groupings of Members: and,

iv. National processes.

2.6.4.4.3 Members should have a clear description of the requirements that are agreed upon.

Note: It is important to note the difference between aspirational requirements and agreed requirements. Once requirements are established, this will provide essential information for the monitoring and measurement of conformance.

2.6.4.4.4 Members should identify and adhere to any statutory or regulatory requirements in relation to the provision of observations.

2.6.4.4.5 Members should design and develop, or otherwise implement, observing systems to satisfy the agreed user requirements.

2.6.4.4.6 Members should use a formal change management process to ensure that all changes are assessed, approved, implemented and reviewed in a controlled manner.

2.6.4.4.7 Members should conduct purchasing in a controlled manner.

Note: Observing systems often require large expenditure and are highly specialized, and therefore clear and concise specifications are needed. Staff responsible for purchasing orders or for providing information to suppliers must ensure that the information and specifications provided are clear, unambiguous and based on meeting the design objectives and system requirements to enable the supply of the appropriate and correct products and services. The undertaking of purchasing in a controlled manner entails application of the following activities and processes:

i. Undertaking written specification of all performance requirements for equipment and/or services;

ii. Ensuring that purchasing is subject to a competitive process of more than one candidate for supply of equipment or services;

iii. Assessment of candidates for supply of equipment or services based on merit and suitability for purpose, which can be discerned from:

   a. Written tendering or quotation of candidates;

   b. Experience or reliable anecdotal evidence of past performance: and,

   c. Recommendation of Member or recognized organizations and agencies; and,

iv. Documentation of the purchasing process and outcomes.

2.6.4.4.8 Members should include in their QMS the WIGOS provisions covering methods of observation, calibration and traceability, operational practices, maintenance, and observational metadata.

2.6.4.4.9 Members should implement practices and procedures which ensure that observations remain accurate.

Note: Observations need to be checked as they are produced to ensure they meet the agreed requirements. The means to do this include automated algorithms, manual inspection and oversight.

2.6.4.5 Requirements for monitoring, performance measurement, analysis and improvement

2.6.4.5.1 Members should use the agreed user requirements for observations (see 2.6.4.4) as a basis for defining and implementing appropriate measures of performance and success.

Note: It is important to gain a clear understanding of how satisfied users are with observations. It requires the monitoring of information relating to users' perception and whether their expectations have been met. Surveys are commonly used for this purpose.

2.6.4.5.2 Members should implement activities to gain information on the satisfaction of users of observations.

2.6.4.5.3 Members should ensure that staff are made aware of the methods that have been employed for determining user perceptions and expectations and that they are applied consistently.

2.6.4.5.4 Members should regularly conduct and analyse the results of internal audits of WIGOS processes and procedures as part of the management processes of the observing system.

Note: A detailed explanation on the requirements of the internal audit process is provided in the *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100) 2013 edition, section "8.2.2 Internal audit".

2.6.4.5.5 Members should monitor the degree of adherence to the defined processes and requirements for producing observations.

Note: Ideally performance monitoring will be conducted against specific Key Performance Indicators and target levels of performance.

2.6.4.5.6 Members should monitor and measure the fitness for purpose and the quality of their observations as they are produced in order to compare their characteristics with the agreed requirements.

Note: The means to do this include:

i. The devising, implementation and routine analysis of manually or automatically generated Key Performance Indicators and their associated targets; and,

ii. Manual inspection and oversight of observational data produced.

2.6.4.5.7 Members should record instances of non-conformity with requirements, and endeavour to rectify problems in a timely manner.

2.6.4.5.8 Members should maintain a documented corrective action procedure relevant to observations.

2.6.4.5.9 Members should specify and implement procedure(s) that describe(s) how non-conforming observations or observational metadata are identified, how they are dealt with, who is responsible for deciding what to do, what action should be taken and what records are to be kept.

Note: A detailed explanation on the requirements of the corrective action process is provided in the *Guide to the Implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100) 2013 edition, section "8.2.3 and 8.2.4 Monitoring and measurement of processes and products".

2.6.4.5.10 Members should analyse monitoring results to detect any performance related changes, trends and deficiencies and use the results and analyses as input to activities aimed at continual improvement.

Note: Analysing trends and taking action prior to the occurrence of a case of non-conformity helps to prevent problems.

2.6.4.5.11 Members should maintain documented preventive action procedures relevant to observing systems and ensure that staff are aware of and, if necessary, trained in their routine application.

Note: Due consideration might be given to combining the preventive and the corrective action procedures for efficiency and to simplify the process.

2.6.5 Compliance, Certification and Accreditation

Note: While WMO encourages the certification of Member quality management systems by recognized accreditation agencies, unless otherwise specified as a requirement of a particular WIGOS Component System or subsystem, there is no general regulated requirement for certification of QMS for WIGOS observing systems.

2.6.6 Documentation

2.6.6.1 Members should include the WIGOS quality policy (2.6.2.1) and objectives (2.6.4.2) in their QMS Quality Manual.

2.6.6.2 Members should include in their QMS documentation those documents that describe the procedures related to WIGOS, including in particular those relating to control of non-conforming observations, corrective actions and preventive actions.

2.6.6.3 Members should include in their QMS documentation those documents that describe the procedures required to ensure the effective planning, operation and control of its WIGOS processes.

2.6.6.4 Members should include in their QMS documentation those records required by the ISO 9001 standard.

Note: More detailed information on Documentation requirements is provided in the *Guide to the implementation of a Quality Management System for National Meteorological and Hydrological Services* (WMO-No. 1100) 2013 edition, section “4.2 Documentation requirements”.

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APPENDIX 2.5

Eight Principles of Quality Management of the WMO Quality Management Framework applied to WIGOS

1. User and client focus

Members should identify, document and understand the current and future needs of their users and clients for meteorological, climatological, hydrological, marine and related environmental observations.

Note: The means to achieve this includes participation in and the application of the WMO Rolling Review of Requirements (RRR) process (see section 2.2.4 and Appendix 2.3).

2. Leadership

Members should clearly define the goals and directions of their observing systems and create an environment in which staff are encouraged to work in that direction.

Note: The relevant WMO technical commissions provide technical guidance and leadership for the implementation of WIGOS. They provide information on WIGOS goals and directions, and stimulate the active involvement of technical experts from Member countries.

3. Involvement of people

Experts from Member countries should be fully involved in the implementation of regulations pertaining to WIGOS quality management.

4. Process approach

Members should adopt a process-based approach to management of observing systems.

5. System approach to management

Members should identify, understand and manage WIGOS observing systems as sets of processes that may be operational, scientific or administrative, with the overall objective of producing the required observations outputs.

6. Continual improvement

Members should ensure that continual improvement is an integral and permanent component of WIGOS observing systems and is implemented through a range of processes and activities that include: active participation in the WMO RRR; auditing of observing systems and sites; data quality monitoring and evaluation, and ensuring routine consultation with, and review of feedback from, WIGOS users and Application Areas, primarily through the WMO Rolling Review of Requirements.

Note: The resulting outcome is the improvement of either the quality of observations or the efficiency of observing systems.

7. Factual approach to decision-making

Members should ensure that decisions, requirements and regulations associated with the design, development, implementation, operation, maintenance and evolution of WIGOS observing systems are based on scientifically, factually and analytically derived information.

Note: The above mentioned information is available to Members through tools such as the WMO RRR, the WIGOS Information Resource (WIR), the Observing Systems Capability Analysis and Review (OSCAR) tool, and through WMO endorsed planning documents such as the "*Implementation Plan for Evolution of Global Observing Systems*" (WIGOS Technical Report No. 2013-4) and others. For further information see section 2.2.4, Appendix 2.3 and Attachment 2.2.

8. Mutually beneficial supplier relationships

Members should participate in, and share with each other and with suppliers, information and results of, tests, trials and intercomparisons of instruments and systems, for the mutual benefit of both WIGOS and suppliers.

Note: Suppliers of instruments, systems and related products should be evaluated and selected on the basis of their ability to meet requirements and on the past performance of their products and services.

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2.7 Capacity Development

2.7.1 General

2.7.1.1 Members should identify their needs for capacity development in all activity areas of WIGOS.

2.7.1.2 Members should develop plans to meet their capacity development needs.

Note: In addition to national resources allocated to National Meteorological and Hydrological Services, other support may be available to Members such as: other domestic agencies, their WMO regional association, other Members through bilateral or multilateral arrangements, and WMO Programmes (including appropriate technical commissions).

2.7.1.3 Members should establish bilateral and multi-lateral collaborations (within and beyond their Region) where necessary to address significant capacity development needs.

2.7.1.4 When planning capacity development activities, Members should take a holistic approach considering institutional, infrastructural, procedural, and human resources requirements to support both the current and continuing resource requirements for installation, operation, maintenance, inspection, and training. For this purpose, Members should prepare specific capacity development plans with measurable objectives to enable effective implementation, monitoring, and assessment.

Note: Funds to meet these requirements should be planned well ahead, subject to national policies of Members, to assure long-term sustainable networks.

2.7.2 Training

2.7.2.1 Members shall provide adequate training for their staff, or take other appropriate actions to ensure that all staff are suitably qualified and competent for the work assigned to them.

Note: This requirement is applied both to initial recruitment or introductory training and to continuing professional development.

2.7.2.2 Each Member should ensure that the qualifications, competencies, skills (and thus training) and numbers of their personnel or other contractors are well matched to the range of tasks to be performed.

2.7.2.3 Each Member should communicate to the staff their role and how they contribute to the achievement of the quality objectives.

2.7.3 Infrastructural Capacity Development

2.7.3.1 Members should regularly review their infrastructure for collecting and making available observations and observational metadata and, as necessary, develop prioritized plans and priorities for capacity development.

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3. ATTRIBUTES SPECIFIC TO THE SURFACE-BASED SUB-SYSTEM OF WIGOS

3.1. Requirements

Note: The observational user requirements of WMO Application Areas are expressed in a technology free manner. Hence they apply to all of WIGOS in common, not to any specific sub-system. The provisions of section 2.1 apply across all WIGOS sub-systems.

3.2. Design, planning and evolution

3.2.1 Composition of the surface-based sub-system of WIGOS

3.2.1.1 The WIGOS surface-based sub-system shall be composed of surface stations within the component networks (i.e. GOS, GAW, WHOS, GCW).

3.2.1.2 Members should implement elements of the WIGOS surface-based sub-system under the coordination of regional associations when appropriate.

Note: Information regarding the current capabilities of the surface-based subsystem is to be available through the Observing Systems Capability Analysis and Review Tool (OSCAR) at: http://www.wmo.int/oscar.

3.3. Instrumentation and Methods of Observation

3.3.1.1 Members shall classify their surface meteorological and climatological observing stations on land.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, (1.1.2), Annex 1.B provides guidelines on the classification of surface observing sites on land to indicate their representativeness for the measurement of different variables.

Note 2: The content of Annex 1.B will be included as an Appendix in a future edition.

3.3.1.2 Members should locate each observing station at a site that permits instrument exposure against the requirements of the particular applications and enables satisfactory non-instrumental observations.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, Annexes 1.B and 1.C provides further guidelines.

Note 2: Requirements for GAW stations are formulated in section 6.

3.3.1.3 Members shall accurately know and refer the position of a station to the World Geodetic System 1984 (WGS-84) and its Earth Geodetic Model 1996 (EGM96)

Note 1: Guidelines are provided in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1 (1.3.3.2).

Note 2: This geodetic system is currently not in general use in hydrology.

Note 3: Its description will be included as an Appendix in a future edition.

3.3.1.4 Members shall define the elevation of the station.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, (1.3.3.2(c)) provides guidelines on defining the elevation of a station.

Note 2: This material will be included as an Appendix in a future edition.

3.3.1.5 If a station is located at an aerodrome, Members shall specify the official elevation of the aerodrome in accordance with the WMO *Technical Regulation* (WMO-No. 49), Volume II, [C.3.1.], Appendix 3, 4.7.2).

3.3.1.6 Members operating Regional Instrument Centres should follow the guidelines concerning capabilities and corresponding functions.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Annex 1.A provides guidelines concerning capabilities and corresponding functions.

Note 2: This material will be included as an Appendix in a future edition.

3.3.1.7 Members operating Regional Marine Instrument Centres should follow the guidelines concerning capabilities and corresponding functions.

Note 1: The Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8), Part II, Chapter 4, Annex 4.A provides guidelines concerning capabilities and corresponding functions for operating Regional Marine Instrument Centres.

Note 2: The content of Annex 4.A will be included as an Appendix in a future edition.

3.3.2 Requirements on Sensors

3.3.2.1 Members shall avoid the use of mercury in their observing systems. Where mercury is still in use, Members shall obey the safety precautions provided.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 3 (3.2.7) provides safety precautions

Note 2: This material will be included as an Appendix in a future edition.

3.3.2.2 For inflation of meteorological balloons, Members should prefer helium over hydrogen. If hydrogen is used, however, Members shall obey to the safety precautions provided.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part II, Chapter 10 (10.6.1) provides safety precautions.

Note 2: This material will be included as an Appendix in a future edition.

3.3.2.3 Members shall calibrate all pyrheliometers, other than absolute pyrheliometers, by comparison using the sun as the source with a pyrheliometer that has traceability to the World Standard Group and a likely uncertainty of calibration equal to or better than the pyrheliometer being calibrated.

Note: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 7 (7.2.1.4) provides the detailed guidelines.

3.3.2.4 Members shall compare, calibrate and maintain barometers according to the guidelines.

Note 1: The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 3 (3.10), provides guidelines on the comparison, calibration and maintenance of barometers.

Note 2: This material will be included as an Appendix in a future edition.

3.4. Operations

3.4.1 General Requirements

3.4.1.1 Members operating surface-based observing systems shall follow the provisions of the section 2.4.1.

3.4.2 Observing Practices

3.4.2.1 Members shall ensure that the exposure, when applicable, of instruments for the same type of observation at different stations be similar in order that observations may be compatible.

3.4.2.2 Members shall determine a reference height for at each surface observing station or system.

Note: A reference height is defined as follows:

1. Elevation of the station. It is the datum level to which barometric pressure reports at the station refer; such current barometric values being termed "station pressure" and understood to refer to the given level for the purpose of maintaining continuity in the pressure records; or
2. For stations not located on aerodromes: elevation of the ground (height above mean sea level of the ground on which the raingauge stands or, if there is no raingauge, the ground beneath the thermometer screen. If there is neither raingauge nor screen, it is the average level of terrain in immediate vicinity of station) in metres rounded up to two decimals; or
3. For stations located on aerodromes it is an official altitude of the aerodrome.

3.4.3 Quality Control

3.4.3.1 Members operating surface-based observing systems shall follow the provisions of the section 2.4.3.

3.4.4 Data and Metadata Reporting

3.4.4.1 Members operating surface-based observing systems shall follow the provisions of the section 2.4.4.

3.4.5 Incident Management

3.4.5.1 Members operating surface-based observing systems shall follow the provisions of the section 2.4.5.

3.4.6 Change Management

3.4.6.1 Members should compare observations from new instruments over an extended interval before the old measurement system is taken out of service or when there has been a change of site. Where this procedure is impractical at all sites, Members should carry out comparisons at selected representative sites.

Note 1: This does not apply to all types of stations and among the exceptions are hydrological stations.

Note 2: Further details can be found in the *Guide to Climatological Practices* (WMO-No. 100), including the required minimum intervals for such comparison.

3.4.7 Maintenance

3.4.7.1 Observing sites and instruments should be maintained regularly so that the quality of observations does not deteriorate significantly between station inspections.

Note: Detailed guidance on maintenance of observing sites, observing systems and instruments is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), the *Guide to Hydrological Practices* (WMO-No. 168, 2008) and the *Manual on Stream Gauging* (WMO-No. 1044, 2010).

3.4.8 Inspection and Supervision

3.4.8.1 Members shall arrange for its surface observing site, station, system to be inspected at sufficiently frequent intervals to ensure that a high standard of observations is maintained; instruments and all their indicators are functioning correctly; and the exposure, when applicable, of the instruments has not changed significantly.

Note 1: Reference is made to the sections 5-8 for the frequency intervals specified for the different types of WIGOS surface observing stations.

Note 2: Detailed guidance on the inspection including the frequency is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part III, Chapter 1.

Note 3: Reference is made to the *Technical Regulations* (WMO-No. 49), Volume II for provisions on the inspection of aeronautical meteorological stations including its frequency.

3.4.8.2 Members shall ensure that inspection is performed by qualified and adequately trained staff.

3.4.8.3 When performing inspection, Members should ensure that:

(a) The siting, selection and installation, as well as exposure when applicable, of instruments are known, recorded and acceptable;

(b) Instruments have approved characteristics, are in good order and regularly verified against relevant standards;

(c) There is uniformity in the methods of observation and in the procedure for reduction of observations.

Note: Detailed guidance on inspection and supervision of observing systems and sites is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) including all of the GAW

measurement guides as referenced in Chapter 16 of the Guide, the *Guide to Hydrological Practices* (WMO-No. 168) and the *Manual on Stream Gauging* (WMO-No. 1044).

3.4.9 Calibration Procedures

3.4.9.1 Members operating surface-based observing systems shall follow the provisions of the section 2.4.9.

3.5 Observational Metadata

Note: Detailed guidance regarding the establishment, maintenance and update of metadata records is given in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), Part I, Chapter 1, 1.3.4 and Part III, Chapter 1, 1.9; *Guide to Climatological Practices* (WMO-No. 100), Chapter 3, 3.3.4; *Guide to the Global Observing System* (WMO-No. 488), Appendix III.3, and the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, Chapter 10.

3.5.1 Members operating surface-based observing systems shall follow the provisions of the section 2.5.

Note: Further provisions specific to the WIGOS component observing system appear in sections 5, 6, 7 and 8.

3.6. Quality Management

3.6.1 Members operating surface-based observing systems shall follow the provisions of the section 2.6.

Note: Further provisions specific to the WIGOS space-based sub-system appear in section 4; specific to the WIGOS component observing system appear in sections 5, 6, 7 and 8.

3.7. Capacity Development

3.7.1 Members operating surface-based observing systems shall follow the provisions of the section 2.7.

Note: Further provisions specific to the WIGOS space-based sub-system appear in section 4; specific to the WIGOS component observing system appear in sections 5, 6, 7 and 8.

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4. ATTRIBUTES SPECIFIC TO THE SPACE-BASED SUB-SYSTEM OF WIGOS

4.1. Requirements

4.1.1 General

4.1.1.1 Members shall strive to develop, implement and operate a space-based environmental observing system in support of WMO Programmes as described in Attachment 4.1.

Note: The space-based sub-system of WIGOS is established through dedicated satellites, remotely observing the characteristics of the atmosphere, the earth and the oceans.

4.1.2 Observed Variables

4.1.2.1 This sub-system shall provide quantitative data enabling, independently or in conjunction with surface-based observations, the determination of variables including but not limited to:

(a) Three-dimension fields of atmospheric temperature and humidity;

(b) Temperature of sea and land surfaces;

(c) Wind fields (including ocean surface winds);

(d) Cloud properties (amount, type, top height, top temperature, and water content);

(e) Radiation balance;

(f) Precipitation (liquid and frozen);

(g) Lightning;

(h) Ozone concentration (total column and vertical profile);

(i) Greenhouse gas concentration;

(j) Aerosol concentration and properties;

(k) Volcanic ash cloud occurrence and concentration;

(l) Vegetation type and status and soil moisture;

(m) Flood and forest fire occurrence;

(n) Snow and ice properties;

(o) Ocean colour;

(p) Wave height, direction and spectra;

(q) Sea level and surface currents;

(r) Sea ice properties;

(s) Solar activity;

(t) Space environment (electric and magnetic field, energetic particle flux, electron density).

Note: Information regarding the current capabilities of the space-based subsystem is available through the Observing Systems Capability Analysis and Review Tool (OSCAR) at: www.wmo.int/oscar.

4.1.3 Observing performance requirements

4.1.3.1 Satellite operators providing observational data to WIGOS shall strive to meet, to the extent possible, the uncertainty, timeliness, temporal and spatial resolution, and coverage requirements of WIGOS as defined in the WIGOS Information Resource (WIR), based on the Rolling Requirements Review process described in section 2.

Note 1: The term “satellite operators” is used in the *Manual on WIGOS* (WMO-No. XXXX) to refer to “Members or coordinated group of Members operating environmental satellites”.

Note 2: A coordinated group of Members operating environmental satellites is a group of Members acting jointly to operate one or more satellites through an international space agency such as the European Space Agency or EUMETSAT

Note 3: These requirements are recorded and maintained in the requirements database: http://www.wmo.int/oscar.

4.1.4 Global planning

4.1.4.1 Satellite operators shall cooperate to ensure that a constellation of satellite systems is planned and implemented to guarantee the continuous provision of space-based observations in support of WMO Programmes.

Note: Collaboration is pursued within the Coordination Group for Meteorological Satellites, which includes all Members operating space-based observation systems in support of WMO Programmes.

4.1.5 Continuity

4.1.5.1 Satellite operators working together under the auspices of the Coordination Group for Meteorological Satellites or otherwise, should ensure the continuity of operation, and of the data dissemination and distribution services of the operational satellites within the sub-system through appropriate contingency arrangements and re-launch plans.

4.1.6 Overlap

4.1.6.1 Satellite operators should ensure an adequate period of overlap of new and old satellite systems in order to determine inter-satellite instrumental biases and maintain the homogeneity and consistency of time series observations, unless reliable transfer standards are available.

4.1.7 Interoperability

4.1.7.1 Satellite operators shall achieve the greatest possible interoperability of their different systems.

4.1.7.2 Satellite operators shall make available sufficient technical details about the instruments, data processing, transmissions, and the dissemination schedules for Members to fully exploit the data.

4.2. Design, planning and evolution

Note: The space-based sub-system is composed of:

a. An Earth observation space segment;

b. An associated ground segment for data reception, processing, dissemination, and stewardship;

c. A user segment.

4.2.1 Space segment architecture

Note: The overall architecture of the space segment is described in Attachment 4.1.

It is defined and evolves in consultation with the Coordination Group for Meteorological Satellites.

It includes:

- A constellation of geostationary satellites;
- A core constellation of sun-synchronous satellites distributed over three separated orbital planes;
- Other operational satellites operated on either sun-synchronous orbits or other appropriate Low-Earth orbits;
- Research and Development satellites on appropriate orbits.

4.2.2 Space programme life cycles

4.2.2.1 Satellite operators shall consider a trade-off between the need for a long series to pay-off the development cost and the user learning curve, on one hand, and the need to develop a new generation in order to benefit from state-of-the-art technology, on the other hand.

Note 1: The development of an operational satellite programme is conducted in several phases including: user requirements definition, feasibility assessment at system level, preliminary design, detailed design, development and testing of the subsystems, integration of all subsystems, system testing, launch campaign, and on-orbit commissioning. The overall duration of these development phases is typically of the order of 10 to 15 years.

Note 2: The exploitation phase for an operational programme including a series of recurring satellites is typically of the order of 15 years.

4.3. Instruments and Methods of Observation

Note 1: Space-based observation relies on a wide range of sensor types, e.g. active or passive, operating in various spectral ranges, with various scanning or pointing modes. Information on the principles of Earth Observation from space, the different types of space-based instruments and the derivation of geophysical variables from space-based measurements can be found in the *Guide to Instruments and Methods of Observation*, (WMO-No. 8), Part III.

Note 2: Detailed characteristics of current and planned systems of environmental satellites are available in the satellite module of the Observing System Capabilities Analysis and Review tool (OSCAR), which is available on line (http://www.wmo.int/oscar/space). It also contains an indication of the main instruments that are relevant for each specific variable observable from space, with their potential performance for the respective variables.

4.3.1 Calibration and Traceability

4.3.1.1 Satellite operators shall perform a detailed instrument characterization before launch.

Note: Members must strive to follow the pre-launch instrument characterization guidelines recommended by the Global Space-based Inter-calibration System.

4.3.1.2 After launch, satellite operators shall calibrate all instruments on a routine basis against reference instruments or calibration targets.

Note 1: Advantage should be taken of satellite collocation to perform on-orbit instrument intercomparison and calibration.

Note 2: Calibration must be done in accordance with established and documented methodologies by the Global Space-based Inter-calibration System and the Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation.

4.3.1.3 Satellite operators shall ensure traceability to International Standards (SI) according to international approved standards.

Note: The Implementation Plan for the Global Climate Observing System (WMO/TD-No. 1253) calls for sustained measurement of key variables from space traceable to reference standards, and recommends implementing and evaluating a satellite climate calibration mission.

4.3.1.4 To ensure traceability to International Standards (SI), satellite operators shall define a range of ground-based reference targets for calibration purposes.

4.4. Space Segment Implementation

4.4.1 Operational satellites on Geostationary Earth Orbit

4.4.1.1 Satellite operators should implement an operational constellation of satellites in geostationary orbit as described in Attachment 4.1.

4.4.1.2 Satellite operators shall ensure that the constellation of satellites in geostationary orbit provides full disc imagery at least every 15 minutes, and achieves coverage of all longitudes, throughout a field of view between 60° S and 60° N.

Note: This implies the availability of at least six operational geostationary satellites if located at evenly distributed longitudes, with in-orbit redundancy.

4.4.1.3 Satellite operators should implement rapid-scan capabilities where feasible.

4.4.1.4 For the imagery mission in geostationary orbit, satellite operators should ensure an availability rate of rectified and calibrated data of at least 99 per cent as a target.

4.4.1.5 To meet the essential requirement for continuity of data delivery, satellite operators, shall strive to implement contingency plans, involving the use of in-orbit stand-by flight models and rapid call-up of replacement systems and launches.

4.4.2 Core operational constellation on sun-synchronous Low Earth Orbits (LEO)

4.4.2.1 Operators of LEO satellites should implement a core operational constellation of satellites in three regularly distributed sun-synchronous orbits as described in Attachment 4.1.

4.4.2.2 Operators of the core constellation of environmental LEO satellites on three sun-synchronous orbital planes in early morning, mid-morning and afternoon orbit, shall strive to ensure a high level of robustness allowing the delivery of imagery and sounding data from at least three polar orbiting planes, on not less than 99 per cent of occasions.

Note: This implies provisions for a ground segment, instrument and satellite redundancy, and rapid call-up of replacement launches or on orbit spares.

4.4.3 Other capabilities on Low Earth Orbits

4.4.3.1 Operators of environmental LEO satellites should implement capabilities in appropriate orbits as described in Attachment 4.1.

4.4.4 Research and Development satellites

4.4.4.1 Operators of Research and Development satellites shall consider providing the following observing capabilities:

(a) Advanced observation of the parameters necessary to understand and model the water cycle, the carbon cycle, the energy budget and the chemical processes of the atmosphere;

(b) Pathfinders for future operational missions.

Note: For WMO, the main benefits of Research and Development satellite missions are:

- Support of scientific investigations of atmospheric, oceanic, and other environment related processes,
- Testing or demonstration of new or improved sensors and satellite systems in preparation for new generations of operational capabilities to meet WMO observational requirements.

4.4.4.2 Members shall strive to optimize the usefulness of observations from Research and Development satellites for operational applications. In particular, operators of Research and Development satellites shall make provisions, where possible, to enable near real-time data availability to promote the early use of new types of observations for operational applications.

Note 1: Although neither long-term continuity of service nor a reliable replacement policy are assured, research and development satellites provide, in many cases, observations of great value for operational use.

Note 2: Although they are not operational systems, Research and Development satellites have proven to support operational meteorology, oceanography, hydrology and climatology substantially.

4.5 Ground Segment Implementation

4.5.1 General

4.5.1.1 Satellite operators shall make observational data available to Members over the WMO Information System (WIS) in accordance with the provisions in the *Manual on the WMO Information System* (WMO-No. 1060). Satellite operators shall inform Members of the means of obtaining these data through catalogue entries and shall provide sufficient metadata to enable meaningful use of the data.

4.5.1.2 Satellite operators shall implement facilities for the reception of remote-sensing data (and Data Collection System data when relevant) from operational satellites, and for the processing of quality-controlled environmental observation information, with a view of further near real-time distribution.

4.5.1.3 Satellite operators shall strive to ensure that data from polar-orbiting satellites are acquired on a global basis, without temporal gaps or blind orbits, and that data latency meets WMO timeliness requirements.

4.5.2 Data dissemination

4.5.2.1 Satellite operators shall ensure near real-time data dissemination of the appropriate data sets, per the requirement of Members, either via an appropriately designed ground segment, by direct broadcast, or by re-broadcast via telecommunication satellites.

4.5.2.2 In particular, operators of operational sun-synchronous satellites providing the core meteorological imagery and sounding mission should ensure inclusion of Direct Broadcast capability as follows:

(a) Direct broadcast frequencies, modulations, and formats should allow a particular user to acquire data from either satellite by a single antenna and signal processing hardware. To the extent possible, the frequency bands allocated to Meteorological Satellites should be used;

(b) Direct broadcast shall be provided through a high data rate stream, such as the High Resolution Picture Transmission (HRPT) or its subsequent evolution, to provide meteorological centres with all the data required for numerical weather prediction (NWP), Nowcasting, and other real-time applications;

(c) If possible, a low data rate stream should also be provided, such as the Low Rate Picture Transmission (LRPT), to convey an essential volume of data to users with lower connectivity or low-cost receiving stations.

4.5.2.3 Satellite operators shall consider implementing re-broadcast via telecommunication satellites to complement and supplement direct broadcast services, to facilitate access to integrated data streams including data from different satellites, to non-satellite data and to geophysical data products.

4.5.2.4 Operators of operational geostationary meteorological satellites with rapid-scan capabilities shall strive to provide meteorological centres with data in near-real time as required for nowcasting, numerical weather prediction (NWP) and other real-time applications.

4.5.3 Data Stewardship

4.5.3.1 Satellite operators shall provide full descriptions of all processing steps taken in the generation of satellite data products, including algorithms, characteristics, and outcomes of validation activities.

4.5.3.2 Satellite operators shall preserve long-term raw data records and ancillary data required for their calibration, reprocessing as appropriate, with the necessary traceability information to achieve consistent Fundamental Climate Data Records.

4.5.3.3 Satellite operators shall maintain Level 1B satellite data archives including all relevant metadata pertaining to the location, orbit parameters and calibration procedures used.

4.5.3.4 Satellite operators shall ensure that their archiving system is capable of providing on-line access to the archive catalogue with a browsing facility, provides adequate description of data formats, and will allow users to download data.

4.5.4 Data collection systems

4.5.4.1 Satellite operators with a capability to receive data and/or products from Data Collection Platforms (DCP) shall maintain technical and operational coordination under the auspices of CGMS in order to ensure compatibility.

4.5.4.2 Satellite operators shall maintain a number of “international” DCP channels identically on all geostationary satellites to support the operation of mobile platforms moving across all individual geostationary footprints.

4.5.4.3 Satellite operators shall publish details of the technical characteristics and operational procedures of their data-collection missions, including the admission and certification procedures.

4.5.5 User Segment

4.5.5.1 Operators of research and development satellites shall implement capabilities enabling Members to access the data in one of the following ways: via downloading data from server(s), via receiving data from a re-broadcasting service, or via receiving from a direct broadcast capability.

4.5.5.2 Members shall endeavour to install and maintain in their territory at least one system enabling access to digital data from both LEO and geostationary operational satellite constellations, either a receiver of re-broadcast service providing the required information in an integrated way, or a combination of dedicated direct readout stations.

4.5.5.3 Where appropriate, Members should strive to utilize fixed or moving DCP systems (for example to cover data-sparse areas) to take advantage of the data-collection and relay capability of the environmental observation satellites.

4.6. Observational Metadata

4.6.1 For each space-based system they operate, satellite operators shall record, retain and make available observational metadata in accordance with the provisions of section 2.5.

4.7. Quality Management

4.7.1 Quality Indicators

4.7.1.1 Satellite operators shall include appropriate quality indicators in the metadata for each datasets, in accordance with the provisions of section 2.5.

4.8. Capacity Development

4.8.1 Centres of Excellence

4.8.1.1 Satellite operators, and other Members having the capability to do so, shall provide support to education and training of instructors in the use of satellite data and capabilities e.g. at specialized Regional Meteorological Training Centres or other training institutes designated as Centres of Excellence in satellite meteorology, in order to build up expertise and facilities at a number of regional growth points.

4.8.2 Training strategy

4.8.2.1 Satellite operators should focus their assistance, to the extent possible, on one or more of these Centres of Excellence within their service areas and contribute to the Virtual Laboratory for Training and Education in Satellite Meteorology.

Note: The aim of the Education and Training strategy implemented through the Virtual Laboratory is to systematically improve the use of satellite data for meteorology, operational hydrology, and climate applications, with a focus on meeting the needs of developing countries.

4.8.3 User preparation for new systems

4.8.3.1 In order to facilitate a smooth transition to new satellite capabilities, satellite operators should make provisions for appropriate preparation of the users through training, guidance to necessary upgrades of receiving equipment and processing software, and information and tools to facilitate the development and testing of user applications.

4.8.3.2 In addition to working through the Virtual Laboratory, Members should, as appropriate, exploit partnerships with organizations providing education and training in environmental satellite applications, depending on their specific needs.

4.8.4 Engagement between Users and Data Providers

4.8.4.1 In order to achieve the most effective utilization of satellite data, Members should pursue the close engagement between users and data providers at a regional level.

4.8.4.2 Working with their regional association, Members should follow systematic steps to document the regional requirements for satellite data access and exchange.

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ATTACHMENT 4.1

CGMS BASELINE FOR THE OPERATIONAL CONTRIBUTION TO THE GOS

(adopted by CGMS-39 on 6 October 2011)

FUTURE SATELLITE MISSIONS TO BE PERFORMED ON OPERATIONAL/SUSTAINED BASIS

Introduction

In support of the programmes coordinated or co-sponsored by WMO for weather and climate, CGMS Members plan to maintain the operational capabilities and services described below, that constitute the "CGMS baseline for the operational contribution to the GOS".

While this particular document focuses on missions that are decided and managed in an operational or sustained framework, with a perspective of long-term follow-on, this in no way precludes the importance of other missions undertaken e.g. on a research or demonstration basis. First of all, because today's research and development are the foundation of tomorrow's operational missions. Furthermore, because many missions initiated in an R&D framework for a limited duration are eventually extended well beyond their design life time and provide longstanding support to both scientific and operational activities.

This baseline defines a constellation of geostationary satellites, a core meteorological mission on three sun-synchronous orbits, other missions in sun-synchronous orbits, missions in other Low Earth Orbits, and contains cross-cutting considerations on contingency planning, inter-calibration, data availability and dissemination.

I. Constellation in geostationary orbit

At least six geostationary satellites shall be operated at evenly distributed locations with in orbit redundancy, and perform the following missions:

(a) Advanced visible and infrared imagery (at least 16 spectral channels, 2km resolution) over the full disc at least every 15 minutes

(b) Infrared sounding (hyperspectral on some positions)

(c) Lightning detection

(d) Data collection

(e) Space environment monitoring

On selected positions, the following missions shall be performed:

(f) Earth Radiation Budget monitoring

(g) High spectral resolution UV sounding

(h) Solar activity monitoring

II. LEO sun-synchronous missions

Operational sun-synchronous satellites shall be operated around three orbital planes in mid-morning ("am", nominally 09:30 descending, 21:30 ascending ECT), afternoon ("pm", nominally 13:30 ascending ECT) and early morning (nominally 05:30 descending, 17:30 ascending ECT) and, as a constellation, shall perform the following missions:

1) Core meteorological mission nominally on 3 orbital planes

(i) Multispectral visible and infrared imagery

(j) Infrared hyperspectral sounding (at least am and pm)

(k) Microwave sounding

(l) Microwave imagery

2) Other missions on sun-synchronous orbits

(m) Wind scatterometry over sea surfaces (at least two orbital planes)

(n) Ocean surface topography by radar altimetry (at least on am and pm orbits, supplemented by a reference mission on a high-precision, inclined orbit)

(o) Radio-occultation sounding (at least am and pm, supplemented by a constellation in specific orbits)

(p) Broadband VIS/IR radiometer for Earth Radiation balance (at least am and pm)

(q) Total Solar Irradiance (at least one)

(r) Contribution to atmospheric composition observations (at least am and pm)

(s) Narrow-band Vis/NIR imagers (at least one sun-synchronous, am spacecraft) for ocean colour, vegetation and aerosol monitoring

(t) High-resolution multi-spectral Vis/IR imagers (constellation of sun-synchronous satellites, preferably in am)

(u) IR dual-angle view imagery for high-accuracy SST (at least one am spacecraft)

(v) Particle detection and/or electron density (at least am and pm)

(w) Magnetic field (at least am and pm)

(x) Solar activity (at least two)

(y) Data collection

III. Other LEO missions

The following missions shall be performed on an operational basis by Low Earth Orbit satellites on appropriate orbits:

(z) Ocean surface topography by radar altimetry (A reference mission on high-precision, inclined orbit, complementing two instruments on sun-synchronous am and pm orbit)

(aa) Radio-Occultation sounding (dedicated constellation of sensors on appropriate orbits)

IV. Contingency Planning

The CGMS baseline is associated with contingency plans for geostationary and polar-orbiting satellite systems, which are detailed in the CGMS Global Contingency Plan[2].

V. Inter-calibration

Instruments should be inter-calibrated on a routine basis against reference instruments or calibration sites. The routine and operational inter-calibration and corrections shall be performed in accordance with standards as agreed by the Global Space-based Inter-calibration System (GSICS).

VI. Data availability and dissemination

VI.1. Data open availability with suitable timeliness

All operational environmental observation satellite systems should be designed to ensure the provision of data with suitable timeliness, as appropriate for their intended applications. Data should be preserved for the long term and documented with metadata allowing their interpretation and utilization. The satellite operators should establish dissemination contents and schedules that take into account the data requirements of users. Re-broadcast via telecommunication satellites should complement and supplement direct broadcast services, which allows cost-efficient access to integrated data streams including data from different satellites, non-satellite data and

2 The Global Contingency Plan (http://www.wmo.int/pages/prog/sat/documents/CGMS_Contingency-Plan-2007.pdf) should be updated accordingly. It should indicate that in case of potential gaps on core sun-synchronous missions, absolute priority should be given to observation from mid-morning and early afternoon orbits, in order to maintain the continuity of these datasets.

geophysical products. The dissemination systems should utilize all-weather resilient telecommunication means.

VI.2. Direct broadcast for core meteorological missions in LEO

The core meteorological satellite systems in LEO orbits, and other operational observation satellite systems when relevant, should ensure near real-time data dissemination of imagery, sounding, and other real-time data of interest to Members by direct broadcast. Direct broadcast frequencies, modulations, and formats for polar-orbiting satellites should allow a particular user to acquire data from either satellite by a single antenna and signal processing hardware. Direct Broadcast should use allocations in all-weather resilient frequency bands.

VII. Note

The present update of the CGMS baseline is adopted in the light of satellite mission plans as they are known in October 2011.

5 ATTRIBUTES SPECIFIC TO THE GLOBAL OBSERVING SYSTEM OF THE WORLD WEATHER WATCH

Note 1: The provisions of sections 1, 2, 3 and 4 are common to all WIGOS component observing systems including the GOS.

Note 2: Provisions specific to the GOS are currently set out in the *Manual on the Global Observing System* (WMO-No. 544), Volume I).

6 ATTRIBUTES SPECIFIC TO THE OBSERVING COMPONENT OF THE GLOBAL ATMOSPHERE WATCH

Note: The provisions of sections 1, 2, 3 and 4are common to all WIGOS component observing systems, including the GAW. The further provisions of section 6 are specific to GAW.

6.1. Requirements

6.1.1 Members should perform the observations of atmospheric composition and related physical parameters using a combination of surface-based stations and platforms (fixed stations, mobile platforms and remote sensing) and space-based platforms.

6.1.2 Members should use the requirements from the RRR process, particularly in the atmospheric chemistry application area in developing their GAW stations.

Note 1: The user requirements are reviewed on a regular basis through the RRR process by the Scientific Advisory Groups for each variable, in consultation with the user community and input from Members. The RRR process is described in section 2.2.4 and Appendix 2.3.

Note 2: Scientific Advisory Groups exist for the six GAW focal areas and their terms of reference are defined by the Commission for Atmospheric Sciences.

6.1.3 Members should follow the Data Quality Objectives specified by the GAW Programme for the individual variables observed.

6.1.4 Members should establish and operate their GAW stations such that they satisfy the station requirements specified in Attachment 6.1.

6.1.5 Members operating GAW stations shall undertake long-term and uninterrupted operation with stability and continuity of data collection that is adequate for purpose outlined in 6.2.1.

6.2. Design, Planning and Evolution

6.2.1 Members should design, plan and further evolve their GAW observing network and stations to address the user requirements and, in particular those that concern key environmental issues and application areas, including but not limited to the following areas:

- Stratospheric ozone depletion and the increase of ultraviolet (UV) radiation.
- Changes in the weather and climate related to human influence on atmospheric composition, particularly, related to the changes in greenhouse gases, ozone and reactive gases, and aerosols.
- Risk assessment of air pollution and UV on human health and the environment and issues involving long-range transport of air pollution and its deposition.

6.2.2 Members should contribute observations through operating or supporting suitable platforms at GAW stations and/or through contributing networks.

6.2.3 When doing so, Members shall register their contribution in the GAW Station Information System (GAWSIS), and submit their observations to the relevant GAW Data Centre.

6.2.4 Members operating a contributing network shall provide a description of the network and register the stations in GAWSIS and provide corresponding metadata.

6.2.5 Members should ensure that the frequency and spacing of the various observations is suited to the temporal and spatial requirements of the specific issues addressed in section 6.2.1.

6.3. Instrumentation and Methods of Observation

6.3.1 General requirements of Instruments

6.3.1.1 Members should use recommended types of instruments or methods of observation for variables observed at their stations, and follow further guidance available.

Note 1: Guidance is provided in the Standard Operating Procedures (SOPs) and Measurement Guidelines (MG).

Note 2: Instruments suitable for use at GAW sites are defined by the Scientific Advisory Groups for each parameter, in terms of stability, precision and accuracy.

Note 3: SOP describe the standard approach to operate this kind of instrument.

Note 4: MG describe the standard approach for this kind of measurement regardless of the instrument.

6.3.2 Calibration and Traceability

6.3.2.1 Members shall perform calibrations and maintain traceability to the GAW primary standards, where available.

Note 1: GAW primary standard is a single network standard, assigned by WMO. In the case of contributing networks the network observations are traceable to the network standard, which in turn is traceable to GAW primary standard.

Note 2: Details on calibrations are specified by the Standard Operating Procedures and Measurement Guidelines.

6.3.2.2 Members should utilize GAW central facilities to sustain the global compatibility of observations.

Note: GAW central facilities include: Central Calibration Laboratories, World Calibration Centres, Regional Calibration Centres, and Quality Assurance/Scientific Activities Centres.

6.4. Operations

6.4.1 Observing system implementation monitoring

6.4.1.1 Members shall monitor the operation of GAW stations for which they are responsible and ensure that they follow the relevant procedures for quality assurance and data submission. Members shall seek assistance from Central Facilities, Scientific Advisory Groups and Expert Teams if operational problems cannot be solved locally.

Note: The procedures to be used in monitoring the operation of GAW are determined within the Commission for Atmospheric Sciences (CAS) in consultation with the participating Members.

6.4.1.2 Members should systematically monitor compliance with GAW regulations, in collaboration with relevant constituent bodies and the Secretariat, in order to identify critical cases of non-compliance (deficiencies) and undertake measures for their timely resolution.

6.4.2 Quality Assurance

6.4.2.1 Members should follow specified quality assurance practices and procedures.

Note: Details are given in the GAW Standard Operational Procedures and Measurement Guidelines, and further documents provided by the Scientific Advisory Groups and Central Facilities.

6.4.2.2 Members shall maintain detailed metadata records in accordance with procedures and practices specified in this Manual.

6.4.2.3 Members should participate in independent evaluation of quality of observations, including intercomparisons and system audits, as appropriate to the observed variables.

6.4.2.4 Members shall permit World Data Centres to perform independent evaluation of the data quality of their observations.

6.4.3 Data and Metadata representation and format

6.4.3.1 Members shall submit their observational data and associated metadata to the relevant GAW World Data Centres for the variables observed at the station within agreed time limits.

6.4.3.2 Members shall use the formats specified by the relevant World Data Centre when submitting their observational data and metadata.

6.5. Observational Metadata

Note: the general provisions on observation metadata are specified in section 2.5.

6.5.1 Members shall provide metadata associated with instrumentation, site or platform, calibration history as requested by the World Data Centre for each parameter, and by GAWSIS.

6.5.2 Members shall provide such additional metadata as required by GAWSIS and any World Data Centre to which they contribute that are necessary to understand their observations.

6.6. Quality Management

Note: the general regulations on Quality management are specified in section 2.6.

6.7. Capacity Development

Note: General provisions for capacity development are provided in sections 2.7, 3.7 and 4.7.

6.7.1 Members not capable of implementing required standards should establish agreements with appropriate Central Facilities or establish partnership with more experienced stations in the form of stations twinning.

Note: In some regions of the world, and for some GAW variables, where there is a clear lack of capacity, Members may be requested to help support a station, or existing stations may be approached to become a part of GAW. Such requests and invitations come after approval by the appropriate Scientific Advisory Group (SAGs).

6.7.2 Members should use the GAW Training and Education Centre (GAWTEC) programme, as available for capacity building and staff training in measurement of the specific GAW variables.

ATTACHMENT 6.1

General requirements for GAW stations

Essential characteristics of GAW Regional Stations:

1. The station location is chosen such that, for the variables measured, it is regionally representative and is normally free of the influence of significant local pollution sources.

2. There are adequate power, air conditioning, communication and building facilities to sustain long term observations with greater than 90% data capture (i.e. <10% missing data).

3. The technical support provided is trained in the operation of the equipment.

4. There is a commitment by the responsible agency to long-term observations of at least one of the GAW variables in the GAW focal areas (ozone, aerosols, greenhouse gases, reactive gases, UV radiation, and precipitation chemistry).

5. The GAW observations made are of known quality and linked to the GAW Primary Standard.

6. The data and associated metadata are submitted to one of the GAW World Data Centres, typically no later than one year after the observations are made. Changes of metadata including instrumentation, traceability, observation procedures, are reported to the responsible WDC in a timely manner.

7. If required, observations are submitted to a designated data distribution system in near real-time.

8. Standard meteorological in situ observations, necessary for the accurate determination and interpretation of the GAW variables, are recommended to be made with known quality.

9. The station characteristics and observational programme are updated in the GAW Station Information System (GAWSIS) on a regular basis.

10. A station logbook (i.e. record of observations made and activities that may affect observations) is maintained and is used in the data validation process.

Additional Essential characteristics needed for a GAW Global Station:

In addition to the essential characteristics of Regional stations, a GAW Global station should fulfil the following additional requirements, namely:

11. Measure variables in at least three of the six GAW focal areas.

12. Have a strong scientific supporting programme with appropriate data analysis and interpretation within the country and, if possible, the support of more than one agency.

13. Provide a facility at which intensive campaign research can augment the long-term routine GAW observations and where testing and development of new GAW methods can be undertaken.

GAW Contributing Networks

GAW contributing networks involve observations from multiple stations. The stations comprising contributing networks should satisfy the criteria of either regional or global stations adjusted by the contributing network regulations (e.g. within the contributing network data submission requirements or standard used can differ from those required for regional and global stations). In the case of standards different from the WMO standards, the network standards must have a confirmed traceability to the WMO standards in the cases where such standards exist. Data submission regulations for the contributing networks must be not worse than the ones required within GAW. A station designation of global or regional, if it already exists for individual stations, always takes precedence. To be used in global assessments data from the contributing stations must be submitted to the GAW World Data Centres.

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7. ATTRIBUTES SPECIFIC TO THE WMO HYDROLOGICAL OBSERVING SYSTEM

Note: The provisions of sections 1, 2, 3 and 4are common to all WIGOS component observing systems, including the WHOS. The further provisions of section 7 are specific to the WHOS.

7.1 Requirements

7.1.1 Members shall establish and operate a hydrological observing system according to its national requirements.

7.1.2 Members should also operate their hydrological observing systems to address the requirements of the RRR process, in particular for the hydrology application area.

Note 1: A hydrological observing system includes networks of hydrological observing stations as defined in Technical Regulations Volume III – Hydrology, Chapter D.1.1 which should make observations of elements as described in Chapter D.1.2 Hydrological Observations.

Note 2: Chapter D.1.4 Hydrological Data Transmission states “Transmission facilities should be organized for the international exchange of hydrological data, forecast and warnings on the basis of bilateral or multilateral agreement.” Further provisions for data transmission and international exchange through the WMO Information System (WIS) are given in the *Technical Regulations*, Volume I, Part II and the *Manual on WMO Information System* (WMO-No. 1060) and the *Manual on the Global Telecommunication System* (WMO-No. 386), Volume I.

7.1.3 Members shall provide on a free and unrestricted basis those hydrological data and products which are necessary for the provision of services in support of the protection of life and property and for the well-being of all peoples.

7.1.4 Members should also provide additional hydrological data and products where available, which are required by WMO Programmes and its Members as specified in 7.1.2.

7.1.5 At a global level, the WMO Hydrological Observing System (WHOS) shall allow access to sources of hydrological observations in near-real time from Members around the world.

Note: Currently, many Members are making such observations publically available on the Internet.

7.1.6 Members should provide these sources of observations to the WHOS.

Note: Hydrological observations available through WHOS will initially comprise stage (water level) and discharge. This will likely expand over time to include other elements as identified in the Rolling Review of Requirements process at the national, regional and global levels.

7.2 Design, planning and evolution

Note: Design, planning and evolution is common to all WIGOS component observing systems.

7.2.1 Members should design and plan their observing network considering the review of the current and planned WMO Hydrological Observing System capabilities, undertaken as outlined in the Rolling Review of Requirements (RRR) as described in section 2.2.4.

7.3 Instrumentation and Methods of Observation

7.3.1 General Requirements of Instruments

7.3.1.1 Members should equip their stations with properly calibrated instruments and should arrange for these stations to follow adequate observational and measuring techniques to ensure that the measurements and observations of the various hydrological elements are accurate enough to address the needs of hydrology and other applications areas.

Note: Technical Regulations Volume III provides that Members should use instruments for measurement of stage (water level) in conformance with the specifications of its Annex II — Water level measuring devices.

7.3.1.2 Members should ensure that the uncertainty in the observation of the stage (water level) of rivers, estuaries, lakes, and reservoirs not exceed:

(a) In general, 10 mm at the 95 per cent confidence level;

(b) Under difficult conditions, 20 mm at the 95 per cent confidence level.

Note: Stage (Water level) observations are used primarily as an index for computing streamflow discharge when a unique relation exists between stage (water level) and discharge.

7.3.2 Stage and discharge observations from hydrometric stations

Note: Technical Regulations, Volume III provides that Members should establish and operate hydrometric stations for measuring stage (water level), velocity and discharge in conformance with the specifications of its Annex VI — Establishment and operation of a hydrometric station.

7.3.2.1 Members should ensure that the number of discharge measurements at a stream gauging station are adequate to define the rating curve for the station at all times.

Note 1: Technical Regulations, Volume III provides that Members should use the methods for determining the stage-discharge relation (rating curve) of a station as specified in its Annex VII — Determination of the stage-discharge relation.

Note 2: Technical Regulations, Volume III provides that Members should, when undertaking moving-boat discharge measurements, ensure that equipment and operational procedures are as specified in its Annex XII — Discharge measurements by the moving-boat method.

7.3.2.2 Members should measure river discharges to an accuracy commensurate with flow and local conditions. Percentage uncertainty of the discharge measurement should not exceed:

(a) In general, 5 per cent at the 95 per cent confidence level;

(b) Under difficult conditions, 10 per cent at the 95 per cent confidence level.

Note 1: Technical Regulations, Volume III provides that Members should evaluate the uncertainty in discharge measurements in conformance with the specifications in its Annex VIII — Estimation of uncertainty of discharge measurements.

Note 2: Discharge measurements are taken to establish and verify the stability of a rating curve. Stage (water level) observations are converted to estimates of discharge using the rating curve on an on-going basis.

7.3.3 Calibration Procedures

Note 1: Technical Regulations, Volume III provides that Members should adhere to the specifications of facilities, equipment and procedure for the calibration of current meters as specified in its Annex I — Calibration of current meters in straight open tanks.

Note 2: Technical Regulations, Volume III provides that Members should ensure that operational requirements, construction, calibration and maintenance of rotating element current meters are as specified in its Annex IV — Rotating element type current meters.

7.3.3.1 Members should recalibrate acoustic velocity meters on a routine basis to ensure stability of the calibration, using measurement standards traceable to international or national standards. Where no such standards exist, Members should record the basis used for calibration or verification.

Note: Additional information pertaining to the calibration of instruments can be found in the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, and the *Manual on Stream Gauging* (WMO-No. 1044).

7.4 Operations

7.4.1 Observing Practices

7.4.1.1 Members should collect and preserve their hydrological records.

7.4.1.2 Members should make the necessary arrangements to facilitate the retrieval and analysis of their hydrological observations by automatic data-processing equipment.

7.4.1.3 Where automatic registration is not available, Members should ensure the observations of elements for hydrological purposes are made at regular intervals appropriate for the elements and their intended purposes.

7.4.1.4 Members should maintain in their archives an up-to-date inventory of their hydrological observations.

7.4.1.5 Members should generally ensure uniformity in time of observations within a catchment area.

7.4.1.6 Members should select the time units used in processing hydrological data for international exchange from the following:

(a) The Gregorian calendar year;

(b) The months of this calendar;

(c) The mean solar day, from midnight to midnight, according to the zonal time, when the data permit;

(d) Other periods by mutual agreement in the case of international drainage basins or in the case of drainage basins in the same type of region.

7.4.1.7 For hydrometric stations where data are internationally exchanged, Members should process the following characteristics for each year:

(a) Maximum instantaneous and minimum daily mean values of stages (water levels) and discharge;

(b) Mean daily stages (water levels) and/or mean daily discharges.

7.4.1.8 For rivers under flood conditions or where there are variable controls, Members should make special measurements at intervals frequent enough to define the hydrograph.

7.4.1.9 When sudden and dangerous increases in river levels occur, Members should make and report observations as soon as possible without regard to the usual time of observation, to meet the intended operational use.

7.4.1.10 Members should measure and store stage (water level) observations as instantaneous values rather than averaged values.

7.4.2 Quality Control

7.4.2.1 Members should maintain detailed records for each station and for each parameter, containing metadata related to the measurements, maintenance and calibration of equipment.

7.4.2.2 Members should perform periodic audits of their stations and collected data.

7.4.2.3 Members should ensure that recorded hydrological observations are converted to a form suitable for archiving and retrieval.

Note: Observations may be initially recorded using various media from paper to electronic digital form. As computer archiving has become a standard practice by most Members, it is advantageous to convert data to the required format early in the process.

7.4.2.4 Members should ensure their data undergo, at various stages, a range of checks to determine their uncertainty and correctness.

7.4.2.5 With accelerating developments in technology, Members should ensure that data-processing and quality control systems are well-organized and that the relevant staff are trained to understand and use them.

Note: Data are collected and recorded in many ways, ranging from manual reading of simple gauges to a variety of automated data-collection, transmission and filing systems.

7.4.2.6 Members should consider the adoption of a quality management system, as described in section 2.6.

Note: Organizations usually employ an accredited certification agency to provide independent verification.

7.4.2.7 Members should undertake data processing and quality control as described in relevant publications.

Note: Such publications include the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, Chapter 9, the *Manual on Flood Forecasting and Warning* (WMO-No. 1072), Chapter 6 and the *Manual on Stream Gauging* (WMO-No. 1044), Volume II, Chapter 6.

7.4.3 Observations and Observational Metadata Reporting

7.4.3.1 Members should ensure when making available hydrological information for international purposes the use of open text or appropriate code forms as specified on the basis of bilateral or multilateral agreements.

7.4.3.2 Members should ensure that transmission facilities are organized for the international exchange of hydrological observations on the basis of bilateral or multilateral agreement.

7.4.3.3 In order to make data globally available for real-time exchange and for discovery, access and retrieval, Members should report stage and discharge observations in compliance with WMO Information System (WIS) metadata standards.

Note 1: WIS may also be used for access to hydrological observations not required in real time.

Note 2: The regulation governing exchanges in international code forms, are specified in the *Manual on Codes* (WMO-No. 306), Volume I).

Note 3: Coded information exclusively for bilateral or multilateral exchange amongst Members may be in other forms by mutual agreement.

7.4.4 Incident Management

Note: General provisions for Incident Management are provided in section 2.4.5.

7.4.5 Change Management

Note: General provisions for Change Management are provided in section 2.4.6.

7.4.6 Maintenance

7.4.6.1 Members should determine the frequency and timing of visits to recording stations by the length of time that the station can be expected to function without maintenance and the uncertainty requirements of the data.

Note 1: There is a relation between the frequency of the visits and the resultant quality of the data collected. Too long a time between visits may result in frequent recorder malfunction and, thus, in loss of data, while frequent visits are both time consuming and costly.

Note 2: Some data collection devices may suffer a drift in the relationship between the variable that is recorded and that which the recorded value represents. An example of this is a non-stable stage-discharge relationship.

Note 3: Two visits per year are considered an absolute minimum, and preferably more often to avoid the dangers of losing data and/or having data severely affected by problems such as silting, vandalism or seasonal vegetative growth.

7.4.6.2 Members should schedule periodical visits to the station to recalibrate the equipment or the measurement equations.

7.4.6.3 Members should periodically inspect stations using trained personnel to ensure the correct functioning of instruments.

7.4.6.4 Members should ensure a formal written inspection is done routinely, preferably each year, to check overall performance of instruments (and local observer, if applicable).

7.4.6.5 Members, when routinely inspecting sites, should:

(a) Measure gauge datum to check for and record any changes in levels:

(b) Check the stability of the rating curve, review the relationships between the gauges and permanent level reference points to verify that no movement of the gauges has taken place;

(c) Review the gauging frequency achieved and the rating changes identified; and

(d) Undertake a number of maintenance activities as described in section 7.4.6.8 and 7.4.6.9.

Note: It is vital, for the quality of data, that resources for gaugings be allocated and prioritized using rigorous and timely analysis of the probability and frequency of rating changes.

7.4.6.6 Members should ensure maintenance activities are conducted at data-collection sites at intervals sufficient to ensure that the quality of the data being recorded is adequate.

7.4.6.7 Members should ensure such activities are conducted by the observer responsible for the sites, if there is one. Members should ensure such activities are also occasionally performed by an inspector.

7.4.6.8 Members should undertake the following maintenance activities at all collection sites:

(a) Service the instruments;

(b) Replace or upgrade instruments, as required;

(c) Retrieve or record observations;

(d) Perform the recommended checks on retrieved records;

(e) Carry out general checks of all equipment, for example, transmission lines;

(f) Check and maintain the site to the recommended specifications;

(g) Check and maintain access to the station;

(h) Record, in note form, all of the above activities;

(i) Comment on changes in land use or vegetation;

(j) Clear debris and overgrowth from all parts of the installation.

7.4.6.9 Members should undertake the following maintenance activities at discharge collection sites:

(a) Check the bank stability, as necessary;

(b) Check the level and condition of gauge boards, as necessary;

(c) Check and service the flow-measuring devices (cableways, etc.), as necessary;

(d) Check and repair control structures, as necessary;

(e) Regularly survey cross-sections and take photographs of major station changes after events or with vegetation or land-use changes;

(f) Record, in note form, all of the above activities and their results; and

(g) Inspect the area around or upstream of the site, and record any significant land-use or other changes in related hydrological characteristics, such as ice.

Note: Further details are found in the *Manual on Stream Gauging* (WMO-No. 1044).

7.4.6.10 Members should have a well-trained technician or inspector visit stations immediately after every severe flood in order to check the stability of the river section and the gauges. If there is a local observer, Members should train this person to check for these problems and communicate them to the regional or local office.

7.4.6.11 Members should not programme flood gaugings as part of a routine inspection trip because of the unpredictable nature of floods.

7.4.6.12 Members should establish a flood action plan prior to the beginning of the storm or flood season and should specify priority sites and types of data required.

Note: If flood gaugings are required at a site, the preparations ideally would be made during the preceding dry or non-flood season so that all is ready during the annual flood season.

7.4.6.13 Members should consider undertaking the following additional measures if severe flooding is likely:

(a) Upgrade site access (helipad, if necessary);

(b Equip a temporary campsite with provisions;

(c) Store and check gauging equipment; and

(d) Flood-proof instrumentation such as stage recorders.

7.4.6.14 Following the recession of floodwaters, Members should pay particular attention to ensuring the safety and security of the data-collection site and to restoring normal operation of on-site instrumentation.

Note: In some cases, redesign and reconstruction of the site may be required. Such work would ideally take into account information obtained as a result of the flood.

7.4.7 Calibration procedures

Note: Determination of a rating curve is described in section 7.3.2. Calibration procedures for current meters, is described in section 7.3.3.

7.5 Observational Metadata

Note 1: Provisions for describing observational metadata, for recording and retaining observational metadata, and for exchanging and archiving observational metadata are provided in section 2.5. These apply to all WIGOS component observing systems including the WHOS. Further provisions specific to WHOS are stated here.

Note 2: The contents of observational metadata are detailed in Appendix 2.4including WIGOS metadata and other metadata of specific relevance for WHOS.

Note 3: Within an organization or country, a hydrological information system or a station registration file and a historical operations file (as indicated in the Guide to Hydrological Practices, WMO–No.168) or similar repositories may be used as a convenient means to compile a set of metadata about a hydrological station and its observations.

7.5.1 In addition to the provisions in section 2.5, Members should record, retain and make available the WIGOS observational metadata and also the additional observational metadata specified in the Appendix 2.4.

7.5.2 Members who use their own station identifiers for hydrological stations should maintain the means to match these with the WMO station identifiers, as specified in Appendix 2.4.

7.5.3 Members should collect and record additional detailed observational metadata identifying the purpose of the station in accordance with provisions in section 2.5.

Note: Further details are found in the *Guide to Hydrological Practices* (WMO-No. 168), Volume I, Chapter 10.

7.6 Quality Management

Note 1: Provisions for the implementation of quality management in WIGOS are provided in section 2.6. These apply to all WIGOS component observing systems including the WHOS.

Note 2: The WMO Hydrology and Water Resources Programme has developed material on the implementation of the WMO Quality Management Framework in Hydrology and for adopting this in national operations. Some Members have achieved compliance with the ISO 9001:2008 standard and examples have been documented to assist other Members.

7.7 Capacity Development

Note 1: Provisions for the implementation of capacity development in WIGOS are provided in section 2.7.

Note 2: Whatever the level of technical sophistication of a data-collection authority, the quality of its staff remains its most valuable resource.

7.7.1 Members should undertake careful recruitment, training and management to attain and maintain the appropriate personnel with the most appropriate skill sets.

7.7.2 Members should pursue a carefully structured training programme for all personnel engaged in field and office practices pertaining to data collection because they are in a strong position to influence the quality of the final data.

Note: Formal training ideally will aim at providing both a general course in first principles, plus training modules to teach in-house field and office procedures. All material is to be relevant and current.

7.7.3 Members should provide training classes, follow-up exercises, and on-the-job training to field personnel before they make streamflow and survey measurements using various technologies such as Acoustic Doppler Current Profiler (ADCP) and mechanical current meters.

7.7.4 Members should provide training classes, follow-up exercises, and on-the-job training on data collection practices and processing of data to increase employee productivity and programme effectiveness.

7.7.5 Members should have appropriate technologies in place, such as hydrological information systems, to allow for streamflow data processing and to allow the effective and efficient delivery of metadata, data and data products to users.

7.7.6 Members should have adequate number of stations to meet priority needs and ensure sufficient resources to maintain and operate sites to attain required accuracies and reliability of data for their intended use.

8. ATTRIBUTES SPECIFIC TO THE OBSERVING COMPONENT OF THE GLOBAL CRYOSPHERIC WATCH

Note: The provisions of sections 1, 2, 3 and 4 are common to all WIGOS component observing systems including the GCW. The further provisions of section 8 are specific to the GCW.

8.1 Members should collaborate actively in, and give all possible support to, the development and implementation of the observing component of Global Cryosphere Watch.

Note: GCW implementation encompasses the use of surface- and space-based observations, observing standard and recommended practices and procedures, and best practices for the measurement of essential cryospheric variables, and full assessment of error characteristics of in situ and satellite products. The initial focus of CryoNet, the surface-based standardized core observing network, is to promote the addition of cryospheric observations taken according to GCW standard and recommended practices and procedures, guidelines and best practices, at existing sites rather than creating new sites. The development of GCW includes the development of a CryoNet Guide.

8.2 Members should encourage partnerships between organizations to coordinate observing, capacity building and training activities relevant to cryospheric observations and to assist with the compilation and development of manuals on standard and recommended practices and procedures for cryospheric observation.

8.3 CryoNet shall be structured in two different classes of observational sites: Basic Sites and Integrated Sites with the following requirements:

- Basic Sites shall monitor single or multiple components of the cryosphere (glaciers, ice shelves, ice sheets, snow, permafrost, sea ice, river/lake ice, and solid precipitation) and shall observe multiple variables of each component. They shall measure auxiliary meteorological variables, shall comply with GCW agreed practices, shall be currently active, shall have long term financial commitment and shall make data freely available, whenever possible in (near) real time. Basic Sites should be suitable for the assessment of long-term changes of the cryosphere as well as for the validation of satellite data and related models.
- CryoNet Integrated Sites shall promote, through worldwide scientific collaboration, progress in the scientific understanding of the processes that change the cryosphere. These sites shall integrate in situ and space-based observations and create platforms of cryospheric observatories. In addition to the requirements for Basic Sites, CryoNet Integrated Sites shall monitor at least one of the other spheres (such as, hydrosphere, biosphere and atmosphere), have a broader research focus, have supporting staff and have training capability. Integrated Sites are particularly important for the study of feedbacks and complex interactions between the atmosphere, cryosphere, biosphere and ocean.
- CryoNet Sites contain one or more CryoNet Stations:
  - Primary Stations shall have target of long-term operation and a four (4) year initial commitment.
  - Baseline stations shall have long-term operational commitment and long-term (more than 10 years) records.

8.4 For inclusion of a GCW surface measurement site or station into CryoNet, Members and partners shall meet defined criteria. The minimum requirements are in Attachment 8.1.

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ATTACHMENT 8.1

The minimum requirements for inclusion of a GCW surface measurement site or station in CryoNet

1. The site location is chosen such that, for the cryospheric components measured, it is representative for the surrounding region.

2. User needs have been considered in the observation design process.

3. CryoNet sites have to be active and perform sustained observations according to CryoNet best practices. There shall be a commitment to continue measurements for a minimum of four (4) years.

4. Personnel are trained in the operation and maintenance of the site.

5. The responsible agencies are committed, to the extent reasonable, to sustaining long-term observations of at least one cryosphere component, including auxiliary meteorological variables.

6. The relevant CryoNet observations are of documented quality. The measurements are made and quality controlled according to CryoNet best practices.

7. Associated standard meteorological in situ observations, when necessary for the accurate determination and interpretation of the GCW variables, are made with documented quality.

8. A logbook for observations and activities that may affect observations is maintained and used in the data validation process.

9. The data and metadata including changes in instrumentation, traceability, observation procedures are submitted in a timely manner to a data centre that is interoperable with the GCW portal.

10. The station characteristics and observational programme information are kept up-to-date in the GCW station information database. Station metadata are also provided to the WIGOS Information Resource (WIR) and maintained regularly.

Attachment to Appendix 2.4

WIGOS Metadata Standard

Inter-Commission Coordination Group on the WMO Integrated Global Observing System (ICG-WIGOS) Task Team on WIGOS Metadata (TT-WMD)

Membership:

CBS: Karl Monnik, Bureau of Meteorology, Australia (co-chair 2014–)

CAS: Jörg Klausen, Federal Office of Meteorology and Climatology MeteoSwiss, Switzerland (co-chair 2014–)

CIMO: Brian Howe, Environment Canada, Canada (Chair, 2013–2014), Ercan Büyükbas, Turkish State Meteorological Service, Turkey (2014–)

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Draft Version 0.2

27 January 2015

VERSION CONTROL

Version	Date	Who	What
0.0.0	06-06-2013	J. Klausen	Consolidate input received from Brian Howe after TT-WMD telecom-2
0.0	06-06-2013	J. Klausen	Same as v0.0.0 w/o track changes; new definition of 1-04, code list 1-05
0.0.1	10-06-2013	J. Klausen	Included content for category 4 (environment)
0.0.2	30-06-2013	S Taylor	Included content for category 10 (contact)
0.0.3	01-07-2013	T Boston	Edits to category 7 (station/platform)
0.0.4	02-07-2013	K Monnik	
0.0.5	16-07-2013	J. Klausen, B. Howe	Version after Telecon-3
0.0.6	18-07-2013	T. Boston	Edits to category 4 (environment), category 7 (station/platform); code tables 4-02; 7-03
0.0.7	06-08-2013	J. Klausen	After Telecon-4
0.0.8	02-09-2013	T. Boston, B. Howe	Edits to topography category 5 and platform/station model corresponding code table.
0.0.9	03-09-2013	J. Klausen	After Telecon-5
0.0.10	??	??	Intermediate version of uncertain origin
0.0.11	03-10-2013	J,.Klausen	After Telecon-6, with expansions not discussed during telecom
0.0.12	03-10-2013	B. Howe	After Telecon-6 with changes accepted.
0.0.13	24-10-2013	B. Howe	After Telecon-7
0.0.13.ra	31-10-2013	R. Atkinson	Responses to a number of comments in 0.0.13
0.0.13.ra+km	04-11-2013	K. Monnik	General edits, additions to Cat 8, added examples to Cat 1, 5, 7.
0.0.14	04-11-2013	J. Klausen	After Telecon-8
0.0.14 km	06-11-2013	K. Monnik	Minor changes to 6.06, 8.03, 8.10, plus selected comments from Blair Trewin (AU)
0.0.15	11-11-2013	J. Klausen	After Telecon-9, and including feed-back from P. Pilon/R. Atkinson
0.0.16			After Telecon-10
0.0.17	19-12-2013	J. Klausen	After Telecon-11
0.0.18	06-02-2014	J. Klausen, K. Monnik	Response to Wiel Wauben, Bruce Forgan; version after Telecon-12, with further additions and edits, formatting
0.0.19			
0.0.20	12-03-2014 18-03-2014	B. Howe J. Klausen	After Telecon-15, accepted ICG-WIGOS MCO classifications and added two requested fields. Numerous other updates accepted. Comments by ET-SUP carried over.
0.0.21	27-03-2014	J. Klausen	Element 5-04 (Reporting interval (space)) explicitly listed; code table 5-05 included; element 5-11 (reference time) defined and explained; numbering in list of category 5 corrected; Figures 1 and 2 updated
0.0.22	03-04-2014	J. Klausen	After Telecon-16
0.0.23	28-04-2014	J. Klausen	After Telecon-17, several changes accepted, minor editing, fixed a few cross-references
0.1	15-05-2014	J. Klausen	Version after TT-WMD-2; dropped notion of “Core” in favor of a phased implementation; added element 8-00; dropped 4-04; moved element 8-05 to become 4-04; editorial improvements
0.1.01	19-05-2014	WIGOS PO	Editorial
0.1.02	03-07-2014	WIGOS PO	Review with comments and proposed changes
0.1.03	10-07-2014	TT-WMD	WebEx Sessions (03rd and 10th July 2014)
0.1.04	25-11-2014	J. Klausen	Includes several corrections and changes as they accumulated.
0.1.05	04-12-2014	TT-WMD-3	As of the end of TT-WMD 3rd session
0.1.06a	17-12-2014	L. Nunes	Intermediate editing version
0.1.06b	20-01-2015	L. Nunes	Second intermediate editing version
0.1.06	26-01-2015	Co-chairs and Secretariat	WebEx session on 20150123, plus Secretariat edits on 20150126
0.2	27-01-2015	TT-WMD	WebEx, plus co-chairs and Secretariat edits on 20150128

Table of Contents

I – Purpose and Scope of WIGOS Metadata

An important aspect of WIGOS (WMO Integrated Global Observing System) implementation is ensuring maximum usefulness of WIGOS observations. Observations without metadata are of very limited use: it is only when accompanied by adequate metadata (data describing the data) that the full potential of the observations can be utilized. Metadata of two complementary types are required. The first of these is **discovery metadata** – information that facilitates data discovery, access and retrieval. **These metadata are WIS (WMO Information System) metadata** and are specified and handled as part of WIS. The second type is **interpretation/description or observational metadata** – information that enables data values to be interpreted in context. **These latter metadata are WIGOS metadata** and are the subject of this standard, which provides a WIGOS standard for the interpretation metadata required for the effective utilization of observations from all WIGOS component observing systems by all users.

WIGOS metadata should describe the observed variable, the conditions under which it was observed, how it was measured, and how the data has been processed, in order to provide data users with confidence that the use of the data is appropriate for their application. GCOS (Global Climate Observing System) Climate Monitoring Principle #3 describes the relevance of metadata as:

> *"The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e., metadata) should be documented and treated with the same care as the data themselves."*

WIGOS observations consist of an exceedingly wide range of data from the manual observations to complex combinations of satellite hyper-spectral frequency bands, measured *in situ* or remotely, from single dimension to multiple dimensions, and those involving processing. A comprehensive metadata standard to cover all types of observations is by nature complex to define. A user should be able to use the WIGOS metadata to identify the conditions under which the observation (or measurement) was made, and any aspects which may affect its use or understanding, i.e. to determine whether the observations are fit for the purpose.

II – WIGOS Metadata Categories

Ten categories of WIGOS metadata have been identified. These are listed in Table 1 below. They define the WIGOS metadata standard, each category consisting of one or more metadata elements. All of the categories listed are considered to be important for the documentation and interpretation of observations made, and even for their use in the distant future. Hence, the standard currently declares many elements that are clearly not needed for applications focusing on more immediate use of observations. For these applications, such as numerical weather prediction, aeronautical or other transport sector applications, advisories, etc., profiles of the standard may be developed. The categories are in no particular order but reflect the need to specify the observed variable; to answer why, where and how the observation was made; how the raw data were processed; and what the quality of the observation is.

A schematic composition of all categories, containing the individual elements is shown in Figure 1. Note that some of these elements will most likely be implemented using several individual entities (e.g., geospatial location will consist of the a combination of elements, such as latitude, longitude, elevation or a set of polar coordinates, as well as a reference to the geo-positioning methods used). Chapter VII contains a set of tables detailing all the elements, including definition, notes/examples, and obligations/implementation phase. Code tables enabling users to select from pre-defined vocabularies to facilitate the application of the WIGOS metadata standard and the exchange of metadata are presented in Annex I.

Table 1: WIGOS Metadata Categories

#	Category	Description
1	Observed variable	Specifies the basic characteristics of the observed variable and the resulting datasets.
2	Purpose of observation	Specifies the main application area(s) of the observation and the observing programme(s) and networks the observation is affiliated to.
3	Station/platform	Specifies the environmental monitoring facility, including fixed station, moving equipment or remote sensing platform, at which the observation is made.
4	Environment	Describes the geographical environment within which the observation is made. It also provides an unstructured element for additional meta-information that is considered relevant for adequate use of the data and that is not captured anywhere else in this standard.
5	Instruments and methods of observation	Specifies the method of observation and describes characteristics of the instrument(s) used to make the observation. If multiple instruments are used to generate the observation, then this category should be repeated.
6	Sampling	Specifies how sampling and/or analysis are used to derive the reported observation or how a specimen is collected.
7	Data processing and reporting	Specifies how raw data are transferred into the observed variable and reported to the users.
8	Data quality	Specifies the data quality and traceability of the observation.
9	Ownership and data policy	Specifies who is responsible for the observation and owns it.
10	Contact	Specifies where information about the observation or dataset can be obtained.

For example, an observation/dataset may have the following metadata categories associated with it:

- One or several purpose(s) of observation:
- Data processing procedures associated with the instruments;
- Instruments which have been used to make the observation;
- A station/platform to which the instrument(s) belong(s);
- Ownership and data policy restriction;
- Contact.

An instrument output may contribute to observations of one or more variables. For example:

- A four wire humidity probe can produce temperature and humidity, as well as dew point;
- A sonic anemometer does report wind speed, wind direction and can report air temperature;
- A spectrometer can report absorption due to many different chemical species.

An instrument typically will be associated with the categories:

- Instruments and methods of observation;
- Sampling (e.g. 10 Hz samples of air temperature);
- Data processing and reporting (e.g. ceilometer reporting of 10 min statistics of cloud height following processing through sky condition algorithm).

An observed variable may be influenced or characterized by the environment, for example:

- Wind speed (observed variable) on top of a hill (environment);
- River yield (observed variable) characterized by the upstream catchment and land use.

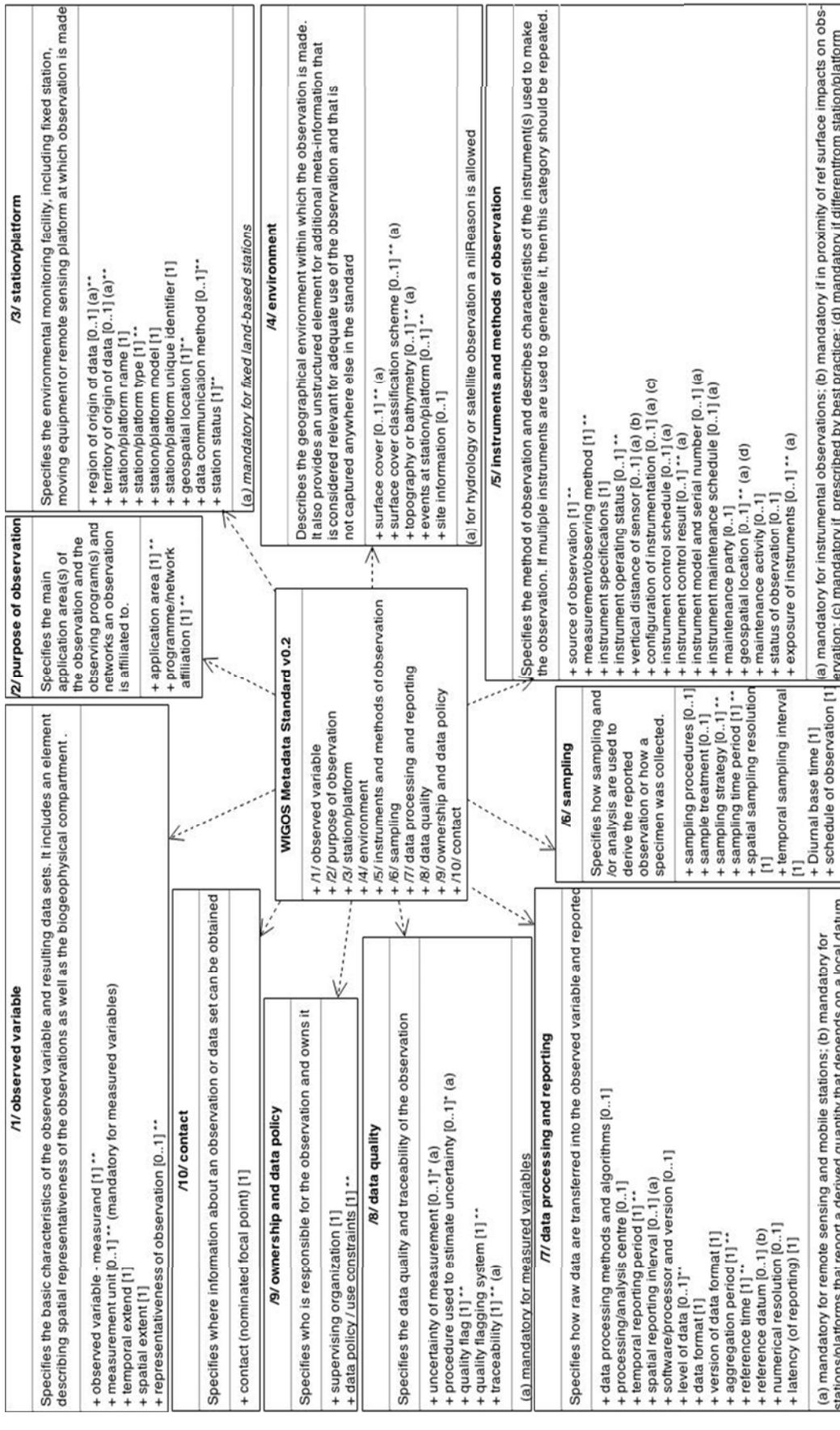

Figure 1. UML diagram specifying the WIGOS Metadata Standard (: code tables expected; [0..1*]: optional or conditional elements. Conditional elements become mandatory if a given condition is met. Conditions are referenced in parentheses. Optional elements may be declared mandatory as part of profiling the standard for specific application areas; [1..*]: mandatory elements. These elements must be reported, and if no value is available, a nilReason must be reported, which indicates that the metadata is "unknown", or "not available")**

Table 2. Names and Definition of Elements

An asterisk (*) denotes the element is required for the WIGOS Rolling Review of Requirements (RRR) process. A hash sign (#) denotes that it is acceptable to record a "mandatory" element with a value of nilReason (that indicates that the metadata is either “unknown”, or “not applicable”, or “not available”).

Category	Id	Name	Definition	MCO	Phase
Observed variable	1-01	Observed variable – measurand	Variable intended to be measured or observed or derived, including the biogeophysical context	M*	1
	1-02	Measurement unit	Real scalar quantity, defined and adopted by convention, with which any other quantity of the same kind can be compared to express the ratio of the two quantities as a number [VIM3, 1.9]	C*	1
	1-03	Temporal extent	Time period covered by a series of observations inclusive of the specified date-time indications (measurement history)	M*	1
	1-04	Spatial extent	Typical georeferenced volume covered by the observations	M*	1
	1-05	Representativeness	Spatial extent of the region around the observation for which it is representative	O	2
Purpose of observ.	2-01	Application area(s)	Context within, or intended application(s) for which the observation is primarily made or which has/have the most stringent requirements	M*	1
	2-02	Programme/Network affiliation	The global, regional or national Programmes/network(s) that the station/platform is associated with	M	1
Station/platform	3-01	Region of origin of data	WMO Region	C*	1
	3-02	Territory of origin of data	Country or territory name of the location of the observation	C*	1
	3-03	Station/platform name	Official name of the station/platform	M	1
	3-04	Station/platform type	A categorization of the type of environmental monitoring facility at which an observed variable is measured	M*	2
	3-05	Station/platform model	The model of the monitoring equipment used at the station/platform	M*#	3
	3-06	Station/platform unique identifier	A unique and persistent identifier for an environmental monitoring facility (station/platform), which may be used as an external point of reference	M*	1
	3-07	Geospatial location	Position in space defining the location of the environmental monitoring station/platform at the time of observation	M*	1
	3-08	Data communication method	Data communication method between the station/platform and some central facility	O	2
	3-09	Station Status	Declared reporting status of the station	M	1
Environment	4-01	Surface cover	The observed (bio)physical cover on the earth’s surface in the vicinity of the observation	C	3
	4-02	Surface cover classification scheme	Name and reference or link to document describing the classification scheme	C	3
	4-03	Topography or bathymetry	The shape or configuration of a geographical feature, represented on a map by contour lines	C	3
	4-04	Events at station/platform	Description of human action or natural event at the station or at the vicinity that may influence the observation	O	2
	4-05	Site information	Non-formalized information about the location and its surroundings at which an observation is made and that may influence it	O	2

Category	Id	Name	Definition	MCO	Phase
Instruments and methods of observation	5-01	Source of observation	The source of the dataset described by the metadata	M	1
	5-02	Measurement/observing method	The method of measurement/observation used	M#	1
	5-03	Instrument specifications	Intrinsic capability of the measurement/observing method to measure the designated element, including range, stability, precision, etc	M*#	1
	5-04	Instrument operating status	The status of an instrument with respect to its operation	O	3
	5-05	Vertical distance of sensor	Vertical distance of the sensor from a (specified) reference level such as local ground, or deck of a marine platform at the point where the sensor is located; or sea surface	C*	1
	5-06	Configuration of instrumentation	Description of any shielding or configuration/setup of the instrumentation or auxiliary equipment needed to make the observation or to reduce the impact of extraneous influences on the observation	C#	3
	5-07	Instrument control schedule	Description of schedule for calibrations or verification of instrument	C	3
	5-08	Instrument control result	The result of an instrument control check, including date, time, location, standard type and period of validity	C#	3
	5-09	Instrument model and serial number	Details of manufacturer, model number, serial number and firmware version if applicable	C#	3
	5-10	Instrument routine maintenance	A description of maintenance that is routinely performed on an instrument	C#	3
	5-11	Maintenance party	Identifier of the organization or individual who performed the maintenance activity	O	2
	5-12	Geospatial location	Geospatial location of instrument/sensor	C*	2
	5-13	Maintenance Activity	Description of maintenance performed on instrument	O	3
	5-14	Status of observation	Official status of observation	O	3
	5-15	Exposure of instruments	The degree to which an instrument is affected by external influences and reflects the value of the observed variable	C	2
Sampling	6-01	Sampling procedures	Procedures involved in obtaining a sample	O	3
	6-02	Sample treatment	Chemical or physical treatment of sample prior to analysis	O	3
	6-03	Sampling strategy	The strategy used to generate the observed variable	O*	1
	6-04	Sampling time period	The period of time over which a measurement is taken	M#	3
	6-05	Spatial sampling resolution	Spatial resolution refers to the size of the smallest observable object. The intrinsic resolution of an imaging system is determined primarily by the instantaneous field of view of the sensor, which is a measure of the ground area viewed by a single detector element in a given instance in time	M#	2
	6-06	Temporal sampling interval	Time period between the beginning of consecutive sampling periods	M	3
	6-07	Diurnal base time	Time to which diurnal statistics are referenced	M	1
	6-08	Schedule of observation	Schedule of observation	M	1

Category	Id	Name	Definition	MCO	Phase
Data processing and Reporting	7-01	Data processing methods and algorithms	A description of the processing used to generate the observation and list of algorithms utilized to derive the resultant value	O	3
	7-02	Processing/analysis center	Center at which the observation is processed	O	2
	7-03	Temporal reporting period	Time period over which the observable variable is reported	M*	1
	7-04	Spatial reporting interval	Spatial interval at which the observed variable is reported	C*	1
	7-05	Software/processor and version	Name and version of the software or processor utilized to derive the element value	O	3
	7-06	Level of data	Level of data processing	O	2
	7-07	Data format	Description of the format in which the observed variable is being provided	M	3
	7-08	Version of data format	Version of the data format in which the observed variable is being provided	M	3
	7-09	Aggregation period	Time period over which individual samples/observations are aggregated	M	2
	7-10	Reference time	Time base to which date and time stamps refer	M	2
	7-11	Reference datum	Reference datum used to convert observed quantity to reported quantity	C	1
	7-12	Numerical resolution	Measure of the detail in which a numerical quantity is expressed	O	3
	7-13	Latency (of reporting)	The typical time between completion of the observation or collection of the datum and when the datum is reported	M	3
Data quality	8-01	Uncertainty of measurement	Non-negative parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the observation/measurand	C*#	2
	8-02	Procedure used to estimate uncertainty	A reference or link pointing to a document describing the procedures / algorithms used to derive the uncertainty statement	C*#	2
	8-03	Quality flag	An ordered list of qualifiers indicating the result of a quality control process applied to the observation	M#	2
	8-04	Quality flagging system	Reference to the system used to flag the quality of the observation	M#	2
	8-05	Traceability	Statement defining traceability to a standard, including sequence of measurement standards and calibrations that is used to relate a measurement result to a reference [VIM 3 2.4.2]	C*#	2
Ownership and data policy	9-01	Supervising organization	Name of organization who owns the observation	M	2
	9-02	Data policy/use constraints	Details relating to the use and limitations surrounding data imposed by the supervising organization	M*	1
Contact	10-01	Contact (Nominated Focal Point)	Principal contact (Nominated Focal Point, FP) for resource	M	1

III – A Note on Space and Time

It is important to understand that WIGOS metadata are intended to describe an individual observation or a dataset, i.e. one or several observations, including the where, when, how, and even why the observations were made. As a consequence, references to space and time are made in several places throughout the standard.

Figure 2 illustrates the concepts and terms used to describe the **temporal aspects** of an observation or dataset, including sampling strategy, analysis, data processing and reporting.

The concepts and terms used to describe **spatial aspects** (i.e., geospatial location) of observations are even more complex (cf. Fig. 3). For example, for ground-based in-situ observations, the spatial extent of the observation coincides with the geospatial location of the sensor, which in most cases will be time-invariant and is normally close to the geospatial location of the station/platform where the observation was made. For a satellite-based lidar system, the situation is quite different. Depending on the granularity of metadata desired, the spatial extent of the individual observation may be an individual pixel in space, the straight line probed during an individual laser pulse, or perhaps an entire swath. In any case, the spatial extent of the observation will not coincide with the location of the sensor. The WIGOS metadata standard therefore needs to take into account such elements as:

1. The spatial extent of the observed variable (e.g. atmospheric column above a Dobson Spectrophotometer) (cf. 1-04)
2. The geospatial location of the station/platform (e.g. radar transmitter/receiver or aircraft position/route) (cf. 3-07)
3. The geospatial location of the instrument (e.g. the anemometer is adjacent to a runway) (cf. 5-05 Vertical Distance and 5-12 geospatial location)
4. The spatial representativeness of the observation (cf. 1-05)

All these are expressed in terms of geospatial location, specifying either a zero-dimensional geographic extent (a point), a one-dimensional geographic extent (a line, either straight or curved), a two-dimensional geographic extent (a plane or other surface), or a three-dimensional geographic extent (a volume).

A station/platform can be:

1. Collocated with the observed quantity as for in situ surface observing station (e.g. an Automatic Weather Station - AWS)
2. Collocated with the instrument but remote to the observed quantity (e.g. radar)
3. Remote from where the instrument may transmit data to the station (e.g. airport surface station where instruments are located across the airport, or a balloon atmosphere profiling station)
4. In motion and travelling through the observed medium (e.g. AMDAR - Aircraft Meteorological Data Relay - equipped aircraft)
5. In motion and remote to the observed medium (e.g. satellite platform)

An instrument can be:

1. Collocated with the observed variable (e.g. surface temperature sensor)
2. Remote to the observed variable (e.g. radar transmitter/receiver)
3. In motion but located in the observed medium (e.g. radiosonde)
4. In motion and remote from the observed quantity (e.g. satellite based radiometer)
5. Located within a standardized enclosure (e.g. a temperature sensor within a Stevenson screen)

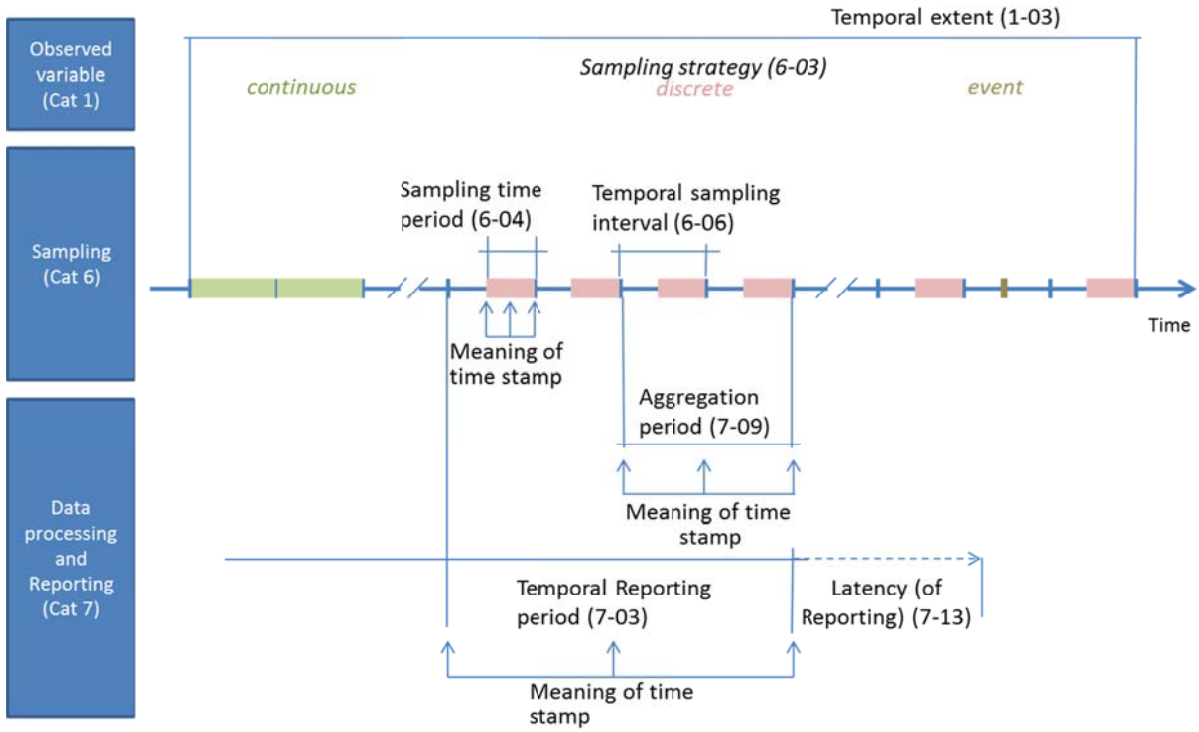

Figure 2. Graphical representation of temporal elements referenced in WIGOS Metadata categories

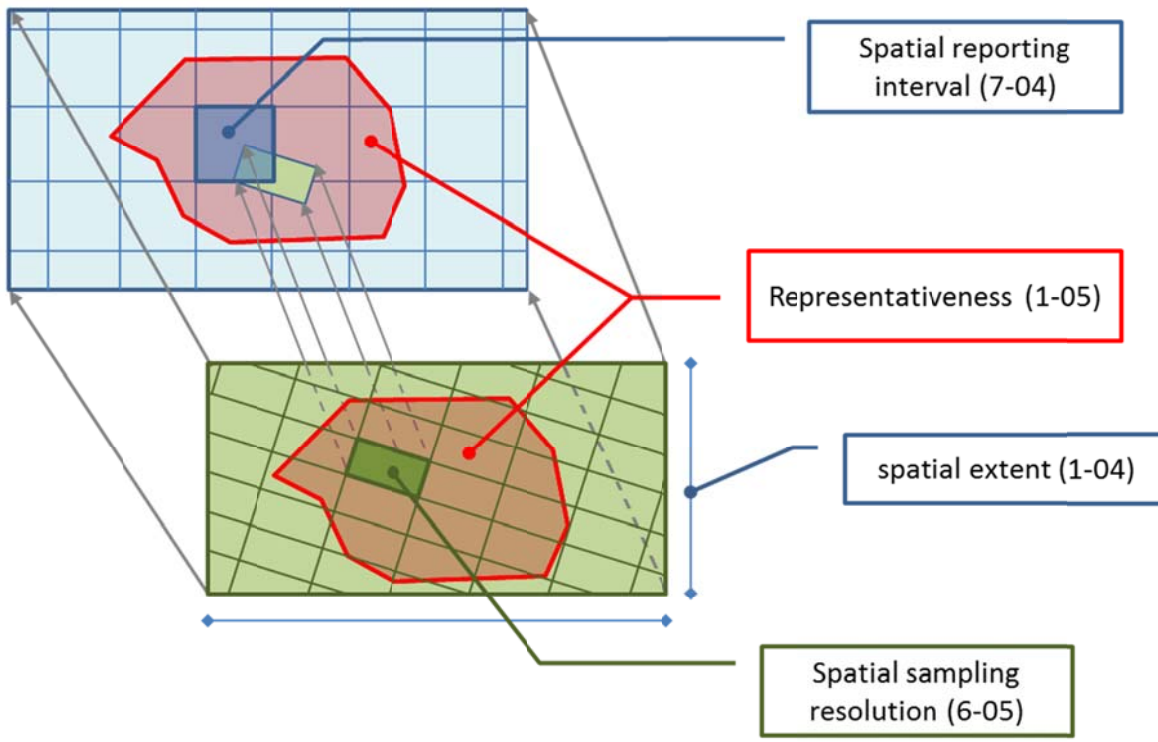

Figure 3. Graphical representation of spatial elements referenced in WIGOS Metadata categories

IV – Reporting Obligations for WIGOS Metadata

According with the International Organization for Standardization (ISO), the metadata elements are classified as either mandatory (M), conditional (C), or optional (O).

Mandatory metadata elements shall always be made available. The content of the corresponding fields shall never be empty, either the metadata “value” or the reason for no-value, shall be made available.

Most of the elements in this standard are considered **mandatory** in view of enabling adequate future use of observations by all WMO Application Areas. Metadata providers are expected to report mandatory metadata elements, and a formal validation of a metadata record will fail if mandatory elements are not reported. If Members cannot provide all the Mandatory elements the reason for that shall be reported as “not applicable” or “unknown” or “not available”. The motivation for this is that knowledge of the reason why a mandatory metadata element is not available provides more information than not reporting a mandatory element at all. In the tables of chapter VII, these cases are indicated with M$^{\#}$.

Conditional metadata elements shall be made available when the specified condition or conditions are met, in which case the content of the corresponding fields shall never be empty, either the metadata “value” or the reason for no-value, shall be made available. For example, the element “Spatial reporting interval” is classified as conditional, because it only applies to remote sensing observations and mobile platforms. Therefore, the elements in this category should be considered mandatory for remote sensing and mobile observing systems but not so for e.g., surface land stations.

Optional metadata elements should also be made available. They provide useful information that can help to better understand an observation. In this version of the standard, very few elements are considered optional. Optional elements are likely to be important for a particular community, but less so for others.

V – Technical Implementation and Use of Standard

This document is a semantic standard that specifies the elements that exist and that can be recorded and reported. It does not specify how the information shall be encoded or exchanged. However, the following are likely scenarios and important aspects that may help the reader appreciate what lies ahead.

1. The most likely implementation will be in XML (Extensible Markup Language), in line with the specifications for WIS metadata and common interoperability standards. Regardless of the final implementation, the full metadata record describing a dataset can be envisioned as a tree with the categories as branches off the stem, and the individual elements as leaves on these branches. Some branches may occur more than once, e.g., a dataset may have been generated using more than one instrument at once, in which case two branches for 'instrument' may be required.

2. Not all of the elements specified in this document need to be updated at the same frequency. Some elements, such as position of a land-based station are more or less time-invariant, while others, such as a specific sensor, may change regularly every year. Still other elements, such as environment, may change gradually or rarely, but perhaps abruptly. Finally, elements restricting the application of an observation, e.g., to road condition forecasting, may have to be transmitted with every observation. The implementation of the WIGOS metadata needs to be able to deal with this.

3. Not all applications of observations require the full suite of metadata as specified in this standard at any given time. The amount of metadata that needs to be provided to be able to make adequate use of an observation, for example for the purpose of issuing a heavy precipitation warning, is much less than for the adequate use of even the same observation for a climatological analysis. On the other hand, the metadata needed for near-real-time applications may also need to be provided in near-real-time. This is important to realize, as it makes the task of providing WIGOS metadata much more tractable. The implementation of WIGOS metadata needs to be able to cope with vastly different update intervals, and incremental submission of additional metadata to allow the creation of 'complete' metadata records.

4. Users will want to obtain and filter datasets according to certain criteria/properties as described within each WIGOS metadata record. This functionality requires either a central repository for WIGOS metadata or full interoperability of the archives collecting WIGOS metadata.

How, then can these requirements be met? In the case where observations are clearly only used for some near-real-time application and there is clearly no long-term use or re-analysis application to be expected, a profile of the WIGOS metadata standard may be specified that declares a specific subset of metadata elements as mandatory. This is depicted schematically in Figure 4.

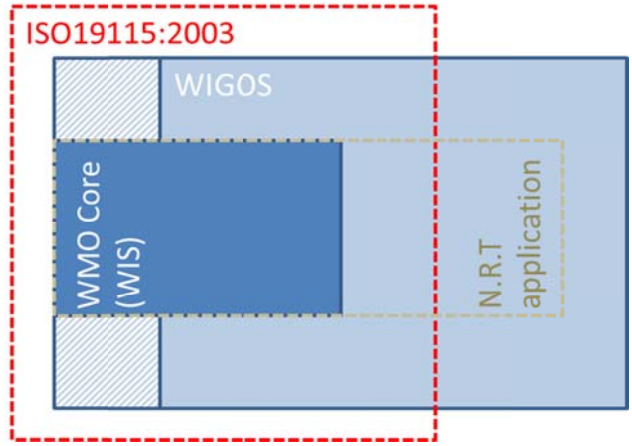

Figure 4. Schematic of the relationship of WIS and WIGOS metadata and the scope of the ISO19115 standard. The WMO Core is a profile of ISO19115. WIGOS metadata exceed the scope of ISO19115 standard. A possible profile (subset) of WIGOS metadata elements for some specific near-real-time application is also shown.

Importantly, all WIGOS metadata elements (or group of elements) will have to be time-stamped with the time of validity and associated to a unique identifier for a dataset during transmission and for archiving. The specification of time stamps should also include a statement on the use of daylight savings time. Using this approach, increments of a 'full' WIGOS metadata record can be transmitted anytime changes occur and updates are deemed necessary. At the archive, the increments can be added to the existing metadata record for that dataset, establishing the full history of a particular observation with time.

VI – Adoption through a Phased Approach

Making available WIGOS metadata will generate substantial benefits for Members, but developing the capacity to make available these metadata also requires a substantial effort on the part of (meta)data providers. To help Members comply with obligations, guidance material will be developed and provided.

Moreover, obligations will be enforced in phases in order to allow Members sufficient time to develop the capacity to comply. Balancing the effort required to generate and make available the metadata elements, and the need to have this information to make adequate use of observations, implementation will proceed through three phases as shown in Table 3. Importantly, elements required by the end of **Phase I** are either listed as mandatory elements in WMO-No. 9, Vol. A or are of critical importance for the Observing Systems Capability Analysis and Review (OSCAR) tool of the WIR (WIGOS Information Resource), and are considered of benefit for all application areas. **Phase II** adds elements recognized to be more challenging for Members, but the knowledge of which is still of rather immediate need for the adequate use of observations, in particular for assessing quality of observations. **Phase III** adds the remaining elements specified in this version of the standard.

Elements emerging as being important for specific application areas or observing programmes will be added to the standard as it evolves.

Table 3. List of elements specified in the WIGOS Metadata Standard and the phases for implementation by Members

Category	Phase I	Phase II	Phase III
	2016	2017–2018	2019–2020
1. Observed variable	**1-01 Observed variable – measurand (M)**	1-05 Representativeness (O)	
	1-02 Measurement unit (C)		
	1-03 Temporal extent (M)		
	1-04 Spatial extent (M)		
2. Purpose of observation	**2-01 Application area(s) (M)**		
	2-02 Programmes/Network affiliation (M)		
3. Station/ Platform	*3-01 Region of origin of data (C)*	**3-04 Station/platform type (M)**	**3-05 Station/platform model (M)**
	3-02 Territory of origin of data (C)	3-08 Data communication method (O)	
	3-03 Station/platform name (M)		
	3-06 Station/platform unique identifier (M)		
	3-07 Geospatial location (M)		
	3-09 Station status (M)		
4. Environment		4-04 Events at Station/platform (O)	*4-01 Surface cover (C)*
		4-05 Site information (O)	*4-02 Surface Cover classification scheme (C)*
			4-03 Topography or Bathymetry (C)

Category	Phase I	Phase II	Phase III
	2016	2017–2018	2019–2020
5. Instruments and Methods of Observation	**5-01 Source of observation (M)**	5-11 Maintenance party (O)	5-04 Instrument operating status (O)
	5-02 Measurement/observing method (M)	*5-12 Geospatial location (C)*	*5-06 Configuration of instrumentation (C)*
	5-03 Instrument specifications (M)	*5-15 Exposure of instrument (C)*	*5-07 Instrument control schedule (C)*
	5-05 Vertical distance of sensor (C)		*5-08 Instrument control result (C)*
			5-09 Instrument model and serial number (C)
			5-10 Instrument routine maintenance (C)
			5-13 Maintenance Activity (O)
			5-14 Status of observation (O)
6. Sampling	6-03 Sampling strategy (O)	**6-05 Spatial sampling resolution (M)**	6-01 Sampling procedures (O)
	6-07 Diurnal base time (M)		6-02 Sample treatment (O)
	6-08 Schedule of observation (M)		**6-04 Sampling time period (M)**
			6-06 Temporal sampling interval (M)
7. Data Processing and Reporting	**7-03 Temporal reporting period (M)**	7-02 Processing/analysis center (O)	7-01 Data processing methods and algorithms (O)
	7-04 Spatial reporting interval (C)	7-06 Level of data (O)	7-05 Software/processor and version (O)
	7-11 Reference datum (C)	**7-09 Aggregation period (M)**	**7-07 Data format (M)**
		7-10 Reference time (M)	**7-08 Version of data format (M)**
			7-12 Numerical resolution (O)
			7-13 Latency (of reporting) (M)
8. Data Quality		8-01 Uncertainty of measurement (C)	
		8-02 Procedure used to estimate uncertainty (C)	
		8-03 Quality flag (M)	
		8-04 Quality flagging system (M)	
		8-05 Traceability (C)	
9. Ownership and Data Policy	**9-02 Data policy/use constraints (M)**	9-**01 Supervising organization (M)**	
10. Contact	**10-01 Contact (Nominated Focal Point) (M)**		

VII – Detailed specification of WIGOS metadata elements

Category 1: Observed variable

Specifies the basic characteristics of the observed variable and the resulting datasets. It includes an element describing the spatial representativeness of the observation as well as the biogeophysical compartment the observation describe.

Id	Name	Definition	Note or Example	Code Table	ItemMCO[1]
1-01	Observed variable (measurand)	Variable intended to be measured or observed or derived, including the biogeophysical context	*[ISO19156] NOTE 1:* In conventional measurement theory the term "measurement" is used. However, a distinction between measurement and category-observation has been adopted in more recent work so the term "observation" is used for the general concept. "Measurement" may be reserved for cases where the result is a numeric quantity. *NOTE 2:* The biogeophysical context is expressed in terms of Domain, Subdomain/Matrix, and Layer, and variables are organized hierarchically using these dimensions. Relevant domains, matrices and layers include atmosphere, aerosol, lake, river, ocean, soil, cloud water, aerosol particulate phase, land surface, troposphere, upper troposphere/lower stratosphere, space, etc. *EXAMPLES:* In hydrology, this would typically be stage or discharge. Present weather; Air temperature near the surface; CO_2 mixing ratio in the atmosphere	1-01	M* (Phase 1)
1-02	Measurement unit	Real scalar quantity, defined and adopted by convention, with which any other quantity of the same kind can be compared to express the ratio of the two quantities as a number [VIM3, 1.9]	*[*JCGM 200:2012*, 1.9] NOTE 1.* Measurement units are designated by conventionally assigned names and symbols.	1-02	C* (Phase 1)

[1] An asterisk (*) denotes the element is required for the WIGOS Rolling Review of Requirements (RRR) process. A hash sign (#) denotes that it is acceptable to record a "mandatory" element with a value of nilReason (that indicates that the metadata is either "unknown", or "not applicable", or "not available").

Id	Name	Definition	Note or Example	Code Table	ItemMCO[1]
			*[*JCGM 200:2012*, 1.9] NOTE 2* Measurement units of quantities of the same quantity dimension may be designated by the same name and symbol even when the quantities are not of the same kind. For example, joule per kelvin and J/K are respectively the name and symbol of both a measurement unit of heat capacity and a measurement unit of entropy, which are generally not considered to be quantities of the same kind. However, in some cases special measurement unit names are restricted to be used with quantities of a specific kind only. For example, the measurement unit 'second to the power minus one' (1/s) is called hertz (Hz) when used for frequencies and becquerel (Bq) when used for activities of radionuclides. *[*JCGM 200:2012*, 1.9] NOTE 3* Measurement units of **quantities of dimension one** are numbers. In some cases these measurement units are given special names, e.g. radian, steradian, and decibel, or are expressed by quotients such as millimole per mole equal to 10^{-3} and microgram per kilogram equal to 10^{-9}. *[*JCGM 200:2012*, 1.9] NOTE 4* For a given quantity, the short term "unit" is often combined with the quantity name, such as "mass unit" or "unit of mass". *EXAMPLE* In hydrology, this would typically be m for stage or m^3/s for discharge.		
1-03	Temporal extent	Time period covered by a series of observations inclusive of the specified date-time indications (measurement history)	*NOTE 1*: The Temporal Extent is defined through the begin and end dates of observations. *NOTE 2*: If the data are still being added to, omit the End date (but specify a Begin date). *NOTE 3*: If there are gaps in the data collection (e.g. 1950-1955 then collection resumes 1960-present) then the first date recorded should be the earliest date and the last the most recent, ignoring the gap.		M* (Phase 1)

Id	Name	Definition	Note or Example	Code Table	ItemMCO[1]
			EXAMPLES: Surface temperature at the station Säntis has been observed since 1 September 1882. The CO_2 record at Mauna Loa extends from 1958 to today. Continuous, 1-hourly aggregates are available from the World Data Centre for Greenhouse Gases for the period 1974-01-01 to 2011-12-31		
1-04	Spatial extent	Typical spatial georeferenced volume covered by the observations	*NOTE 1*: The spatial extent of an observed quantity can be a zero-, one-, two-, or three-dimensional feature and will be expressed in terms of a series of geospatial locations describing a geometric shape. *NOTE 2*: A zero-dimensional geospatial location of an observation implies either an in-situ (point) observation or, by convention, a column-averaged quantity above the specified geospatial location in nadir. One-dimensional geospatial location of an observation implies a distribution / profile of a quantity along a trajectory (e.g., a straight line from the ground up with a given zenith angle). A two-dimensional geospatial location of an observation implies an area or hyper-surface (e.g., a radar image, or a satellite pixel of a property near the surface). A three-dimensional geospatial location of an observation implies a volume-averaged quantity (e.g., a radar pixel in 3D-space). *EXAMPLES:* i) Air temperature at a surface observing site: Sydney Airport NSW: Lat. -33.9465 N; Lon. 151.1731 E, Alt: 6.0 m above msl. ii) The projected area or volume of the cone around a particular weather radar with a maximum range of 370 km (radar reflectivity) and 150 km (Doppler); to be expressed as a geometric shape. iii) 3-dimensional grid of radar pixels iv) Infrared and visible imagery by meteorological satellite (sunsynchronous): VIRR (FY-3), Global coverage twice/day (IR) or once/day (VIS) v) River discharge by gauge: size and geometric shape of a river Catchment.		M* (Phase 1)

Id	Name	Definition	Note or Example	Code Table	ItemMCO[1]
1-05	Representativeness	Spatial extent of the region around the observation for which it is representative	*NOTE*: The representativeness of an observation is the degree to which it describes the value of the variable needed for a specific purpose. Therefore, it is not a fixed quality of any observation, but results from joint appraisal of instrumentation, measurement interval and exposure against the requirements of some particular application (WMO-No. 8, 2008). Representativeness of an observed value describes the concept that the result of an observation made at a given geospatial location would be compatible with the result of other observations of the same quantity at other geospatial locations. In statistics, the term describes the notion that a sample of a population allows an adequate description of the whole population. Assessing representativeness can only be accomplished in the context of the question the data [or observations] are supposed to address. In the simplest terms, if the data [or observations] can answer the question, it is representative (Ramsey and Hewitt, 2005). The representativeness of an environmental observation depends on the spatio-temporal dynamics of the observed quantity (Henne et al., 2010). Representativeness of an observation can sometimes be specified quantitatively, in most cases qualitatively, based on experience or heuristic arguments.	1-05	O (Phase 2)

Condition:

{1-02} variables that are measured, rather than classified

Category 2: Purpose of Observation

Specifies the main application area(s) of the observation and the observing programme(s) and networks the observation is affiliated to.

Id	Name	Definition	Note or Example	Code Table	ItemMCO
2-01	Application area(s)	Context within, or intended application(s) for which the observation is primarily made or which has/have the most stringent requirements	*NOTE:* Many observations serve more than one purpose, meeting the requirements of various applications areas. In such cases, the application area for which the station was originally established should be listed first.	2-01	M* (Phase 1)
2-02	Program/Network affiliation	The global, regional or national program/network(s) that the station/platform is associated with	*EXAMPLES:* GUAN, AMDAR, GAW, RBSN, WHOS, etc. (full names to be referenced in code table)	2-02	M (Phase 1)

Category 3: Station/Platform

Specifies the environmental monitoring facility, including fixed station, moving equipment or remote sensing platform at which the observation is made.

Id	Name	Definition	Note or Example	Code Table	ItemMCO
3-01	Region of origin of data	WMO Region	*NOTE:* WMO divides Member countries into six Regional Associations responsible for coordination of meteorological, hydrological and related activities within their respective Regions.	3-01	C* (Phase 1)
3-02	Territory of origin of data	Country or territory name of the location of the observation	*NOTE*: Mandatory for fixed stations, optional for mobile stations *EXAMPLE*: Australia.	3-02	C* (Phase 1)
3-03	Station/platform name	Official name of the station/platform	*EXAMPLES*: Mauna Loa, South Pole		M (Phase 1)
3-04	Station/platform type	A categorization of the type of environmental monitoring facility at which an observed variable is measured	*NOTE*: Code table according to See [INSPIRE D2.8.III.7, 2013]	3-04	M* (Phase 2)
3-05	Station/platform model	The model of the monitoring equipment used at the station/platform	*EXAMPLES*: 'Landsat 8' is a platform/station model of 'satellite'; 'Almos Automatic Weather Station (AWS)' is a model of a 'land station'; 'Airbus A340-600' is a model of an 'aircraft'.		M*# (Phase 3)
3-06	Station/platform unique identifier	A unique and persistent identifier for an environmental monitoring facility (station/platform), which may be used as an external point of reference	*NOTE*: A globally unique identifier assigned by WMO for a station. Where a station has multiple identifiers, there must be a way of recording that they are synonyms. To be defined according to WMO guidelines. *EXAMPLE*: Ship: Call sign.		M* (Phase 1)
3-07	Geospatial location	Position in space defining the location of the environmental monitoring station/platform at the time of observation	*NOTE 1*: Required for fixed stations; for stations following pre-determined trajectory (e.g. satellites); *NOTE 2*: The elevation of a fixed terrestrial station is defined as the height above sea level of the ground on which the station stands ("Hha" in WMO Pub. 9 Vol A).	11-01 11-02	M* (Phase 1)

Id	Name	Definition	Note or Example	Code Table	ItemMCO
			NOTE 3: The geospatial location can be a zero-, one-, two-, or three-dimensional feature. *NOTE 4*: Geographical coordinates can be specified in decimal degrees. Latitudes are specified with reference to the equator, with positive sign for latitudes north of the equator, and negative sign for latitudes south of the equator. Longitudes are specified with reference to the Greenwich meridian, with positive sign for longitudes east of Greenwich, and negative sign for meridians west of Greenwich. Elevation is a signed number specified in some distance measure (e.g., meters) relative to a reference elevation, with positive sign in the direction away from the Earth centre. *NOTE 5*: The latitudinal and longitudinal positions of a station referred to in the World Geodetic System 1984 (WGS-84) Earth Geodetic Model 1996 (EGM96) must be recorded to a resolution of at least 0.001 decimal degrees (WMO-No. 8, 2008, Part I, Chapter 1, 1.3.3.2). *NOTE 6:* This element comprises 3 entities, the coordinates (Lat/Long/Alt), the "geopositioning method" (code table 11-01) which produced the coordinates, as well as the "geospatial reference system" (code table 11-02) used. *EXAMPLES:* (i) The station Jungfraujoch is located at 46.54749°N 7.98509°E (3580.00 m a.m.s.l.). The reference system is WGS-84. (ii) Voluntary Observing Ship Route: WMO Regional Association 5, Sub Area 6 (R56) (iii) [geostationary satellite] Meteosat-8 (MSG-1) 3.6°E (iv) [sun-synchronous satellite] NOAA-19 Height 870 km; Local Solar Time (LST) 13:39 (v) Weather Watch Radar: Warruwi NT -11.6485° N, 133.3800 E, Height 19.1 m amsl. (vi) River discharge gauge: Warrego River at Cunnamulla Weir 28.1000 S, 145.6833 E, Height: 180 m amsl.		

Id	Name	Definition	Note or Example	Code Table	ItemMCO
3-08	Data communication method	Data communication method between the station/platform and some central facility	*EXAMPLES*: Inmarsat-C, ARGOS, Cellular, Globalstar, GMS(DCP), Iridium, Orbcomm, VSat, landline telephone, mail	3-08	O (Phase 2)
3-09	Station status	Declared reporting status of the station	*NOTE:* Refer to the code table	3-09	M (Phase 1)

Conditions:

{3-01, 3-02}: Mandatory for fixed land-based stations, optional for mobile stations

Category 4: Environment

Describes the geographical environment within which the observation is made. It also provides an unstructured element for additional meta-information that is considered relevant for adequate use of the observations and that is not captured anywhere else in the standard.

Id	Name	Definition	Note or Example	Code table	ItemMCO
4-01	Surface cover	The observed (bio)physical cover on the Earth's surface in the vicinity of the observation	*NOTE 1:* To be applied to 3 different geographic scales of the vicinity of the observation, namely horizontal radii of <100 m, of 100 m to 3 km, and of 3 km to 100 km. *NOTE 2:* Surface cover or land cover is distinct from land use despite the two terms often being used interchangeably. Land use is a description of how people utilize the land and socio-economic activity – urban and agricultural land uses are two of the most commonly known land use classes. At any one point or place, there may be multiple and alternate land uses, the specification of which may have a political dimension (Wikipedia, 2013). *NOTE 2:* There are various classification methods for 'land cover'. The MODIS product MCD12Q1 provides 5 different classifications on 500 m resolution grid (https://lpdaac.usgs.gov/products/modis_products_table/mcd12q1). These include the IGBP, UMD, LAI/fPAR, NPP and PFT classifications. *NOTE 3:* An alternative approach is the 'Land Cover Classification System' (LCCS) adopted by the Food and Agriculture Organization of the United Nations. Translation of other systems to LCCS has been explored by Herold et al. (2009). Eight major land cover types are identified during the first, dichotomous classification phase. These are refined in a subsequent so-called Modular-Hierarchical Phase, in which land cover classes are created by the combination of sets of pre-defined classifiers. These classifiers are tailored to each of the eight major land cover types. This process can be supported by software (http://www.glcn.org/sof_7_en.jsp) or manually using a field log sheet (http://commons.wikimedia.org/wiki/File:LCCS_field_protokoll.png)	4-01	C (Phase 3)

Id	Name	Definition	Note or Example	Code table	ItemMCO
4-02	Surface cover classification scheme	Name and reference or link to document describing the classification scheme	IGBP, UMD, LAI/fPAR, NPP and PFT, LCCS (recommended implementation as a URI pointing to the code table)	4-02	C (Phase 3)
4-03	Topography or bathymetry	The shape or configuration of a geographical feature, represented on a map by contour lines	*NOTE 1*:Topography shall be formally expressed with the four elements 'local topography', 'relative elevation', 'topographic context', and 'altitude/depth'. *NOTE 2:* The term 'altitude' is used for elevations above mean sea level. The term 'depth' is used for elevations below mean sea level. *EXAMPLES (can be converted into entries of the code table):* "a ridge at low relative elevation within valleys of middle altitude" "a depression within plains of very low depth"	4-03	C (Phase 3)
4-04	Events at station/platform	Description of human action or natural event at the station or in the vicinity that may influence the observation		4-04 or free text	O (Phase 2)
4-05	Site information	Non-formalized information about the location and its surroundings at which an observation is made and that may influence it	*NOTE 1:* This information may be frequently changing (for example ocean debris impacting buoys). *NOTE 2:* In hydrology, description and dating of activities occurring in the basin that can affect the observed discharge, e.g., construction of a regulation structure upstream of the gauging location that significantly affects the hydrological regime, inter-basin diversion of water into or from the basin upstream of the gauging location, significant change in consumptive use, land cover or land use. *EXAMPLES:* maps, plans, photographs, descriptions and other unique site information that is difficult to express in words or that cannot easily be quantified.		O (Phase 2)

Conditions:

Either {4-01 and 4-02 and 4-03} or a nilReason="not applicable" must be reported. For hydrology and satellite observations, specifying nilReason is appropriate.

Category 5: Instruments and Methods of Observation

Specifies the method of observation and describes characteristics of the instrument(s) used to make the observation. If multiple instruments are used to generate the observation, then this category should be repeated.

Id	Name	Definition	Note or Example	Code Table	ItemMCO
5-01	Source of observation	The source of the dataset described by the metadata	*NOTE:* Refer to the Code table	5-01	M (Phase 1)
5-02	Measurement/observing method	The method of measurement/ observation used	*EXAMPLES:* Temperature can be determined using different principles: liquid in glass; mechanical; electrical resistance; thermistor; thermocouple. Likewise, humidity is determined in AMDAR as amass mixing ratio. Several chemical variables can be determined using infrared absorption spectroscopy. In hydrology, stage would be observed using a staff gauge, electric tape, pressure transducer, gas bubbler, or acoustics. Examples of satellite observation principles: Cross-nadir scanning IR sounder; MW imaging/sounding radiometer, conical scanning, etc. Visual observation of weather, cloud type, etc.	5-02	M[#] (Phase 1)
5-03	Instrument specifications	Intrinsic capability of the measurement/observing method to measure the designated element, including range, stability, precision, etc.	*NOTE 1*: The metadata record can be "not available". *NOTE 2*: Includes the Upper limit of operational range and the Lower limit of operational range *EXAMPLES:* 1) Barometer measurement range 800–1100 hPa (i.e. unsuitable for some mountain ranges, Mt Everest ~300hPa) 2) Maximum distance a human observer can observe given the topography.		M*[#] (Phase 1)
5-04	Instrument operating status	The status of an instrument with respect to its operation	*NOTE:* To be recorded by data providers for each individual observation	5-04	O (Phase 3)

Id	Name	Definition	Note or Example	Code Table	ItemMCO
5-05	Vertical distance of sensor	Vertical distance of the sensor from a (specified) reference level such as local ground, or deck of a marine platform at the point where the sensor is located; or sea surface	*NOTE 1:* The reference surface (generally a surface which will strongly influence the observation) must be specified. *NOTE 2:* Away from center of earth, positive. Negative values indicate position below reference surface. *EXAMPLES:* i) Air temperature: height of the temperature sensor is 1.50 m above ground surface (station level). ii) Surface wind: 10.0 m above ground surface (station level) iii) Soil temperature: 0.50 m below soil surface; iv) Ship: Visual Obs Height: 22.0 m a.s.l. v) Weather Watch Radar: Warruwi AU 24.3 m above ground surface (see 7-07) vi) Transmissometer 2.55 above runway surface vii) depth of buoy relative to lowest astronomical tide viii) Pressure sensor: vertical distance above mean sea level ix) For satellites, e.g., geostationary orbit at 36000 km above geoid, or LEO at 800 km above geoid		C* (Phase 1)
5-06	Configuration of instrumentation	Description of any shielding or configuration/setup of the instrumentation or auxiliary equipment needed to make the observation or to reduce the impact of extraneous influences on the observation	*EXAMPLES:* shelter, temperature control, etc. Internal volume: [m^3] Aspirated: [Natural/forced/na] Aspiration rate: m^3s^{-1} Shielding from: [radiation/precipitation/ wind/etc.]		C# (Phase 3)
5-07	Instrument control schedule	Description of schedule for calibrations or verification of instrument	*EXAMPLE:* Every year on first week of February		C (Phase 3)

Id	Name	Definition	Note or Example	Code Table	ItemMCO
5-08	Instrument control result	The result of an instrument control check, including date, time, location, standard type and period of validity	*NOTE 1:* For the result of control check code table 5-08 is to be used *NOTE 2:* record even if "not available" *NOTE 3:* Information should contain at least the following elements: Standard type: [International, Primary, Secondary, Reference, Working, Transfer, Travelling, collective] Standard name: [free text] Standard reference: [serial number or equivalent] Within verification limit [Y/N] *NOTE 4*: Can be implemented with a URI pointing to a document containing this information *EXAMPLE:* *20140207 15:30 UTC, travelling standard, <name>, <S/N>, field calibration, result: in calibration,* validity: 4 years	5-08	C# (Phase 3)
5-09	Instrument model and serial number	Details of manufacturer, model number, serial number and firmware version if applicable	*NOTE 1*: Record "not available" NOTE 2: Use the following formats: Instrument manufacturer: [free text] Instrument model: [free text] Instrument serial number: [free text] Firmware version: [free text] *EXAMPLE*: Vaisala PTB330B G2120006		C# (Phase 3)
5-10	Instrument routine maintenance	A description of schedule maintenance that is performed on an instrument	*EXAMPLE*: Daily cleaning of a radiation sensor.		C# (Phase 3)
5-11	Maintenance party	Identifier of the organization or individual who performed the maintenance activity			O (Phase 2)

Id	Name	Definition	Note or Example	Code Table	ItemMCO
5-12	Geospatial location	Geospatial location of instrument/sensor	*NOTE 1:* Geographic location of instrument such as airfield anemometer or transmissometer. *NOTE 2:* This element comprises 3 entities, the coordinates (Lat/Long/Alt), the "geopositioning method" (code table 11-01) which produced the coordinates, as well as the "geospatial reference system" (code table 11-02) used. *EXAMPLES:* 1) Melbourne Airport AU (East anemometer) –37.6602 N, 144.8443 E, 122.00 m amsl. 2) relative position of wind sensor aboard ship 3) 30 km upstream of river mouth	11-01 11-02	C* (Phase 2)
5-13	Maintenance Activity	Description of maintenance performed on instrument	*NOTE:* A log of actual maintenance activity, both planned and corrective		O (Phase 3)
5-14	Status of observation	Official status of observation	*NOTE:* A binary flag	5-14	O (Phase 3)
5-15	Exposure of instruments	The degree to which an instrument is affected by external influences and reflects the value of the observed variable	NOTE: The exposure of an instrument results from joint appraisal of the environment, measurement interval and exposure against the requirements of some particular application. Expressed in terms of code table.	5-15	C (Phase 2)

Conditions:

{5-07, 5-08, 5-09, 5-10, 5-15} mandatory for instrumental observations

{5-05} mandatory for instrumental observations and if proximity of reference surface impacts on observation

{5-06} mandatory for instrumental observations and if prescribed by “best practice”.

{5-12} mandatory for instrumental observations and if different from station/platform

Category 6: Sampling

Specifies how sampling and/or analysis are used to derive the reported observation or how a specimen is collected.

Id	Name	Definition	Note or Example	Code Table	ItemMCO
6-01	Sampling procedures	Procedures involved in obtaining a sample	*EXAMPLES*: Temperature measurements are made using a XYZ thermometer and reported results are an average of 10 measurements made in a given hour. Aerosols may be sampled with an inlet with size-cutoff at 2.5 µm and be deposited on a teflon filter. Manual reading of a liquid-in-glass thermometer every three hours. As an exception, an observer may observe the state of the sky from home rather than at the station during night. Rain fall is accumulated during the whole week-end and distributed evenly over these 2 days.		O (Phase 3)
6-02	Sample treatment	Chemical or physical treatment of sample prior to analysis	*EXAMPLES*: Homogenization, milling, mixing, drying, sieving, heating, melting, freezing, evaporation…		O (Phase 3)
6-03	Sampling strategy	The strategy used to generate the observed variable	*EXAMPLES*: Continuous: global radiation, atmospheric pressure, or continuous ozone monitoring with a UV monitor; Discrete: gas chromatographic analysis of carbon monoxide, radar rainfall; Event: grab water samples, flask sampling of air, etc.	6-03	O* (Phase 1)
6-04	Sampling time period	The period of time over which a measurement is taken	*NOTE:* Includes the sampling time period, plus the meaning of time stamp (11–03). *EXAMPLES*: surface winds sampled every 0.25 s (frequency 4 Hz) (WMO, 2008); surface winds measured once per hour; Barometric pressure measured once every 6 minutes; water column height measured every 15 seconds; water temperature measured once per hour (NOAA, 2009); For each example, Time stamp indicates “end of period”.	11-03	M[#] (Phase 3)

Id	Name	Definition	Note or Example	Code Table	ItemMCO
6-05	Spatial sampling resolution	Spatial resolution refers to the size of the smallest observable object. The intrinsic resolution of an imaging system is determined primarily by the instantaneous field of view of the sensor, which is a measure of the ground area viewed by a single detector element in a given instance in time.	*EXAMPLES*: AVHRR: 1.1 km IFOV s.s.p. The sample is a point in space or a very small volume resembling a point, e.g., a temperature sampled by a thermocouple element: No size to be reported; The sample is a line, either straight (e.g., a line of sight of a DOAS instrument) or curved (e.g., the humidity sampled by an aircraft in flight). The 'length' of the line is to be reported; The sample is an area, either rectangular or of any other shape, e.g., the pixel of a satellite or the reach of a radar image. The 'length x length' of the area is to be reported; The sample is a volume, e.g. a water sample or a well-mixed volume of air sampled by flask. The 'length x length x length' of the volume is to be reported.		M[#] (Phase 2)
6-06	Temporal sampling interval	Time period between the beginning of consecutive sampling periods			M (Phase 3)
6-07	Diurnal base time	Time to which diurnal statistics are referenced	*Examples* Rain fall observation is accumulated for 24 hours up until 0700z, the diurnal base time here is 0700z. Daily temperature maxima refer to the period 0600 local time, the diurnal base time here is 0600z.		M (Phase 1)
6-08	Schedule of observation	Schedule of observation	*EXAMPLES:* AMDAR profiling observations are available from Zurich airport between 0600 and 1200 local time; Radio-sondes are collected at a particular station from January to August on weekdays at 0000z and 1200z		M (Phase 1)

Category 7: Data Processing and Reporting

Specifies how raw data are transferred into the observed variables and reported to the users.

Id	Name	Definition	Note or Example	Code table	ItemMCO
7-01	Data processing methods and algorithms	A description of the processing used to generate the observation and list of algorithms utilized to derive the resultant value	*NOTE*: In hydrology, this would be the equation(s) defining the rating curve and any shifts or corrections applied to the data or the curve.		O (Phase 3)
7-02	Processing/analysis center	Center at which the observation is processed.	*EXAMPLES*: Chemical analysis, AMDAR processing center, National Hydrological Service office.		O (Phase 2)
7-03	Temporal reporting period	Time period over which the observed variable is reported	*NOTE:* Includes the temporal reporting interval, plus the meaning of time stamp. *EXAMPLES*: Hourly, daily, monthly, seasonal, event-based, 80 seconds interval during the day, etc. In each case, the meaning, “beginning, “middle”, or “end” of period is indicated.	11-03	M* (Phase 1)
7-04	Spatial reporting interval	Spatial interval at which the observed variable is reported	*NOTE*: This is applicable only to remote sensing observations and mobile platforms in general. For most remote-sensing observations, this will be redundant with element 6-06. *EXAMPLES:* – An observation from a satellite may be reported with a spatial resolution of 10 km x 20 km. – An aircraft may sample every 1 km along its trajectory (cf. 6-06), but may report at a spatial interval of 10 km.		C* (Phase 1)
7-05	Software/processor and version	Name and version of the software or processor utilized to derive the element value	*EXAMPLES*: Avionics version, retrieval algorithm version; MCH Database Management System version 25/10/2013.		O (Phase 3)

Id	Name	Definition	Note or Example	Code table	ItemMCO
7-06	Level of data	Level of data processing	*NOTE*: Pre or Post processing.	7-06	O (Phase 2)
7-07	Data format[2]	Description of the format in which the observed variable is being provided.	*EXAMPLES*: ASCII, BUFR, NASA AMES, HDF, XML, AMDAR, comma-separated (CSV), tab-separated (.txt), MCH (for interchange)		M (Phase 3)
7-08	Version of data format[3]	Version of the data format in which the observed variable is being provided.	*EXAMPLES*: FM 12–XIV Ext. SYNOP; FM 42-XI Ext. AMDAR, FM 94-XIV BUFR Version 20.0.0, Radar: ODIM_H5		M (Phase 3)
7-09	Aggregation period	Time period over which individual samples/observations are aggregated	*NOTE:* Includes the aggregation interval, plus the meaning of time stamp. *EXAMPLES*: 5 minute mean, meaning of time stamp is “middle of period”; daily maximum, meaning of time stamp is “end of period”; event based, meaning of time stamp is “beginning of period”.	11-03	M (Phase 2)
7-10	Reference time	Time base to which date and time stamps refer	*NOTE:* The reference time must not be confused with the time zone (which is part of the representation of the time stamp), but indicates what the source of the time stamp is, i.e., to which reference time the time stamps of the observation are aligned. *EXAMPLES*: NIST time server NTP pool project	7-10	M (Phase 2)

[2] Provided as part of the WIS metadata records

[3] Provided as part of the WIS metadata records

Id	Name	Definition	Note or Example	Code table	ItemMCO
7-11	Reference datum	Reference datum used to convert observed quantity to reported quantity	*NOTE 1:* Atmospheric pressure can be reported as (i) Field elevation Pressure (QFE), where the reference datum is the elevation corresponding to the official elevation of the aerodrome; (ii) Atmospheric pressure at nautical height (QNH), where the reference datum is mean sea level and the pressure altitude relationship of the ICAO standard atmosphere is used. Where observed atmospheric pressure cannot be reduced to mean sea level, a station should, by regional agreement, report either the geopotential of an agreed 'constant pressure level' or the pressure reduced to an agreed datum for the station. The level chosen for the station should be reported in this field. (Ref: WMO-No. 8 3.11.1). *NOTE 2:* Hydrology may report a gauge zero which is the gauge height of zero flow.		C (Phase 1)
7-12	Numerical resolution	Measure of the detail in which a numerical quantity is expressed	*NOTE 1*: The resolution of a numerical quantity is a measure of the detail in which the quantity is expressed. It can be expressed as the smallest possible difference between two numbers. It can also be expressed as the number of significant figures of a number, which are those digits that carry meaning contributing to its resolution.		O (Phase 3)

Id	Name	Definition	Note or Example	Code table	ItemMCO
			EXAMPLE: if a measurement resolution to four decimal places (0.0001) is given as 12.23 then it might be understood that only two decimal places of resolution are available. Stating the result as 12.2300 makes clear that it is precise to four decimal places (in this case, six significant figures). *NOTE 2*: The notion of measurement resolution is related but must not be confounded with the uncertainty of an observation *EXAMPLES*: – An anemometer may measure wind speed with a measurement resolution of 0.1 ms^{-1} with a 1 Hz scan rate. Observations may be aggregated to 1-minute values and may be rounded and reported with a (reduced) measurement resolution of 1 ms^{-1}. – A barometer may be capable of measuring atmospheric pressure with a readout resolution of 1 hPa and an uncertainty of 5 hPa (k=2). The data can be reported to the nearest hPa, however, the measurement resolution should be stated as “5 hPa” or “3 significant digits”. – An ocean thermometer measures temperature to 0.0001 °C. – Seawater salinity measured to 0.001 salinity units (derived from conductivity measurements with a resolution of 0.01 Sm^{-1})		

Id	Name	Definition	Note or Example	Code table	ItemMCO
7-13	Latency (of reporting)	The typical time between completion of the observation or collection of the datum and when the datum is reported	(i) For satellite data, the "observation" (e.g. a complete image) can take 20 minutes to generate. Hence the latency would be the time between the completion of the image collection, and when it is available. Typically this can be 2–3 minutes. Some satellite products such as SST can take about 10 minutes of processing until it is available. (ii) A radar volumetric scan can take 6–10 minutes (in Australia), so the latency would be the time between the completion of the scan and when the data is locally available. In Australia, this varies between a few seconds to several minutes depending on delays in data communications. (iii) AWS data may have a latency of 1–20 seconds (or considerably more in some places) between the completion of the observation and arrival of the data at a central archive.		M (Phase 3)

Conditions:

{7-04}: mandatory for remote sensing observations and mobile platforms in general

{7-11}: mandatory for stations/platforms that report a derived observation value that depends on a local datum

Category 8: Data Quality

Specifies the data quality and traceability of the observation

Id	Name	Definition	Note or Example	Code Table	ItemMCO
8-01	Uncertainty of measurement	Non-negative parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the observation/ measurand	*NOTE 1:* In principle, an uncertainty statement needs to be reported for each observation, as it can change from observation to observation. If the uncertainty of observations remain virtually constant over time, it is sufficient to report the uncertainty at the beginning of the period and then again when substantial changes of the uncertainty occur. The actual uncertainty statements should be reported with the observations. *NOTE 2:* Complex observations such as gridded satellite imagery may contain large error covariance matrices that are not useful for the purpose of this standard. Such information must be kept with the data, and it is sufficient to report an aggregate (e.g., mean or median) uncertainty in the metadata. *NOTE 3:* Uncertainty may be expressed, for example, as a standard deviation (or a given multiple of it), or the half-width of an interval having a stated level of confidence. *NOTE 4:* Uncertainty of measurement comprises, in general, many components. Some of these components may be evaluated from the statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. The other components, which also can be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information. *NOTE 5:* It is understood that the result of the measurement is the best estimate of the value of the measurand, and that all components of uncertainty, including those arising from systematic effects, such as components associated with corrections and reference standards, contribute to the dispersion. *EXAMPLE:* A thermometer reading may yield a value of 13.7 °C. A quality assessment of that observation may indicate that it has an expanded uncertainty of +/– 0.3 °C (k=2), where k=2 is a coverage factor corresponding approximately to a confidence interval of 95%		C*# (Phase 2)
8-02	Procedure used to estimate uncertainty	A reference or link pointing to a document describing the procedures/algorithms used to derive the uncertainty statement	*NOTE:* Uncertainty is a well-defined term, and guidance material exists to assist in the assessment of the uncertainty of observations and a formulation of adequate uncertainty statements. The authoritative source is the “Guide for the Expression of Uncertainty in Measurement” (JCGM 100:2008).		

Id	Name	Definition	Note or Example	Code Table	ItemMCO
8-03	Quality flag	An ordered list of qualifiers indicating the result of a quality control process applied to the observation	*NOTE 1:* BUFR code table series 0-33 contains data quality flags/definitions. *NOTE 2:* To be recorded by data providers for each individual observation	8-03	M[#] (Phase 2)
8-04	Quality flagging system	Reference to the system used to flag the quality of the observation	*NOTE 1:* At present, there is no single, globally accepted flagging system. The purpose of this element is to make reference to the flagging system used. This reference should either be a URL to a document explaining the meaning of the quality flag, or a link to a code table where this information can be found. *NOTE 2*: The use of the BUFR quality codes listed above is recommended (WMO, 2013)	8-04	
8-05	Traceability	Statement defining traceability to a standard, including sequence of measurement standards and calibrations that is used to relate a measurement result to a reference [VIM 3 2.4.2]	*NOTE 1:* A metrological traceability chain is defined through a calibration hierarchy; *VIM 3, 2.4.2]* *NOTE 2:* A metrological traceability chain is used to establish metrological traceability of a measurement result. *[VIM 3, 2.4.2]* *NOTE 3:* A comparison between two measurement standards may be viewed as a calibration if the comparison is used to check and, if necessary, correct the quantity value and measurement uncertainty attributed to one of the measurement standards; *[VIM 3, 2.4.2]* *NOTE 4:* For the statement on traceability, code table 8-05 is to be used	8-05	C*[#] (Phase 2)

Conditions:

{8-01, 8-02 and 8-05} variables that are measured, rather than classified

Category 9: Ownership & Data Policy

Specifies who is responsible for the observation and owns it.

Id	Name	Definition	Note or Example	Code Table	ItemMCO
9-01	Supervising organization	Name of organization who owns the observation	*EXAMPLES:* *for satellite operators* EUMETSAT, ESA, NOAA, NASA, CMA, RapidEye, ISRO		M (Phase 2)
9-02	Data policy/use constraints	Details relating to the use and limitations surrounding data imposed by the supervising organization	*NOTE:* Only one single use constraint with a value taken from WMO_DataLicenseCode is allowed to ensure unambiguity. (WMO, 2013b, p15)	9-02	M* (Phase 1)

Category 10: Contact

Specifies where information about an observation or dataset can be obtained.

Id	Name	Definition	Note or Example	Code Table	ItemMCO
10-01	Contact (Nominated Focal Point)	Principal contact (Nominated Focal Point, FP) for resource	*NOTE:* The FP would be able to provide data users with information regarding individual observing platforms and their observations. *EXAMPLES:* Programme or Network Manager, e.g. E-AMDAR Technical Coordinator (TC) has responsibility for data quality of several airlines' fleets, has information on aircraft type/software/known errors etc.		M (Phase 1)

VIII – References

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ANNEX – Code Tables

Code table: 1-01

Code table title: Observed variable – measurand [Code table under development]

#	Domain	Sub-domain	Matrix	VARIABLE	Mode of Observation	WMO 306 code (BUFR / CREX)
1-01-01	Atmosphere	Atmospheric Pressure		Atmospheric Pressure	I, V	0 10 004
1-01-02		Temperature		Ambient air temperature (over specified surface)	I, V	0 12 101
				Maximum temperature		
1-01-03		Temperature		Dew-point temperature	I, V	0 12 103
1-01-04		Temperature		Ground (surface) temperature (over specified surface)	I, V	0 12 120
1-01-05	Terrestrial	Temperature	Soil	Soil temperature	I, V	0 12 130
1-01-06		Temperature		Snow temperature	I, V	0 12 131
1-01-07		Temperature		Water temperature – river, lake, sea, well	I, V	0 13 082 or 0 22 043
1-01-08		Humidity		Relative humidity	I, V	0 13 003
1-01-09		Humidity		Mass mixing ratio	I, V	0 13 110
1-01-10		Humidity		Soil moisture	I, V	0 13 111
1-01-11		Humidity		Water vapour pressure	I, V	0 13 004
1-01-12		Humidity		Evaporation/evapotranspiration	T	0 13 033
1-01-13		Humidity		Object wetness duration	T	0 13 112
1-01-14	Atmosphere	Wind		Direction	I, V	0 11 001
1-01-15		Wind		Speed	I, V	0 11 002
1-01-16		Wind		Gust Speed	I, V	0 11 041
1-01-17		Wind		X,Y component of wind vector	I, V	0 11 003
1-01-18		Wind		Z component of wind vector (horizontal and vertical profile)		0 11 004, 0 11 006
1-01-19		Wind		Turbulence type (Low levels and wake vortex)	I, V	-
1-01-20		Wind		Turbulence intensity	I, V	-
1-01-21		Radiation		Sunshine duration	T	0 14 031
1-01-22		Radiation		Background luminance	I, V	0 14 056
1-01-23		Radiation		Global downward solar radiation	I, T, V	0 14 028
1-01-24		Radiation		Global upward solar radiation	I, T, V	0 14 052
1-01-25		Radiation		Diffuse solar radiation	I, T, V	0 14 029
1-01-26		Radiation		Direct solar radiation	I, T, V	0 14 030
1-01-27		Radiation		Downward long-wave radiation	I, T, V	0 14 002
1-01-28		Radiation		Upward long-wave radiation	I, T, V	0 14 002
1-01-29		Radiation		Net radiation	I, T, V	0 14 053
1-01-30		Radiation		UV-B radiation	I, T, V	0 14 072

#	Domain	Sub-domain	Matrix	VARIABLE	Mode of Observation	WMO 306 code (BUFR / CREX)
1-01-31		Radiation		Photosynthetically active radiation	I, T, V	0 14 054
1-01-32		Radiation		Surface albedo	I, V	0 14 019
1-01-33		Radiation		Soil heat Flux	I, T, V	0 14 057
1-01-34		Clouds		Cloud base height	I, V	0 20 013
1-01-35		Clouds		Cloud top height	I, V	0 20 014
1-01-36		Clouds		Cloud type, convective vs other types	I	0 20 012
1-01-37		Clouds		Cloud hydrometeor concentration	I, V	0 20 130
1-01-38		Clouds		Effective radius of cloud hydrometeors	I, V	0 20 131
1-01-39		Clouds		Cloud liquid water content	I, V	0 20 132
1-01-40		Clouds		Optical depth within each layer	I, V	-
1-01-41		Clouds		Optical depth of fog	I, V	-
1-01-42		Clouds		Height of inversion	I, V	0 20 093
1-01-43		Clouds		Cloud cover	I, V	0 20 010
1-01-44		Clouds		Cloud amount	I, V	0 20 011
1-01-45		Precipitation		Accumulation	T	0 13 011
1-01-46		Precipitation		Depth of fresh snowfall	T	0 13 118
1-01-47		Precipitation		Duration	T	0 26 020
1-01-48		Precipitation		Size of precipitating element	I, V	0 13 058, 0 20 066
1-01-49		Precipitation		Intensity - quantitative	I, V	0 13 155
1-01-50		Precipitation		Type	I, V	0 20 021
1-01-51		Precipitation		Rate of ice accretion	I, V	0 13 114
1-01-52		Obscurations		Obscuration type	I, V	0 20 025
1-01-53		Obscurations		Hydrometeor type	I, V	0 20 025
1-01-54		Obscurations		Lithometeor type	I, V	0 20 025
1-01-55		Obscurations		Hydrometeor radius	I, V	0 20 133
1-01-56		Obscurations		Extinction coefficient	I, V	0 15 029
1-01-57		Obscurations		Meteorological Optical Range	I, V	0 15 051
1-01-58		Obscurations		Runway visual range	I, V	0 20 061
1-01-59		Obscurations		Other weather type	I, V	0 20 023
1-01-60		Lightning		Lightning rates of discharge	I, V	0 20 126
1-01-61		Lightning		Lightning discharge type (cloud to cloud, cloud to surface)	I, V	0 20 023
1-01-62		Lightning		Lightning discharge polarity	I, V	0 20 119
1-01-63		Lightning		Lightning discharge energy	I, V	-
1-01-64		Lightning		Lightning - distance from station	I, V	0 20 127
1-01-65		Lightning		Lightning - direction from station	I, V	0 20 128
1-01-66		Hydrologic And Marine Observations		Flow discharge – river	I, V	0 23 040

#	Domain	Sub-domain	Matrix	VARIABLE	Mode of Observation	WMO 306 code (BUFR / CREX)
1-01-67		Hydrologic And Marine Observations		Flow discharge – well	I, V	0 23 041
1-01-68		Hydrologic And Marine Observations		Ground water level	I, V	0 13 074
1-01-69		Hydrologic And Marine Observations		Ice surface temperature	I, V	0 12 132
1-01-70		Hydrologic And Marine Observations		Ice thickness - river, lake	I, V	0 08 029, 0 13 115
1-01-71		Hydrologic And Marine Observations		Ice thickness - glacier, sea	I, V	0 08 029, 0 13 115
1-01-72		Hydrologic And Marine Observations		Ice thickness	T	2 01 133, 2 02 129, 0 20 031, 2 02 000, 2 01 000
1-01-73		Hydrologic And Marine Observations		Water level	I, V	0 13 071, 0 13 072
1-01-74		Hydrologic And Marine Observations		Wave height	V	0 22 021
1-01-75		Hydrologic And Marine Observations		Wave period	V	2 01 129, 0 22 011, 2 01 000
1-01-76		Hydrologic And Marine Observations		Wave direction	V	0 22 001
1-01-77		Hydrologic And Marine Observations		1D spectral wave energy density	V, T	2 01 135, 0 22 069, 2 01 000
1-01-78		Hydrologic And Marine Observations		2D spectral wave energy density	V, T	2 01 135, 0 22 069, 2 01 000
1-01-79		Hydrologic And Marine Observations		Water practical salinity	I, V	2 01 130, 0 22 064, 2 01 000

#	Domain	Sub-domain	Matrix	VARIABLE	Mode of Observation	WMO 306 code (BUFR / CREX)
1-01-80		Hydrologic And Marine Observations		Water conductivity	I, V	2 01 132, 0 22 066, 2 01 000
1-01-81		Hydrologic And Marine Observations		Water pressure	I, V	2 07 001, 0 22 065, 2 07 000
1-01-82		Hydrologic And Marine Observations		Ice mass	T	0 20 135
1-01-83		Hydrologic And Marine Observations		Snow density (liquid water content)	T	0 13 117
1-01-84		Hydrologic And Marine Observations		Tidal elevation with respect to local chart datum	I, V	2 01 129, 0 22 038, 2 01 000
1-01-85		Hydrologic And Marine Observations		Tidal elevation with respect to national land datum	I, V	2 01 129, 0 22 037, 2 01 000
1-01-86		Hydrologic And Marine Observations		Meteorological residual tidal elevation (surge or offset)	I, V	0 22 040
1-01-87		Hydrologic And Marine Observations		Ocean Current - Direction	I, V	0 22 004 or 0 22 005
1-01-88		Hydrologic And Marine Observations		Ocean Current - Speed	I, V	0 22 031 or 0 22 032
1-01-89		Other Surface Variables		Runway conditions	I, V	0 20 085
1-01-90		Other Surface Variables		Braking action/friction coefficient	I, V	0 20 089
1-01-91		Other Surface Variables		State of ground	I, V	0 20 062
1-01-92		Other Surface Variables		Type of surface specified	I, V	0 08 010
1-01-93		Other Surface Variables		Snow depth	T	0 13 013
1-01-94		Other		Gamma radiation dose rate	I, T	0 24 014
1-01-95		Other		Categories of stability	I, V	0 13 041

Code table: 1-02

Code table title: Measurement unit [according to common code table C–6 (WMO, 2013)]

#	Name	Conventional abbreviation	Abbreviation in IA5/ASCII	Abbreviation in ITA2	Definition in base units
1-02-1	metre	m	m	M	-
1-02-2	kilogram	kg	kg	KG	-
1-02-3	second	s	s	S	-
1-02-4	ampere	A	A	A	-
1-02-5	kelvin	K	K	K	-
1-02-6	mole	mol	mol	MOL	-
1-02-7	candela	cd	cd	CD	-
1-02-8	radian	rad	rad	RAD	-
1-02-9	steradian	sr	sr	SR	-
1-02-10	hertz	Hz	Hz	HZ	s^{-1}
1-02-11	newton	N	N	N	kg m s^{-2}
1-02-12	pascal	Pa	Pa	PAL	kg m^{-1} s^{-2}
1-02-13	joule	J	J	J	kg m^2 s^{-2}
1-02-14	watt	W	W	W	kg m^2 s^{-3}
1-02-15	coulomb	C	C	C	A s
1-02-16	volt	V	V	V	kg m^2 s^{-3} A^{-1}
1-02-17	farad	F	F	F	kg^{-1} m^{-2} s^4 A^2
1-02-18	ohm	Ω	Ohm	OHM	kg m^2 s^{-3} A^{-2}
1-02-19	siemens	S	S	SIE	kg^{-1} m^{-2} s^3 A^2
1-02-20	weber	Wb	Wb	WB	kg m^2 s^{-2} A^{-1}
1-02-21	tesla	T	T	T	kg s^{-2} A^{-1}
1-02-22	henry	H	H	H	kg m^2 s^{-2} A^{-2}
1-02-23	degree celsius	°C	Cel	CEL	K+273.15
1-02-24	lumen	lm	lm	LM	cd sr
1-02-25	lux	lx	lx	LX	cd sr m^{-2}
1-02-26	becquerel	Bq	Bq	BQ	s^{-1}
1-02-27	gray	Gy	Gy	GY	m^2 s^{-2}
1-02-28	sievert	Sv	Sv	SV	m^2 s^{-2}

#	Name	Conventional abbreviation	Abbreviation in IA5/ASCII	Abbreviation in ITA2	Definition in base units
1-02-29	degree (angle)	°	deg	DEG	
1-02-30	minute (angle)	'	'	MNT	
1-02-31	second (angle)	"	"	SEC	
1-02-32	litre	l or L	l or L	L	
1-02-33	minute (time)	min	min	MIN	
1-02-34	hour	h	h	HR	
1-02-35	day	d	d	D	
1-02-36	tonne	t	t	TNE	
1-02-37	electron volt	eV	eV	EV	
1-02-38	atomic mass unit	u	u	U	
1-02-39	astronomic unit	AU	AU	ASU	
1-02-40	parsec	pc	pc	PRS	
1-02-41	nautical	mile			
1-02-42	knot	kt	kt	KT	
1-02-43	decibel	dB	dB	DB	
1-02-44	hectare	ha	ha	HAR	
1-02-45	week				
1-02-46	year	a	a	ANN	
1-02-47	per cent	%	%	PERCENT	
1-02-48	parts per thousand	‰	0/00	PERTHOU	
1-02-49	eighths of cloud	okta	okta	OKTA	
1-02-50	degrees TRUE	°	deg	DEG	
1-02-51	degrees per second	degree/s	deg/s	DEG/S	
1-02-52	degrees Celsius	°C	C	C	
1-02-53	degrees Celsius per metre	°C/m	C/m	C/M	
1-02-54	degrees Celsius per 100 metres	°C/100 m	C/100 m	C/100 M	
1-02-55	Dobson unit	DU	DU	DU	
1-02-56	month	mon	mon	MON	
1-02-57	per second (same as hertz)	s^{-1}	/s	/S	
1-02-58	per second squared	s^{-2}	s^{-2}		
1-02-59	knots per 1000 metres	kt/1000 m	kt/km	KT/KM	

#	Name	Conventional abbreviation	Abbreviation in IA5/ASCII	Abbreviation in ITA2	Definition in base units
1-02-60	Foot	ft	ft	FT	
1-02-61	Inch	In	in	IN	
1-02-62	decipascals per second (microbar per second)	dPa s^{-1}	dPa/s	DPAL/S	
1-02-63	centibars per second	cb s-1	cb/s	CB/S	
1-02-64	centibars per 12 hours	cb/12 h	cb/12 h	CB/12 HR	
1-02-65	dekapascal	daPa	daPa	DAPAL	
1-02-66	hectopascal	hPa	hPa	HPAL	
1-02-67	hectopascals per second	hPa s^{-1}	hPa/s	HPAL/S	
1-02-68	hectopascals per hour	hPa h^{-1}	hPa/h	HPAL/HR	
1-02-69	hectopascals per 3 hours	hPa/3 h	hPa/3 h	HPAL/3 HR	
1-02-70	nanobar=hPa 10-6	nbar	nbar	NBAR	
1-02-71	grams per kilogram	g kg^{-1}	g/kg	G/KG	
1-02-72	grams per kilogram per second	g kg^{-1} s^{-1}	g kg^{-1} s^{-1}		
1-02-73	kilograms per kilogram	kg kg^{-1}	kg/kg	KG/KG	
1-02-74	kilograms per kilogram per second	kg kg^{-1} s^{-1}	kg kg^{-1} s^{-1}		
1-02-75	kilograms per square metre	kg m^{-2}	kg m^{-2}		
1-02-76	acceleration due to gravity	g	G		
1-02-77	geopotential metre	gpm	gpm		
1-02-78	millimetre	mm	mm	MM	
1-02-79	millimetres per second	mm s^{-1}	mm/s	MM/S	
1-02-80	millimetres per hour	mm h^{-1}	mm/h	MM/HR	
1-02-81	millimetres to the sixth power per cubic metre	mm^6 m^{-3}	mm^6 m^{-3}		
1-02-82	centimetre	cm	cm	CM	
1-02-83	centimetres per second	cm $^{-1}$	cm/s	CM/S	
1-02-84	centimetres per hour	cm h^{-1}	cm/h	CM/HR	
1-02-85	decimetre	dm	dm	DM	
1-02-86	metres per second	m s^{-1}	m/s	M/S	
1-02-87	metres per second per metre	m s^{-1}/m	m s^{-1}/m		
1-02-88	metres per second per 1000 metres	m s^{-1}/1000 m	m s^{-1}/km		
1-02-89	square metres	m^2	m^2	M2	
1-02-90	square metres per second	m^2 s^{-1}	m^2/s	M2/S	

#	Name	Conventional abbreviation	Abbreviation in IA5/ASCII	Abbreviation in ITA2	Definition in base units
1-02-91	kilometre	Km	km	KM	
1-02-92	kilometres per hour	km h^{-1}	km/h	KM/HR	
1-02-93	kilometres per day	km/d	km/d	KM/D	
1-02-94	per metre	m^{-1}	m^{-1}	/M	
1-02-95	becquerels per litre	Bq l^{-1}	Bq/l	BQ/L	
1-02-96	becquerels per square metre	Bq m^{-2}	Bq m^{-2}	BQ/M2	
1-02-97	becquerels per cubic metre	Bq m^{-3}	Bq m^{-3}	BQ/M3	
1-02-98	millisievert	mSv	mSv	MSV	
1-02-99	metres per second squared	m s^{-2}	m s^{-2}		
1-02-100	square metres second	m^2 s	m^2 s		
1-02-101	square metres per second squared	m^2 s^{-2}	m^2 s^{-2}		
1-02-102	square metres per radian second	m^2 rad^{-1} s	m^2 rad^{-1} s		
1-02-103	square metres per hertz	m^2 Hz^{-1}	m^2/Hz		
1-02-104	cubic metres	m^3	m^3		
1-02-105	cubic metres per second	m^3 s^{-1}	m^3/s		
1-02-106	cubic metres per cubic metre	m^3 m^{-3}	m^3 m^{-3}		
1-02-107	metres to the fourth power	m^4	m^4		
1-02-108	metres to the two thirds power per second	$m^{2/3}$ s^{-1}	$m^{2/3}$ s^{-1}		
1-02-109	logarithm per metre	log (m^{-1})	log (m^{-1})		
1-02-110	logarithm per square metre	log (m^{-2})	log (m^{-2})		
1-02-111	kilograms per metre	kg m^{-1}	kg/m		
1-02-112	kilograms per square metre per second	kg m^{-2} s^{-1}	kg m^{-2} s^{-1}		
1-02-113	kilograms per cubic metre	kg m^{-3}	kg m^{-3}		
1-02-114	per square kilogram per second	kg^{-2} s^{-1}	kg^{-2} s^{-1}		
1-02-115	seconds per metre	s m^{-1}	s/m		
1-02-116	kelvin metres per second	K m s^{-1}	K m s^{-1}		
1-02-117	kelvins per metre	K m^{-1}	K/m		
1-02-118	kelvin square metres per kilogram per second	k m^2 kg^{-1} s^{-1}	k m^2 kg^{-1} s^{-1}		
1-02-119	moles per mole	mol mol^{-1}	mol/mol		
1-02-120	radians per metre	rad m^{-1}	rad/m		
1-02-121	newtons per square metre	N m^{-2}	N m^{-2}		

#	Name	Conventional abbreviation	Abbreviation in IA5/ASCII	Abbreviation in ITA2	Definition in base units
1-02-122	pascals per second	Pa s^{-1}	Pa/s		
1-02-123	kilopascal	kPa	kPa		
1-02-124	joules per square metre	J m^{-2}	J m^{-2}		
1-02-125	joules per kilogram	J kg^{-1}	J/kg		
1-02-126	watts per metre per steradian	W m^{-1} sr^{-1}	W m^{-1} sr^{-1}		
1-02-127	watts per square metre	W m^{-2}	W m^{-2}		
1-02-128	watts per square metre per steradian	W m^{-2} sr^{-1}	W m^{-2} sr^{-1}		
1-02-129	watts per square metre per steradian centimetre	W m^{-2} sr^{-1} cm	W m^{-2} sr^{-1} cm		
1-02-130	watts per square metre per steradian metre	W m^{-2} sr^{-1} m	W m^{-2} sr^{-1} m		
1-02-131	watts per cubic metre per steradian	W m^{-3} sr^{-1}	W m^{-3} sr^{-1}		
1-02-132	siemens per metre	S m^{-1}	S/m		
1-02-133	square degrees	$degree^2$	deg^2		
1-02-134	becquerel seconds per cubic metre	Bq s m^{-3}	Bq s m^{-3}		
1-02-135	decibels per metre	dB m^{-1}	dB/m		
1-02-136	decibels per degree	dB $degree^{-1}$	dB/deg		
1-02-137	pH unit	pH unit	pH unit		
1-02-138	N units	N units	N units		

Code table: 1-05

Code table title: Representativeness [(WMO, 2008) (WMO, 2013)], plus extension

#	Name	Definition
1-05-0	Nil reason	None of the codes in the table is applicable in the context of the observed quantity or unknown, or not available information
1-05-1	microscale	An area or volume less than 100 m horizontal extent (for example, evaporation)
1-05-2	toposcale, local scale	An area or volume of 100 m to 3 km horizontal extent (for example, air pollution, tornadoes)
1-05-3	mesoscale	An area or volume of 3 km to 100 km horizontal extent (for example, thunderstorms, sea and mountain breezes)
1-05-4	large scale	An area or volume of 100 km to 3000 km horizontal extent (for example, fronts, various cyclones, cloud clusters)
1-05-5	planetary scale	An area or volume of more than 3000 km horizontal extent (for example, long upper tropospheric waves)
1-05-6	drainage area	An area (also known as 'catchment') having a common outlet for its surface runoff, in km^2

Code table: 2-01

Code table title: Application area(s) [Code table under development]

#	Name	Definition
2-01-1	Global numerical weather prediction (GNWP)	Source: http://www.wmo.int/pages/prog/www/wigos/wir/application-areas.html
2-01-2	High-resolution numerical weather prediction (HRNWP)	Ibid
2-01-3	Nowcasting and very short range forecasting (NVSRF)	Ibid
2-01-4	Seasonal and inter-annual forecasting (SIAF)	Ibid
2-01-5	General weather forecasting	Ibid
2-01-6	Aeronautical meteorology	Ibid
2-01-7	Ocean applications	Ibid
2-01-8	Agricultural meteorology	Ibid
2-01-9	Hydrology	Ibid
2-01-10	Climate monitoring (as undertaken through the Global Climate Observing System, GCOS)	Ibid
2-01-11	Climate applications	Ibid
2-01-12	Space weather	Ibid
2-01-13	Cryosphere applications	Source: EGOS-IP
2-01-14	Energy sector	
2-01-15	Transportation sector	
2-01-16	Health sector	
2-01-17	Terrestrial ecology	
2-01-18	Operational air quality forecasting	
2-01-19	Atmospheric composition forecasting	
2-01-20	Atmospheric composition monitoring and analysis	
2-01-21	Large urban complexes	

Code table: 2-02

Code table title: Programme/Network affiliation [Code table under development]

#	Name	Definition	Sponsor and/or Contributing to
2-02-01	AMDAR	Global Aircraft Meteorological DAta Relay	WMO/GOS
2-02-02	EPA	Environmental Protection Agency	
2-02-03	EUMETNET	Grouping of European National Meteorological Services	WMO/GOS
2-02-04	WMO/GAW	World Meteorological Organization/Global Atmospheric Watch	
2-02-05	GCOS	Global Climate Observing System	
2-02-06	GCW	Global Cryosphere Watch	
2-02-07	GOOS	Global Ocean Observing System	
2-02-08	IPA	International Permafrost Association	
2-02-09	JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology	WMO/GOS
2-02-10	WMO/GOS	World Meteorological Organization/Global Observing System	
2-02-11	GTOS	Global Terrestrial Observing System	
2-02-12	IAGOS	In-service Aircraft for a Global Observing System	
2-02-13	WHYCOS	World Hydrological Cycle Observing System	
2-02-14	WMO/CLW	World Meteorological Office/Climate and Water Department	
2-02-15	ADNET	Asian dust and aerosol lidar observation network	GALION ; WMO/GAW
2-02-16	Aeronet	**AE**rosol **RO**botic **NET**work	NASA?
2-02-17	ANTON	Antarctic Observing Network	WMO/GOS
2-02-18	ASAP	Automated Shipboard Aerological Program	WMO/GOS
2-02-19	BSRN	Baseline Surface Radiation Network	WMO/GAW & GCOS
2-02-20	CASTNET	Clean Air Status and Trends Network	(National – USA)
2-02-21	CIS-LiNet	Lidar network for monitoring atmosphere over CIS regions	GALION ; WMO/GAW
2-02-22	CLN	CREST Lidar Network	GALION ; WMO/GAW
2-02-23	DART	Deep-ocean Assessment and Reporting of Tsunamis	NOAA Centre for Tsunamis Research
2-02-24	E-AMDAR	European - Aircraft Meteorological DAta Relay	EUMETNET ; WMO/GOS
2-02-25	E-ASAP	European - Automated Shipboard Aerological Program	EUMETNET ; WMO/GOS
2-02-26	E-GVAP	European - GNSS water vapour programme	EUMETNET ; WMO/GOS
2-02-27	E-PROFILE	European – wind profiles from radar	EUMETNET ; WMO/GOS
2-02-28	E-SURFMAR	European - Surface Marine Operational Service	EUMETNET ; WMO/GOS
2-02-29	EARLINET	European Aerosol Research Lidar Network	GALION ; WMO/GAW
2-02-30	GALION	GAW Aerosol Lidar Observation Network	WMO/GAW

#	Name	Definition	Sponsor and/or Contributing to
2-02-31	GAW-PFR	GAW-Precision Filter Radiometers	WMO/GAW
2-02-32	German AOD Network	*German Aerosol Optical Depth Network*	WMO/GAW
2-02-33	GLOSS	Global Sea Level Observing System	JCOMM ; WMO/GOS
2-02-34	GRUAN	GCOS Reference Upper Air Network	GCOS
2-02-35	GSN	GCOS Surface Network	GCOS
2-02-36	GTN-G	Global Terrestrial Network - Glaciers	GCOS
2-02-37	GTN-H	Global Terrestrial Network - Hydrology	WMO/CLW ; GCOS ; GTOS
2-02-38	GTN-P	Global Terrestrial Network - Permafrost	IPA ; GCOS ; GTOS
2-02-39	GUAN	GCOS Upper Air Network	GCOS
2-02-40	IAGOS-MOZAIC	Measurement of Ozone and Water Vapour on Airbus in-service Aircraft	IAGOS
2-02-41	LALINET	Latin America Lidar Network	GALION ; WMO/GAW
2-02-42	MPLNET	Micro Pulse Lidar Network	GALION ; WMO/GAW
2-02-43	NDACC	*Network for the Detection of Atmospheric Composition Change*	GALION ; WMO/GAW
2-02-44	OPERA	*European Weather Radar Project*	*EUMETNET ; (WMO/GOS)*
2-02-45	PIRATA	*Prediction and Research Moored Array in the Atlantic*	*GOOS ; WMO/GOS*
2-02-46	PolarAOD	*Polar Aerosol Optical Depth Measurement Network Project*	WMO/GAW
2-02-47	RAMA	*Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction*	*NOAA*
2-02-48	RBCN	Regional Basic Climatological Network	WMO/GOS
2-02-49	RBON	Regional Basic Observing Network	WMO/GOS
2-02-50	RBSN	Regional Basic Synoptic Network	WMO/GOS
2-02-51	TAO	Tropical Atmosphere and Ocean Array	NOAA; GCOS
2-02-52	SKYNET	Aerosol -cloud-radiation interaction in the atmosphere project	WMO/GAW
2-02-53	SibRad		WMO/GAW
2-02-54	SOOP	Ship of Opportunity	JCOMM ; WMO/GOS
2-02-55	U.S. IOOS	United States Integrated Ocean Observing System	(National – USA)
2-02-56	VOS	Voluntary Observing Fleet	JCOMM ; WMO/GOS
2-02-57	VOSCLIM	Voluntary Observing Fleet (VOS) Climate Project	JCOMM ; WMO/GOS
2-02-58	WRAP	Worldwide Recurring ASAP Project	JCOMM ; WMO/GOS

Code table: 3-01

Code table title: Region of origin of data

#	Name	Definition
3-01-1	I	Africa
3-01-2	II	Asia
3-01-3	III	South America
3-01-4	IV	North America, Central America and the Caribbean
3-01-5	V	South-West Pacific
3-01-6	VI	Europe
3-01-7	VII	Antarctica

Code table: 3-02

Code table title: Territory of origin of data

#	Name	ISO3 Country Code
3-02-01	Afghanistan	AFG
3-02-02	Albania	ALB
3-02-03	Algeria	DZA
3-02-04	Angola	AGO
3-02-05	Antarctica	ATA
3-02-06	Antigua and Barbuda	ATG
3-02-07	Argentina	ARG
3-02-08	Armenia	ARM
3-02-09	Australia	AUS
3-02-10	Austria	AUT
3-02-11	Azerbaijan	AZE
3-02-12	Bahamas	BHS
3-02-13	Bahrain	BHR
3-02-14	Bangladesh	BGD
3-02-15	Barbados	BRB
3-02-16	Belarus	BLR
3-02-17	Belgium	BEL

#	Name	ISO3 Country Code
3-02-18	Belize	BLZ
3-02-19	Benin	BEN
3-02-20	Bhutan	BTN
3-02-21	Bolivia, Plurinational State of	BOL
3-02-22	Bosnia and Herzegovina	BIH
3-02-23	Botswana	BWA
3-02-24	Brazil	BRA
3-02-25	British Caribbean Territories	BCT
3-02-26	Brunei Darussalam	BRN
3-02-27	Bulgaria	BGR
3-02-28	Burkina Faso	BFA
3-02-29	Burundi	BDI
3-02-30	Cabo Verde	CPV
3-02-31	Cambodia	KHM
3-02-32	Cameroon	CMR
3-02-33	Canada	CAN
3-02-34	Central African Republic	CAF
3-02-35	Chad	TCD
3-02-36	Chile	CHL
3-02-37	China	CHN
3-02-38	Colombia	COL
3-02-39	Comoros	COM
3-02-40	Congo	COG
3-02-41	Cook Islands	COK
3-02-42	Costa Rica	CRI
3-02-43	Côte d'Ivoire	CIV
3-02-44	Croatia	HRV
3-02-45	Cuba	CUB
3-02-46	Curaçao and Sint Maarten	CUW
3-02-47	Cyprus	CYP

#	Name	ISO3 Country Code
3-02-48	Czech Republic	CZE
3-02-49	Democratic People's Republic of Korea	PRK
3-02-50	Democratic Republic of the Congo	COD
3-02-51	Denmark	DNK
3-02-52	Djibouti	DJI
3-02-53	Dominica	DMA
3-02-54	Dominican Republic	DOM
3-02-55	Ecuador	ECU
3-02-56	Egypt	EGY
3-02-57	El Salvador	SLV
3-02-58	Eritrea	ERI
3-02-59	Estonia	EST
3-02-60	Ethiopia	ETH
3-02-61	Fiji	FJI
3-02-62	Finland	FIN
3-02-63	France	FRA
3-02-64	French Polynesia	PYF
3-02-65	Gabon	GAB
3-02-66	Gambia	GMB
3-02-67	Georgia	GEO
3-02-68	Germany	DEU
3-02-69	Ghana	GHA
3-02-70	Greece	GRC
3-02-71	Guatemala	GTM
3-02-72	Guinea	GIN
3-02-73	Guinea-Bissau	GNB
3-02-74	Guyana	GUY
3-02-75	Haiti	HTI
3-02-76	Honduras	HND
3-02-77	Hong Kong, China	HKG

#	Name	ISO3 Country Code
3-02-78	Hungary	HUN
3-02-79	Iceland	ISL
3-02-80	India	IND
3-02-81	Indonesia	IDN
3-02-82	Iran, Islamic Republic of	IRN
3-02-83	Iraq	IRQ
3-02-84	Ireland	IRL
3-02-85	Israel	ISR
3-02-86	Italy	ITA
3-02-87	Jamaica	JAM
3-02-88	Japan	JPN
3-02-89	Jordan	JOR
3-02-90	Kazakhstan	KAZ
3-02-91	Kenya	KEN
3-02-92	Kiribati	KIR
3-02-93	Kuwait	KWT
3-02-94	Kyrgyzstan	KGZ
3-02-95	Lao People’s Democratic Republic	LAO
3-02-96	Latvia	LVA
3-02-97	Lebanon	LBN
3-02-98	Lesotho	LSO
3-02-99	Liberia	LBR
3-02-100	Libya	LBY
3-02-101	Liechtenstein	LIE
3-02-102	Lithuania	LTU
3-02-103	Luxembourg	LUX
3-02-104	Macao, China	MAC
3-02-105	Madagascar	MDG
3-02-106	Malawi	MWI
3-02-107	Malaysia	MYS

#	Name	ISO3 Country Code
3-02-108	Maldives	MDV
3-02-109	Mali	MLI
3-02-110	Malta	MLT
3-02-111	Mauritania	MRT
3-02-112	Mauritius	MUS
3-02-113	Mexico	MEX
3-02-114	Micronesia, Federated States of	FSM
3-02-115	Monaco	MCO
3-02-116	Mongolia	MNG
3-02-117	Montenegro	MNE
3-02-118	Morocco	MAR
3-02-119	Mozambique	MOZ
3-02-120	Myanmar	MMR
3-02-121	Namibia	NAM
3-02-122	Nepal	NPL
3-02-123	Netherlands	NLD
3-02-124	New Caledonia	NCL
3-02-125	New Zealand	NZL
3-02-126	Nicaragua	NIC
3-02-127	Niger	NER
3-02-128	Nigeria	NGA
3-02-129	Niue	NIU
3-02-130	Norway	NOR
3-02-131	Oman	OMN
3-02-132	Pakistan	PAK
3-02-133	Panama	PAN
3-02-134	Papua New Guinea	PNG
3-02-135	Paraguay	PRY
3-02-136	Peru	PER
3-02-137	Philippines	PHL

#	Name	ISO3 Country Code
3-02-138	Poland	POL
3-02-139	Portugal	PRT
3-02-140	Qatar	QAT
3-02-141	Republic of Korea	KOR
3-02-142	Republic of Moldova	MDA
3-02-143	Romania	ROM
3-02-144	Russian Federation	RUS
3-02-145	Rwanda	RWA
3-02-146	Saint Lucia	LCA
3-02-147	Samoa	WSM
3-02-148	Sao Tome and Principe	STP
3-02-149	Saudi Arabia	SAU
3-02-150	Senegal	SEN
3-02-151	Serbia	SRB
3-02-152	Seychelles	SYC
3-02-153	Sierra Leone	SLE
3-02-154	Singapore	SGP
3-02-155	Slovakia	SVK
3-02-156	Slovenia	SVN
3-02-157	Solomon Islands	SLB
3-02-158	Somalia	SOM
3-02-159	South Africa	ZAF
3-02-160	South Sudan	SSD
3-02-161	Spain	ESP
3-02-162	Sri Lanka	LKA
3-02-163	Sudan	SDN
3-02-164	Suriname	SUR
3-02-165	Swaziland	SWZ
3-02-166	Sweden	SWE
3-02-167	Switzerland	CHE

#	Name	ISO3 Country Code
3-02-168	Syrian Arab Republic	SYR
3-02-169	Tajikistan	TJK
3-02-170	Thailand	THA
3-02-171	The former Yugoslav Republic of Macedonia	
3-02-172	Timor-Leste	TLS
3-02-173	Togo	TGO
3-02-174	Tonga	TON
3-02-175	Trinidad and Tobago	TTO
3-02-176	Tunisia	TUN
3-02-177	Turkey	TUR
3-02-178	Turkmenistan	TKM
3-02-179	Tuvalu	TUV
3-02-180	Uganda	UGA
3-02-181	Ukraine	UKR
3-02-182	United Arab Emirates	ARE
3-02-183	United Kingdom of Great Britain and Northern Ireland	GBR
3-02-184	United Republic of Tanzania	TZA
3-02-185	United States	USA
3-02-186	Uruguay	URY
3-02-187	Uzbekistan	UZB
3-02-188	Vanuatu	VUT
3-02-189	Venezuela, Bolivarian Republic of	VEN
3-02-190	Viet Nam	VNM
3-02-191	Yemen	YEM
3-02-192	Zambia	ZMB
3-02-193	Zimbabwe	ZWE

Code table: 3-04

Code table title: Station/platform type (simplified) [WMO, 2012]

#	Name	Definition
3-04-1	land station	An observing station or field site situated on land, either fixed or mobile.
3-04-2	sea station	An observing station situated at sea. Sea stations include ships, ocean weather stations and stations on fixed or drifting platforms (rigs, platforms, lightships, buoys and ice floes).
3-04-3	aircraft	An airplane, helicopter or airship used to make environmental observations.
3-04-4	satellite	A platform placed in orbit around the earth to make environmental observations.
3-04-5	underwater platform	A platform under a lake or sea surface, including autonomous underwater vehicles.

Code table: 3-08

Code table title: Data communication method [Code table under development]

#	Name	Definition
3-08-01	ARGOS	Argos is a Geosynchronous/Geostationary Earth Orbit (GEO) satellite-based system which collects data from Platform Terminal Transmitters, PTTs, and distributes sensor and location data to the final users. http://www.argos-system.org/
3-08-02	Cellular	Land based wireless communication network distributed over land areas, each served by at least one fixed-location transceiver, known as a cell site or base station
3-08-03	Globalstar	Globalstar is a low Earth orbit (LEO) satellite constellation for satellite phone and low-speed data communications
3-08-04	GMS (DCP)	Collection of meteorological data from the Geostationary Meteorological Satellite of the Japan Meteorological Agency (GMS) Data Collection Platform (DCP) installed on ships, buoys, aircraft and weather stations
3-08-05	Iridium	The Iridium satellite constellation is a large group of Low Earth Orbit (LEO) satellites providing voice and data coverage to satellite phones, pagers and integrated transceivers over Earth's entire surface
3-08-06	ORBCOMM	ORBCOMM is a company that offers machine-to-machine global asset monitoring and messaging services from its constellation of LEO communications satellites.
3-08-07	VSAT	A very small aperture terminal (VSAT) is a two-way satellite ground station used in satellite communications of data, voice and video signals which access satellites in geosynchronous orbit to relay data from small remote earth stations (terminals) to other terminals master earth station hubs.
3-08-08	Landline telephone	A landline telephone refers to a phone or modem that uses a physical telephone line for communication.
3-08-09	Radio modem	
3-08-10	E-mail	

Code table: 3-09

Code table title: Station status

#	Name	Definition
3-09-1	Planned	The station is planned to be deployed sometime in the future, and all information provided is indicative only. No observations are taken.
3-09-2	Pre-operational	The station is deployed and producing data but still not fully ready to start reporting operationally.
3-09-3	Operational/Reporting	The station fully complies with the reporting obligations of the observation programme/network concerned
3-09-4	Partly reporting	The station partially complies with the reporting obligations of the observation programme/network concerned
3-09-5	Temporarily suspended	The station is considered non-reporting/non-operational for a certain period of time; The station is expected to resume its operational/reporting status after the temporarily suspension interval
3-09-6	Closed	The station has been declared as closed by the responsible supervising organization

Code table: 4-01-01

Code table title: Land cover types (IGBP)

#	Name	Definition
4-01-01-00	Not applicable	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-01-01-01	Water	Cf. https://lpdaac.usgs.gov/products/modis_products_table/mcd12q1
4-01-01-02	Evergreen Needleleaf forest	
4-01-01-03	Evergreen Broadleaf forest	
4-01-01-04	Deciduous Needleleaf forest	
4-01-01-05	Deciduous Broadleaf forest	
4-01-01-06	Mixed forest	
4-01-01-07	Closed shrublands	
4-01-01-08	Open shrublands	
4-01-01-09	Woody savannas	
4-01-01-10	Savannas	
4-01-01-11	Grasslands	
4-01-01-12	Permanent wetlands	
4-01-01-13	Croplands	
4-01-01-14	Urban and built-up	
4-01-01-15	Cropland/Natural vegetation mosaic	
4-01-01-16	Snow and ice	
4-01-01-17	Barren or sparsely vegetated	
4-01-01-99	Unclassified	

Code table: 4-01-02

Code table title: Land cover types (UMD)

#	Name	Definition
4-01-02-00	Not applicable	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-01-02-01	Water	Cf. https://lpdaac.usgs.gov/products/modis_products_table/mcd12q1
4-01-02-02	Evergreen Needleleaf forest	
4-01-02-03	Evergreen Broadleaf forest	
4-01-02-04	Deciduous Needleleaf forest	
4-01-02-05	Deciduous Broadleaf forest	
4-01-02-06	Mixed forest	
4-01-02-07	Closed shrublands	
4-01-02-08	Open shrublands	
4-01-02-09	Woody savannas	
4-01-02-10	Savannas	
4-01-02-11	Grasslands	
4-01-02-12	Croplands	
4-01-02-13	Urban and built-up	
4-01-02-14	Barren or sparsely vegetated	
4-01-02-99	Unclassified	

Code table: 4-01-03

Code table title: Land cover types (LAI/fPAR)

#	Name	Definition
4-01-03-00	Not applicable	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-01-03-01	Water	Cf. https://lpdaac.usgs.gov/products/modis_products_table/mcd12q1
4-01-03-02	Grasses/Cereal crops	
4-01-03-03	Shrubs	
4-01-03-04	Broadleaf crops	
4-01-03-05	Savanna	
4-01-03-06	Evergreen broadleaf forest	
4-01-03-07	Deciduous broadleaf forest	
4-01-03-08	Evergreen needleleaf forest	
4-01-03-09	Deciduous needleleaf forest	
4-01-03-10	Non vegetated	
4-01-03-11	Urban	
4-01-03-99	Unclassified	

Code table: 4-01-04

Code table title: Land cover types (NPP)

#	Name	Definition
4-01-04-00	Not applicable	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-01-04-01	Water	Cf. https://lpdaac.usgs.gov/products/modis_products_table/mcd12q1
4-01-04-02	Evergreen needleleaf vegetation	
4-01-04-03	Evergreen broadleaf vegetation	
4-01-04-04	Deciduous needleleaf vegetation	
4-01-04-05	Deciduous broadleaf vegetation	
4-01-04-06	Annual broadleaf vegetation	
4-01-04-07	Non-vegetated land	
4-01-04-08	Urban	
4-01-04-99	Unclassified	

Code table: 4-01-05

Code table title: Land cover types (PFT)

#	Name	Definition
4-01-05-00	Water	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-01-05-01	Evergreen Needleleaf trees	Cf. https://lpdaac.usgs.gov/products/modis_products_table/mcd12q1
4-01-05-02	Evergreen Broadleaf trees	
4-01-05-03	Deciduous Needleleaf trees	
4-01-05-04	Deciduous Broadleaf trees	
4-01-05-05	Shrub	
4-01-05-06	Grass	
4-01-05-07	Cereal crops	
4-01-05-08	Broad-leaf crops	
4-01-05-09	Urban and built-up	
4-01-05-10	Snow and ice	
4-01-05-11	Barren or sparse vegetation	
4-01-05-254	Unclassified	
4-01-05-255	Fill Value	

Code table: 4-01-06

Code table title: Land cover types (LCCS)

#	Name	Definition
4-01-06-00	Not applicable	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-01-06-01	Cultivated and Managed Terrestrial Areas	cf. Antonio Di Gregorio (2005)
4-01-06-02	Natural and Semi-Natural Terrestrial Vegetation	
4-01-06-03	Cultivated Aquatic or Regularly Flooded Areas	
4-01-06-04	Natural and Semi-Natural Aquatic or Regularly Flooded Vegetation	
4-01-06-05	Artificial Surfaces and Associated Areas	
4-01-06-06	Bare Areas	
4-01-06-07	Artificial Waterbodies, Snow and Ice	
4-01-06-08	Natural Waterbodies, Snow and Ice	
4-01-06-99	Unclassified	

Code table: 4-02

Code table title: Surface cover classification scheme

#	Name	Definition
4-02-00	Not applicable	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-02-01	Land cover types (IGBP)	International Geosphere-Biosphere Programme https://lpdaac.usgs.gov/products/modis_products_table/mcd12q1
4-02-02	Land cover types (UMD)	The University of Maryland Department of Geography generated global land cover classification collection from 1998. http://glcf.umd.edu/data/landcover/
4-02-03	Land cover types (LAI/fPAR)	Leaf Area Index (LAI) and Fractional Photosynthetically Active Radiation (FPAR). FPAR/LAI is the Fraction of Absorbed Photosynthetically Active radiation that a plant canopy absorbs for photosynthesis and growth in the 0.4 – 0.7nm spectral range.
4-02-04	Land cover types (NPP)	Net Primary Production (NPP) land cover scheme
4-02-05	Land cover types (PFT)	Plant Functional Types (PFT) land cover scheme
4-02-06	Land cover types (LCCS)	Land cover classification scheme (LCCS)

Code table: 4-03-01

Code table title: Local topography (based on Speight 2009)

#	Name	Definition
4-03-01-0	Not applicable	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-03-01-1	Hilltop	Higher than all or nearly all of the surrounding land or subsurface.
4-03-01-2	Ridge	Higher than all or nearly all of the surrounding land or subsurface, but elongated and extending beyond a 50 m radius.
4-03-01-3	Slope	Neither crest nor depression or valley bottom, and with a slope more than 3%.
4-03-01-4	Flat	Slope less than 3% and not a top, ridge, valley bottom or depression. Use for plains.
4-03-01-5	Valley bottom	Lower than nearly all of surrounding land or subsurface, but water can flow out.
4-03-01-6	Depression	Lower than surrounding land or subsurface, with no above-ground outlet for water.

Code table: 4-03-02

Code table title: Relative elevation

#	Name	Definition
4-03-02-0	Not applicable	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-03-02-1	Lowest	In the bottom 5% of the elevation range
4-03-02-2	Low	Between 5% and 25% of the elevation range
4-03-02-3	Middle	Between 25% and 75% of the elevation range
4-03-02-4	High	Between 75% and 95% of the elevation range
4-03-02-5	Highest	In the highest 5% of the elevation range

Code table: 4-03-03

Code table title: Topographic context (based on Hammond 1954)

#	Name	Definition
4-03-03-0	Not applicable	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-03-03-1	Plains	Very low relief
4-03-03-2	Hollows	Low relief, tending to convergent form
4-03-03-3	Rises	Low relief, tending to divergent form
4-03-03-4	Valleys	Medium relief, tending to convergent form
4-03-03-5	Hills	Medium relief, tending to divergent form
4-03-03-6	Mountains	High relief

Code table: 4-03-04

Code table title: Altitude/Depth

#	Name	Definition
4-03-04-0	Not applicable	None of the codes in the table are applicable in the context of this particular observation (nilReason)
4-03-04-1	Very small	between -100 m and 100 m
4-03-04-2	Small	Between -300 and -100 m or between 100 and 300 m
4-03-04-3	Middle	Between -1000 and -300 m or between 300 and 1000 m
4-03-04-4	Large	Between -3000 and -1000 m Between 1000 and 3000 m
4-03-04-5	Very large	Deeper than -3000 m or above 3000 m

Code table: 4-04

Code table title: Events at station/platform [Code table under development]

#	Name	Definition
4-04-01	Grass-cutting	
4-04-02	Snow clearing	
4-04-03	Tree removal	
4-04-04	Construction activity	
4-04-05	Road work	
4-04-06	Biomass burning	Anthropogenic or natural
4-04-07	Dust storm	
4-04-08	Storm damage	
4-04-09	Wind storm	
4-04-10	Flood	
4-04-11	Fire	
4-04-12	Earthquake	
4-04-13	Land slide	
4-04-14	Storm surge or tsunami	
4-04-15	Lightning	
4-04-16	Vandalism	

Code table: 5-01

Code table title: Source of observation

#	Name	Definition
5-01-1	Automatic observation	Automatically produced measurement result
5-01-2	Manual observation	Manual reading of instrument
5-01-3	Visual observation	Human, non-instrumented observation

Code table: 5-02

Code table title: Measurement/observing method [Code table under development]

Code table: 5-04

Code table title: Instrument operating status

#	Name	Definition
5-04-1	Operational	The instrument is declared operational and subject to routine maintenance
5-04-2	Testing	The instrument is deployed for testing purposes and the information provided may not be reliable
5-04-3	Not in service	The instrument is deployed but presently not in service

Code table: 5-08

Code table title: Instrument control result

#	Name	Definition
5-08-0	no changes - in calibration	Instrument verified and found to be in calibration
5-08-1	no changes - out of calibration	Instrument checked and found to be out of calibration; no changes to calibration function
5-08-2	no changes – calibration unknown	Instrument visited but calibration could not be carried out
5-08-3	recalibrated - in calibration	Instrument checked and found to be out of calibration; instrument recalibrated (calibration function changed)

Code table: 5-14

Code table title: Status of observation

#	Name	Definition
5-14-01	Primary	The primary or official observation of the observed variable
5-14-02	Additional	Additional or supplemented observation of the observed variable

Code table: 5-15

Code table title: Exposure of instrument

#	Name	Definition
5-04-1	Class 1	exposure of instrument allows reference level measurements
5-04-2	Class 2	exposure of instrument has small or infrequence influence on measurement
5-04-3	Class 3	exposure of instrument leads to increased uncertainty or occasional invalid measurements
5-04-4	Class 4	exposure of instrument leads to high uncertainty or regular invalid measurements
5-04-5	Class 5	exposure of instrument leads to invalid measurements

Code table: 6-03

Code table title: Sampling strategy

#	Name	Definition
6-03-1	Continuous	Sampling is done continuously, but not necessarily at regular time intervals. Sampling is integrating, i.e., none of the medium escapes observations.
6-03-2	Discrete	Sampling is done at regular time intervals for certain sampling periods that are smaller than the time interval. Sampling is not integrating, i.e., parts of the medium escape observation.
6-03-3	Event	Sampling is done at irregular time intervals.

Code table: 7-06

Code table title: Level of data

#	Name	Definition	
		CIMO (WMO-No. 8, 2008, Updated 2010)	**CEOS** (http://www.ceos.org/images/WGISS/Documents/Handbook.pdf)
7-06-0	Unknown		
7-06-1	Raw		Physical information: Data in their original packets, as received from a satellite
7-06-2	Level 0	Analogue/digital electric signals	Physical information: Reconstructed unprocessed instrument data at full space time resolution with all available supplemental information to be used in subsequent processing (e.g., ephemeris, health and safety) appended.
7-06-3	Level I	Level I data (Primary Data): in general, are instrument readings expressed in appropriate physical units, and referred to Earth geographical coordinates. They require conversion to the normal meteorological variables (identified in Part I, Chapter 1). Level I data themselves are in many cases obtained from the processing of electrical signals such as voltages, referred to as raw data. Examples of these data are satellite radiances and water-vapour pressure, positions of constant-level balloons, etc. but not raw telemetry signals. Level I data still require conversion to the meteorological parameters specified in the data requirements.	Physical information: Unpacked, reformatted level 0 data, with all supplemental information to be used in subsequent processing appended. Optional radiometric and geometric correction applied to produce parameters in physical units. Data generally presented as full time/space resolution. A wide variety of sub level products are possible.
7-06-4	Level II	Level II Data (Meteorological parameters). They may be obtained directly from many kinds of simple instruments, or derived from Level I data. For example, a sensor cannot measure visibility, which is a Level II quantity; instead, sensors measure the extinction coefficient, which is a Level I quantity.	Geophysical information. Retrieved environmental variables (e.g., ocean wave height, soil moisture, ice concentration) at the same resolution and location as the level 1 source data.
7-06-5	Level III	Level III (Initial state parameters) are internally consistent data sets, generally in grid-point form obtained from level II data by applying established initialization procedures. NOTE: Data exchanged internationally are level II or level III data.	Geophysical information. Data or retrieved environmental variables which have been spatially and/or temporally re-sampled (i.e., derived from level 1 or 2 products). Such re-sampling may include averaging and compositing.
7-06-6	Level IV		Thematic information. Model output or results from analyses of lower level data (i.e., variables that are not directly measured by the instruments, but are derived from these measurements).

Code table: 7-10

Code table title: Reference time [Code table under development]

#	Name	Definition
7-10-0	Unknown	
7-10-1	Time Server	
7-10-2	Radio Clock	
7-10-3	Manual Comparison	

Code table: 8-03-01

Code table title: Quality flag [From BUFR code table 0 33 020 (WMO, 2013) - Code table under development]

#	Name	Definition
8-03-01-0	Good	
8-03-01-1	Inconsistent	
8-03-01-2	Doubtful	
8-03-01-3	Wrong	
8-03-01-4	Not checked	
8-03-01-5	Has been changed	
8-03-01-6	Estimated	
8-03-01-7	Missing value	

Code table: 8-03-02

Code table title: Quality flag [From OGC WaterML 2.0]

#	Name	Definition
8-03-02-0	Good	The data has been examined and represents a reliable measurement.
8-03-02-1	Suspect	The data should be treated as suspect.
8-03-02-2	Estimate	The data is an estimate only, not a direct measurement.
8-03-02-3	Poor	The data should be considered as low quality and may have been rejected.
8-03-02-4	Unchecked	The data has not been checked by any qualitative method.
8-03-02-5	Missing	The data is missing.

Code table: 8-04

Code table title: Quality Flag System

#	Name	Definition
8-04-0	Unknown	Quality flag system not known
8-04-1	WMO BUFR table 0 33 020	http://codes.wmo.int/bufr4/codeflag/0-33-020
8-04-2	Other quality flagging system	Quality flags are specified according to another system

Code table: 8-05

Code table title: Traceability

#	Name	Definition
8-05-0	Unknown	Traceability not known
8-05-1	Traceable to international standard	Traceable to an international standard
8-05-2	Traceable to other standard	Not traceable to an international standard

Code table: 9-02

Code table title: WMO_DataLicenseCode (WMO 2013a, Table 14)

#	Name	Definition
9-02-1	WMOEssential	WMO Essential Data: free and unrestricted international exchange of basic data and products.
9-02-2	WMOAdditional	WMO Additional Data: free and unrestricted access to data and products exchanged under the auspices of WMO to the research and education communities for non-commercial activities. A more precise definition of the data policy may be additionally supplied within the metadata. In all cases it shall be the responsibility of the data consumer to ensure that they understand the data policy specified by the data provider – which may necessitate dialogue with the data publisher for confirmation of terms and conditions.
9-02-3	WMOOther	Data identified for global distribution via WMO infrastructure (GTS / WIS) that is not covered by WMO Resolution 25 neither WMO Resolution 40; e.g. aviation OPMET data. Data marked with “WMOOther” data policy shall be treated like “WMOAdditional” where a more precise definition of the data policy may be additionally supplied within the metadata. In all cases it shall be the responsibility of the data consumer to ensure that they understand the data policy specified by the data provider – which may necessitate dialogue with the data publisher for confirmation of terms and conditions.

ADDITIONAL CODE TABLES, NOT SPECIFIC TO A PARTICULAR METADATA CATEGORY OR ELEMENT

Code table: 11-01

Code table title: "Coordinates Source/Service" [Code table under development]

#	Name	Definition
11-1-01	GPS	
11-1-02	ARGOS DOPPLER	
11-1-03	IRIDIUM DOPPLER	
11-1-04	ARGOS Kalman	
11-1-05	GALILEO	
11-1-06	LORAN	
11-1-07	Surveyed	
11-1-08	From map	

Code table: 11-02

Code table title: "Coordinates reference" [Code table under development]

#	Name	Definition
11-1-01	WGS84	
11-1-02		
11-1-03		
11-1-04		
11-1-05		
11-1-06		
11-1-07		

Code table: 11-03

Code table title: Meaning of time stamp

#	Name	Definition
11-03-1	Beginning	Time stamps indicate the beginning of a period covering the range up to but excluding the following time stamp.
11-03-2	End	Time stamps indicate the end of a period covering the range up to but excluding the preceding time stamp.
11-03-3	Middle	Time stamps indicate the middle of a period beginning at the middle of the range described by this and the preceding time stamp and ending right before the middle of the range described by this and the following time stamp.

Resolution 27 (Cg-17)

INSTRUMENTS AND METHODS OF OBSERVATION PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 7 (Cg-XVI) – Instruments and Methods of Observation Programme,

(2) That the Commission for Instruments and Methods of Observation (CIMO) at its sixteenth session approved changes to the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8),

Considering:

(1) The continued need for the provision of high-quality, compatible and homogeneous meteorological data, which is of the utmost importance for operational and research activities of Members,

(2) The need for ensuring the whole-of-life sustainability of observing systems (including, inter alia, regular maintenance, calibration and prompt repair) and long-term performance in their prevailing climatic conditions,

(3) The need for continuous standardization of instruments and observing methods and worldwide traceability of measurements to the International System (SI) of units,

(4) The need for improved coordination and quality control of widely used surface-based systems, including remote-sensing systems such as weather radars and radar wind profilers, providing crucial information for the issuance of warnings,

(5) The need for more robust instruments capable of withstanding severe weather events and measuring associated extreme meteorological, hydrological and related variables and the need for continuous improvement of related observing technologies and methodologies,

(6) The importance of applying new technology for the cost-effective generation of measurements and acquisition of observational data,

(7) The need to ensure interoperability among observing technologies and systems to effectively implement the WMO Integrated Global Observing System (WIGOS),

(8) The continuing need for training of instrument specialists and technicians for the operation, maintenance and calibration of observing technology, especially individuals from developing countries,

(9) The need to continue to carry out intercomparisons of instruments and observing systems,

(10) The need to comply with the Minamata Convention on Mercury when it enters into force in 2020 and the impact it will have on Members that are still using mercury-based instruments in their networks,

(11) The need for continuing close collaboration of the Commission for Instruments and Methods of Observation (CIMO) with other technical commissions and programmes, for meeting their requirements and those of all WMO high priorities, such as WIGOS, the Global Framework for Climate Services (GFCS), Global Cryosphere Watch (GCW), the requirements of the International Civil Aviation Organization and high-quality impact-based forecasts for measurements and observations,

(12) The role of the Regional Instrument Centres (RICs), Regional Marine Instrument Centres (RMICs) and Regional Radiation Centres (RRCs) in promoting instrument calibration, training and capacity-building,

(13) The role that CIMO Testbeds and Lead Centres will play in the integration of various surface-based remote-sensing systems, as well as cost-effective development of conventional and automatic observing systems within the WIGOS framework,

Reaffirms the co-leading role of CIMO, together with the Commission for Basic Systems, in the development and implementation of WIGOS and further reaffirms that WMO, in further developing and implementing its Instruments and Methods of Observation Programme, should continue its collaboration with international bodies such as the International Bureau of Weights and Measures (BIPM), the International Organization for Standardization (ISO), the Association of Hydro-Meteorological Equipment Industry (HMEI) and the European Cooperation in the Field of Scientific and Technical Research (COST), as well as with the Network of European Meteorological Services;

Requests the Executive Council, with the assistance of CIMO and other relevant technical commissions, to promote, guide and assist in the implementation of the Instruments and Methods of Observation Programme;

Requests the regional associations:

(1) To continue providing proactive support for regional aspects of the Instruments and Methods of Observation Programme, especially as regards capacity development;

(2) To assess, together with CIMO, the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), or a relevant national or international agency, at least every five years, existing RICs, RMICs and RRCs to verify their capabilities and performance;

(3) To regularly review the requirements of their Members for services to be provided by RICs, RMICs and RRCs;

(4) To organize regular Regional Pyrheliometer Comparisons at one of the RRCs and inter-laboratory calibration tests among existing RICs;

(5) To inform CIMO of their particular requirements and priorities related to the development of guidance material and training needs pertaining to instruments and methods of observation and to collaborate with CIMO in organizing such events;

Requests the presidents of technical commissions to keep under continuous study and review the aspects of instruments and methods of observation related to their fields of specialization and to communicate their requirements to CIMO;

Requests Members:

(1) To collaborate actively in, and to give all possible support to, the implementation of the Instruments and Methods of Observation Programme;

(2) To continue and, if possible, increase their activities related to the development of new instruments and observing systems with an emphasis on interoperability and cost-effectiveness;

(3) To share their expertise and publish reports on the operation of advanced observing systems, as well as on the process they followed to phase out mercury from their observing systems;

(4) To support and participate in global and regional intercomparisons of instruments and new methods of observation and to apply the results of those comparisons in their observing networks;

(5) To support and participate in the development of new observing standards, such as those for automation of manual, visual and subjective observations, weather radars, wind profilers, lidars and measurement in extreme conditions;

(6) To promote the development of procedures for quality management of observations, instrument maintenance, calibration and operational practices and collaborate with other countries, as needed, in the development and implementation of their own plans;

(7) To promote metrology and to ensure traceability of measurements to SI;

(8) To support RICs, RMICs and RRCs to enable them to fulfil their mandates and provide support to Members of the Region according to their terms of reference;

(9) To support CIMO Testbeds and Lead Centres in the development of guidance on integration of ground-based remote-sensing and in situ observations and the development of standard procedures for all aspects of instrument use and operation with a view to promoting worldwide instrument compatibility and interoperability;

(10) To ensure the ongoing training of instrument specialists and technicians to guarantee the proper maintenance of their observing systems;

Requests the Secretary-General:

(1) To take necessary actions to assist WMO bodies, in particular CIMO, in the coordination and implementation of the Instruments and Methods of Observation Programme;

(2) To provide funding for instrument intercomparisons within the regular WMO budget;

(3) To assist Members, as necessary, but in particular the least developed countries, the small island developing States and the developing countries, in overcoming difficulties that may arise in the implementation of the Programme;

(4) To assist the Executive Council, the regional associations and CIMO in the implementation of the present resolution;

(5) To arrange for the publication of the amendments to the *Guide to Meteorological Instruments and Methods of Observation*, as approved by CIMO at its sixteenth session, and its translation in other WMO official languages;

(6) To provide needed support to update *the International Cloud Atlas* (WMO-No. 407), Volume I – *Manual on the Observation of Clouds and Other Meteors*, and Volume II, and to arrange for its publication.

Note: This resolution replaces Resolution 7 (Cg-XVI), which is no longer in force.

Resolution 28 (Cg-17)

REPORT OF THE SIXTEENTH SESSION OF THE COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 8 (Cg-XVI) – Report of the fifteenth session of the Commission for Instruments and Methods of Observation,

(2) The *Abridged Final Report with Resolutions and Recommendations of the Sixteenth Session of the Commission for Instruments and Methods of Observation* (WMO-No. 1138),

Decides:

(1) To note the report;

(2) To note Resolutions 1 to 4 (CIMO-16);

(3) To take action on each of the following recommendations as follows:

Recommendation 1 (CIMO-16) – Publication and translation of the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8), 2014 edition

(a) Approves this recommendation;

(b) Requests the Secretary-General to identify the resources to translate the new edition of the Guide in WMO official languages from within the regular budget, in-kind contributions from Members or voluntary contributions to the Commission for Instruments and Methods of Observation (CIMO) Trust Fund;

Recommendation 2 (CIMO-16) – Recognition of centennial observing stations

(a) Approves this recommendation;

(b) Requests the Secretary-General to provide support to this initiative;

Recommendation 3 (CIMO-16) – Revision of the *International Cloud Atlas* (WMO-No. 407)

(a) Approves this recommendation;

(b) Recommends Members to support the development of the International Cloud Atlas through voluntary contributions to the CIMO Trust Fund and secondments;

(c) Recommends that other relevant technical commissions collaborate with CIMO, as appropriate;

(d) Recommends that the Secretary-General identify the necessary resources to complete the work;

Recommendation 4 (CIMO-16) – Review of resolutions of the Executive Council related to the Commission for Instruments and Methods of Observation

(a) Approves this recommendation.

Resolution 29 (Cg-17)

RADIO FREQUENCIES FOR METEOROLOGICAL AND RELATED ENVIRONMENTAL ACTIVITIES

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The WMO Strategic and Operating Plans,

(2) Resolution 4 (Cg-XV) – Radio frequencies for meteorological and related environmental activities,

(3) The current radio-frequency allocations and regulatory provisions related to the meteorological aids, meteorological satellite, Earth-exploration satellite and radiolocation (weather and wind profiler radars) services in the Radio Regulations of the International Telecommunication Union (ITU),

(4) The outcome of the ITU World Radiocommunication Conferences (WRCs),

(5) The agenda of the forthcoming ITU World Radiocommunication Conference and related WMO positions submitted during the ITU preparatory process to WRCs,

Considering:

(1) The prime importance of the specific radiocommunication services for meteorological and related environmental activities required for the detection and early warning of hazards and the prevention and mitigation of natural and technological (human-induced) disasters, the safety of life and property, the protection of the environment, climate change studies and scientific research,

(2) The importance of information provided by the Earth-exploration systems including meteorological systems for a wide range of economic activities such as agriculture, transportation, construction and tourism,

(3) The crucial importance of the allocation of suitable radio-frequency bands for the operation of surface-based meteorological observing systems, including in particular radiosondes, weather radars and wind profiler radars,

(4) The crucial importance of the allocation of suitable radio-frequency bands for the operation of meteorological and research and development satellites, including remote-sensing, data collection and data distribution links,

Stressing that some radio-frequency bands are a unique natural resource due to their special characteristics and natural radiation enabling space-borne passive sensing of the atmosphere and the Earth surface, which deserve adequate allocation to the Earth-exploration satellite service (passive) and absolute protection from interference,

Expresses its serious concern at the continuing threat to several radio-frequency bands allocated to the meteorological aids, meteorological-satellite, Earth-exploration satellite and radiolocation (weather and wind profiler radars) services posed by the development of other radiocommunication services;

Requests the Commission for Basic Systems to pursue the continuous review of regulatory and technical matters related to radio frequencies for operational and research meteorological and related environmental activities, and preparation of guidance and information for National Meteorological and Hydrological Services, in coordination with other technical commissions,

especially the Commission for Instruments and Methods of Observation, and in liaison with other relevant international bodies, in particular the Coordination Group for Meteorological Satellites;

Urges all Members to do their utmost to ensure the availability and protection of suitable radio-frequency bands required for meteorological and related environmental operations and research, and in particular:

(1) To ensure that their national radiocommunication administrations are fully aware of the importance of and requirements for radio frequencies for meteorological and related activities, and to seek their support in the ITU World Radiocommunication Conferences and Radiocommunication Sector (ITU-R) activities;

(2) To participate actively in the national, regional and international activities on relevant radiocommunication regulatory issues and, in particular, to involve experts from their Services in the work of relevant regional telecommunication organizations and of ITU-R, especially ITU-R Study Groups 5 and 7 on Terrestrial (including radiolocation) and Science Services, respectively;

(3) To register adequately with their national radiocommunication administrations all radiocommunication stations and radio frequencies used for meteorological and related environmental operations and research;

Appeals to the International Telecommunication Union and its Member Administrations:

(1) To ensure the availability and absolute protection of the radio-frequency bands which, due to their special physical characteristics, are a unique natural resource for spaceborne passive sensing of the atmosphere and the Earth surface and are of crucial importance for weather, water and climate research and operations;

(2) To give due consideration to the WMO requirements for radio-frequency allocations and regulatory provisions for meteorological and related environmental operations and research;

(3) To pay special attention to the WMO positions related to the WRC agenda, in the light of Appeals (1) and (2) above;

Requests the Secretary-General:

(1) To bring the present resolution to the attention of all concerned, including the International Telecommunication Union;

(2) To pursue as a matter of high priority the coordination role of the Secretariat in radio-frequency matters, especially with ITU-R, including participation of WMO in ITU-R Radiocommunication Study Groups, conference preparatory meetings and World Radiocommunication Conferences;

(3) To facilitate the coordination between National Meteorological and Hydrological Services and their national radiocommunication administrations, particularly in preparing for the ITU World Radiocommunication Conferences, by providing appropriate information and documentation;

(4) To assist the Commission for Basic Systems in the implementation of the present resolution.

Note: This resolution replaces Resolution 4 (Cg-XV), which is no longer in force.

Resolution 30 (Cg-17)

GUIDE TO NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES' PARTICIPATION IN RADIO-FREQUENCY COORDINATION

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

Noting Resolution 29 (Cg-17) – Radio frequencies for meteorological and related environmental activities,

Considering Recommendation 13 (CBS-Ext.(2014)) – Guide to National Meteorological and Hydrological Services Participation in Radio-frequency Coordination,

Decides to approve the Guide to National Meteorological and Hydrological Services' Participation in Radio-frequency Coordination, as provided in the annex to Recommendation 13 (CBS-Ext.(2014));

Requests the Secretary-General to take appropriate action to publish the new Guide in order that Members are able to use it in their preparation processes for the World Radiocommunication Conference 2015;

Authorizes the Secretary-General to make any consequent editorial amendments.

Resolution 31 (Cg-17)

REPORT OF THE EXTRAORDINARY SESSION (2014) OF THE COMMISSION FOR BASIC SYSTEMS RELEVANT TO CENTRES AND NETWORKS OF THE WMO INFORMATION SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

Noting:

(1) Resolution 45 (Cg-XVI) – Technical Regulations of the World Meteorological Organization,

(2) Resolution 51 (Cg-XVI) – Designation of Centres of the WMO Information System,

(3) The *Technical Regulations* (WMO-No. 49), Volume I – General Meteorological Standards and Recommended Practices, Part I, section 3,

(4) The *Manual on the WMO Information System* (WMO-No. 1060), in which paragraph 1.7.1 emphasizes the importance of dedicated telecommunications for routing exchange of time- and operational-critical data,

Considering:

(1) Recommendation 9 (CBS-Ext.(2014)) – Establishment of a SATCOM Users' Forum,

(2) Recommendation 19 (CBS-Ext.(2014)) – Critical role of WMO Information System networks,

(3) Recommendation 20 (CBS-Ext.(2014)) – Updates to the *Manual on the WMO Information System* (WMO-No.1060),

Recalling Resolution 40 (Cg-XII) – WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities, that urged Members to strengthen their commitment to free and unrestricted exchange of meteorological and related data and products,

Decides:

(1) To remove the conditional reference to centres' designations as described in Table 1 of the annex to the present resolution;

(2) To designate as WMO Information System (WIS) Data Collection or Production Centres those centres listed in Table 2 of the annex to the present resolution;

(3) To extend the conditional designation of those WIS centres listed in Table 3 of the annex to the present resolution until the sixteenth session of the Commission for Basic Systems;

(4) To withdraw the designation as a WIS Data Collection or Production Centre of the International Polar Year data repository, Sweden;

(5) To approve Recommendation 9 (CBS-Ext.(2014)) to establish a SATCOM users' forum;

(6) To classify telecommunications between WIS centres as an essential service for creating and distributing data, products, warnings and advisories for the protection of life and property;

Urges Members to recognize the critical importance of providing unrestricted exchange of information and supporting WMO telecommunication networks between National Meteorological and Hydrological Services in support of public and economic safety and well-being, and to endeavour to support and protect this information flow and its supporting technologies in their national and international decision-making;

Requests the Secretary-General:

(1) To take appropriate actions to update the list of centres in the *Manual on the WMO Information System* to conform with the present resolution;

(2) To facilitate the necessary arrangements to implement the SATCOM users' forum;

(3) To stress within the United Nations system the critical importance of unrestricted international exchange of information and supporting WMO telecommunication networks between National Meteorological and Hydrological Services in support of public and economic safety and well-being, and of access to technology required to support this.

Annex to Resolution 31 (Cg-17)

DATA COLLECTION OR PRODUCTION CENTRE DESIGNATIONS

Table 1. DCPCs to have conditional marker removed from Manual on WIS

Member State or Org	*Centre*	*ID No.*	*CBS Endorsement*	*Principal GISC*	*WIS Manual action*
Croatia	Croatia MMC	9	Endorsed	Offenbach	Remove conditional marker (*) from Manual on WIS
Czech Republic	RTH Prague	125	Endorsed	Offenbach	Remove conditional marker (*) from Manual on WIS
France	RSMC-Activity-TC (La Reunion)	56	Endorsed	Toulouse	Remove conditional marker (*) from Manual on WIS
India	RTH New Delhi	100	Endorsed	New Delhi	Remove conditional marker (*) from Manual on WIS
Iran, Islamic Republic of	RTH Tehran	177	Endorsed	Tehran	Remove conditional marker (*) from Manual on WIS
Italy	RTH Rome	97	Endorsed	Offenbach	Remove conditional marker (*) from Manual on WIS
Saudi Arabia	RTH Jeddah	13	Endorsed	Jeddah	Remove conditional marker (*) from Manual on WIS
Serbia	RCC Belgrade	147	Endorsed	Offenbach	Remove conditional marker (*) from Manual on WIS
South Africa	RTH Pretoria	176	Endorsed	Pretoria	Remove conditional marker (*) from Manual on WIS
Sweden	RTH Norrkoping	11	Endorsed	Offenbach	Remove conditional marker (*) from Manual on WIS
USA	WMC Washington (RTH)	G7	Endorsed	Washington	Remove conditional marker (*) from Manual on WIS

Table 2. Centres endorsed by the Commission for Basic Systems at its extraordinary session (2014) to serve as WIS Data Collection or Production Centres (DCPCs) and recognized as satisfying the pre-operational compliance requirements

Member or International Organization	*Centre*	*Principal GISC*
Austria	RTH (Vienna)	Offenbach
France	Radar Data Centre (ODC Toulouse)	Toulouse
Japan	NICT (Space Weather)	Tokyo
New Zealand	RSMC-Geographical	Melbourne
New Zealand	RTH (Wellington)	Melbourne
New Zealand	VAAC (Wellington)	Melbourne
Qatar	Gulf Marine Centre	Jeddah
Spain	MEDARE	Toulouse
Thailand	RTH (Bangkok)	Tokyo
Turkey	RCC (EMCC – RA VI)	Offenbach
UK	GCOS Lead Centre for Antarctica (BAS Cambridge)	Exeter
UK	Radar Data Centre (ODC Exeter)	Exeter
UK**	RSMC-Activity-ATM	Exeter
UK	VAAC (London)	Exeter
UK	WAFC (London)	Exeter

** Replaces RSMC-EER

Table 3. Centres designated as WIS Centres by Resolution 51 (Cg-XVI) that have not been endorsed by the Commission for Basic Systems

Member	*Centre*	*Member*	*Centre*
Finland	FMI-ARC	USA	GOSIC
Germany	GRDC	USA	NCEP
India	RSMC-TC	USA	NCAR
Italy	RSMC Rome	USA	NGDC
Netherlands	RCC De Bilt	USA	NODC
Netherlands	Satellite Centre De Bilt	USA	NESDIS
Sweden	Baltrad	USA	ARL

Resolution 32 (Cg-17)

REPORT OF THE EXTRAORDINARY SESSION (2014) OF THE COMMISSION FOR BASIC SYSTEMS RELEVANT TO TECHNICAL REGULATIONS CONCERNING THE GLOBAL TELECOMMUNICATION SYSTEM, DATA MANAGEMENT AND THE WMO INFORMATION SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

Noting:

(1) Resolution 45 (Cg-XVI) – Technical Regulations of the World Meteorological Organization,

(2) Resolution 1 (Cg-XVI) – World Weather Watch Programme for 2012–2015,

(3) The *Technical Regulations* (WMO-No. 49), Volume I – General Meteorological Standards and Recommended Practices, Part I section 2.3 and section 3,

(4) That the 2013 edition of the *Technical Regulations* (WMO-No. 49), Volume II – Meteorological Service for International Air Navigation, introduced a requirement to exchange specific types of information in extensible markup language (XML),

(5) The desirability of maintaining consistency of presentation across Technical Regulations,

Considering:

(1) Recommendation 4 (CBS-Ext.(2014)) – Amendments to the *Manual on the Global Telecommunication System* (WMO-No. 386),

(2) Recommendation 6 (CBS-Ext.(2014)) – Amendments to the *Manual on Codes* (WMO-No. 306), Volume I.2 – Amendments to Regulations for reporting traditional observation data in Table Driven Code Forms: BUFR or CREX,

(3) Recommendation 7 (CBS-Ext.(2014)) – Amendments to the *Manual on Codes* (WMO-No. 306), Volume I.2 – Representation of missing character strings,

(4) Recommendation 8 (CBS-Ext.(2014)) – Migration to Table Driven Code Forms,

(5) Recommendation 10 (CBS-Ext.(2014)) – Representation of aviation information in extensible markup language,

(6) Recommendation 20 (CBS-Ext.(2014)) – Updates to the *Manual on the WMO Information System* (WMO-No. 1060),

(7) Recommendation 21 (CBS-Ext.(2014)) – Updates to the *Guide to the WMO Information System* (WMO-No. 1061),

Recalling that the Sixteenth World Meteorological Congress had supported the request made by the Executive Council at its sixty-second session that all technical commissions develop competence standards in their areas of expertise,

Decides to take action on each of the recommendations as follows:

Recommendation 4 (CBS-Ext.(2014)) – Amendments to the *Manual on the Global Telecommunication System* (WMO-No. 386)

(a) Approves this recommendation with effect from 1 January 2016;

(b) Requests the Secretary-General to make the amendments, as given in the annex to this recommendation, to the *Manual on the Global Telecommunication System*;

(c) Authorizes the Secretary-General to make any consequent editorial amendments;

Recommendation 6 (CBS-Ext.(2014)) – Amendments to the *Manual on Codes* (WMO-No. 306), Volume I.2 – Amendments to Regulations for reporting traditional observation data in Table Driven Code Forms: BUFR or CREX

Recommendation 7 (CBS-Ext.(2014)) – Amendments to the *Manual on Codes* (WMO-No. 306), Volume I.2 – Representation of missing character strings

(a) Approves these recommendations with effect from 4 November 2015;

(b) Requests the Secretary-General to make the amendments, as given in the annexes to these recommendations, to the *Manual on Codes*;

(c) Authorizes the Secretary-General to make any consequent editorial amendments;

Recommendation 8 (CBS-Ext.(2014)) – Migration to Table Driven Code Forms

(a) Approves this recommendation with effect from 1 July 2015;

Recommendation 10 (CBS-Ext.(2014)) – Representation of aviation information in extensible markup language

(a) Approves this recommendation with effect from 1 January 2016;

(b) Requests the Secretary-General to make the amendments, as given in the annexes to this recommendation, to the *Manual on Codes*;

(c) Authorizes the Secretary-General to make any consequent editorial amendments;

Recommendation 20 (CBS-Ext.(2014)) – Updates to the *Manual on the WMO Information System* (WMO-No. 1060*)*, Recommends (1) and (5)

(a) Approves Recommends (1) and (5) of this recommendation with effect from 1 July 2015;

(b) Requests the Secretary-General to make the amendments, as given in Annexes 1 and 3 to this recommendation, to the Manual on the WMO Information System;

(c) Authorizes the Secretary-General to make any consequent editorial amendments;

Recommendation 21 (CBS-Ext.(2014)) – Updates to the *Guide to the WMO Information System* (WMO-No. 1061)

(a) Approves the modifications to the *Guide to the WMO Information System* described in Annexes 1 to 4 of this recommendation;

(b) Approves changes to the text of the *Technical Regulations* as described in Annex 1 to the present resolution;

(c) Approves changes to the text of the *Manual on the WMO Information System* as described in Annex 2 to the present resolution;

(d) Approves changes to the text of the *Guide to the WMO Information System* as described in Annex 3 to the present resolution;

(e) Approves the text in Annex 5 of this recommendation for inclusion as a new Appendix E of the *Manual on the WMO Information System*;

(f) Approves the text in Annex 6 of this recommendation for inclusion as a new Appendix D of the *Guide to the WMO Information System*;

(g) Decides that these changes will apply from 1 July 2015;

(h) Requests the Secretary-General to make these amendments to the *Technical Regulations*, the *Manual on the WMO Information System* and the *Guide to the WMO Information System*;

(i) Authorizes the Secretary-General to make any consequent editorial amendments.

Annex 1 to Resolution 32 (Cg-17)

INTRODUCING WMO INFORMATION SYSTEM COMPETENCIES TO THE *TECHNICAL REGULATIONS* (WMO-No. 49), VOLUME I

Introduce the following paragraphs into WMO-No 49 *Technical Regulations* Volume I, Part II, Section 5 “Competences of Meteorological, Hydrological and Climatological Personnel”.

5.4 WMO Information System

5.4.1 Members operating one or more WMO Information System (WIS) centres should ensure that the centres have access to people who between them are able to contribute the required standard Information Technology and management competences together with competences that are specific to the WMO Information System.

5.4.2 Members should consider the following areas of competence:

5.4.2.1 Manage the physical infrastructure;

5.4.2.2 Manage the operational applications;

5.4.2.3 Manage the data flow;

5.4.2.4 Manage the data discovery;

5.4.2.5 Manage WIS centre to centre interactions;

5.4.2.6 Manage external user interactions;

5.4.2.7 Manage the operational service.

5.4.3 When assessing the level of competence needed and the number of people who need to be available who possess that level of competence, Members should consider, among other factors:

5.4.3.1 The organizational context, priorities and stakeholder requirements;

5.4.3.2 The way in which internal and external personnel are used to provide WIS services;

5.4.3.3 The available resources and capabilities (financial, human, technological and facilities);

5.4.3.4 National and institutional legislation, rules and procedures.

Note: More details on competences related to the WMO Information System may be found in WMO-No. 1060 *Manual on WMO Information System*, and guidance on developing these competences is available in WMO-No. 1061 *Guide to the WMO Information System*.

Annex 2 to Resolution 32 (Cg-17)

INTRODUCING WMO INFORMATION SYSTEM COMPETENCIES TO THE *MANUAL ON THE WMO INFORMATION SYSTEM* (WMO-No. 1060)

Introduce the following paragraph into WMO-No. 1060 *Manual on the WMO Information System* Part I – Organization and Responsibilities.

1.8 Competences of Personnel

As recommended by WMO-No. 49 *Technical Regulations* Volume I, Part II, Section 5 Competences of Meteorological, Hydrological and Climatological Personnel centres should ensure that they have access to an adequate number of people who between them have the required levels of the WIS competences that are defined in Annex D of that manual.

Note: Guidance on developing these competences is available in WMO-No. 1061 *Guide to the WMO Information System*.

Annex 3 to Resolution 32 (Cg-17)

INTRODUCING WMO INFORMATION SYSTEM COMPETENCIES TO THE *GUIDE TO THE WMO INFORMATION SYSTEM* (WMO-No. 1061)

Introduce the following paragraphs into WMO-No 1061 *Guide to the WMO Information System* Part I – Organization and Responsibilities.

1.8 Competences of Personnel

1.8.1 WMO-No. 1060 *Manual on WIS*, Part 1 paragraph 1.8 recommends that Members operating WIS centres ensure that the centres have access to adequate staff with an appropriate level of competence in areas appropriate operating the WIS.

1.8.2 WIS centres need access to generic Information Technology and management competences. There are many sources of training and development resources for these competences available from government or commercial sources, from libraries and from the Internet.

1.8.3 WIS centres also need access to competences that are specific to the WIS. Guidance on how these competences may be assessed and developed is provided in Annex D to the present guide.

Resolution 33 (Cg-17)

REPORT OF THE EXTRAORDINARY SESSION (2014) OF THE COMMISSION FOR BASIC SYSTEMS RELEVANT TO STANDARDIZATION OF DATA MANAGEMENT PRACTICES

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

Noting:

(1) Resolution 45 (Cg-XVI) – Technical Regulations of the World Meteorological Organization,

(2) Resolution 1 (Cg-XVI) – World Weather Watch Programme for 2012–2015,

(3) The *Technical Regulations* (WMO-No. 49), Volume I – General Meteorological Standards and Recommended Practices, Part I, sections 2 and 3,

(4) That the *International Meteorological Vocabulary* (WMO-No. 182) has not been revised since 1992,

(5) That the *Manual on the WMO Information System* (WMO-No. 1060) defines the WMO Information System but does not specify practices for many stages in the life cycle of information,

(6) That the Global Framework for Climate Services, the WMO Integrated Global Observing System (WIGOS), the Global Data-processing and Forecasting System and many other WMO activities rely on data being organized, stored and processed as well as exchanged,

(7) Recommendation 24 (CBS-Ext.(2014)) – Standardization of data management practices,

Decides that the scope of the WMO Information System (WIS) will be extended to include setting and auditing standards for centres that hold information in support of WMO Programmes, and to provide guidance on other aspects of data management, to be known as Part C of the WMO Information System;

Requests the Commission for Basic Systems:

(1) To investigate the requirements for a standard methodology of identifying objects to which WMO Programmes need to refer;

(2) To lead a cross-cutting activity that involves all technical commissions to coordinate development of guidance for Members in relation to all stages of the effective management of information throughout its lifecycle, and to include this guidance, associated standards and procedures in Part C of the WMO Information System;

(3) To develop and implement a procedure to create and maintain a set of definitions for use in WIS and WIGOS and to allow these to be identified as authoritative within the WMO METEOTERM application.

Resolution 34 (Cg-17)

DEFINITION OF STANDARDS FOR CLIMATE DATA MANAGEMENT SYSTEMS AND THEIR REFERENCE IN THE WMO INFORMATION SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The recommendation made by the Commission for Climatology (CCl) at its sixteenth session in Recommendation 1 (CCl-16) – Reflecting Climate Data Management System specifications in WMO Technical Regulations, that the Commission for Basic Systems (CBS) work closely with CCl in order to identify the relevant parts of the CCl Climate Data Management System (CDMS) specifications publication for possible inclusion in the WMO Technical Regulations,

(2) That the *Manual on the WMO Information System* (WMO-No. 1060) is Annex VII to the Technical Regulations,

Noting further:

(1) That the CCl Expert Team on Climate Data Management Systems developed a CDMS specifications publication, specifying the functionality that is expected within a CDMS, which was subsequently endorsed by the Commission at its sixteenth session,

(2) That the *Manual on the WMO Information System* and the *Guide to the WMO Information System* (WMO-No. 1061) are designed to ensure adequate uniformity and standardization in the data, information and communication practices, procedures and specifications employed among Members in the operation of the WMO Information System (WIS),

Considering:

(1) That in the absence of standards for Climate Data Management Systems, and given the variety of CDMS solutions in use worldwide, the international exchange of climate data and the computation of basic climate statistics are suffering in many cases from inconsistency, and that capacity-building, including training, becomes less efficient and less effective,

(2) That the definition of standards for CDMSs should already form an element of the CCl-led inter-programme initiative to work towards a High-quality Global Data Management Framework for Climate and that there is potential benefit from using the CBS data infrastructure comprised of the Global Data-processing and Forecasting System, WIS and the WMO Integrated Global Observing System to deliver such a Framework,

Decides:

(1) To further develop the CDMS specifications in view of developing WMO Standards for Climate Data Management and related systems in consultation with regional associations;

(2) That these standards shall be referenced in WIS regulations and reference material, including the Manual on WIS and the Guide to WIS, in close collaboration between CCl and CBS;

Requests the Commissions for Climatology and Basic Systems to work jointly to develop these standards and submit a proposal to the Executive Council;

Requests the Secretary-General to facilitate this work and data rescue implementation in the countries in need using available funds, including through the Voluntary Cooperation Programme, or through other resource mobilization mechanisms.

Resolution 35 (Cg-17)

WMO RECOGNITION OF LONG-TERM OBSERVING STATIONS

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The efforts led by the Commission for Climatology (CCl) in responding to the request of the Executive Council at its sixty-fifth session to the Commission, jointly with the Global Climate Observing System (GCOS) and the Commission for Instruments and Methods of Observation (CIMO), for establishing a mechanism for the recognition of centennial stations based on a minimum set of objective assessment criteria,

(2) That draft criteria for WMO recognition of centennial observing stations have been defined by the participants in the WMO Scoping Meeting on a Potential WMO Recognition Mechanism for Centennial Observing Stations,

Noting further:

(1) That the initiative received the support of CCl and CIMO at their sixteenth sessions and the Commission for Basic Systems (CBS) at its extraordinary session in 2014,

(2) Recommendation 2 (CIMO-16) – Recognition of centennial stations,

Recognizing the importance of long-term observations for documenting and analysing long-term variations on multidecadal to centennial timescales and thus providing a reference for current and future assessments of the Earth's climate,

Considering:

(1) That a formal WMO recognition of these stations is expected to contribute to the efforts of Members in operating and maintaining their observing stations under the most suitable conditions,

(2) That such a formal mechanism should be established based on a list of criteria that help identifying objectively these stations, thus allowing their cataloguing within the appropriate WMO regulatory material,

Decides to develop a recognition mechanism for long-term observing stations, including centennial observing stations, and the possibility of intermediate-level certification for 50 years and 75 years of observations;

Requests the Secretary-General to facilitate the collaboration of Members with CCl and the contribution from GCOS, CIMO and CBS in testing the implementation of this mechanism on a limited number of stations, as a test phase, and submit the conclusions of the test for consideration by the Executive Council.

Resolution 36 (Cg-17)

DESIGNATION OF THE CENTRE FOR MARINE-METEOROLOGICAL AND OCEANOGRAPHIC CLIMATE DATA IN TIANJIN, CHINA

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 2 (EC-64) – Report of the fourth session of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology,

(2) Resolution 16 (Cg-XVI) – Climate data requirements,

(3) Resolution 24 (Cg-XVI) – Marine Meteorology and Oceanography Programme,

(4) Resolution 48 (Cg-XVI) – Implementation of the Global Framework for Climate Services,

(5) Recommendation 2 (JCOMM-4) – Marine Climate Data System (MCDS),

Recalling:

(1) That the terms of reference of Centres for Marine-Meteorological and Oceanographic Climate Data (CMOCs), together with their capabilities and corresponding functions, are provided in Annex 2 of Recommendation 2 (JCOMM-4),

(2) That the mechanism for formal designation and withdrawal of CMOCs by WMO and the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC of UNESCO) is detailed in Annex 3 of that Recommendation,

Noting further the proposal from China to run a CMOC at the National Marine Data and Information Service (NMDIS) of the State Oceanic Administration, China,

Having considered:

(1) The mechanism for formal designation of CMOCs, and evaluation criteria,

(2) The successful demonstration provided by NMDIS, China regarding its capability to run a CMOC, including a statement of compliance and commitment in terms of CMOC capabilities and corresponding functions, in accordance with the procedures and criteria established by the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) and the IOC/UNESCO International Oceanographic Data and Information Exchange,

Recognizing:

(1) The need of Members for high-quality marine meteorology and oceanographic climate data from the world's oceans to address the requirements of WMO and IOC/UNESCO programmes and co-sponsored programmes, and in particular those of the Global Framework for Climate Services,

(2) That the CMOCs facilitate fulfilling these requirements, and will contribute to improve the availability, recovery and archival of contemporary and historical data, metadata and products and to obtain standardized and high-quality marine data and products in a more timely manner,

(3) The excellent facilities and experience of NMDIS, China for managing historical marine meteorological and oceanographic climate data and metadata,

Decides to approve the establishment of a Centre for Marine-Meteorological and Oceanographic Climate Data at the National Marine Data and Information Service of the State Oceanic Administration in Tianjin, China (CMOC/China);

Urges the newly established CMOC/China to ensure that a near-term implementation plan, as specified by JCOMM during the evaluation of the candidature of CMOC/China, is promulgated at the earliest opportunity;

Requests the Secretary-General to continue to promote a global coverage of fewer than 10 CMOCs, particularly keeping in view the needs of developing and the least developed countries, through resource mobilization efforts with Members having capacity in the field of marine climatology, relevant partnering agencies in the United Nations system and development agencies;

Requests the co-presidents of JCOMM to promote establishment of CMOCs in other regions, and consult with the Commission for Climatology, the regional associations and their relevant working groups or other entities responsible for coordination of climate activities within the Regions on all matters related to CMOC implementation;

Urges Members to support CMOC activities, use the facilities and provide feedback to JCOMM on its effectiveness and the potential for improvement.

Resolution 37 (Cg-17)

PREPARATION FOR NEW SATELLITE SYSTEMS

THE WORLD METEOROLOGICAL CONGRESS,

Having considered the *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

Noting:

(1) Recommendation 14 (CBS-Ext.(2014)) – Preparation for new satellite systems,

(2) Resolution 12 (EC-65) – Regional requirements for satellite data access and exchange, adopted by the Executive Council at its sixty-fifth session,

Noting further:

(1) That the transition to the operation of new satellite systems enables significant enhancements of products and services delivered by Members,

(2) That the implementation of such new satellite systems in operational schemes has a major impact on user infrastructure, systems, applications and services, and generally requires coordinated actions at the scientific, technical, financial, organizational and educational levels,

(3) That timely and careful preparation is essential to avoid disruption of operations upon transition to a new system and to take best advantage of the new capabilities as early as possible to provide a better service to users,

(4) That new generation geostationary systems are being implemented or planned to be implemented in the 2014–2020 timeframe by Japan, China, the United States of America, the Republic of Korea, the Russian Federation and the European Organization for the Exploitation of Meteorological Satellites,

(5) That other new generation systems are being developed for implementation in polar orbit and other orbit types in the coming decade,

Recalling:

(1) The Guidelines for ensuring user readiness for new generation satellites adopted by the Commission for Basic Systems (CBS) at its fifteenth session,

(2) The Satellite User Readiness Navigator (SATURN) implemented by the Secretariat, which is a one-stop portal to technical information from satellite operators related to the new systems,

(3) The Observing Systems Capability Analysis and Review tool (OSCAR), which is part of the WMO Integrated Global Observing System Operational Information Resource and contains comprehensive information on space-based systems of relevance to WMO,

Strongly recommends to all concerned Members to set up user preparation projects in advance of the launches of new satellite systems, in accordance with the CBS Guidelines for ensuring user readiness for new generation satellites;

Urges the satellite operators to provide regular and timely updates on their new systems through appropriate means and in particular through inputs to SATURN and OSCAR;

Requests the Commission for Basic Systems, through the Expert Team on Satellite Systems and the Inter-programme Expert Team on Satellite Utilization and Products, the regional associations, through their appropriate expert groups on satellite data access and exchange, the Consultative Meetings on High-level Policy on Satellite Matters and the Secretariat to take appropriate actions in collaboration with satellite operators in order to raise awareness among Members and to facilitate a seamless transition to the exploitation of the new satellite systems.

Resolution 38 (Cg-17)

FOUR-YEAR PLAN FOR WMO COORDINATION OF SPACE WEATHER ACTIVITIES

THE WORLD METEOROLOGICAL CONGRESS,

Having considered:

(1) The *Abridged Final Report with Resolutions of the Sixty-sixth Session of the Executive Council* (WMO-No. 1136),

(2) The *Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2014 of the Commission for Basic Systems* (WMO-No. 1140),

(3) The *Abridged Final Report with Resolutions and Recommendations of the Fifteenth Session of the Commission for Aeronautical Meteorology* (WMO-No. 1139),

(4) The report of the International Civil Aviation Organization (ICAO) and WMO Conjoint Meteorology Divisional Meeting in July 2014,

Noting:

(1) The impact of space weather on observation and telecommunication infrastructures, aviation and maritime safety, energy distribution networks and satellite-based navigation services, among other areas,

(2) The need for a coordinated effort by Members to address the observing and service requirements to protect against the hazards of space weather as stated by the Sixteenth World Meteorological Congress,

(3) The potential for synergy between the delivery of space weather services and of meteorological services,

(4) The recommendation of the Conjoint ICAO/WMO Meteorology Divisional Meeting concerning development of provisions for space weather in view of enabling space weather services to international air navigation with a forthcoming amendment to ICAO Annex 3/WMO Technical Regulations in 2018,

Noting further:

(1) The valuable achievements of the Inter-programme Coordination Team on Space Weather under the joint leadership of the Commission for Basic Systems (CBS) and the Commission for Aeronautical Meteorology (CAeM),

(2) The expected benefit of including space weather observing systems as the WMO Integrated Global Observing System components in order to ensure coordinated, sustained, quality observations required to support space weather services,

(3) The expected benefit of managing and sharing space weather data in the WMO Information System framework,

(4) The need to ensure the right level of operational expertise to support the development of space weather services in support of international air navigation and other key areas,

Having considered the draft Four-year Plan for WMO Coordination of Space Weather Activities, as given in the annex to the present resolution,

Invites the space agencies, especially agencies with meteorological and environmental space observation programmes, to maintain or to implement the capability to observe space weather phenomena from space, including observations at Lagrangian points;

Requests CAeM and CBS to consider existing responsibilities, working mechanisms, expert teams and integration within relevant WMO programmes in finalizing the draft Four-year Plan for WMO Coordination of Space Weather Activities, and present to the Executive Council a recommendation to approve it and jointly ensure its efficient alignment and implementation, within available resources;

Requests CBS to re-examine the naming and the definitions of space weather and space meteorology in all WMO official languages, in consultation with the International Council for Science, specifically the International Astronomical Union and the International Union for Geodesy and Geophysics, and ensure that proper language is used in WMO guidance and that regulatory material is publicized as appropriate;

Requests Members to support the implementation of the planned space weather activities with participation of experts and through voluntary contributions to the Space Weather Trust Fund and through in-kind contributions;

Requests the Secretary-General:

(1) To take appropriate actions to support these activities including the partnership with relevant organizations such as the International Space Environment Service, as well as national and international space agencies;

(2) To submit a report on the achieved results and a proposal for future actions in this domain to Eighteenth Congress.

Annex to Resolution 38 (Cg-17)

FOUR-YEAR PLAN FOR WMO COORDINATION OF SPACE WEATHER ACTIVITIES

WORLD METEOROLOGICAL ORGANIZATION

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FOUR-YEAR PLAN FOR WMO COORDINATION OF SPACE WEATHER ACTIVITIES

DRAFT 1

30 January 2015

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1 INTRODUCTION

1.1 Purpose of this document

In response to the Sixteenth WMO Congress[1] and the sixty-sixth session of the WMO Executive Council (EC-66)[2], the present document defines a plan to be implemented in 2016–2019 to improve capabilities of WMO Members to deliver space weather services.

The activities under this plan are aligned with the WMO Strategic Plan; a working structure is designed to integrate space weather efforts within core WMO Programmes, and an estimation is provided of the required resources and expected benefits.

As a result of this planned effort, space-based and ground-based observing systems for space weather will be better coordinated; consistent, quality-assured space weather products will be available to all Members through WIS; and, in particular, space weather services for civil aviation will be addressed as required by the International Civil Aviation Organization (ICAO). The proposed high-level organization is expected to facilitate the effective coordination with initiatives external to WMO and to enable the long-term improvement of space weather service capabilities.

1.2 Definition of space weather

Space Weather is defined here as the physical and phenomenological state of the natural space environment including the sun, the solar wind, the magnetosphere, the ionosphere and the thermosphere, and its interaction with the Earth.

The associated discipline aims, through observation, monitoring, analysis and modelling, at understanding the driving processes, predicting the state of the Sun, the interplanetary and planetary environments including the Earth's magnetic field, their disturbances, and forecasting and nowcasting the potential impacts of these disturbances on ground-based or space-based infrastructure and human life or health.

Note: In practice, the same expression is commonly used to designate the state of the space environment (the weather occurring in space) and the related discipline (the *meteorology of space*). It should not be confused with "satellite meteorology", which deals with the weather on Earth *observed from space*.

1.3 Societal needs and trends of space weather services

There is an increasing societal demand for space weather services as a result of growing dependence on technologies impacted by space weather: air navigation on polar routes exposed to space weather events; fleet of satellites used operationally for telecommunication, broadcasting, observation or positioning; use of satellite-based navigation and timing signals that are affected by ionospheric disturbances; electric power grids that are exposed to geomagnetically induced currents with potentially disastrous cascading effects.

Emergency management agencies are developing procedures to manage the risks of severe space weather events as part of their overall risk management approach. Space weather services are regularly used today in a number of countries by the commercial airlines, the satellite industry, drilling and surveying operations, power grid operators, pipeline designers and users of satellite-based navigation systems. It is anticipated that this demand will expand with broader awareness of the impact of space weather events, increasing exposure of the society, and greater maturity of space weather products and services.

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1 Sixteenth WMO Congress, Abridged Final Report, WMO-No. 1077, paragraph 3.7.11 and Annex IV

2 Executive Council, sixty-sixth session, Abridged Final Report, paragraph 4.4.91

1.4 Need of international coordination of space weather activities

The need to strengthen international coordination has been regularly stressed by international bodies involved in space weather such as the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) and the Space Weather Panel of the Committee on Space Research (COSPAR). Annex 1 provides an overview of the major international initiatives in this respect. None of them is currently addressing the end-to-end spectrum of activities needed for fully operational space weather services, but they represent a valuable resource that can be leveraged by WMO through appropriate partnerships.

For instance, numerous space-based and ground-based assets exist today that could be used to improve space weather services, but these assets are often not effectively coordinated, or easily available beyond the community which operates them. Observations are not systematically interoperable, shared in near-real time, and documented with metadata enabling their discovery and efficient use. There is no coordinated planning to avoid gaps on critical observations.

Alerts, warnings and forecasts must be communicated effectively to ensure consistent messages during extreme events and enable post-event verification and evaluation. Space weather services to aviation must be standardized, coordinated, evaluated and delivered along procedures to be agreed among ICAO and WMO.

In summary, operational coordination is the missing link between the international initiatives mentioned above and the fulfilment of user needs.

1.5 WMO ICTSW activities in space weather

The Inter-Programme Coordination Team on Space Weather (ICTSW)[3] initiated its activities in 2010 under the auspices of CBS and CAeM. As of January 2015 it involves experts from twenty-three WMO Members, and several international organizations: European Union, ICAO, the International Space Environment Service (ISES)[4], the International Telecommunications Union (ITU).

The initial achievements of ICTSW to-date include the formulation of observation requirements, the Statement of Guidance on space weather observation, the establishment of a Space Weather Product Portal, and the support to CAeM to review the ICAO concept of future space weather services to aviation. These results demonstrate the benefit that can be brought by WMO in this new area in providing a framework for cooperation and coordination, and building bridges between the space weather community and the operational meteorological community. This role, played by WMO through ICTSW, has been acknowledged and encouraged by various international partners.

However, a number of challenges are still in front of us. Further mobilization of experts, sustained engagement of WMO Members to operate observing systems and share data, continued support by the Secretariat, would be required in order to achieve a breakthrough in the capability of WMO Members to provide and benefit from space weather services. A way forward to address these challenges is detailed in the present four-year plan.

1.6 WMO Members and space weather

Space weather exposure as described in Section 1.3 potentially affects all WMO Members, but the specific organization of responsibilities to address these issues may significantly differ among WMO Members. For several WMO Members[5] the mandate of the National Meteorological or Hydrological Service (NMHS) includes a space weather forecasting and warning responsibility, or at least an important building block of it such as ionospheric or geomagnetic observation.

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[3] See: http://www.wmo.int/pages/prog/sat/spaceweather-ictsw_en.php

[4] International Space Environment Service: http://www.ises-spaceweather.org/

[5] Including Argentina, Australia, China, Finland, Russian Federation, Republic of Korea, United Kingdom, United States.

In many cases, however, space weather activities are led by different national institutes which can be as diverse as the space agency, a solar observatory, a geomagnetic laboratory, or a radio-communication agency. This is the case of most ICTSW members. In such cases, the Permanent Representative has nominated an expert from the relevant organization to contribute to this WMO activity. A cooperation framework may exist between the NMHS and the space weather organization, for instance when ground-based space weather observations are collocated with weather stations. In some cases, such cooperation was prompted by the opportunity to participate in ICTSW.

2 VISION OF WMO SPACE WEATHER ACTIVITIES

2.1 Coordination of space weather activities

Space weather phenomena are best monitored through coordinated efforts of multiple nations. They are triggered by events occurring on the Sun and in interplanetary space, are ranging from the global to the regional scale, are potentially affecting a global community and require extensive observation capabilities.

The global nature of WMO, as well as its intergovernmental status, its longstanding experience of operational coordination, its scientific basis, the potential synergy between meteorological and space weather activities, the strong connection of WMO with the aeronautical sector through CAeM, and its engagement for the protection of life and property, are major assets enabling WMO to play a key role in this needed international coordination of space weather activities.

Considering, on one hand, the societal needs which are not fulfilled and, on the other hand, the strengths and capabilities of WMO, WMO undertakes international coordination of operational space weather monitoring and forecasting with a view to support the protection of life, property and critical infrastructures and the impacted economic activities. In providing a truly global and intergovernmental framework, WMO should enable international commitments and facilitate the establishment of a global framework for operational space weather services, for example in the context of the ICAO convention.

2.2 High-level goals

The following high-level goals are proposed for this activity:

- Promote the sustained availability, quality, and interoperability of the observations that are essential to support space weather warning and other services, while optimizing the overall cost of the observing system;

- Improve the collection, exchange and delivery of space weather data and information through open sharing, internationally agreed standards, and coordinated procedures taking advantage of the WMO Information System (WIS);

- Ensure that space weather analysis, modelling and forecasting methods allow the delivery of operational services on the best possible scientific basis; facilitate the transfer of technical and scientific advances from research to operations;

- Support the emergence and establishment of cost-effective and high-value services in identifying and addressing user requirements, focusing on the sectors where internationally coordinated responses are required, in coordination with aviation and other major application sectors, building on the Aeronautical Meteorology Programme (AeMP) and Public Weather Service (PWS) programme;

- Foster the production of high-quality end products and services by WMO Members, building on ISES centres and other examples of recognized services, in developing best practices, to improve the accuracy, reliability, interoperability, overall cost-efficiency of the provision of services;

- Improve the emergency warning procedures and global preparedness to space weather hazards in accordance with the WMO Strategy on Disaster Risk Reduction;

- Promote synergy between the space weather and the meteorological/climate communities and activities, and advance the understanding of space weather impacts on weather and climate processes;

- Support training and capacity-building, based on science and operational experience, to develop skills in the generation and interpretation of space weather products and services in order to allow WMO Members to utilize existing information in a meaningful way, build their own service capabilities, and facilitate user uptake of new products and services.

In pursuing the goals above it is recommended to:

- Build on the achievements of ICTSW and the momentum gained within this team;

- Establish actions for the next four-year period and update the working structure for space weather activities within WMO;

- Foster multi-disciplinary collaboration, noting the diversity of organizational schemes of space weather activities which in many countries are conducted outside the NMHS;

- Leverage national, regional or global initiatives and programmes, avoiding duplication but promoting instead complementary action through partnerships with internationally recognized UN or non-UN entities active in this area.

These activities must be underpinned by regular communication to raise awareness and understanding of the WMO community about space weather, report on the benefits of coordinated actions, provide external visibility and maintain a communication flow with external partners.

Furthermore, it is important to establish a high-level, effective coordination mechanism bridging the technical activities with the broader strategy and implementation of WMO Programmes.

3 ACTIVITIES

Key activities are described below, including their objectives, expected benefits, and possible challenges. These activities are structured in seven high-level functions related respectively to the Products and services level (3.1, 3.2, and 3.3), the System level (3.4, 3.5, and 3.6) and the Strategic level (3.7), as illustrated in Figure 1.

While this breakdown is intended to give a comprehensive view of the scope of activities to be addressed, a distinction is made between:

- Actions to be addressed in first priority, with expected deliverables within the four-year period, and with a target time frame for completion;

- Other actions that are either long-term actions for which the main outcome cannot be expected within the four-year period, or actions that will be addressed only if time and resources allow because they have a lower priority.

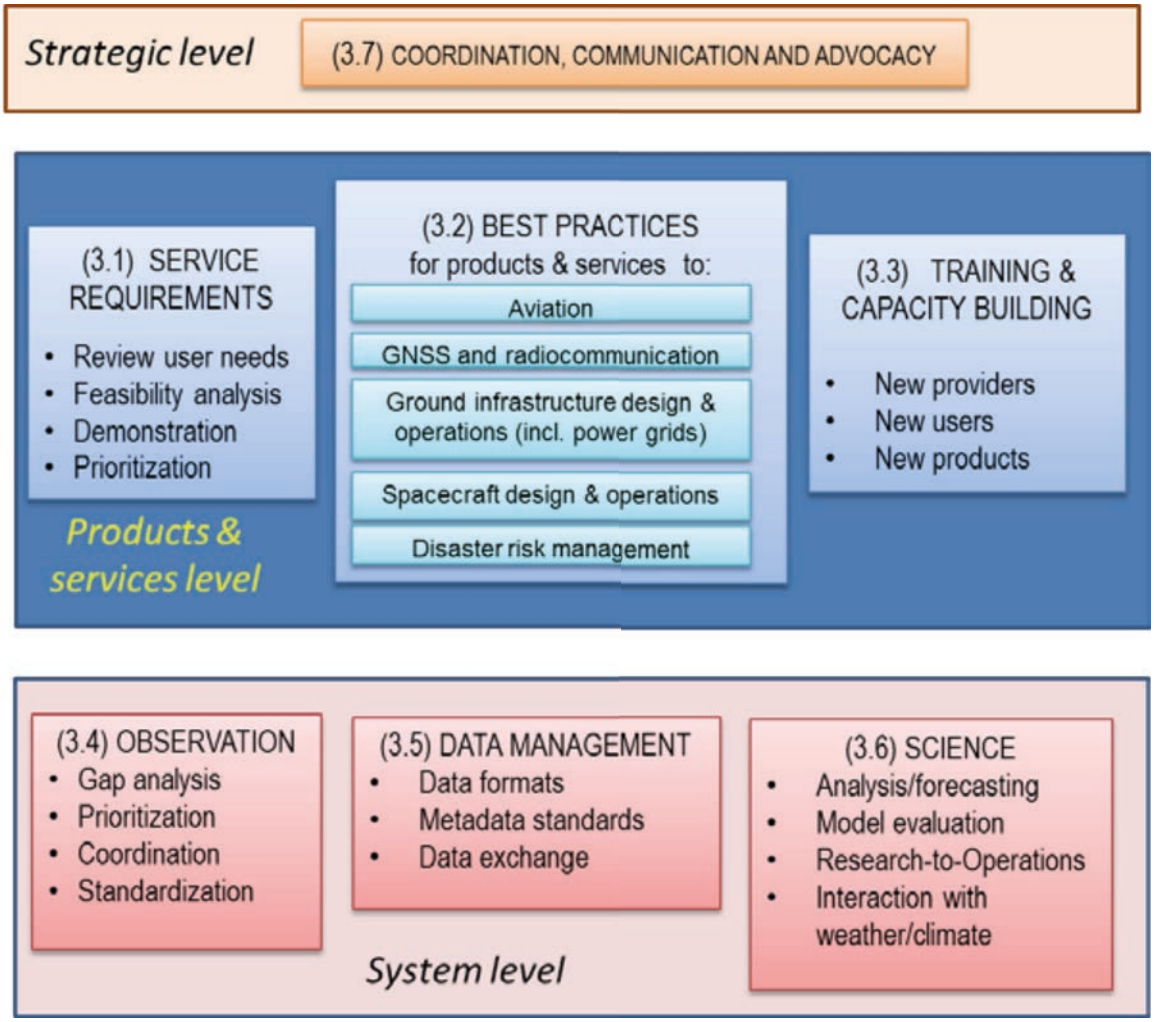

Figure 1. Schematic functional breakdown of the proposed key activities

3.1 Reviewing user requirements for space weather products and services, and priorities for coordinated responses

Goal: to support the emergence and establishment of cost-effective and high-value services in identifying and addressing user requirements, focusing on the sectors where internationally coordinated responses are required.

There are challenges, since space weather services haven't reached a level of maturity comparable with meteorological operations and potential users may not be aware of the capabilities of space weather services, and of how to use them. Demonstrations are needed to support the user-provider dialogue, helping users refine their requirements and providers to understand them, evaluate their feasibility, and specify a service responding effectively to these requirements. The specification of widely used end products should be harmonized.

The requirements for products and services should be analysed in the following sectors:

- Aviation, where space weather services are being defined as part of Annex 3 of the ICAO Convention, and additional requirements are expressed by commercial airlines;
- Infrastructures impacted by geomagnetic disturbances, including the energy sector;
- Radio-communication, satellite radio-navigation and remote sensing radars;
- Spacecraft design, launch and operations;
- Disaster Risk Reduction (DRR) management;
- Other users' needs gathered and communicated e.g. by the NMHS.

First priority actions	Deliverable	Time frame
Support to WMO AeMP representation on the relevant ICAO working groups to review the feasibility of the draft requirements of ICAO for space weather services to aviation, and advise ICAO on the corresponding draft Standard And Recommended Practices (SARP)	ICAO requirement analysis ICAO SARP review	2016
Support to WMO AeMP representation on the relevant ICAO working groups to define the role, number, and required capabilities of future global and regional space weather centres for the provision of space weather services to aviation	Roles, capabilities and target number of space weather centres for ICAO	2016
Survey of application sectors, other than aviation, where international coordination of services is required or desirable	List of priority services requiring international coordination	2017
Other actions (Long term or lower priority)	**Deliverable**	**Time frame**
Expand the Space Weather Product Portal to provide a representative sample of products for demonstration purposes and communicate on it	Additional products	2016–2019 (Continuous)
Investigate whether and how space weather impacts are addressed in national disaster risk reduction plans and the need for coordinated action	Survey on space weather element in national risk registers	2017
Analyse requirements for space weather services regarding radio-propagation in collaboration with ITU-R/SG-3 and ICG	Statement to ITU-R/SG-3, roadmap for development of such services	2018

3.2 Developing best practices for products and services

Goal: to foster the production of high-quality end products and services by WMO Members, building on the experience of ISES Regional Warning Centres or other recognized providers, in developing best practices to improve accuracy, reliability, interoperability, and overall cost-efficiency of provision of services; in particular, improve the emergency warning procedures and global preparedness to space weather hazards in accordance with the WMO strategy on Disaster Risk Reduction.

Best practices shall be defined in interaction with major users to best respond to the evolving needs of key socio-economic sectors and public safety. They should be based on scientific assessments and quality management principles (thus implying user focus).

First priority actions	Deliverable	Time frame
Establish real-time coordination and consultation mechanisms among warning centres for extreme events	Consultation procedure for extreme events	2016
Review the existing global and regional space weather event scales and develop an international, community agreed, scale or set of scales to characterize the severity of space weather events with a view to facilitate emergency procedures and verification activities	Community agreed space weather scales	2017
Other actions (Long term or lower priority)	**Deliverable**	**Time frame**
Collaborate with CGMS to review the procedure for recording spacecraft anomalies attributed to space environment, including the archiving and utilization of this data	Agreed procedure spacecraft anomaly data	2017
Develop best practices for space weather centres during extreme events, in collaboration with DRR programme	Guide on extreme space weather events	2018

3.3 Training and capacity-building, for new service providers and user uptake

Goal: Support training and capacity-building, based on science and operational experience, to develop skills in the generation and interpretation of space weather products and services, in order to allow WMO Members to utilize existing information in a meaningful way, build their own service capabilities, and facilitate user uptake of new products and services.

First priority actions	Deliverable	Time frame
Select existing training material and make it available on line through the Space Weather Product Portal	Training material on the Space Weather Product Portal	2016
Identify target audiences, including NMHS meteorologists who wish to establish space weather service delivery within their organization, and training objectives	Schedule of training programme to support NMHS interest	2017
Conduct training sessions in coordination with the VLab and partner organizations, provide tutorial tools.	Completed training programme, feedback for training improvements	2018
Other actions (Long term or lower priority)	**Deliverable**	**Time frame**
Develop new educational material, in different languages and with content structured for different regional needs	Region-specific resources for space weather service improvement	>2019
Contribute to user information events to raise awareness of space weather impacts and of potential benefit of using space weather services	Co-sponsored events	2018

3.4 Coordinating ground- and space-based space weather observations

Goal: High-level coordination of satellite-based and ground-based observations to ensure the sustained availability, quality and interoperability of the observations that are essential to support space weather warning and other services, while optimizing the overall cost of the observing system.

This will be achieved through integration of space weather observing systems as component systems of WIGOS. It includes review of space-based and surface-based observations requirements, harmonization of sensor specifications, analysing priorities and monitoring plans to fill the gaps in space weather observation.

First priority actions	Deliverable	Time frame
Update the space weather observation requirements and the Statement of Guidance for space weather observation as part of the WMO RRR process	Requirements in OSCAR and updated SOG	2016
List the key ground-based measurements to be performed on a routine operational basis, with required observation cycles	Initial list and specification of measurements	2016
List the space weather observatories performing the required measurements above (analogue to Vol. A)	List of observatories	2017
Develop observation metadata characterizing the measurements above	WIGOS metadata	2017
Update space weather space-based capabilities assessment in OSCAR/space as a support to gap analysis	OSCAR/Space update including gap analysis	2017

First priority actions	Deliverable	Time frame
Dialogue with space agencies (including major agencies such as NASA, and international satellite coordination bodies such as CGMS) and relevant authorities, on actions needed to fill the gaps in space-based observation	Gap analysis communicated to major stakeholders in space observation	2017
Prepare initial addition to the WIGOS Manual	Draft update of WIGOS Manual	2018
Other actions (Long term or lower priority)	**Deliverable**	**Time frame**
Expand observing capabilities, communication infrastructure and procedures in order to fill the gaps in observation and improve data availability	Reduction of gaps	>2019
Expand the lists of measurements and observatories	Updated lists	>2019
Harmonize sensor specifications for energetic particle measurements and best practices for intercalibration and intercomparison of measurements	Specification guidelines, Intercomparison procedures	>2019
Agree on quality standards for ground-based space weather observations (existing standards, or new provisions for inclusion into CIMO Guide if relevant)	Observation quality standards	>2019

3.5 Promoting and facilitating data management, standardization and exchange

Goal: to improve the collection, exchange and delivery of space weather data and information through open sharing, internationally agreed standards, and coordinated procedures taking advantage of the WMO Information System (WIS).

A major challenge is the stringent timeliness constraints of most space weather data.

First priority actions	Deliverable	Time frame
Identify list of essential data and products to be considered for routine exchange on the WIS, characterize them with appropriate discovery metadata, register and make them available in the WIS (with IPET-MDRD)	Set of space weather data and products discoverable and globally available, in near real-time in WIS	2016
Register space weather centres as Data Collection or Production Centre (DCPC) or National Centres (NC) in the WIS (with IPET-WISC)	Additional space weather centres designated as DCPC or NC	2016
Other actions (Long term or lower priority)	**Deliverable**	**Time frame**
Investigate the applicability and advantages of new formats, including e.g. RINEX/GTEX, for exchange of space weather data and products	Recommended format implementation	2016
Investigate the applicability and advantages of new protocols, such as the Common Alert Protocol (CAP)	Recommended protocol	2017

3.6 Evaluating space weather analysis and forecasting methods, promoting transition of mature research models to operations and synergy with climate/weather modelling

Goals:

- To ensure that space weather analysis, modelling and forecasting methods allow the delivery of operational services on the best possible scientific basis; facilitate the transfer of technical and scientific advances from research to operations;

- To promote synergy between the space weather and the meteorological/climate communities and activities and advance the understanding of space weather impacts on weather and climate processes.

This entails support to the development of operational, data-assimilative, predictive models, benefiting from advanced weather and climate prediction capabilities, and community initiatives for model coupling and evaluation. The dialogue between the research and operational space weather communities should be encouraged with a view to regularly assess methods and services potentially mature for operational use. The dialogue should also be encouraged between the space weather and the meteorological/climate communities.

First priority actions	Deliverable	Time frame
Share lessons-learned in the usage of space weather models in daily forecasting activities	Handbook for good practices in space weather forecasting	2017
Define skill scores and other verification techniques to assess the potential value of existing research models for user-oriented services	Objective evaluation of existing models	2018
Other actions (Long term or lower priority)	**Deliverable**	**Time frame**
Workshops on space weather impacts on Essential Climate Variables	Improved understanding of space weather–climate linkages	2017
Evaluate the benefit of whole atmosphere models (from the surface to the top of the thermosphere) used in conjunction with other space weather models	Impact evaluation of whole atmosphere models	2018
Workshop on data-assimilation capabilities for Sun-Earth system models to improve forecast skill	Guidelines for utilization of available data in numerical prediction models	2019

3.7 Coordinating the actions and ensuring a science-based, authoritative communication on operational space weather activities in the United Nations system and beyond

It is important to establish a high-level, effective coordination mechanism bridging the technical activities with the broader strategy and implementation of WMO Programmes.

This must be underpinned by regular communication aiming to:

- Raise awareness and achieve understanding, by all Members, of the importance of space weather services and to seek feedback on success and limiting factors;
- Demonstrate the benefits of acting in coordination, for optimization of resources and higher reliability of space weather information;
- Provide visibility on WMO space weather activities and maintain an information flow with external partners to ensure that efforts well supplement each other;
- Inform the society on the capabilities of space weather information and services as well as the limitations of these services in the state of the art.

While the COPUOS is an appropriate forum to communicate at the strategic level within the UN system, the dialogue with the space weather scientific and operational community and with key user groups is best achieved at targeted conferences. The annual “Space Weather Workshop” organized by the USA and the “European Space Weather Week” organized in Europe are the most active venues and host a number collocated events including discussion panels and user interaction. A comparable initiative is emerging in Asia, the Asia Oceania Space Weather Alliance (AOSWA).

First priority actions	Deliverable	Time frame
Keep COPUOS informed of the WMO plan for space weather and of the challenges requiring mobilization of effort beyond the WMO community	Reports	Annual
Report at the annual space weather workshops organized in the USA, in Europe, and in Asia	Presentations, or panel sessions	Annual
Identify cases demonstrating the benefit of space weather activities coordinated by WMO	Report on case studies	2017–2019
Provide the WMO Congress (Cg-18) with a draft plan for space weather activities beyond 2019 (e.g. within a Space Weather Watch programme)	Draft plan	2019
Other actions (Long term or lower priority)	**Deliverable**	**Time frame**
Coordinate with COSPAR on the interaction between this plan and the COSPAR roadmap implementation	Feedback	Annual
Address regional implementation of space weather services at Regional Association meetings or associated Technical Conferences	Presentation at RA meeting or Technical Conference	RA meetings

4 ORGANIZATION AND IMPLEMENTATION

4.1 Mapping of activities with WMO strategic priorities and activities

The table below summarizes the mapping of space weather activities with the seven key priorities of the draft WMO Strategic Plan 2016–2019 submitted to the Seventeenth WMO Congress for approval.

Key priorities in the draft WMO Strategic Plan 2016–2019	Related activity in the space weather four-year plan
Improve the effectiveness of high-quality impact-based forecasts and early warnings of high-impact meteorological, hydrological and related environmental hazards, thereby contributing to international efforts on disaster risk reduction, resilience and prevention	Improving global preparedness to space weather hazards, as requested by Cg-XVI, contributes to international efforts on disaster risk reduction, resilience and prevention.
Implement climate services under the Global Framework for Climate Services (GFCS)	Interactions of space weather with terrestrial climate are a matter of investigation
Complete the implementation of WIGOS/WIS	Prepare the integration of space weather observations in WIGOS and WIS. This was requested by EC-LX, and is well engaged.
Improve the ability of NMHSs to meet International Civil Aviation Organization (ICAO) requirements	The emerging needs and challenges of space weather services to aviation are being addressed in priority in response to ICAO requirements
Improve operational meteorological and hydrological monitoring and prediction services in polar and high mountain regions	As space weather events can be particularly acute in the Polar Regions because of the structure of the geomagnetic field, predicting geomagnetic and ionospheric disturbances and energetic particle impacts (sometimes visible in the form of aurorae) is important
Enhance the capacity of NMHSs to deliver on their mission by assisting with human resource development, technical and institutional capacities and improved infrastructure	Capacity building towards the delivery of space weather services

Key priorities in the draft WMO Strategic Plan 2016–2019	Related activity in the space weather four-year plan
Continue to conduct a strategic review of WMO structures, operating arrangements and budgeting practices focusing on the effectiveness of constituent body activities and the Secretariat arrangements	To ensure operational effectiveness, the proposed organisation would limit the standing working structure to one Inter-programme coordinating team linked to the relevant commissions, regional associations, partners and user representatives

WMO space weather activities are led by the WMO Space Programme, which is a cross-cutting programme. As of 2015, these activities are already integrated into a number of WMO Programmes and projects as indicated below.

In the WIGOS perspective, space weather is fully integrated in the Rolling Review of Requirements (RRR). Space Weather is considered as a WMO "Application area" in the RRR process: space weather observation requirements have been defined and recorded in the OSCAR/Requirements[6] database; an assessment of the current gaps in our observing systems is documented in a Statement of Guidance; and a chapter and several actions are dedicated to space weather observation in the Implementation Plan for the Evolution of the Global Observing Systems (EGOS-IP)[7].

The *Instruments and Methods of Observation Programme (IMOP)* has just completed a new issue of the Guide on Instruments and Methods of Observation (CIMO Guide). Observation of space weather from space is addressed in its new Part III on Space-based observations.

The *Steering Group on Radio Frequency Coordination (SG-RFC)* has initiated consideration of frequency allocation issues for space weather observations in the microwave domain, based on inputs from ICTSW.

Regarding the WIS, a pilot project is underway within ICTSW and ISES to evaluate the use of the WIS for the exchange of space weather forecast products (geomagnetic activity, solar flares, and solar energetic particles).

Within the Aeronautical Meteorology Programme, ICTSW has supported the Aeronautical Meteorology Division in reviewing the ICAO Concept of Operations for space weather services to global air traffic navigation and provided guidance on the future organization of an effective operational space weather service delivery coordinated by WMO. ICAO recognizes WMO, through ICTSW, as a source of technical advice on space weather matters. The continuing active participation of WMO will be essential as it is anticipated that Annex 3 of the ICAO Convention will make such space weather services for civil aviation mandatory.

Space weather training is included in the training strategy of the WMO-CGMS Virtual Laboratory (VLab) for Education and Training in Satellite Meteorology, partnering with COSPAR.

4.2 Working structure

In order to address all the activity domains under this four-year plan, a pool of experts is needed in the following areas:

- Space weather basic systems, including issues related to observation techniques and networks, data management and exchange, data centres, and space climatology;
- Space weather science, including issues related to modelling, model evaluation and verification, interaction with climate, and transition from research to operations;

[6] See: http://www.wmo-sat.info/oscar/applicationareas/view/25.

[7] See chapter 7 in: http://www.wmo.int/pages/prog/www/OSY/Publications/EGOS-IP-2025/EGOS-IP-2025-en.pdf

- Space weather applications, including requirements evaluation, the delivery of services, capacity building and user interaction.

The proposal aims at close integration into the existing structure of WMO technical commissions, strong linkage with relevant external partners, and increased involvement of space weather experts covering a broad range of expertise. It should also avoid a multiplication of teams with unnecessary overheads and reporting interfaces. It is thus proposed to replace the current ICTSW by an Inter-Programme Team on Space Weather Information, Systems and Services (IPT-SWISS), who will pursue the work of ICTSW in close cooperation with the technical commissions, the space weather service provider community represented by ISES, and representatives of users.

IPT-SWISS shall coordinate the space weather activity throughout technical commissions and regional associations. IPT-SWISS Members would include: space weather experts nominated by CBS, CAeM, and other relevant technical commissions such as the Commission for Instruments and Methods of Observation (CIMO), and the Commission for Atmospheric Sciences (CAS); points of contacts nominated by the regional associations; and a representative of ISES. Major partners and stakeholders could be invited as Associate Members at no cost to WMO. IPT-SWISS would report in parallel to CBS and CAeM who would agree on a coordinated mechanism in order to provide joint oversight of IPT-SWISS. Draft Terms of Reference are contained in Annex 2.

IPT-SWISS will designate experts, among its members, to contribute to the relevant expert teams of the involved technical commissions. It would form ad-hoc task teams as appropriate, for topics requiring a specific expertise. In the context of a working arrangement with ISES discussed in 4.3, some of these ad hoc task teams could be jointly established with ISES and supported by ISES experts.

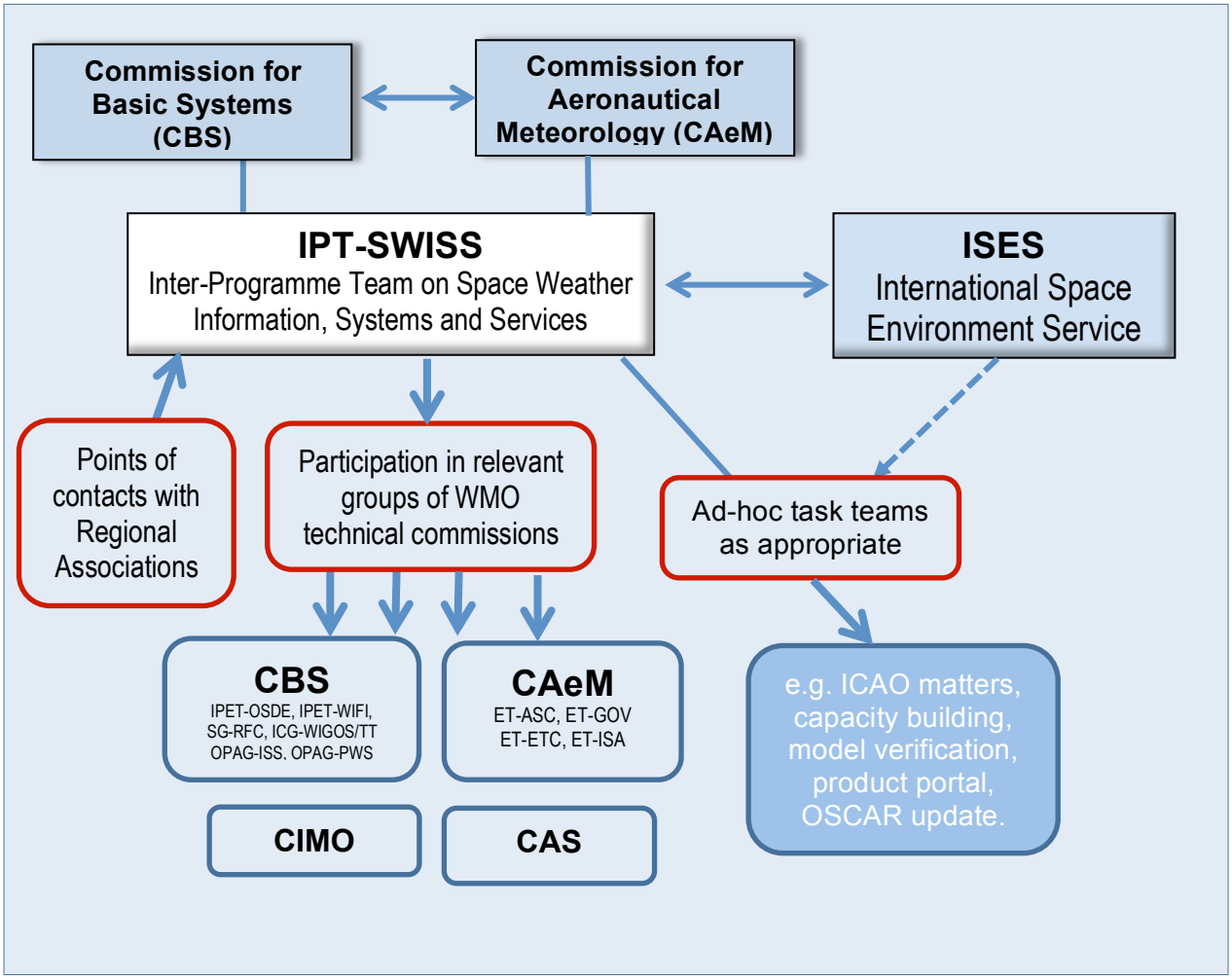

Figure 2. Proposed organization of space weather activities

It is expected that, CAeM and CBS will consult each other via their presidents after Cg-17 to proceed with a call for nominations for IPT-SWISS with a view to establish this team at the beginning of 2016. Work would be pursued by ICTSW until then. At the last meeting of ICTSW, tentatively in the 4th quarter 2015, the action plan will be updated taking into account the outcome of Congress and of CBS-CAeM consultations.

4.3 Partnership and user engagement

Partnership with ISES

A working arrangement is being prepared with ISES through an exchange of letters in order to formalize the collaboration with this organization which is the trigger and the enabler of WMO activity in space weather. Through this arrangement ISES and WMO would state the intention to act in close cooperation with each other in order to facilitate the improvement and coordination of operational Space Weather services delivered by WMO Members and ISES Centres.

In particular, ISES and WMO would:

- Keep each other informed concerning all programmes of work, activities and publications on matters of common interest;
- Contribute to the specification of Space Weather services, in particular the services to be delivered in support to ICAO (through the appropriate bodies of CAeM), and to the development of best practices, e.g. for emergency warnings;
- Advance the standardization of operational Space Weather observations, data management, products generation and dissemination, relying as appropriate on relevant international standards, such as WMO and/or ICSU standards;
- Raise public awareness on Space Weather and its impact, and support preparedness to Space Weather extreme events;
- Conduct joint surveys on needs of current and Space Weather services;
- Facilitate the transition of scientific knowledge on space weather into operational services to the society.

ISES and WMO would pursue these activities through joint technical meetings and workshops, and coordinated communications and outreach actions. The representatives of ISES and WMO will be invited to participate, without vote, in deliberations of the WMO Executive Council, or the ISES Annual Meetings respectively and, where appropriate, in their working groups on issues of mutual interest.

Other partners and user organizations

WMO and ISES will support initiatives bringing together space weather service providers, partners and key users: for instance, ITU, as well as the International Committee on GNSS (ICG)[8], or the North American Electric Reliability Corporation (NERC). Major partners or representatives of important potential or actual user communities could be invited to participate in IPT-SWISS as Associate Members.

As concerns ITU, it should be clarified that the relationship is two-fold:

[8] International Committee on GNSS: http://www.oosa.unvienna.org/oosa/fr/SAP/gnss/icg.html

- Since space weather disturbances in the ionosphere affect the propagation of radio-waves used in telecommunication and radio-navigation, ITU-R/SG-3[9] is potentially a proxy for these user communities;

- Since space weather observations partly rely on passive or active surface-based, or space-based measurements in microwave frequency bands, which may require a frequency allocation and protection, space weather interests must be represented in ITU-R/SG-7[10], as part of the discussion on radio-frequency coordination, which is led in WMO by the CBS Steering Group on Radio-Frequency Coordination (SG-RFC).

4.4 Resources and benefits

This action plan is in continuity of the activity pursued with the current ICTSW, though with a significant expansion as necessary to move from a “demonstration stage” to an actual implementation enabling a breakthrough with tangible benefits in several applications.

Resources

The engagement of Members through their space weather experts and the support from the Secretariat, ideally at the level of one full-time person, are critical for the success of this plan. Given the tight situation of staff resources within the Secretariat, a minimum level of support could be achieved in supplementing the Secretariat staff with experts seconded by Members and external consultancy. With this assumption, the level of financial resources needed annually to cover the activities of the present four-year plan is estimated at CHF 240 000.

Table 1. Tentative estimation of the annual level of resources needed to support the plan

Type of expenditures	Annual cost (CHF)
Participation of qualified experts in one annual meeting of IPT-SWISS and related task teams	60 000
Participation of IPT-SWISS members in relevant bodies of WMO technical commissions	30 000
Liaison with external partners	20 000
Communication actions, development or translation of training material	20 000
One seminar	50 000
Consultancy and financial support to secondment of staff to supplement the Secretariat	60 000
Total	240 000

In accordance with the regular budget proposal for the seventeenth financial period, it is assumed that the non-staff resources allocated to space weather activities in the regular budget (WMO Space Programme and possibly the Aeronautical Meteorology Programme) will remain marginal and need to be leveraged by extrabudgetary resources including:

- In-kind contributions from Members (for example, translation of training material, secondment of staff, or participation in meetings at no cost to WMO);

[9] ITU-Radio-communication sector Study Group 3 on Radio-propagation

[10] ITU-Radio-communication sector Study Group 7 on Science services

- Co-sponsoring of events (e.g. training seminar supported by COSPAR);
- Voluntary contributions to a Space Weather Trust Fund, as discussed by EC-66.

Table 2. Tentative breakdown of resources

Tentative indication of annual resources	(CHF)
Regular Budget (WMO Space Programme)	20 000
In-kind contributions	30 000
Co-sponsored events	30 000
Voluntary contributions to the Space Weather Trust Fund	160 000
Total	240 000

A tentative breakdown of annual resources is indicated in Table 2. It is anticipated that the WMO Members who are running a national space weather programme, would be the first inclined to contribute to the Space Weather Trust Fund, in view of the benefit of leveraging their national activities through data exchange, sharing best practices, and optimization of efforts, which could largely exceed the individual contribution from these Members.

Benefits

This activity plan is expected to provide significant benefits to the Members, in terms of more precise observations and improved reliability, accuracy, and timeliness of forecasts and warnings to their users. Once space weather services have reached a mature stage they can generate revenue to the information provider (e.g. cost recovery mechanism for the services required by ICAO, alert services to power grid, telecommunication or GNSS operators). The potential benefits derived from WMO space weather activities have been described in the report completed in 2008[11].

5 CONCLUSIONS

The early achievements of ICTSW in the sixteenth financial period (2012–2015) illustrate the broad field of activity that could benefit from WMO involvement in space weather, and demonstrate the capability of WMO to effectively facilitate a breakthrough in this area and play a recognized role in the international space weather community. Given the new requirements for space weather services to aviation and the emerging demand in other sectors, it is recommended that WMO engages more directly during the seventeenth financial period (2016–2019), and possibly beyond, to build up a sustainable basis for global, reliable, space weather service capabilities.

The present plan identifies a set of high-priority activities, which are considered necessary and feasible in the four-year time frame, and would lead to clear deliverables and tangible outcomes. Other desirable actions are identified and should be conducted as well if time and resources allow. It is furthermore suggested that the WMO Members who are currently the most advanced in that field engage technically, through their experts, and financially, through a modest contribution to the Space Weather Trust Fund, to take the lead in implementing the plan, thus demonstrating the benefits of this activity to other Members who may not be familiar with space weather yet.

The proposed activities are in line with several of the WMO strategic priorities for the seventeenth period.

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[11] The potential role of WMO in Space Weather, WMO, SP-5, TD-1482, 2008

ANNEX 1: MAIN INTERNATIONAL INITIATIVES IN SPACE WEATHER

In the paragraphs below we briefly introduce the global initiatives focusing respectively on operational matters (ISES, CGMS, ICAO/IAVWOPSG), on policy (COPUOS), on research and education (COSPAR, ILWS, ISWI, SCOSTEP), and several regional initiatives.

ISES

ISES is, since 1962, a collaborative network of space weather service-providing organizations around the globe. Its aim is to improve and to coordinate operational space weather services. ISES members share data and forecasts and provide a broad range of services, including: forecasts, warnings, and alerts of solar, magnetospheric, and ionospheric conditions; space environment data; customer-focused event analyses; and long-range predictions of the solar cycle. ISES currently includes 16 Regional Warning Centres, four Associate Warning Centres, and one Collaborative Expert Centre. ISES is a Network Member of the International Council for Science World Data System (ICSU-WDS) and collaborates closely with WMO.

CGMS

The Coordination Group for Meteorological Satellites (CGMS) is a technical coordination body of satellite operators focusing primarily on weather and climate satellite programmes in response to WMO requirements. In 2014, CGMS decided to include objectives related to space weather monitoring into its multi-year High-Level Priority Plan and agreed on Terms of Reference for CGMS Space Weather Activities. It is anticipated that CGMS will soon extend the scope of its activity towards space-based observation of space weather variables.

ICAO/IAVWOPSG

The International Civil Aviation Organization (ICAO) is addressing space weather issues through its International Airways Volcano Watch Operations Group (IAVWOPSG). IAVWOPSG has issued a Concept of Operations and is developing requirements for operational space weather services, in consultation with WMO, with a view to include such services in an amendment to Annex 3 of the ICAO Convention. The Conjoint WMO/CAeM-Met Divisional meeting in July 2014 has confirmed this objective, while considering that several issues required further consideration, including the definition of the roles, requirements, capabilities and overall number of global and regional forecasting centres, as well as their designation process, governance, cost recovery principles, competency standards and duration of mandate.

COPUOS

Since 2013, the Committee on Peaceful Uses of the Outer Space (COPUOS) of the United Nations General Assembly has started to address space weather issues within its Scientific and Technical Sub-Committee (STSC) in the context of the long-term sustainability of space assets and activities. It called for strengthening international coordination of efforts to monitor the space environment and welcomed the initial steps taken by WMO.

Research and education: COSPAR, ILWS, ISWI, SCOSTEP

The Committee on Space Research (COSPAR) of the International Council for Science (ICSU) has a standing Space Weather Panel. Together with ILWS (described below), it has developed in 2014 a roadmap for improving the understanding of space weather processes and supporting the development of space weather services[12]. The roadmap recommends actions pertaining to: (i) maintaining existing essential capabilities; (ii) developing modelling capability, research, or data infrastructure; and (iii) deploying new or additional instrumentation. The roadmap acknowledges WMO space weather activities.

[12] Understanding space weather to shield society: A global road map for 2015–2025 commissioned by COSPAR and ILWS, Schrijver, C. et al., *Advances in Space Research*, 55 (2015), pp. 2745–2807.

Furthermore, a Memorandum of Understanding was signed in 2012 by WMO and COSPAR for establishing a partnership on training and capacity-building between the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) and COSPAR. COSPAR is funding space weather training events in developing countries in this framework.

International Living With a Star (ILWS) aims to stimulate space research to understand the governing processes of the connected Sun-Earth System as an integrated entity.

The *International Space Weather Initiative (ISWI)* was initiated by COPUOS to develop scientific insight on near-Earth space weather. ISWI is distributing ground-based monitoring instruments around the globe, hosting workshops and schools, and promoting joint research.

The *Scientific Committee on Solar Terrestrial Physics (SCOSTEP)* of ICSU runs international interdisciplinary scientific programmes and promotes solar-terrestrial physics.

There are scientific organizations involved in particular aspects, such as International Union of Radio-Science (URSI)[13], the International Astronomical Union (IAU)[14] or the International Association of Geomagnetism and Aeronomy (IAGA[15]).

Regional initiatives

The European Commission has supported several space weather related projects through the COST action framework (European Cooperation in Science and Technology)[16] and through the Seventh Framework Programme (FP7). This has led to establishing space weather data services such as SEPserver[17], ESPAS[18], HELIO[19] and AFFECTS[20].

The European Space Agency (ESA) launched in 2009 a Space Situational Awareness (SSA) optional programme involving 14 of its Member States[21]. One of the three elements of the programme is dedicated to space weather and aims to implement space weather monitoring and information services in Europe to support spacecraft operations and other applications.

The Asia-Oceania Space Weather Alliance (AOSWA), currently involving organizations from 13 countries, was established in 2010 for encouraging cooperation and sharing information among institutes in Asia-Oceania region concerned with, and interested in space weather.

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[13] International Union of Radio-Science: http://www.ursi.org/en/home.asp

[14] International Astronomical Union: http://www.iau.org

[15] International Association of Geomagnetism and Aeronomy: http://www.iugg.org/IAGA/

[16] COST 724 in 2003–2007, COST ES0803 in 2008–2012.

[17] http://server.sepserver.eu/. This server contains data on Solar Energetic Particle events.

[18] http://www.espas-fp7.eu/. Near-Earth space data infrastructure for e-science.

[19] http://www.helio-vo.eu/. Heliophysics integrated laboratory.

[20] http://www.affects-fp7.eu/. Advanced Forecast For Ensuring Communications Through Space.

[21] ESA/SSA participating countries include: Austria, Belgium, Czech Republic, Denmark, Finland, Germany, Italy, Luxembourg, Norway, Poland, Romania, Sweden, Switzerland, United Kingdom.

ANNEX 2: DRAFT TERMS OF REFERENCE OF IPT-SWISS

Scope

The responsibility of the Inter-Programme Team on Space Weather Information, Systems and Services (IPT-SWISS) is to coordinate space weather activities within the WMO Programmes, to maintain linkage with the constituent bodies and their relevant subsidiary groups, to maintain linkage with partner organizations, and to provide guidance to WMO Members. IPT-SWISS is established under Commission for Basic Systems (CBS) and the Commission for Aeronautical Meteorology (CAeM) who will provide joint oversight in consultation with each other via their presidents.

Main tasks

(a) Integration of Space Weather observations, through review of space- and surface-based observation requirements, harmonization of space-based sensor specifications, monitoring plans for Space Weather observations;

(b) Standardization and enhancement of Space Weather data exchange and delivery through the WMO Information System (WIS);

(c) Coordinating the development of SPW best practices for end-products and services, including e.g. quality assurance guidelines and emergency warning procedures, in collaboration with aviation and other major application sectors;

(d) Encouraging the dialogue between the research and operational space weather communities;

(e) Organization of capacity building, training and outreach activities towards WMO Members and space weather potential users;

(f) Provision of guidance to WMO Members and programmes on space weather matters, and conduct appropriate actions as requested by CBS and CAeM.

Composition

IPT-SWISS will be composed of members nominated by the relevant technical commissions, points of contacts nominated by the regional associations and associate members including representatives of ISES and other partners or major user applications.

IPT-SWISS members shall cover the various fields of expertise necessary to address space weather matters within WMO and will contribute to the relevant expert teams or other groups of WMO technical commissions including: Commission for Basic Systems (CBS)[22]; Commission for Aeronautical Meteorology (CAeM)[23]; Commission for Instruments and Methods of Observation (CIMO); Commission for Atmospheric Sciences (CAS).

IPT-SWISS will form ad hoc teams as appropriate focusing on topics requiring a particular field of expertise, for a particular time frame.

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[22] Such as the Inter-Programme Expert Teams on Observing System Design and Evolution (IPET-OSDE), on WIGOS Framework Implementation (IPET-WIFI), on Data Representation Maintenance Monitoring (IPET-DRMM), on Metadata and Data Representation Development (ET-MDRD), or the Steering group on Radio-Frequency Coordination (SG-RFC).

[23] Such as the Expert Team on Aviation, Science and Climate (ET-ASC), on Information & Services for Aviation (ET-ISA), on Education, Training and Competencies (ET-ETC).

Resolution 39 (Cg-17)

GLOBAL CLIMATE OBSERVING SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The 1998 Memorandum of Understanding between WMO, the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization, the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU) concerning the Global Climate Observing System (GCOS),

(2) The terms of reference of GCOS National Coordinators in the *Summary Report of the Eleventh Session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS* (GCOS-87, WMO/TD-No. 1189)), Annex XII,

(3) Decisions 11/CP.9 – Global observing systems for climate, 5/CP.10 – Implementation of the global observing system for climate and 9/CP.15 – Systematic climate observations, of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) taken at its ninth, tenth and fifteenth sessions, respectively,

(4) The *Progress Report on the Implementation of the Global Observing System for Climate in support of the UNFCCC 2004–2008* (GCOS-129, WMO/TD-No. 1489),

(5) The *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* (2010 Update) (GCOS-138, WMO/TD-No. 1523),

(6) The *Systematic Observation Requirements for Satellite-based Products for Climate*, *2011 update* (GCOS-154); Supplement details to the satellite-based component of the Implementation Plan for the Global Observing System for Climate in support of the UNFCCC,

(7) The 10-year Implementation Plan of the Global Earth Observation System of Systems (GEOSS) and the Group on Earth Observations 2012–2015 Workplan,

(8) The Implementation Plan of the Global Framework for Climate Services (GFCS), annex and appendices to the Observing and Monitoring Component, 2014,

Considering:

(1) The increasing needs of Members and international organizations for comprehensive, continuous, reliable climate and climate-related data and information,

(2) That observations made in the past have supported science-based and climate assessments, and that climate observation must be enhanced and continued into the future to enable users:

   (a) To detect further climate change and determine its causes,

   (b) To model and predict the climate system,

   (c) To assess impacts of climate variability and change,

   (d) To monitor the effectiveness of policies for mitigating climate change,

   (e) To support adaptation to climate change,

(f) To develop climate information services,

(g) To promote sustainable national economic development,

(h) To meet other requirements under the UNFCCC and other international conventions and agreements,

(3) The specific observational needs of the WMO Integrated Global Observing System, and needs from the findings of the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report and from activities of special interest to GCOS sponsors such as Future Earth and Blue Planet,

(4) The objectives of GCOS as identified in the Memorandum of Understanding to support all aspects of the World Climate Programme, which includes the World Climate Research Programme and the Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation, and relevant aspects of other climate-related global programmes, and its essential role in underpinning the full range of climate applications and services provided by National Meteorological and Hydrological Services (NMHSs) and other organizations,

(5) The deficiencies in the number and availability of systematic observations of climate,

(6) The need to implement and, as necessary, to update the Regional Action Plans developed through the GCOS Regional Workshop Programme,

(7) The need to incorporate climate information into social and economic decision-making, particularly in support of the United Nations sustainable development goals in developing countries, with a special focus on Africa,

Recognizing:

(1) The importance of efficient coordination and interoperability across the various component observing systems of GCOS and effective integration of in situ and space-based observations in meeting user needs,

(2) The stringent requirements on long-term observations of the climate system to ensure their adequacy for climate applications,

(3) The unique opportunities for coordinated national and international reliable physical, chemical and biological observation of Essential Climate Variables across the atmospheric, oceanic and terrestrial domains, including hydrological and carbon cycles and the cryosphere, provided through the joint sponsorship of GCOS by WMO, IOC, UNEP and ICSU,

(4) The new opportunities for increased international support, enhanced interoperability and improved integration opened up by the prospect of embedding the GCOS system of systems within the emerging operational structure of the Global Earth Observation System of Systems,

(5) The fundamental importance of GCOS to the Global Framework for Climate Services,

Recognizing with appreciation:

(1) The important contribution of the GCOS Steering Committee and its panels in providing scientific and technical guidance to WMO and other sponsoring and participating organizations for the planning, implementation and further development of GCOS,

(2) The critical role of the Executive Council, technical commissions and regional associations in coordinating the implementation of the WMO component systems of GCOS,

(3) The substantial achievements of Members in implementing their climate observing systems in support of both national needs and the international objectives of GCOS,

(4) The close collaboration among the co-sponsors of GCOS and with the Steering Committees and Secretariats of their other jointly sponsored observing systems, the Global Ocean Observing System and the Global Terrestrial Observing System,

(5) The support provided by a range of national and international donor organizations for GCOS planning and implementation,

Reaffirms the continuing strong commitment of WMO to the objectives of GCOS and support for its implementation in order to meet the full range of user needs;

Decides to strengthen and to continue GCOS as a programme of the Organization as regulated by the 1998 Memorandum of Understanding with partners such as IOC, UNEP and ICSU, and as regulated by new memorandums of understanding agreed by international sponsors;

Recalling the GCOS Climate Monitoring Principles for effective monitoring of the climate system as stated in the Implementation Plan for the Global Observing System for climate and adopted by the Fourteenth World Meteorological Congress in Resolution 9 (Cg-XIV) – GCOS Climate Monitoring Principles,

Urges Members:

(1) To strengthen their national atmospheric, oceanographic and terrestrial climate observing networks and systems, including networks and systems for the hydrological and carbon cycles and the cryosphere within the framework of GCOS and in support of user needs;

(2) To assist developing countries to strengthen their observing networks, to improve their capacity to acquire climate-relevant data, and to enhance their provision of climate services by implementing projects in the 10 GCOS Regional Action Plans, and by contributing to the implementation of the ClimDev Africa Programme and to similar initiatives in other regions;

(3) To ensure, to the extent possible, the long-term continuity of the critical space-based components of GCOS, including the generation and dissemination of the satellite-based climate data and products based on the Essential Climate Variables that are required to meet the needs of NMHSs, the Conference of the Parties to UNFCCC, IPCC and other users of climate services;

(4) To establish GCOS National Committees and to identify GCOS National Coordinators in order to facilitate coordinated national action on observing systems for climate, taking into account the joint international sponsorship of GCOS and the evolving international arrangements for GEOSS and GFCS;

(5) To ensure that their delegations to sessions of the Conference of the Parties to UNFCCC and its subsidiary bodies are properly informed of the key role played by NMHSs in implementing and operating observing systems necessary to meet national obligations under the Convention, for example through the inclusion in national delegations of representatives of NMHSs;

(6) To encourage their NMHSs to provide effective leadership in the preparation of national reports to the UNFCCC on their activities with regard to systematic observation of the global climate system, including the identification of gaps, using revised UNFCCC reporting guidelines on global climate observing systems that reflect the priorities of the GCOS

Implementation Plan and which incorporate reporting on the Essential Climate Variables identified therein;

(7) To enhance their support to the GCOS Secretariat, through secondment of experts and through contributions to the Climate Observing System Fund or to specific planning and implementation mechanisms, so as to enable the Secretariat to support the full range of implementation agents in its efforts to establish an effectively operating GCOS programme;

Requests the Executive Council:

(1) To keep the progress of GCOS under regular review and to provide support and guidance on its further development and implementation;

(2) To advise and assist Members, sponsoring bodies and other international organizations in the implementation of global observing systems for climate;

Requests the technical commissions:

(1) To lead the development and implementation of the components of GCOS for which they are responsible in the light of advice from the GCOS Steering Committee;

(2) To contribute to the UNFCCC Nairobi work programme on impacts, vulnerability and adaptation to climate change, in particular to the elements of the programme related to data and observations;

(3) To coordinate activities on climate observations with GFCS and GEOSS and to establish clear mandates with respect to the responsibilities of GCOS, GFCS and GEOSS in the field of climate observations.

Requests the regional associations to foster effective, coordinated implementation of GCOS at the regional level, in close consultation with the regional counterparts of the other international sponsors of GCOS;

Invites the GCOS Steering Committee to continue to provide broadly based strategic advice to all relevant WMO bodies on the implementation and further development of GCOS;

Requests the Secretary-General, within the regular budget allocation:

(1) To support the further planning, development and implementation of GCOS, following the recommendations of the GCOS Implementation Plan;

(2) To encourage and assist Permanent Representatives of Members to take the lead in the establishment of GCOS National Committees and the designation of GCOS National Coordinators;

(3) To bring the present resolution to the attention of all concerned, including co-sponsors of GCOS.

Note: This resolution replaces Resolution 29 (Cg-XVI), which is no longer in force.

Resolution 40 (Cg-17)

WMO POLAR AND HIGH-MOUNTAIN ACTIVITIES

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 55 (Cg-XVI) – Antarctic Observing Network,

(2) Resolution 56 (Cg-XVI) – Amendments to the *Manual on the Global Observing System* (WMO-No 544), Volume II, Regional Aspects – The Antarctic,

(3) Resolution 57 (Cg-XVI) – Global Integrated Polar Prediction System,

(4) Resolution 58 (Cg-XVI) – WMO polar activities,

(5) Resolution 59 (Cg-XVI) – International Polar Decade Initiative,

(6) Resolution 60 (Cg-XVI) – Global Cryosphere Watch,

(7) Resolution 17 (EC-64) – Polar Prediction Project,

(8) The WMO Strategic Plan 2016–2019,

(9) Resolution 40 (Cg-XII) – WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities,

Considering:

(1) The growing demand for services based on sustained observations and research in polar and high-mountain regions, which prompted the Sixteenth World Meteorological Congress to endorse the Global Integrated Polar Prediction System and the Global Cryosphere Watch (GCW),

(2) The requirement for focus on safety services responding to the increasing levels of shipping in the Arctic,

(3) That there remain key gaps in scientific understanding of processes and interactions in high-latitude and high-altitude regions, including, inter alia, boundary layer behaviour, polar clouds and precipitation, sea ice/ocean dynamics, hydrology, permafrost and ice sheet dynamics, and their influence on the Earth system,

(4) That there is consensus about the amplification of climate change and variability in polar and high-mountain regions, yet these regions remain under-sampled,

(5) That successful implementation of the International Polar Year (IPY) 2007–2008 has resulted in a legacy of enhanced polar observing systems and research on the polar environment,

(6) That arrangements ensuring the legacy of the IPY-enhanced observational networks are cross-cutting and should be closely coordinated with the implementation of the WMO Integrated Global Observing System (WIGOS), and designed to improve in a most efficient way the capability of Members to provide the expanding range of operational services and to better serve research programme requirements,

(7) That continuity of long-term series of hydrometeorological and related environmental observations is critical to detection of environmental change,

(8) That there is a growing consensus that hydrometeorological and related environmental data and products from publicly funded research should be made widely available and that there are mutual benefits in making appropriate research data available for forecasting and climate purposes,

(9) That there is a continuing need to coordinate WMO activities with other international organizations active in polar and high-mountain regions,

(10) That operational and research observing networks in polar regions, including the Antarctic Observing Network (AntON), and the cryosphere in general, including the observing component of GCW, should be integrated within the framework of WIGOS and the WMO Information System (WIS) and be enhanced to include cryosphere-related variables,

(11) The achievements of the Executive Council Panel of Experts on Polar Observations, Research and Services in ensuring coordination of operational activities with other international organizations active in polar and high-mountain regions and in engaging WMO technical commissions and regional associations in the work of the Panel,

(12) That polar and high-mountain regions are recognized as one of the seven key priorities of WMO,

Recognizing the growing economic activities in polar regions that have an impact on climate change in these regions and the rest of the world,

Decides:

(1) That an integrated approach is needed to provide required services to users and advice to governments about adaptation and mitigation, based on an understanding of the global impact of changes in polar and high-mountain regions, and as the changing climate in the polar regions will have an impact on weather and climate in other regions of the world, teleconnection impact studies will be part of this integrated approach;

(2) That operational and research observing networks including AntON, the observing component of GCW, oceanographic observations and other activities in polar and high-mountain regions, should be integrated within the framework of WIGOS and WIS;

(3) That concerted efforts continue to be made to engage Members, technical commissions and regional associations, as well as the World Weather Research Programme and other relevant research and international bodies, to improve services in high-latitude and high-altitude regions by promoting observations and predictive capability on timescales from hours to centuries;

Invites Members, particularly those that have operational activities in polar and high-mountain regions:

(1) To ensure continuity of their weather, climate, hydrology and related environmental activities in polar and high-mountain regions;

(2) To ensure that appropriate hydrometeorological and related environmental data from publicly funded research is made available to the operational community in real-time or near real-time;

(3) To provide additional observations in polar and high-mountain regions by using manned and automatic hydrometeorological stations, atmospheric soundings, remote-sensing systems and other geophysical observatories on land, by recruiting additional voluntary

observing ships, by equipping aircraft with appropriate means of recording and distributing observations, and by deploying automated observing platforms on and under the sea and ice, in order to meet the needs of numerical weather prediction, hydrological services, climate studies and research programmes, including in particular the Year of Polar Prediction from mid-2017 to mid-2019;

(4) To enhance their satellite programmes in delivering appropriate satellite observing system infrastructure and products and services required for polar and high-mountain regions;

(5) To consider the possibility of cooperating with other Members in sharing the costs of reopening and operating previously functioning stations, in expanding existing stations or in deploying new observing and communication systems;

(6) To support WMO polar and high-mountain activities by providing both human and financial resources in its endeavours to enhance observations, research and services in polar and high-mountain regions;

Encourages Members to liaise with all their national groups that may have operational activities in polar and high-mountain regions;

Requests the Executive Council:

(1) To promote the coordination of weather, climate, hydrology and related environmental activities in polar and high-mountain regions;

(2) To ensure close collaboration with other international organizations concerned such as the Antarctic Treaty Consultative Meeting, the Arctic Council, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, the Group on Earth Observations and the International Council for Science and their relevant bodies (for example, the Scientific Committee on Antarctic Research, the International Arctic Science Committee, the International Association of Cryospheric Sciences) and other relevant associations of the International Union of Geodesy and Geophysics, the Council of Managers of National Antarctic Programs, the Forum of Arctic Research Operators, and the International Centre for Integrated Mountain Development;

(3) To ensure that WMO polar and high-mountain activities are aligned with the WMO Strategic Plan 2016–2019;

Requests the regional associations and the technical commissions to support WMO polar and high-mountain activities;

Requests the Secretary-General to bring the present resolution to the attention of all concerned.

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Note: This resolution replaces Resolution 58 (Cg-XVI), which is no longer in force.

Resolution 41 (Cg-17)

ANTARCTIC OBSERVING NETWORK

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 55 (Cg-XVI) – Antarctic Observing Network,

(2) The *Technical Regulations* (WMO-No. 49), Volume I, Part II, 1.3.1.1.2,

(3) The WMO Strategic Plan 2016–2019,

(4) The *Manual on the Global Observing System* (WMO-No. 544), Volume I, Global Aspects, Part III, sections 2.1.3 and 2.1.4, and Volume II, Regional Aspects – The Antarctic,

Considering:

(1) That the establishment and maintenance of an Antarctic Observing Network (AntON) of surface and upper-air stations to meet the requirements of Members constitutes one of the most important obligations of Members under Article 2 of the Convention of the World Meteorological Organization,

(2) That the density of the current Antarctic Observing Network of surface and upper-air stations is much less than that desirable to properly characterize Antarctic weather and climate,

(3) That in order to provide a good representation of the climate of Antarctica, there is no need to distinguish between a synoptic and climate network,

(4) That observing stations in Antarctica contribute significantly to the WMO Global Cryosphere Watch (GCW),

(5) That manned stations in Antarctica also contribute vital ozone and other observations to the Global Atmosphere Watch,

(6) The need for further integration of Antarctic observing systems according to the WMO Integrated Global Observing System practices,

(7) The needs of the research community as expressed by the Scientific Committee on Antarctic Research,

Decides that the stations and the observational programmes listed in the annex to the present resolution constitute the Antarctic Observing Network;

Urges Members:

(1) To secure full implementation of the network of stations and observational programmes set forth in the annex to the present resolution, particularly those contributing to the Global Climate Observing System;

(2) To seek to maintain, and where possible restore, radiosonde stations in Antarctica;

(3) To consider their observing stations for inclusion into the core, standardized GCW Observing Network based on its selection criteria;

(4) To consider the possibility of cooperating with other Members in sharing the costs of reopening and operating silent stations and opening new stations at key locations;

(5) To comply with the standard times of observation, the coding procedures and the data-collection standards, as laid down in the *Technical Regulations*, Volume I and the *Manual on the Global Observing System*, the *Manual on Codes* (WMO-No. 306), the *Manual on the Global Telecommunication System* (WMO-No. 386) and the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485), providing the data in real-time as far as practicable;

(6) To validate station positions and elevations using modern surveying techniques against those given in *Weather Reporting* (WMO-No. 9), Volume A – Observing Stations at the required resolution and to communicate the results of these measurements to the Secretariat;

(7) In complying with the WMO Technical Regulations and considering practicalities of the environment in which instrument systems operate in the Antarctic, ensure that traceable calibration certificates are available for instrumentation, in line with the International Organization for Standardization quality management certification;

(8) To keep updated the observational metadata for all the stations, to make available appropriate discovery metadata and to provide them with all observational datasets through the WMO Information System;

(9) To make historic research and routine observational data available to appropriate Antarctic Data Collection and Production Centres for archiving for climate purposes with the focus on the Global Framework for Climate Services;

(10) To incorporate existing research and new installations into AntON;

(11) To ensure that feedback is given to stations when numerical weather prediction systems detect problems with data or their transmission;

Requests the Secretary-General to bring any changes to the Antarctic Observing Network to the attention of Members.

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Note: This resolution replaces Resolution 55 (Cg-XVI), which is no longer in force.

Annex to Resolution 41 (Cg-17)

PROPOSED LIST OF STATIONS IN THE ANTARCTIC OBSERVING NETWORK

This list shows the stations currently comprising the Antarctic Observing Network (AntON). It shows whether the stations currently contribute synoptic (S), climate (C) or upper-air (U) synoptic observations that are to be sent to the Global Telecommunication System (GTS), whether they are GCOS Surface Network (GSN), GCOS Upper-Air Network (GUAN) or Global Atmosphere Watch (GAW) stations. Key stations are those that are Global Climate Observing System (GCOS) stations or are over 200 km distant from a GCOS station. Station numbers beginning AA are sent on the GTS in SYNOP MOBIL code form. All operational AntON stations are expected to produce CLIMAT messages, provided that they have suitable data.

Note: In addition to AntON stations, a number of other stations in the Southern Ocean (within the responsibility of Regional Associations (RAs) I, III and IV) lie in the EC-PORS zone of interest and are, therefore, listed below AntON for information.

Abbreviations: X = message or data expected; Add = suggestion for addition to the RBCN; Closed = GAWSIS indicates station is closed or inactive.

Antarctic stations[1]									
WMO no	***Station***	***Operator***	***Type***	***S/C***	***U***	***Key***	***GSN***	***GUAN***	***GAW***
88963	Esperanza	Argentina		X		X	X		
88968	Orcadas	Argentina		X		X	X		
89002	Neumayer	Germany		X	X	X	X	X	X
89003	Halvfarryggen EP11	Netherlands	AWS	X					
89004	SANAE	South Africa		X		X	X		
89009	Amundsen-Scott	USA		X	X	X	X	X	X
89013	Baldrick	UK (BAS)	AWS	X		X			
89014	Nordenskiold	Finland	AWS	X		X			
89022	Halley	UK (BAS)		X	X	X	X	X	X
89034	Belgrano II	Argentina		X		X			X
89049 *(Note: Last data Sep 2011)*	AGO-2	USA (USAP)	AWS	X		X			
89050	Bellingshausen	Russian Federation		X		X	X		
89051 (Note: to be installed in 2015)	Petrel	Argentina	AWS	X					
89053	Carlini	Argentina		X		X			
89054	Dinamet	Uruguay		X					
89055	Marambio	Argentina		X	X	X	X	X	X
89056	Frei	Chile		X		X	X		X
89057	Arturo Prat	Chile	AWS	X					
89058	Great Wall	China		X					
89059	O'Higgins	Chile		X		X			
89061	Palmer	USA		X		X			X
89062	Rothera	UK (BAS)		X	X	X	X		X
89063	Vernadsky	Ukraine		X		X	X		X
89064 (NOTE: In summer only)	Juan Carlos I	Spain		X					
89065	Fossil Bluff	UK (BAS)	AWS	X		X	X		
89066	San Martin	Argentina		X		X			X
89070	Gabriel de Castilla	Spain	AWS	X					
89087	Thiel Mountains	USA (ANI)	AWS	X		X			
89108	Henry	USA (UoW)	AWS	X		X			
89132	Russkaya	Russian Federation	AWS	X		X			
89251	King Sejong	Rep. of Korea (KOPRI)	AWS	X					X
89252 *(Note: Last data Sep 2011)*	Comandante Ferraz	Brazil		X					
89253 *(Note: Last data July 2013)*	Joinville Island	Brazil	AWS	X					
89257	Limbert	UK (BAS)	AWS	X		X			

Antarctic stations[1]									
WMO no	***Station***	***Operator***	***Type***	***S/C***	***U***	***Key***	***GSN***	***GUAN***	***GAW***
89260	Larsen B Scar Inlet EP17	Netherlands	AWS	X					
89262	Larsen Ice Shelf	UK (BAS)	AWS	X		X	X		
89265	Larsen C1 EP14	Netherlands	AWS	X					
89266	Butler Island	UK (BAS)	AWS	X		X	X		
89267	Larsen C EP15	Netherlands	AWS	X					
89269	Bonaparte Point	USA (UoW)	AWS	X					
89272	Sky Blu	UK (BAS)	AWS	X		X	X		
89314	Theresa	USA (UoW)	AWS	X		X			
89324	Byrd Station	USA (UoW)	AWS	X		X	X		
89327 (Note: AWS close to life time)	Mount Siple	USA (UoW)	AWS	X		X	X		
89329	Harry	USA (UoW)	AWS	X		X	X		
89332 *(Note: Last data March 2013)*	Elizabeth	USA (UoW)	AWS	X		X			
89345	Siple Dome	USA (UoW)	AWS	X		X	X		
89376	Gill	USA (UoW)	AWS	X		X	X		
89377	Lettau	USA (UoW)	AWS	X		X	X		
89504	Troll	Norway	AWS	X		X			
89507	Kohnen EP9	Netherlands	AWS	X		X			
89512	Novolazarevskaya	Russian Federation		X	X	X	X	X	X
89514	Maitri	India		X					X
89526	Princess Elisabeth/ Utsteinen	Belgium/ Netherlands	AWS	X					
89528 *(Note: Last data Jan 2012)*	AGO-3	USA (USAP)	AWS	X					
89532	Syowa	Japan		X	X	X	X	X	X
89536	Plateau Station B EP12	Netherlands	AWS	X		X			
89542	Molodeznaja	Russian Federation	AWS	X		X			
89558	Pole of Relative Inaccessibility EP13	Netherlands	AWS	X		X			
89564	Mawson	Australia (BoM)		X	X	X	X	X	Closed
89570 *(Note: Last data Dec 2013)*	Davis (Whoop Whoop)	Australia (AAD)	AWS	X					
89571	Davis	Australia (BoM)		X	X	X	X	X	X
89573	Zhongshan	China		X		X	X		X
89574	Progress	Russian Federation		X		X	X		
89575	Druzhnaya 4	Russian Federation	AWS	X					
89577	Dome A	Australia (AAD)	AWS	X		X	X		
89578	Eagle	Australia (AAD)	AWS	X		X			
89586 *(Note: Last data Oct 2011)*	Davis (Mount Brown)	Australia (AAD)	AWS	X		X			
89592	Mirnyj	Russian Federation		X	X	X	X	X	X
89598	AGO-4	USA (UoW)	AWS	X		X			
89601	Oazic Bangera	Russian Federation	AWS	X					
89606	Vostok	Russian Federation		X	X	X	X	X	X

Antarctic stations[1]									
WMO no	***Station***	***Operator***	***Type***	***S/C***	***U***	***Key***	***GSN***	***GUAN***	***GAW***
89610 *(Note: Last data Sep 2013)*	Casey (Cape Poinsett)	Australia (AAD)	AWS	X		X			
89611	Casey	Australia (BoM)		X	X	X	X	X	Closed
89614	Wilkins Runway West	Australia (AAD)	AWS	X					
89615	Wilkins Runway East	Australia (BoM/AAD)	AWS	X					
89625	Concordia	Italy		X	X	X	X		X
89628 *(Note: Last data Dec 2012)*	AGO-1	USA (USAP)	AWS	X		X			
89642	Dumont d'Urville	France		X	X	X	X	X	X
89643 *(Note: Last data Jan 2009)*	Port Martin	USA (UoW/France)	AWS	X					
89646	Sitry (Irene)	Italy	AWS	X		X			
89648	Mid Point (Giulia)	Italy	AWS	X		X			
89657	Leningradskaya	Russian Federation	AWS	X		X			
89659	Priestley Nevee (Modesta)	Italy	AWS	X		X			
89661	Cape Phillips (Silvia)	Italy	AWS	X		X			
89662	Mario Zuchelli Station	Italy		X	X	X	X		
89859	Jang Bogo	Rep. of Korea (KOPRI)		X	X				
89664	McMurdo	USA		X	X	X	X	X	X
89665	Scott Base	New Zealand				X			X
89666	Cape Ross (Arelis)	Italy	AWS	X		X			
89667	Pegasus North	USA (UoW)	AWS	X		X			
89671 *(Note: New station not yet on the GTS)*	Cape Hallett	USA (UoW)	AWS	X					
89734	Dome Fuji	USA (UoW/Japan)	AWS	X					
89744	Relay Station	USA (UoW/Japan)	AWS	X		X	X		
89767	Amery Ice Shelf (C3)	Australia (AAD)	AWS	X		X			
89768	Minna Bluff	USA (UoW)	AWS	X					
89769	Linda	USA (UoW)	AWS	X					
89799	Nico	USA (UoW)	AWS	X		X			
89807	Casey (Snyder Rocks)	Australia (AAD)	AWS	X					
89809 *(Note: Last data May 2014)*	Casey Skiway South	Australia (AAD)	AWS	X		X			
89811	Casey (Law Dome Summit)	Australia (AAD)	AWS	X		X			X
89815 *(Note: Last data May 2013)*	Casey (Haupt Nunatak)	Australia (AAD)	AWS	X					
89828	Dome C II	USA (UoW/France)	AWS	X		X	X		
89832	D-10	USA (UoW/France)	AWS	X					
89834	D-47	USA (UoW/France)	AWS	X					
89836 *(Note: NO SYNOPs)*	D-85	USA (UoW/France)	AWS			X			
89864	Manuela	USA (UoW)	AWS	X					

Antarctic stations[1]									
WMO no	***Station***	***Operator***	***Type***	***S/C***	***U***	***Key***	***GSN***	***GUAN***	***GAW***
89865	Whitlock	USA (UoW)	AWS	X		X	X		
89866	Marble Point	USA (UoW)	AWS	X		X	X		
89868	Schwerdtfeger	USA (UoW)	AWS	X					
89869	Marilyn	USA (UoW)	AWS	X		X	X		
89872	Ferrell	USA (UoW)	AWS	X		X	X		
89873	Elaine	USA (UoW)	AWS	X					
89879	Possession Island	USA (UoW)	AWS	X		X	X		
AAALE *(Note: NO SYNOPs)*	Cape King (Alessandra)	Italy	AWS	X					
AABIR *(Note: Last data Nov 2011)*	Cape Bird	USA (UoW)	AWS	X					
AABRI	Brianna	USA (UoW)	AWS	X		X			
AADIS	Dismal Island	USA (UoW)	AWS	X					
AADEN (Note: Intermittent)	Cape Denison	USA (UoW / Australia)	AWS	X		X			
AAEMI	Emilia	USA (UoW)	AWS	X					
AAERC	Eric	USA (UoW)	AWS	X		X			
AAERI	Erin	USA (UoW)	AWS	X		X			
AAKOM	Kominko-Slade	USA (UoW)	AWS	X					
AALAU	Laurie II	USA (UoW)	AWS	X					
AALOL *(Note: NO SYNOPs)*	Tourmaline Plateau (Lola)	Italy	AWS	X					
AAMIZ *(Note: Last data Dec 2012)*	Mizuho	USA (UoW/Japan)	AWS	X		X			
AAPEG *(Note: Last data March 2014)*	Pegasus South	USA (UoW)	AWS	X					
AAPET *(Note: NO SYNOPs)*	Peter I Oy	USA (UoW)	AWS	X		X			
AAPIG *(Note: Last data Dec 2011)*	Pine Island Glacier	USA	AWS	X		X			
AARIT *(Note: NO SYNOPs)*	Enigma Lake (Rita)	Italy	AWS	X					
AASOF	Sophia-B	Italy	AWS	X					
AAUNI	Union Glacier	USA (ANI)	AWS	X		X			
AAVIT	Vito	USA (UoW)	AWS	X		X			
AAWIL *(Note: NO SYNOPs)*	Willie Field	USA (UoW)	AWS	X					
AAWIN *(Note: NO SYNOPs)*	Windless Bight	USA (UoW)	AWS	X					
AAZOR *(Note: NO SYNOPs)*	Priestley Glacier (Zoraida)	Italy	AWS	X					
AAJAN	Janet	USA (UoW)	AWS	X		X			
AABEA	Bear Peninsula	USA (UoW)	AWS	X					
AAEVA	Evans Knoll	USA (UoW)	AWS	X					
AATHU	Thurston Island	USA (UoW)	AWS	X		X			
AANSC	Nascent	USA	AWS	X					
AASAB	Sabrina	USA (UoW)	AWS	X					
AAJAS	JASE 2007	Japan	AWS	X					
AAPDAS	PANDA-South	USA (UoW) / China	AWS	X					

Antarctic stations[1]									
WMO no	***Station***	***Operator***	***Type***	***S/C***	***U***	***Key***	***GSN***	***GUAN***	***GAW***
AAMP2	Marble Point II	USA	AWS	X					
AAMEG	Margaret	USA (UoW)	AWS	X					
AALOR	Lome	USA (UoW)	AWS	X					
AABAT	Alexander Tall Tower!	USA (UoW)	AWS	X					
	PANDA-North	China/Australia	AWS	X		X			
	Criosphera	Brazil	AWS	X					
	AWS 1	USA	AWS	X					
	Lindsey Island	Rep. of Korea	AWS	X					
	Camp Maudheimvida	Finland	AWS	X					
	Paola	Italy	AWS	X					

[1] GCOS Surface Network (GSN) / GCOS Upper-air Network (GUAN) / Global Atmosphere Watch (GAW) for reference only

Sub Antarctic stations (in Regions I, III or V)											
WMO no	***Station***	***Operator***	***Type***	***S***	***RBSN***	***C***	***RBCN***	***GSN***	***U***	***GUAN***	***GAW***
61997	Isle Crozet	France		X	X	X	X	X			X
61998	Isle Kerguelen	France		X	X	X	X	X	X	X	X
68906	Gough Island	South Africa		X	X	X	X	X	X	X	
68992 *(Note: Station not in operation, but key GCOS station)*	Bouvetoya	Norway		-	X	X	X	X			
68994	Marion Island	South Africa		X	X	X	X	X	X	X	Closed
88870	Mount Byron	UK	AWS	X		X					
88878	Pebble Island	UK	AWS	X		X					
88881	Mount Kent	UK	AWS	X		X					
88883	Weddell Island	UK	AWS	X		X	Add				
88889	Mount Pleasant Airport	UK	AWS	X	X	X	X	X	X	X	
88894	Mount Alice	UK	AWS	X		X					
88897	Sea Lion Island	UK	AWS	X		X					
88900	Bird Island	UK (BAS)	AWS	X		X	Add				X
88903	Grytviken	UK (BAS)	AWS	X	X	X	Add	X			X
88986	South Thule Island	South Africa	AWS	-		X	Add				
93929	Enderby Island	New Zealand	AWS	X	X	X					
93947	Campbell Island	New Zealand	AWS	X	X	X	X	X			
94997	Heard Island (The Spit)	Australia		X	X	X					
94998	Macquarie Island	Australia		X	X	X	X	X	X	X	X

Resolution 42 (Cg-17)

AMENDMENTS TO THE *MANUAL ON THE GLOBAL OBSERVING SYSTEM* (WMO-No. 544), VOLUME II, REGIONAL ASPECTS – THE ANTARCTIC

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 58 (Cg-XVI) – WMO polar activities,

(2) Resolution 56 (Cg-XVI) – Amendments to the *Manual on the Global Observing System* (WMO-No. 544), Volume II, Regional Aspects – The Antarctic,

(3) The WMO Strategic Plan 2016–2019,

Decides to amend the *Manual on the Global Observing System*, Volume II, Regional Aspects – The Antarctic, as given in the annex to the present resolution;

Requests the Secretary-General:

(1) To make the appropriate amendments as given in the annex to the present resolution;

(2) To bring the present resolution to the attention of Members.

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Note: This resolution replaces Resolution 56 (Cg-XVI), which is no longer in force.

Annex to Resolution 42 (Cg-17)

AMENDMENTS TO THE *MANUAL ON THE GLOBAL OBSERVING SYSTEM* (WMO-No. 544), VOLUME II, REGIONAL ASPECTS – THE ANTARCTIC

7. THE ANTARCTIC

7.1 ANTARCTIC OBSERVING NETWORK OF SURFACE AND UPPER-AIR OBSERVING STATIONS

7.1.1 COMPOSITION OF THE ANTARCTIC OBSERVING NETWORK

7.1.1.1 The Antarctic Observing Network (AntON) is composed of surface and upper-air stations adequate to meet the requirements of Members, and constitutes one of the most important obligations of Members under Article 2 of the WMO Convention.

7.1.1.2 The AntON is reviewed by a designated subsidiary body of the Executive Council and adopted by the Council or the WMO Congress in a resolution. The list of stations constituting the AntON is given in the annex to a resolution approved by Congress or the Executive Council. Changes are announced in the monthly Operational Newsletter issued by the Secretariat (see 7.1.6 below).

7.1.1.3 Manned surface land stations included in the AntON shall conform to the specifications laid down for land stations in Volume I of this Manual.

7.1.2 SURFACE SYNOPTIC OBSERVATIONS

7.1.2.1 All manned surface stations included in the AntON shall make surface observations at the four main standard times of observation, that is, 0000, 0600, 1200 and 1800 UTC. Whenever possible and desirable, observations should also be made at some or all of the four intermediate standard times of observation, that is, 0300, 0900, 1500 and 2100 UTC. Any surface station that cannot carry out the full observational programme should give priority to carrying out the observations at the main standard times.

7.1.2.2 Automatic Weather Stations (AWS) should measure pressure, temperature, wind speed and direction at least hourly. Additional measurements should be made as far as possible.

7.1.3 UPPER-AIR SYNOPTIC OBSERVATIONS

7.1.3.1 All upper-air stations included in the AntON should carry out radiosonde and/or radiowind observations at 0000 and 1200 UTC. Other considerations permitting, those stations that are unable to carry out the full observing programme should give priority to the observations that maintain the historic record. Stations that are separated by no more than about 600 km may wish to consider bilateral arrangements whereby each undertakes one of the ascents so as to complete between them the full observing programme required.

7.1.4 CLIMATOLOGICAL OBSERVATIONS

7.1.4.1 As far as possible, all AntON surface stations shall report CLIMAT messages for better monitoring of climate.

7.1.4.2 CLIMAT reports from AntON stations shall be regarded as essential data in the sense of Resolution 40 (Cg-XII) – WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities.

7.1.5 OPERATIONAL PROCEDURES

7.1.5.1 Members are urged to comply fully with the global coding procedures and data-collection standards in accordance with procedures laid down in the WMO *Technical Regulations* (WMO-No. 49), *Manual on Codes* (WMO-No. 306), *Manual on the Global Telecommunication System* (WMO-No. 386), *Manual on the WMO Information System* (WMO-No. 1060), and in this Manual when operating the stations in the AntON.

7.1.6 ARRANGEMENTS AND PROCEDURES FOR UPDATING AND AMENDING THE ANTARCTIC OBSERVING NETWORK

7.1.6.1 Certain minor changes in the AntON of surface and upper-air stations that do not affect the data requirements for the Antarctic as a whole are inevitable. To provide a simple and rapid means of effecting changes by Members, the following procedure shall be followed:

(a) The President of WMO may approve, at the request of the Member concerned, on the advice of the Chairperson of a dedicated Executive Council subsidiary body and in consultation with the Secretary-General, minor amendments to the AntON. Any proposed significant change in the composition of AntON would still require the formal agreement of Members operating components of the AntON;

(b) The Secretary-General shall notify all Members of WMO through the Operational Newsletter or by circular letter of changes agreed with the President of WMO.

7.2 WEATHER REPORTING BY TRAVERSE PARTIES

7.2.1 Members operating stations in the Antarctic are encouraged to instruct all traverse parties to make surface observations wherever circumstances permit when they are more than 200 km away from their base. The observations, which should be carried out as close as possible to the standard times of observations, should be transmitted at least once a day.

7.3 AUTOMATIC WEATHER STATIONS IN THE ANTARCTIC

7.3.1 Members are encouraged to use automatic weather stations as a part of the AntON, taking advantage of the data-collection capabilities of polar-orbiting satellites and, in some cases, of the geostationary satellites.

7.4 SHIPS OPERATING IN ANTARCTIC WATERS

7.4.1 Members should ensure that all research vessels, supply vessels and tourist ships operating in the Antarctic make regular surface synoptic observations at main and intermediate synoptic hours, and transmit these data in real time. When these data cannot be transmitted in real time they should be submitted in delayed mode or as historic data.

7.4.2 Members should also ensure that vessels, whenever practicable, also make upper-air observations, and that any observations made are transmitted in real time.

7.5 SURFACE DRIFTING BUOYS

7.5.1 Members are encouraged to enhance their deployment and maintenance of surface drifting buoys, which shall be equipped with at least atmospheric pressure and sea surface temperature sensors, transmitting data in real time. Members are also encouraged to further develop buoy technology to enhance operations and real-time reporting both on and off the ice.

7.6 AIRCRAFT REPORTS

7.6.1 Members are encouraged to arrange for making, recording and distributing in real time observational reports from all flights to/from and within the Antarctic.

7.7 ADDITIONAL AND EXTENDED OBSERVATIONS

7.7.1 Members are encouraged to arrange for making, recording and distributing in real time additional and extended observations from ships and stations in the Antarctic. A list of observations made for the Global Atmosphere Watch (GAW) should be recorded in the GAW Station Information System (GAWSIS).

7.8 METADATA

7.8.1 Members/Operators of the observing stations/platforms shall provide observational and discovery metadata to WMO according to practices described in the Manual on WIGOS (WMO-No. XXXX).

Resolution 43 (Cg-17)

GLOBAL CRYOSPHERE WATCH

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 60 (Cg-XVI) – Global Cryosphere Watch,

(2) The Sixteenth World Meteorological Congress decision to develop the Global Cryosphere Watch (GCW) as an International Polar Year legacy with the goal of achieving an operational GCW,

(3) That the GCW working structure has been initiated and significant progress has been made towards an operational GCW, including building the core, standardized GCW observing network – CryoNet,

(4) The GCW Implementation Plan developed under the auspices of the Executive Council,

Considering:

(1) That the cryosphere is global, existing in various forms spanning all latitudes and occurring in approximately 100 countries in addition to the Antarctic continent,

(2) That the cryosphere is an integrative element within the climate system and provides one of the most useful indicators of climate change, yet it is arguably the most under-sampled domain in the climate system,

(3) That cryosphere-related feedbacks in the amplification of climate change cause impacts on weather, climate and water globally,

(4) That the cryosphere, its changes and their impacts have received increased scientific scrutiny and continuous attention by decision-makers and coverage by the media, creating an unparalleled demand for authoritative information on past, present and future states of the world's snow and ice resources,

(5) That the GCW is a significant component of the WMO Integrated Global Observing System (WIGOS) and the WMO Information System (WIS), particularly in promoting interoperable and reference observations, and near-real-time data and information exchange,

(6) That the GCW is recognized as a significant contribution to developing and implementing cryosphere observations and services within the Global Framework for Climate Services,

(7) That the GCW can only succeed through the work of Members in partnership with other organizations that have cryospheric interests,

(8) That the development of GCW has progressed with the limited resources allocated by Sixteenth Congress and with support from extrabudgetary resources,

Appreciating:

(1) The important contributions Members, international partner organizations and programmes make towards the development of GCW,

(2) The relevant work undertaken by Members, the Executive Council, regional associations, technical commissions and the Executive Council Panel of Experts on Polar Observations, Research and Services on the development and implementation of the GCW initiative launched by Sixteenth Congress,

(3) The contributions of Members to the Trust Fund for Polar Observations, Research and Services in support of GCW development,

Decides to mainstream and implement GCW in WMO Programmes as a cross-cutting activity;

Decides further that implementation activities will be undertaken during the seventeenth financial period as one of the major efforts of the Organization with the goal that GCW should become operational;

Invites partner organizations:

(1) To collaborate with WMO on the implementation of GCW;

(2) To support the implementation of GCW by providing both human and financial resources;

Requests the Executive Council:

(1) To establish a mechanism to steer and monitor the activity and to achieve the broadest possible collaboration and cooperation;

(2) To ensure the active participation and representation of the principal bodies concerned and also the participation, as appropriate, of technical experts and representatives of agencies undertaking observing and research initiatives relevant to the cryosphere;

Requests the regional associations and technical commissions to include this activity in their work programmes in order to fully accommodate the cross-programme nature of GCW;

Urges Members:

(1) To develop their observing systems to support the observing component of GCW;

(2) To coordinate their WIGOS and WIS implementation activities with GCW implementation;

(3) To provide experts to participate in GCW-related work;

(4) To provide both human and financial resources to help support the implementation of GCW;

(5) To support regional and global GCW implementation activities, including the establishment of the operational CryoNet, the core, standardized GCW Network;

(6) To keep the Secretary-General informed about their GCW implementation activities;

(7) To share relevant experience and cooperate with one another in implementing GCW, including assistance to Members with specific GCW implementation needs;

Requests the Secretary-General:

(1) To ensure, to the extent possible within available resources, management of, and provide support to, the implementation of the GCW;

(2) To establish a GCW Coordination/Project Office;

(3) To coordinate and collaborate GCW activities with United Nations system organizations and other relevant international organizations and programmes.

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Note: This resolution replaces Resolution 60 (Cg-XVI), which is no longer in force.

Resolution 44 (Cg-17)

AVIATION RESEARCH AND DEVELOPMENT PROJECT

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 11 (Cg-XVI) – World Weather Research Programme,

(2) Resolution 53 (Cg-XVI) – Aeronautical Meteorology Programme,

(3) Resolution 14 (Cg-XV) – Atmospheric Research and Environment Programme,

(4) The WMO Strategic Plan 2016–2019,

(5) The *Strategic Plan for the Implementation of WMO's World Weather Research Programme (WWRP): 2009–2017* (WMO/TD-No. 1505),

(6) The International Civil Aviation Organization (ICAO) Global Air Navigation Plan (2013 edition) and its Aviation System Block Upgrades methodology,

Noting further:

(1) The responsibility of WMO and relevant bodies within the United Nations system to provide the authoritative scientific information on the state of weather, climate, water resources and the environment,

(2) The increasing demand for numerical weather prediction (NWP) research in support of providing high-resolution weather modelling tools to improve forecasting accuracy as well as enhance products and services for aviation,

(3) The increasing need to move towards environmental predictions, using as a core driver the traditional NWP systems, coupled with other modelling subsystems, with a consideration of the socioeconomic impacts, as distinct from strictly traditional weather-only predictions,

(4) The important role of the National Meteorological and Hydrological Services with respect to integrated observations via their extensive monitoring system infrastructures, and specific scientific expertise in areas such as numerical modelling with four-dimensional and coupled data assimilation techniques and real-time data delivery,

Endorses the conduct of the Aviation Research and Development Project (AvRDP) with a main purpose to demonstrate the capability of nowcasting and mesoscale modelling techniques in support of the development of next-generation aviation products and services, thus contributing to the Aviation System Block Upgrades methodology of the ICAO Global Aviation Navigation Plan;

Requests Members participating in the project:

(1) To provide all possible support to the development and improvement of networks for observations of boundary layer processes related to aviation topics;

(2) To ensure the support to specific field campaigns of AvRDP;

(3) To cooperate in the development of modelling tools for nowcasting and very high-resolution forecasting;

(4) To collaborate with air traffic management stakeholders and other relevant partners in order to ensure that project outcomes are fit-for-purpose;

Requests the presidents of the Commission for Atmospheric Sciences, the Commission for Aeronautical Meteorology and the Commission for Basic Systems:

(1) To establish effective coordination in implementing the AvRDP activities;

(2) To stimulate and coordinate research and development activities and studies of nowcasting methods, numerical prediction tools and assimilation methods to increase potential benefits of AvRDP implementation for Members;

Requests the presidents of regional associations concerned to support the implementation of AvRDP and disseminate the outcomes on a regional basis;

Requests the Executive Council:

(1) To monitor the implementation of AvRDP and advise its governing bodies in order to ensure successful completion of the project;

(2) To ensure, when appropriate, that the demonstration project phase is followed by fast transfer of the results into operational practice;

Requests the Secretary-General:

(1) To support, within available budgetary resources, the implementation of AvRDP;

(2) To organize appropriate events for the dissemination of project results for the maximum benefit of Members, within available budgetary resources;

(3) To maintain WMO collaboration in matters related to aviation with relevant organizations and aviation stakeholders.

Resolution 45 (Cg-17)

WORLD WEATHER RESEARCH PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The *Abridged Final Report with Resolutions and Recommendations of the Sixteenth Session of the Commission for Atmospheric Sciences* (WMO-No. 1128),

(2) Resolution 11 (Cg-XVI) – World Weather Research Programme,

(3) Resolution 14 (Cg-XV) – Atmospheric Research and Environment Programme,

(4) Resolution 11 (EC-66) – Post THORPEX activities,

(5) The WMO Strategic Plan 2016–2019,

(6) The *Strategic Plan for the Implementation of WMO's World Weather Research Programme (WWRP): 2009–2017* (WMO/TD-No. 1505),

(7) The final report with recommendations of the ninth meeting of the Management Group of the Commission for Atmospheric Sciences,

(8) That the skillful prediction of high-impact weather is one of the greatest scientific and societal challenges of the twenty-first century,

Noting further:

(1) The heightened public awareness and concerns for global, regional and local climate, weather and environmental issues in general,

(2) The responsibility of WMO and relevant bodies within the United Nations system to provide the authoritative scientific information on the state of weather, climate, water resources and the environment,

(3) The responsibility of WMO and relevant bodies within the United Nations system to provide the authoritative scientific voice on the state and behaviour of the atmosphere, weather and climate of the planet, and the role of National Meteorological and Hydrological Services (NMHSs) in forecasting events with high societal and economic impacts,

(4) The increasing demand by numerical weather prediction (NWP) research and operations for support in adding aerosols, ozone and other atmospheric compounds to improve forecasting accuracy as well as enhance products and services,

(5) The increasing need to move towards environmental predictions, using as a core driver the traditional NWP systems, coupled with other modelling subsystems, with a consideration of the socioeconomic impacts, as distinct from strictly traditional weather-only predictions,

(6) The important role of NMHSs with respect to integrated observations via their extensive monitoring system infrastructures and specific scientific expertise in areas such as numerical modelling with four-dimensional and coupled data assimilation techniques and real-time data delivery,

(7) The need for more and more accurate environmental forecasts from global to regional and local scales to provide actionable information to decision-makers and citizens,

(8) The international role of WMO in environmental issues that are becoming more extensive, multidisciplinary and complex,

Decides that the main substance of the World Weather Research Programme, and in particular the three major projects (polar prediction, sub-seasonal to seasonal prediction, and high-impact weather), shall be as indicated in the WMO Strategic Plan 2016–2019 and in the WMO Operating Plan;

Requests Members:

(1) To provide all possible support to the implementation of the WWRP, including voluntary contributions to the Trust Funds of the three major projects;

(2) To pursue coordination regarding the Programme with other relevant technical commissions, the Global Framework for Climate Services (GFCS) and activities through the Commission for Atmospheric Sciences Open Programme Area Group on the WWRP;

(3) To stimulate and coordinate socioeconomic research and development activities and studies to increase the value of environmental prediction outputs for the benefit of Members;

(4) To arrange for the provision of assistance and advice with respect to the Education and Training Programme, including an Earth system interdisciplinary summer school programme;

(5) To cooperate on more rapid data exchange and management in support of research activities and applications, including improvement and verifications of environmental prediction systems, assimilation methods in NWP and coupled systems, and process studies;

(6) To contribute to research efforts so that the understanding of the physical, chemical, dynamical, radiative, biospheric and human factors controlling predictability of the Earth system from minutes to sub-seasonal timescale can be improved;

Requests the president of the Commission for Atmospheric Sciences to arrange for the development and implementation of WMO activities in the WWRP, including the three major projects, through appropriate partnerships and towards the achievement of the 10-year goals;

Requests the regional associations:

(1) To encourage Members to participate in and contribute to WWRP activities in the Regions;

(2) To stimulate Members to support research and development projects and forecast demonstration projects and related training activities, and to facilitate modelling and observational data exchange;

Requests the Executive Council:

(1) To take all necessary actions, including specific actions on sub-seasonal to seasonal forecasts, polar research and the high-impact weather towards the fullest possible implementation of the WWRP, in accordance with the WMO Strategic Plan;

(2) To support the work of the Commission for Atmospheric Sciences, and other bodies concerned, in the further development of the WWRP;

(3) To continue its oversight role in new areas of collaborative research across programmes and commissions through an appropriate mechanism;

Requests the Secretary-General:

(1) To take all necessary actions, including specific actions on sub-seasonal to seasonal forecasts, high-impact weather and polar research, within available budgetary resources, for the implementation of the Programme;

(2) To assist Members participating in the Programme, particularly developing countries, by facilitating the training and exchange of scientists, and the provision of advice, guidance and services, as required, within available budgetary resources;

(3) To take all necessary actions to develop and maintain the collaboration between WMO, through the WWRP, and other agencies, groups and institutions, which can contribute to the further development and implementation of WWRP projects, and to seek further support from such agencies and other national and international institutions and from Members.

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Note: This resolution replaces Resolution 11 (Cg-XVI), which is no longer in force.

Resolution 46 (Cg-17)

INTEGRATED GLOBAL GREENHOUSE GAS INFORMATION SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The *Abridged Final Report with Resolutions and Recommendations of the Sixteenth Session of the Commission for Atmospheric Sciences* (WMO-No. 1128),

(2) That the Global Framework for Climate Services is one of the priorities of WMO,

(3) The United Nations Framework Convention on Climate Change (UNFCCC),

Noting further:

(1) That the Intergovernmental Panel on Climate Change in its Fifth Assessment Report recognized emissions of greenhouse gases as the major driver of climate change,

(2) The responsibility of WMO and other relevant bodies within the United Nations system to provide the authoritative scientific information on the state of weather, climate, water resources and the environment,

(3) That the Global Atmosphere Watch (GAW) Programme coordinates observations and analysis of greenhouse gases in the atmosphere globally,

(4) That greenhouse gases, aerosols and ozone are designated Essential Climate Variables established by the Global Climate Observing System (GCOS) in support of the UNFCCC and that the GAW global carbon dioxide, methane and nitrous oxide monitoring networks are recognized by GCOS as comprehensive (and a subset as baseline) GCOS networks,

(5) That there is a growing need for actionable information to understand and manage greenhouse gas budgets on enhanced temporal and spatial scales and that the Integrated Global Greenhouse Gas Information System (IG^3IS) would address this need,

Requests Members:

(1) To give all possible support to the development, improvement and modernization of networks for observations of greenhouse gases and co-emitted species;

(2) To carry out greenhouse gas observations in accordance with GAW quality assurance principles;

(3) To ensure submission of observational data as well as metadata to the dedicated WMO/GAW Data Centre as well as the GAW Station Information System within the period of time required to support IG^3IS, as will be documented in the specification of requirements through the WMO Integrated Global Observing System and its Observing Systems Capability Analysis and Review Tool/Requirements catalogue;

(4) To cooperate on development of modelling tools for inverse modelling and anthropogenic greenhouse gas flux attribution;

(5) To collaborate with organizations and institutions that address the carbon budget of biosphere and ocean;

Requests the president of the Commission for Atmospheric Sciences:

(1) To encourage Members represented in the Commission to support implementation of IG^3IS;

(2) To stimulate and coordinate research and development activities and studies of carbon cycles to increase potential benefits of IG^3IS implementation for Members;

(3) To work together with other technical commissions on implementation of IG^3IS;

Requests the regional associations to implement IG^3IS on a regional scale;

Requests the Executive Council:

(1) To take, within available budgetary resources, all necessary actions towards the fullest possible implementation of IG^3IS as a tool supporting the Global Framework for Climate Services and its Implementation Plan in accordance with the WMO Strategic and Operational Plans;

(2) To support the work of the Commission for Atmospheric Sciences in the development of IG^{3}IS,

Requests the Secretary-General:

(1) To take all necessary actions, within available budgetary resources, for the implementation of IG^{3}IS;

(2) To assist Members implementing IG^{3}IS, particularly developing countries, by facilitating the training and exchange of scientists, and the provision of advice, guidance and services, as required, within available budgetary resources;

(3) To take all necessary actions to develop and maintain WMO collaboration in matters related to the carbon cycle with relevant organizations, agencies, groups and institutions, such as the Food and Agriculture Organization of the United Nations, the International Maritime Organization, the United Nations Environment Programme, the United Nations Educational, Scientific and Cultural Organization, and the Group on Earth Observations.

Resolution 47 (Cg-17)

GLOBAL ATMOSPHERE WATCH PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The *Abridged Final Report with Resolutions and Recommendations of the Sixteenth Session of the Commission for Atmospheric Sciences* (WMO-No. 1128),

(2) Resolution 10 (Cg-XVI) – Global Atmosphere Watch Programme,

(3) Resolution 15 (Cg-XV) – Stratospheric ozone observations,

(4) The WMO Strategic Plan 2016–2019,

(5) The Vienna Convention for the Protection of the Ozone Layer, the Montreal Protocol on Substances that Deplete the Ozone Layer and its subsequent amendments, the United Nations Framework Convention on Climate Change and the United Nations Economic Commission for Europe Convention on Long-Range Transboundary Air Pollution and other environment-oriented conventions,

Noting further:

(1) The heightened public awareness and concerns for global, regional and local climate, weather and environmental issues in general,

(2) The responsibility of WMO and other relevant bodies within the United Nations system to provide the authoritative scientific information on the state of weather, climate, water resources and the environment,

(3) The central role played by the atmosphere in environmental issues, such as the global increase of greenhouse gases and their impact on climate, effects of aerosols on weather, climate and human health, stratospheric ozone depletion and related increase in ultraviolet radiation, long-range pollutant transport, urban and regional air quality, and atmospheric deposition and its impact on biogeochemical cycles,

(4) The increasing demand by numerical weather prediction (NWP) research and operations for integrating aerosols, ozone and other atmospheric compounds to improve forecasting accuracy as well as enhance products and services,

(5) The development of the WMO Global Atmosphere Watch (GAW) Programme towards a science for services concept,

(6) That the focus of the GAW is primarily on greenhouse gases, ozone, ultraviolet radiation, aerosols, selected reactive gases and atmospheric deposition,

(7) The need for cross-cutting applications, including biomass burning, volcanic ash transport, sandstorms and duststorms, services for agriculture and biological systems, and urban services,

(8) The potential of National Meteorological and Hydrological Services (NMHSs) to contribute substantially to integrated observations and modelling activities, as they are well positioned through their capacities to observe, undertake research including development and application of models, operationalize, verify and validate, disseminate and reach out,

(9) That changes in air pollution, climate and the biogeochemical cycles of trace components in the atmosphere, such as carbon-containing and nitrogen-containing compounds, give rise to environmental problems that are often strongly affected by meteorological processes,

(10) That the links between air quality, climate and extreme weather events are not well quantified and need further research to underpin those links,

Requests Members:

(1) To support current observations for sufficiently long periods to allow for trend analysis, support of conventions and climatological studies and upgrade the elements of the observing system that are out of date;

(2) To provide all possible support to the further development of the observational component of GAW as a contribution to the WMO Integrated Global Observing System especially in data-sparse regions and to support application areas that require atmospheric composition observations utilizing ground-based and satellite platforms, including implementation of multi-component measurements;

(3) To carry out observations in accordance with the GAW quality assurance principles;

(4) To ensure submission of observational data and metadata to dedicated WMO/GAW Data Centres and GAW Station Information System within the agreed period of time as specified in the GAW Implementation Plan to support WMO publications, bulletins and assessments;

(5) To progressively implement near-real-time data exchange in support of selected applications, including verification of atmospheric composition forecasts, satellite observations, assimilation in NWP and process studies;

(6) To contribute research efforts for improved understanding of physical, chemical, dynamical, radiative, biospheric and human factors controlling variability of atmospheric composition;

(7) To undertake modelling studies of atmospheric composition past and future changes in relation to changing meteorology and emissions and taking into consideration feedbacks in the Earth system;

(8) To provide all possible support to the implementation of GAW Urban Research Meteorology and Environment (GURME) pilot projects as research contributions towards integrated urban services;

(9) To contribute to trust funds related to GAW activities;

(10) To support training activities related to atmospheric composition;

Requests the president of the Commission for Atmospheric Sciences (CAS):

(1) To encourage Members represented in the Commission to participate in and contribute to GAW and to trust funds related to its activities;

(2) To encourage and coordinate research and development activities and studies to increase the value of environmental prediction for the benefit of Members;

(3) To support the work of the CAS Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee;

(4) To work closely with the other technical commissions on issues of joint interest;

Requests the regional associations:

(1) To encourage Members to participate in and contribute to GAW activities in the Regions;

(2) To encourage Members to support calibration and training facilities related to atmospheric composition in the Regions;

(3) To support regional GURME activities;

Requests the Executive Council:

(1) To take, within available budgetary resources, all necessary actions towards the fullest possible implementation of GAW, in accordance with the WMO Strategic and Operational Plans;

(2) To support the work of the Commission for Atmospheric Sciences and other bodies concerned in the development of GAW and joint GAW-related cross-cutting activities.

Requests the Secretary-General:

(1) To take all necessary actions, within available budgetary resources, for the implementation of the GAW Programme;

(2) To support cross-cutting modelling activities within GAW and joint activities with other research programmes and to assist developing countries in building their capabilities to participate in these activities;

(3) To assist Members to participate in GAW, particularly developing countries, by facilitating the training and exchange of scientists, and the provision of guidance and services, as required, within available budgetary resources;

(4) To take all necessary actions to develop and maintain WMO collaboration in matters of atmospheric composition and related physical parameters through GAW with relevant organizations, agencies, groups and institutions, such as the Food and Agriculture Organization of the United Nations, the International Maritime Organization, the United Nations Environment Programme, the United Nations Educational, Scientific and Cultural Organization, the World Health Organization, the European Union, the Group on Earth Observations and the International Council for Science.

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Note: This resolution replaces Resolution 10 (Cg-XVI), which is no longer in force.

Resolution 48 (Cg-17)

GLOBAL INTEGRATED POLAR PREDICTION SYSTEM

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 57 (Cg-XVI) – Global Integrated Polar Prediction System,

(2) Resolution 17 (EC-64) – Polar Prediction Project,

Considering:

(1) The multiple manifestations of climate change at higher latitudes as well as their important implications for regions in lower latitudes, and the importance of better understanding of weather, climate, water and related environmental variability and change for improvement of polar predictions on all weather and climate timescales,

(2) The increased economic and transportation activities in polar regions and the associated long-term requirement for sustained integrated observations, environmental predictions, and climate and hydrological information to support decision-making,

(3) That there remain key gaps for improved polar prediction:

   (a) Scientific understanding of processes and interactions in polar regions, including stable boundary layers, polar clouds and precipitation, sea ice/ocean dynamics, hydrology, permafrost and ice sheet dynamics,

   (b) Scientific understanding of the linkages between weather, climate and ice changes in polar regions and lower latitudes,

   (c) Sustaining and optimizing in situ and satellite observations in polar regions, including reference observations,

   (d) Improved forecasting systems in polar regions, including enhanced (coupled) models, data assimilation as well as ensemble prediction systems,

   (e) Relevant products and services for polar regions,

(4) The global benefits of a Global Integrated Polar Prediction System (GIPPS), enabling not only service delivery and observing strategies in polar regions, but also addressing key uncertainties in the data and information on polar weather, climate, water and related environmental variability and change, thereby improving global prediction, contributing to all WMO strategic priorities, in particular disaster risk reduction, and to the Global Framework for Climate Services,

(5) That GIPPS cannot be accomplished by WMO alone, and will require a collaborative research and development component involving the World Weather Research Programme (WWRP) and the World Climate Research Programme (WCRP), as well as other WMO Programmes and external partners, and subsequent efforts to organize and deliver services for societal benefits,

Acknowledging in particular the contributions of the national operational and research programmes of Members to monitoring and real-time data provision, process studies, and current prediction systems tailored to the polar regions,

Decides:

(1) That the research in support of GIPPS will be carried out through coordinated activities under the WWRP Polar Prediction Project (PPP, timescales of hours to seasons) and the WCRP Polar Climate Predictability Initiative (PCPI, timescales of seasons to decades);

(2) To continue the decadal endeavor towards GIPPS, as an International Polar Year legacy to benefit the global community;

(3) That GIPPS should provide information to meet user needs and for decision-making especially related to high-impact and severe weather and climatic extremes, on timescales from hours to centuries;

Requests the Executive Council:

(1) To provide broad oversight, guidance and monitoring of progress of GIPPS development;

(2) To ensure there is broad consultation with and participation of other international organizations and agencies that wish to contribute to the development of GIPPS;

(3) To submit a comprehensive report updating GIPPS progress to the Eighteenth World Meteorological Congress;

Requests the technical commissions and the regional associations to support the work of the Executive Council through the coordinated international research, development and implementation of GIPPS and to advise on possible future governance structures;

Invites relevant national bodies and international organizations, such as the International Council for Science, research programmes conducted under the aegis of the Scientific Committee on Antarctic Research, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, the International Arctic Science Committee, the International Association of Cryospheric Sciences, and other relevant associations of the International Union of Geodesy and Geophysics and WMO co-sponsored and WMO-led Programmes such as WCRP and the Global Climate Observing System, to join in the multi-year endeavour towards an operational GIPPS;

Requests Members:

(1) To support efforts to address the key gaps in scientific understanding of the Earth system and environmental processes and interactions in polar regions;

(2) To promote and establish national and international research programmes towards this endeavour;

(3) To provide adequate voluntary resources to support development of GIPPS, including contributions to relevant trust funds;

Requests the Secretary-General:

(1) Within available budgetary resources, to support the development of GIPPS;

(2) To strengthen coordination and collaborate closely with relevant international partner organizations and programmes in pursuing this endeavour;

(3) To take any further actions necessary to implement these decisions;

(4) To bring the present resolution to the attention of all concerned.

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Note: This resolution replaces Resolution 57 (Cg-XVI), which is no longer in force.

Resolution 49 (Cg-17)

YEAR OF POLAR PREDICTION

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 48 (Cg-17) – Global Integrated Polar Prediction System,

(2) Resolution 58 (Cg-XVI) – WMO polar activities,

(3) Resolution 59 (Cg-XVI) – International Polar Decade Initiative,

(4) Resolution 17 (EC-64) – Polar Prediction Project,

Considering:

(1) That the concerns about amplification of climate change at higher latitudes, combined with an increasing interest of many governments in polar regions, call for a much better understanding of weather, climate, water resources and related environmental variability and change, in order to improve the ability to reliably monitor and quantitatively predict weather and climate from the immediate term out to seasons, decades and centuries ahead,

(2) The increased economic and transportation activities in polar regions, the life and livelihoods of communities, and the associated long-term requirement for sustained integrated observational and predictive environmental, climate and hydrological information to support wide-ranging decision-making,

(3) That there are key gaps in understanding, monitoring and forecasting environmental processes in polar regions, which would be clearly identified and evaluated through a focused period of intensified observations and numerical modelling experimentation,

(4) The global benefits of a Global Integrated Polar Prediction System (GIPPS), addressing key uncertainties in weather, climate, water resources and related environmental variability and change, and improving global prediction, contributing to all WMO strategic priorities, in particular disaster risk reduction, and to the Global Framework for Climate Services,

(5) That GIPPS cannot be accomplished by WMO alone, and will require collaborative research and development involving the World Weather Research Programme and the World Climate Research Programme (WCRP), other WMO Programmes and external partners,

Acknowledging in particular the contributions of the national operational and research programmes of Members to monitoring and real-time data provision, process studies, and current prediction systems tailored to the polar regions,

Decides that WMO should support a period of intensive observing, numerical modelling simulations, verification, user-engagement and education activities through the Year of Polar Prediction (YOPP), planned from -2017, and a subsequent research consolidation phase in order to enable a significant improvement in environmental prediction capabilities for polar regions and beyond;

Requests relevant technical commissions and regional associations to support the coordinated international research, development and implementation of YOPP;

Invites relevant national bodies and international organizations, such as the International Council for Science, research programmes conducted under the aegis of the Scientific Committee on Antarctic Research, the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization, the International Arctic Science Committee, the International Association of Cryospheric Sciences, and other relevant associations of the International Union of Geodesy and Geophysics and WMO co-sponsored and WMO-led programmes such as WCRP and the Global Climate Observing System, to join the YOPP activities;

Requests Members:

(1) To support the improvement of the existing conventional observing systems over and near the polar regions, by increasing the frequency of routine synoptic and radiosonde observations during certain intensive observing periods during YOPP;

(2) To provide logistical support to planned field campaign activities;

(3) To promote possible additional observations;

(4) To provide access to remote-sensing observations over and near the polar regions;

(5) To support and participate in YOPP activities including numerical modelling simulations, verification, user-engagement and education;

(6) To provide adequate voluntary resources to support the development and implementation of YOPP, including contributions to the Polar Prediction Trust Fund;

Requests the Secretary-General:

(1) Within available budgetary resources, to support the development and implementation of YOPP;

(2) To strengthen coordination and collaborate closely with relevant international partner organizations and programmes in pursuing this endeavour;

(3) To take any further actions necessary to implement these decisions;

(4) To bring the present resolution to the attention of all concerned.

Resolution 50 (Cg-17)

CAPACITY DEVELOPMENT PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 33 (Cg-VIII) – Coordination of technical cooperation at the national and regional levels,

(2) Resolution 36 (Cg-VIII) – Technical cooperation among developing countries in the field of meteorology and operational hydrology,

(3) Resolution 30 (Cg-XI) – Development of National Meteorological and Hydrological Services,

(4) Resolution 30 (Cg-XVI) – Voluntary Cooperation Programme,

(5) Resolution 31 (Cg-XVI) – Education and Training Programme,

(6) Resolution 33 (Cg-XVI) – WMO Programme for the Least Developed Countries,

(7) Resolution 34 (Cg-XVI) – WMO Regional Programme,

(8) Resolution 49 (Cg-XVI) – WMO Strategy for Capacity Development,

(9) Resolution 69 (Cg-17) – WMO Strategic Plan 2016–2019,

(10) Resolution 54 (Cg-17) – Programme for WMO Small Island Developing States and Member Island Territories,

Recalling:

(1) The WMO Strategic Plan 2016–2019, which calls for enhancing capabilities of Members and their National Meteorological and Hydrological Services (NMHSs) and strengthening partnerships, cooperation and good governance,

(2) That the bodies associated with implementing capacity development activities within WMO should be oriented to direct and support the WMO Strategic Plan in a holistic and sustainable manner rather than by way of a number of uncoordinated, one-off activities,

(3) That the adoption of the WMO Strategy for Capacity Development by the Executive Council in Resolution 18 (EC-64) – WMO Capacity Development Strategy, and its associated Implementation Plan in Resolution 16 (EC-65) – Implementation Plan of the WMO Strategy for Capacity Development, incorporated the Technical Cooperation Programme mechanisms along with other mechanisms into a cross-cutting approach that included the efforts of all WMO bodies and partners,

Considering:

(1) The need for collective and coordinated activities across all WMO Programmes, especially the Programme for Least Developed Countries, Small Island Developing States and Member Island Territories, the Education and Training Programme, the Voluntary Cooperation Programme, and the WMO Regional Programme being more directly related to the implementation of Expected Result 6 – Strengthened Capacity Development of the WMO Strategic and Operating Plans throughout the seventeenth financial period (2016–2019),

(2) The importance of resource mobilization and development partnership efforts to strengthen the capacity of NMHSs enabling them to provide services for the benefit of Members and to meet their international obligations,

(3) The need to incorporate into capacity development programmes further emphasis on NMHS compliance with the WMO Technical Regulations, knowledge-based gap analysis, national strategic planning, regional political support, development partnerships, advocacy, project assistance, focused fellowships and training in priority areas, the management and modernization of NMHSs, and increased involvement of developing countries in WMO research,

Decides to establish a Capacity Development Programme, as described in the annex to the present resolution;

Urges Members to implement the strategic approaches to capacity development corresponding to the six Strategic Objectives of the WMO Strategy for Capacity Development with a view to effective, efficient and sustainable development of their NMHSs as a critical component of national development;

Requests the Executive Council:

(1) To establish the mechanism to oversee and review progress of the Capacity Development Programme in addressing the priorities of WMO and the Strategic Objectives of the WMO Strategy for Capacity Development during the intersessional period;

(2) To provide a report to the Eighteenth World Meteorological Congress on progress made;

Requests the presidents of regional associations to undertake coordinated actions aimed at developing regional support for the Capacity Development Programme and the development of NMHSs;

Requests the presidents of technical commissions to provide advice relating to the needs of Members in support of the capacity development of NMHSs, especially in their compliance with WMO Regulations and recommended practices;

Requests the Secretary-General to administer the Capacity Development Programme and to provide resources for its activities within the approved budget and as may be available through extrabudgetary funding.

Annex to Resolution 50 (Cg-17)

CAPACITY DEVELOPMENT PROGRAMME

Purpose and scope

1. The purpose of the Capacity Development Programme is to ensure, through collaborative efforts of Members and for their mutual benefit, the enhancement and development of the capabilities of NMHSs, so that they can contribute to, and participate effectively and efficiently in, the implementation of WMO Programmes, for the benefit of the global community and in support of national sustainable development. Therefore, the Programme makes a major contribution to the implementation, through the WMO Programmes, of all WMO strategies and their associated expected results.

2. The Programme helps to ensure that NMHSs have the required technical infrastructure, legal and institutional framework, staff competencies, as well as financial, political, regional and other resources. In view of the changing world economic situation, and noting the changing pattern of capacity development globally, WMO must explore new sources of funding and innovative approaches for its capacity development activities. WMO Member countries, and in particular their NMHSs, will receive advice and assistance from the Programme on the potential sources of funding for capacity development activities, and on how they can be tapped.

3. The Programme assists in the analysis of global, national and regional needs coupled with the WMO Capacity Development Strategy which provides a basis for developing priorities in Capacity Development Programmes managed by WMO. These programmes are to contribute effectively to development activities through:

(a) Achieving suitable levels of meteorological and hydrological services in Member countries;

(b) Creating the required component of the infrastructure for sustainable development;

(c) Realizing the collective goals of the agreed WMO Programmes.

The Programme will allow Members and partners to meet the most important needs, to identify and obtain support for capacity development projects and programmes that will yield maximum benefits, and assist WMO, including the Secretariat, in assigning priorities in its activities.

Overall objectives

4. In close collaboration with the WMO Regional Programme and WMO scientific and technical programmes, the overall objectives of the Programme are to implement the Capacity Development Strategy by assisting Members:

(a) To identify the services required of NMHSs as well as the human, infrastructural, institutional/legal and procedural gaps, which limit a Member's ability to deliver these services;

(b) To identify gaps that may exist in a Members compliance with WMO Technical Regulations with a view to using this information to further development and enhancement of their NMHSs towards compliance;

(c) To formulate strategic plans and appropriate project/programme proposals for NMHSs to meet domestic and international obligations and to seek appropriate national and regional political support for their implementation;

(d) To gather and exchange information on the needs of potential recipient Members and on the possibilities offered by Members and other potential development partners and institutions, as well as in the mobilization of the required national and international resources;

(e) To develop and implement regional and national capacity development projects and programmes, to enhance services to Members derived from meteorology, hydrology, climatology, and other environmental sciences, as required;

(f) With the support necessary to ensure that relevant scientific and technical aspects of projects and national development activities are in line with the established WMO Standards, Guidelines and Recommended Practices;

(g) To develop the capacities of their NMHSs and of relevant national and regional institutions by advocating for external and internal support as may be necessary to meet national requirements for services, national development activities and to comply with WMO standards;

(h) By promoting international cooperation in capacity development of NMHSs and related institutions to ensure that Members have the pertinent capacity and resources needed, particularly to bridge the gap between the levels of relevant services provided;

(i) Through the establishment of dynamic and synergistic partnerships with development partners and regional and international organizations, such as those within the United Nations system, that the relevant meteorological, hydrological and environmental aspects of projects derived from these partnerships are developed and implemented according to the recognized standards and guidelines;

(j) To build the technical, strategic, operational and managerial skills of NMHS staff, including skills for the mobilization of resources, as critical aspects for ensuring sustainable development of the NMHS and related services.

Capacity Development Programme governance

5. The governance for the Programme is provided by the Executive Council (EC).

Programme structure

6. The Programme will be structured, planned and implemented on a national, regional and global basis. Activities will be supported from a range of sources including regular and extrabudgetary resources as well as in-kind contributions of WMO Members and other development partners. The Programme will support other WMO Programmes in the implementation of priority activities and will require collaboration of all WMO bodies and Programmes. The Programme will include as core components:

(a) Education and Training Programme;

(b) Programme for the Least Developed Countries;

(c) Programme for WMO SIDS and Member Island Territories;

(d) Regional Programme;

(e) WMO Voluntary Cooperation Programme;

(f) Resource mobilization and development partnership activities.

Resolution 51 (Cg-17)

EDUCATION AND TRAINING PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting Resolution 31 (Cg-XVI) – Education and Training Programme,

Considering:

(1) That education and training in meteorology, hydrology, climatology and related disciplines is a major cross-cutting activity of WMO that has made, and has the potential to continue to make, positive impacts on the products and services provided by National Meteorological and Hydrological Services (NMHSs),

(2) That high-quality, initial and ongoing education and training of staff are critical to ensuring the required effectiveness of NMHSs and thus fundamental to the successful implementation of the various WMO Programmes,

(3) That each of the high-priority areas identified in the WMO Strategic Plan 2016–2019 has elements related to education and training,

(4) That the need for specialists in the application of meteorology, climatology and hydrology in support of the United Nations sustainable development goals and social and economic progress remains acute in many developing countries, particularly in the least developed countries and small island developing States,

(5) That the Education and Training Programme (ETRP) is a component of the WMO Capacity Development Strategy that assists NMHSs in their human resources development with due attention to their development status and to gender equity,

Noting that whilst WMO Regional Training Centres (RTCs) are the backbone of the institutions providing education and training for Members, many other WMO recognized centres such as Regional Climate Centres (RCCs), Global Information System Centres (GISCs), Regional Instrument Centres (RICs) and the WMO-Coordination Group for Meteorological Satellites (CGMS) Virtual Laboratory for Education and Training in Satellite Meteorology (VLab) all provide specialist education and training to Members,

Decides:

(1) That the major thrust of the Education and Training Programme should continue to be directed towards assisting the NMHSs of Members to develop competent and qualified staff by ensuring the availability of quality-assured education and training opportunities to enable them to effectively meet their relevant national, regional and international obligations and challenges;

(2) That the main strategy of the Programme to achieve this goal is to collaborate with national and international partners, WMO-RTCs, training institutions, schools, universities, media, and public and private sectors in order to assist NMHSs to meet their education and training needs using traditional and distance-learning methods in the most cost-effective manner;

(3) That special emphasis should be placed on promoting and supporting the exchange and sharing of training publications and resources, training approaches and expertise between Members;

(4) That the Programme should contribute to the WMO Strategy for Service Delivery, the WMO Capacity Development Strategy and the Global Framework for Climate Services;

Urges Members:

(1) To collaborate in, and give all possible support to, the implementation of the WMO education and training activities, in particular by sharing national education and training opportunities and resources with other Members;

(2) To strengthen their national capacity in the attainment of self-sufficiency in meeting their education and training needs and be gender-sensitive in developing and delivering their human resources programmes, including through enhanced application of distance learning;

(3) To make maximum use of the training opportunities offered by the WMO-RTCs for the training of personnel and to support those centres to become more efficient and focused on meeting regional education and training needs and the needs of other Regions under request;

(4) To ensure that their recruitment and continuous professional development activities take into account the qualification and competency requirements outlined in the *Technical Regulations* (WMO-No. 49), Volume I;

Urges Members hosting WMO Centres such as RCCs, GISCs, RICs and the component institutions of the WMO-CGMS VLab to continue their contribution and support for education and training of Members in line with the goals and objectives of the ETRP;

Invites the presidents of regional associations and technical commissions:

(1) To regularly review the education and training needs within their Regions or commissions including needs assessment and training requirements, peer-review monitoring and evaluation, with the aim of prioritizing regional and specialized training needs of Members;

(2) To ensure that RTCs have a regional outlook, particularly in the selection and delivery of meteorological, climatological and hydrological courses;

(3) To improve coordination of ongoing activities within and between Regions and within relevant subject areas;

(4) To encourage and support dialogues between WMO-RTCs, the countries hosting WMO-RTCs and their respective regional associations as required, under the revised Executive Council criteria for the recognition and reconfirmation of WMO RTCs, with the objective to further develop those centres within the context of addressing the needs of Members in the WMO high-priority areas;

Requests the technical commissions to give high priority to the development and review of competence standards and requirements within the area of responsibility of each of the commissions, in conjunction with the ETRP, with the aim of ensuring that the service needs of Members continue to be linked with the technical standards, requirements and recommendations of the commissions through education and training;

Requests the Executive Council:

(1) To take all necessary actions to enable the Education and Training Programme to meet its objectives under the WMO Strategic Plan 2016–2019 and beyond;

(2) To give high priority to ensuring effective overall coordination and leadership of the Programme and ensure that WMO standards are maintained;

(3) To continue to draw fully on the advice and assistance of experts in meteorological, climatological and hydrological education and training in the further development of the Programme;

(4) To further elaborate on the proposal to undertake a feasibility study into the WMO Global Campus involving a consortium of RTCs, NMHSs and other institutions developing and delivering courses to assist Members in meeting their education and training requirements, particularly the consideration of strengthening the ability of RTCs to contribute to and benefit from the WMO Global Campus;

(5) To continue to develop, supported by the Programme, more detailed guidance on competency assessment to assist Members to adapt, implement and assess the competence standards and requirements in a consistent manner;

Requests the Secretary-General:

(1) To support education and training activities as one of the top WMO priority areas;

(2) To continue to collaborate closely with Members and facilitate collaboration between Members to ensure the effective implementation of the WMO education and training activities;

(3) To continue to provide assistance and advice on the education and training, and qualification and competence requirements, of NMHS staff, as well as on the training tools, materials and methodologies suitable for use by WMO-RTCs and national training institutions of NMHSs, particularly those from developing countries;

(4) To maintain close liaison with the Standing Conference of Heads of Training Institutions in all areas of interest to education and training development and delivery, particularly with respect to the effective use of distance-learning technologies;

(5) To support the promotion of varied training solutions and methods in education and training through the provision of the necessary resources for their implementation and further development of the WMO Global Campus feasibility study;

(6) To support the requests of Members for education and training assistance in meteorology and hydrology, including through multilateral arrangements;

(7) To undertake active mobilization of extrabudgetary resources so as to meet the growing demand for education and training fellowships.

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Note: This resolution replaces Resolution 31 (Cg-XVI), which is no longer in force.

Resolution 52 (Cg-17)

RECOGNITION AND RECONFIRMATION OF WMO REGIONAL TRAINING CENTRES

THE WORLD METEOROLOGICAL CONGRESS,

Noting that WMO Regional Training Centres (RTCs) are essential partners in the delivery of WMO education and training activities (Resolution 51 (Cg-17) – Education and Training Programme),

Noting further:

(1) The revised Executive Council criteria for the recognition and reconfirmation of RTCs, as adopted by the Executive Council at its sixty-sixth session in Resolution 15 (EC-66) – Executive Council Criteria for the recognition and reconfirmation of WMO Regional Training Centres,

(2) The outcome of the reviews by experts of the Executive Council on the recognition of a new RTC in the Republic of Korea, reconfiguration of the RTC in Brazil, recommendation for a new component to the RTC in India and reconfirmation of the RTC in Niger,

Recalling:

(1) That the Executive Council at its sixty-fourth session had limited the reconfirmation of RTCs reviewed during the period 2012–2015 to 31 December 2015 to allow for any changes in the RTC review, recognition and reconfirmation processes,

(2) That the recommendations from the review into the future roles and operations of RTCs were approved by the Executive Council at its sixty-sixth session and that the reconfirmation of RTCs was now tied to a four-year cycle based upon the cycle of regional association sessions,

(3) That the reconfirmation of existing RTCs could not occur until at least the Executive Council session following each regional association session,

Decides:

(1) To extend the reconfirmation of the RTCs in China, India and Uzbekistan to 31 December 2017, the RTCs in Indonesia, Israel, the Russian Federation and Turkey to 31 December 2018 and the RTC in Kenya to 31 December 2019;

(2) To recognize the Korean Meteorological Administration training centre as a Regional Association II (Asia) RTC hosted in the Republic of Korea;

(3) To replace the Federal University of Para–UFPA in Belem as the sole component of the RTC in Brazil with a consortium of university and training institutes, including the Federal University of Para–UFPA, known as CVEM (Virtual Training Centre) as a Regional Association III (South America) RTC with support for Spanish-speaking countries in Regional Associations III and IV (North America, Central America and the Caribbean) and Portuguese-speaking countries outside of Regional Association III;

(4) To recognize the Department of Hydrology of the Indian Institute of Technology-Roorkee as a fourth component of the Regional Association II RTC hosted in India;

(5) To reconfirm the African School of Meteorology and Civil Aviation and the Regional Training Centre for Agrometeorology and Operational Hydrology and their Applications as the two components of the Regional Association I (Africa) RTC hosted in Niger;

Requests Regional Associations I, II and III to coordinate with and support the RTCs in their Regions in accordance with the roles and responsibilities for regional associations defined in the Executive Council Criteria for recognition and reconfirmation of RTCs in Resolution 15 (EC-66);

Requests the Permanent Representatives of the RTC host countries to coordinate with and support the RTCs in their countries in accordance with the roles and responsibilities for host countries defined in the Executive Council Criteria;

Requests the Directors of the RTCs/RTC components to undertake their roles and responsibilities defined in the EC Criteria;

Requests the Secretary-General to support and promote these RTCs/RTC components within the resources available for RTC support.

Resolution 53 (Cg-17)

WMO GLOBAL CAMPUS FEASIBILITY STUDY

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 16 (EC-66) – Feasibility study for establishing a WMO Global Campus,

(2) Resolution 51 (Cg-17) – Education and Training Programme,

Recognizing:

(1) That the WMO Global Campus proposal is about improving the coordination, communication and collaboration between WMO Regional Training Centres (RTCs) and other partners so they act as a more cohesive community to better meet the needs of Members in 2016–2019 and beyond,

(2) The key role that RTCs are expected to play in developing the WMO Global Campus and delivering courses associated with it,

(3) That RTCs alone are not able to address the increasing demand and scope for education and training and thus new partners and organizations need to be entrained into the

education and training community to work with RTCs and thus expand the resources and opportunities available to Members,

(4) That activities contributing to the feasibility study of the WMO Global Campus agreed by the Executive Council at its sixty-sixth session are already showing improvements for Member training institutions and increased access to training opportunities for Members,

(5) That the WMO Global Campus steering committee has set a target of March 2018 for the three demonstration activities designed to show Members the potential benefits of implementing the WMO Global Campus,

Decides to continue the feasibility study initially agreed by the Executive Council at its sixty-sixth session;

Requests the Executive Council to monitor and review progress of the feasibility study, including the role of RTCs and WMO-affiliated training institutes, guiding the development of a formal proposal to be considered at the Eighteenth World Meteorological Congress;

Requests Members to support the feasibility study activities and provide comments and feedback to the Secretary-General and to the Executive Council to assist in the development and monitoring of the proposal;

Requests the Secretary-General to provide support within available resources for the further development of the proposal, giving due attention to the involvement of RTCs.

Resolution 54 (Cg-17)

PROGRAMME FOR WMO SMALL ISLAND DEVELOPING STATES AND MEMBER ISLAND TERRITORIES

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The outcome of the third International Conference on Small Island Developing States: the SIDS Accelerated Modalities of Action (SAMOA) Pathway,

(2) The United Nations conferences and summits on sustainable development: the Rio Declaration on Environment and Development, Agenda 21, the Programme for the Further Implementation of Agenda 21, the Plan of Implementation of the World Summit on Sustainable Development (Johannesburg Plan of Implementation including chapter VII on the sustainable development of small island developing States) and the Johannesburg Declaration on Sustainable Development, the Programme of Action for the Sustainable Development of Small Island Developing States (Barbados Programme of Action) and the Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States, the Sendai Framework for Disaster Risk Reduction 2015–2030, the outcome document of the United Nations Conference on Sustainable Development entitled The future we want, and the United Nations post-2015 sustainable development goals,

(3) The need to assist WMO small island developing States (SIDS) and Member Island Territories in the implementation of the SAMOA Pathway,

Noting further that the SAMOA Pathway calls for concrete measures to expeditiously advance the sustainable development of SIDS, including through internationally agreed development goals, in order for them to eradicate poverty, build resilience and improve quality of life, and to expeditiously implement through genuine and durable partnerships the global effort in support of the sustainable development of SIDS through concrete, focused, forward-looking and action-oriented programmes,

Recognizing:

(1) That sea-level rise and other adverse impacts of climate change continue to pose significant risk to WMO SIDS and Member Island Territories and their efforts to achieve sustainable development and, for many, represent the gravest of threats to their survival and viability, including for some through the loss of territory,

(2) That the adverse impacts of climate change compound existing challenges in SIDS and have placed additional burdens on their national budgets and their efforts to achieve sustainable development goals,

(3) That international cooperation and partnerships of various kinds and across a wide variety of stakeholders such as the SAMOA Pathway partnerships listed in the United Nations System Implementation Matrix are critical for the implementation of the sustainable development of SIDS,

(4) That the SAMOA Pathway presents a basis for concrete, focused, forward-looking and action-oriented programmes and actions, in the agreed priority areas: sustained and sustainable, inclusive and equitable economic growth with decent work for all, climate change, sustainable energy, disaster risk reduction, oceans and seas, food security and nutrition, water and sanitation, sustainable transportation, sustainable consumption and production, management of chemicals and waste including hazardous waste, health and non-communicable diseases, gender equality and women's empowerment, social development, biodiversity, and invasive alien species,

Decides:

(1) To establish the Programme for WMO Small Island Developing States and Member Island Territories, with the long-term objectives of:

   (a) Implementing concrete, focused, forward-looking initiatives that contribute to the implementation of the SAMOA Pathway priority areas and sustainable development in the WMO SIDS and Member Island Territories;

   (b) Ensuring that the National Meteorological and Hydrological Services of WMO SIDS and Member Island Territories can contribute effectively to sustainable development programmes within their countries including through genuine and durable partnerships;

(2) To establish this Programme within the Development and Regional Activities Department of WMO;

Requests the Secretary-General to ensure that this Programme and its activities are reflected in the WMO Operating Plan 2016–2019 and are supported to the extent possible within available resources;

Requests the Executive Council to monitor the development and implementation of the Programme and to advise on the best ways to effectively and efficiently implement it;

Urges Members to support the implementation of the Programme for WMO Small Island Developing States and Member Island Territories through technical assistance, voluntary contributions and in-kind contributions.

Resolution 55 (Cg-17)

WMO REGIONAL PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 34 (Cg-XVI) – WMO Regional Programme,

(2) Resolution 1 (EC-64) – Review of the role and responsibilities of regional associations,

(3) Resolution 80 (Cg-17) – General terms of reference of regional associations,

(4) Resolution 50 (Cg-17) – Capacity Development Programme,

(5) The achievements and challenges of the Regions reported in the abridged final reports of the sessions of the six WMO regional associations held during the sixteenth financial period,

Considering:

(1) The need for collective and coordinated activities of the regional associations in the implementation of the WMO Strategic and Operating Plans throughout the seventeenth financial period (2016–2019),

(2) The improved definition of the role of the regional associations and the WMO Regional Offices in identifying regional requirements and mainstreaming the capacity development activities,

(3) The need for maintaining and broadening the liaison and cooperation with international and regional partner organizations in developing and implementing weather-, climate- and hydrology-related programmes and projects for the benefit of Members,

(4) The need for WMO to be strongly and efficiently represented at the regional and subregional levels among other international organizations as a world leader in weather, climate and hydrological matters,

(5) The need for ongoing support and advice to Members, particularly developing and least developed countries and small island developing States, aimed at enhancing the role, operations and visibility of the National Meteorological and Hydrological Services (NMHSs) based on a comprehensive understanding of their contribution to regional and subregional cooperation scenarios and to national development agendas,

Decides:

(1) That the WMO Regional Programme shall be continued;

(2) That the major thrusts of the Programme will be:

   (a) To coordinate and organize activities of Members at the regional and all levels relating to the planning, implementation and evaluation of agreed programmes, strategies and activities;

   (b) To study the needs of the NMHSs of Members with regard to their technical and institutional capacity and identify gaps impeding timely implementation of planned programmes and activities; to collaborate with Members, technical commissions and other bodies, as necessary, in resolving critical deficiencies;

(c) To promote cooperation and efficiency through the establishment of regional networks and facilities based upon identified regional needs in close coordination with the technical commissions concerned; to monitor the performance of regional networks and facilities and require corrective measures as necessary;

(d) To establish regional operating plans and other implementation plans, as necessary, addressing agreed strategic priorities from a regional perspective and ensuring the engagement of Members in focused activities aimed at achieving the Expected Results of the WMO Strategic Plan;

(e) To structure work to address regional priority areas and engage the available expertise of Members to provide guidance and assistance in accordance with the needs of the Region;

(f) To build and promote cooperation and partnership with relevant regional organizations, including the United Nations Regional Commissions, other United Nations bodies, subregional organizations, development partners, nongovernmental organizations and professional associations;

(g) To ensure visibility and recognition of WMO in the respective Regions and engagement in regional initiatives and projects related to the strategic priorities of the Organization;

Urges Members:

(1) To contribute to the maximum extent possible to the Programme during the seventeenth financial period including support to Regional Offices and WMO Offices in the Regions through secondments and other appropriate means;

(2) To continue their support to the subsidiary bodies of the regional associations based on the principle of volunteerism;

Requests the presidents of regional associations to maintain strong liaison and ensure interregional cooperation and consistency on regional priorities, programmes and projects that cross regional borders;

Requests the presidents of regional associations and the presidents of technical commissions to maintain strong liaison and undertake joint coordinated actions aimed at harmonized and synchronous implementation of various programmes and projects;

Requests the presidents of technical commissions to consider and provide advice relating to the needs of regional associations in planning and implementation of scientific and technical programme activities;

Requests the Secretary-General:

(1) To continue to administer the WMO Regional Programme and to support resources for its activities within the approved budget;

(2) To review, in consultation with the presidents of regional associations concerned, the current set-up of the WMO Regional Offices and WMO Offices in the Regions and propose measures for improving their effectiveness and efficiency, including appropriate relocations, within available resources.

Note: This resolution replaces Resolution 34 (Cg-XVI), which is no longer in force.

Resolution 56 (Cg-17)

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

THE WORLD METEOROLOGICAL CONGRESS,

Noting Resolution 28 (Cg-XVI) – Intergovernmental Panel on Climate Change,

Recognizing the key role of the Intergovernmental Panel on Climate Change (IPCC) in preparing and disseminating scientific, technical and socioeconomic assessments to underpin national and international policy formulation on the climate change issue,

Congratulates the Panel for:

(1) The highly successful completion of the IPCC Fifth Assessment Report;

(2) The completion of the Special Report entitled *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*;

(3) The ongoing work of the Task Force on National Greenhouse Gas Inventories, which continues to assess and develop greenhouse gas inventory methods and practices that are scientifically sound and relevant to all countries;

Expresses:

(1) Its sincere appreciation and gratitude to former IPCC Chairperson Mr R.K. Pachauri, to the Acting Chairperson Mr Ismail A.R. El Gizouli and to the co-chairpersons of the IPCC Working Groups and the Task Force on National Greenhouse Gas Inventories as well as IPCC Vice-Chairpersons and all members of the IPCC Bureau and of the Bureau of the Task Force on National Greenhouse Gas Inventories for their work at the Panel and for successfully guiding the activities of their respective Working Groups and Task Force during the fifth assessment cycle, and to the Secretary of the IPCC, Ms Renate Christ, for the support provided to the above;

(2) Its thanks to all the experts, and in particular those from developing countries, who have actively contributed to the writing and reviewing of IPCC reports, in particular the coordinating lead authors, lead authors and review editors;

(3) Its gratitude to governments, institutions and organizations that have generously contributed to the work of the Panel and to the joint WMO/United Nations Environment Programme (UNEP) IPCC Trust Fund;

(4) Its gratitude to the Governments of Germany, Japan, The Netherlands, Switzerland and the United States of America for hosting Technical Support Units for IPCC Working Groups, the Synthesis Report and the Task Force;

(5) Its appreciation to the United Nations Environment Programme for its continued co-sponsorship of the Panel;

Noting:

(1) That the Panel at its forty-first session has taken decisions on future work of IPCC and the structure of the IPCC Bureau,

(2) The role of WMO Members and that substantial benefits flow to National Meteorological and Hydrological Services (NMHSs) and the IPCC through the active involvement of the Services in the work of the Panel,

Recognizing that the IPCC terms of reference are comprised of decisions by the World Meteorological Congress, the United Nations Environment Assembly of UNEP and the Panel itself, and have served the Panel well in performing its activities,

Recognizing the increasing IPCC workload for the scientists and NMHSs, the need for regional assessments and the increasing communication demands,

Encourages the Panel:

(1) To continue its activities under its existing terms of reference subject to any further requests from WMO and UNEP;

(2) To continue to work closely with the United Nations Framework Convention on Climate Change and respond to the needs of the Convention for scientific, technical and socioeconomic assessments, including through assessment reports, special reports, methodology reports and technical papers;

(3) To address the above-mentioned challenges, including the increasing user demands for regional assessments;

Requests the Chairperson of IPCC to continue to report regularly on the progress of the work of the Panel to the Executive Council and the World Meteorological Congress;

Requests the Secretary-General, jointly with the Executive Director of UNEP, to maintain financial and organizational support to the extent possible for the IPCC Secretariat, and to assist with publication and dissemination of IPCC reports;

Requests the Panel to proactively encourage more active participation of NMHSs in its activities;

Further requests the Panel to clarify the roles, responsibilities and working arrangements between the IPCC Secretariat and the Technical Support Units for delivering the necessary support to the Panel, its Working Groups and Task Forces and to inform the World Meteorological Congress on these matters;

Urges Members:

(1) To actively participate in the work of the Intergovernmental Panel on Climate Change, in particular with the contribution of scientists and experts from NMHSs and from developing countries;

(2) To promote the outcomes of the activities of the Panel;

(3) To maintain, and where possible to increase, their financial support for IPCC activities through contributions to the WMO/UNEP IPCC Trust Fund;

(4) To promote accuracy of climate data for later use in different scenarios of climate change.

Note: This resolution replaces Resolution 28 (Cg-XVI), which is no longer in force.

Resolution 57 (Cg-17)

PARTICIPATION OF WMO IN THE INTERNATIONAL POLAR PARTNERSHIP INITIATIVE

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 59 (Cg-XVI) – International Polar Decade Initiative,

(2) The concept document International Polar Partnership Initiative (IPPI) prepared by the interagency Steering Group on a long-term cooperative international polar initiative,

(3) The proposal of the Executive Council at its sixty-sixth session to consider the participation of WMO in the International Polar Partnership Initiative,

Considering:

(1) The important role of the polar regions in global weather, climate and water, including extreme events, the changing carbon cycle, sea-level rise, the “Arctic amplification” of climate change and the importance of teleconnections to the rest of the globe, including the tropics,

(2) Ongoing activities in both polar regions and the particular significance of the Arctic “opening” for the global economy,

(3) The need for effective environmental stewardship in the polar regions encompassing environmental risk management, preparedness for prevention of and response to pollution, conducting search and rescue operations, and support to local populations including indigenous communities,

(4) The elevated costs of field research and observations in the polar environment that impede the development of comprehensive and sustained regional observing systems and result in the insufficient understanding of underlying processes and reduced accuracy of environmental information and skill of predictions in the polar regions,

(5) The research planning processes pursued under the auspices of several international organizations including the International Arctic Science Committee and the Scientific Committee on Antarctic Research including relevant activities under the auspices of the Future Earth initiative,

(6) Polar activities undertaken by WMO including, inter alia, the Global Integrated Polar Prediction System under the World Weather Research Programme (WWRP) Polar Prediction Project (PPP) and the World Climate Research Programme Polar Climate Predictability Initiative, the planning of the Year of Polar Prediction (2017–2019) under the WWRP-PPP, the Global Cryosphere Watch, the Antarctic Observing Network, and polar activities of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology,

(7) Multiple synergies between Arctic and Antarctic activities, research, observations and services conducted by other international partners and similar synergies between the polar, Third Pole and high-mountain regions,

(8) Substantial investments in polar scientific research and infrastructure made by many countries during the International Polar Year 2007–2008 and after, and their positive outcomes in terms of new technologies for observations and analysis and improved Earth system models,

(9) The conclusion, by the interagency Steering Group on a long-term cooperative international polar initiative, that the main polar challenges are not addressed at present as effectively as required,

Recognizing that a number of international organizations expressed their support for the IPPI proposal and concept,

Endorses the participation of WMO in the further development of the IPPI concept;

Requests the Executive Council:

(1) To define and discuss WMO representation in the development of the IPPI planning documents, with a view to ensuring alignment with the identified priorities of WMO polar and high-mountain activities;

(2) To ensure mutual benefits are derived between WMO and other IPPI participants;

(3) To coordinate participation of WMO in relevant activities that would be conducted under the auspices of IPPI;

Requests the Secretary-General to bring the present resolution to the attention of all concerned.

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Note: This resolution replaces Resolution 59 (Cg-XVI), which is no longer in force.

Resolution 58 (Cg-17)

PUBLICATIONS FOR THE SEVENTEENTH FINANCIAL PERIOD

THE WORLD METEOROLOGICAL CONGRESS,

Noting Resolution 35 (Cg-XVI) – Publications Programme for the sixteenth financial period,

Recognizing:

(1) That the free and unrestricted dissemination of WMO publications to the operational, scientific, educational and other interested institutions of Members promotes awareness and broader use of WMO standards, guides and other products,

(2) The benefits of interactive and dynamic content and different formats, such as HTML and e-publications, to be read on different mobile devices or in printed form,

(3) That WMO constituent bodies, in consultation with the relevant Members, can identify publications that should be translated in all WMO official languages,

Decides:

(1) That the management of the Publications Programme, notably the presentation and method of reproduction of publications and the most economical use of the available publication funds, including the revenue from sales of publications, shall be the responsibility of the Secretary-General within the framework established by the World Meteorological Congress and taking into account the guidance given by the Executive Council;

(2) That additional publications may be produced during the seventeenth financial period given the availability of the necessary funding;

Adopts the list of WMO publications proposed by the Executive Council, technical commissions, regional associations and the Secretariat to be produced during the seventeenth financial period and identified in the regular budget proposal, as provided in the annex to the present resolution;

Requests the Executive Council:

(1) To continue to review regularly the status of the Publications Programme, taking into account the funds and facilities available, and to review the ongoing needs resulting from the introduction of new technologies and the expanding availability of alternatives to printed material;

(2) To consider any proposals for improved services and enhanced cost-efficiency, and to provide guidance on the best way to ensure the flow of information to Members and others through the Publications Programme;

Requests the Secretary-General to provide the Executive Council with the appropriate mechanism and resources for the regular review of the Publications Programme, and to allocate funding within the available budget for the further development of electronic publishing.

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Note: This resolution replaces Resolution 35 (Cg-XVI), which remains in force only until 31 December 2015.

Annex to Resolution 58 (Cg-17)

WMO PUBLICATIONS FOR PRODUCTION DURING THE SEVENTEENTH FINANCIAL PERIOD AND PROVIDED FOR IN THE REGULAR BUDGET

Publication	Number	Languages	Responsibility
1. Governance and technical publications			
Basic documents	WMO-No. 15	A, C, E, F, R, S	CER
Abridged reports with resolutions of Congress		A, C, E, F, R, S	ASGO
Abridged reports with resolutions of the Executive Council		A, C, E, F, R, S	ASGO
Abridged reports with resolutions and recommendations of the regional associations		Same as for session documentation	DRA
Abridged reports with resolutions and recommendations of the technical commissions		A, C, E, F, R, S	Technical departments
Abridged reports with resolutions of the Intergovernmental Board on Climate Services		A, C, E, F, R, S	
Abridged reports with resolutions of the Management Committee of IBCS		E	GFCS Office
Resolutions of Congress and the Executive Council	WMO-No. 508	E	CER
WMO Strategic Plan 2016–2019		A, C, E, F, R, S	SPO

Publication	Number	Languages	Responsibility
WMO Operating Plan 2016–2019		A, C, E, F, R, S	SPO
Technical Regulations, Volume I	WMO-No. 49	A, C, E, F, R, S	Technical commissions, technical departments
Technical Regulations, Volume II	WMO-No. 49	A, C, E, F, R, S	CAeM, WDS
Technical Regulations, Volume III	WMO-No. 49	A, C, E, F, R, S	CHy, CLW
Technical Regulations, Annexes: Annex I – *International Cloud Atlas*, Volume I – *Manual on the Observation of Clouds and Other Meteors*	WMO -No. 407	E	CIMO, OBS
Annex II – *Manual on Codes*, Volume I.1 (Part A – Alphanumeric Codes); Volume I.2 (Part B – Binary Codes, Part C – Common Features to Binary and Alphanumeric Codes), Volume I.3 (Part D – Representations derived from data models)	WMO-No. 306	E, F, R, S	CBS, OBS
Annex III – *Manual on the Global Telecommunication System*, Volume I	WMO-No. 386	E, F, R, S	CBS, OBS
Annex IV – *Manual on the Global Data-processing and Forecasting System*	WMO-No. 485	E, F, R, S	CBS, OBS
Annex V – *Manual on the Global Observing System*, Volume I	WMO-No. 544	E, F, R, S	CBS, OBS
Annex VI – *Manual on Marine Meteorological Services*, Volume I	WMO-No. 558	E, F, R, S	JCOMM, OBS and WDS
Annex VII – *Manual on the WMO Information System*	WMO-No. 1060	A, C, E, F, R, S	CBS, OBS
Manual on the WMO Integrated Global Observing System		A, C, E, F, R, S	CBS, OBS
Manual on Water Resources Assessment		E, F, R, S	CHy, CLW
Manual on Flood Risk Mapping		E**	CHy, CLW
Guide to Meteorological Instruments and Methods of Observation	WMO-No. 8	C, E, F, R, S	CIMO, OBS
Guide to Climatological Practices	WMO-No. 100	A, C, E, F, R, S*	CCl, CLW
Guide to Hydrological Practices, Volumes I and II	WMO-No. 168	E, F, R, S	CHy, CLW
Guide to Marine Meteorological Services	WMO-No. 471	E, F, R, S	JCOMM, OBS
Guide to the Global Observing System	WMO-No. 488	C, E, F, R, S	CBS, OBS
Guide to Public Weather Services Practices	WMO-No. 834	E, F, R, S	CBS, WDS
Guide to the WMO Information System	WMO-No. 1061	A, C, E, F, R, S	CBS, OBS
Guide to the WMO Integrated Global Observing System		A, C, E, F, R, S*	
WMO Global Climate Summary for 2011–2015 Technical Reference on the Global Data Management Framework for Climate		A, C, E, F, R, S	CCl, OBS
Seamless Prediction of the Earth System: from Minutes to Months	WMO-No. 1156	A, C, E, F, R, S*	ARE
2. General information publications:			
WMO *Bulletin*		E, F, R, S	CER
World Meteorological Day package		E, F, R, S	CER
WMO Statement on the Global Climate		A, C, E, F, R, S	CER
WMO Greenhouse Bulletin		A, C, E, F, R, S	ARE

*Subject to the availability of resources.

The estimated cost of the production of the *Guide to the WMO Integrated Global Observing System* in all six languages is approximately CHF 110 000.

The estimated cost of the production of the *Guide to Climatological Practices* in all six languages is approximately CHF 37 000.

The estimated cost of the production of the Seamless Prediction of the Earth System: from Minutes to Months in all six languages is approximately CHF 325 000.

**A decision regarding translation will be made when the publication is finalized, subject to the availability of resources. The number of languages produced will be based on the number of countries requesting translation, for whom the indicated language is their official language of communication with the Secretariat.

Resolution 59 (Cg-17)

GENDER EQUALITY AND EMPOWERMENT OF WOMEN

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 54 (Cg-XVI) – WMO gender mainstreaming,

(2) The *Abridged Final Report with Resolutions of the Sixteenth World Meteorological Congress* (WMO-No. 1077), Annex XII – The WMO Policy on Gender Mainstreaming,

(3) The Progress Report of the Secretary-General on Implementation of the WMO Policy on Gender Mainstreaming,

(4) The *Conference Report – Conference on the Gender Dimensions of Weather and Climate Services* (WMO-No. 1148), Statement and sector-specific recommendations,

Noting further:

(1) The ongoing review of implementation of the Beijing Declaration and Platform for Action (Beijing+20) and the remaining challenges identified,

(2) The goal on gender equality and the empowerment of women envisioned in the post-2015 sustainable development agenda,

(3) The outcomes of the Third United Nations World Conference on Disaster Risk Reduction with respect to integrating a gender perspective in disaster risk reduction and mobilizing women's leadership in building resilience,

(4) The decisions of the Conference of the Parties to the United Nations Framework Convention on Climate Change for a gender-sensitive climate policy and the participation of women in negotiations and in technical bodies that are established to discuss climate action,

Considering:

(1) The continuous importance of mainstreaming gender in WMO governance, programmes, communications and processes,

(2) The need to improve the understanding of the gender-specific impacts of weather and climate with a view to delivering user-tailored, gender-sensitive information and services,

(3) The need to ensure equal access for women and men to weather, hydrological and climate services,

(4) The need to expand and increase women's participation and leadership in science and policy-making in general, and in meteorology, climatology and hydrology in particular,

Recognizing the positive impact that gender diversity makes on the quality of leadership and decision-making, and the need for all leaders, both women and men, to actively work to promote gender equality,

Decides to amend the WMO Policy on Gender Mainstreaming and rename it WMO Gender Equality Policy;

Requests the Executive Council:

(1) To develop a WMO Gender Action Plan;

(2) To oversee implementation of the Policy;

Requests the technical commissions and the regional associations:

(1) To develop action plans on implementation of the Policy within their areas of responsibility;

(2) To continue compiling statistics on the participation of men and women in the work of regional associations and technical commissions;

(3) To take action on the outcomes and recommendations of the Conference on the Gender Dimensions of Weather and Climate Services;

(4) To report to the Executive Council and the World Meteorological Congress on progress;

Requests the Intergovernmental Board on Climate Services:

(1) To incorporate relevant recommendations of the Conference on the Gender Dimensions of Weather and Climate Services in the Implementation Plan of the Global Framework for Climate Services;

(2) To compile statistics on the participation of men and women in the work of the Global Framework for Climate Services;

(3) To report to the World Meteorological Congress on progress;

Urges Members:

(1) To contribute to the implementation of the WMO Policy on Gender Equality at the national level;

(2) To take into account the outcomes and recommendations of the Conference on the Gender Dimensions of Weather and Climate Services in the development and provision of services at the national and local levels;

(3) To support actions intended to mainstream gender in WMO structures, programmes and processes;

(4) To respond to regular surveys on gender equality in WMO and in National Meteorological and Hydrological Services, and designate gender focal points;

(5) To nominate more female candidates to participate in the work of technical commissions as members of their management groups as well as members of relevant expert teams, working groups and programmes;

(6) To nominate more female candidates to other WMO constituent bodies and their working structures as well as to training events and for WMO fellowships;

(7) To increase the representation of women in their delegations to WMO constituent body meetings;

(8) To support outreach initiatives at early education levels, such as high school, aimed at promoting increased representation of women in science-related careers in National Meteorological and Hydrological Services;

(9) To provide encouragement and support for an increased number of women to work as professional staff in National Meteorological and Hydrological Services, including at decision-making levels;

(10) To contribute to the WMO Gender Equality Activities Trust Fund;

Invites partners:

(1) To continue collaborating with WMO on advancing gender equality and the empowerment of women;

(2) To take into account the outcomes and recommendations of the Conference on the Gender Dimensions of Weather and Climate Services in their policies and programmes;

Requests the Secretary-General:

(1) To support the development of a WMO Gender Action Plan and facilitate its implementation;

(2) To support Members in implementation of the outcomes and recommendations of the Conference on the Gender Dimensions of Weather and Climate Services;

(3) To maintain and expand the multi-stakeholder partnership established as a result of organization of the Conference and collaborate closely with relevant stakeholders;

(4) To advocate gender equality and the empowerment of women and promote related action;

(5) To continue monitoring progress on implementation of the Policy and the present resolution and to report to the Executive Council and the World Meteorological Congress on progress.

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Note: This resolution replaces Resolution 54 (Cg-XVI), which is no longer in force.

Annex to Resolution 59 (Cg-17)

WMO GENDER EQUALITY POLICY

1. GENERAL

1.1 Purpose

The purpose of the Gender Equality Policy is to promote, encourage and facilitate gender equality across the World Meteorological Organization (WMO) and to establish a mechanism by which progress can be measured.

1.2 Definitions

1.2.1 All references to WMO encompass the Executive Council, regional associations, technical commissions and the Secretariat. The Policy also refers to National Meteorological and Hydrological Services (NMHS).

1.2.2 For the purposes of this Policy, WMO has adopted the definitions of gender and gender equality that were developed by the United Nations.

1.2.3 Gender refers to the social attributes and opportunities associated with being male and female and the relationships between women and men and girls and boys, as well as the relations between women and those between men. These attributes, opportunities and relationships are socially constructed and are learned through socialization processes. They are context/ time-specific and changeable. Gender determines what is expected, allowed and valued in a women or a man in a given context. In most societies there are differences and inequalities between women and men in responsibilities assigned, activities undertaken, access to and control over resources, as well as decision-making opportunities. Gender is part of the broader socio-cultural context. Other important criteria for socio-cultural analysis include class, race, poverty level, ethnic group and age.[1]

1.2.4 Gender equality refers to the equal rights, responsibilities and opportunities of women and men and girls and boys. Equality does not mean that women and men will become the same but that women's and men's rights, responsibilities and opportunities will not depend on whether they are born male or female. Gender equality implies that the interests, needs and priorities of both women and men are taken into consideration, recognizing the diversity of different groups of women and men. Equality between women and men is seen both as a human rights issue and as a precondition for, and indicator of, sustainable people-centred development.[2]

1.3 The WMO Vision on Gender Equality

1.3.1 Under its collaborative framework, WMO provides world leadership and expertise in international cooperation in the delivery and use of high quality, authoritative weather, hydrological, climate and related environmental services by its Members, for the improvement of the well-being of societies of all nations. It does so through the coordination of standards and practices among its Members, based on core values of professionalism, excellence, impartiality, cultural sensitivity, non-discrimination and team spirit in international service.

1.3.2 The gender perspective of this vision is to realize fully the professional and human potential of both women and men through equal employment opportunities and to provide improved access to basic and enhanced environmental services that are responsive and sensitive to women's and men's priorities and needs and will make a difference to their lives.

2. GOALS AND OBJECTIVES

2.1 Goal

The overall goal is to achieve gender equality within WMO. The provision of enhanced and gender-sensitive weather, hydrological, climate and related environmental services will contribute to an improved response to human needs related to weather, climate and water.

2.2 Objectives

2.2.1 The objectives of the Gender Equality Policy are as follows:

(a) To ensure equality of opportunity for women and men within the WMO Secretariat;

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[1] http://www.un.org/womenwatch/osagi/conceptsandefinitions.htm

[2] Ibid.

(b) To ensure equality of opportunity for women and men to participate in all WMO constituent bodies and capacity-building initiatives;

(c) To ensure equality of opportunity for women and men in National Meteorological and Hydrological Services;

(d) To ensure gender sensitive development and delivery of all services provided through coordination of WMO, including equal access and equal user capacity for women and men; and

(e) To ensure that all WMO projects and programmes are gender sensitive.

3. METHODS

3.1 Gender Mainstreaming

3.1.1 Gender mainstreaming is "the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in all areas and at all levels. It is a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres so that women and men benefit equally and inequality is not perpetuated. The ultimate goal is to achieve gender equality." (ECOSOC 1997/2, 18 July 1997)

3.1.2 Gender mainstreaming is the primary tool that will be used to achieve the goal of gender equality within WMO. It will be supported by targeted capacity-building and training as required.

4. EXPECTED OUTCOMES

4.1 Gender Sensitive Strategic Planning

All strategic planning documents produced by WMO will be sensitive to issues related to the advancement of gender equality and the empowerment of women as well as include a commitment to ensuring that activities and initiatives promote gender equality.

4.2 Gender Sensitive Governance

Policy-making organs, constituent bodies and top-level management in WMO will provide visible support, accountability and transparency to ensuring gender equality. This will include the provision of adequate resources for gender mainstreaming activities in regular budget planning and the inclusion of gender equality in all communications and consultations with stakeholders. WMO will promote more clear communications between countries on gender equality issues and the development of gender-sensitive human resource policies. WMO will ensure that gender focal points are appointed at all levels and that an organization-wide mechanism is established to direct gender mainstreaming activities.

4.3 Gender Sensitive Human Resources

Human Resources management in WMO will aim to eliminate all forms of discrimination and to promote equality of opportunity between men and women, and foster balanced work/life arrangements for differing personal/family situations. This will include the use of balanced recruitment, selection and retention practices, the provision of equitable working conditions and the provision of equal opportunities for training at local, regional and international levels in a manner that aims to achieve equilibrium in gender representation. It will aim for balanced work/life arrangements for differing personal/family situations. There will be provision of fair opportunities for promotion and equitable distribution of work responsibilities at all levels. Both men and women will be included in decision-making on WMO activities and programmes. Outreach programmes will be developed and implemented to promote meteorology and hydrology and related sciences as attractive careers for women and men.

4.4 Gender Sensitive Weather, Hydrological and Climate Services

4.4.1 WMO will endeavour to ensure equitable access to, interpretation of and use of information and services by both women and men. Efforts will be made to ensure effective participation of both women and men in public education and awareness activities as well as in user forums. The diverse needs of both women and men users will be taken into account and gender sensitive programmes and projects will be designed and implemented accordingly. WMO will further seek to increase the involvement of women in the development of weather, hydrological, climate and related environmental products and services.

4.4.2 Particular efforts will be made to:

(a) Improve the understanding of the gender-specific impacts of weather and climate and of the gender dimensions of weather and climate services on disaster risk reduction, water resources management, public health, agriculture and food security, and other relevant areas;

(b) Pursue strategies and structures to increase the involvement of women as well as men in the development and communication of gender-sensitive weather, hydrological and climate services;

(c) Produce and communicate gender-sensitive weather, hydrological, climate and related environmental services;

(d) Ensure access for women to products and services;

(e) Strengthen the capacity of women as well as men in climate-sensitive sectors through technical and communications education, training and professional development; and

(f) Increase investment in gender-based weather, hydrological, climate and related environmental services.

5. CAPACITY DEVELOPMENT

5.1 Staff Development

Efforts will be made to build understanding of the objectives and rationale for the Gender Equality Policy as well as of specific tools and mechanisms for mainstreaming gender in all aspects of WMO work.

5.2 Technical Areas

Efforts will be made to improve understanding of the gender-specific impacts of weather and climate and of the gender dimensions of weather and climate services through increased research, outreach and training, including through the development of relevant capacity-building tools and materials.

6. COMMUNICATIONS

6.1 All communications from WMO will be written in gender-sensitive language, gender-sensitive formats, and utilizing gender-sensitive methodologies, including all communications with Member States. Member States will routinely be asked to consider including female candidates in lists of experts nominated to WMO bodies.

6.2 The Secretariat will serve as a conduit for sharing best practices on gender mainstreaming.

7. RESOURCE ALLOCATION

WMO will ensure that funding for gender equality work is made available through regular budget planning and voluntary contributions.

8. ROLES AND RESPONSIBILITIES

8.1 Secretariat

8.1.1 All Secretariat staff members are expected to familiarize themselves with the WMO Gender Equality Policy and to carry out their daily work in a manner that is fully consistent with the guidelines specified in the policy.

8.1.2 Senior managers have a particular responsibility to ensure that the goals and objectives specified in the Gender Equality Policy are met by WMO and its constituent bodies. They will be expected to set gender objectives in their annual workplans.

8.2 Regional Associations

The regional associations should be aware of and implement the WMO Gender Equality Policy within their area of responsibility. Efforts should be made to ensure that a minimum of at least 30 per cent of the members of their working structures is female and that this percentage rises progressively within each financial period. The longer-term objective will be to reach parity between male and female members. To this end, the regional associations should designate a member of their management committees responsible for gender equality.

8.3 Technical Commissions

The technical commissions should be aware of and implement the WMO Gender Equality Policy within their area of responsibility. Efforts should be made to ensure that a minimum of at least 30 per cent of the members of their working structures is female and that this percentage rises progressively within each financial period. The longer-term objective will be to reach parity between male and female members.

8.4 Members

Members should support and enable implementation of the WMO Gender Equality Policy and facilitate gender mainstreaming activities stemming from the Policy wherever possible. They also have the responsibility to communicate the Policy and support implementation at the national level.

9. MONITORING AND COMPLIANCE

9.1 Ultimate responsibility for monitoring and compliance with the Policy will lie with constituent bodies and the Secretary-General. Implementation will be reviewed once each financial period based on the set of monitoring indicators developed. To this end, sex-disaggregated data will be collected on all aspects of WMO work, including membership in constituent body structures. Upon review and evaluation of sex-disaggregated data, methods and indicators will be assessed and modified as necessary. Further review will be provided on an ad hoc basis by the WMO Internal Oversight Office.

9.2 Regional associations and technical commissions will be expected to report to the Executive Council on progress, at least once during each financial cycle.

10. IMPLEMENTATION FRAMEWORK

An action plan will be developed and updated after each Congress to facilitate the objectives and expected outcomes elaborated in the WMO Gender Equality Policy.

Resolution 60 (Cg-17)

WMO POLICY FOR THE INTERNATIONAL EXCHANGE OF CLIMATE DATA AND PRODUCTS TO SUPPORT THE IMPLEMENTATION OF THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 40 (Cg-XII) – WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities,

(2) Resolution 25 (Cg-XIII) – Exchange of hydrological data and products,

(3) Resolution 16 (Cg-XVI) – Climate data requirements,

(4) Resolution 48 (Cg-XVI) – Implementation of the Global Framework for Climate Services,

(5) Resolution 1 (Cg-Ext.(2012)) – Implementation Plan of the Global Framework for Climate Services,

(6) Resolution 2 (Cg-Ext.(2012)) – Establishment of the Intergovernmental Board on Climate Services,

(7) Resolution XXII-6 – IOC Oceanographic Data Exchange Policy, adopted by the Assembly of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization at its twenty-second session,

(8) The *Abridged Final Report with Resolutions of the Sixty-fifth Session of the Executive Council* (WMO-No. 1118), Annex II – The role and operation of National Meteorological and Hydrological Services – A Statement by the World Meteorological Organization,

Recalling:

(1) That the World Meteorological Congress at its extraordinary session in 2012 had adopted the Implementation Plan of the Global Framework for Climate Services (GFCS) for the subsequent consideration of the Intergovernmental Board on Climate Services,

(2) That the vision of the Framework is to enable society to manage better the risks and opportunities arising from climate variability and change, especially for those who are most vulnerable to climate-related hazards,

(3) That of the eight principles for the implementation of the Framework, principles 2, 4, 5 and 6 state that:

   (a) The primary goal will be to ensure greater availability of, access to and use of enhanced climate services for all countries,

   (b) Climate services must be operational and continuously updated,

   (c) Climate information is primarily an international public good provided by governments, which will have a central role in its management,

   (d) It will promote the free and open exchange of climate-relevant data, tools and scientifically based methods while respecting national and international policies,

(4) That WMO, and its constituent bodies, play an essential role in the establishment and maintenance of systems for the rapid exchange of meteorological and related information,

(5) That Resolution 1 (Cg-Ext.(2012)) urges governments to strengthen national, regional and global capabilities to collect, rescue and exchange data and products, to generate climate information and products, and to provide climate services to enhance decision-making through implementation of a framework for climate services at the national level,

(6) That WMO Resolution 40 (Cg-XII) recognizes:

(a) The basic responsibility of Members and their National Meteorological or Hydrometeorological Services (NMSs) to provide universal services in support of safety, security and economic benefits for the peoples of their countries,

(b) The dependence of Members and their NMSs on the stable, cooperative international exchange of meteorological and related data and products for discharging their responsibilities,

(c) The continuing requirement for Governments to provide for the meteorological infrastructure of their countries,

(d) The continuing need for, and benefits from, strengthening the capabilities of NMSs, in particular in developing countries, to improve the provision of services,

(e) The dependence of the research and education communities on access to meteorological and related data and products,

Recalling further the terminology defined in Annex 4 to WMO Resolution 40 (Cg-XII):

(1) "Free and unrestricted" means non-discriminatory and without charge,

(2) "Without charge", in the context of Resolution 40 (Cg-XII) means at no more than the cost of reproduction and delivery, without charge for the data and products themselves,

(3) Products are developed from geophysical (meteorological, oceanographic and so forth) observational data acquired and produced by Members to support WMO programme requirements,

Considering:

(1) That the present resolution will apply only to meteorological, hydrological and climatological data and products, including related environmental data and products, developed or acquired under WMO auspices and required to support the implementation of the Framework, hereinafter referred to as GFCS relevant data and products,

(2) The fundamental importance of the free and unrestricted exchange of GFCS relevant data and products among Members to facilitate the implementation of the Framework and to enable society to manage better the risks and opportunities arising from climate variability and change, especially for those who are most vulnerable to climate-related hazards,

(3) That the role of the WMO World Data Centres (WDCs), Global Producing Centres for Long-range Forecasts (GPCLRFs), Regional Climate Centres (RCCs), Regional Climate Outlook Forums (RCOFs) and the International Council for Science (ICSU) World Data System (WDS) in the provision of consolidated global and regional GFCS relevant data and products, as well as the framework of the Global Climate Observing System (GCOS) Essential Climate Variables (ECVs) (Atmospheric, Oceanic and Terrestrial), results in a substantial contribution of WMO to the Framework, in particular through the GFCS Climate Services Information System (CSIS),

(4) The WMO Statement on the role and operation of National Meteorological and Hydrological Services (NMHSs) in relation to their role in the provision of national GFCS relevant data and products in furthering applications of meteorology, climatology and hydrology and water resources management to all human activities, and in their role in the Framework at the national, regional and, in some cases, global levels,

(5) The importance of the contribution of other GFCS partner organizations and the role these organizations can play in support of the goals and objectives of the Framework,

(6) The priority areas (health, disaster risk reduction, agriculture and food security, water and energy) for the implementation of the Framework and the GFCS relevant data related requirements of these priority areas as identified in the annexes to the Implementation Plan of the Global Framework for Climate Services,

Recognizing:

(1) The need for increased access to different types of GFCS relevant data and products to support the GFCS Implementation Plan, in accordance with Resolution 1 (Cg-Ext. (2012)),

(2) The importance of access to reliable, relevant and timely data and products in supporting resilience to climate variability and change and underpinning sustainable development as espoused at various international forums, such as the United Nations Conference on Sustainable Development (Rio +20), and the meetings of the Conference of the Parties of the United Nations Framework Convention on Climate Change, the Third United Nations World Conference on Disaster Risk Reduction and the planned General Assembly of the United Nations that will adopt the post-2015 sustainable development goals,

(3) That increased availability of, and access to, GFCS relevant data, especially in data-sparse regions, can lead to better quality and will create a greater variety of products and services,

(4) That increased use of reliable climate products and stronger collaboration between providers and users can lead to improved climate-smart decisions, including those decisions relevant to climate change issues,

(5) The successful experience gained by Members in the development and implementation of Resolutions 40 (Cg-XII) and 25 (Cg-XIII),

Recognizing further:

(1) The rights of governments to choose the manner by and the extent to which they make their GFCS relevant data and products available domestically and for international exchange, taking into consideration relevant international instruments and national policies and legislation,

(2) The obligation of users of GFCS relevant data and products to respect the conditions of use set by the owners of the data and products, such as attribution or compensation, to facilitate access to the data and products,

(3) That different NMHSs have different business models and that some of these are predicated on cost recovery from the users, including the private sector, of data and products as a means of supporting the costly infrastructure necessary for generating such data and products,

(4) The significant and increasing levels of resources being allocated internationally for implementation of activities consistent with, and supportive of, the objectives of the GFCS,

Decides:

(1) To adopt the policies and practices, including the guidelines, of Resolution 40 (Cg-XII) and Resolution 25 (Cg-XIII) for the exchange of GFCS relevant data and products to enable the achievement of the goals and objectives of the Framework;

(2) That the climate data and products covered by Resolution 40 (Cg-XII) and the GFCS relevant data and products subsumed under Resolution 25 (Cg-XIII) will continue to be governed by these resolutions;

(3) That the GFCS relevant data and products from the WMO WDCs, GPCLRFs, RCCs, RCOFs and the ICSU WDS, as well as from the framework of the GCOS ECVs (Atmospheric, Oceanic and Terrestrial), will constitute an essential contribution to the Framework and therefore should be made accessible among Members, in particular through the GFCS CSIS, on a free and unrestricted basis;

Urges Members:

(1) To provide the additional GFCS relevant data and products that are required to support and sustain the operational climate services as the core element of the Framework and WMO initiatives at the global, regional and national levels and, further, as mutually agreed, to assist other Members to enhance access to GFCS relevant data and products and in the provision of climate services in their countries; such additional GFCS relevant data and products are listed in the annex to the present resolution and could have conditions associated with their use, such as restrictions on their use for commercial purposes, attribution of their source or licensing;

(2) To establish funding mechanisms, including new investments, for sustaining the network of stations and sensors needed for the global observing systems for climate, and also the maintenance and operation of the data preparation and management systems necessary to support the implementation of the present resolution;

Further urges Members:

(1) To strengthen their commitment to the free and unrestricted exchange of GFCS relevant data and products;

(2) To increase the volume of GFCS relevant data and products accessible to meet the needs for implementation of the Framework and the requirements of GFCS partners;

(3) To make use of the WMO Information System (WIS) for the exchange of GFCS relevant data and products among Members;

(4) To promote the central role that NMHSs play at the national, regional and, in some cases, global levels in the provision of information, in particular to the WIS;

(5) To provide the related metadata as defined by WIS and WMO Integrated Global Observing System standards;

(6) To strengthen their support to the WMO WDCs, GPCLRFs, RCCs, RCOFs, the ICSU WDS, as well as the framework of the GCOS ECVs, in the collection and supply to and by these centres of GFCS relevant data and products on a free and unrestricted basis;

(7) To implement the practice on the international exchange of GFCS relevant data and products, as described in Decides (1) to (3) above;

(8) To inform all third parties of any terms and conditions associated with the additional GFCS relevant data and products, including their related metadata, such as ownership and attribution;

(9) To make best efforts to ensure that users and subsequent users are aware of the conditions of use of the additional GFCS relevant data and products, particularly regarding their redistribution;

Requests the Intergovernmental Board on Climate Services:

(1) To apply the present resolution in the context of the implementation of the Framework;

(2) To consider the GFCS relevant data and products that are needed under the auspices of WMO to contribute to the Framework and make recommendations in this respect to the Executive Council for its consideration;

(3) To strengthen effective coordination with GFCS partners, including the Food and Agriculture Organization of the United Nations, the World Food Programme, the World Health Organization, the United Nations Office for Disaster Risk Reduction, the United Nations Educational, Scientific and Cultural Organization including its International Oceanographic Commission, the United Nations Development Programme, the United Nations Environment Programme, and other relevant international organizations;

(4) To encourage GFCS partners to adopt similar policies and practices concerning the free and unrestricted exchange of their relevant data and products in support of GFCS implementation;

(5) To consider and recommend to the World Meteorological Congress how third-party data and products could be treated in the context of the implementation of the present resolution;

Requests the Executive Council:

(1) To invite the president of the Commission for Climatology and the president of the Commission for Basic Systems, in collaboration with other technical commissions, to provide advice and assistance on the technical aspects of implementation of the present resolution and ensure that appropriate standards are identified, implemented and maintained;

(2) To task the technical commissions, as appropriate, to regularly review and update the GFCS relevant data and products to be provided by the global and regional climate centres, with a view to increasing the access to and availability of GFCS relevant data and products;

(3) To take into consideration the views of the Intergovernmental Board on Climate Services with respect to the issues that may arise with the implementation of the present resolution;

(4) To monitor the implementation of policies and practices of the present resolution and, if necessary, make proposals in this respect to the Eighteenth World Meteorological Congress;

(5) To take into consideration the recommendations by the Intergovernmental Board on Climate Services with regard to its needs for GFCS relevant data and products developed or acquired under WMO auspices and, if necessary, make proposals to the World Meteorological Congress for changes to the annex to the present resolution;

(6) To foster initiatives:

(a) That enhance the capabilities of Members, especially least developed countries and developing countries, to provide, deliver and improve access to GFCS relevant data and products to adequately respond to user needs and to enable their use in decision-making by all relevant societal sectors;

(b) That support Members in the implementation of the present resolution, especially those that are most vulnerable to climate-related hazards;

Requests the Secretary-General:

(1) To undertake a global survey, to the extent possible within the resources available, and analysis of the various data policies and models of service provision of Members, for example, cost recovery and public services, identifying successful strategies and best practices that can assist NMHSs in making the case to their governments and partners for establishing funding mechanisms, including new investments, for sustaining the network of stations and sensors needed for the global observing systems for climate, and also the maintenance and operation of the data preparation and management systems, necessary to support the implementation of the present resolution;

(2) To promote and fully disseminate this policy to all Members to facilitate the exchange of GFCS relevant data and products among related national institutions responsible for meteorological or hydrological activities to enhance the provision of climate services at the national level;

(3) To bring the present resolution to the attention of Members, WMO WDCs, RCCs, GPCLRFs, the ICSU WDS, GFCS partners and other international organizations and entities involved in supporting and financing GFCS implementation;

(4) To make known to all Members those GFCS relevant data and products that have conditions on their use;

(5) To implement a process for monitoring the accessibility and exchange of GFCS relevant data and products under the present resolution.

Annex to Resolution 60 (Cg-17)

GLOBAL FRAMEWORK FOR CLIMATE SERVICES RELEVANT DATA AND PRODUCTS THAT SHOULD BE EXCHANGED AMONG MEMBERS TO SUPPORT THE IMPLEMENTATION OF THE FRAMEWORK

Purpose

The purpose of this listing of GFCS relevant data and products is to identify a set of data and products which Congress considers necessary to enable society to manage better the risks and opportunities arising from climate variability and change for all nations, especially for those who are most vulnerable to climate-related hazards.

Contents

In addition to the climate data and products provided under Annex 1 to Resolution 40 (Cg-XII), as well as the GFCS relevant data and products subsumed within the general designation of hydrological data and products in Resolution 25 (Cg-XIII), and in addition to all data and products that are already available on a free and unrestricted basis, the following types of data and products are considered necessary for the implementation of GFCS:

(1) Historical climate time-series from the Regional Basic Climate Networks (RBCNs), the GCOS Upper-Air Network and GCOS Surface Network at a temporal and spatial resolution necessary to resolve the statistics of climate, including trends and extremes;

(2) Essential climate variables for the ocean (full depth) (as defined by the GCOS Implementation Plan);

(3) Climate relevant coastal interface data, in particular sea level, waves and storm surges;

(4) Data on the composition of the atmosphere including aerosols;

(5) Climate relevant satellite data and products;

(6) Climate relevant cryospheric data, in particular snow cover, snow depth, glacial monitoring, permafrost and lake and river ice.

Resolution 61 (Cg-17)

GOVERNANCE OF THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The *Abridged Final Report with Resolutions of the First Session of the Intergovernmental Board on Climate Services* (WMO-No. 1124),

(2) The Implementation Plan of the Global Framework for Climate Services (GFCS), approved by the Intergovernmental Board on Climate Services (IBCS) at its first session, along with its annexes and exemplars,

(3) The *Abridged Final Report with Resolutions of the Second Session of the Intergovernmental Board on Climate Services* (WMO-No. 1149),

(4) The *Abridged Final Report with Resolutions of the Extraordinary Session 2012 of the World Meteorological Congress* (WMO-No. 1102), Part I,

(5) The *Abridged Final Report with Resolutions of the Sixteenth World Meteorological Congress* (WMO-No. 1077),

Recognizing:

(1) The critical role of the Intergovernmental Board on Climate Services in guiding the work of the Framework,

(2) The importance to ensure sustainability and continuity to the work of the Board,

(3) The implications and risks of relying on extrabudgetary resources for the support to the sessions of the Board and its Management Committee,

Decides to hold ordinary plenary meetings of the Board only once in the intersessional period between sessions of the World Meteorological Congress, prior to each session, and that the Management Committee meet once a year to provide advice and oversight and to manage implementation of the Framework;

Requests the Secretary-General:

(1) To make funding available, to the extent possible within available resources, for conference services for IBCS sessions from the WMO budget, in consideration of other GFCS activities;

(2) To bring the present resolution to the attention of all concerned.

Resolution 62 (Cg-17)

RELATIONSHIP AND INTERACTION BETWEEN THE INTERGOVERNMENTAL BOARD ON CLIMATE SERVICES AND WMO CONSTITUENT BODIES

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The *Abridged Final Report with Resolutions of the First Session of the Intergovernmental Board on Climate Services* (WMO-No. 1124),

(2) The Implementation Plan of the Global Framework for Climate Services (GFCS), approved by the Intergovernmental Board for Climate Services (IBCS) at its first session, along with its annexes and exemplars,

(3) The *Abridged Final Report with Resolutions of the Second Session of the Intergovernmental Board on Climate Services* (WMO-No. 1149),

(4) The *Abridged Final Report with Resolutions of the Extraordinary Session 2012 of the World Meteorological Congress* (WMO-No. 1102), Part I,

(5) The *Abridged Final Report with Resolutions of the Sixteenth World Meteorological Congress* (WMO-No. 1077),

Recognizing the need to establish and maintain the relationship and interaction between the Intergovernmental Board on Climate Services and the constituent bodies of WMO as well as substructures of partner organizations,

Decides to adopt the following arrangements:

(1) Executive Council: The IBCS Chairperson, with the Vice–Chairperson as alternate, unless they are Executive Council members themselves, shall be invited to inform the Executive Council at its sessions on progress and requirements and needs of the Board; the Executive Council shall designate a representative to attend IBCS sessions as well as IBCS Management Committee sessions;

(2) Regional associations: Regional associations shall invite the IBCS designated representative to their sessions to inform the associations on progress, requirements and needs of the Board for the specific Regions as appropriate; the Board shall delegate the responsibility to a member of its Management Committee from that Region or to the Chairperson or Vice-Chairperson/Co-Vice-Chairpersons as appropriate;

(3) Technical commissions: Technical commissions shall invite the IBCS designated representative to their sessions to inform the commissions on progress and requirements and needs of the Board as appropriate; the Board shall delegate the responsibility to a

member of its Management Committee or to the Chairperson or Vice-Chairperson/Co-Vice-Chairpersons as appropriate; the Chairperson of IBCS shall invite the presidents of technical commissions, as deemed appropriate, to attend IBCS as well as Management Committee sessions;

(4) Technical commissions and Programmes: Relevant technical commissions and WMO Programmes should identify a GFCS liaison; these individuals can report through the technical commission Management Groups on ways to better align technical commission operating plans with GFCS activities and, conversely, inform the Board of relevant technical commission activities that support the Framework;

(5) Secretary-General: WMO should reach out to the technical commissions, or equivalent, of GFCS partner organizations, as needed, for input into IBCS Partner Advisory Committee activities; the Secretary-General should also submit relevant activities as GFCS contributions via the existing processes established for other partners;

Requests the Secretary-General to bring the present resolution to the attention of all concerned.

Resolution 63 (Cg-17)

ENERGY AS AN ADDITIONAL PRIORITY AREA OF THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The *Abridged Final Report with Resolutions of the First Session of the Intergovernmental Board on Climate Services* (WMO-No. 1124),

(2) The Implementation Plan of the Global Framework for Climate Services (GFCS) approved by the Intergovernmental Board on Climate Services at its first session, along with its annexes and exemplars,

(3) The *Abridged Final Report with Resolutions of the Second Session of the Intergovernmental Board on Climate Services* (WMO-No. 1149),

Recognizing:

(1) The demand and importance of sustainable energy for global sustainable development including in the four priority areas of the Framework,

(2) The implications of international efforts to limit dangerous climate change for dramatically increased adoption of climate-sensitive renewable energy sources such as wind, solar power and hydropower,

(3) That with increased climate variability and change, the sensitivity of the energy sector to weather and climate will increase, and thus the demand for climate services for the energy sector,

Recognizing also:

(1) The potential for the Framework to contribute to improved energy-related outcomes, both in terms of promotion of renewable energy sources and energy saving as well as through

protection of energy infrastructure and delivery systems from weather and climate extremes,

(2) That GFCS implementation has already started on four key climate-sensitive sectors, and that this experience can now be extended for addressing the energy sector,

Taking into account:

(1) The current effort for the establishment of United Nations sustainable development goals, which may include a specific global goal and targets on energy,

(2) The establishment of the Sustainable Energy for All initiative in 2011 by the Secretary-General of the United Nations, which is now a strong partnership involving more than 100 countries including 85 developing countries,

(3) The United Nations Framework Convention on Climate Change Lima call for climate action and the prioritization of low-emission power generation as a key strategic result of the Green Climate Fund which is nearing operation,

Decides:

(1) To adopt energy as the fifth priority of the Framework;

(2) To develop the Energy Exemplar as a means of guiding the enhanced provision of climate services for the energy sector and engaging the relevant stakeholders;

(3) To pilot interventions identified in selected countries with the support of Members and partners to inform the process of Exemplar development and implementation;

Encourages the IBCS Partner Advisory Committee to advise on how partners can contribute to the Exemplar and its conclusions and recommendations;

Encourages Members and the IBCS Partner Advisory Committee to support development of the Exemplar and the implementation of selected pilot activities by seconding experts on energy or financial resources to the GFCS Trust Fund;

Requests the Intergovernmental Board on Climate Services to provide oversight on the further development and implementation of the Energy Exemplar;

Requests the Secretary-General and the Board to ensure that resources and efforts directed towards the new GFCS priority area of energy will not hinder or compete with the early progress being made in the four initial priority areas;

Requests the Secretary-General:

(1) To support the further development of the Exemplar and mobilize resources and expertise for its completion;

(2) To bring the present resolution to the attention of all concerned.

Resolution 64 (Cg-17)

DEVELOPMENT OF A RESULTS-BASED FRAMEWORK FOR WMO SUPPORT TO THE IMPLEMENTATION OF THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) The *Abridged Final Report with Resolutions of the First Session of the Intergovernmental Board on Climate Services* (WMO-No. 1124),

(2) The Implementation Plan of the Global Framework for Climate Services (GFCS) approved by the Intergovernmental Board on Climate Services at its first session, along with its annexes and exemplars,

(3) The reports of the sessions of all regional associations and technical commissions held during the financial period 2012–2015,

Noting further:

(1) The prominence of climate-related issues in the post-2015 policy dialogue and frameworks and the accompanying increased visibility of, and anticipated demand for, climate services,

(2) The priority accorded to supporting GFCS implementation in the WMO Strategic Plan 2016–2019,

(3) The significant investments being made in supporting climate services globally and the expected continued growth thereof,

(4) The experience gained in supporting GFCS implementation by WMO and its partners to date,

(5) The large volume of current and planned activities supporting GFCS implementation across technical commissions, regional associations and programmes, including co-sponsored programmes, and the need to further align them and to be able to document their combined GFCS-related outputs and results,

Requests the Secretary-General:

(1) To develop a results-based framework identifying the specific WMO contributions to GFCS implementation and associated expected outputs over the seventeenth financial period in line with the WMO Strategic Plan 2016–2019;

(2) To focus the framework on achieving coordination and synergies across the technical commissions, regional associations and programmes, including co-sponsored programmes, for supporting GFCS implementation at the regional and country levels;

(3) To ensure that the framework is driven by country-level implementation support requirements including through a focus on specific illustrative countries as a means of making certain that the activities and outputs address particular identified needs in particular contexts while at the same time emphasizing measures with broad applicability;

(4) To ensure that activities included in the framework are explicitly identified as contributions to GFCS implementation as requested by the Intergovernmental Board on Climate Services at its second session;

(5) To bring the present resolution to the attention of GFCS partners and encourage them to similarly identify their contributions to GFCS implementation;

Requests the Executive Council to explore mechanisms, taking into account previous successes such as the Intercommission Coordination Group on the WMO Integrated Global Observing System, and implement and monitor, to the extent possible within available resources, a mechanism to advance WMO contributions to the Global Framework for Climate Services, in line with a results-based framework, with participation from relevant working groups of the technical commissions and regional associations, and co-sponsored programmes;

Requests the technical commissions, regional associations and programmes, including co-sponsored programmes:

(1) To contribute to the development of the results framework;

(2) To report back on the outputs generated and results achieved in the context of the framework as part of their ongoing reporting processes.

Resolution 65 (Cg-17)

TOWARDS A WMO APPROACH TO EMERGING DATA CHALLENGES

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 69 (Cg-17) – WMO Strategic Plan 2016–2019,

(2) Resolution 40 (Cg-XII) – WMO policy and practice for the exchange of meteorological and related data and products including guidelines on the relationships in commercial meteorological activities,

(3) Resolution 25 (Cg-XIII) – Exchange of hydrological data and products,

(4) Resolution 16 (Cg-XVI) – Climate data requirements,

(5) Resolution 48 (Cg-XVI) – Implementation of the Global Framework for Climate Services,

(6) Resolution 1 (Cg-Ext.(2012)) – Implementation Plan of the Global Framework for Climate Services,

(7) Resolution XXII-6 – IOC Oceanographic Data Exchange Policy, adopted by the Assembly of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization at its twenty-second session,

(8) The *Abridged Final Report with Resolutions of the Sixty-fifth Session of the Executive Council* (WMO-No. 1118), Annex II – The role and operation of National Meteorological and Hydrological Services – A Statement by the World Meteorological Organization,

Recognizing:

(1) That the principles of good data management being developed through the WMO Integrated Global Observing System (WIGOS), the WMO Information System (WIS) and

other WMO Programmes are an essential first step in addressing the complex issues of big data, crowd-sourced data, and new and emerging sources of data,

(2) That, as a key support activity during the WIGOS pre-operational phase, the Intercommission Coordination Group on the WMO Integrated Global Observing System will give attention to the need for effective data management and custodianship practices throughout the lifecycle of data, for example from the point of measurement and data collection, through data integration, processing and exchange, to long-term archival, and that WIGOS will develop guidance for Members for inclusion in the Guide on WIGOS,

(3) That, with the expansion of mobile phones and other devices, social networking platforms, satellite data, observing system data and numerical weather prediction data, real-time digital data are ever increasing in volumes and speed of delivery, creating new data sources and datasets, where traditional methods of data access, exchange, processing and storage may not be adequate or appropriate,

(4) That, as the diversity and volumes of these data types and datasets increase, so do the risks and opportunities, and there is a need to find appropriate ways through which the meteorological community can benefit from these non-traditional sources, striving to support standards for timeliness and quality and considering issues of privacy, transparency and liability,

(5) That, in August 2014, the Secretary-General of the United Nations, Ban Ki-moon, asked an Independent Expert Advisory Group to make concrete recommendations on bringing about a data revolution in sustainable development, suggesting that issues of future data exchange would require special attention from the meteorological community,

(6) That some National Meteorological and Hydrological Services are already exploring crowd-sourcing and big data partnerships and collaboration with the private sector, especially in the area of data mining and warehousing of large social media data streams, and that there is interest in exchange of experiences, and potentially the development of a WMO approach in these areas,

Decides to undertake a review of the challenges and risks, opportunities and benefits related to big data, crowd-sourced data, social media as well as emerging and future data sources, and their potential impact on Members, as the basis for production of a guidance document for Members;

Requests the Executive Council to guide the review, taking this matter up at its sixty-seventh session, and to report on its implementation to the Eighteenth World Meteorological Congress;

Requests the Commission for Basic Systems, in coordination with other technical commissions, in particular the Commission for Hydrology, to undertake the review;

Requests the Secretary-General:

(1) To invite Members and regional associations to assist in this review, within existing resources, by, for example, highlighting ongoing and future efforts to address these challenges, opportunities, benefits and impacts within their countries and as they relate to WMO systems and services;

(2) To coordinate the work done by the relevant WMO Programmes in this area;

(3) To keep Members apprised of developments.

Resolution 66 (Cg-17)

WMO SUPPORT TO EVOLVING AERONAUTICAL METEOROLOGICAL SERVICES

THE WORLD METEOROLOGICAL CONGRESS,

Noting the fourth edition of the *Global Air Navigation Plan* (GANP) (ICAO Doc 9750) endorsed by the Assembly of the International Civil Aviation Organization (ICAO) at its thirty-eighth session in 2013, and its objective for safe, sustained growth of air transport, and increased efficiency and responsible environmental stewardship that societies and economies globally now require,

Noting further:

(1) That GANP represents a rolling 15-year strategy to guide complementary and sector-wide air transport improvements over the period 2013–2028 and beyond, and will be implemented through the Aviation System Block Upgrades (ASBU) methodology,

(2) The outcome of the Conjoint ICAO/WMO Meteorology Divisional Meeting expressed in 29 recommendations, calling for closely coordinated follow up actions by ICAO and WMO,

Recognizing that the integration of the aeronautical meteorological information in the future system-wide information management will be a key enabler to the realization of a globally harmonized, interoperable air traffic management system,

Recognizing further:

(1) That the implementation of the performance improvements envisaged in ASBU will imply significant institutional, technological and operational changes in the provision of aeronautical meteorological service by Members,

(2) The need for developing relevant background material and guidance on the envisaged changes to assist Members in their related capacity development plans, risk assessment and change management,

(3) That the success of the meteorological components of ASBU will be strongly dependent on an accelerated transfer of scientific and technological achievements that have demonstrated value to aviation stakeholders into operational practice,

(4) That in order to address effectively relevant aspects of GANP and ASBU developments, WMO should strengthen and expand its cooperation and partnership with aviation stakeholders at all levels,

Endorses WMO engagement, in close coordination with ICAO, in the follow-up of the recommendations of the Conjoint ICAO/WMO Meteorology Divisional Meeting;

Decides that WMO, in close coordination with ICAO, should continue to provide expert support in its area of competency to the implementation of the meteorology modules of GANP and ASBU;

Requests the Executive Council to closely monitor the progress by ICAO towards GANP and ASBU, and to take all appropriate actions to ensure there is effective WMO influence on the meteorology elements of GANP and ASBU, in particular on governance and business model changes stemming from GANP and ASBU;

Requests the president of the Commission for Aeronautical Meteorology (CAeM), supported by the CAeM Management Group and expert teams, to act as a focal point for the WMO activities related to GANP and ASBU to ensure that they are coordinated and guided competently, and to address as a matter of priority the need for evaluation of emerging risks for the National Meteorological and Hydrological Services, development of guidance and sharing of best practices,

in order to assist Members to make informed decisions in their mid- to long-term planning of aeronautical meteorological services;

Requests the presidents of technical commissions concerned to closely coordinate appropriate actions related to scientific, technological and operational aspects of GANP and ASBU;

Requests the presidents of regional associations:

(1) To monitor regional developments, in particular the extended regionalization of some services, in order to ensure an inclusive approach through equitable regional and subregional partnerships, as well as sharing information and experience in the provision of meteorological services to air traffic management;

(2) To align their operating plans in terms of regional and subregional activities supporting the future air traffic management system;

Urges Members to share information and experience in developing and integrating aeronautical meteorological services in support of GANP and ASBU;

Requests the Secretary-General to provide secretarial and financial support, within the approved budget, to the activities related to GANP and ASBU prioritized by CAeM, including regional and subregional events intended to raise the awareness Members of the impacts, risks and opportunities for the National Meteorological and Hydrological Services.

Resolution 67 (Cg-17)

WMO GUIDANCE ON PARTNERSHIPS WITH THE PRIVATE SECTOR

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 26 (Cg-XIII) – Role and operation of National Meteorological Services,

(2) The *Abridged Final Report with Resolutions of the Sixteenth World Meteorological Congress* (WMO-No. 1077), Annex XI – World Meteorological Organization Statement on the Role and Operation of National Meteorological and Hydrological Services for Directors,

(3) The WMO Strategic Plan 2016–2019,

Noting further:

(1) The rapid development and increased socioeconomic benefits of meteorological, hydrological and related environmental services based on the advanced observing and information technologies,

(2) The interest expressed by a wide range of socioeconomic stakeholders to better understand and use such meteorological, hydrological and related environmental services,

(3) The context to emerge from the adoption by the General Assembly of the United Nations of a post-2015 development agenda, leading to enhanced partnership between the public and private sectors in the provision of development financing and enhancement of national and regional capacities,

Requests the regional associations and the technical commissions to investigate the opportunities and challenges related to partnerships with the private sector, developing guidance and advice which includes identifying opportunities for dialogue with the private sector in their workplans, documenting positive and constructive examples of partnership, identifying existing relevant WMO principles, policies, guidelines and standards that require consideration and advise the Executive Council accordingly, to help both the public and private sectors to avoid conflicts and encourage cooperation;

Requests the Secretary-General to provide the resources to the extent possible to leverage existing opportunities for dialogue for the development of guidance material and advice, including supporting regional association and technical commission meetings and other forums;

Requests the Executive Council to guide the Secretary-General to study the different business models used by National Meteorological and Hydrological Services in order to understand the challenges and benefits associated with partnerships with the private sector and share such analysis with all Members;

Further requests the Executive Council to guide the development and monitor guidance material and advice to support effective engagement between the National Meteorological and Hydrological Services and the private sector and report on the implementation of the present resolution at regular sessions of the World Meteorological Congress;

Urges Members to facilitate this initiative through financial and in-kind support.

Resolution 68 (Cg-17)

ESTABLISHING A WMO CROSS-CUTTING URBAN FOCUS

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) That half of the world's population currently lives in urban areas, and that by 2050 this number is projected to rise to 70 per cent,

(2) That urban issues are under consideration for inclusion in the new United Nations sustainable development goals,

(3) That a United Nations system-wide new Urban Agenda is being developed,

Concerned that urban areas are vulnerable to weather extremes including heatwaves, flooding, droughts, storm surge for coastal areas, air pollution and impacts brought about by climate change,

Considering the agreed priorities in the WMO Strategic Plan 2016–2019,

Recognizing that WMO and its Members need to address the above in an integrated fashion providing weather, climate, hydrological and related environmental services tailored to urban needs,

Recognizing further that these services will be relevant for urban resilience and sustainable development, city planning, infrastructure design, transportation, power supply, water supply, food safety, disaster risk reduction, climate change adaptation and mitigation, the anticipation and

mitigation of natural hazards (including flooding and droughts), reducing the vulnerability and exposure of the population, especially the poor, to natural hazards, and the health of citizens,

Decides that urban activities should be a specific cross-cutting element within WMO;

Requests Members:

(1) To bring to the attention of the appropriate national authorities the importance of demonstrating weather, climate, hydrological and related environmental activities that support urban issues, at the United Nations Conference on Housing and Sustainable Urban Development (HABITAT III);

(2) To encourage strengthening the cooperation between National Meteorological and Hydrological Services and the appropriate national authorities to further develop integrated urban services for decision-makers, stakeholders and the general public, and to deploy the latest communication technologies in service delivery;

Requests the technical commissions:

(1) To define relevant urban activities to be addressed by the relevant commissions in their upcoming sessions, including as elements of the agreed WMO priorities;

(2) To request their working bodies to integrate the urban dimension in their activities in a coherent manner;

(3) To include reference to urban activities in their reports to the Executive Council;

Requests the regional associations:

(1) To take on board a focus on urban matters and to address this in their upcoming sessions;

(2) To include reference to urban activities in their reports to the Executive Council;

Requests the Executive Council:

(1) To set priorities on activities relevant to urban issues;

(2) To provide guidance on the development of a service delivery strategy to address urban needs;

(3) To coordinate the work of technical commissions on urban issues in a seamless and holistic manner;

Requests the Secretary-General to arrange for the coordination of integrated urban activities in WMO.

Resolution 69 (Cg-17)

WMO STRATEGIC PLAN 2016–2019

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 36 (Cg-XVI) – WMO Strategic Plan (2012–2015),

(2) Resolution 38 (Cg-XVI) – Preparation of the Strategic Plan for 2016–2019,

(3) The decisions of the Executive Council concerning the development of the WMO Strategic Plan,

(4) The recommendations of regional associations and technical commissions reflected in their respective session reports,

Noting further that the WMO strategic planning process for the period 2016–2019 is based on and comprises three interlinked key components, namely:

(1) The WMO Strategic Plan, which provides a high-level statement of the future direction and priorities of WMO,

(2) The WMO Operating Plan, which presents time-bound specific programme activities and projects needed to address the global societal needs and achieve the Expected Results,

(3) The WMO Results-based Budget, which identifies resources for implementing the Strategic Plan, including functioning of constituent bodies, the Secretariat and programme activities,

Approves, under the provision of Article 8 (a), (b) and (c) of the Convention of the World Meteorological Organization, the WMO Strategic Plan for the period 2016–2019, as contained in the annex to the present resolution;

Urges Members to take the WMO Strategic Plan into account in developing and carrying out their national development, climate services, disaster risk reduction and other relevant strategies on programmes in meteorology, hydrology and related disciplines, as well as in their participation in the programmes of the Organization;

Requests the Executive Council, the regional associations, the technical commissions and the Secretary-General to adhere to the strategic direction and priorities set forth in the Strategic Plan and to organize programme activities so as to achieve the Expected Results;

Requests the Executive Council to use the Strategic Plan, complemented by the WMO Operating Plan, as a benchmark to monitor progress and performance in achieving the Expected Results by implementing programmes and activities of the Organization and to submit a report to the Eighteenth World Meteorological Congress;

Requests the Secretary-General to arrange for the publication of the Strategic Plan, for its distribution to all Members and constituent bodies of WMO, to United Nations system and other international organizations, and other partner organizations, as appropriate.

Note: This resolution replaces Resolution 36 (Cg-XVI), which remains in force only until 31 December 2015.

Annex to Resolution 69 (Cg-17)

WMO STRATEGIC PLAN 2016–2019

WMO STRATEGIC PLAN 2016–2019

Executive Summary

Context

Weather, marine weather, climate, hydrological and environmental monitoring and prediction services are recognized for their essential contributions to the protection of life and property from meteorological and hydrological hazards including severe storms, excessive heat, droughts and floods. Furthermore, they also underpin economic growth in sectors including agriculture and food production, transportation, energy and water resources. High-impact weather and climate extremes are likely to occur with greater frequency and intensity due to climate variability and change. And today, these changes in weather, climate, water, the chemical composition of the atmosphere as well as other related environmental conditions, like e.g. caused by space weather effects, are having compelling consequences for the environment and for the prosperity of nations. Investments to strengthen monitoring infrastructures and improve the quality of weather, marine weather, climate and hydrological predictions can result in effective disaster prevention and socio-economic planning. Future investments are also required to optimize socio-economic benefits to mitigate and adapt to high-impact weather, marine weather, climate and hydrological extremes.

The implications of changing weather, climate, water and related environmental conditions are escalating the demand from governments, institutions and citizens for more useful and reliable information, products and services. The World Meteorological Organization (WMO) and its Members' National Meteorological and Hydrological Services (NMHSs) play a foundational and authoritative role in the provision of these products and services. This demand is also fuelling growth in value-added private sector service providers.

WMO and NMHSs are exploring methods to improve efficiencies through regional collaboration and cooperation, forming cost-effective partnerships amongst themselves, other institutions and private sector service providers. This will improve the capacity of NMHSs to meet governments' expectations for saving lives, reducing damages, contributing to economic growth and supporting environmental stewardship.

The Role of National Meteorological and Hydrological Services

Weather-, marine weather-, climate- and water-related hazards do not necessarily need to become natural disasters. NMHSs strive to provide early warnings of high-impact events. Likewise, they provide information on climate extremes and variability, enabling society to better adapt to a changing climate through improved community resilience, water resource management and food security strategies.

NMHSs play an active role in the national and regional ISDR Platforms to bring together elements of science, operational services and relationships with both public and private sector in disaster risk management in a holistic way. Information products and services provided by NMHSs positively impact critical decisions made in economic sectors sensitive to the extremes of weather, climate and water. These services provided by NMHSs also help to improve environmental quality, enable safe and efficient transportation and support positive health outcomes through warnings of health impacts of poor air quality or vector-borne disease outbreaks. Therefore the services provided by the NMHSs are of enormous benefit for decision-makers addressing global, regional and national challenges.

The Value of Sustained Meteorological and Hydrological Infrastructure

To deliver effective value-added weather, marine weather, climate and hydrological services, NMHSs must have a strong understanding of the needs of government, the public and other key stakeholders. To deliver high quality services that meet the needs of decision-makers, NMHSs must develop, maintain and improve scientific and technological infrastructure and attract and retain skilled personnel to operate and manage sophisticated meteorological, hydrological and related environmental networks. The benefits of these services to governments, institutions and

citizens hinge on real-time monitoring and modelling of atmospheric and related ocean processes and water cycle which form the basis for all weather, marine weather, climate and hydrological forecasts and projections.

To be sustainable, NMHSs require investment in their core infrastructure, including robust and globally-coordinated observation systems, information and computing technologies, and human resource development. Some essential infrastructure components needed to support service delivery (e.g. high performance computing) are not available at all NMHSs. WMO has an essential and unique role in providing the frameworks for the required global and regional coordination and cooperation that supports all Members (e.g. Global and Regional Specialized Centres, Regional Training Centres, etc.).

The Role of WMO

WMO is a Specialized Agency of the United Nations (UN) with 191 Member States and Territories. It is the UN system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the land and oceans, the weather and climate it produces and the resulting distribution of water resources. Since its establishment in 1950, WMO has been central in facilitating international collaboration and cooperation for observations, data and knowledge exchange, setting standards, coordinating scientific and technical methods and capacity development for the benefit of its Members and their NMHSs. WMO Programmes such as the World Weather Watch facilitate the gathering, processing and sharing of information, expertise and technology to create cost-effective solutions for the provision of weather, marine weather, climate, hydrological and related environmental services delivered by its Members.

Under the WMO framework, NMHSs deploy, operate and sustain essential infrastructure in a coordinated manner to deliver a wide range of services that support decision-making on current and emerging issues. NMHSs benefit from strengthened partnerships with United Nation bodies active in the field of climate adaptation, such as the UN Climate Adaptation Committee and in relation with climate mitigation, such as the Climate Technology Centre & Network (CTCN). WMO supports the work of the broader international community and international Conventions or Treaties such as the United Nations Framework Convention on Climate Change (UNFCCC) and the UN Convention to Combat Desertification (UNCCD). This collaborative framework results in a much more efficient use of global resources

The WMO Strategic Plan

The WMO Strategic Plan sets the directions and priorities to guide the activities of Members and all WMO constituent bodies to enable all Members to improve their core information, products and services, maintain necessary infrastructures, and to directly benefit from advancements in science and technology. This Plan emphasizes the following key priorities to advance the realization of the eight expected results, which outline the benefits and improvements to the capacity of all Members:

1. Improve the accuracy and effectiveness of impact-based forecasts and multi-hazard early warnings of high-impact meteorological, hydrological and related environmental hazards from the tropics to the poles;
2. Implement climate services under the Global Framework for Climate Services (GFCS);
3. Strengthen the global observing systems through the implementation of the WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS);
4. Improve the ability of NMHSs to provide sustainable high quality services in support to safety, efficiency and regularity of the air traffic management worldwide;
5. Improve operational meteorological and hydrological monitoring, prediction and services in polar, high mountain regions;
6. Enhance the capacity of NMHSs to deliver on their mission; and
7. Improve efficiency and effectiveness of WMO through adopting continuous improvement measures and recommendations based on a strategic review of WMO structures, operating arrangements and budgeting practices.

WMO STRATEGIC PRIORITIES

1. *Disaster Risk Reduction*
2. *Global Framework for Climate Services*
3. *WMO Integrated Global Observing System*
4. *Aviation meteorological services.*
5. *Polar and high mountains regions.*
6. *Capacity Development*
7. *Governance*

These priorities reflect the inputs from all WMO Members and constituent bodies and guide decisions for the upcoming financial period 2016–2019 to ensure that the Plan brings the greatest benefits to Members. These priorities as well as expected results (Annex I) are reflected in the integrated draft WMO results-based budget and detailed in the draft WMO Operating Plan, which presents time-bound programme activities and projects. The draft WMO Operating Plan forms the basis for resource allocation, and defines the risks and performance matrices against which to assess progress to achieve expected results through the WMO Monitoring and Evaluation System.

WMO STRATEGIC PLAN 2016–2019

Global Societal Needs

Context

High-impact weather, marine weather, climate and hydrological events (storms, floods, droughts, etc.) have devastating effects throughout the world, resulting in injury and loss of life, displacement of people, work destruction and destruction of communities. Furthermore, air pollution is responsible for 3.2 million premature deaths worldwide every year. The personal and social costs of these losses are tremendous; the financial impacts alone are enormous – insured losses from natural catastrophes have ranged between $10B and $50B a year internationally over the past decade (Figure 1).

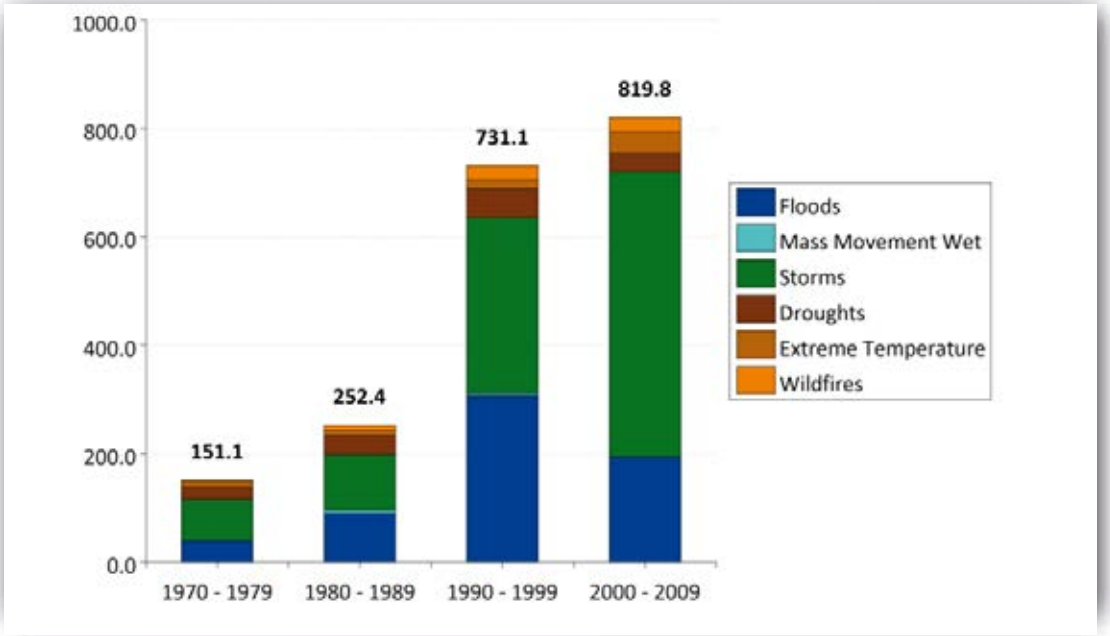

Figure 1. The global total economic losses by decade and by hazard type in USD billions adjusted to 2011 (during the period 1970–2009 *(Source: WMO and CRED, 2013)*)

This rise in economic losses can be partly attributed to the increasing vulnerability of people and infrastructure to the impact of weather and climate extremes due to growing human settlements – particularly in flood plains and coastal regions, urbanization, the rise of megacities, economic inter-dependencies and obsolescence of infrastructures. Weather, marine weather, climate and hydrological extremes are contributing to ever larger economic losses and in some cases slower economic post-disaster recovery, particularly in developing, least developed and small island developing states.

A global analysis of the statistics of disasters as a consequence of environmental hazards indicates a significant increase in the total number of disasters having larger impacts on the economy, but conversely, a notable decrease in the associated number of total deaths. There is strong evidence that increasingly accurate early warnings and their integration into disaster risk reduction approaches have contributed to significant saving of lives. Nevertheless, high-impact weather such as tropical storms continues to pose elevated risks to the safety of lives and property, particularly in developing and least developed countries. Typhoon *Haiyan* that devastated the Philippines in 2013 is a stark reminder of this ongoing reality.

Enabling Sustainable Development

Recognizing the growing socio-economic and environmental risks and the benefits that meteorological and hydrological services bring, WMO Programmes are being designed to improve the capabilities of all NMHSs, especially those in developing, least developed and small island developing states, to meet their mandates and benefit their governments, institutions and citizens. WMO, through its Members, constituencies and Secretariat, implements programmes and project initiatives to meet the following broad Global Societal Needs of fundamental importance to every Member of the Organization and contribute to the post-2015 sustainable development agenda:

- **Improved protection of life and property** to reduce disaster risks by mitigating the impacts of hazardous weather, climate, water and other environmental events and addressing the need for improved safety of transport on land, at sea, and in the air;

- **End poverty, ensure sustainable resilient livelihoods, food security, access to water and energy, healthy lives, gender equality, and economic growth, and combat climate change** by making available weather, climate, hydrological and related environmental services to support climate risk management, climate resilience, green economy, disaster risk reduction, food security and agriculture, improved health and social well-being of citizens, water management, and tapping renewable energy resources such as hydro-, solar- and wind-power;

- **Sustainable use of natural resources and improved environmental quality** by designing weather, climate, water and related environmental services to manage atmospheric, terrestrial and water resources at all time-scales, and the development and management of other natural resources.

The weather, marine weather, climate and hydrological services provided by NMHSs are fundamental to support the three interdependent pillars of sustainable development: Social, Economic, and Environmental. The contribution of WMO and its Members to each of these pillars is described in Annex II. The value of these services increases with the quality, accuracy, timeliness, location specificity and utility of the information applied in the decision-making process to reduce risks and to optimize benefits.

Weather and hydrological services enable shorter term preparedness and response to events, whereas longer term climate information at the seasonal and decadal timescale is essential for long-term planning purposes. WMO has spearheaded the establishment of the Global Framework for Climate Services to guide the development and application of science-based climate information and services in support of decision-making. The vision of the GFCS is to enable society to better manage the risks and opportunities arising from climate variability and change, especially for those who are most vulnerable to such risks. Together with the shorter term information NMHSs provide, this will allow seamless information to be provided across all timescales in support of sustainable development.

The Role of National Meteorological and Hydrological Services

Figure 2 below illustrates the role of a National Meteorological and Hydrological Service in responding to the Global Societal Needs. NMHSs are built upon a foundation of observations and data that, together with research activities, are used to produce relevant, timely and quality information and services. Such information and services can positively impact the critical decisions of those who are sensitive to the extremes of weather, climate and water as well as help decision-makers address societal needs. Early warnings of high-impact weather, marine weather, climate and hydrological events can contribute to improved food security strategies, community resilience and water resource management, enabling society to adapt to climate change, prevent loss of life and property and limit the disastrous effects of high-impact weather events. These services also help to improve environmental quality, enable safe and efficient transportation and support positive health outcomes through warnings of health impacts from poor air quality or vector-borne disease outbreaks.

WMO plays an essential role in coordinating global meteorological data and in setting service delivery quality standards for NMHSs. The efficiency and effectiveness of NMHSs is enhanced through improved data interoperability and quality management systems, enabling them to better fulfil their mandates, demonstrate their relevance and raise their visibility within national governments and with other stakeholder organizations.

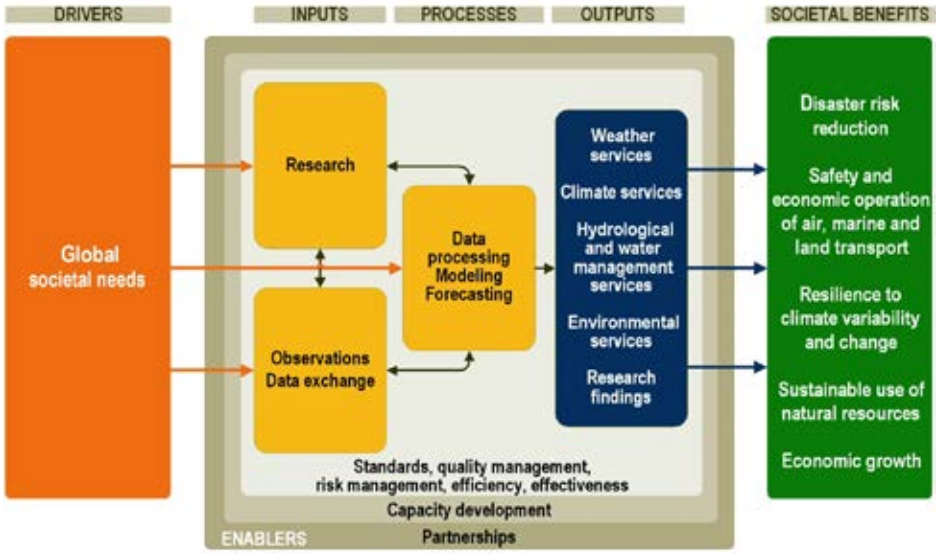

Figure 2. Schematic representation of the processes involved in delivering effective weather, climate and hydrological services and processes to achieve them linked with the mandate of WMO

The Role of WMO

Under its collaborative framework, WMO provides world leadership and expertise in international cooperation in the delivery and use of high quality, authoritative weather, climate, hydrological and related environmental services by its Members, for the improvement of the well-being of societies of all nations. It does so through the coordination of standards and practices among its Members, based on core values of professionalism, excellence, impartiality, cultural sensitivity, non-discrimination and team spirit in international service. WMO's mission, as described in its Convention, is:

(a) To facilitate worldwide cooperation in the establishment of networks of stations for the conduct of meteorological observations as well as hydrological and other geophysical observations, and to promote the establishment and maintenance of centres charged with the provision of meteorological, hydrological and related services;

(b) To promote the establishment and maintenance of systems for the rapid global exchange of meteorological, hydrological and related information;

(c) To promote standardization of meteorological, hydrological and related observations and to ensure the uniform publication of observations and statistics;

(d) To further the application of meteorology to aviation, shipping, water management, agriculture and other human activities;

(e) To promote activities in operational hydrology and to promote close cooperation between meteorological and hydrological services;

(f) To encourage research and training in meteorology, hydrology and, as appropriate, in related fields, and to assist in coordinating international aspects such as research and training; and

(g) To provide guidance to national regulations on provision of official meteorological information and advice, through the Common Alerting Protocol and Register of Alerting Authorities.

The mandate of WMO directly supports the delivery of effective services by NMHSs for the safety of life, the protection of property and support for sustainable development.

Building on Achievements

For decades, WMO Members and their NMHSs have made remarkable progress delivering on WMO priorities. Recent examples over the last four years are:

(a) WMO has played a key role in the establishment of the Global Framework for Climate Services, bringing operational climate services a step closer to realizing their full potential;

(b) Significant advances among the NMHSs in implementing quality management systems and personnel competency standards to further improve the efficiency and safety of international aviation;

(c) Coordination of international scientific developments in support of new and evolving environmental hazard services and associated monitoring systems, e.g. for space weather, air pollution, sand and dust storms and volcanic ash;

(d) Global and regional plans have been developed for implementing the WMO Integrated Global Observing System and 360 national, regional and global centres have enhanced their capabilities in support of the WMO Information System (WIS); and

(e) The provision by NMHSs, and use by disaster and civil protection agencies, of severe weather forecasts and warnings has improved in many regions through the implementation of severe weather forecasting demonstration projects.

This WMO Strategic Plan builds upon these achievements.

Emerging Challenges

Internal Factors Influencing WMO Priorities 2016–2019

Many challenges confront WMO Members, especially those who face significant development and capability gaps in serving the weather-, climate-, and water-related needs of their governments, institutions and citizens. Reliable, high quality services that help prevent the loss of life and property, contribute to economic growth, and support environmental stewardship worldwide depend upon:

(a) Understanding and integrating the needs of various user communities, including disaster and civil protection agencies, into forecasts and warning programmes, taking into account gender-specific aspects;

(b) Availability of modern meteorological, climatological and hydrological infrastructure and availability of well trained, motivated and competent personnel to gather, process, archive and facilitate the rapid exchange of data and products;

(c) Capability to maintain high standards of observations, data and metadata;

(d) Participation in, and access to, research that leads to improved monitoring, prediction and understanding of the atmosphere and hydrosphere at all spatial and temporal scales;

(e) Capability to prepare and deliver high quality understandable, relevant and gender-sensitive early warnings and forecasts of weather-, climate- and water-related hazards, with an increased emphasis on impact-based forecasts and risk-based warnings; and,

(f) Effective mobilization of resources, efficiency in their use and effective modern governance and decision-making nationally, regionally and globally.

External Factors Influencing WMO Priorities 2016–2019

High-impact weather, marine weather, climate and hydrological extremes continue to have significant consequences around the globe and have caught the attention of world leaders. Concerns are mounting about the increasing socio-economic vulnerabilities, risks and severity of these events due to climate variability and change, coupled with increased urbanization and especially in densely populated coastal areas, and the importance of shipping for commerce. The rapidly increasing scale of environmental change being observed in the Polar Regions is already having significant implications on weather and climate patterns worldwide. Demands are escalating for improved monitoring, more accurate and reliable data, better forecasts and advanced impact-based warnings, which inform decision-making that mitigates and adapts to these risks and minimizes disastrous consequences. Continuing economic pressures around the world mean that there is an increasing drive to deliver these service improvements as efficiently as possible.

Significant changes in the socio-economic sectors that are addressed by WMO Programmes, including health, agriculture and food production, transportation, water resource management and energy sectors are also shaping the demands for services from NMHSs now and will continue in the future:

(a) The implementation of the Global Air Navigation Plan of ICAO will have significant implications on the way meteorological services for aviation will be delivered, due to further globalization and regionalization, a shift from a “product-centric” to a “data-centric” approach, and a strong demand for research and innovation to support future global air traffic management;

(b) Expansion of maritime transportation into sparsely monitored and less skilful predicted Polar Regions comes with elevated risks associated with increased variability of weather, climate and sea-ice conditions;

(c) Real-time operational climate services at national, regional and global levels are needed urgently to support the GFCS priorities of agriculture production and food security, reduced disaster risk, human health and sustainable water resources. Such services will also have significant relevance for the energy sector, urban infrastructure and transportation;

(d) Shifts in the intensity and distribution of precipitation patterns worldwide and continued declines of snow and ice conditions especially in the high mountain regions will further implicate water resource and flood management and related decision-making;

(e) New Sendai Framework for DRR 2015–2030 and post-2015 sustainable development agenda emphasize the importance of weather and climate resilience and risk reduction and the need for associated scientific information and services;

(f) Increasing urbanization and population, which is expected to grow by a further 1 billion by 2025, will increase the vulnerability and exposure of people to natural hazards; moreover these hazards are not always gender-neutral;

(g) The burgeoning use of new technologies, such as wireless and social media, and citizens' expectations for tailored understandable information and 'just-in-time' delivery, require NMHSs to use these new technologies to remain effective and relevant;

(h) Slow economic global growth may have a negative impact on resource mobilization; NMHSs need to demonstrate resource efficiencies, cost-benefit and value; and

(i) Increased activity in the value-added, third party meteorological and hydrological sector, while offering benefits to business and consumers, may impact NMHSs; it is imperative for NMHSs to remain highly visible and relevant to communities and governments so that they get appropriate support for their critical roles, particularly as the official and authoritative national voice for early warnings.

WORLD IS CHANGING

- ✓ *Global population 9 billion in 2050*
- ✓ *700 million living in extreme poverty*
- ✓ More than 50% living in urban areas, 72% by 2050
- ✓ 23 Megacities today, 37 by 2050
- ✓ 232 *million* of international migrants
- ✓ 780 *million* have no access to clean water
- ✓ *1.3 billion lack electricity*
- ✓ *7 million premature deaths due to air pollution*

Box: Source – Synthesis Report of the UN SG on the post-2015 sustainable development agenda (A/69/700); Sustainable Energy for All – 2013, WHO-2012; UN-HABITAT-2013.

WMO Priorities 2016–2019

WMO priorities for 2016–2019 reflect the inputs from all WMO constituent bodies and in particular the six regional associations, which gathered the collective views of all 191 WMO Members. All bodies recognize the significance of WMO's research priorities in the area of high-impact weather forecasting, seasonal to sub-seasonal prediction, polar prediction and urban meteorology as the means of enabling improvements to operational service delivery. This is also the case for advancements in monitoring and information technologies, in particular the need to keep WIS aligned with WIGOS developments.

The following key priorities will be given additional emphasis in WMO's Programmes and Result-based Budget for 2016–2019:

(a) **Disaster risk reduction**: improve the accuracy and effectiveness of impact-based forecasts and multi-hazard early warnings of high-impact meteorological, hydrological and related environmental hazards from the tropics to the poles, thereby contributing to international efforts on disaster risk reduction, resilience and prevention, in particular in response to the risks associated with increasing population exposure;

(b) **Global Framework for Climate Services**: Implement climate services under the GFCS particularly for countries that lack them by: (a) establishing regional climate centres; (b) identifying user requirements for climate products; (c) developing the Climate Services Information System (CSIS); (d) advancing the Sub-seasonal to Seasonal (S2S) Prediction skill;

(c) **WMO Integrated Global Observing System**: Strengthen the global observing systems through full implementation of the WIGOS and WMO Information System (WIS) for robust, standardized, integrated, accurate and quality assured relevant observations of the Earth System to support all WMO priorities and expected results;

(d) **Aviation meteorological services**: Improve the ability of NMHSs to provide sustainable high quality services in support of safety, efficiency and regularity of the air traffic management worldwide, with due account to environmental factors by: (a) accelerating the implementation of ICAO / WMO competency and qualification standards and Quality Management Systems (QMS); (b) addressing emerging requirements and challenges related to the 2013–2028 Global Air Navigation Plan, in particular concerning ICAO's Block 1 Upgrades (ASBUs); and (c) strengthening the sustainability and competitiveness of aeronautical meteorological service provision through improved cost recovery mechanisms and suitable business models for service delivery frameworks;

(e) **Polar and high mountain regions**: Improve operational meteorological and hydrological monitoring, prediction and services in polar, high mountain regions and beyond by: (a) operationalizing the Global Cryosphere Watch (GCW); (b) better understanding the implications of changes in these regions on the global weather and climate patters; and (c) advancing the polar prediction under the Global Integrated Polar Prediction System (GIPPS);

(f) **Capacity Development**: Enhance the capacity of NMHSs to deliver on their mission by developing and improving competent human resource, technical and institutional capacities and infrastructure, particularly in developing, least developed and small island developing states; and

(g) **WMO Governance**: Improve efficiency and effectiveness of WMO though adopting continuous improvement measures and recommendations based on a strategic review of WMO structures, operating arrangements and budgeting practices.

Expected Results

To achieve significant, targeted improvements of services to address the escalating needs, WMO will focus its endeavours on the following Expected Results:

1. **Improved service quality and service delivery**: Enhanced capabilities of Members to deliver and improve access to high-quality weather, climate, hydrological and related environmental predictions, information, warnings and services in response to users' needs and to enable their use in decision-making by relevant societal sectors.

2. **Reduced Disaster Risk**: Enhanced capabilities of Members to reduce risks and potential impacts of hazards caused by weather, climate, water and related environmental elements.

3. **Improved Data Processing, Modelling and Forecasting**: Enhanced capabilities of Members to produce better weather, climate, water and related environmental information, predictions and warnings to support, in particular, reduced disaster risk and climate impact and adaptation strategies.

4. **Improved Observations and Data Exchange**: Enhanced capabilities of Members to access, develop, implement and use integrated and interoperable Earth- and space-based observation systems for weather, climate and hydrological observations, as well as related environmental and space weather observations, based on world standards set by WMO.

5. **Advance Targeted Research**: Enhanced capabilities of Members to contribute to and draw benefits from the global research capability for weather, climate, water and related environmental science and technology development.

6. **Strengthened Capacity Development**: Enhanced capabilities of Members' NMHSs, in particular, in developing and least developed countries and Small Island Developing States, to fulfil their mandates.

7. **Strengthened Partnerships**: New and strengthened partnerships and cooperation activities to improve NMHSs' performance in delivering services and to demonstrate the value of WMO contributions within the United Nations system, relevant regional organizations, international conventions and national strategies.

8. **Improved Efficiency and Effectiveness**: Ensured effective functioning of policy-making and constituent bodies and oversight of the Organization.

The degree to which this Plan is factored into the national, regional and international development agenda is amongst the risks that will influence the achievement of Expected Results. The fluid global financial situation is having significant impact on voluntary contributions, which provides some of the resources for implementing the strategic priorities, particularly to enhance capacities of NMHSs in developing and least developed countries and small islands developing states.

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Annex I

SCHEMATIC REPRESENTATION OF THE RELATIONSHIPS BETWEEN GLOBAL SOCIETAL NEEDS, WMO PRIORITIES 2016–2019 AND EXPECTED RESULTS

Global Societal Needs	Priorities		Expected Results
Improved protection of life and property End poverty, ensure sustainable resilient livelihoods, food security, sustainable access to water and energy, healthy lives, gender equality and economic growth, and combat climate change Sustainable use of natural resources and improved environmental quality	Disaster Risk Reduction	1	Improved service quality and service delivery *Enhanced capabilities of Members to deliver and improve access to high-quality weather, climate, hydrological and related environmental predictions, information, warnings and services in response to users' needs and to enable their use in decision-making by relevant societal sectors*
		2	Reduced Disaster Risk *Enhanced capabilities of Members to reduce risks and potential impacts of hazards caused by weather, climate, water and related environmental elements*
	Global Framework for Climate Services	3	Improved Data Processing, Modelling and Forecasting *Enhanced capabilities of Members to produce better weather, climate, water and related environmental information, predictions and warnings to support, in particular, reduced disaster risk and climate impact and adaptation strategies*
	WMO Integrated Global Observing System Aviation meteorological services	4	Improved Observations and Data Exchange *Enhanced capabilities of Members to access, develop, implement and use integrated and interoperable Earth- and space-based observation systems for weather, climate and hydrological observations, as well as related environmental and space weather observations, based on world standards set by WMO*
	Polar and high mountain regions monitoring, prediction and services	5	Advance Targeted Research *Enhanced capabilities of Members to contribute to and draw benefits from the global research capacity for weather, climate, water and the related environmental science and technology development*
	Capacity development	6	Strengthened Capacity Development *Enhanced capabilities of Members' NMHSs, in particular, in developing and least developed countries and Small Island Developing States, to fulfil their mandates*
	WMO governance	7	Strengthened Partnerships *New and strengthened partnerships and cooperation activities to improve NMHSs' performance in delivering services and to demonstrate the value of WMO contributions within the United Nations system, relevant regional organizations, international conventions and national strategies*
		8	Improved Efficiency and Effectiveness *Ensured effective functioning of policy-making and constituent bodies and oversight of the Organization.*

Annex II

BENEFITS OF WEATHER, MARINE WEATHER, CLIMATE, HYDROLOGICAL AND RELATED ENVIRONMENTAL SERVICES

Social Benefits

NMHSs and other institutions of WMO Members contribute to the safety and well-being of society through their efforts to provide information on the impacts on lives and livelihoods of natural hazards, to improve the safety of transport on land, at sea, and in the air and to contribute to human and environmental health outcomes. Improving operational climate services through the GFCS implementation will enhance national capabilities to support climate-smart decision-making. This will further increase the resilience of society to longer-term climate variability and change. Critical to success are the service delivery interactions with the community of users, including open access to global weather, hydrological, climate and related data, knowledge and impact-relevant products and services.

Sendai Framework for DRR 2015–2030 (SFDRR), the successor to the Hyogo Framework for Action (HFA) has been established in 2015. The WMO and its Members will be guided by its objectives, particularly in support of disaster prevention and community resilience through improved ability of NMHSs to warn and inform citizens of natural hazards. Effective disaster risk reduction is founded on actions that are informed by science-based weather, climate, water and related environmental information about the potential hazards. Seasonal climate forecasts are useful for strategic and tactical planning of climate-sensitive activities, while the analysis of multi-year hazard patterns and trends, combined with climate change scenarios, can underpin longer-term strategic planning.

Climate-related risk knowledge on month to decadal timescales helps institutions and organizations at global, regional and national levels to develop risk management plans based upon:

(a) Early warning systems and preparedness;

(b) Medium- and long-term sectoral planning (e.g., land zoning, infrastructure development and agricultural management); and

(c) Utilization of hazard-indexed insurance and financing mechanisms to reduce the impacts of disasters at various levels.

Economic Benefits

Accurate, timely and impact-oriented weather, marine weather, climate, hydrological and related environmental services from Members, in particular from their NMHSs, make a significant contribution to economic stability, efficiency and growth in many sectors. Examples include in water resource management, food production, aviation and marine transportation and energy, especially hydro-, solar- and wind-power. Early warning services and forecasts inform economically-driven decisions that mitigate the effects of meteorological and hydrological hazards. Improved climate products and services offer significant economic benefits.

WMO Members also monitor space weather conditions and processes (e.g. solar flares, geomagnetic storms, etc.) which can have significant impacts on economic sectors such as aviation, telecommunications, satellite operations and electricity transmission. Governments and the aviation industry rely on WMO and its Members to provide advice on the dispersion of volcanic ash, a significant hazard to aircraft and with associated downstream impacts on numerous economic sectors. In response to nuclear or industrial accidents, WMO works in close collaboration with agencies such as the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO) to provide advice and information to reduce community impacts.

Environmental Benefits

WMO and its Members monitor the environment over time, providing insight into possible impacts on our climate, food and water security, natural ecosystems and human health. Changes are occurring in rainfall and temperature, the chemical composition of our atmosphere, surface and groundwater availability, land cover and soil condition, the temperature and chemical balance of our oceans, and pollutants in our air, water, soil and oceans. Subtle changes in these parameters can have profound consequences for ecosystems, biodiversity and our food production systems.

Resolution 70 (Cg-17)

MAXIMUM EXPENDITURE FOR THE SEVENTEENTH FINANCIAL PERIOD (2016–2019)

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Article 23 of the Convention of the World Meteorological Organization,

(2) Article 4 of the Financial Regulations of the Organization,

Considering the emerging priorities included in the WMO Strategic Plan 2016–2019 and the views expressed in the general summary of the report of its seventeenth session (*Abridged Final Report with Resolutions of the Seventeenth World Meteorological Congress* (WMO-No. 1157)),

Authorizes the Executive Council during the seventeenth financial period from 1 January 2016 to 31 December 2019:

(1) To incur expenditures financed out of assessed contributions for the amount of 266 220 000 Swiss francs (CHF 266 220 000);

(2) To apportion such expenditure against the Expected Results;

(3) To approve biennial appropriations within this limit;

(4) To review WMO activities and Programmes, in coordination with the Secretariat, and ensure that priorities identified by the Seventeenth World Meteorological Congress are realized within the available resources and to include in this review considerations of additional efficiencies and savings, activities that could be re-scoped, and programme support costs associated with voluntary contributions, as well as the risks and opportunities associated with the above;

Requests the Executive Council:

(1) To establish the required mechanisms to carry out the work described in the present resolution;

(2) To report to Eighteenth Congress on the results of the review and their implementation;

Requests the Secretary-General to include information on the costs of the WMO activities and Programmes and the objects of expenditure with the results-based budget for the second biennium (2018–2019) and the eighteenth financial period (2020–2023);

Further requests the Secretary-General to seek additional voluntary contributions to support priorities included in the WMO Strategic Plan 2016–2019.

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Note: This resolution replaces Resolution 37 (Cg-XVI), which remains in force only until 31 December 2015.

Resolution 71 (Cg-17)

PREPARATION OF THE STRATEGIC AND OPERATING PLANS 2020–2023

THE WORLD METEOROLOGICAL CONGRESS,

Noting Resolution 69 (Cg-17) – WMO Strategic Plan 2016–2019,

Considering:

(1) That the WMO Strategic and Operating Plans provide useful guidance to Members and their National Meteorological and Hydrological Services in consolidating their own planning policies, programmes and activities,

(2) That there is a continuing need for a sufficiently long lead time in planning the main directions of the scientific and technical work of the Organization,

(3) That the WMO strategic planning process enables the Organization to reflect on intended goals and major expected results in the light of anticipated societal changes and scientific and technical progress,

(4) That the WMO strategic planning process has improved the overall effectiveness of the Organization and thus enhanced its status within the United Nations system in addressing relevant issues,

Reaffirming that the overall purpose of the strategic planning process in WMO is to set strategic directions and priorities to guide the activities of all constituent bodies addressing the global societal needs to achieve Expected Results for the Organization and to provide sufficient guidance for the formulation of the four-year WMO Operating Plan and results-based budget,

Confirming the leading role of the Executive Council and important contributions of regional associations and technical commissions in developing and implementing the Strategic Plan,

Decides that the WMO Strategic and Operating Plans 2020–2023 should be prepared;

Requests the Executive Council:

(1) To organize a planning process taking into account lessons learned from the previous planning phases;

(2) To continue to improve the structure, focus and performance metrics on the basis of evolving societal and economic needs, as well as on the results of evaluation of the performance in the implementation of the Strategic Plans for the periods 2008–2011, 2012–2015 and 2016–2019;

(3) To effectively engage regional associations and technical commissions in the planning process and to consider stronger linkages and complementary roles of technical commissions and regional associations in the planning process;

(4) To develop a better means of integrating and supporting the development of regional and technical components of the WMO-wide Operating Plan;

(5) To identify areas that need further improvements and address them in the order of priority with specific emphasis on establishing baselines, formulating specific, measurable, achievable, realistic and time-bound Key Performance Indicators, setting achievable targets, and synchronization with decision-making by technical commissions and regional associations;

(6) To take into account the outcomes of the work on continuous improvement of WMO working processes and practices;

Requests the regional associations:

(1) To provide regional needs and priorities that should be taken into consideration in developing the WMO Strategic Plan 2020–2023;

(2) To coordinate, as necessary, national contributions to regional aspects of the Plan;

(3) To develop their own Operating Plans in support of the implementation of the WMO Strategic Plan 2020–2023;

Requests the technical commissions:

(1) To lead the formulation of the scientific and technical aspects of WMO Programmes and activities falling within their respective responsibilities in preparing the WMO Operating Plan;

(2) To develop their own Operating Plans in support of the implementation of the WMO Strategic Plan 2020–2023;

Requests the Secretary-General:

(1) To provide Secretariat support to the strategic planning process;

(2) To ensure that the WMO Strategic Plan, the WMO Operating Plan and the budget for the eighteenth financial period are fully coordinated;

(3) To submit the first outline with possible scenarios to the Executive Council at its sixty-eighth session;

(4) To submit the draft WMO Strategic Plan 2020–2023 to the Eighteenth World Meteorological Congress for approval.

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Note: This resolution replaces Resolution 38 (Cg-XVI), which is no longer in force.

Resolution 72 (Cg-17)

USE OF CASH SURPLUS ARISING FROM THE SIXTEENTH FINANCIAL PERIOD (2012–2015)

THE WORLD METEOROLOGICAL CONGRESS,

Noting the financial report of the Secretary-General to the Seventeenth World Meteorological Congress,

Authorizes the suspension of Financial Regulation 9.1 during the seventeenth financial period only, with respect to the distribution of any cash surplus that might result from the sixteenth financial period, and delegates to the Executive Council the allocation of such cash surplus to priority activities.

Resolution 73 (Cg-17)

PLAN FOR FUNDING LIABILITY FOR AFTER-SERVICE HEALTH INSURANCE

THE WORLD METEOROLOGICAL CONGRESS,

Noting the risks associated with the long-term liability for after-service health insurance (ASHI),

Requests the Secretary-General to submit a proposal to the Executive Council that will take into account the decision of the General Assembly of the United Nations at its seventieth session on ASHI when this is available, and authorizes the Executive Council to take a decision;

Further requests the Secretary-General to submit proposals for appropriate short-term measures to manage and contain the WMO ASHI liability, should the decision of the General Assembly not be available by the end of 2015, and to report to the Executive Council at its sixty-eighth session for review and approval, as appropriate.

Resolution 74 (Cg-17)

SHORT-TERM BORROWING AUTHORITY

THE WORLD METEOROLOGICAL CONGRESS,

Noting Resolution 31 (Cg-XIII) – Short-term borrowing authority,

Noting that the bulk of the cash resources required for the implementation of the regular programmes of the Organization as approved by the World Meteorological Congress and the Executive Council derives from the contributions paid by its Members and from the advances made to the Working Capital Fund,

Noting also that substantial delays may occur in the receipt of the contribution assessed on some of its Members,

Stresses the need to ensure the financing of the approved biennial budget;

Urges all Members to pay, on time as foreseen in the Convention of the World Meteorological Organization, their assessed contributions including arrears, if any;

Authorizes the Secretary-General, if the cash balance of the Working Capital Fund proves to be temporarily inadequate for financing the approved budget, to borrow funds on a short-term basis:

(1) From voluntary contributions, excluding those to which Financial Regulation 9.9 applies, to the extent that such borrowing does not affect the activities financed under these funds;

(2) Only in extreme circumstances when no other alternative is available and after consultation with the Executive Council, or the President of WMO acting on its behalf, from governments, banks or other external sources, as a last resort if the acquisition of funds under the authority given in (a) proves to be insufficient or not possible provided that the maximum amount of such borrowing shall not exceed two months' expenditure from the approved biennial budget and that the loan shall be limited in time to six months;

Decides that the repayment of such short-term loans shall be made as soon as contributions received make this possible, it being understood that repayment of loans made under the external borrowing authority will have priority over the repayment of funds borrowed internally and that repayment to funds other than the Working Capital Fund will be made before the repayment to the Working Capital Fund;

Further decides that interest due on such short-term loans shall be charged under Part 6.30 – Insurance, Staff Compensation Fund, audit costs, contingencies and unforeseen expenditures, of the biennial budget if it cannot be met from the miscellaneous income;

Requests the Secretary-General to report to the Executive Council on the action taken within the framework of the present resolution.

_____

Note: This resolution replaces Resolution 31 (Cg-XIII), which is no longer in force.

Resolution 75 (Cg-17)

ASSESSMENT OF PROPORTIONAL CONTRIBUTIONS OF MEMBERS FOR THE SEVENTEENTH FINANCIAL PERIOD

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Article 24 of the Convention of the World Meteorological Organization,

(2) Article 8 of the Financial Regulations of the Organization,

(3) Resolution 39 (Cg-XVI) – Assessment of proportional contributions of Members for the sixteenth financial period,

Decides:

(1) That the latest United Nations scale of assessments to be approved by the General Assembly of the United Nations should continue to be used as the basis for the calculation of the WMO scales of assessments, duly adjusted for differences in membership, as specified in Table 1 of the annex to the present resolution;

(2) That the scale of assessments of proportional contributions of Members for the seventeenth financial period (2016–2019) shall be based on the United Nations scales of assessments adopted by the General Assembly of the United Nations at its sixty-seventh session in 2012 and seventieth session in 2015, and adjusted for differences in membership;

(3) That the proportional contributions of countries that are not Members but may become Members shall be assessed as shown in Table 2 of the annex to the present resolution;

Authorizes the Secretary-General to accept and implement any proposal for the adjustment of individual percentage assessments submitted jointly by two or more Members, provided that the aggregate percentage assessments of any Members submitting such a proposal shall remain after adjustment equal to their aggregate assessments and to inform the Executive Council of any such arrangements;

Authorizes the Executive Council:

(1) To adjust the scale of assessments for the years 2017 to 2019 using the United Nations scale of assessments to be adopted by the General Assembly of the United Nations in 2015 and adjusted for differences in membership, provided that for the WMO scale, the minimum rate shall remain at 0.02 per cent and that corrections shall be made to ensure that no Member's rate of assessment would increase to a level which would exceed 200 per cent of the WMO scale in 2015;

(2) To make a provisional assessment in respect of non-Members should any become Members, the method of assessment being based on principles similar to those governing the assessments laid down in the present resolution.

Note: This resolution replaces Resolution 39 (Cg-XVI), which remains in force only until 31 December 2015.

Annex to Resolution 75 (Cg-17)

PROPOSED WMO SCALE OF ASSESSMENTS

Table 1
Proportional contributions for the seventeenth financial period

	Member	*Scale of assessment for 2012*	*Scale of assessment for 2015*	*Proposed scale of assessment for 2016*
1	Afghanistan	0.02	0.02	0.02
2	Albania	0.02	0.02	0.02
3	Algeria	0.13	0.14	0.14
4	Angola	0.02	0.02	0.02
5	Antigua and Barbuda	0.02	0.02	0.02
6	Argentina	0.28	0.43	0.43
7	Armenia	0.02	0.02	0.02

	Member	*Scale of assessment for 2012*	*Scale of assessment for 2015*	*Proposed scale of assessment for 2016*
8	Australia	1.90	2.04	2.04
9	Austria	0.84	0.79	0.79
10	Azerbaijan	0.02	0.04	0.04
11	Bahamas	0.02	0.02	0.02
12	Bahrain	0.04	0.04	0.04
13	Bangladesh	0.02	0.02	0.02
14	Barbados	0.02	0.02	0.02
15	Belarus	0.04	0.06	0.06
16	Belgium	1.06	0.98	0.98
17	Belize	0.02	0.02	0.02
18	Benin	0.02	0.02	0.02
19	Bhutan	0.02	0.02	0.02
20	Bolivia, Plurinational State of	0.02	0.02	0.02
21	Bosnia and Herzegovina	0.02	0.02	0.02
22	Botswana	0.02	0.02	0.02
23	Brazil	1.59	2.89	2.89
24	British Caribbean Territories	0.02	0.02	0.02
25	Brunei Darussalam	0.03	0.03	0.03
26	Bulgaria	0.04	0.05	0.05
27	Burkina Faso	0.02	0.02	0.02
28	Burundi	0.02	0.02	0.02
29	Cabo Verde	0.02	0.02	0.02
30	Cambodia	0.02	0.02	0.02
31	Cameroon	0.02	0.02	0.02
32	Canada	3.16	2.94	2.94
33	Central African Republic	0.02	0.02	0.02
34	Chad	0.02	0.02	0.02
35	Chile	0.23	0.33	0.33
36	China	3.14	5.07	5.07
37	Colombia	0.14	0.26	0.26
38	Comoros	0.02	0.02	0.02
39	Congo	0.02	0.02	0.02
40	Cook Islands	0.02	0.02	0.02
41	Costa Rica	0.03	0.04	0.04
42	Côte d'Ivoire	0.02	0.02	0.02
43	Croatia	0.10	0.12	0.12

	Member	*Scale of assessment for 2012*	*Scale of assessment for 2015*	*Proposed scale of assessment for 2016*
44	Cuba	0.07	0.07	0.07
45	Curaçao and Sint Maarten	0.02	0.02	0.02
46	Cyprus	0.05	0.05	0.05
47	Czech Republic	0.34	0.38	0.38
48	Democratic People's Republic of Korea	0.02	0.02	0.02
49	Democratic Republic of the Congo	0.02	0.02	0.02
50	Denmark	0.73	0.67	0.67
51	Djibouti	0.02	0.02	0.02
52	Dominica	0.02	0.02	0.02
53	Dominican Republic	0.04	0.04	0.04
54	Ecuador	0.04	0.04	0.04
55	Egypt	0.09	0.13	0.13
56	El Salvador	0.02	0.02	0.02
57	Eritrea	0.02	0.02	0.02
58	Estonia	0.04	0.04	0.04
59	Ethiopia	0.02	0.02	0.02
60	Fiji	0.02	0.02	0.02
61	Finland	0.56	0.51	0.51
62	France	6.03	5.51	5.51
63	French Polynesia	0.02	0.02	0.02
64	Gabon	0.02	0.02	0.02
65	Gambia	0.02	0.02	0.02
66	Georgia	0.02	0.02	0.02
67	Germany	7.89	7.04	7.04
68	Ghana	0.02	0.02	0.02
69	Greece	0.68	0.63	0.63
70	Guatemala	0.03	0.03	0.03
71	Guinea	0.02	0.02	0.02
72	Guinea-Bissau	0.02	0.02	0.02
73	Guyana	0.02	0.02	0.02
74	Haiti	0.02	0.02	0.02
75	Honduras	0.02	0.02	0.02
76	Hong Kong, China	0.02	0.02	0.02
77	Hungary	0.29	0.26	0.26
78	Iceland	0.04	0.03	0.03
79	India	0.53	0.66	0.66

	Member	*Scale of assessment for 2012*	*Scale of assessment for 2015*	*Proposed scale of assessment for 2016*
80	Indonesia	0.23	0.34	0.34
81	Iran, Islamic Republic of	0.23	0.35	0.35
82	Iraq	0.02	0.04	0.04
83	Ireland	0.49	0.41	0.41
84	Israel	0.38	0.39	0.39
85	Italy	4.92	4.38	4.38
86	Jamaica	0.02	0.02	0.02
87	Japan	12.34	10.68	10.68
88	Jordan	0.02	0.02	0.02
89	Kazakhstan	0.06	0.12	0.12
90	Kenya	0.02	0.02	0.02
91	Kiribati	0.02	0.02	0.02
92	Kuwait	0.26	0.27	0.27
93	Kyrgyzstan	0.02	0.02	0.02
94	Lao People's Democratic Republic	0.02	0.02	0.02
95	Latvia	0.04	0.05	0.05
96	Lebanon	0.03	0.04	0.04
97	Lesotho	0.02	0.02	0.02
98	Liberia	0.02	0.02	0.02
99	Libya	0.12	0.14	0.14
100	Lithuania	0.06	0.07	0.07
101	Luxembourg	0.09	0.08	0.08
102	Macao, China	0.02	0.02	0.02
103	Madagascar	0.02	0.02	0.02
104	Malawi	0.02	0.02	0.02
105	Malaysia	0.25	0.28	0.28
106	Maldives	0.02	0.02	0.02
107	Mali	0.02	0.02	0.02
108	Malta	0.02	0.02	0.02
109	Mauritania	0.02	0.02	0.02
110	Mauritius	0.02	0.02	0.02
111	Mexico	2.32	1.81	1.81
112	Micronesia, Federated States of	0.02	0.02	0.02
113	Monaco	0.02	0.02	0.02
114	Mongolia	0.02	0.02	0.02
115	Montenegro	0.02	0.02	0.02

	Member	*Scale of assessment for 2012*	*Scale of assessment for 2015*	*Proposed scale of assessment for 2016*
116	Morocco	0.06	0.06	0.06
117	Mozambique	0.02	0.02	0.02
118	Myanmar	0.02	0.02	0.02
119	Namibia	0.02	0.02	0.02
120	Nepal	0.02	0.02	0.02
121	Netherlands	1.83	1.63	1.63
122	New Caledonia	0.02	0.02	0.02
123	New Zealand	0.27	0.25	0.25
124	Nicaragua	0.02	0.02	0.02
125	Niger	0.02	0.02	0.02
126	Nigeria	0.08	0.09	0.09
127	Niue	0.02	0.02	0.02
128	Norway	0.86	0.84	0.84
129	Oman	0.09	0.10	0.10
130	Pakistan	0.08	0.08	0.08
131	Panama	0.02	0.03	0.03
132	Papua New Guinea	0.02	0.02	0.02
133	Paraguay	0.02	0.02	0.02
134	Peru	0.09	0.12	0.12
135	Philippines	0.09	0.15	0.15
136	Poland	0.82	0.91	0.91
137	Portugal	0.50	0.47	0.47
138	Qatar	0.13	0.21	0.21
139	Republic of Korea	2.23	1.96	1.96
140	Republic of Moldova	0.02	0.02	0.02
141	Romania	0.14	0.22	0.22
142	Russian Federation	1.58	2.40	2.40
143	Rwanda	0.02	0.02	0.02
144	Saint Lucia	0.02	0.02	0.02
145	Samoa	0.02	0.02	0.02
146	Sao Tome and Principe	0.02	0.02	0.02
147	Saudi Arabia	0.82	0.85	0.85
148	Senegal	0.02	0.02	0.02
149	Serbia	0.04	0.04	0.04
150	Seychelles	0.02	0.02	0.02

	Member	*Scale of assessment for 2012*	*Scale of assessment for 2015*	*Proposed scale of assessment for 2016*
151	Sierra Leone	0.02	0.02	0.02
152	Singapore	0.33	0.38	0.38
153	Slovakia	0.12	0.17	0.17
154	Slovenia	0.10	0.10	0.10
155	Solomon Islands	0.02	0.02	0.02
156	Somalia	0.02	0.02	0.02
157	South Africa	0.38	0.37	0.37
158	South Sudan	-	0.02	0.02
159	Spain	3.13	2.93	2.93
160	Sri Lanka	0.02	0.03	0.03
161	Sudan	0.02	0.02	0.02
162	Suriname	0.02	0.02	0.02
163	Swaziland	0.02	0.02	0.02
164	Sweden	1.05	0.95	0.95
165	Switzerland	1.11	1.03	1.03
166	Syrian Arab Republic	0.03	0.04	0.04
167	Tajikistan	0.02	0.02	0.02
168	Thailand	0.21	0.24	0.24
169	The former Yugoslav Republic of Macedonia*	0.02	0.02	0.02
170	Timor-Leste	0.02	0.02	0.02
171	Togo	0.02	0.02	0.02
172	Tonga	0.02	0.02	0.02
173	Trinidad and Tobago	0.04	0.04	0.04
174	Tunisia	0.03	0.04	0.04
175	Turkey	0.61	1.22	1.22
176	Turkmenistan	0.03	0.02	0.02
177	Tuvalu	-	0.02	0.02
178	Uganda	0.02	0.02	0.02
179	Ukraine	0.08	0.10	0.10
180	United Arab Emirates	0.39	0.59	0.59
181	United Kingdom of Great Britain and Northern Ireland	6.50	5.10	5.10
182	United Republic of Tanzania	0.02	0.02	0.02
183	United States of America	21.66	21.68	21.68
184	Uruguay	0.03	0.05	0.05
185	Uzbekistan	0.02	0.02	0.02

	Member	*Scale of assessment for 2012*	*Scale of assessment for 2015*	*Proposed scale of assessment for 2016*
186	Vanuatu	0.02	0.02	0.02
187	Venezuela, Bolivarian Republic of	0.31	0.62	0.62
188	Viet Nam	0.03	0.04	0.04
189	Yemen	0.02	0.02	0.02
190	Zambia	0.02	0.02	0.02
191	Zimbabwe	0.02	0.02	0.02
	Total	**100.00**	**100.00**	**100.00**

Note: For the years 2017 to 2019, the United Nations scales to be approved by the seventieth United Nations General Assembly in 2015 would be adopted, duly adjusted for differences in membership.

* Following the decision of the United Nations General Assembly on 8 April 1993, the State is being provisionally referred to for all purposes within the Organization as "The Former Yugoslav Republic of Macedonia" pending settlement of differences that have arisen over its name.

Table 2
Countries which may become Members

	Country	*Percentage assessment **
1	Andorra	0.02
2	Equatorial Guinea	0.02
2	Grenada	0.02
4	Holy See	0.02
5	Liechtenstein	0.02
6	Marshall Islands	0.02
7	Nauru	0.02
8	Palau	0.02
9	Saint Kitts and Nevis	0.02
10	Saint Vincent and the Grenadines	0.02
11	San Marino	0.02

* Based on the decision regarding minimum percentage to be applied

Resolution 76 (Cg-17)

WORKING CAPITAL FUND

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Resolution 42 (Cg-XV) – Working Capital Fund,

(2) Articles 8 and 9 of the Financial Regulations of the Organization,

(3) Resolution 15 (EC-LXI) – Financing the shortfall in the capital of the Working Capital Fund,

Decides:

(1) That the Working Capital Fund shall continue to be maintained for the following purposes:

   (a) To finance budgetary appropriations pending receipt of contributions;

   (b) To advance such sums as may be necessary to cover unforeseen and extraordinary expenses that cannot be met from current budgetary provisions;

(2) That the principal of the Working Capital Fund during the seventeenth financial period shall be maintained at CHF 7.5 million;

(3) That the existing advances of each Member shall, notwithstanding the provisions of Financial Regulation 9.3, continue to be frozen at the level fixed for the fourteenth financial period;

(4) That the shortfall of the principal, that is, CHF 896 000, shall be provided by crediting interest earned on the investment of cash resources of the Working Capital Fund;

(5) That advances for new Members joining the Organization after 1 January 2016 shall be assessed at the rate established for the scale of assessment for the year of entry.

Resolution 77 (Cg-17)

SECRETARY-GENERAL'S CONTRACT

THE WORLD METEOROLOGICAL CONGRESS,

Noting Article 21 (a) of the Convention of the World Meteorological Organization,

Noting Resolution 41 (Cg-XVI) – Secretary-General's contract,

Decides that the terms of the appointment of the Secretary-General should be as set forth in the contract, as annexed to the present resolution.

_____

Note: This resolution replaces Resolution 41 (Cg-XVI), which remains in force only until 31 December 2015.

Annex to Resolution 77 (Cg-17)

SECRETARY-GENERAL'S CONTRACT

In application of Article 21, paragraph (a) of the Convention of the World Meteorological Organization, prescribing that the Secretary-General shall be appointed by the Congress on such terms as the Congress may approve; and

Having regard to the resolution adopted by the Seventeenth Congress of the World Meteorological Organization approving the terms of appointment included in the present agreement;

It is hereby agreed as follows:

Between the World Meteorological Organization, hereinafter called the Organization, represented by its President, on the one part, and Mr Petteri Taalas appointed Secretary-General by the Seventeenth World Meteorological Congress during its meeting of 4 June 2015, on the other part,

1. The Secretary-General's term of appointment shall take effect from 1 January 2016.

2. The Secretary-General, at the time of taking up his appointment, shall subscribe to the following oath or declaration:

"I solemnly swear (undertake, affirm, promise) to exercise in loyalty, discretion and conscience the functions entrusted to me as an international civil servant of the World Meteorological Organization, to discharge these functions and regulate my conduct with the interests of the Organization only in view, and not to seek or accept instructions in regard to the performance of my duties from any government or other authority external to the Organization."

This oath or declaration shall be made orally by the Secretary-General in the presence of the President and either a Vice-President or another member of the Executive Council.

3. During the term of his appointment, the Secretary-General shall enjoy the privileges and immunities in keeping with his office which are granted him/her by appropriate agreements entered into by the Organization; he shall not engage in any activity that is incompatible with the proper discharge of his duties and Secretary-General of the Organization; he shall renounce any employment or remunerated activities other than those of Secretary-General of the Organization, except those activities authorized by the Executive Council; he shall not accept any honour, decoration, favour, gift or remuneration from any source external to the Organization without first obtaining the approval of the Executive Council.

4. The term of appointment of the Secretary-General shall end:

(a) By expiration of this agreement on 31 December 2019; or

(b) By this official's resignation submitted in writing to the President of the Organization, in which case the Secretary-General shall cease his functions two months after the date of acceptance of his resignation by the Executive Council; or

(c) By termination for serious failure to carry out his duties and obligations, and in particular those set out in paragraphs (2) and (3) of this agreement. In such case, the Secretary-General shall be heard as of right by the Executive Council; if the Executive Council decides to terminate the appointment, the decision shall take effect two months after the date of pronouncement and on conditions to be determined by the Executive Council. After consultation with the Executive Council, the President of the Organization may suspend the

Secretary-General from the exercise of his functions pending investigation by the Executive Council and until this Council has taken a decision.

5. The Secretary-General shall receive from the Organization:

(a) An annual salary of US$ 166,846 net (after deduction for staff assessment), with the application of the appropriate post adjustment at a rate equivalent to that applied to executive heads of other comparable specialized agencies, salary and post adjustment to be paid in monthly instalments; and

(b) An annual representation allowance of 29,000 Swiss francs, to be paid in monthly instalments; and

(c) Other allowances including dependency benefits, education, installation and repatriation grants, payment of removal, if pertinent, and travel and subsistence allowances appropriate and under the conditions applicable to Under-Secretaries of the United Nations.

All the above-mentioned sums will be paid in the currency of the country where the Secretariat is located, unless the Executive Council and the Secretary-General agree to some other arrangement.

The salary and emoluments received from the Organization will be free of tax.

6. The Secretary-General shall be allowed thirty working days' leave each year. In order that the Secretary-General may take his annual leave every two years in his home country, the Organization shall pay the expenses in connection with the travel of the Secretary-General, his spouse and his dependent children, under the conditions applicable to Under-Secretaries of the United Nations.

7. The Secretary-General shall participate in any social security scheme established by the Organization, the benefits he would receive being not less favourable than those which would accrue in similar circumstances to an official of the next highest rank of the staff covered by the scheme.

8. Any divergence of views concerning the application or interpretation of the present agreement, which it shall not have been possible to settle by direct discussion between the parties, can be submitted by one or the other of the parties to the judgement of the Administrative Tribunal, the competence of which is recognized by the Organization, whose decisions will be final. For any appeals by the Secretary-General against the non-observation of the statutes of the United Nations Joint Staff Pension Fund, of which the Secretary-General shall be a participant in accordance with the regulations and rules of that Fund, the Administrative Tribunal whose jurisdiction has been accepted by the Organization for pension cases is recognized hereby as the competent arbitrator.

Done and signed in duplicate at _____ on the _____ 2015.

_____	_____
(Mr David Grimes) President of the World Meteorological Organization	(Mr Petteri Taalas) Secretary-General appointed by the Seventeenth World Meteorological Congress

Resolution 78 (Cg-17)

AMENDMENT TO THE STAFF REGULATIONS

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) That Article 8 (d) of the Convention of the World Meteorological Organization authorizes the World Meteorological Congress to determine regulations prescribing the procedures of the various bodies of the Organization and, in particular, the Staff Regulations,

(2) The Staff Regulations of the World Meteorological Organization, as contained in *Basic Documents No. 1* (WMO-No. 15), 2012 edition,

Considering the amendment of the mandatory age of separation by decision of the General Assembly of the United Nations in its Resolution 67/257 – United Nations common system: report of the International Civil Service Commission,

Considering also the WMO Gender Equality Policy adopted by Seventeenth Congress in Resolution 59 (Cg-17) – Gender equality and empowerment of women,

Decides to amend the Staff Regulations, Article 9, paragraph 9.5, as set out in the annex to the present resolution, which shall apply retroactively to 1 January 2014;

Further decides to amend the Staff Regulations, Article 4, paragraph 4.2 to promote gender balance, as set out in the annex to the present resolution, which shall apply as of 1 July 2015.

Annex to Resolution 78 (Cg-17)

STAFF REGULATIONS OF THE WORLD METEOROLOGICAL ORGANIZATION

Contained in *Basic Documents No. 1* (WMO-No. 15), 2012 edition

Article 4

4.2 The paramount consideration in the appointment, transfer or promotion of the staff shall be the necessity of securing the highest standards of efficiency, competence and integrity. Due regard shall be paid to the importance of recruiting and maintaining the staff on as wide a geographical basis and gender balance as possible.

Article 9

9.5 Normally staff members shall not be retained in active service beyond the age of 60 years, and not beyond the age of 62 years in the case of staff members appointed on or after 1 January 1990, and not beyond the age of 65 years in the case of staff members appointed on or after 1 January 2014. The Secretary-General may, in the interests of the Organization, extend these age limits in exceptional cases.

The extension of the age limit of a staff member in the Professional category and above shall require the authority of the Executive Council.

Resolution 79 (Cg-17)

AMENDMENTS TO THE GENERAL REGULATIONS OF THE WORLD METEOROLOGICAL ORGANIZATION – LIMITATION OF THE NUMBER OF TERMS OF OFFICE OF THE SECRETARY-GENERAL

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Article 21 of the Convention of the World Meteorological Organization,

(2) Regulation 198 of the General Regulations of the Organization, as contained in *Basic Documents No. 1* (WMO-No. 15), 2012 edition,

Considering the report of the Joint Inspection Unit, JIU/REP/2009/8 – Selection and Conditions of Service of Executive Heads in the United Nations System Organizations,

Decides that a Secretary-General may serve a maximum of two four-year terms, and that this decision will take effect from the Seventeenth World Meteorological Congress and will apply to any candidate who may have previously served in the post;

Requests the Secretary-General to reflect this change in Regulation 198 of the General Regulations and to inform all concerned of this decision.

Resolution 80 (Cg-17)

GENERAL TERMS OF REFERENCE OF REGIONAL ASSOCIATIONS

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) Regulation 162 and Annex II of the General Regulations of the Organization, as contained in *Basic Documents No. 1* (WMO-No. 15), 2012 edition,

(2) Resolution 1 (EC-64) – Review of the role and responsibilities of regional associations,

Noting further the proposal on the terms of reference of regional associations recommended by the Executive Council at its sixty-sixth session,

Recognizing the need to ensure consistency across the constituent bodies, particularly in developing and documenting a WMO integrated planning and implementation process,

Decides to amend Regulation 162 and Annex II of the General Regulations as defined in the annex to the present resolution;

Requests the Secretary-General to reflect these changes in Regulation 162 and Annex II to the General Regulations, to inform all concerned of this decision and to continue to support the work of the regional associations as provided for in the General Regulations.

Annex to Resolution 80 (Cg-17)

AMENDMENTS TO THE GENERAL REGULATIONS OF THE WORLD METEOROLOGICAL ORGANIZATION

Amendment to Regulation 162 (addition of the underlined text)

The associations of the Organization and their general terms of reference shall be those specified in Annex II to these Regulations. Each association shall be responsible for carrying out the functions specified in Article 18 (d) of the Convention within the area allotted to that association in Annex II.

Amendment to Annex II (inclusion of the following text before the geographical description)

General terms of reference

In carrying out the functions specified in Article 18 (d) of the Convention within the allotted geographical areas defined in this Annex, under the general guidance of Congress and the Executive Council and with support from the Secretariat, each regional association, in close coordination and collaboration with other bodies concerned, shall:

(a) Coordinate and organize activities of their Members at regional and subregional levels relating to the planning, implementation and evaluation of agreed programmes, strategies and activities;

(b) Study the needs of its Members and subregions with regard to their technical and institutional capacity and identify gaps impeding timely implementation of planned programmes and activities; collaborate with Members, technical commissions and other bodies, as necessary, in resolving critical deficiencies;

(c) Promote cooperation and efficiency through establishment of regional networks and facilities based upon identified regional needs in close coordination with the technical commissions concerned; monitor the performance of regional networks and facilities and require corrective measures as necessary;

(d) Establish regional operating plans and other implementation plans, as necessary, addressing agreed strategic priorities from a regional perspective and ensuring engagement of the Members in focused activities aimed at achieving the expected results of the WMO Strategic Plan;

(e) Structure its work to address regional priority areas and engage the available expertise of its Members to provide guidance and assistance in accordance with the needs of the Region;

(f) Build and promote cooperation and partnership with relevant regional organizations, including the UN Regional Economic Commissions, other UN bodies, subregional organizations, development partners, NGOs and professional associations;

(g) Ensure visibility and recognition of WMO in their respective Regions and engagement in regional initiatives and projects related to the strategic priorities of the Organization.

Resolution 81 (Cg-17)

FINANCIAL REGULATIONS OF THE WORLD METEOROLOGICAL ORGANIZATION

THE WORLD METEOROLOGICAL CONGRESS,

Noting the Financial Regulations of the World Meteorological Organization, as contained in *Basic Documents No. 1* (WMO-No. 15), 2012 edition,

Decides that the Financial Regulations as set out in *Basic Documents No. 1* shall be amended as shown in the annex to the present resolution.

Annex to Resolution 81 (Cg-17)

FINANCIAL REGULATIONS OF THE WORLD METEOROLOGICAL ORGANIZATION

ARTICLE 1

Applicability

1.1 These Regulations shall govern the financial administration of the World Meteorological Organization (hereinafter called the Organization). They may be amended only by Congress. In the event of any conflict between any provisions of these Regulations and any provisions of the Convention, the Convention shall prevail.

ARTICLE 2

The financial period

2.1 The financial period shall be four years beginning on 1 January of the calendar year immediately following a session of Congress and ending on 31 December of the fourth year.

2.2 Nevertheless, in the event that a session of Congress is completed before the beginning of the last full year of a financial period, a new financial period shall begin on 1 January following that session of Congress.

ARTICLE 3

Maximum expenditures for the financial period

3.1 Estimates of maximum expenditures which may be incurred by the Organization in the financial period shall be prepared by the Secretary-General.

3.2 The estimates shall cover the income and expenditures for the financial period to which they relate and shall be presented in Swiss francs.

3.3 The estimates shall be presented in a results-based budget format and shall be accompanied by such informational annexes and explanatory statements as may be requested by, or on behalf of, Congress, and such further annexes or statements as the Secretary-General may deem necessary and useful.

3.4 The estimates shall be submitted to the Executive Council at least five weeks prior to the meeting at which they will be considered. The Executive Council shall examine them and prepare a report on them to Congress.

3.5 The estimates prepared by the Secretary-General shall be transmitted to all Members at least six months prior to the opening of Congress. The report of the Executive Council on the

estimates shall be transmitted with the estimates or as soon as possible thereafter, but not later than three months before the beginning of the session of Congress.

3.6 The maximum expenditures for the following financial period shall be voted by Congress after consideration of the estimates and of any supplementary estimates prepared by the Secretary-General and of the reports of the Executive Council on them.

3.7 Supplementary estimates for the financial period may be submitted to the Executive Council by the Secretary-General during the interval between the submission of the estimates to the Executive Council and the opening of Congress.

3.8 The Secretary-General shall prepare each supplementary estimate in a form consistent with the applicable portion of the estimates for the financial period.

3.9 When time permits, the Executive Council shall examine the supplementary estimates and prepare a report thereon to Congress; otherwise they shall be left for consideration by Congress.

ARTICLE 4

Authorization of appropriations for the financial period

4.1 The maximum expenditures voted by Congress shall constitute an authority to the Executive Council to approve appropriations for each of the two bienniums comprising the financial period. The total appropriations shall not exceed the amount voted by Congress.

4.2 Transfers between appropriation parts may be authorized by the Executive Council, subject to the total amount of such transfers not exceeding 3 (three) per cent of the total maximum expenditure authorized for the financial period.

ARTICLE 5

The biennium

5.1 The first biennium will begin with the commencement of the financial period, followed by the second biennium beginning on 1 January of the third year of the financial period.

ARTICLE 6

The biennial budget

6.1 The biennial budget estimates shall be prepared by the Secretary-General.

6.2 The estimates shall cover income and expenditure for the biennium to which they relate and shall be presented in Swiss francs.

6.3 The biennial budget estimates shall be presented in a results-based budget format and shall be accompanied by such informational annexes and explanatory statements as may be requested by, or on behalf of, the Executive Council, and such further annexes or statements as the Secretary-General may deem necessary and useful.

6.4 The Secretary-General shall submit to the regular meeting of the Executive Council estimates for the following biennium. The estimates shall be transmitted to all members of the Executive Council at least five weeks prior to the opening of the regular session of the Executive Council.

6.5 The budget for the following biennium shall be approved by the Executive Council.

6.6 Supplementary estimates may be submitted by the Secretary-General whenever necessary.

6.7 The Secretary-General shall prepare these supplementary estimates in the same form as that of the applicable portions of the estimates for the biennium and shall submit the estimates to the Executive Council for approval.

ARTICLE 7

Appropriations

7.1 The appropriations approved by the Executive Council shall constitute an authorization to the Secretary-General to enter into commitments and make payments for the purposes for which the appropriations were approved and up to the amounts so approved.

7.2 Appropriations shall be available to enter into commitments during the biennium to which they relate.

7.3 Appropriations shall remain available for twelve months following the end of the financial year to which they relate to the extent that they are required to discharge commitments in respect of goods delivered and services rendered in the financial year and to discharge any other outstanding legal commitments of the financial year. At the end of the first biennium the remaining balance shall be re-appropriated subject to the approval of the Executive Council to the corresponding parts of the budget of the second biennium for the implementation of the programme approved by Congress.

7.4 At the end of the twelve-month period following the end of the two biennia provided in Regulation 7.3, the then remaining balance of any appropriations retained shall be surrendered.

7.5 Notwithstanding the provisions of Regulations 7.3 and 7.4 in the case of outstanding legal obligations in respect of fellowships, the portion of the appropriation required shall remain available until the fellowships are completed or otherwise terminated. At the time of the termination of the fellowship, any remaining balance shall be retained in the General Fund for the sole purpose of financing further long-term and short-term fellowships.

7.6 Amounts surrendered in accordance with Regulations 7.3 and 7.4 shall be retained for the purposes approved by Congress for the financial period subject to the provisions of Regulation 9.1.

7.7 A transfer between appropriation sections of the results-based budget format may be made by the Secretary-General subject to confirmation by the Executive Council.

ARTICLE 8

Provision of funds

Assessments

8.1 Appropriations shall be financed by contributions from Members of the Organization according to the scale of assessments determined by Congress, such contributions to be adjusted in accordance with the provisions of Regulation 8.2. Pending the receipt of such contributions the appropriations may be financed from the Working Capital Fund.

8.2 For each of the two years of a biennium the contributions of Members shall be assessed on the basis of one half of the appropriations approved by the Executive Council for the biennium, except that adjustments shall be made to the assessment in respect of:

(a) Supplementary appropriations for which contributions have not previously been assessed on Members;

(b) Half of the estimated miscellaneous income for the biennium for which credits have not previously been taken into account and any adjustments in estimated income previously taken into account.

8.3 After the Executive Council has approved the biennial budget and determined the amount needed for the Working Capital Fund, the Secretary-General shall:

(a) Transmit the relevant documents to the Members of the Organization;

(b) Inform the Members of their commitments in respect of annual contributions and advances to the Working Capital Fund;

(c) Request them to remit their contributions and advances.

8.4 Contributions and advances shall be considered as due and payable in full within 30 days of the receipt of the communication of the Secretary-General referred to in Regulation 8.3 above, or as of the first day of the year to which they relate, whichever is the later. As of 1 January of the following year, the unpaid balance of such contributions and advances shall be considered to be one year in arrears.

8.5 Annual contributions and advances to the Working Capital Fund of the Organization shall be assessed and paid in Swiss francs.

8.6 Notwithstanding the provisions of Regulation 8.5 and to facilitate payments by Members, the Secretary-General may accept, to the extent he may find it practicable, payments of contributions in freely convertible currencies other than the Swiss franc. The exchange rate applicable to these payments in establishing their equivalent in the currency of the State in which the Organization has its headquarters shall be the official United Nations rate of exchange in force on the date of credit to the WMO bank account.

8.7 Payments made by a Member of the Organization shall be credited first to the Working Capital Fund, then applied in chronological order to the reduction of the contributions which are due in accordance with the scale of assessments.

8.8 Notwithstanding the provisions of Regulation 8.7, amounts received in respect of the current year's contribution will be credited to that year providing that the full yearly instalment due under the terms of special arrangements as established by Congress concerning the repayment of long-outstanding contributions has been paid to the Organization. These special arrangements may be concluded with any Member being in arrears for more than four years on the date of entry into force of such arrangements.

8.9 The Secretary-General shall submit to the regular sessions of the Executive Council a report on the collection of contributions and advances to the Working Capital Fund.

Contributions from new Members

8.10 New Members of the Organization shall be required to make a contribution for the unexpired portion of the biennium in which they become Members and to provide their proportion of the total advances to the Working Capital Fund at rates to be determined provisionally by the Executive Council, subject to subsequent approval by Congress.

Contributions from Members withdrawing from the Organization

8.11 A Member withdrawing from the Organization shall make its contribution for the period from the beginning of the biennium in which it withdraws up to and including the date of its withdrawal and shall be entitled only to the amount standing to its credit in the Working Capital Fund, less any sum due from that Member of the Organization.

ARTICLE 9

Funds

9.1 There shall be established a General Fund for the purpose of accounting for expenditures authorized under Regulations 7.1, 7.2 and 7.3. The General Fund will be credited with contributions paid by Members under Regulations 8.1, 8.10, 8.11 and miscellaneous income as defined under Regulation 10.1. Cash surpluses on the General Fund shall be credited on the basis of the scale of assessments to the Members of the Organization as follows.

(a) For Members who have paid in full their previous contributions, by deduction from the next assessment;

(b) For Members who have paid in full their contribution in respect of all previous financial periods, but who have not paid in full their contributions in respect of the period that relates to the surplus to be distributed, by reduction of their arrears, and thereafter by deduction from the next assessment;

(c) For Members who are in arrears for more than the financial period concerning the one which relates to the surplus to be distributed, their share of the surplus will be retained

by the World Meteorological Organization in a special account and will be paid when the provisions of Regulation 9.1 (a) or (b) are met.

9.2 The term cash surplus on the General Fund shall consist of the sum of:

(i) Unexpended appropriations surrendered at the end of the two biennia making up the financial period in accordance with Regulation 7.4;

(ii) Plus the amount resulting from receipt of contributions paid by Members during the financial period in excess of the amount appropriated by the Executive Council for the two biennia making up the financial period, or less the amount resulting from receipt of contributions paid by Members during the financial period, if lower than the amount appropriated by the Executive Council for the two biennia making up the financial period;

(iii) Less any amount retained for purposes approved by Congress for the financial period in accordance with the provisions of Regulation 7.6, or available for fellowships in accordance with Regulation 7.5.

Working Capital Fund

9.3 There shall be established a Working Capital Fund to an amount fixed by Congress and for purposes to be determined from time to time by the Executive Council. The moneys of the Working Capital Fund shall be advanced by the Members of the Organization, or at the discretion of Congress provided from interest to the extent that it is earned on the investment of the cash resources of the Fund. Interest retained in the Fund shall be credited to Members' advance accounts in accordance with current balances. Advances by Members shall be calculated by the Executive Council in accordance with the scale of assessments for the apportionment of the expenses of the Organization, and shall be carried to the credit of those Members that have made such advances.

9.4 Advances made from the Working Capital Fund to finance appropriations during a biennium shall be reimbursed to the Fund as soon as and to the extent that income is available for that purpose.

9.5 Except when such advances are recoverable from some other source, advances made from the Working Capital Fund for unforeseen and extraordinary expenses or other authorized purposes shall be reimbursed through the submission of supplementary estimates.

9.6 Income derived from investments of the Working Capital Fund, not retained in the Fund to meet an increase in the level of the capital of the Fund, shall be credited to miscellaneous income.

9.7 Trust funds, reserve and special accounts may be established by the Secretary-General and shall be reported to the Executive Council.

9.8 The purpose and limits of each trust fund, reserve and special account shall be clearly defined by the Executive Council. Unless otherwise provided by Congress, such funds and accounts shall be administered in accordance with the present Financial Regulations.

9.9 Income derived from investments of trust funds, reserve and special accounts shall be credited as provided in the provisions applicable to such funds or accounts or at the request of the donors at any time. In other circumstances, Regulation 10.1 shall apply.

ARTICLE 10

Other income

10.1 All other income, except:

(a) Contributions to the budget;

(b) Direct refunds of General Fund expenditures made during the current biennium;

(c) Advances or deposits to funds and accounts;

(d) Interest earned on the Working Capital Fund to the extent that it is required to augment the level of the Working Capital Fund;

(e) Revenue from rental of excess space, conference rooms and cafeteria facilities;

(f) Revenue from programme support cost charges to trust funds;

shall be classed as miscellaneous income, for credit to the General Fund, unless otherwise specified in accordance with Regulation 9.9.

Voluntary contributions, gifts or donations

10.2 Voluntary contributions, whether or not in cash, may be accepted by the Secretary-General, provided that the purposes for which the contributions are made are consistent with the policies, aims and activities of the Organization and provided that the acceptance of such contributions that directly or indirectly involve additional financial liability for the Organization shall require the consent of Congress or, in case of urgency, of the Executive Council.

10.3 Moneys accepted for purposes specified by the donor shall be treated as trust funds or special accounts under Regulations 9.7 and 9.8.

10.4 Moneys accepted in respect of which no purpose is specified shall be treated as miscellaneous income and shall be reported as “gifts” in the annual financial statements.

ARTICLE 11

Custody of funds

11.1 The Secretary-General shall designate the bank or banks in which the funds of the Organization shall be kept.

ARTICLE 12

Investment of funds

12.1 The Secretary-General may make short-term investments of moneys not needed for immediate requirements.

12.2 The Secretary-General may make long-term investments of moneys standing to the credit of trust funds, reserve and special accounts, except as may be otherwise provided by the appropriate authority in respect of each such fund or account and having regard to the particular requirements as to the liquidity of funds in each case.

ARTICLE 13

Internal control

13.1 The Secretary-General shall:

(a) Establish detailed Financial Rules and procedures in order to ensure effective financial administration, the exercise of economy and effective custody of the physical assets of the Organization;

(b) Cause all payments to be made on the basis of supporting vouchers and other documents that ensure that the services or goods have been received, and that payments have not previously been made;

(c) Designate the officers who may receive moneys, incur obligations and make payments on behalf of the Organization.

13.2 (a) In addition to payments authorized under clause (b) below, and notwithstanding Regulation 13.1 (b) above, the Secretary-General may, when he deems it in the interest of the Organization to do so, authorize progress payments;

(b) Except where normal commercial practice in the interest of the Organization so requires, no contract or purchase order shall be made on behalf of the Organization which requires a payment in advance of the delivery of goods or performance of contractual services.

13.3 No obligations shall be incurred until allotments or other appropriate authorizations have been made in writing under the authority of the Secretary-General or by the officer to whom such authority has been delegated.

Ex gratia payments

13.4 The Secretary-General may with the approval of the President make such ex gratia payments as he deems to be necessary in the interest of the Organization, provided that a statement of such payments shall be submitted to the Executive Council with the financial statements as detailed in Regulation 14.1.

Writing-off of losses or deficiencies

13.5 The Secretary-General may, after full investigation, authorize the writing-off of losses of cash, stores and other assets, except unpaid contributions, provided that a statement of all such amounts written off shall be submitted to the External Auditor with the financial statements.

Contracts and purchases

13.6 Tenders for equipment, supplies and other requirements shall be invited by advertisement, except where the Secretary-General deems that, in the interests of the Organization, a departure from the rule is desirable.

Internal oversight

13.7 Under the broader scheme of internal oversight, the Secretary-General shall establish an office to provide for an independent verification of financial, administrative and operational activities of WMO, including programme evaluation, monitoring mechanisms and consulting services. The office shall be called the Internal Oversight Office and shall ensure:

(a) The regularity of the receipt, custody and disposal of all funds and other financial resources of the Organization;

(b) The conformity of expenditure with the appropriations or other financial provisions voted by Congress or approved by the Executive Council, or with the purpose and rules related to trust funds and special accounts;

(c) The compliance of all financial and other management activities with the established legislation;

(d) The timeliness, completeness and accuracy of financial and other administrative data;

(e) The effective, efficient and economical use of all resources of the Organization.

13.8 The Internal Oversight Office shall also be responsible for investigating all allegations or presumptions of fraud, waste, mismanagement or misconduct and for conducting inspections of services and organizational units.

13.9 The Secretary-General shall appoint a technically qualified head of Internal Oversight Office after consulting with, and obtaining the approval of, the President of WMO acting on behalf of the Executive Council. Notwithstanding Articles 9, 10 and 11 of the Staff Regulations dealing with separation from service, disciplinary measures and appeals, respectively, the Secretary-General shall likewise consult the President of WMO acting on behalf of the Executive Council and obtain his approval before separation of the head of the Office. These actions by the President in accordance with General Regulation 146 shall be reported to the following regular session of the Executive Council.

13.10 The Internal Oversight Office shall function in accordance with the following provisions:

(a) The head of the Office shall report directly to the Secretary-General;

(b) The Office shall have full, free and prompt access to all records, property, personnel, operations and functions within the Organization that, in its opinion, are relevant to the subject matter under review;

(c) It shall be available to receive directly from individual staff members' complaints or information concerning the possible existence of fraud, waste, mismanagement or

misconduct. No reprisals shall be taken against staff members providing such information unless this was wilfully provided with the knowledge that it was false or with intent to misinform;

(d) It shall report the results of its work and make recommendations to the Secretary-General with a copy to responsible managers for action and the External Auditor. At the request of the head of the Office, any such report shall be submitted to the Executive Council together with the Secretary- General's comments thereon;

(e) The Office shall submit a summary report annually to the Secretary-General with a copy to the External Auditor on its activities, including the orientation and scope of such activities. This report shall be submitted to the Executive Council by the Secretary-General together with any comments he wishes to make;

(f) It shall monitor the implementation of recommendations duly noted by the Executive Council.

ARTICLE 14

Financial statements

14.1 The Secretary-General shall submit to the Executive Council, for its approval, annual financial statements showing for the year to which they relate:

(a) A statement of financial position;

(b) A statement of financial performance;

(c) A statement of changes in net assets/equity;

(d) A statement of cash flow;

(e) A statement of comparison of actual amounts and the approved budget;

(f) Notes, comprising a summary of significant accounting policies and other explanatory notes.

In addition, the Secretary-General shall maintain, for management purposes, such accounting records as are necessary.

14.2 The Secretary-General shall submit for the second year of the biennium, in addition to the financial statements for the year as indicated in Regulation 14.1, a statement showing for the biennium to which they relate the status of appropriations, including:

(a) The original budget appropriations;

(b) The appropriations as modified by any transfers;

(c) Credits, if any, other than the appropriations approved by the Executive Council;

(d) The amounts charged against those appropriations and/or other credits.

14.3 The financial statements of the Organization shall be presented in Swiss francs and shall be prepared in accordance with International Public Sector Accounting Standards. Accounting records may, however, be kept in such currency or currencies as the Secretary-General may deem necessary.

14.4 Appropriate separate accounts shall be maintained for all trust funds, reserve and special accounts.

14.5 The financial statements shall be submitted by the Secretary-General to the External Auditor not later than 31 March following the end of the financial year to which they relate.

14.6 The Secretary-General shall submit, in addition to the financial statements of the first year of the financial period a statement of the total expenditures made in respect of the previous financial period. The statement shall be prepared on the same basis as the Statement of comparison of actual amounts and approved budget included in the financial statements in accordance with Regulation 14.1 (e).

ARTICLE 15

External audit

Appointment

15.1 An External Auditor, who shall be the Auditor-General (or officer holding the equivalent title) of a Member, shall be appointed in the manner decided by the Executive Council for a period of four years.

Tenure of office

15.2 If the External Auditor ceases to hold that office in his or her own country, his or her tenure of office as External Auditor shall thereupon be terminated and he or she shall be succeeded as External Auditor by his or her successor as Auditor-General. The External Auditor may not otherwise be removed during his or her tenure of office except by the Executive Council.

Scope of audit

15.3 The audit shall be conducted in conformity with generally accepted common auditing standards, and, subject to any special directions of the Executive Council, in accordance with the additional terms of reference set out in the annex to these Regulations.

15.4 The External Auditor may make observations with respect to the efficiency of the financial procedures, the accounting system, the internal financial controls and, in general, the administration and management of the Organization.

15.5 The External Auditor shall be completely independent and solely responsible for the conduct of the audit.

15.6 The Executive Council may request the External Auditor to perform certain specific examinations and issue separate reports on the results.

Facilities

15.7 The Secretary-General shall provide the External Auditor with the facilities he or she may require in the performance of the audit.

15.8 For the purpose of making a local or special examination or of effecting economies of audit cost, the External Auditor may engage the services of any national Auditor-General (or equivalent title) or commercial public auditors of known repute or any other person or firm who, in the opinion of the External Auditor, is technically qualified.

Reporting

15.9 The External Auditor shall issue reports on the audit of the financial statements and relevant schedules, which shall include such information as he or she deems necessary in regard to matters referred to in Regulation 15.4 and in the additional terms of reference.

15.10 The External Auditor’s reports shall be transmitted, together with the relevant audited financial statements, to the Executive Council, which shall examine them in accordance with any directions given by Congress.

15.11 The financial statements, together with the External Auditor’s certificates, shall be transmitted to the Members of the Organization by the Secretary-General.

ARTICLE 16

Decisions involving expenditures

16.1 No regional association, technical commission or other competent body shall take a decision involving either an administrative change in a programme approved by Congress or the Executive Council, or the possible requirement of expenditure, unless it has received and taken account of a report from the Secretary-General on the administrative and financial implications of the proposal. Where, in the opinion of the Secretary-General, the proposed expenditure cannot be made from the existing appropriations, it shall not be incurred until the Executive Council has made the necessary appropriations, unless the Secretary- General

certifies that provision can be made under the conditions of the resolution of the Executive Council relating to unforeseen expenditure.

ARTICLE 17

General provisions

17.1 In case of urgency and with the approval of the President of the Organization, the Secretary-General shall refer to Members, for decision by correspondence, financial matters that are beyond the competence of the Executive Council.

17.2 The applications of any of the present Regulations may be suspended for a period that shall not extend beyond the next session of Congress if the Executive Council has decided that the matter under consideration is of such a character that a decision should be taken before the next Congress. In such circumstances, the proposal of the Executive Council for such a suspension shall be communicated by the Secretary-General to all Members for consultation and subsequently for a postal ballot according to the procedures for voting by correspondence in the General Regulations.

17.3 In the application of Regulation 17.1 the proposal shall be adopted, and in the application of Regulation 17.2 the suspension of regulations shall be put into force, if two thirds of the votes cast for and against that have reached the Secretariat within 90 days of the date of dispatch of the request to vote to Members are in the affirmative. The decisions shall be communicated to all Members.

17.4 In case of doubt as to the interpretation or application of any of these Financial Regulations, the Secretary-General is authorized to rule thereon, subject to confirmation by the President in important cases.

17.5 The present Financial Regulations do not apply to the field projects of the technical cooperation activities of the Organization financed by the United Nations Development Programme; the Secretary- General is authorized to administer those activities under Financial Regulations and Rules established by the governing body and the Administrator of the United Nations Development Programme.

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ANNEX

ADDITIONAL TERMS OF REFERENCE GOVERNING EXTERNAL AUDIT

(1) The External Auditor shall perform such audit of the financial statements of the Organization, including all trust funds and special accounts, as he or she deems necessary in order to satisfy himself or herself:

(a) That the financial statements are in accord with the books and records of the Organization;

(b) That the financial transactions reflected in the statements have been in accordance with the rules and regulations, the budgetary provisions and other applicable directives;

(c) That the securities and moneys on deposit and on hand have been verified by certificate received direct from the Organization’s depositaries or by actual count;

(d) That the internal controls are adequate in the light of the extent of reliance placed thereupon;

(e) That procedures satisfactory to the External Auditor have been applied to the recording of all assets, liabilities, surpluses and deficits.

(2) The External Auditor shall be the sole judge as to the acceptance in whole or in part of certifications and representations by the Secretary-General and may proceed to such detailed

examination and verification as he or she chooses of all financial records, including those relating to supplies and equipment.

(3) The External Auditor and his or her staff have free access at all convenient times to all books, records and other documentation that are, in the opinion of the External Auditor, necessary for the performance of the audit. Information that is classified as privileged and which the Secretary-General (or his designated senior official) agrees is required by the External Auditor for the purposes of the audit and information classified as confidential shall be made available on application. The External Auditor and his or her staff shall respect the privileged and confidential nature of any information so classified that has been made available and shall not make use of it except in direct connection with the performance of the audit. The External Auditor may draw the attention of the Executive Council to any denial of information classified as privileged that in his or her opinion was required for the purpose of the audit.

(4) The External Auditor shall have no power to disallow items in the financial statements but shall draw to the attention of the Secretary-General for appropriate action any transaction concerning which he or she entertains doubt as to legality or propriety. Audit objections to these, or any other transactions, arising during the examination of the financial statements shall be communicated immediately to the Secretary-General.

(5) The External Auditor shall express and sign an opinion on the financial statements of the Organization. The opinion shall include the following basic elements:

(a) The identification of the financial statements audited;

(b) A reference to the responsibility of the Secretary-General and the responsibility of the External Auditor;

(c) A reference to the audit standards followed;

(d) A description of the work performed;

(e) An expression of opinion on the financial statements as to whether:

  (i) The financial statements present fairly the financial position as at the end of the period and the results of the operations for the period;

  (ii) The financial statements were prepared in accordance with the stated accounting policies;

  (iii) The accounting policies were applied on a basis consistent with that of the preceding financial period;

(f) An expression of opinion on the compliance of transactions with the Financial Regulations and legislative authority;

(g) The date of the opinion;

(h) The *External* Auditor's name and position;

(i) Should it be necessary, a reference to the report of the External Auditor on the financial statements.

(6) The report of the External Auditor to the Executive Council on financial operations of the period should mention:

(a) The type and scope of his or her examination;

(b) Matters affecting the completeness or accuracy of the financial statements, including, where appropriate:

  (i) Information necessary to the correct interpretation of the financial statements;

  (ii) Any amounts which ought to have been received but which have not been brought to account;

  (iii) Any amounts for which a legal or contingent obligation exists and which have not been recorded or reflected in the financial statements;

  (iv) Expenditures not properly substantiated;

(v) Whether proper books of accounts have been kept. Where in the presentation of statements there are deviations of a material nature from the generally accepted accounting principles applied on a consistent basis, these should be disclosed;

(c) Other matters that should be brought to the notice of the Executive Council, such as:

(i) Cases of fraud or presumptive fraud;

(ii) Wasteful or improper expenditure of the Organization's money or other assets (notwithstanding that the accounting for the transaction may be correct);

(iii) Expenditure likely to commit the Organization to further outlay on a large scale;

(iv) Any defect in the general system or detailed regulations governing the control of receipts and disbursements or of supplies and equipment;

(v) Expenditure not in accordance with the intention of Congress and/or the Executive Council after making allowance for duly authorized transfers within the budget;

(vi) Expenditure in excess of appropriations as amended by duly authorized transfers within the budget;

(vii) Expenditure not in conformity with the authority that governs it;

(d) The accuracy or otherwise of the supplies and equipment records as determined by stock-taking and examination of the records;

(e) If appropriate, transactions accounted for in a previous year concerning which further information has been obtained or transactions in a later year concerning which it seems desirable that the Executive Council should have early knowledge.

(7) The External Auditor may make such observations with respect to his or her findings resulting from the audit and such comments on the Secretary-General's financial report as he or she deems appropriate to the Executive Council or to the Secretary-General.

(8) Whenever the scope of audit of the External Auditor is restricted, or whenever he or she is unable to obtain sufficient evidence, the External Auditor shall refer to the matter in his or her report, making clear in the report the reasons for his or her comments and the- effect on the financial position and the financial transactions as recorded.

(9) In no case shall the External Auditor include criticism in his or her report without first affording the Secretary-General an adequate opportunity of explanation on the matter under observation.

(10) The External Auditor is not required to mention any matter referred to in the foregoing that, in his or her opinion, is insignificant in all respects.

Resolution 82 (Cg-17)

REVIEW OF PREVIOUS CONGRESS RESOLUTIONS

THE WORLD METEOROLOGICAL CONGRESS,

Considering that it is important not to let accumulate a collection of resolutions from previous sessions of the World Meteorological Congress, some of which have become redundant and others which have been replaced by new decisions,

Noting:

(1) Regulation 136 (17) of the General Regulations of the Organization, as contained in *Basic Documents No. 1* (WMO-No. 15), 2012 edition, concerning the review of previous Congress resolutions,

(2) Resolution 46 (Cg-XVI) – Review of previous Congress resolutions,

Having examined its previous resolutions still in force,

Decides:

(1) To keep in force the following resolutions:

Second Congress (Cg-II)	18*
Third Congress (Cg-III)	3, 4
Fifth Congress (Cg-V)	6,
Seventh Congress (Cg-VII)	32, 39
Eighth Congress (Cg-VIII)	33, 36*, 48
Ninth Congress (Cg-IX)	9*, 30
Tenth Congress (Cg-X)	31*
Eleventh Congress (Cg-XI)	8*, 19, 37
Twelfth Congress (Cg-XII)	21*, 35, 40*
Thirteenth Congress (Cg-XIII)	25, 26
Fourteenth Congress (Cg-XIV)	5, 6, 24, 46
Fifteenth Congress (Cg-XV)	21, 22, 29*, 38*, 39*, 41*, 42*, 45*
Sixteenth Congress (Cg-XVI)	5, 6, 13, 14, 15, 16, 19, 21, 22, 23, 24, 25, 27, 30, 32, 33, 40, 42, 43, 44, 45, 47, 48, 52
Extraordinary Congress (Cg-Ext.(2012))	1, 2

(2) To keep in force the following resolutions but only until 31 December 2015:

Sixteenth Congress (Cg-XVI)	1, 35, 36, 37, 39, 41
Extraordinary Congress (Cg-Ext.(2012))	3

(3) Not to keep in force the other resolutions adopted before its seventeenth session;

Requests the Secretary-General to publish the in-force resolutions, including those with corrigenda, in a new issue of *Resolutions of Congress and the Executive Council* (WMO-No. 508) and to bring this publication to the attention of all parties concerned.

_____

Note: This resolution replaces Resolution 46 (Cg-XVI), which is no longer in force.

* Indicates that some resolution(s) mentioned in the given resolution are now not in force (see the annex to the present resolution).

Annex to Resolution 82 (Cg-17)

FOOTNOTES TO THE FOLLOWING RESOLUTIONS

1. **Resolution 18 (Cg-II) – "Definition of the Guides of the World Meteorological Organization"**

   Resolution 17 (Cg-II) not in force

   Resolution 12 (Cg-IV) not in force

2. **Resolution 36 (Cg-VIII) – Technical co-operation among developing countries in the field of meteorology and operational hydrology**

   Resolution 2 (EC-XXX) not in force

3. **Resolution 9 (Cg-IX) – United Nations Conference on the Law of the Sea**

   Resolution 16 (Cg-VIII) not in force

4. **Resolution 31 (Cg-X) – Incentive scheme for early payment of contributions**

   To Delete footnote "*See Resolution 28 (Cg-X)"

5. **Resolution 8 (Cg-XI) – Establishment of a WMO Special Trust Fund for climate and atmospheric environment activities**

   Resolution 5 (EC-XLI) not in force

6. **Resolution 21 (Cg-XII) – Global Runoff Data Centre (GRDC)**

   Resolution 11 (EC-XLV) not in force

7. **Resolution 40 (Cg-XII) – WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities**

   Resolutions 23 (EC-XLII), 20, 21, 22 (EC-XLVI) and 2 (EC-XLII) not in force

8. **Resolution 29 (Cg-XV) – Evolution of National Meteorological and Hydrological Services and WMO**

   Resolution 21 (EC-LVII) not in force

9. **Resolution 38 (Cg-XV) – Audit Committee**

   Resolutions 15 (EC-LVI), 11 (EC-LVII) not in force

10. **Resolution 39 (Cg-XV) – Financial Advisory Committee**

    Resolution 29 (Cg-X) not in force

11. **Resolution 41 (Cg-XV) – Settlement of Long-outstanding Contributions**

    Resolution 12 (EC-LVIII) not in force

12. **Resolution 42 (Cg-XV) – Working Capital Fund**

    Resolution 37 (Cg-XIV) not in force

13. **Resolution 45 (Cg-XV) – Emblem and Flag of the World Meteorological Organization**

    Resolution 2 (EC-X), 20 (EC-LVII) not in force

Resolution 83 (Cg-17)

TRIBUTE TO THE SECRETARY-GENERAL

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

(1) That the contract of the Secretary-General, Mr Michel Jarraud, will terminate on 31 December 2015, at which time he will have completed 12 years of continuous service in that office,

(2) That prior to his appointment as Secretary-General Mr Jarraud had served as Deputy Secretary-General in the Secretariat for a period of 9 years,

(3) That by the end of his contract in December 2015 Mr Jarraud would have rendered dedicated service to the Organization for a total of 21 years,

Recognizing:

(1) That Mr Jarraud has played an important and continuous role in the activities of the Organization during his entire career,

(2) That he has, in particular, performed his duties as Secretary-General at all times in a manner which merits the highest praise and commendation,

(3) That he has thereby rendered outstanding services to the World Meteorological Organization and hence to the cause of international cooperation, policy-making and advancements of meteorology, hydrology and climatology, and their contribution to sustainable development,

Places on record its deep appreciation and gratitude to Mr Jarraud;

Accords to Mr Jarraud, at the conclusion of his contract as Secretary-General, the honorary title of Secretary-General Emeritus.

ANNEXES

ANNEX I
Annex to paragraph 2.3 of the general summary

RECOMMENDATIONS OF THE THIRTY-FOURTH MEETING OF THE FINANCIAL ADVISORY COMMITTEE

Proposed budget for the seventeenth financial period (2016–2019)

Recommendation 1

Taking into account views of several FINAC members on affordability constraints at the national level, so as to assist Congress in prioritizing activities and deciding on the budget, that Congress requests:

1.1 Additional details for the increases proposed under the Major Cost Drivers,

1.2 Considerations for additional savings and efficiencies,

1.3 A more explicit indication of the consequences in case of reductions of the proposed level of funding to ZNG,

1.4 Analysis of possible areas/activities to deemphasize or discontinue, and

1.5 The feasibility of using voluntary resources for some of the proposed activities to be explored and programme support cost reconsidered.

Report of the Audit Committee

Recommendation 2

Congress requests the Audit Committee to issue more detailed and substantive reports.

Report of the Secretary-General on the cash surplus or deficit at the end of the fifteenth financial period (2008–2011)

Recommendation 3

That Congress notes the report.

Financial report of the Secretary-General for the sixteenth financial period (2012–2015)

Recommendation 4

That Congress take note of the financial report of the Secretary-General to the Seventeenth Congress and requests that future financial statements present more clarity when presenting differences between IPSAS accrual based figures and cash basis figures as was previously presented under UNSAS.

Scale of assessments for the seventeenth financial period (2016–2019)

Recommendation 5

That Congress:

5.1 Approve the text in paragraphs 11.2.1–11.2.11 for inclusion in the general summary of the present report,

5.2 Adopt Resolution 75 (Cg-17) – Assessment of proportional contributions of Members for the seventeenth financial period,

5.3 Adopt Resolution 76 (Cg-17) – Working Capital Fund,

5.4 Request EC to monitor and assess the impact of negative interest rate policy and to keep the matter under review.

Proposed plan for funding long-term liabilities for employee benefits

Recommendation 6

That Congress:

6.1. Requests the Secretary-General to submit a proposal to the Executive Council that will take into account the decision of UNGA-70 on ASHI when this is available, and authorized the Executive Council to take a decision;

6.2. Should the decision of UNGA-70 not be available by end 2015, requests the Secretary-General to submit proposals for appropriate short term measures to manage and contain the WMO ASHI liability and to report to EC-68 for review and approval, as appropriate.

Revisions to the Financial Regulations

Recommendation 7

That Congress approves the proposed revisions to the WMO Financial Regulations.

Proposed revision to Resolution 31 (Cg-XIII) – Short-term borrowing authority

Recommendation 8

That Congress approves the recommendation of the Executive Council that the Secretary-General's short-term borrowing authority be expanded to include voluntary contribution funds excluding those to which Financial Regulation 9.9 applies.

ANNEX II
Annex to paragraph 2.5.28 of the general summary

LONG-TERM PLANNING TO SUPPORT AERONAUTICAL METEOROLOGY AS A WMO STRATEGIC PRIORITY

Recommendation 2 (CAeM-15)
LONG-TERM PLANNING TO SUPPORT AERONAUTICAL METEOROLOGY AS A WMO STRATEGIC PRIORITY

THE COMMISSION FOR AERONAUTICAL METEOROLOGY,

Noting:

(1) The *WMO Strategic Plan 2012–2015* (WMO-No. 1069),

(2) The draft WMO Strategic and Operating Plans (2016–2019) endorsed by the Executive Council at its sixty-sixth session,

(3) The meteorology component of the International Civil Aviation Organization (ICAO) Global Air Navigation Plan and its Aviation System Block Upgrades methodology,

(4) The outcomes of the CAeM Technical Conference (TECO-2014),

Recognizing the responsibility of the Commission in fulfilling the strategic priorities and expected results of the draft WMO Strategic and Operating Plans (2016–2019),

Recognizing further the long-term planning envisaged in the Global Air Navigation Plan and the Aviation System Block Upgrades with a time horizon of 2028 and beyond, the related impacts on Members and the need for the Commission to ensure synchronized planning of related WMO activities,

Recommends:

(1) That aeronautical meteorology continue to be given high priority in the WMO strategic planning;

(2) That a longer-term planning approach be applied to the Aeronautical Meteorology Programme consistent with the Aviation System Block Upgrades methodology and timeline;

(3) That special attention be given to the governance issues related to changing service delivery models, including the regionalization and globalization of services;

(4) That a coherent approach be applied to the information management being developed by WMO and ICAO (that is, the WMO Information System and the System-wide Information Management) to ensure full interoperability;

(5) That relevant capacity development programmes be designed to assist Members in adapting to the changes in aeronautical meteorological service provision;

Requests the Secretary-General to bring the present recommendation to the attention of the Seventeenth World Meteorological Congress in 2015 and other relevant bodies engaged in the WMO strategic planning process.

ANNEX III
Annex to paragraph 3.1.33 of the general summary

AERONAUTICAL METEOROLOGY PROGRAMME DESCRIPTION

1. Historical background

As stated in the Convention, one of the purposes of the WMO is “to further the application of meteorology to aviation”. To pursue this goal, WMO had established the Aeronautical Meteorology Programme (AeMP) to mainstream the activities of the Organization related to aviation and to ensure effective coordination with partners, including the International Civil Aviation Organization (ICAO).

International cooperation in aeronautical meteorology can be dated back to the International Meteorological Organization (IMO) years. The Commission for the Application of Meteorology to Air Navigation (CAMAN) was established by the Paris Conference of Directors (CD) of the IMO as

early as 1919. In 1935, CAMAN was replaced by a new International Commission for Aeronautical Meteorology (ICAeM) consisting of members appointed by governments in order that it could work effectively with the International Commission for Air Navigation (ICAN) – the predecessor of ICAO. Thus, ICAeM became the first intergovernmental body in meteorology and its experience influenced the transformation of IMO after World War II into the intergovernmental World Meteorological Organization (WMO). In 1951, the First Congress of WMO established Technical Commissions including the Commission for Aeronautical Meteorology (CAeM) on the basis of the ICAeM.

2. Main long-term objectives

The main long-term objectives of the Aeronautical Meteorology Programme are:

(a) To contribute to a globally harmonized meteorological service to the international air navigation meeting the requirements of the aviation users for meteorological information and services and contributing to safety, efficiency and regularity of aviation transport;

(b) To support the continuous improvement of the meteorological service to aviation through coordinating the underpinning science and technology activities and their transfer to operational practice;

(c) To achieve the highest possible level of compliance of the WMO Members with the technical regulations, standard and recommended practices established by WMO and ICAO for the provision of aeronautical meteorological service;

(d) To promote effective and efficient services through international cooperation;

(e) To contribute to the assessment of the linkages between the aviation and environment including the impacts of the climate change and variation on future aviation operations;

(f) To establish globally agreed requirements for the qualification and competence of the aeronautical meteorological personnel as part of the quality management system (QMS) for the provision of aeronautical meteorological services.

3. Purpose and scope

The aeronautical meteorology services are governed jointly by the ICAO and WMO as “sister” UN agencies with the common goal of establishing a global regulatory framework that provides the basis for the Member countries to establish their national service provision programmes in a highly coordinated and interoperable manner. Therefore, the main purpose of the AeMP is to coordinate all WMO activities related to aeronautical meteorology and to ensure an effective liaison with ICAO. To this end, WMO and ICAO established working arrangements specifying the roles and responsibilities of the two Organizations in order to ensure the efficiency of the joined work and avoid duplication of resources. The AeMP supports the major WMO role in the development of the meteorological techniques and practices for the provision of services, based on the identified user requirements as coordinated and conveyed by ICAO. The AeMP coordinates with other WMO Programmes on all matters related to aeronautical meteorology, including: the basic meteorological networks and facilities required for effective provision of meteorological service to international air navigation; setting standards on aeronautical climatological information; responsibility for the definition of aeronautical meteorological personnel qualification and competency standards; and the advancement of science and technology in support of the ever growing demand for interoperable, fit-for-purpose, quality information and services by the aviation transport sector.

The AeMP plays a major role in providing targeted assistance to Members, particularly in developing and least developed countries, to develop their capacity to meet the international requirements for quality, competency and performance of the aeronautical meteorological service. The governance and partnership element of the programme provides guidance material, exchange

of best practice models, documentation and training to Members in providing services to the required standards. In this regard, the AeMP promotes the establishment of fair, equitable and transparent cost-recovery mechanisms needed for a sustainable and high quality aeronautical meteorological service.

A major task for the AeMP is to ensure the effective coordination of the WMO in following up the recommendations of the Conjoint ICAO/WMO MET Divisional Meeting (MET DIV 2014). To that end, the scope of the AeMP has necessarily been expanded to coordinate the meteorological aspects of the ICAO Global Air Navigation Plan (GANP) and its Aviation System Block Upgrades (ASBU) methodology. The GANP will cover the broad spectrum of institutional, regulatory, technological and operational aspects of the envisaged performance improvements in support of the "One Sky" global ATM concept with a horizon of the year 2028 and beyond. Among these aspects are the integration of the meteorological information in the System-Wide Information Management (SWIM), the enhancement of the international facilities like the World Area Forecast System (WAFS) and the International Airways Volcano Watch (IAVW), and the development of new generation of services, to support safe, effective and efficient Air Traffic Management (ATM), Trajectory Based Operations (TBO) and to mitigate the impacts of the "space weather". The Meteorology Divisional Meeting (2014) also recommended that the AeMP should investigate the impacts of climate change and variability on global aviation operations.

4. Governance and work structure

The constituent body providing technical guidance to the AeMP is the Commission for Aeronautical Meteorology (CAeM). The Commission meets in session every four years and occasionally, conjointly with the ICAO Meteorology Divisional Meeting (the latest one took place in Montreal, Canada, in July 2014). The fifteenth session of CAeM established a new structure including a Management Group (CAeM-MG) and the following expert teams:

(a) Expert Team on Communication, Coordination and Partnership (ET-CCP);

(b) Expert Team on Aviation, Science and Climate (ET-ASC);

(c) Expert Team on Education, Training and Competency (ET-ETC);

(d) Expert Team on Governance (ET-GOV);

(e) Expert Team on Information and Services for Aviation (ET-ISA);

(f) Task Team on Quality Management Systems (TT-QMS) (to remain active until Cg-17).

The work of CAeM and its subsidiary bodies is supported by the AEM Division in the Secretariat, which is part of the Weather and Disaster Risk Reduction Services (WDS) Department.

5. Programme priorities for the intersessional period 2016–2019

CAeM-15 (July 2014), in considering the GANP and ASBU timeline covering the period to 2028 and beyond, recommended to Congress to endorse a long-term planning approach to support aeronautical meteorology as a WMO strategic priority. Such an approach will allow the AeMP to provide a level of coordination that is consistent with ICAO ASBU planning and implementation roadmaps.

The CAeM Technical Conference "Aviation Meteorology – Building Blocks for the Future" (Montreal, Canada, July 2014) collated Members' support for the AeMP to play an important role in guiding Members' activities in the following priority areas:

- Evolving global air traffic management (ATM) and related meteorology (MET) support
  - Raising Members' awareness of the GANP and ASBU, their MET components and timelines, and associated institutional and regulatory impacts;
  - Integration of WMO-related aspects of MET information management to ensure interoperability and compliance with ICAO System-Wide Information Management (SWIM);
  - Support ICAO in the development of provisions for operational space weather services for international air navigation;
  - Support further development of the WAFS, IAVW, and the services for nuclear and chemical emergencies based on the concepts of operation and roadmaps endorsed by MET Divisional Meeting 2014;
  - Investigate the impacts of climate change and variability on global aviation operations and associated provision of services to respond to these.
- Enhanced compliance with ICAO and WMO regulations
  - Continued assistance to Members in implementing and sustaining QMS for the provision of aeronautical meteorological services;
  - Guide the implementation of competency and qualification standards for Aeronautical Meteorological Personnel through further development of appropriate guidance material and learning opportunities;
  - Assist Members in the development of cost-recovery mechanisms, in particular in the developing and least developed countries;
  - Promote a culture of quality and continuous improvement for all aspects of aviation MET service provision.
- Enhanced governance and partnership
  - Develop further governance guidance for Members to respond to the envisaged institutional changes to the service delivery and business models and address related cost-recovery aspects;
  - Assist Members to keep pace with the global and regional developments – work on scalable solutions with inclusiveness principle to ensure sustainability of basic infrastructures;
  - Promote improved communication, engagement and collaboration with aviation stakeholders;
  - Promote efficiency and effectiveness through regional cooperation in providing meteorological service to international air navigation;
  - Develop appropriate risk assessment methodology to assist Members in their national planning aligned with the ASBU timelines.

Further information is available on the WMO AeMP website: http://www.wmo.int/aemp/.

ANNEX IV
Annex to paragraph 3.1.100 of the general summary

MARINE METEOROLOGY AND OCEANOGRAPHY PROGRAMME DESCRIPTION

Main Long-term Objectives

The Marine Meteorology and Oceanography Programme (MMOP) regulates, coordinates and facilitates the sustained provision of global and regional coverage of observational data, products and services to address the continued and expanding requirements of the maritime user community for met-ocean services and information, focusing on safety of life and property at sea, integrated coastal management and societal impacts. It keeps WMO Members informed of advances in the domains of marine meteorology and oceanography.

The main long-term objectives of MMOP are:

(i) To enhance the provision of marine meteorological and oceanographic services by Members in support of the safety of life and property at sea and in coastal areas;

(ii) To manage the evolution of an effective and efficient programme through the selective incorporation of advances in science and technology; and to work to ensure that all countries have the capacity to benefit from and contribute to these advances, and the implementation of the programme in general.

Purpose and Scope

The MMOP coordinates, develops and recommends standards and procedures, for a fully integrated marine observing, data management and services system that uses state-of-the-art technologies and capabilities. The Programme aims to maximize the benefits to Members in the projects, programmes and activities that it coordinates in their interest and in aid of the global marine community in general.

The scope of MMOP is defined by responding to the evolving needs of all users of marine data and products, and includes an outreach programme to enhance the national capacity of all maritime countries. While ensuring safety at sea has remained the priority, other applications such as coastal area management, disaster risk reduction, and climate services have become increasingly important.

The MMOP contributes to the effective implementation of the WMO Strategic Plan and its activities are strongly linked to other WMO Programmes. The MMOP contributes principally to the WMO priority on high impact services for disaster risk reduction while also contributing to the GFCS, WIGOS, WIS, Capacity Development and Polar priorities.

Governance

The overall technical guidance and governance for MMOP is provided by the JCOMM, jointly sponsored by WMO and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. The MMOP interacts closely with the Commission for Basic Systems (CBS), the Commission for Instruments and Methods of Observation (CIMO), the Commission for Hydrology (CHy) and the Commission for Agricultural Meteorology (CAgM.)

Programme Structure

In collaboration with JCOMM, the cooperative programme has been structured into three Programme Areas:

1. Services and Forecasting Systems Programme Area: promotes a globally distributed and inter-connected system that is responsive to the evolving needs of all users of marine data and products; promotes the implementation of an outreach programme to enhance the national capacity of all maritime countries;

2. Observations Programme Area: responsible for the development, coordination and maintenance of moored buoy, drifting buoy, and ship-based observational networks and related telecommunications facilities, while addressing observational user requirements and the integration between in situ and satellite observing systems. It also monitors the efficiency of the overall observing system and recommends and coordinates changes designed to improve it;

3. Data Management Programme Area: for the development of the required data standards, best practices, procedures, and collaboration with partner organizations to assure the flow in real-time and delayed mode of marine meteorological and oceanographic data and products to the WIS to serve the needs of the WMO Application Areas as well as those of the entire marine meteorology and oceanographic community, and the GFCS; offers its expertise to other groups to specify and implement their own data management requirements.

To improve Members abilities in the delivery of marine meteorological and oceanographic services, the Programme utilizes cross-cutting strategies including:

1. Capacity Development and Outreach: to enhance the capacity of all Members to contribute to and benefit from the data and services delivered under MMOP;

2. Satellite Data Requirements: to determine the detailed requirements for satellite and other remote sensing ocean data in the delivery of marine and ocean services;

3. International coordination: within the UN system, with other intergovernmental and non-governmental organizations, with the marine user community, and with the private sector in general;

4. Development and promotion of standards and best practices;

5. Enabling access to data and services (e.g. through the use of WIS, Ocean Data Portal (ODP) and other services);

6. Development of Competencies for Marine Meteorological and Oceanographic (MMO) Services Personnel.

ANNEX V
Annex to paragraph 3.1.160 of the general summary

GLOBAL INITIATIVES IN AGRICULTURAL METEOROLOGY

CONCEPT NOTE

The Commission for Agricultural Meteorology (CAgM) is fully supportive of the Global Framework for Climate Services (GFCS) and has noted the five GFCS pillars; Observations/ Monitoring (OBS), Research/Modelling/Prediction (RES), Climate Services Information System (CSIS) and User Interface Platform (UIP) which are all supplemented with Capacity Development (CD).

At the sixteenth session of CAgM in April 2014, the draft WMO Strategic Plan 2016–2019 was presented and it was also noted that GFCS was one of the WMO priorities for 2016–2019. The Commission incorporated these priorities into the future structure and workplan. However, it was also discussed that there is limitation of technical and human resources to fulfil these WMO priorities and to meet the future challenges in agricultural meteorology for food/water security and sustainable rural development.

The emerging requirements for WMO Members in agricultural meteorology include the development of high quality, value-added, operational services at the farmer level, high-resolution information products, feedback mechanism from users, application of state-of-the-art weather and climate models, and increased collection of ground-based measurements for agricultural meteorological applications and for validating remotely sensed information.

In the previous intersessional period of CAgM (2010–2014), there were many activities that could be related to the GFCS Pillars. These include:

(a) World AgroMeteorological Information Service (WAMIS-www.wamis.org)

- CSIS, UIP, CD

(b) International Society of Agricultural Meteorology (INSAM-www.agrometeorology.org)

- CD, RES, UIP

(c) National Agricultural Meteorological Station Network (NASNET)

- OBS

(d) Regional Training Centres, Roving seminars, Field schools, etc.

- CD

(e) Technical Conference prior to Commission Sessions, Joint CAgM Expert Team meetings with RA Working Groups

- RES, UIP

(f) Regional Agricultural Meteorological Pilot projects

- CD, CSIS, UIP, RES, OBS

(g) WIS, WIGOS related activities in agricultural meteorology

- UIP, RES, OBS

Based on Commission discussions during the past few years, CAgM has launched the Global Initiatives in AgroMeteorology (GIAM) at CAgM-16 in order to provide a structure for CAgM and AgMP to support to the GFCS. This structure includes:

(a) Global Centres of Research and Excellence in AgroMeteorology (GCREAM) for CD

GCREAMs are education and research organizations around the world, working in partnership collaboration, to provide synergistic cutting-edge technologies and pioneering solutions to the climate, food and water nexus, while preserving the environment for future generations. A crucial goal is to provide greater incentives for young people to take stronger and central roles in the inter-disciplinary and related fields of agricultural meteorology. GCREAMs will contribute to the Global Campus being developed by WMO. The following institutions have been identified as potential contributors to GCREAM: WMO; Seoul National University, Republic of Korea; University of Florence and the Institute of Biometeorology (IBIMET), Italy; George Mason University, USA; Institute of Agronomy, Campinas, Brazil; University of Southern Queensland, Australia; National Institute for Agro-Environmental Sciences (NIAES), Japan; Nanjing University of Information Science and

Technology (NUIST), China; Indian Meteorological Department (IMD), India; Institute of Agricultural Meteorology of ROSGIDROMET, Russian Federation; and the University of the Free State, South Africa.

(b) Global Federation of AgroMeteorological Societies (GFAMS: GlobalFAMS) for UIP

There are many agricultural meteorologists that are not involved in CAgM activities but which are represented by national agricultural meteorological societies or organizations. GlobalFAMS would establish a permanent exchange of knowledge and supporting tools for operational agricultural meteorologists at a national level and would engage with more agricultural meteorologists that could enrich the Commission with new experts and ideas. GlobalFAMS has already been established legally in Italy, and the first official meeting will take place in 2015. The TECO before the next CAgM session in 2018 would be organized with many members of these national agricultural meteorological societies or organizations.

(c) WAMIS Next Phase for CSIS, UIP, RES

The first phase of WAMIS is complete. The current website (www.wamis.org) is a static portal of agricultural meteorological bulletins and links to Members websites. The WAMIS Next Phase will demonstrate new technologies such as GIS online, integrated soil moisture products, online tools and web facilities, online crop models, applications for agriculture based on weather forecasts (standard and sub-seasonal to seasonal), especially employing Cloud service architecture. WAMIS would continue to be a WIS DCPC with the support of KMA and KISTI, including backup supports from DWD, QMD, INMET and NCAR.

(d) Global Alliance of Phenology Observation Network (GAPON) for OBS

The Alliance would facilitate strengthening existing national level phenology observation at NMHSs through global collaborations such as the International Society of BioMeteorology (ISB). It would focus on the establishment of phenology monitoring network at a global scale with standardization, data sharing, analysis and prediction through global collaborations among associated national and regional institutions. There have already been initial discussions among GAPON partners, including with the ISB, and the proposed Joint CCl/CAgM Expert Group could also contribute in this effort.

(e) Global AgroMeteorological Outlook System (GAMOS) for RES, OBS

This would focus on developing applications based on weather forecasts for agriculture. There is already initial work on examining the use of standard and subseasonal to seasonal forecasts (S2S) for agricultural meteorological applications, primarily focusing on crop status monitoring and yield projection through early warning and risk management systems. A S2S pilot project is currently being established with several institutions from the Republic of Korea and CAS.

(f) Global AgroMeteorological Pilot Projects (GAMPP) for RES

Pilot projects would be developed from each regional association (RA) and with cooperation and collaboration with other technical commissions to strengthen regional/global capacity developments in GFCS implementation. A Global Challenge Research (GCR) project is now under discussion as GAMPP implementation. It aims at establishing multi-disciplinary joint research on mitigation/ adaptation policymaking support system using S2S outcomes under climate variability, together with experts from the Agriculture & Agri-Food Canada (AAFC), Seoul National University (SNU) and Nanjing University of Information Science & Technology (NUIST) at its initial stage. These pilot projects will draw from the GIAM elements to provide an integrated package of support in selected countries as part of the overall GFCS support for country-level activities.

ANNEX VI
Annex to paragraph 4.1.88 of the general summary

HIGH-LEVEL MEETING ON NATIONAL DROUGHT POLICY

FINAL DECLARATION

(DECLARATION OPENING)

DO 1: We, the Heads of State and Government, Ministers, Heads of Delegations and Experts, attending the High Level Meeting on National Drought Policy (HMNDP) in Geneva, 11–15 March 2013:

(PREAMBULAR PART)

Urgency of the problem

PP 1: Acknowledging that droughts are natural phenomena that have caused human suffering since the beginning of humanity, and are being aggravated as a result of climate change;

PP 2: Noting the interrelationships between drought, land degradation and desertification (DLDD), and the high impacts of DLDD in many countries, notably the developing and the least developed countries, and the tragic consequences of droughts, particularly in Africa;

PP 3: Acknowledging the role of the UN agencies, and in particular the United Nations Convention to Combat Desertification (UNCCD) in line with its mandate, provisions and principles in particular Parts II and III of the Convention, to assist in the combat against drought and desertification;

PP 4: Observing that drought has major implications in terms of the loss of human lives, food insecurity, degradation of natural resources, negative consequences on the environment's fauna and flora, poverty and social unrest and that there are increasingly immediate short-term and long-term economic losses in a number of economic sectors including, inter alia, agriculture, animal husbandry, fisheries, water supply, industry, energy production and tourism;

PP 5: Concerned with the impacts of climate variability and change and the likely shift in the patterns of droughts and possible increase in the frequency, severity, and duration of droughts, thus further increasing the risk of social, economic and environmental losses;

PP 6: Underscoring that addressing climate change can contribute to reducing the aggravation of droughts and that it requires action, in accordance with the principles and provisions of the United Nations Framework Convention on Climate Change;

PP 7: Noting that desertification, land degradation and drought are global challenges that continue to pose serious challenges for the sustainable development of all countries, in particular the developing countries;

PP 8: Acknowledging that there are insufficient policies for appropriate drought management and pro-active drought preparedness in many countries around the world and that there is need for enhancing international cooperation to support all countries, in particular developing countries in managing droughts and building resilience, and that countries continue to respond to droughts in a reactive, crisis management mode;

PP 9: Recognizing also the urgent needs for countries to manage droughts effectively, and better cope with their environmental, economic and social impacts;

PP 10: Recognizing that to better cope with droughts, countries need to understand the need for improved risk management strategies and develop preparedness plans to reduce drought risks;

Scientific progress in drought monitoring and early warning systems

PP 11: Recognizing that advances in drought monitoring and early warning and information systems, under government authority, and the use of local knowledge and traditional practices can contribute to enhanced societal resilience and more robust planning and investment decisions, including the reduction of consequences of drought impacts;

PP 12: Recognizing that scientific advances in seasonal to inter-annual and multi-decadal climate predictions offer an additional opportunity for the continued development of new tools and services to support improved management of droughts;

Need for vulnerability and impact assessment

PP 13: Noting the need for urgent intersectoral coordination of the assessment of drought vulnerability and drought management;

Need for rapid relief and response

PP 14: Noting the need to identify emergency measures that will reduce the impact of current droughts while reducing vulnerability to future occurrences, relief must be targeted to the affected communities and socio-economic sectors and reach them in a timely fashion;

PP 15: Noting also the need to create synergies between drought relief measures and the preparedness, mitigation and adaptation actions for long-term resilience;

Need for effective drought policies

PP 16: Recalling the commitment in the outcome document of the UN Conference on Sustainable Development (Rio +20) to significantly improve the implementation of Integrated Water Resources Management at all levels, as appropriate;

PP 17: Recalling that the UNCCD is pertinent to the promotion of sustainable development and that it calls for the establishment of effective policies to combat land degradation and desertification and mitigate the effects of droughts;

PP 18: Recalling also the call of the COP 10 of UNCCD for an advocacy policy framework on drought for promoting the establishment of national drought management policies;

PP 19: Recalling the decision of governments to create the Global Framework for Climate Services (GFCS) to strengthen production, availability, delivery and application of science-based climate prediction and services;

(OPERATIVE PART)

OP 1: Encourage all Governments around the world to develop and implement National Drought Management Policies, consistent with their national development laws, conditions, capabilities and objectives, guided, inter alia, by the following:

- Develop proactive drought impact mitigation, preventive and planning measures, risk management, fostering of science, appropriate technology and innovation, public outreach and resource management as key elements of effective national drought policy;

- Promote greater collaboration to enhance the quality of local/national/regional/global observation networks and delivery systems;

- Improve public awareness of drought risk and preparedness for drought;

- Consider, where possible within the legal framework of each country, economic instruments, and financial strategies, including risk reduction, risk sharing and risk transfer tools in drought management plans;
- Establish emergency relief plans based on sound management of natural resources and self-help at appropriate governance levels;
- Link drought management plans to local/national development policies;

OP 2: Urge the World Meteorological Organization, the UNCCD and the Food and Agriculture Organization of the United Nations (FAO), other related UN agencies, programmes and treaties, as well as other concerned parties, to assist governments, especially the developing countries, in the development of National Drought Management Policies and their implementation;

OP 3: Urge the developed countries to assist developing countries, especially the least developed countries, with the means of implementation towards the comprehensive development and implementation of National Drought Management Policies in accordance with the principles and provisions of the UNCCD;

OP 4: Encourage the promotion of international cooperation, including north-south cooperation complemented by south-south cooperation, as appropriate, to foster drought policies in developing countries;

OP 5: Invite WMO, UNCCD and FAO to update the draft versions of the Science and Policy documents taking into account the recommendations from the HMNDP and circulate them to all Governments for their review prior to finalization, to assist governments in the development and implementation of the National Drought Management Policies.

ANNEX VII
Annex to paragraph 4.2.6.19 of the general summary

2014 LIST OF STATIONS OF CRYONET

	Site	Operating Country	Location	Integrated?
30	**Syowa**	Japan	Antarctica	yes
33	**Dome-C**	France	Antarctica	no
12	**Morenas Coloradas Rockglacier**	Argentina	Argentina	no
24	**Vuriloches**	Argentina	Argentina	no
25	**Aonikenk**	Argentina	Argentina	no
3	**Sonnblick**	Austria	Austria	yes
11	**Zongo Glacier**	France	Bolivia (Plurinational State of)	yes
8	**Eureka**	Canada	Canada	no
36	**Valle Nevado**	Chile	Chile	no

	Site	Operating Country	Location	Integrated?
4	Qilianshan Station of Glaciology and Ecologic Environment	China	China	no
6	Qilian	China	China	yes
7	Tanggula Cryosphere and Environment Observation Station	China	China	no
20	Xidatan	China	China	yes
21	Tanggula	China	China	yes
27	Tianshan	China	China	no
29	The Koxkar Glacier Camp (KGC)	China	China	yes
10	Antisana 15 alfa	Ecuador	Ecuador	no
5	Sodankylä-Pallas	Finland	Finland	yes
16	Saint-Sorlin Glacier	France	France	yes
17	Argentiere Glacier	France	France	yes
18	Mer de Glace Glacier	France	France	no
19	Gebroulaz Glacier	France	France	no
1	SIGMA-A	Japan	Greenland	no
2	PROMICE Greenland Ice Sheet Monitoring Network	Denmark	Greenland	no
28	Zackenberg	Denmark	Greenland	yes
31	SIGMA-B	Japan	Greenland	no
9	Hofsjökull	Iceland	Iceland	no
35	Forni Glacier	Italy	Italy	no
15	Glaciar Norte	Mexico	Mexico	no
13	Quelccaya Ice Cap	USA	Peru	no
22	Tiksi	Russian Federation	Russian Federation	yes
23	Ice Base Cape Baranova	Russian Federation	Russian Federation	yes
34	Spasskaya Pad (Yakutsk)	Japan	Russian Federation	yes
32	Col de Porte	France	France	yes
14	Davos	Switzerland	Switzerland	yes
26	Barrow Baseline Observatory	USA	USA	yes

Note: By clicking on the Site name, the Site-specific metadata can be viewed.

ANNEX VIII
Annex to paragraph 4.2.6.28 of the general summary

GLOBAL CRYOSPHERE WATCH IMPLEMENTATION PLAN

WORLD METEOROLOGICAL ORGANIZATION

GLOBAL CRYOSPHERE WATCH (GCW) IMPLEMENTATION PLAN

Version 1.6

(24 January 2015)

DOCUMENT VERSIONS

Version	Author(s)	Date	Description
0.1	EC-PORS GCW Task Team	Nov 2011	Initial draft
0.2	J. Key	25 Jan 2012	Major modifications based on 1st implementation meeting (working groups, impacts; structure and timeline figures); revised and expanded tasks
0.3	J. Key	31 Jan 2012	Additional recommendations and task from GCW Implementation Meeting report
0.4	J. Key	2 Feb 2012	Added appendices; other minor modifications
0.5	M. Ondráš	10 Feb 2012	Restructuring based on guidance from EC-PORS-3
0.6	J. Key, B. Goodison, M. Ondráš	28 Mar 2012	Updated GCW structure figure; added Table 2; updated timeline; removed annexes
0.7	J. Key	16 May 2012	Expanded and moved Purpose section; added additional details where needed; trimmed background sections; updated framework and timeline figures
0.8	B. Goodison	18 May 2012	Revisions, error checking to match IP with other documents and current GCW practice
0.8.1	J. Key, M. Ondráš, B. Goodison	6 Aug 2012	Incorporated comments from extended GCW task team (E. Brun, W. Meier, B. Angle, W. Schoener); some restructuring
1.0	J. Key, B. Goodison	19 Oct 2012	Incorporated comments from EC-PORS and partners
1.1	J. Key	25 Sep 2013	Revised framework based on recommendations from EC-PORS-3 and the 1st GCW Implementation Workshop
1.2	J. Key, B. Goodison, M. Ondráš, Ø. Godøy	14 Jan 2014	Added regional groups to the framework; updated framework figure; added the Snow Watch Group to the Products Team; updated Portal Team description; added SWE Tracker; additional indicators of success; revised dates of key implementation activities; updated timeline; removed outdated material
1.3	B. Goodison, J. Key	11 Feb 2014	Incorporated comments from Steering Group; added site type and website figures; revised Appendix 1; added Annex 3 moved project phase section; updated portal links figure
1.4	J. Key	1 Mar 2014	Updated based on EC-PORS-5 feedback: restructured the implementation section; new framework figure; revised partnership criteria
1.5	M. Ondráš, J. Key. Ø. Godøy	7 Nov 2014	Changed definition of *cryosphere*; updated steering group and team structure; updated milestone/task timelines; updated data portal and website section; updated structure figure; additions on snow chemistry
1.6	Steering Group	24 Jan 2015	Updated with new surface site and station definitions and figure; updated new working group and team description and framework figure; updated portal connections figure

TABLE OF CONTENTS

1 Purpose of this Document

This document describes the implementation of the World Meteorological Organization's Global Cryosphere Watch (GCW). The focus of the plan is on the GCW organizational structure and key activities during the development and implementation phase (2012-2019), as presented in the GCW Implementation Strategy that was approved by the Fifteenth World Meteorological Congress. The document provides background information for senior representatives of National Meteorological and Hydrological Services (NMHSs) and related institutions on GCW, applications of cryosphere data, a conceptual framework, an operational structure, near-term tasks, milestones and deliverables, management, indicators of success, partnerships, and an indication of resources. This plan will be periodically updated as GCW evolves over the coming years.

2 Introduction

The cryosphere is a component of the Earth System that includes snow cover, sea ice, lake and river ice, glaciers, ice caps, ice sheets, permafrost, seasonally frozen ground, and solid precipitation at the surface.[1] The cryosphere is global, existing not just in the Arctic, Antarctic and mountain regions, but also in various forms at all latitudes and in approximately one hundred countries. The cryosphere provides some of the most useful indicators of climate variability and change, yet is one the most under-sampled domains of the Earth System. Improved cryospheric monitoring and integration of that monitoring is essential to fully assess, predict, and adapt to variability and change in the Earth's weather, climate and water cycles.

The cryosphere, its changes, and its impacts have received increased attention in recent years. Today it receives constant coverage by the media, creating a demand for authoritative information on the state of the world's snow and ice resources from polar ice to tropical glaciers, based on data from paleoclimate records, current observations, and future projections. WMO, with the co-operation of other national and international bodies and organizations, and using its global observing and telecommunication capability, is in a position to provide an integrated, authoritative, continuing assessment of the cryosphere – a Global Cryosphere Watch (GCW).

2.1 Rationale for GCW

WMO's ability to support ongoing development and delivery of weather, climate, and water services contributes to ensuring the sustainable development and well being of nations. GCW will provide, directly or indirectly, data, information, products and analyses that will help Members and partners provide needed services to the wider user community. GCW will help us understand, assess, predict, mitigate, and adapt to climate variability and change and improve weather forecasting and hazard warnings, thus helping reduce the risk of loss of life and property from natural and human-induced disasters. It will contribute to improved management of energy and water resources, including flood forecasting and hydropower production, help support sustainable agriculture, and improve our ability to monitor and conserve biodiversity. Cryosphere information is required for infrastructure design in cold climates, improved management and protection of terrestrial, coastal and marine ecosystems, and an improved understanding of environmental factors affecting human health and well-being. The cryosphere impacts all nations, their people and their economy.[1]

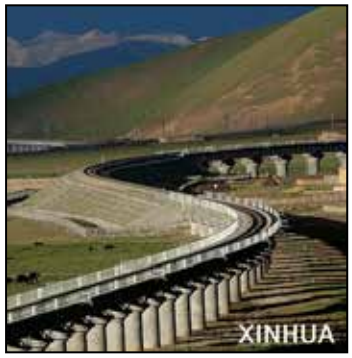
Changes in the cryosphere have been shown to contribute to global climate variability and change. Albedo changes from the loss of sea ice and snow cover, along with accelerating methane emissions from thawing permafrost, are heating the planet at a rate equivalent to approximately 3 billion metric tons of CO_2, comparable to about 42% of US global warming emissions. The emission of GHGs and changes in albedo from a melting Arctic are projected to more than double the Arctic's contribution to global warming by 2100.

[1] While elements of the *cryosphere* are often defined to contain frozen water, permafrost can be "dry". The GCW definition includes elements of the cryosphere that occur on or beneath the Earth's surface, or that are measured at the surface in the case of solid precipitation. It therefore excludes ice clouds.

Sea level rise is a major concern for coastal regions, especially heavily populated zones, and is critical for a number of small island nations. Although the volume equivalent of glaciers in terms of global sea level rise is small (0.5 m) compared to that of the ice sheets of Greenland (7 m) and Antarctica (about 70 m), their melt contribution to sea level rise during the second half of the 20th century was 2.5 times more than the loss of ice from the Greenland and Antarctic ice sheets.

The amount of snow and the rate of snowmelt can govern the timing and characteristics of runoff. In the western United States as much as 75% of water supplies come from snowmelt, and most central Asian countries/regions rely on meltwater for agriculture and industry. Many countries rely on snowmelt forecasts to predict river runoff, determine flood potential, and to provide flood alerts. Mountain glaciers are an important water resource for many communities and they play a vital role in local hydrological cycles. The contamination of these glaciers by anthropogenic aerosol pollutants poses a threat to population centres that rely on them for potable water. Changes in the cryosphere affect hydropower operations in alpine and continental regions.

Wave-induced undercutting of permafrost leads to coastal erosion by the action of waves and currents. Shortened periods of seasonal ice-cover, and later development of the fast ice and its earlier break up, expose coastlines to more severe storms that occur during transition seasons. Local coastal losses to erosion of the order of 30 metres per year have been observed in some locations in both Russian Federation (Siberia) and Canada.



Transportation is directly impacted by changes in snow cover, fresh-water and sea ice extent and thickness, and the degradation of permafrost. Persistent reductions in Arctic multi-year sea ice cover would benefit marine transportation and related socio-economic developments, but present a risk for marine ecosystems. Thawing of permafrost can lead to the degradation of roads, railroads and northern airstrips. Snowfall frequency and magnitude directly affect road and rail traffic and aircraft operations with significant cost implications to national economies. River and lake-ice provide winter roads for access to remote areas.

The design of buildings and infrastructure in cold climates must consider the presence of permafrost and seasonally frozen ground. Knowledge of thermal and ground ice conditions is critical for land use planning and engineering design in permafrost regions. The development of oil and gas deposits in ice-covered seas and shelves depends on the ice regime and the presence of icebergs, which together determine the economic feasibility of exploration and production projects.

Other sectors such as wildlife, recreation, and tourism are significantly affected by short-term and long-term changes in snow and ice conditions. Cryosphere-related hazards include avalanches, catastrophic spring floods from the rapid melting of snow, glacial lake outburst floods, the high variability of lake break-up and freeze-up dates that have significant short- and long-term impacts, including increased risks, and hence costs, for the insurance industry.

Cryosphere data and products support the development and delivery of climate, weather and water services by Members, including in the key GFCS areas of food security, water, health, and disaster risk reduction. Snow and ice data are required for weather and climate research and in many types of practical applications such as engineering, services to society, and various types of land- and marine-related resource management. The performance of numerical weather forecasts strongly depends on the accuracy of initial conditions for predictive models, including snow and ice conditions. Ice services provide forecasts for navigation and offshore activities. Cryospheric data play a critical role in climate reanalyses, as input to the assimilation systems and for verification of model fields.

GCW will provide information for decision-making and policy development related to climate, water and weather, for use in real time, for climate change adaptation and mitigation, and for risk

management. Over time, this information will become more service-oriented. During initial GCW consultation, Members emphasized the regional and global impacts of the cryosphere, particularly:

- Sea level rise threatens vital infrastructure, settlements and facilities of small island states and low-lying coastal zones;
- Changes in sea-ice affect access to the polar oceans and surrounding seas, in turn affecting economic development, accessibility to resources, navigation, tourism, marine safety and security. Declining summer sea-ice may also impact ocean circulation and weather patterns in the mid-latitudes;
- Permafrost thawing impacts infrastructure and is a potential major source of methane, a greenhouse gas;
- Changes in, and contamination of, the cryosphere have major impacts on water supply, food production, availability of potable water, freshwater ecosystems, hydropower production, and the risk of floods and droughts;
- Natural hazards such as icebergs, avalanches and glacier outburst floods create risks for transportation, tourism and economic development;
- Cryospheric data and information are required for improved numerical weather prediction and climate monitoring and prediction in polar and alpine regions as well as globally;
- Changes in large-scale dynamics have major, and currently not well predicted, impacts on climate in North America, Europe and Asia.

GCW will provide a mechanism to translate user needs into observational requirements, and requirements into observing system design, implementation, integration, and data.

2.2 Mission and Objectives

GCW will be an international mechanism for supporting all key cryospheric in-situ and remote sensing observations. To meet the needs of WMO Members and partners in delivering services to users, the media, public, decision and policy makers,

> *GCW will provide authoritative, clear, and useable data, information, and analyses on the past, current, and future state of the cryosphere.*

In its fully developed form, GCW will include observation, monitoring, assessment, product development, and research. GCW will have a positive impact on prediction, thus supporting assessments of the future state of the cryosphere. It will provide the framework for reliable, comprehensive, sustained observing of the cryosphere through a coordinated and integrated approach on national to global scales to deliver quality-assured global and regional products and services. GCW will help bridge the gap between research and operations, between scientists and practitioners.

GCW will organize analyses and assessments of the cryosphere to support science, decision-making, environmental policy and services through, inter alia, its foundational support to the Global Framework for Climate Services (GFCS), the Global Integrated Polar Prediction System (GIPPS) including its WWRP Polar Prediction Project (PPP) and WCRP Polar Predictability Initiative (PPI), and the Polar Regional Climate Centres (PRCCs) and Polar Climate Outlook Forums (PCOFs).

To meet these objectives, GCW implementation will encompass:

- *Requirements:* Meet evolving cryospheric observing requirements of WMO Members, partners, and the scientific community, by contributing to the WMO Rolling Review of Requirements (RRR) process.

- *Integration:* Provide a framework to assess the state of the cryosphere and its interactions within the Earth System, emphasizing integrated products using surface- and space-based observations while including a mechanism for early detection of, and support for, endangered long-term monitoring.
- *Standardization and assessment:* Enhance the quality and "authority" of data by improving observing standards and best practices for the measurement of essential cryospheric variables, by addressing potential differences and inconsistencies in current practices, and by fully assessing error characteristics of in situ and satellite products.
- *Observing network design and evolution:* Based on the *Requirements* and *Standardization* objectives, the GCW core observing network (CryoNet) will be designed to provide global compatibility of cryospheric data and interoperability of deployed systems.
- *Access:* Improve exchange of, access to, and utilization of observations and products from WMO observing systems and those of its partners.
- *Coordination:* Foster research and development activities and coherent planning for future observing systems and global observing network optimization, especially within the WMO Integrated Global Observing System (WIGOS), by working with all WMO Programmes, technical commissions (TCs), regional associations (RAs), partner organizations and the scientific community.

CryoNet, the core, standardized observing component of GCW is a component of WIGOS. Implementation is directly linked to the WIGOS Implementation Plan (WIGOS-IP) and the evolution of the global observing systems. GCW will coordinate relevant cryospheric activities with the Global Climate Observing System (GCOS), which includes the climate-related components of the Global Ocean Observing System (GOOS) and the Global Terrestrial Observing System (GTOS), hence enhancing GCOS support to the UNFCCC. The WMO Information System (WIS) will provide a vehicle for data and products collection and dissemination within and outside the WMO community. Through WIGOS and WIS, GCW will also provide a fundamental contribution to the Antarctic Observing Network (AntON) and the Global Earth Observation System of Systems (GEOSS).

GCW will contribute to the observational activities for the cryosphere identified in the GFCS Implementation Plan, its Annexes and its compendium of projects to provide essential data and products needed for services required by GFCS users.

2.3 Project Phases

2.3.1 GCW Definition Phase (2007-2011)

Following a review of the feasibility study for developing and implementing GCW within WMO, EC-LXI in 2009 endorsed the next steps for developing GCW with the guidance of the WMO Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS). In 2011, Cg-XVI decided to embark on the development of the Global Cryosphere Watch as an IPY legacy with a view towards achieving an operational GCW.

Extensive consultation contributed to the rationale, concept, principles and characteristics of GCW as well as the engagement of WMO Programmes and TCs, key partners from other agencies, institutes and organizations, and the scientific community who could contribute to the development and implementation of GCW. Pilot and demonstration projects were identified to test GCW implementation.

2.3.2 GCW Development Phase (2012–2015)

The Development Phase, undertaken between 2012 and 2015, will be led by the GCW Steering Group (GSG) under the responsibility of EC-PORS and coordinated with WMO constituent bodies and partners. It will focus on developing the internal GCW working structure of groups and teams

charged with the development of agreed measurement practices and guidelines, the establishment of the core, standardized GCW Observing Network (CryoNet), the establishment of a system for documenting activities, practices and provision of products (GCW Website, regulatory materials) and reporting of data (GCW Data Portal).

2.3.3 GCW Implementation Phase (2016–2019)

The Implementation Phase, undertaken between 2016 and 2019, will be led by the GCW Steering Group (GSG) under the responsibility of either the EC or a technical commission and coordinated with WMO constituent bodies, partners and WMO and international Programmes. It will focus on implementing a newly defined GCW Programme in line with tasks and activities described in this GCW Implementation Plan (IP) and in GCW workshop reports, with a special emphasis on operating a standardized observing network (CryoNet), the sustainable provision of quality data to the WMO GTS/WIS through the GCW Data Portal, and the sustainable provision of authorized GCW products. The GCW-IP is a living document that will be regularly reviewed and updated. Initial timelines and deliverables are given in the *Deliverables and Milestones* section.

2.3.4 GCW Operational Phase (2020 onward)

Once the framework is established, GCW enters its Operational Phase based on the agreed practices and objectives stated in the GCW Programme. It will continue to evolve to improve service delivery and support decision-making in response to the needs of users and technological opportunities. The implementation of the GCW programme will establish an improved scientific basis for national, regional and international efforts towards sustainable development. The programme will include assistance to Members and partners in the development and maintenance physical and human resources, and the knowledge needed to support the provision of services.

3 Implementation

3.1 Conceptual Framework Overview

The framework, or conceptual model, for GCW is given in Figure 1. It illustrates the “why, what, and how” of GCW operation. GCW’s governance will be integrated with WMO structures and interfaced with those of partner organizations. The GCW Steering Group (GSG) and Working Groups (WG) are central to GCW operations. The GCW Steering Group will provide high-level guidance on GCW development and implementation and will steer the activities of its Working Groups. The GSG currently reports to the WMO Executive Council through the Panel of Experts on Polar Observations, Research and Services (EC-PORS) and provides recommendations for GCW development and implementation for consideration by the WMO Executive Council and the WMO Congress. Working Groups and their Teams are responsible for implementing the tasks identified in this implementation plan, in workshop reports, and by sponsors, partners, the scientific community, and users of GCW products and information. Regional groups will be formed where it will foster multi-national collaboration between Members with interests in the same region, e.g., in Asia for Third Pole issues and for the pan-Arctic for high latitude northern issues.

GCW data include basic measurements and higher-level products. The GCW Data Portal (http://gcw.met.no) is a web interface that contains information about datasets (metadata), but not necessarily the data themselves. Instead, it links to data that are stored at partner data centres and therefore functions as a catalogue. It is WIS compatible and will become a WIS Data Collection and Production Centre (DCPC) to allow for ingesting the available data into GTS/WIS. Information and analysis products will be derived from surface and satellite observations, operational products, reanalyses, and research datasets. The GCW Website (http://globalcryospherewatch.org) is the window to GCW, providing information on the programme itself, activities, cryosphere news, products and information, observing networks and systems, guidelines and standards, and reference and outreach material such as a comprehensive cryosphere glossary. It is the key GCW outreach mechanism – it provides the “Watch” and complements the portal in supporting cryosphere services.

Collaboration and cooperation through partnership is essential. Cryospheric data, information, products and knowledge will be provided not only from National Meteorological and Hydrological Services (NMHSs), but also from national and international partner organizations, agencies, and the scientific community. National weather and ice services, space agencies, and research groups are critical to the development, implementation and success of GCW. They not only provide the basic observations for GCW, but also contribute the development of measurement practices, observational requirements, and product selection.

GCW will include an effective interface with the user community. Capacity-building and training will be included in all aspects of the GCW framework.

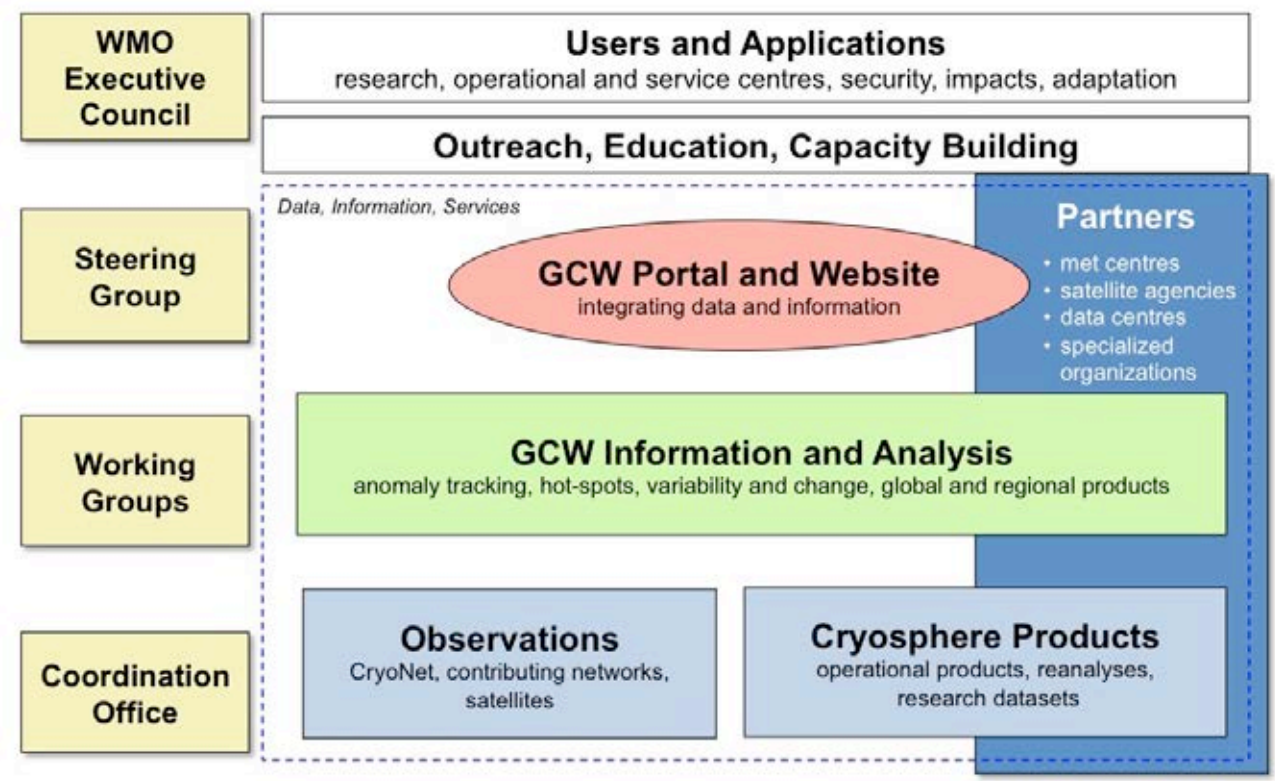


Figure 1. Conceptual Framework for GCW operation

3.2 The GCW Steering Group (GSG) and Working Groups

3.2.1 GCW Steering Group

The GCW Steering Group (GSG) will provide high-level guidance on GCW implementation and further development. It will be concerned with process and general direction more than specific actions. It will establish GCW Working Groups, provide oversight of the Groups and provide guidance on the conduct of GCW Pilot and Demonstration Projects. The GSG is comprised of experts from EC-PORS, relevant WMO Programmes, TCs and co-sponsored programmes, and from partners and contributors. EC-PORS appoints its chairperson and vice-chairperson. The GSG currently reports to EC-PORS on GCW activities and provides recommendations for GCW development and implementation for consideration by the WMO Executive Council and the WMO Congress. The GSG liaises with GCW focal points as well as representatives of partner organizations and will provide annual reports to all stakeholders, as appropriate, through the GCW website and/or newsletter.

3.2.2 Working Groups

Three Working Groups have been established:

- The **Observations Working Grou**p;
- The **Integrated Products Working Group**; and
- The **Information and Services Working Group**.

Working Groups will establish Teams, as needed, to address the priority tasks defined in the work plans of the Groups. Initially, the Observations Working Group includes the **CryoNet Team**, the **Best Practices Team,** and the **Solid Precipitation Team**. The Integrated Products Working Group includes the **Snow Watch Team**. The Information and Services Working Group contains the **Portal Team**, the **Terminology Team,** and the **Website and Outreach Team**. All Groups and Teams will facilitate interaction between the operational and research communities.

Working Group and Team members will be selected experts nominated by sponsors, partners and contributors to GCW. Working Groups and Teams may be joint working groups with GCW partners and contributors. Teams, their scope, and activities will evolve as GCW moves toward the operational phase.

The Observations Working Group will address capabilities and needs for surface-based and satellite observations. It will be responsible for the establishment and coordination of operations of the GCW surface-based observational network, including the core network called **CryoNet**. The Group will develop a network strategy and procedures for becoming part of the GCW network, evaluate proposed sites, and will determine data availability. It will develop relevant material to be included in the WMO Technical Regulations and in the WIGOS Manual. To establish CryoNet, it will define the types of sites in cold climate regions, on land or sea, operating a sustained, standardized programme for observing and monitoring as many cryospheric components and variables as possible. An example of a robust snow measurement programme for a land site is given in Appendix 1. This Group will compile best practices, guidelines, and standards, facilitate instrument intercomparisons, and promote interaction and collaboration between the scientific and operational communities. It will conduct an inventory of measurement methods and infrastructure at sites that measure components of the cryosphere. The Observations Working Group will assess user needs, periodically review and update observing system requirements and capabilities and contribute to the WMO Rolling Review of Requirements database and liaise with the Polar Space Task Group (PSTG).

The Integrated Products Working Group will identify key GCW datasets. This includes the development of an inventory of candidate in situ and satellite products for GCW that are mature (product quality) and generally accepted (credible) by the operational and scientific community. The Group will facilitate the harmonization of products (e.g., multiple sea ice estimates), product intercomparisons, and oversee development of data policies for GCW including data exchange by WMO Members. The Group will consider data homogeneity, interoperability, and compatibility of GCW observing and monitoring systems and derived cryospheric products.

The Information and Services Working Group will be responsible for the ongoing development and operation of the GCW Data Portal and its Data Catalogue, cryospheric metadata and terminology, the GCW website, and outreach activities. The Group will manage linkages to data contributors, work with national focal points, and develop documentation for outside use. It will work through interoperability issues with data centres and other programmes. The Group will be available to speak to the media and policymakers, provide guidance for outreach products and work with social media. A variety of outreach materials will be developed to educate the public, Members, funding agencies, and policymakers on the cryosphere and its importance to society.

GCW will have numerous, diverse stakeholders both within WMO and with its partners. GCW will establish an effective communication, outreach and education strategy in collaboration with WMO Members, Programmes, RAs, TCs, co-sponsors and partners. It will take advantage of outreach

programmes developed and effectively deployed through IPY and with organizations such as Association of Polar Early Career Scientists (APECS) and the Global Learning and Observations to Benefit the Environment programme (GLOBE).

3.3 WMO Members, Focal Points, Commissions, and Panels

Interested WMO Members have provided focal points for the development of GCW. The focal points are formally nominated by the Members' Permanent Representatives with WMO. There may be more than one per country. Focal points may be from outside the Member's National Meteorological and Hydrological Service (NMHS), recognizing that other bodies may have operational and/or research responsibilities for the cryosphere. The focal point(s) will liaise with the GCW Task Teams and regional groups. They will serve as the national contact(s) for, and contribute to, the development and implementation of GCW and its activities locally, nationally, regionally and globally. They will liaise with national bodies that have responsibilities for information, products and services related to the cryosphere, engage national representatives of international organizations partnering with GCW, identify national and regional cryosphere-related issues, needs and gaps, engage their WMO Regional Association, identify needs and opportunities for capacity-building and resource mobilization. More information on focal point responsibilities is given in the *GCW Focal Points Terms of Reference* (see http://www.wmo.int/pages/prog/www/OSY/Reports/GCW-IM-1_FinalReport_rev1.pdf). To date over 30 countries from all WMO Regions identified contacts for the development and implementation of GCW.

GCW will engage WMO co-sponsored programmes, technical commissions (TCs), regional associations (RAs), inter-governmental bodies, and scientific bodies that have cryospheric interests and responsibilities. WMO's co-sponsored programmes are essential partners. WCRP/CliC coordinated the development of the GCW feasibility study and co-led with SCAR the development of the Integrated Global Observing Strategy Partnership (IGOS-P) Cryosphere Theme (hereinafter "CryOS"). The WMO-IOC-UNEP-ICSU Steering Committee for GCOS endorsed the creation of GCW as a mechanism for integrating cryospheric observations. Potential co-sponsorship of GCW is an option. Memorandum of understanding or agreements would have to be established among all sponsors, as appropriate.

3.4 Collaboration and Cooperation with Other International Programmes

GCW is an initiative sponsored by WMO in which WMO and partners individually and collectively contribute to GCW's Mission and objectives. Collaboration, cooperation and commitment are essential to successful conduct of GCW activities at the international, regional and national levels. From the very beginning of GCW, partnerships were being developed, with government agencies and other institutions that measure, monitor, or archive cryosphere data and information from in-situ and satellite research and operational networks and model sources, and with international bodies and services involved in cryospheric observations, services, or research. These include, but are not limited to, the International Permafrost Association (IPA), the World Glacier Monitoring Service (WGMS), a service of the International Association of Cryospheric Sciences (IACS), the Scientific Committee for Antarctic Research (SCAR), the Global Precipitation Climatology Centre (GPCC), and the US National Snow and Ice Data Center (NSIDC). Additionally, international organizations, such as the International Council for Science (ICSU), the Intergovernmental Oceanographic Commission (IOC) and International Hydrological Programme (IHP) of UNESCO, and regional bodies such as the International Centre for Integrated Mountain Development (ICIMOD) are being engaged in the development and implementation of GCW.

EC-PORS has facilitated engagement of organizations with polar interests in the development of GCW. EC-PORS has members from the Arctic Monitoring and Assessment Programme (AMAP), the International Arctic Science Committee (IASC), and SCAR. Through the EC-PORS Antarctic Task Team, GCW has direct linkages to the Antarctic Treaty Consultative Meeting (ATCM). At its thirty-seventh session, ATCM welcomed the development of GCW. WMO's Polar Space Task Group (PSTG), which reports through EC-PORS, provides engagement of CEOS and major satellite operators like CSA, ESA, EUMETSAT, JAXA, NASA, and NOAA.

Programmes such as GCOS, GOOS and GTOS (the Global Climate, Ocean, and Terrestrial Observing Systems) have contributed to the development of GCW. GTOS and GCOS, currently through the Terrestrial Observations Panel for Climate (TOPC), guide the development of global terrestrial networks for climate (GTNs) and for permafrost, glaciers, hydrology, run-off, and lakes (GTN-P, GTN-G, GTN-H, GTN-R, GTN-L). GCW will work with the GCOS Secretariat, GCOS Panels and implementing bodies. The Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), particularly through its Expert Team on Sea Ice and the Data Buoy Cooperation panel (DBCP) are contributing to the development of the sea ice observing component of GCW. Additional contributions on sea ice measurements and polar ocean observing systems will come from regional organizations such as the Arctic Ocean Science Board (AOSB), EuroGOOS, and the newly established Arctic GOOS Regional Alliance, and professional consortia like the International Ice Charting Working Group.

Examples of collaborative activities with these programmes and partners include:

- Coordination of GCW development and implementation;
- Compilation and development of manuals on best practices for cryospheric measurements and observation;
- Coordinated observing, capacity-building and training with their existing networks;
- Development of community monitoring of the cryosphere;
- Co-publication of glossaries of cryospheric vocabulary and terminology;
- Development of satellite, in situ, and other product inventories relevant to GCW;
- Joint intercomparison of products;
- Development of regional GCW activities and fostering the transfer of research observations to operations, thereby ensuring sustainability;
- Training and outreach in snow and ice measurement; and
- Advising on outreach materials and methods.

GCW will not assume the mandate of any of its partners/collaborators and will avoid duplication of effort. Instead, GCW will enable partners/collaborators to exercise their mandate effectively. Close collaboration between research scientists and "practitioners", who are often scientists themselves but working in operational services, is one of the key aims of GCW. This can be facilitated by collaboration between GCW and its partners in addressing the above noted tasks.

Criteria for GCW partnership are given in Annex 3.

3.5 Observations

The core GCW surface-based observational network, called *CryoNet*, will be comprised of sites with varying capabilities. It will build on existing cryosphere observing programmes and promote the addition of standardized cryospheric observations to existing facilities in order to create more robust environmental observatories.

Two types of sites are envisioned based on the number of “spheres” that are monitored (e.g. cryosphere, atmosphere, hydrosphere, biosphere, etc.). See Figure 2. CryoNet Basic Sites monitor one or more components of the cryosphere (glaciers, ice shelves, ice sheets, snow, permafrost, sea ice, river/lake ice, and solid precipitation) and observe multiple variables of each component. Basic Sites also measure auxiliary meteorological variables, comply with GCW best practices, are actively taking measurements, have a long-term financial commitment, make data freely available, and make data available in (near) real time whenever possible. CryoNet Integrated Sites, in addition to the Basic Sites characteristics, monitor at least one other sphere, have a broader research focus, have support staff, and have training capability. Integrated Sites are particularly important for the study of feedbacks and complex interactions between the atmosphere, cryosphere, biosphere, and ocean.

CryoNet Sites contain one or more CryoNet Stations. **Primary Stations** have a target (intent) of long-term operation and have at least a 4-year initial commitment. **Baseline Stations** have a long-term operational commitment and long-term (more than 10 years) data records.

As encouraged by GCOS, GCW will facilitate the establishment of high-latitude sites with co-located measurements of key variables, especially permafrost and snow cover, thus enhancing GCOS/GTOS Networks for Permafrost (GTN-P), Glaciers (-G) and Hydrology (-H) and including the measurements of solid precipitation. In addition, aerosol contamination of surface snow (dust, black carbon, heavy metals, etc.) will also be monitored to link with existing atmospheric measurements from the GAW network. GAW stations and WCRP/Coordinated Energy and Water Cycle Observations Project (CEOP) reference sites in cold climates are potential candidates. Community monitoring also offers new network opportunities for GCW.

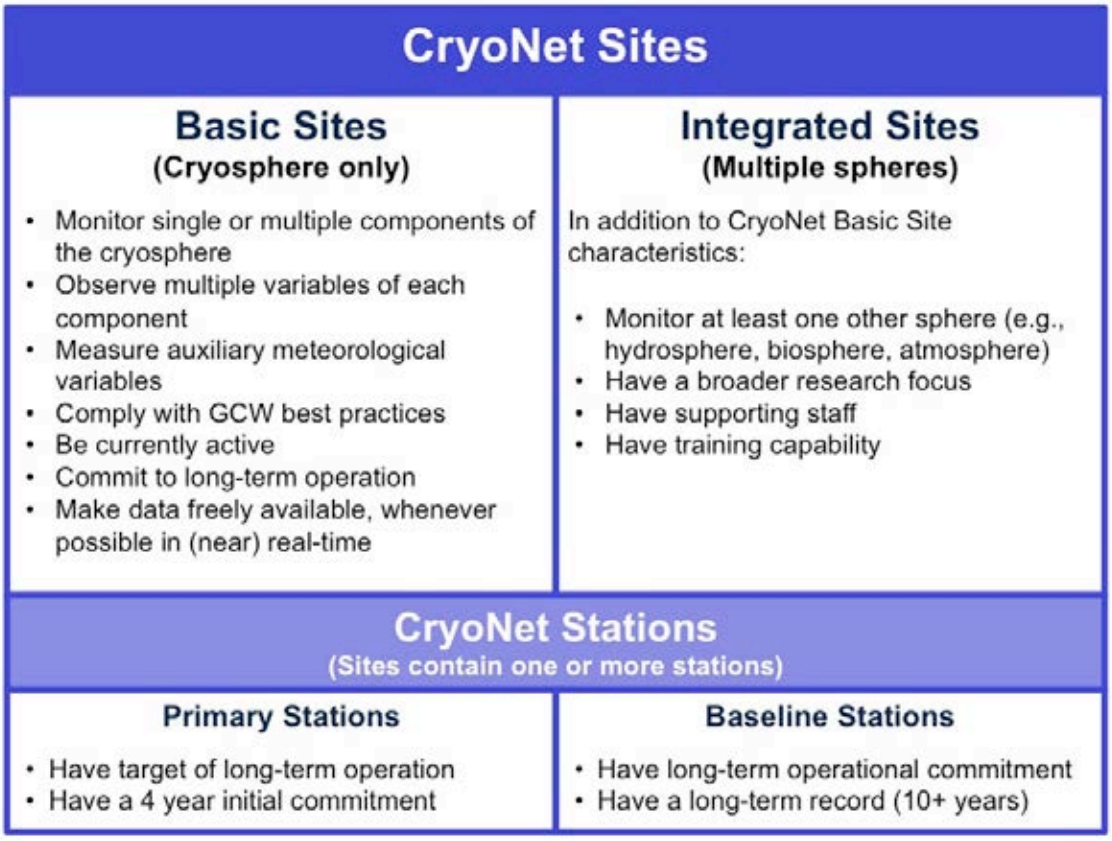


Figure 2. Properties of the different CryoNet Site and Station types

Members, through their GCW focal points, and participants in CryoNet workshops have recommended potential sites. Many Members have proposed contributing to GCW through their sites in China, Finland, the USA, Austria, Asia, and South America. For example, China has established supersites in the “Third Pole” region where the High Asian cryosphere (HAC) serves as the Asian “water tower” for over a billion people. Finland has the Sodankylä-Pallas site in the boreal forest. Its infrastructure is designed for integrated monitoring of soil-snow-vegetation-atmosphere interaction and provides reference measurements for satellite sensors and model development on a continuous basis. Some of the atmospheric observatory sites operated by the International Arctic Systems for Observing the Atmosphere (IASOA) program are being expanded to include measurements of surface properties, including permafrost, making them ideal for inclusion in CryoNet. Current IASOA member observatories include Barrow USA, Eureka and Alert-Canada, Summit-Greenland, Ny-Alesund-Norway, Abisko-Sweden, Pallas and Sodankylä-Finland, Tiksi and Cherski-Russian Federation, and the Arctic Drifting Station-Russian Federation.

The process of selecting sites and stations as part of the CryoNet network is in its initial stage (see http://globalcryospherewatch.org/cryonet/stations.php). It will be completed by May 2016.

GCW will drive performance and provide motivation for high quality observations. Being a CryoNet site means being part of an international, operational, global observing system and thus providing observations of known quality for research and knowledge beyond a site's local region.

Satellite agencies, particularly through the WMO Polar Space Task Group (PSTG), and modelling groups such as ECMWF will provide guidance in the development of the surface observing network, given the importance of in situ observations for the validation of satellite products and model parameterization.

3.6 Products

The *Integrated Products Working Group* will encourage and support, where possible, workshops for intercomparisons of similar products to assess quality and to ensure the authoritative basis for products. For example, as a direct outcome of a recommendation of the First GCW Snow Watch Workshop, ESA has offered to organize and support a *"Satellite Snow Products intercomparison and evaluation EXercise – SnowPEX*" project to be carried out by a team of international experts. The project will intercompare and validate current global/hemispheric satellite snow products for assessing their quality and for better quantifying the uncertainty of long-term trends of the seasonal snow pack deduced from satellite data.

Such activities complement some intercomparisons conducted previously. The WCRP/SCAR/IASC Climate and Cryosphere Project (CliC) sponsored a workshop on the evaluation of satellite-derived sea ice extent and concentration products. This task was identified as a pilot project in the initial GCW feasibility study. The results of the intercomparison will provide valuable information to GCW on the many available products and on the process for determining "authoritative" information. Similarly, the WCRP Observation and Assimilation Panel (WOAP) held a workshop on essential climate variables (ECVs), where it was proposed to create an inventory of satellite and in situ ECV products with information on product maturity, accuracy, users, applications, and adherence to the GCOS guidelines for ECV datasets. Efforts such as these are important steps in enhancing product usability.

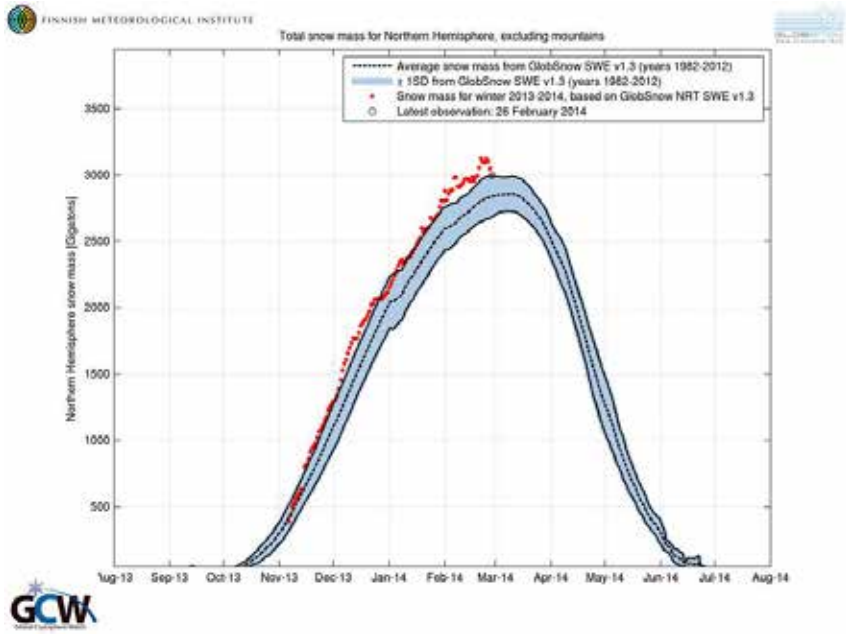


Figure 3. Example of a product for monitoring snow water equivalent. (GCW/FMI)

High-level monitoring products will complement the more basic observational datasets provided by GCW and its partners. The *Snow Watch Team* has stimulated the development of new daily "trackers" for Northern Hemisphere snow extent and snow water equivalent. Snow trackers have been developed for GCW by the Finnish Meteorological Institute and by Environment Canada. Figure 3 shows the GCW/FMI tracker for snow mass over the Northern Hemisphere (excluding

mountains). All products are available in near real-time on the GCW website. Satellite, in-situ and operational NWP analyses contribute to the development of these snow products.

For satellite products, the Polar Space Task Group of EC-PORS, with its direct connection to Space Agencies, will work with GCW to identify new products to support GCW pilot projects and services.

3.7 GCW Data Portal and Website

GCW data and information are available to WMO Members, their partners, and users through two components (Figure 4). One component, the GCW Website, provides project information, near real-time graphics illustrating the state of the cryosphere, scientific assessments, cryosphere news, observational requirements, measurement standards, and documents. The other component is the GCW Data Portal (http://gcw.met.no) and its data catalogue. The main purposes of the Data Catalogue are: (a) to provide an overview of datasets relevant to GCW; (b) to provide access to datasets wherever possible (e.g. real time data streams, archive access); and (c) to connect GCW with the WMO Information System (WIS) and WMO Global Telecommunication System (GTS) when real-time exchange of data is requested by the GCW community. The intention is to establish the GCW Data Portal as a WIS Data Collection and Production Centre (DCPC) and to rely on WIS and WIGOS efforts for standardising the metadata that are submitted to WMO. GCW data management follows a metadata-driven approach where datasets are described through metadata exchanged between contributing data centres and the GCW catalogue.

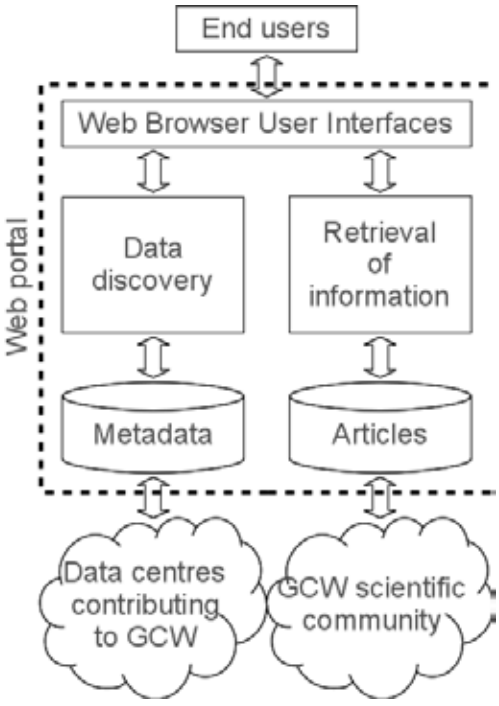


Figure 4. The GCW Data Portal has two components. One addresses editorial information (right) and the other addresses datasets (left).

The GCW Data Portal and its data catalogue is an enabling service for the information component in the sense that it identifies relevant datasets and their location and provides an interface that can be utilized in the evaluation or description of GCW data and products. GCW efforts in data management will integrate cryospheric datasets at national, regional and global scales. It will provide access to data and information on past, present and future cryospheric conditions. In order to achieve this, the data portal needs to be attached to real-time (e.g. WMO GTS or a robust Internet exchange) and near real-time data management systems and to data archives. While interfacing with existing data management systems, GCW will respect partnership, ownership, and data-sharing policies of its partners.

GCW itself will produce few low-level datasets, but instead relies on distributed data management technologies and partners to establish the GCW catalogue, which will publish WIS-compliant descriptions of GCW data and products into WMO's Global Information System Centres (GISCs) catalogues. This will create a unified interface to datasets in an otherwise fragmented terrain. No data will be kept in the GCW catalogue without an agreement with the data producer following a request from the user community.

The ingested metadata will be harvested from project specific, national and international catalogues. In addition to harvesting existing catalogues, the data management part of the GCW Data Portal will facilitate forms for submission of metadata on datasets not handled by existing catalogues. Currently only a limited number of catalogues are integrated, but dialogues on integration have been established with a number of catalogues (Figure 5). Quite frequently this involves some degree of adaptation of systems on either side in this exchange of metadata.

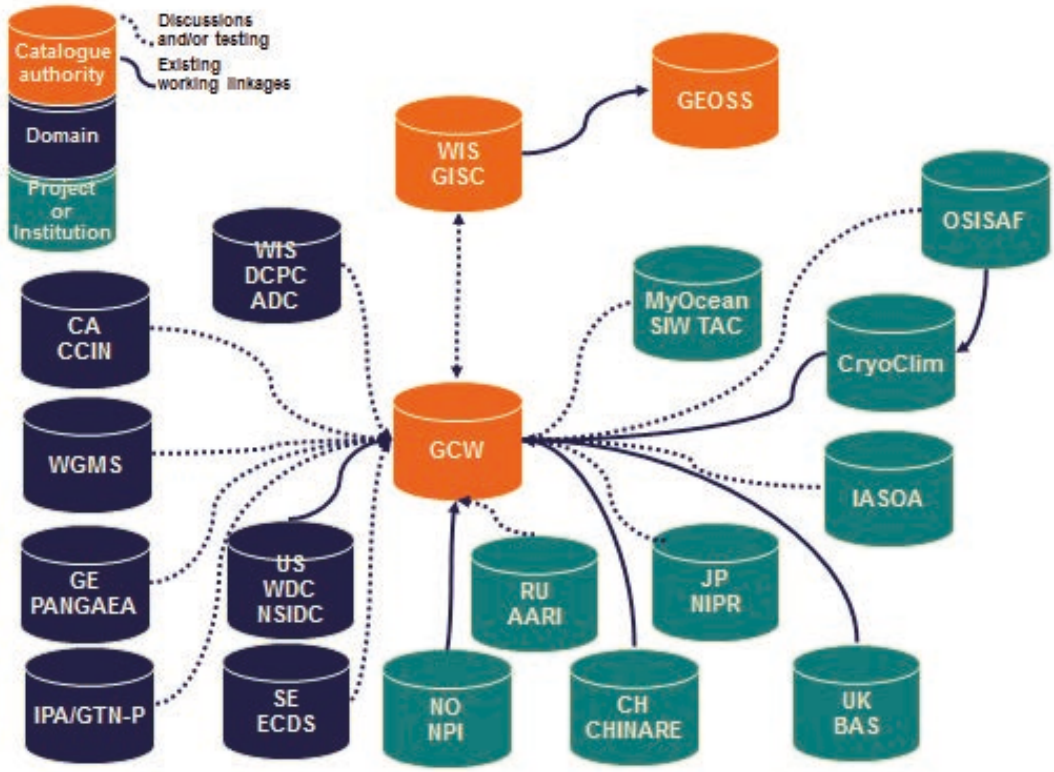


Figure 5. Data centres being addressed within GCW data management currently or in the short-term. Solid lines indicate existing linkages; dashed lines indicate ongoing discussions and/or testing.

There are technological considerations for catalogue interoperability, involving harvesting/exporting metadata using standard interoperability interfaces and documentation standards (e.g. OAI-PMH, OGC CSW, ISO23950, ISO19115, GCMD DIF). There are relevant frameworks for catalogue interoperability including WMO Information System (WIS), ICSU World Data System (WDS), Group on Earth Observation (GEO).

The GCW Data Portal has been developed by the Norwegian Meteorological Institute (METNO), building on their web-based tool for searching data. IPY data centres/portals, such as METNO, Canadian Cryosphere Information Network (CCIN), British Antarctic Survey (BAS), and US National Snow and Ice Data Center (NSIDC) are already interoperable. This approach will facilitate seamless access with NMHSs (primarily utilizing WIS) and external data centres holding relevant cryospheric data and information at the national or global scale.

The GCW Website has been developed and implemented (http://globalcryospherewatch.org, Figure 6). The purpose of the website is to provide a centralized point of access for background and operational information, observational user requirements, the state of the cryosphere, news and "hot topics", meeting information, GCW documents, outreach material, a description of the contributing observing networks and their capabilities, information on standards and best practices, and data policies. It links to the METNO data portal. The website is an information resource; the portal is a metadata and data resource.

Figure 6. GCW Website home page

3.8 Other Tasks and Projects

The Integrated Global Observing Strategy Partnership (IGOS-P) Cryosphere Theme (CryOS) provides a framework for developing and implementing GCW. Developed through widespread consultation within the global cryosphere community, it details observational capabilities and requirements and gives recommendations for filling gaps. It proposes measures to develop and coordinate cryospheric components of WIGOS, GCOS/GOOS/GTOS and other systems, so that cryospheric products will meet most user requirements within approximately 10-15 years.

GCW will directly address some CryOS recommendations. These include, but are not limited to, the revision of observational requirements, further development of measurement methods, and the compilation of a consistent, multi-language cryosphere glossary.

3.8.1 Observational Requirements

Observational requirements and capabilities will be periodically updated based on evolving user needs, instrumentation, and error analyses. GCW observational requirements will be formulated based on various sets of existing user requirements. In particular, the IGOS Cryosphere Theme Report contains the most comprehensive set of observational capabilities and requirements for the cryosphere. It is available at http://igos-cryosphere.org/.

GCW observational requirements will become part of the WMO Rolling Review of Requirements (RRR) and will be accessible through the WMO's Observing Systems Capability Analysis and Review Tool (OSCAR). A cryosphere theme has been created in the RRR. The RRR is specified in the *Manual on the Global Observing System* (WMO-No. 544), elaborated in the *Guide to the* Global Observing System (WMO-No. 488), and described further on the WMO website at http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html.

GCW will also promote the use of Observing System Simulation Experiments (OSSE) to evaluate gaps in the spatial distribution of measurement sites. Optimizing an observing network requires the use of numerical models to establish observing priorities and identify gaps.

3.8.2 Measurement Practices

The *Best Practices Team* will review existing instrument and observing methods and practices for the cryosphere in the *Guide to Meteorological Instruments and Methods of Observation* (CIMO Guide), and consider whether the CIMO Guide should be expanded to include instruments for the cryosphere. GCW partners have, or are in the process of developing, specific manuals for components of the cryosphere. The *Team* will develop a similar compilation of other existing documents on best practices, guidelines and standards that are in use in the cryosphere community. A *GCW Manual* will provide a consolidated document complementing current material in the *WIGOS Manual*, the CIMO Guide and partner's manuals. All standard practices will be documented in the *WMO Technical Regulations*.

Formal instrument intercomparisons should be conducted to determine and intercompare performance characteristics of instruments under field or laboratory conditions and to link readings of different instruments, helping to ensure data compatibility and homogeneity. The current WMO Solid Precipitation Intercomparison Experiment (SPICE) (including snowfall and snow depth) is of direct relevance to GCW and is a demonstration project for GCW. It provides an excellent example of the process to conduct a formal instrument field intercomparison for use by Members and the science community. GCW integrated CryoNet sites could also be suitable instrument intercomparison sites.

3.8.3 Terminology

The *Terminology Team* will identify current cryosphere glossaries and develop and evaluate terminologies, vocabularies, and ontologies. It has focus areas for snow, sea ice, ice sheets, glaciers, permafrost, and climate modelling. The GCW glossary currently on the website has over 2100 cryosphere terms from several different sources, including WMO's METEOTERM database. Expert teams will oversee the population and acceptance of terms. Ultimately, with the help of Members, the goal would be to make the glossary available in other UN languages.

3.8.4 Other

Other GCW projects will focus on regional or national contributions to standardization, integration and interoperability. Projects will involve contributions of WMO Members, Programmes and TCs, and contributing partners. Projects that contribute to demonstrating GCW's operation include:

(a) CIMO's Solid Precipitation InterComparison Experiment (SPICE) including snowfall, and snow depth measurements;

(b) Norway's CryoClim initiative to develop new operational services for long-term systematic climate monitoring of the cryosphere;

(c) ESA's "Global Monitoring of Essential Climate Variables" programme (Climate Change Initiative) for the cryosphere;

(d) Services provided by the World Glacier Monitoring Service (WGMS), University of Zurich, Switzerland, which is operated under the auspices of the International Council for Science World Data System (ICSU/WDS), International Association of Cryospheric Sciences of the

International Union of Geodesy and Geophysics (IUGG/IACS), UNEP, UNESCO and WMO;

(e) Activities of the Nordic Centre of Excellence (NCoE): SVALI - Stability and Variations of Arctic Land Ice;

(f) USGS Benchmark Glacier Programme and the IPY Data and Information Service (IPYDIS) global partnership of data centres, archives, and networks creating interoperability between cryosphere data centres in Norway, USA, Canada and the UK;

(g) Svalbard Integrated Arctic Earth Observing System (SIOS), a Norwegian-initiated project to create an international research infrastructure on the Svalbard archipelago; SIOS will develop and implement methods for building observational networks;

(h) Canadian Cryosphere Information Network (CCIN), which also supports the Polar Data Catalogue;

(i) ECMWF's initiative to improve global weather and climate predictions through improved snow processes, modelling and reanalysis, and assimilation of non-real-time snow depth data.

GCW will build on existing programmes and projects, but additional pilot and demonstration projects should be established in different regions, including alpine areas, central Asia (notably the "Third Pole"), the tropics, and Antarctica.

3.9 Prioritization of Tasks

Tasks will be prioritized based on meetings with partners and the cryosphere community, regional and international cryosphere conferences and workshops, and Task Team meetings and workshops. The tasks will be discussed with the Steering Group to determine priorities and budget allocation. For example, the First GCW Implementation Meeting (November 2011, Geneva) was effectively a meeting of an ad hoc GCW community of practice. Near-term tasks were suggested, discussed, and prioritized. Similarly, tasks for the surface network and for snow products were prioritized in the First CryoNet workshop (November 2012, Vienna) and the First Snow Watch Workshop (Toronto, January 2013). Workshops such as these are needed on an ongoing basis to provide guidance on GCW development and implementation.

3.10 Capacity-Building

GCW must develop an effective capacity-building strategy. A coordinated capacity-building effort should respond to the needs at national and regional levels, as identified by Members, which would assist all countries in improving and sustaining observation and exchange of cryospheric data and information. For developing and the least developed countries there is a need to ensure access to, and effective utilization of, observations, data and products, related technologies and new knowledge. For example, information on potential sea level rise, loss of mountain snow and ice, including tropical glaciers, and improved understanding of the impact of cryospheric changes in the Antarctic on extreme weather and climate in tropical and sub-tropical regions has been identified by Members as a need to which GCW can contribute.

Human resources are critical to the success of the programme. GCW will continue to explore ways to entrain new expertise into the programme as part of its capacity-building effort.

Capacity building will be coordinated with existing WMO efforts and will take advantage of mechanisms established by WIGOS and other WMO Programmes, RAs, TCs, and GCW partners.

4 Deliverables and Milestones

Upon approval and within available resources, GCW will address tasks associated with the key deliverables and milestones. Figure 7 shows the key milestones and timelines. The aim is to begin to implement tasks now, recognizing the complexity of engaging NMHSs and their national partner agencies, national and international institutes, and the scientific community.

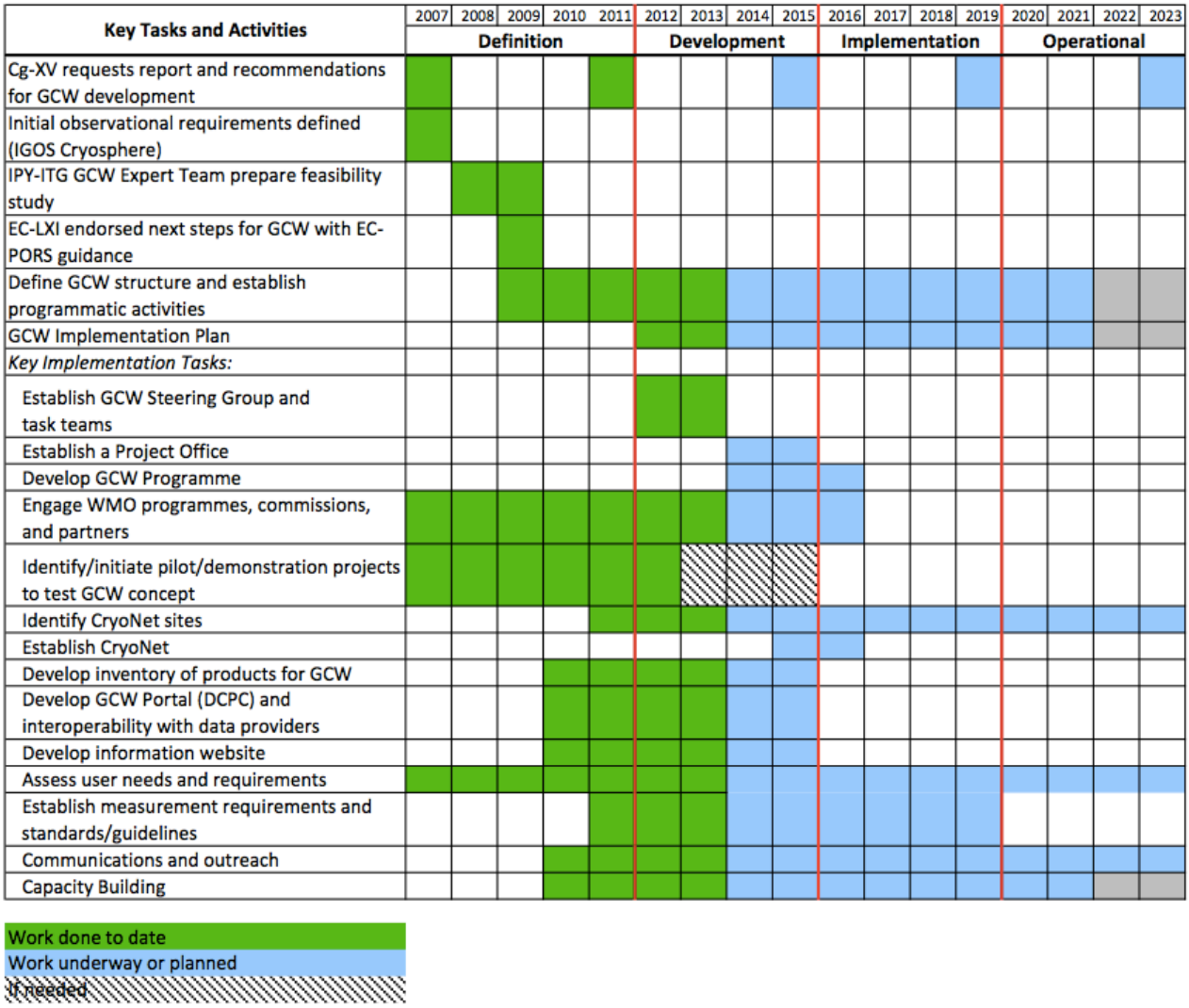


Figure 7. GCW Milestones and Deliverables as agreed by Cg-XVI

Key implementation activities are given in Table 1. Some of these were described earlier in this Plan. The responsible GCW Working Groups and Teams and relevant outside groups that are expected to contribute (data centres, national agencies, etc.) are listed. The approximate implementation timeframe for each activity is also given.

Table 1. Key GCW Implementation Activities
(Global activities shaded yellow, regional shaded green, national shaded grey)

Task #	Activities	Responsibilities		Time Frame
		Lead	Other Stakeholders	
1. Governance				
1.1	Create GCW Steering Group (GSG)	EC-PORS	-	2014
1.2	Establish Working Groups (WG)	GSG	-	2013-2014
1.3	Establish national GCW groups	Members	-	2014-2015
1.4	Establish regional CryoNet collaborations, particularly in Asia and South America	CryoNet Team, Members	NMHSs, research partners	2013-2015
1.5	Define a GCW WMO Programme	EC-PORS, GSG	-	Before Cg-XVII
1.6	Annual assessment of progress (indicators of success)	GSG	Task Teams	Annually
1.7	Integrate GCW objectives into WMO SOP 2016–2019	EC-PORS, Secretariat, GSG		2014-2015
2. Observing System and Products				
2.1	Select appropriate CryOS recommendations for GCW implementation	GSG, all teams	-	2012
2.2	Initiate pilot and demonstration projects	Teams	Members	2012-2016
2.3	Create an inventory of the current network and measurement practices	Best Practices Team	NMHSs, research partners	2012-2015
2.4	Identify and select stations for the core GCW network of surface sites (CryoNet)	CryoNet Team	NMHSs, research institutions	2012 onward
2.4	Establish CryoNet	CryoNet Team	NMHSs, research institutions	2016
2.5	Select candidate products for GCW	Integrated Products WG	Focal Points	2012-onward
2.5.1	Perform satellite and in situ product intercomparisons	Integrated Products WG	PSTG, Focal Points, NMHSs	2014-onward
2.5.2	Historical data sets (data rescue; e.g., snow depth)	Integrated Products WG	NMHSs, data centres	2014-onward
2.6	Develop and implement data portal	Portal Team	MetNo, NSIDC	2012-onward
2.7	Assess user needs and requirements; contribute to RRR	Observations WG	NMHSs	2012-2015
2.8	Establish best practices and measurement standards	Observations WG	NMHSs	2012-onward
2.9	Evaluate existing terminologies or glossaries; create or update as necessary	Integrated Products WG	Members, UNESCO, research partners	2013-onward
2.10	Annual State of the Cryosphere assessments	Website and Outreach Team	-	Annually
3. Capacity Building				
3.1	Provide assistance to Members to introduce and implement GCW nationally			Ongoing
3.2	Develop GCW guidelines, training materials, and other relevant documentation			Ongoing
3.3	Develop partnerships with NMHs and international bodies.		NMHSs, international bodies such as IPA, GCOS, IASC, etc.	Ongoing
4. Outreach				
4.1	Develop information website	Website and Outreach Team	-	2012-2013
4.2	Create outreach materials (handouts, brochure, newsletter, etc.)	Website and Outreach Team	-	2012-2015

5 GCW Management and Oversight

GCW requires cooperation, collaboration and coordination within WMO and with external partners, for which working arrangements between WMO and partners would be established.

5.1 Oversight

Initially, the WMO Executive Council, through its EC-PORS, will oversee GCW's development and implementation, recognizing that the structure of the Secretariat will have to adapt, as and when appropriate, to ensure optimal management of, and support to, the initiative. The GCW Steering Group provides high-level guidance and reports to EC-PORS on behalf of GCW.

5.2 GCW Project Office

A GCW Project Office is to support all GCW activities, including coordination with partners, monitoring of implementation, reporting and follow-up actions. It will provide support to national focal points and activities and will liaise with WMO and external programmes and groups. The Office should coordinate GCW inclusion in existing observing activities at the international and national levels and align its processes with their activities and frameworks. The Office shall also pursue active linkages with WMO Programmes and with relevant international organizations. Some suggested tasks that the Office could oversee, depending on available human resources are:

- Provide support to the GCW Steering Group, Working Groups and Task Teams;
- Make available all relevant information to the GCW Steering Group, Working Groups, Task Teams, focal points, and GCW members;
- Obtain, in coordination with focal points, nomination of national contacts from IASC, IACS, WGMS, IPA, SCAR, and others;
- Periodically inform PRs on GCW activities and request nomination of focal points, as appropriate;
- Support focal points in the development of national GCW activities;
- Liaise with WMO on capacity-building, resource mobilization, communication;
- Liaise with UNESCO;
- Liaise with WIGOS/WIS and GFCS teams, as needed;
- Seek funding opportunities;
- Maintain the Implementation Plan (with assistance from teams);
- Provide financial guidance and coordination;
- Seek WMO and other support for GCW meetings, as appropriate;
- Provide travel arrangements and support for GCW meetings, as needed.

The Office shall report on GCW activities to the Steering Group and to EC-PORS annually. Several options were considered for coordination of GCW activities following a decision of Cg-XVI in 2011 to develop GCW. To this point, no offer has been received to host the Project Office or to support it through the seconded experts working remotely. Taking into account the cost involved in establishing support for GCW as soon as possible, it is recommended that GCW activities be coordinated by a Project Officer located in the WMO Headquarters in Geneva.

5.3 Meetings and Reporting

The GCW Steering Group shall report annually to EC-PORS, including recommendations for GCW development and implementation for consideration by the WMO Executive Council and the WMO

Congress, and provide annual reports to all stakeholders, as appropriate through GCW website and/or Newsletter. EC-PORS will provide guidance on GCW structure, tasks, and progress.

Implementation meetings will be held regularly (e.g. every two years based on consultations with partners) and possibly in conjunction with other international or regional meetings such as Regional Climate Outlook Forums or partner scientific conferences. The implementation meetings will include participants from a broad cross-section of the cryosphere community as well as national, institutional, and programme focal points. All aspects of GCW implementation will be evaluated.

Workshops on various aspects of implementation, such as CryoNet development and product intercomparisons, will be held as needed. GCW task team members will participate in Polar Space Task Group, GCOS Steering Committee, and other relevant group meetings.

5.4 Indicators of Success

Metrics that could be used to evaluate the success of GCW include:

CryoNet:

1. Total number of sites in the network and the proportions of site types
2. Number of sites measuring each of the core set of measurements
3. Number of sites measuring cryospheric variables beyond the core set

Products:

4. Number of cryospheric “trackers”
5. Number of satellite products by cryospheric element
6. Satellite product inventory (per cent complete)

Portal and website:

7. Interoperability (number of data centres and/or per cent complete)
8. Number of products available through the GCW Data Portal
9. Number of near real-time products on website (all sources)
10. Number of users

Outreach and communication:

11. Glossary development (per cent complete)
12. Number of educational materials
13. Social media “friends”

Resources:

14. Financial commitments by Members
15. Political and personnel commitments by Members

Other:

16. Updates to RRR for observational requirements
17. Number of CryOS recommendations that have been implemented

6 Resources

6.1 Funding

The successful launch of GCW depends directly on the availability of resources. Support of the definition phase has been through funding by Members to the GCW and EC-PORS Trust Funds (namely, part-time temporary staff and consultative meetings), supplemented by in-kind contribution from Members for technical expertise. The Sixteenth WMO Congress approved basic support from the WMO regular budget.

However, additional resources will need to be provided through the WMO Secretariat for both staff and non-staff costs for the implementation and coordination that goes beyond the programmatic activities of the Secretariat to date. One full staff position, as a minimum, would be needed in the WMO Secretariat for GCW implementation activities. The GCW Project Office and operational budget require a core allocation from the WMO regular budget, with targeted funds from other sources including:

- GCW and EC-PORS Trust Funds to supplement the WMO regular budget;
- In-kind contributions, e.g. Task Office/activity funded by a Member(s);
- Staff secondments;
- Project Compendium that includes a request for GCW funding from voluntary contributions, seeking contributions totalling CHF 2.4M for implementation of EC-PORS activities over four years, including GCW to support the Steering Group and expert teams in implementing GCW and provide some Secretariat support for GCW development, coordination and implementation.

7 References

1. Resolution 60 (Cg-XVI) – Global Cryosphere Watch

2. IGOS, 2007. Integrated Global Observing Strategy Cryosphere Theme Report - For the Monitoring of our Environment from Space and from Earth. Geneva: World Meteorological Organization. WMO/TD-No. 1405. 100 pp.

Appendix 1: Example of Measurements at Surface Land Sites

Examples of measurements made at sites where snow is the primary cryospheric element are given below. Glacier, ice sheet, permafrost, and sea ice sites will have different measurement requirements.

Example of measurements made at a CryoNet Integrated Site

Continuous automatic observations of the atmosphere at one or more locations

- Automatic synoptic weather station observations (including temperature 2 m, temperature ground, dew point temperature, air pressure, air relative humidity, wind speed, wind direction, precipitation, cloud height, amount of clouds, visibility, snow depth, prevailing weather code)
- Radiation observations (incoming and reflected)
- Precipitation
- Atmospheric soundings (troposphere and stratosphere)
- CO_2 and/or methane fluxes between the atmosphere and soil-vegetation system (preferably for different ecosystems)
- Water table depth on wetlands
- Aerosol optical depth
- Energy fluxes (sensible, latent and soil heat), evaporation/transpiration and soil respiration.
- Specific reference measurements for cryosphere monitoring satellite instruments

Regular manual observations of snow

- SWE and snow depth on snow pits (forest and bog sites)
- Snowpack layering and snow grain size on snow pits (visible snow grain size observations/photography and/or specific surface area (SSA) measurements)
- Soil frost depth
- Snow surveys (snow courses with a preferable length of some kilometres)
- Aerosol contamination in snow

Continuous automatic observations of snow, soil, and permafrost at one or more locations

- Soil moisture profiles
- Soil temperature/soil frost profiles
- Snow depth and/or SWE
- Snow temperature profiles

Example of measurements made at a CryoNet Basic Site

Continuous automatic data

- Soil moisture profiles
- Soil temperature/soil frost profiles
- Snow depth and SWE
- Snow temperature profiles
- Automatic synoptic weather station observations

Regular manual observations

- SWE and snow depth on snow pits (forest and bog sites)
- Snowpack layering and snow grain size on snow pits (visible snow grain size observations)
- Snow surveys (snow courses with a preferable length of some kilometres)
- Aerosol contamination in snow

Appendix 2: List of Acronyms

APECS	Association of Polar Early Career Scientists
Arctic-HYDRA	Arctic Hydrological Cycle Monitoring, Modelling and Assessment Programme
BAS	British Antarctic Survey
CAS	WMO Commission for Atmospheric Sciences
CBS	WMO Commission for Basic Systems
Cg	WMO Congress
CEOP	Coordinated Energy and Water Cycle Observations Project
CHy	WMO Commission for Hydrology
CliC	Climate and Cryosphere Project
CryOS	Cryosphere Observing System, generally referring to the IGOS Cryosphere Theme
EC	WMO Executive Council
ECV	Essential Climate Variable
ESA	European Space Agency
GCOS	Global Climate Observing System
GAW	Global Atmosphere Watch
GCW	Global Cryosphere Watch
GEOSS	Global Earth Observation System of Systems
GFCS	Global Framework for Climate Services
GIPPS	Global Integrated Polar Prediction System
GLOBE	Global Learning and Observations to Benefit the Environment program
GOOS	Global Ocean Observing System
GSG	GCW Steering Group
GTN-G	Global Terrestrial Network for Glaciers
GTN-H	Global Terrestrial Network for Hydrology
GTN-P	Global Terrestrial Network for Permafrost
GTOS	Global Terrestrial Observing System
IACS	International Association of Cryospheric Sciences
IAOOS	The Integrated Arctic Ocean Observing System
IASSA	International Arctic Social Sciences Association

IASC	International Arctic Science Committee
ICSU	International Council for Science
IGOS-P	Integrated Global Observing Strategy – Partners
IICWG	International Ice Chart Working Group
IOC	Intergovernmental Oceanographic Commission
IPA	International Permafrost Association
IPY	International Polar Year 2007-2008
IUGG	International Union of Geodesy and Geophysics
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
NOAA	National Oceanic and Atmospheric Administration (USA)
NMHS	National Meteorological and Hydrological Service
NSIDC	National Snow and Ice Data Center (USA)
PCOF	Polar Climate Outlook Forum
PR	Permanent Representative
PSTG	WMO Polar Space Task Group
SAON	Sustaining Arctic Observing Networks
SCAR	Scientific Committee on Antarctic Research
SOOS	Southern Ocean Observing System
SSA	Specific Surface Area
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WOAP	WCRP Observation and Assimilation Panel
WCRP	World Climate Research Programme
WDS	World Data System of ICSU
WGMS	World Glacier Monitoring Service
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WMO	World Meteorological Organization

Annex 1: WMO Decisions on GCW

Cg-XV (2007) welcomed the proposal of Canada that WMO would create a Global Cryosphere Watch, which would be an important component of the International Polar Year 2007-2008 (IPY) legacy and requested the WMO Inter-commission Task Group on IPY to establish an ad hoc expert group to explore the possibility of such a global system and prepare recommendations for its development.

Several experts were involved in the preparation of the Feasibility Study "Global Cryosphere Watch: Background, Concept, Status, Next Steps" that formed a basis for the Report on "Global Cryosphere Watch (GCW): Background, Concept, Status, Next Steps" submitted to EC-LXI for information. This study was based on the Integrated Global Observing Strategy Partnership (IGOS-P) Cryosphere Theme (hereinafter "CryOS"). EC-LXI endorsed the next steps for developing GCW based on the report's suggestions and requested EC-PORS to provide guidance and momentum for the implementation of GCW.

EC-LXII, noting the ever-increasing interest in the cryosphere globally and the requirement for authoritative information, agreed that the GCW initiative was even more timely and that there was an urgency to move forward with an implementation strategy to be developed under the auspices of EC-PORS and submitted to Cg-XVI for consideration. The Council strongly urged Members to support GCW activities, including the provision of support for meetings and workshops, and contributions to the GCW Trust Fund to provide secretariat support for the development of GCW.

Cg-XVI (2011) approved the GCW Implementation Strategy, urging Members and international partner organizations and programmes to collaborate actively in, and give all possible support to, the development and implementation of this initiative, and to support GCW. Congress requested the Executive Council to establish a mechanism to steer and monitor the activity and to achieve the broadest possible collaboration and cooperation, to ensure the active participation and representation of the principal bodies concerned and also the participation, as appropriate, of technical experts and representatives of agencies undertaking observing and research initiatives relevant to the cryosphere, and to submit a comprehensive report including an updated implementation plan of GCW to the Seventeenth WMO Congress.

GCW and the WMO Strategic Plan

The cryosphere, by its nature, is intrinsically interdisciplinary. In the context of the WMO Strategic Plan 2012-2015, GCW is a crosscutting activity contributing to all five priority areas and to achieving the expected results of all Strategic Thrusts. It cuts across all the WMO technical departments (Observing and Information Systems, Research, Climate and Water, Weather and Disaster Risk Reduction Services), joint sponsored activities (e.g. WCRP, GCOS) and WMO TCs. GCW will:

* Enhance capabilities to produce better climate predictions and assessments, hydrological forecasts and assessments, weather forecasts and warnings;

* Provide the mechanism to integrate the atmospheric, terrestrial (including hydrology) and marine cryosphere Essential Climate Variables (ECVs) within GCOS;

* Coordinate cryospheric observations of WMO and other agencies and organizations;

* Be built as a part of the WIGOS and WIS.

The WMO Executive Council, at its Sixty-sixth session (June 2014), decided to recommend to the WMO Congress further improvements to the draft WMO Strategic Plan 2016-2019, including a new priority related to operational polar weather, climate, and hydrological services focusing on operationalizing the Global Cryosphere Watch and advancing the Global Integrated Polar Prediction System (GIPPS).

Annex 2: Cryosphere Observing System Gaps

While there are numerous snow and ice surface measurement sites across the Arctic, Antarctic and high-altitude alpine regions, the spatial coverage is sparse compared to lower latitudes. Furthermore, operations at existing stations are, in general, not well coordinated. There is a need to improve the coordination of resources provided by national and international agencies responsible for cryospheric observations, and to facilitate the transition of research-based products into sustained monitoring systems. There is also a need to standardize the types and methods of measurements at surface stations, so that a consistent set of snow and ice properties is available globally.

The satellite observing system for the cryosphere is robust, and missions planned for the next 10-20 years will provide even greater capabilities. There are, however, some potential gaps that will be detrimental to long-term monitoring. In particular, the current gap in laser altimetry and the potential near-future gap in gravity measurements will impact ice sheet and glacier monitoring and change assessment. Even for systems that are robust, such as passive microwave, there needs to be long-range planning to assure continuous coverage and overlapping operational periods for sensors to assure inter-satellite calibration, which is crucial for high-quality climate records. Additionally, there are some critical parameters that are difficult to measure from space, notably sea ice thickness, snow water equivalent, and accumulation on glaciers, ice sheets, and sea ice.

Table A2.1 provides a summary of the observing system for many snow and ice properties and a qualitative assessment of their maturity. It lists the measurement approach for the major variables, the status of the networks (operational or research), a qualitative assessment of how well each is meeting the measurement requirements, and major issues. Airborne measurements are not addressed. There are many shortcomings in the cryosphere observing system that give rise to sometimes-large uncertainties.

Table A2.1. Observational readiness of many snow and ice measurements for the observing system overall. Green: satisfies requirement (roughly 85%+); blue: meets requirements most of the time (70%+); yellow: meets requirements some of the time, or only for specific conditions; red: does not meet requirement. O: operational, R: research, C: commercial, L: long-term (20+ yrs) record.

	In Situ	Satellite	Major Gaps in Observations
Ocean:			
Sea ice extent	coastal radar (R), ship observations	passive microwave (O, L); scatterometer (R)	In situ coverage is sparse and incomplete
Sea ice concentration	coastal and ship manual observations	passive microwave (O, L), SAR (O, C), optical and IR (O, L)	Potentially large uncertainties in satellite retrievals in certain conditions (melt, freeze-up); SAR coverage remains incomplete
Sea ice thickness	Coastal and ship manual observations ice-profiling sonar on moorings (O); mass balance buoys (C), electromagnetic sleds (R)	optical (R), altimeters (R), SAR (R)	Satellite methods are still developing; snow depth on ice is an unknown
Sea ice stage of development	Coastal and ship manual observations	SAR (O, C, R), optical and IR (O, L)	SAR coverage remains incomplete
Sea ice motion	drifting buoys (O, L); coastal radar (R)	passive microwave (O, L); optical (R); SAR (O, R)	In situ measurements are sparse

	In Situ	Satellite	Major Gaps in Observations
Sea ice topography	ship manual observations	altimeters (R), SAR (O, R)	Retrieval possible only on a basis of high-resolution information
Icebergs	Air manual and radar reconnaissance Ship manual observations	radar (O, C), optical (O, L), altimeter (R)	Satellite methods of automatic identification and tracking are still developing; coverage of high-resolution information remains incomplete
Snow depth on sea ice	depth gauge (R)	passive microwave (R); altimeter (R)	Satellite method is limited to first-year ice with potentially large uncertainties; in situ data are sparse
Sea level	tide gauges (O, L); bottom pressure recorders (C)	altimeters (R)	
Surface temperature	drifting buoys (O, L)	optical (O, L)	Uncertainty in satellite estimates due to cloud cover
Albedo	radiometers (O, L)	optical (O, L)	Sparse in situ coverage; significant uncertainty
Terrestrial:			
Snow cover extent	manual observations, depth gauge (O, L)	optical (O, L)	Large uncertainty in relating point measurements of extent to large areas
Snowfall/solid precipitation	catchment, optical, and other gauges	(none)	Lack of standardized measurement systems and practices
Snow depth	depth gauge (O, L)	optical (R); passive microwave (O)	Satellite optical method is limited to tall-grass prairie
Snow water equivalent	various methods (O)	passive microwave (R)	In situ coverage is sparse
Freshwater ice (lake and river ice) extent	visual observations (O, L)	optical (R)	Declining observation network
Glacier, ice cap, ice sheet mass balance	various methods (R)	radar (R), gravity (R)	Sporadic coverage
Glacier length, area	surveys (R, L)	optical (R)	Incomplete coverage
Glacier, ice cap, ice sheet motion	GPS (R)	InSAR, optical (R)	Sporadic coverage
Permafrost: ground temperature	boreholes (O, L)	(none)	Large portions of the Arctic not covered
Permafrost active layer thickness	boreholes, probes (O, L)	passive microwave (R)	Large portions of the Arctic not covered
Surface temperature	thermisters, thermocouples (O, L)	optical (O, L)	Satellite method is clear sky “skin” temperature
Surface albedo	radiometers (O, L)	optical (O, L)	Sporadic in situ coverage; significant uncertainty

Annex 3: GCW Partnership Criteria

International Partners:

1. Any international organization, professional union, association or data centre that is actively involved in cryosphere activities, that has a willingness to contribute tangibly to the implementation of the WMO GCW initiative, and that is active internationally in structure and membership, is invited and encouraged to become an "International Partner" of GCW.

2. A formal statement of intent to be a GCW International Partner should be sent to the WMO GCW Secretariat for consideration by the WMO GCW Steering Group. The statement should address how the organization will contribute to GCW implementation and to GCW Team activities. Requests are reviewed and endorsed formally. In accepting Partner status, special attention will be given to the following criteria:

(a) Extensive global networks of members or partners or a high global presence or visibility, through regional or country offices, on measurement, research, product generation, or data archival and distribution activities;

(b) Specific expertise with a strong emphasis on cryosphere issues in their organizational mandate.

3. The Partner organization should appoint one focal point and one alternate as principal contact persons for GCW. The full contact information of the focal point and the alternate should be provided to the WMO GCW Secretariat. The focal point (or alternate of the Partner) is eligible to participate in GCW Steering Group meetings.

4. After clearance through the GCW Secretariat, each Partner may display GCW visual identifier(s) and link to the GCW website on its own website. Each Partner will have their logo on the GCW website with a link to the Partner's website. Partners will have an opportunity to display information on the GCW web-page, but only if it is directly related to activities that are part of the agreed GCW Implementation Plan and Task Team activities.

5. A Partner may only use the GCW visual identifier(s) in relation to activities that are part of the GCW activities.

6. Each Partner should provide, on an annual basis, a short assessment on their Partner status with the Global Cryosphere Watch and how they are engaged in activities with the GCW.

7. Any Partner may at any time withdraw from the Partner status with the GCW by giving notice to that effect to GCW Secretariat.

8. Partnerships will be re-evaluated every four years. Ineffective partnerships will be terminated.

National and Regional Partners:

9. Organizations with a single country or regional cryosphere focus will be considered for "National Partner" or "Regional Partner" status. Requirements for this status is as outlined for an international partner, but at the national or regional level.

10. Partner status will not normally be granted to any state or government agency.

11. NMHSs and their national collaborators in cryosphere initiatives who make tangible or in-kind contributions to the development, implementation, and operation of GCW contribute to GCW as a Member of WMO and will be considered "contributors" rather than partners.

ANNEX IX
Annex to paragraph 4.3.22 of the general summary

WORLD CLIMATE RESEARCH PROGRAMME DESCRIPTION

Mission and Objectives

The mission of WCRP is to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society.

The two overarching objectives of the World Climate Research Programme are to determine:

1. The predictability of climate;
2. The effect of human activities on climate.

Scope of the Programme

The main foci of WCRP research are:

(a) Observing changes in the components of the Earth system (atmosphere, oceans, land and cryosphere) and at the interfaces among these components;

(b) Improving our knowledge and understanding of global and regional climate variability and change, and of the mechanisms responsible for this change;

(c) Assessing and attributing significant trends in global and regional climates;

(d) Developing and improving numerical models that are capable of simulating, predicting, and assessing the climate system for a wide range of space and timescales;

(e) Investigating the sensitivity of the climate system to natural and human-induced forcing and estimating the changes resulting from specific disturbing influences;

(f) Facilitating the translation of climate research results to useful information and knowledge for practical applications in support of sustainable development and climate services.

To achieve its objectives, the WCRP cooperates, as appropriate, with other cognate programmes in the field of Earth system science. In particular, the WCRP will continue to develop its cooperation with legacy projects and their constituencies from the Earth System Science Partnership, namely the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme (IHDP) and DIVERSITAS being transitioned into Future Earth, in order to introduce the chemical, biological, ecological and socioeconomic dimensions into models and field studies of the environment, thus promoting further advances in the knowledge of the total Earth system and the understanding of global change in support of sustainable development and global climate services.

Current Programme

WCRP Grand Challenges

WCRP JSC has identified six Grand Science Challenges of particularly high societal importance and as areas of research in which it is possible to expect significant progress within next five to ten years. They serve as unifying themes across the four WCRP core projects and the various working groups:

(a) Regional climate information;

(b) Sea-level rise and regional impacts;

(c) Cryosphere in a changing climate;

(d) Clouds, circulation and climate sensitivity;

(e) Changes in water availability; and

(f) Understanding and predicting weather and climate extremes.

WCRP Projects

The ongoing research priorities of the WCRP are pursued through four internationally coordinated core projects:

Climate and Cryosphere (CliC)

Mission:

To assess and quantify the impacts of climatic variability and change on components of the cryosphere and their consequences for the climate system, and determine the stability of the global cryosphere.

Climate and Oceans – Variability, Predictability and Change (CLIVAR)

Mission:

To understand the dynamics, the interaction, and the predictability of the coupled ocean-atmosphere system.

Global Energy and Water Exchanges (GEWEX)

Mission:

To observe, understand and model the hydrological cycle and energy fluxes in the Earth's atmosphere and at the surface.

Stratosphere-troposphere Processes and their Role in Climate (SPARC)

Mission:

To determine the role of stratosphere-troposphere processes in the Earth’s climate, with a particular emphasis on the interaction between chemistry and climate.

WCRP modelling activities are coordinated by the WCRP Modelling Advisory Council (WMAC). WMAC ensures cooperation with the main WCRP partners and coordination among the WCRP modelling and prediction groups:

Working Group on Coupled Modelling (WGCM)

Mission:

To foster the development and review of coupled climate models, including organization of model intercomparison projects for the global environmental assessments such as IPCC.

Working Group on Seasonal to Interannual Prediction (WGSIP)

Mission:

To develop a programme of numerical experimentation for seasonal-to-interannual variability and predictability, paying special attention to assessing and improving predictions.

Working Group on Numerical Experimentation (WGNE)

Mission:

To foster the development of atmospheric circulation models for use in weather, climate, water and environmental prediction on all timescales and diagnosing and resolving shortcomings.

WGNE is jointly co-sponsored by the WCRP Joint Scientific Committee and the WMO Commission for Atmospheric Sciences (CAS).

Working Group on Regional Climate (WGRC)

Mission:

To prioritize and coordinate regional climate research within the WCRP and serve as the conduit for two-way information exchange between the WCRP and the various institutions and coordinating bodies that provide climate service including the Global Framework for Climate Services (GFCS).

WCRP observation activities are coordinated by the **WCRP Data Advisory Council (WDAC).** The WDAC mission is to act as an overall coordination function for WCRP data, information, and observations, to guide their high-level aspects across the WCRP, and to ensure cooperation with main WCRP partners such as the Global Climate Observing System (GCOS) and other observing programmes.

WCRP also co-sponsors, with the WMO Commission for Climatology (CCl) and the Joint WMO/IOC Technical Commission for Marine Meteorology and Oceanography, the **Expert Team on Climate Change Detection and Indices (ETCCDI)** that provides international coordination and organizes collaboration on climate change detection and indices and indicators of climate variability and change and related methodologies, from the surface and subsurface ocean to the stratosphere.

Together with IGBP, Scientific Committee on Oceanic Research (SCOR), and the international Commission for Atmospheric Chemistry and Global Pollution (iCACGP), WCRP is a sponsor of the Surface Ocean – Lower Atmosphere Study (SOLAS).

Functions of the Programme

Recognizing that diagnostic, theoretical and experimental research activities relevant to the climate system are carried out by scientific research establishments within nations, the broad aim of the WCRP is to coordinate and enhance these national efforts, in order to constitute a comprehensive international research programme implemented through concerted actions of participating institutions. The principal functions of the WCRP are then:

(a) To initiate specific regional or global experiments for the study of particular phenomena or processes;

(b) To identify research priorities for recommendation to national scientific institutes and funding agencies;

(c) To propose and facilitate the implementation of relevant international research activities as required;

(d) To arrange for the rapid and effective dissemination of information on current results and new developments in climate research;

(e) To facilitate translation and interpretation of scientifically complex information into useful information and knowledge for practical applications in sustainable development and climate services;

(f) To support training and development of next generation of climate experts, especially for developing regions of the world.

ANNEX X
Annex to paragraph 4.3.103 of the general summary

GLOBAL PROGRAMME OF RESEARCH ON CLIMATE CHANGE VULNERABILITY, IMPACTS AND ADAPTATION

Mission

The overall aim of PROVIA is to provide international direction to and improve the coherence of research on climate change vulnerability, impacts and adaptation (VIA).

With this in mind, the mission of PROVIA is to create and maintain an active interface between the scientific community and decision-makers involved in VIA issues, and to improve the availability and accessibility of relevant knowledge to the people and organizations that need it most.

Objectives

(a) To advance policy-relevant research on vulnerability, impacts, and adaptation related to climate change;

(b) To coordinate and facilitate the dissemination and practical application of this research for the benefit and value of society.

Principles of Engagement

To meet its objectives and fulfil its mission, PROVIA will:

(a) Build and maintain an active interface between the research community and decision-makers and other stakeholders involved in VIA issues;

(b) Promote communication between the community of researchers working on VIA issues and users, by providing a vehicle for exchanging new research results, encouraging cooperative work on specific research challenges, and providing a forum for improving the relevance of research;

(c) Identify VIA research gaps, priorities and emerging issues that are important to both the science and policy communities;

(d) Work with the communities of research and practice to improve the rigour and robustness of VIA research and assessments;

(e) Provide an avenue by which decision-makers can solicit scientific input to new critical policy issues;

(f) Build the capacity of young scientists in developing countries to conduct VIA research and assessments.

ANNEX XI
Annex to paragraph 5.2.7 of the general summary

EDUCATION AND TRAINING PROGRAMME DESCRIPTION

1. Overall objective

The overall objective of ETRP is to assist the National Meteorological and Hydrological Services (NMHS) of Member States develop staff with the qualifications and competencies (knowledge, skills and behaviours) required by the WMO Technical Regulations to deliver the meteorological, hydrological and related services mandated by their Government and that help meet their international obligations.

2. Purpose and scope

To assist Members develop and utilize education and training resources in meteorology, hydrology and climate, and to assist in coordinating the setting of international standards for this education and training.

To assist Members, particularly Least Developed Countries (LDCs) and Small Island Developing States (SIDSs), facing difficulties in providing national initial and ongoing meteorological, hydrological and climate education and training of their personnel. The institutions in which the education and training activities are carried out include WMO Regional Training Centres (RTCs), national meteorological training institutions, the training units of Meteorological Services, universities and research centres. The education and training activities are carried out in accordance with WMO policies such as Gender Mainstreaming, Service Delivery and Capacity Development.

The activities of the ETRP encompass the following broad approaches:

(a) Develop and review the standards and requirements for the education and training of Meteorologists, Meteorological Technicians, Hydrologists or Hydrological Technicians in line with changing international regulations, technical, educational and societal demands;

(b) Liaise with the WMO Technical Commissions in the development of the competencies (knowledge, skills and behaviors) required for the specialist areas overseen by each of the Commissions;

(c) Assist NMHSs develop competent staff, particularly women, to provide meteorological-, climatological- and hydrological-related information and services;

(d) Promote capacity development by assisting NMHSs to become self-sufficient in meeting their education and training needs and developing their human resources;

(e) Promote and strengthen the development and exchange of education and training knowledge, resources and expertise between Members incorporating advances in education and training practices and approaches, and advances in technology appropriate to the facilities, language, capabilities and practices in Member countries;

(f) Promote and strengthen the development of the WMO Regional Training Centres and their ability to assist Members in their home Region, and upon request Members from outside of their Region, meet their education and training requirements;

(g) Promote high-quality continuing education in meteorology, climatology, hydrology and related disciplines to update the knowledge and skill of NMHS staff in line with scientific, technological and educational advances and innovations;

(h) Assist Members and the Secretary-General in raising the awareness of students and the public of meteorology, climatology, hydrology, and related services and careers in weather, water and climate;

(i) Assist Regional Associations and Regional ETR Focal points in the development of competency based training and education needs assessments that are tied to the staffing numbers being collected by the Secretary-General.

These approaches will ensure that the high priority activities of aviation services, WIS and WIGOS, GFCS and Disaster Risk Reduction are supported by the development and execution of appropriate training programmes.

3. ETRP Governance

Oversight for the ETRP is provided by the WMO Executive Council.

4. ETRP structure

ETRP consists of four interdependent components:

(a) Human resources development;

(b) Training activities;

(c) Education and training fellowships;

(d) Support to training events under other WMO Programmes.

4.1 Human resource development

Purpose and scope: To provide a framework for assessing the present and future needs of Members for educated and trained personnel. This framework provides an objective basis for planning and setting priorities, as well as assisting and providing advice to Members. The activities under this component will contribute to the implementation of Expected Result 6 through an enhancement of the management capabilities, including resource mobilization, of personnel in Member States, particularly those from NMHSs.

Long-term objective: Human resource development in NMHSs is supported through a coordinated, priority driven, outcomes-based approach.

4.2 Training activities

Purpose and scope: To contribute to the education and training process with respect to training centres, in particular RTCs, by facilitating the sharing of training materials, instructors, and good practices assistance in the management of training events. The WMO Education and Training Office will assist by acting as the interface between Meteorological and Hydrological Services and the international meteorological and hydrological education and training community. The activities under this component will contribute to the implementation of Expected Result 6 by an enhancement of the capabilities of education and training personnel in Member States, particularly those from NMHSs.

Long-term objectives:

(a) More effective use of training materials and technologies, including distance learning techniques is made by Members;

(b) RTC training activities meet more Member demands;

(c) More effective, and wider, utilization by user sectors of meteorological and hydrological information and services;

(d) New partnerships are developed to help address areas not traditionally covered by RTCs.

4.3 Education and training fellowships

Purpose and scope: To assist Members educate and train meteorological, climatological and hydrological personnel through funding and organization of specially tailored individual and group study training programmes, including management and familiarization visits/ study tours for senior personnel. This component focuses on the provision of long-term and short-term fellowships to NMHS personnel. The activities under this component will contribute to the implementation of Expected Result 6 by an enhancement of the number of qualified personnel in Member States, particularly those from NMHSs. Education and training is mainly provided in subject areas and technologies for which the facilities and teaching expertise are not available at home. Emphasis continues to be placed on using, as a first priority, the training facilities within the Regions concerned, in particular those of the RTCs.

Long-term objective: Human resources in NMHSs are strengthened through the implementation of short- and long-term fellowships.

4.4 Support to training events under other WMO Programmes

Purpose and scope: To monitor, coordinate and assist the planning of training events implemented by Members or the Secretariat under other WMO Programmes. The scope of this component therefore extends to collaboration and interaction with the other major Programmes of the Organization. The activities under this component will contribute to the implementation of Expected Results 1 to 6 by an enhancement of the capabilities of personnel in Member States in specialized areas, particularly those from NMHSs.

Long-term objective: Education and training activities are coordinated across all WMO Programmes. Processes and resources are shared to create greater efficiencies.

ANNEX XII
Annex to paragraph 5.3.11 of the general summary

WMO PROGRAMME FOR THE LEAST DEVELOPED COUNTRIES – PROGRAMME DESCRIPTION

1. Overall objective

The overall objective of the Programme is to enhance the capacities of the NMHSs of the LDCs including those which are SIDS, so that they can contribute efficiently and in a timely manner to the socioeconomic development efforts of the countries concerned through the production and effective use of relevant weather, water and climate information and services in order to eradicate poverty, achieve internationally agreed development goals and enable graduation from the least developed country category.

2. Purpose and scope

In support of the Istanbul Programme of Action for the LDCs for the decade 2011–2020, adopted by the Fourth United Nations Conference on the LDCs, the WMO Programme for the LDCs will contribute to the following strategic and specific areas:

(a) Building viable national productive capacity in all sectors, particularly infrastructure, energy, transport and other weather and climate sensitive sectors;

(b) Promote agriculture, food security and rural development strategies that strengthen support for smallholder farmers and contribute to poverty eradication;

(c) Invest in basic services for health, education, water and sanitation;

(d) Strengthen the resilience of LDCs by reducing their vulnerability to economic, natural and environmental shocks and disasters, as well as climate change and, enhancing their ability to meet these challenges, particularly climate change adaptation and mitigation;

(e) Promoting science and technology for peaceful and development purposes including strengthening national and regional institutions, as appropriate and in line with LDCs' national development priorities;

(f) Strengthening the global partnership and public-private partnerships for inclusive economic growth and sustainable development of LDCs.

The resources mobilized within the framework of this Programme, including those available from the Trust Fund for the NMHSs of Least Developed Countries (established by Cg-XIV), will be used to support the NMHSs of the LDCs to enhance their capabilities to participate and contribute actively to priority areas such as agriculture, food security and rural development, disaster risk reduction, health, water resources management and climate change adaptation. Specific projects will be developed for individual LDCs and on a subregional basis for countries in Africa, Asia and the Pacific.

3. Governance

Overall guidance for the LDC Programme is provided by the Executive Council as part of its oversight of capacity development activities

4. Implementation activities 2016–2019

During the period, project proposals will be developed and resources mobilized to assist the LDCs to:

(a) Raise the profile of NMHSs with the national development outcome and increase government and stakeholders support to their NMHSs, through advocacy and institutional capacity-building, among others;

(b) Improve the infrastructure and operational facilities of NMHSs in LDCs;

(c) Enhance regional cooperation in the countries concerned, especially in areas such as training and the production, delivery and effective use of weather and essential climate services;

(d) Share good practices and experiences.

The main focus will be to ensure that NMHSs are able to address adequately such issues as the relevant priority areas for action in the Istanbul Programme of Action for the LDCs, particularly capacity sectors, agriculture, food security and rural development, disaster risk reduction, water resources management and climate change and environmental sustainability.

In accordance with the Strategic and Operating Plans, activities of the Programme include, inter alia, the following:

(a) Assistance to all LDCs in the preparation and implementation of development plans of their NMHSs based on the priority needs of countries;

(b) Development of technical cooperation projects and programmes on infrastructure development and socioeconomic benefit valuation, climate change issues, including fast track projects;

(c) Provision of support in the area of human resources development through special training of selected staff;

(d) Development of capacity-building activities, including planning, management and resource mobilization;

(e) Resource mobilization and technical assistance for the development of NMHSs activities.

Annex XIII
Annex to paragraph 7.4.3 of the general summary

PROVISIONAL PROGRAMME OF SESSIONS OF CONSTITUENT BODIES DURING THE SEVENTEENTH FINANCIAL PERIOD (2016–2019)

2016

Sixteenth session of Regional Association II (Asia) (RA II-16)

Sixteenth session of the Commission for Basic Systems (CBS-16)

Fifteenth session of the Commission for Hydrology (CHy-15)

2017

Seventeenth session of Regional Association IV (North America, Central America and the Caribbean) (RA IV-17)

Seventeenth session of the Commission for Atmospheric Sciences (CAS-17)

Seventeenth session of Regional Association VI (Europe) (RA VI-17)

Fifth session of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM-5)

Seventeenth session of Regional Association V (South-West Pacific) (RA V-17)

2018

Seventeenth session of the Commission for Climatology (CCl-17)

Seventeenth session of the Commission for Agricultural Meteorology (CAgM-17)

Sixteenth session of the Commission for Aeronautical Meteorology (CAeM-16)

Seventeenth session of the Commission for Instruments and Methods of Observation (CIMO-17)

Seventeenth session of Regional Association I (Africa) (RA I-17)

Third session of the Intergovernmental Board on Climate Services (IBCS-3)

Seventeenth session of Regional Association III (South America) (RA III-17)

2019

Eighteenth session of the World Meteorological Congress (Cg-18)

Seventy-first session of the Executive Council (EC-71)

ANNEX XIV
Annex to paragraph 7.4.3 of the general summary

WMO HOST COUNTRY AGREEMENT TEMPLATE

AGREEMENT BETWEEN THE WORLD METEOROLOGICAL ORGANIZATION AND THE GOVERNMENT OF …… (HOST COUNTRY) REGARDING THE ARRANGEMENTS FOR …… (MEETING)

WHEREAS the Government of …… (HOST COUNTRY), hereinafter referred to as "the Government", has invited the World Meteorological Organization, hereinafter referred to as "the WMO", to hold the …… session of …… (MEETING) in …… (VENUE), hereinafter referred to as "the session",

NOW THEREFORE, the WMO and the Government hereby agree as follows:

ARTICLE I

Date and place of the session

The session shall be held at …… (VENUE), from …… to …… (DATE).

ARTICLE II

Legal Status

In accordance with article 27 (c) of the WMO Convention and General Regulation 18 (a), the Government shall grant to the WMO, the representatives of Members, the officials of WMO and other participants in the session, the privileges, immunities and facilities provided for in the Convention on the Privileges and Immunities of the Specialized Agencies, to which the Government acceded in respect of WMO on dd/mm/yyyy, as well as in the provisions set forth in the following articles.

ARTICLE III

Participation at the session

1. In accordance with the WMO Convention, General Regulations and relevant resolutions and decisions of its constituent bodies, the session shall be open to the participation of:

(a) Duly accredited representatives or observers of:

i. All WMO Members;

ii. Non-Member States invited in accordance with General Regulation 19;

iii. The State of Palestine in accordance with Resolution 39 of the Seventh Congress of the WMO; and

iv. Intergovernmental and non-governmental international organizations concerned by virtue of standing invitations or upon invitation approved by the president of the constituent body concerned;

(b) Members of the WMO Secretariat designated by the Secretary-General of WMO to serve the session;

(c) As well as experts or other persons performing a mission for WMO in connection with the session.

2. The WMO shall provide the Government prior to the commencement of the session with a list containing the names of all persons referred to in paragraph 1 above. Thereafter, it shall inform the Government as soon as possible of any changes to the list of participants to the session.

3. All persons referred to in paragraph 1 shall enjoy immunity from legal process in respect of words spoken or written and any act performed by them in connection with their participation in the session. Throughout the duration of their participation in the session, including the time required by travel on the territory of …… (HOST COUNTRY), they shall not be subject to any measure or arrest or expulsion for the conduct in the exercise of their function or mission.

4. All persons referred to in paragraph 1 shall have the right of entry into and exit from …… (HOST COUNTRY), and no impediment shall be imposed on their transit to and from the conference area. They shall be granted facilities for speedy travel. Visas and entry permits, where required, shall be granted free of charge and as speedily as possible for their effective participation throughout the duration of the meeting, provided the application for the visa is made sufficiently in advance. Arrangements shall also be made to ensure that visas for the duration of the session are delivered at their arrival in the country to participants who were unable to obtain them prior to their departure. Exit permits, where required, shall be granted free of charge, as speedily as possible, and in any case not later than three days before the date of departure.

5. All persons referred to in paragraph 1 shall have the right to take out of …… (HOST COUNTRY) at the time of their departure, without any restriction, any unexpended portions of the funds they brought into …… (HOST COUNTRY) in connection with the session and to reconvert any such funds at the current exchange rate.

6. In the event of an international crisis during the session, the Government shall give all persons referred to in paragraph 1 repatriation facilities comparable to those granted to diplomatic agents.

ARTICLE IV

Premises, equipment, utilities and supplies

1. The Government shall arrange for the provision, at its expense, of appropriate premises, including conference rooms for formal and informal meetings, office space, working areas and other related facilities, as well as the equipment and supplies as are required for the effective functioning of the session as specified in Annex I to this Agreement. The premises, equipment and supplies shall remain at the disposal of the WMO 24 hours a day, including one day prior to the session and, on request, up to a maximum of one day after its close.

2. The Government shall, at its expense, furnish, equip and maintain in good repair all these premises and facilities in a manner adequate for the effective conduct of the session.

3. The Government shall assume responsibility for the provision of telecommunication facilities required for the effective functioning of the session and shall meet the costs of all communications made by the WMO for the purpose of the session as authorized by or on behalf of the representative of the Secretary-General at the session.

ARTICLE V

Accommodation

The Government shall ensure that adequate accommodation in hotels or residences is available at reasonable commercial rates for the participants referred to in article III above.

ARTICLE VI

Medical facilities

1. Medical facilities adequate for first aid in emergencies shall be made available, if and when required.

2. For serious emergencies, the Government shall ensure immediate transportation and admission to a hospital.

ARTICLE VII

Transport

1. The Government shall ensure, if required, the availability of transport for all participants and those attending the session between the principal hotels and the conference area.

2. The Government shall provide an adequate number of cars with drivers for official use by the principal officers and the secretariat of the session, as well as such other local transportation as is required by the secretariat for the effective functioning of the session.

ARTICLE VIII

Local personnel

1. The Government shall appoint a liaison officer who shall be responsible, in consultation with the WMO, for making and carrying out the administrative and personnel arrangements for the session as required under this Agreement.

2. The Government shall recruit and provide an adequate number of local staff necessary for the proper functioning of the session. The exact requirements in this respect will be established by the WMO in consultation with the Government and will be specified in Annex I.

3. The personnel provided by the Government under the present article shall enjoy immunity from legal process in respect of words spoken or written and any act performed by them for WMO in connection with the session.

ARTICLE IX

Customs and financial facilities

The Government shall allow the temporary importation, tax-free and duty-free, of all equipment, supplies and publications which shall be considered as diplomatic goods under Article III, Section 9, b) of the Convention Privileges and Immunities of the United Nations Specialized Agencies. It shall therefore waive import duties and taxes on supplies necessary for the session. It shall issue without delay any necessary import and export permits for this purpose. Once the conference supplies have arrived, the Government shall be responsible for their immediate release from the customs bonds, their transport to the conference venue and their safekeeping.

ARTICLE X

Inviolability and protection of the Session

1. The conference premises specified in Article IV, paragraph 1, above, shall be deemed to constitute premises of the WMO and access thereto shall be subject to the authority of the WMO. The premises shall be inviolable for the duration of the session, including the preparatory stage and the winding-up.

2. The appropriate authorities of the Government shall exercise due diligence to ensure that the tranquillity of the session and its participants is not disturbed by any person or persons attempting unauthorized entry or creating disturbances in the immediate vicinity of the premises; if so requested by the representative of the Secretary-General at the session, they shall assist in the preservation of law and order in the premises.

ARTICLE XI

Financial arrangements

1. The Government agrees to bear the additional costs actually incurred to hold the session in …… (HOST COUNTRY), rather than at the WMO headquarters in Geneva. Such additional costs are provisionally estimated at CHF …… Swiss francs according to the breakdown in Annex II.

2. After the session, the WMO shall provide the Government with a detailed statement of accounts showing the actual costs incurred by the WMO, in Swiss francs, using the United Nations official rate of exchange at the time the payments are made. If the actual costs are higher than the estimated costs, the Government shall remit such difference to WMO within one month of the receipt of the detailed accounts. If the difference is negative, the WMO shall refund such amount to the Government within one month of the establishment of the detailed accounts, or shall dispose of it as instructed by the Government.

3. The final accounts shall be subject to audit as provided in the WMO Financial Regulations and Rules, and the final adjustment of accounts shall be subject to any observations which may arise from the audit carried out by the External Auditor of the WMO, whose determination shall be accepted as final by both WMO and the Government.

ARTICLE XII

Liability

1. The Government shall be responsible for dealing with any action, claim or other demand against the WMO or its officials and arising out of:

(a) Injury to persons or damage to or loss of property in the premises referred to in Article IV that are provided by or are under the control of the Government;

(b) Injury to persons or damage to or loss of property caused by, or incurred in, using the transport services referred to in Article VI that are provided by or are under the control of the Government;

(c) The employment for the session of the personnel provided by the Government under Article VII.

2. The Government shall indemnify and hold harmless the WMO and its officials in respect of such action, claim or other demand, except where such damage, loss or injury is caused by the negligence or willful misconduct of the WMO and its personnel.

ARTICLE XIII

Settlement of disputes

1. Any dispute between the WMO and the Government concerning the interpretation or application of this Agreement that is not settled by negotiation or other agreed mode of settlement shall be referred at the request of either party for final decision to a tribunal of three arbitrators, one to be appointed by the Secretary- General of WMO, one to be appointed by the Government and

the third, who shall be the chairman, to be chosen by the first two; if either party fails to appoint an arbitrator within 60 days of the appointment by the other party, or if these two arbitrators shall fail to agree on the third arbitrator within 60 days of their appointment, the President of the International Court of Justice may make any necessary appointments at the request of either party. Any arbitration shall take place in accordance with the Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL), as at present in force.

2. The Parties agree to accept the Tribunal's decision as final and binding.

ARTICLE XIV

Final provisions

3. This Agreement may be modified by written agreement between the WMO and the Government.

4. This Agreement shall enter into force immediately upon signature by the Parties and shall remain in force for the duration of the session and for such a period thereafter as is necessary for all matters relating to any of its provisions to be settled.

SIGNED this day of 201X in English.

For the World Meteorological Organization

For the Government of …

ANNEX XV
Annex to paragraph 7.9.2 of the general summary

THE ROLE AND OPERATION OF NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES –
A STATEMENT BY THE WORLD METEOROLOGICAL ORGANIZATION FOR DECISION-MAKERS

1. This statement by the World Meteorological Organization (WMO) is to urge decision-makers to enhance their support to National Meteorological and Hydrological Services to fulfil their mandates and deliver services that contribute to meeting societal needs and national development goals.

Key Social and Economic Drivers

2. Population safety and security, water and food security, economic growth and sustainable development, increasing prosperity, enhancing resilience to disasters and climate change, and improving public health, are issues of fundamental importance of every government. To deal with these issues, governments have to develop and implement effective policies that take into consideration the challenges of climate variability and change, and promote fundamental tenets of societal and environmental governance. However, with regard to societal well-being and economic growth, it is common knowledge that we are challenged by variations in our natural environment, made worse by changes in the climate, which threaten sustainable development of human societies through increased occurrence of severe weather and extreme climate events causing disasters and compromising food security, reduce availability of clean fresh water, cause displacement of populations, and the rise and spread of diseases, among other impacts. This is further compounded by growing urbanization and the expansion of human habitation into previously unoccupied high risk places, such as arid zones, mountain slopes, flood plains and the

coastal zones prone to inundations, exposing populations to food insecurity, air and waterborne diseases, heat stress, drought, landslides, floods, storm surges and tsunamis.

3. Over the past decade, disasters from natural hazards have exacted a heavy toll. Globally, over 700 000 people lost their lives, over 1.8 million were injured, and more than 24 million were made homeless as a result of recorded disasters. Overall, almost 1.7 billion people were affected by disasters in various ways. The total economic loss was more than US$ 1.4 trillion. In addition, between 2008 and 2012, 144 million were displaced by disasters. Only with a clear understanding of the risks associated with severe weather and extreme climate events, multi-hazard early warnings, integration of weather and climate information into decision-making and adequate disaster risk reduction and mitigation efforts can we develop resilient societies and sustain economic growth. For every dollar invested in early warnings issued by NMHSs, at least seven dollars of losses are offset.

4. Not all WMO Members' NMHSs have the required scientific, technological and human resources capabilities to monitor, forecast and issue warnings of severe weather and extreme climate events. The ability of NMHSs to provide high quality weather, climate, hydrological and related environmental services depends upon: (a) the availability of modern infrastructure and adequate, well trained human resources to gather, process, archive and exchange data and products; (b) their capacity to maintain high standards of observations and data; (c) their participation and access to research that leads to improved monitoring, predictions and understanding of the changes in weather, climate, water and the related environmental conditions at all spatial and temporal scales; (d) their capability to prepare and deliver high quality early warnings and impact-based forecasts of weather-, climate- and water-related hazards; and (e) their understanding and integrating the needs of various user communities, including emergency management authorities, into forecasts and warning programmes.

The role of National Meteorological and Hydrological Services

5. Investment in weather, hydrological and climate services has a significant contribution to efforts to save lives and property, minimize economic losses and sustain the natural environment. The Convention of the World Meteorological Organization reaffirms'' the vital importance of the mission of the National Meteorological, Hydrometeorological and Hydrological Services in observing and understanding weather and climate and in providing meteorological, hydrological and related services in support of relevant national needs which should include: (a) protection of life and property; (b) safeguarding the environment; (c) contributing to sustainable development; (d) promoting long-term observation and collection of meteorological, hydrological and climatological data, including related environmental data; (e) promotion of endogenous capacity-building; (f) meeting international commitments; and (g) contributing to international cooperation.''

6. As has been the case since the beginning of the modern era of societal and environmental management, knowledge of weather, hydrological and climate processes is key to all aspects of human endeavours as observed from their influence on cultures, traditions and development paths of societies. It is within this framework that NMHSs in various countries have been well positioned to monitor, forecast and issue warnings on a wide range of weather-, climate- and water-related events that affect human life and socioeconomic development. For example, with regard to natural hazards, NMHSs have been tasked to monitor and provide warnings of individual events, and to sensitize the population on their impacts to save lives, enhance resilience of societies, sustain productivity and economic growth, and reduce damage to property.

7. NMHSs are the official authoritative source, and in most countries, a single voice, on weather warnings in their respective countries, and, in many, they are also responsible for climate, hydrology, air quality, seismic and tsunami warnings and for space weather. To reduce and mitigate disasters requires NMHSs to provide quick, timely, accurate, broadly disseminated and understandable information as well as high quality services to inform governments and the public to take appropriate actions in response to warnings. NMHSs, within the framework of WMO, are working to improve the delivery and quality of services to help governments improve decision-making to enhance the resilience of populations to climate variability and change, enhance food

production, improve water resource management, improve health outcomes, develop renewable energy, enable populations to adapt to climate variability and change, reduce risks and mitigate natural hazards and sustain development. By helping governments and the people to avert potential disasters and maximize opportunities for sustainable development, NMHSs are one of the main components of the risk information management, crisis management and development infrastructure of countries in their nation-building endeavours and indeed a contributor to sustainable development, particularly efforts to end poverty, enhance food security, and improve health outcomes, and access to renewable energy and clean water. NMHSs are working together with the public and private sectors to implement multi-hazard early warning systems, which aim to further significantly reduce the number of fatalities caused by weather-, water- and climate-related natural disasters.

8. NMHSs are the national reference point for compliance with the WMO standards. The critical deficiencies that have impacts on safety, nationally and internationally, by preventing Members from providing the required global, regional or national services should be resolved. They affect the ability of the entire global community to attain sustainable development, disaster risk reduction, and safety of transport in air, on land and sea, food security, sustainable management of water resources, manage climate risks, adapt to climate change and build resilient societies. NMHSs should be provided with adequate human, technical and financial resources to implement and operate modern infrastructure for gathering, processing, exchanging observations, data, and products to enable them to deliver high quality weather, climate, hydrological and related environmental services at sub-national, national, regional and global levels.

9. Cooperation amongst various organizations is essential for providing governments with these services. Partnerships between NMHSs and academia, government departments, international and non-governmental organizations, and where appropriate and possible, the private sector and civil society, help society make better decisions based on more complete and accurate weather, water and climate information. These partnerships provide better data coverage and information processing, higher resolution models, and more precise and useful specialized products for societal benefits, including opportunities to better support government and other decision-makers regarding safety, economy, and security. NMHSs should work with these partnerships to develop appropriate national frameworks that facilitate the gathering and sharing of data, and expertise to make the information easy to access in real-time, in useful forms, and at low cost.

Future Requirements

10. NMHSs are expected to play a key role and committed to the implementation of the Global Framework for Climate Services (GFCS) to realize the milestones indicated in the implementation plan that include developing and delivering services for agriculture and food security, water, health and disaster risk reduction initially; expanding climate services to other priority areas in the following years; and ensuring access to improved climate services throughout the world and across all climate-sensitive sectors.

11. In the year 2000, through the internationally agreed development goals, including those contained within the Millennium Declaration, the international community set forth specific targets to be reached by 2015. Beyond the year 2015, the sustainable development goals to succeed the Millennium Declaration, as well as well as post-2015 Disaster Risk Reduction Framework and the United Nations Framework Convention on Climate Change, will have a significant influence on the demands from NMHSs for user-oriented weather, hydrological, climate and related environmental services to meet the evolving needs of governments, partners and other decision-makers to achieve sustainable development. To ensure that evolving needs of societies are met, it is essential that governments and partners invest more in meteorology and hydrology to take advantage of the myriad advances in science and technology provided by NMHSs and their partners, that include the provision of multi-hazard early warnings and related services, 24 hours a day, 365 days a year, and climate services through the GFCS, which when properly applied can provide societies with the underpinning information to reduce and mitigate the impacts of natural hazards, and maximize the benefits from weather- and climate-related opportunities. WMO

enables international cooperation, which is essential, both between countries and within the larger UN framework.

12. Access to good communication ensures that information is available on time wherever it is needed. Governments must recognize the importance of investing in the infrastructure and human resources essential for continuous monitoring of the environment in a harmonized and standardized way through WMO global regulatory framework. They should continuously support NMHSs to implement and operate essential infrastructure, and to modernize and develop this infrastructure to comply with WMO standards.

13. It is essential that societies be prepared to act appropriately in response to warnings. Education and training is paramount for improving preparedness, response and recovery. Early warning systems for natural hazards work only if governments have appropriate systems and their public know how to respond. Information must be easy to access, understand and use. Proactive and effective communication to the public, highlighting the intrinsic uncertainty in forecasts and warnings, is also essential.

14. To be effective, governments and other decision-makers must recognize NMHSs, as part of the international network coordinated through WMO, and as one of the essential driving forces for enhancing safety and well-being of society, ending poverty, sustaining development and economic growth, improving access to clean drinking water, enhancing food production, achieving good health outcomes, mitigating and adapting to climate change, exploiting renewable energy sources and increasing the prosperity of the world's citizens.

15. In order to strengthen the sustainability and competitiveness of NMHSs, governments are encouraged to put in place policies that would facilitate the recovery of costs for meteorological and hydrological services provided by them, particularly from aviation and marine sectors.

ANNEX XVI
Annex to paragraph 8.2.4 of the general summary

VALUE PROPOSITION FOR THE INTERNATIONAL EXCHANGE OF CLIMATE DATA AND PRODUCTS TO SUPPORT THE IMPLEMENTATION OF THE GLOBAL FRAMEWORK FOR CLIMATE SERVICES

Climate change is now a reality and WMO is again faced with the need to develop agreement with respect to the international exchange of climate relevant data. Changes in climate variability are important to many sectors and in a range of spatial and temporal dimensions. This is accompanied by widespread recognition that data in themselves only become of value when they are used to produce services and products that can be used for decisions in support of socioeconomic and environmental benefits. Indeed free and unrestricted access to data can and does facilitate innovation and the discovery of new ways to use, and purposes for, the data.

The benefits realized from climate data and products are greatly enhanced when combined with socioeconomic information. Linking physical and social science information enables a wide range of societal benefits and enhances decision support. The value of these tools and capabilities is traceable directly to practices of free and unrestricted data and products exchange. The greater the availability and sharing of the data, then the greater the applicability and accuracy of these tools and capabilities, which for society supports ready, responsive, and resilient communities.

However, the move to a practice of free and unrestricted access, such as that espoused in Resolutions 40 (Cg-XII) and 25 (Cg-XIII) creates challenges for those countries that have initiated cost recovery policies with respect to climate data collection activities. These policies are primarily aimed at a return from investment of public monies and form part of the income of NMHSs used to

operate and maintain observation networks. There may be a need to address the issue of how to move the cost recovery component from the sale of data to cost recovery from the products and services derived from the data which contain the true value.

This requires NMHSs, or the countries themselves, to be in a position whereby they can receive a return from the investment in the data collection, either through charging for the products and services themselves, or gaining from cost recovery from those private sector agencies that provide the products and services. Capacity for product and services development and delivery is thus a key requirement in support of the implementation of a climate data exchange policy, particularly in least developed and developing countries and small island developing States. The GFCS provides the impetus to achieve this. A new approach to financing and funding of networks that sees cost recovery associated with value added products, returns on investment in societal benefits, public-private partnerships, etc. is needed and guidance on how this should be implemented is required.

This may also require Members to establish financial mechanisms, including new investments, for sustaining the network of stations and sensors needed for the global observing systems for climate, and also the maintenance and operation of the data preparation and management systems, necessary to support the implementation of the policy of free and unrestricted exchange of data and products.

The EC Task Team on the Climate Data Policy identified the following benefits from free and unrestricted access to climate data:

(1) Better quality and greater variety of products and services, especially on a global and regional basis;

(2) Improvements to the numerous other services that are predicated on climate data and information;

(3) Enhanced national and international research into climate and an understanding of the climate system, leading to improved decision-making to benefit society;

(4) Better understanding/appreciation of the importance of these data that will likely lead to more support for the observing systems;

(5) Developing good regional products with the same quality and accuracy over the region;

(6) Encouraging local and regional studies related to the climate;

(7) Promoting education in the climate field, leading to a better understanding of climate, including its system and change;

(8) Promote and strengthen collaboration between providers and users of climate data and products.

ANNEX XVII
Annex to paragraph 9.4.4 of the general summary

COHERENT ORGANIZATION-WIDE SERVICE DELIVERY APPROACH – GENERAL DIRECTIONS

(a) The necessity to require from all programmes involved in delivery of weather, climate, water, and environment-related services to develop further their ability and mechanisms for interaction with users and identifying user requirements as the first step; and to encourage Members to develop their services in a coherent way to optimize the use of limited resources;

(b) Most of the generic principles and attributes of effective service delivery are inherent in the Quality Management System (QMS), thus Members are strongly encouraged, as practically as possible and within available resources, to implement QMS in the entire range of activities and programme areas that involve delivery of services to users;

(c) The WMO Technical Regulations should be reviewed to possibly cover generic aspects of service delivery based on good practices and experience in specific service; the overall culture of compliance with the WMO's and other relevant standards and regulations should be enhanced and regarded as an important performance indicator of a successful service provider;

(d) Improving services and their delivery, as well as efficient arrangements for effective application through fast uptake of science and technology developments should be regarded as a main factor for success; the application programmes should work closely with the science and technology community to identify opportunities and promote effective and affordable solutions in this regard;

(e) Cross-cutting demonstration projects with coherent actions should be initiated on a regional basis in an integrated fashion to help implement the current WMO strategies, programmes and projects focusing on the Strategy;

(f) Priorities should be set for the provision of integrated weather-, climate-, water-, and environment-related services to meet the rapidly changing needs of society, including new applications to address the needs of different sectors, such as: land transportation; health; energy; agriculture and food security; urban service delivery; and the insurance sector;

(g) Training and capacity development should be implemented primarily for the forecasters and managers of NMHSs, and also be offered for the users, on the principles of service delivery and QMS. The Regional Training Centres (RTCs) may provide a basic framework to extend and expand relevant training by all WMO Programmes to include topics related to service delivery to Members;

(h) Competency requirements for different programmes should cover not only basic sets of knowledge/skills/behaviour in producing and delivering forecasts and warnings, but also should outline requirements for delivering services for specified user groups and partners;

(i) Impact-based forecasting and risk-based warnings should be recognized by all WMO Programmes involved in the delivery of weather-, climate-, water- and environment-related services, as supporting social resilience through behaviour modification in society (ref.: agenda item 3.1: Public Weather Services). Issues surrounding the move towards impact-based forecast and warning services should be integrated into a common framework across all WMO Programmes dealing with applications of meteorology.

APPENDIX

LIST OF PARTICIPANTS

1. Officers of the session

David GRIMES	President of WMO
Mieczyslaw OSTOJSKI	Second Vice-President of WMO
Abdalah MOKSSIT	Third Vice-President of WMO

2. Representatives of WMO Members

Afghanistan

Nanguyalai TARZI	Principal Delegate
Nazir A. FOSHANJI	Delegate
Azim WARDAK	Delegate

Albania

Filloreta KODRA (Ms)	Principal Delegate
Dorina XHIXHO (Ms)	Alternate
Fatjon DEMNERI	Delegate
Blerina ZOTO (Ms)	Delegate

Algeria

Boudjemâa DELMI	Principal Delegate
Brahim IHADADENE	Alternate
Djahida BENARBIA (Ms)	Delegate
Djamel BOUCHERF	Delegate
Sidi Ahmed FELLAHI	Delegate
Zoheir KHERROUR	Delegate
Nader LOUAFI	Delegate
Djaouida NEGGACHE (Ms)	Delegate
Abed Salah SAHABI	Delegate

Angola

Apolinário Jorge CORREIA	Principal Delegate
Alberto Samy GUIMARAES	Alternate

Argentina

Andrea Celeste SAULO (Ms)	Principal Delegate
Claudia CAMPETELLA (Ms)	Alternate
Mónica MARINO (Ms)	Alternate

Armenia

Levon VARDANYAN	Principal Delegate

Australia

Robert VERTESSY	Principal Delegate
Sue BARRELL (Ms)	Alternate
Vicki MIDDLETON (Ms)	Alternate
John P. QUINN	Alternate
Ben CHURCHILL	Delegate
Jon GILL	Delegate
Jennifer KANE (Ms)	Delegate

Austria

Michael STAUDINGER	Principal Delegate
Vera FUCHS (Ms)	Delegate
Gerhard WOTAWA	Delegate

Azerbaijan

Khalil RAMAZANOV	Principal Delegate
Sahib KHALILOV	Alternate
Murad N. NAJAFBAYLI	Delegate
Sevinj SULEYMANOVA (Ms)	Delegate

Bahamas

Trevor M. BASDEN	Principal Delegate

Bahrain

Adel T. DAHAM	Principal Delegate
Tariq Mohammed KHALFAN ALNAAR	Alternate
Noora AL-MANSOORI (Ms)	Delegate
Fahad ALBAKER	Delegate
Yusuf Abdulkarim BUCHEERI	Delegate

Bangladesh

Shameem AHSAN	Principal Delegate
Md. ALIMUZZAMAN	Alternate
Md. Nazrul ISLAM	Alternate

Barbados

Hampden LOVELL	Principal Delegate
Shani GRIFFITH-JACK (Ms)	Delegate

Belarus

Maria GERMENCHUK (Ms)	Principal Delegate
Irina DIVAKOVA (Ms)	Delegate
Mikhail KHVOSTOV	Delegate
Viktar MELNIK	Delegate

Belgium

Daniel GELLENS	Principal Delegate
Pierre E. BRUSSELMANS	Delegate
Christian TRICOT	Delegate

Benin

Kokou NAKPON	Principal Delegate

Bhutan

Daw PENJO	Principal Delegate
Tandin DORJI	Delegate
Kinley WANGCHUK	Delegate

Bosnia and Herzegovina

Milos PRICA	Principal Delegate
Almir BIJEDIC	Alternate
Zoran BOZOVIC	Alternate
Darko BOROJEVIC	Delegate
Sabina HODŽIC (Ms)	Delegate
Igor KOVACIC	Delegate
Vesna SIPKA (Ms)	Delegate

Botswana

Thabang Leslie BOTSHOMA	Principal Delegate
Radithupa RADITHUPA	Delegate

Brazil

Regina M. C. DUNLOP (Ms)	Principal Delegate
José A. de S. BRITO	Alternate
José A. ARAVEQUIA	Delegate
Pedro L. D. DALCERO	Delegate

Gabriela Russo LOPES (Ms)	Delegate
Janaina LOURENCATO (Ms)	Delegate
Robson RESSURREICAO	Delegate

British Caribbean Territories

Tyrone SUTHERLAND	Principal Delegate
David FARRELL	Alternate
Kathy-Ann CAESAR (Ms)	Delegate
Glendell DE SOUZA	Delegate

Brunei Darussalam

Muhamad HUSAINI AJI	Principal Delegate
Victor CHEONG	Delegate
Shahalmie HAJI EMRAN	Delegate

Bulgaria

Hristomir BRANZOV	Principal Delegate
Konstantin ANDREEV	Delegate
Georgi KORTCHEV	Delegate
Milena MILENKOVA (Ms)	Delegate
Plamen NINOV	Delegate
Tatiana SPASSOVA (Ms)	Delegate

Burkina Faso

Evelyne M. A. ILBOUDO (Ms)	Principal Delegate
Pascal D. A. YAKA	Alternate

Burundi

Philippe MINANI	Alternate
Aloys RURANTIJE	Alternate
Didace RWABITEGA	Delegate

Cabo Verde

Emanuel A. VEIGA	Principal Delegate
Ester ARAUJO DE BRITO (Ms)	Alternate
Alcides BARROS	Delegate

Cambodia

Heang IV	Alternate
Setha OUK	Delegate

Cameroon

Robert NKILI	Principal Delegate
Anatole Fabien Marie NKOU	Alternate
Richard PHILIPPE	Alternate
Paul BATIBONAK	Delegate
Alain Roger EDOU MVELLE	Delegate

Canada

David GRIMES	Principal Delegate
Michael CROWE	Alternate
Bruce ANGLE	Delegate
Heather AUCOIN (Ms)	Delegate
Gilbert BRUNET	Delegate
Diane CAMPBELL (Ms)	Delegate
Brian DAY	Delegate
Catherine GODIN (Ms)	Delegate
Allan HOWARD	Delegate
Michel JEAN	Delegate
Paul LYON	Delegate
Mike MANORE	Delegate
Thomas PIEKUTOWSKI	Delegate
Esther VAN NES (Ms)	Delegate

Côte d'Ivoire

Daouda KONATE	Principal Delegate
Lancine BAMBA	Delegate

Chad

Bamanga A. MALLOUM	Principal Delegate
Talha Mahamat ALLIM	Alternate

Chile

Guillermo NAVARRO SCHLOTTERBECK	Principal Delegate
Patricio GUESALAGA MEISSNER	Delegate
Rodrigo PAILLALEF	Delegate
Luis A. VIDAL LEMA	Delegate

China

Guoguang ZHENG	Principal Delegate
Xiaonong SHEN	Alternate
Mingmei LI (Ms)	Delegate
Hailong WU	Delegate
Yongke XU	Delegate
Shoubao ZHANG	Delegate
Heng ZHOU	Delegate

Colombia

Omar FRANCO	Principal Delegate
Carlos CARRETERO	Delegate
Laura Perez CURIEUX (Ms)	Delegate
Beatriz LONDONO SOTO (Ms)	Delegate

Comoros

Abdourazakou AN-YNAYA BINTIE (Ms)	Principal Delegate

Congo

Florent S. DZOTA	Principal Delegate
Camille LOUMOUAMOU	Alternate
Ferréol C. P. GASSACKYS	Delegate
Alphonse KANGA	Delegate
Paulin Victor POUEBE	Delegate

Cook Islands

Arona NGARI	Principal Delegate

Costa Rica

Juan Carlos FALLAS	Principal Delegate

Croatia

Ivan CACIC	Principal Delegate
Branka IVANCAN PICEK (Ms)	Delegate
Cleo KOSANOVIC (Ms)	Delegate
Kreso PANDZIC	Delegate
Borivoj TEREK	Delegate
Vlasta TUTIS (Ms)	Delegate

Cuba

Celso PAZOS ALBERDI	Principal Delegate
Alina Revilla ALCAZAR (Ms)	Delegate
Jorge Alejandro P. VAZQUEZ	Delegate

Curaçao and Sint Maarten

Albert MARTIS	Principal Delegate
Joseph ISCAAC	Delegate

Cyprus

Keti SAVVIDOU (Ms)	Principal Delegate

Czech Republic

Vaclav DVORAK	Principal Delegate
Jan DANHELKA	Alternate
Katerina SEQUENSOVA (Ms)	Alternate
Martin BULANEK	Delegate
Pavel GAL	Delegate
Radim TOLASZ	Delegate
Karel VANCURA	Delegate

Democratic People's Republic of Korea

Se Pyong SO	Principal Delegate
Myong Nam CHOE	Alternate
Chang Myong PAEK	Delegate

Democratic Republic of the Congo

Jean Pierre MPUNDU ELONGA	Principal Delegate
Brigitte MUKUNDJI EKAKA-EALE (Ms)	Delegate

Denmark

Marianne THYRRING (Ms)	Principal Delegate
Claus KERN-HANSEN	Alternate
Ellen VAARBY LAURSEN (Ms)	Alternate
Niels LARSEN	Delegate

Djibouti

Djama Mahamoud ALI	Principal Delegate
Ahmed KASIM	Delegate

Dominican Republic

Pablo Miguel MEDINA JIMENEZ	Principal Delegate

Ecuador

Carlos HUGO NARANJO	Principal Delegate
Mónica MARTINEZ MENDUINO (Ms)	Delegate

Egypt

Ahmed ABD-ELAAL	Principal Delegate
Ashraf ZAKEY	Alternate
Mohamed NASR	Delegate
Amr RAMADAN	Delegate
Ahmed SAAD	Delegate

El Salvador

Eugène Arène GUERRA	Principal Delegate

Estonia

Jalmar MANDEL	Principal Delegate
Jüri SEILENTHAL	Delegate
Kristina UIBOPUU (Ms)	Delegate

Ethiopia

Fetene TESHOME	Principal Delegate

Fiji

Nazhat S. KHAN (Ms)	Principal Delegate
Ravind KUMAR	Alternate
Ajendra PRATAP	Delegate

Finland

Petteri TAALAS	Principal Delegate
Maria HURTOLA (Ms)	Alternate
Päivi KAIRAMO (Ms)	Alternate
Juhani DAMSKI	Delegate
Jussi KAUROLA	Delegate
Renne KLINGE	Delegate
Johanna KORHONEN (Ms)	Delegate
Heini LEPPÄNEN (Ms)	Delegate
Alioune NDIAYE	Delegate
Jaakko NUOTTOKARI	Delegate
Emmi OIKARI (Ms)	Delegate
Harri PIETARILA	Delegate
Pekka PLATHAN	Delegate
Joanna SAARINEN (Ms)	Delegate
Anni SALMIA (Ms)	Delegate
Yrjö VIISANEN	Delegate

France

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Olivier GUPTA	Alternate
Dominique LAPEYRE DE CHAVARDÈS	Alternate
Nicolas NIEMTCHINOW	Alternate
Bérengère QUINCY	Alternate
Bernard STRAUSS	Alternate
Patrick BENICHOU	Delegate
Isabelle LELEU (Ms)	Delegate
Marie Pierre MEGANCK (Ms)	Delegate
Michel POUSSE	Delegate
Philippe RAMET	Delegate

French Polynesia

Matteo DELL'ACQUA	Principal Delegate

Gambia

Lamin Mai TOURAY	Principal Delegate
Pa Ousman JARJU	Alternate

Georgia

Shalva TSISKARASHVILI	Principal Delegate
Ramaz CHITANAVA	Alternate
Eka KIPIANI (Ms)	Delegate
Temuri PIPIA	Delegate

Germany

Gerhard ADRIAN	Principal Delegate
Thomas FITSCHEN	Alternate
Detlev FROMMING	Alternate
Klaus-Jürgen SCHREIBER	Alternate
Johannes CULLMANN	Delegate
Jochen DIBBERN	Delegate
Dirk ENGELBART	Delegate
Tobias FUCHS	Delegate
Sarah JONES (Ms)	Delegate
Bjorn ORIWOHL	Delegate
Axel THOMALLA	Delegate

Ghana

Andrew Yaw NKANSAH	Principal Delegate
Hubert OSEI-WUSUANSA	Delegate

Greece

Ioannis POULOPOULOS	Principal Delegate
Theodoros KOLYDAS	Alternate
Konstantina MITA (Ms)	Delegate
Paraskevi NAKIOU (Ms)	Delegate
Anastasia PAPAKRIVOU (Ms)	Delegate

Guatemala

Carlos J. E. MENENDEZ	Alternate
Ana R. TOLEDO (Ms)	Delegate

Guinea

Mamadou Lamine BAH	Principal Delegate
Moussa KOUROUMA	Delegate

Haiti

Max Gédéon BOUTIN	Principal Delegate
Marjorie P. LATORTUE (Ms)	Delegate

Honduras

Giampaolo RIZZO ALVARADO	Principal Delegate
Maria Jose MEJIA (Ms)	Delegate

Hong Kong, China

Chi Ming SHUN	Principal Delegate
Pak-Wai CHAN	Alternate

Hungary

Kornélia RADICS (Ms)	Principal Delegate
Eszter LABO (Ms)	Alternate
Zoltán DUNKEL	Delegate
Márk HORVÁTH	Delegate
Mónika LAKATOS (Ms)	Delegate

Iceland

Arni SNORRASON	Principal Delegate

India

Shailesh NAYAK	Principal Delegate
Laxman Singh RATHORE	Alternate
Harish ARYA	Delegate
S. D. ATTRI	Delegate
Y. S. CHOWDARY	Delegate
Madan GOPAL	Delegate
Alok Ranjan JHA	Delegate
R. KRISHNAN	Delegate
Ajit KUMAR	Delegate
Anil KUMAR	Delegate
K. Balaji MAJUMDAR	Delegate
B. N. REDDY	Delegate
Vishnu REDDY	Delegate
Yogesh Kumar SINGH	Delegate

Indonesia

Andi Eka SAKYA	Principal Delegate
Yunus S. SWARINOTO	Alternate
Triyono WIBOWO	Alternate
Edvin ALDRIAN	Delegate
Neng ALIA (Ms)	Delegate
Febryan AZMIE	Delegate
Agung BAGIAWAN	Delegate
Dodo GUNAWAN	Delegate

Guswanto GUSWANTO	Delegate
Damianus Tri HERYANTO	Delegate
Mulyono Rahadi PRABOWO	Delegate
Nelly Florida RIAMA (Ms)	Delegate
Ernesto SIMANUNGKALIT	Delegate
Maman SUDARISMAN	Delegate
Untoro SUSANTO	Delegate
Muhammad TAKDIR	Delegate
R. M. Michael TENE	Delegate
Adi WINARSO	Delegate

Iran, Islamic Republic of

Parhizkar DAVOOD	Principal Delegate
Mina JABBARI (Ms)	Alternate
Jafar BARMAKI	Delegate
Rahim MEIDANI	Delegate
Farah MOHAMMADI (Ms)	Delegate

Iraq

Imad M. J. AL-LAITHI	Alternate

Ireland

Liam CAMPBELL	Principal Delegate
Eoin MORAN	Alternate
Fleming GERALD	Delegate

Israel

Yoav LEVI	Principal Delegate
Tania BERG-RAFAELI (Ms)	Alternate
Tal AVRECH (Ms)	Delegate

Italy

Leonardo MUSMANNO	Principal Delegate
Carmelo GAMBUZZA	Alternate
Giovanni MARESCA	Alternate
Maurizio Enrico SERRA	Alternate
Maurizio BIASINI	Delegate
Angela CORINA (Ms)	Delegate
Chiara MARSIGLI (Ms)	Delegate
Mauro MESSEROTTI	Delegate
Leone M. MICHAUD	Delegate
Giuseppe ONORATI	Delegate
Tiziana PACCAGNELLA (Ms)	Delegate
Paola PAGLIARDA (Ms)	Delegate
Silvano PECORA	Delegate
Giancarlo M. PEDRINI	Delegate

Jamaica

Jeffery SPOONER	Principal Delegate
Sheldon BARNES	Delegate

Japan

Toshihiko HASHIDA	Alternate
Jitsuko HASEGAWA (Ms)	Delegate
Tatsuya KIMURA	Delegate
Haruka KITAHATA (Ms)	Delegate
Masaya OMORI	Delegate
Hiroyuki SUMINO	Delegate
Kentaro SUZUKI	Delegate

Jordan

Saja S. MAJALI (Ms)	Principal Delegate
Hatem AL-HALABI	Alternate
Ghadeer EL FAYEZ	Delegate
Hussein EL-MOMANI	Delegate

Kazakhstan

Aibek MENDIGARIN	Principal Delegate
Danara ALIMBAYEVA (Ms)	Delegate
Bekaidar SARY	Delegate
Gulzhan TULEBAYEVA (Ms)	Delegate

Kenya

James KONGOTI	Principal Delegate
Stephen KARAU	Alternate
Julius KANDIE	Delegate
Andrew KIHURANI	Delegate
Peter MASIKA	Delegate
Sospeter MUIRURI	Delegate
Vivian TALASH (Ms)	Delegate

Kuwait

Khaled M. AL-SHUAIBI	Principal Delegate
Mohammad Karam ALI	Alternate
Haider ABULHASAN	Delegate
Hussain ALSARRAF	Delegate

Lao People's Democratic Republic

Thongphane SAVANPHET	Principal Delegate
Kalamoungkhoune SOUPHANOUVONG	Delegate
Losoualiene XIAYING	Delegate

Latvia

Raimonds JANSONS	Principal Delegate
Peteris PODVINSKIS	Alternate

Lebanon

Najla R. ASSAKER (Ms)	Principal Delegate
Ahmad ARAFA	Alternate

Lesotho

Ntsime JAFETA	Principal Delegate

Libya

Basma ALGADI (Ms)	Principal Delegate

Lithuania

Vida AUGULIENE (Ms)	Principal Delegate

Luxembourg

Léon WIETOR	Principal Delegate
Francis MAQUIL	Alternate
Martina RECKWERTH (Ms)	Alternate

Macao, China

Soi Kun FONG	Principal Delegate
Ka Cheng LEONG (Ms)	Alternate
Weng Kun LEONG	Delegate
Iu Man TANG	Delegate

Madagascar

Jacques U. ANDRIANTIANA	Principal Delegate
Samuëline RAHARIVELOARIMIZA SOARIJAONA (Ms)	Alternate
Zoaharimalala RABEFITIA	Delegate
Nambinina Claudia RAKOTONDRAHANTA (Ms)	Delegate
Tinasoa RANDRIAMAHAZO (Ms)	Delegate
Solofo A. RAZAFITRIMO	Delegate

Malawi

Jolamu NKHOKWE	Principal Delegate

Malaysia

Che Gayah ISMAIL (Ms)	Principal Delegate
Syuhada ADNAN (Ms)	Alternate

Maldives

Abdullahi MAJEED	Principal Delegate
Ali SHAREEF	Alternate
Geela ALI (Ms)	Delegate
Rishfa RASHEED (Ms)	Delegate
Shiuneen RASHEED (Ms)	Delegate

Mali

Mamadou A. DIALLO	Principal Delegate
Sidi M. Y. SIDIBE	Alternate
Aya THIAM DIALLO (Ms)	Alternate
Mamadou H. KOUMARE	Delegate

Mauritius

I. DHALLADOO	Principal Delegate
Vimla HUREE-AGARWAL	Alternate

Mexico

Juan M. CABALLERO GONZALES	Principal Delegate
Juan R. HEREDIA ACOSTA	Alternate
Beatriz Hernández NARVAEZ (Ms)	Delegate
Vanessa PHILIPPE (Ms)	Delegate
Olivia RODRIGUEZ LOPEZ (Ms)	Delegate
René Lobato SANCHEZ	Delegate
Valeria Cuevas TREJO (Ms)	Delegate
Raúl VARGAS JUAREZ	Delegate
Jose VILLALPANDO	Delegate

Monaco

Carole LANTERI (Ms)	Principal Delegate
Chrystel CHANTELOUBE (Ms)	Delegate
Johannes DE MILLO TERRAZZANI	Delegate
Gilles REALINI	Delegate

Mongolia

Donio TSOGT-OCHIR	Principal Delegate
Eldev-Ochir ERDENEBAT	Alternate

Montenegro

Luka MITROVIC	Principal Delegate
Nebojsa KALUDJEROVIC	Alternate
Andjela ROGAC (Ms)	Alternate
Ivana ADZIC (Ms)	Delegate
Sanja PAVICEVIC (Ms)	Delegate

Morocco

Charafat EL YEDRI AFAILAL (Ms)	Principal Delegate
Abdalah MOKSSIT	Alternate
Mohamed AUAJJAR	Delegate
Omar CHAFKI	Delegate
Hasnae DRIDER (Ms)	Delegate
Hassan HADDOUCH	Delegate
Abdallah NASSIF	Delegate
Abdelaziz OULDBBA	Delegate

Mozambique

Atanasio J. MANHIQUE	Principal Delegate
Pedro COMISSARIO	Alternate
Jaime Valente CHISSANO	Delegate
Juvenal Arcanjo DENGO	Delegate
Isac FILIMONE	Delegate
Flavio Jonas MONJANE	Delegate
Rute Mateus NHAMUCHO (Ms)	Delegate

Myanmar

Hrin Nei THIAM (Ms)	Principal Delegate
SOE MYINT	Alternate
Thu Rein S. H. NAING	Delegate

Namibia

Sabine BOEHLKE-MOELLER (Ms)	Principal Delegate
Jennifer MOETIE (Ms)	Alternate
Erickson NENGOLA	Alternate
FRANZ UIRAB	Alternate
Saima N. ASHIPALA (Ms)	Delegate
Stella KATJINGISIUA (Ms)	Delegate

Nepal

Deepak DHITAL	Principal Delegate
Suresh ADHIKARI	Delegate
Ranjita DAHAL (Ms)	Delegate

Netherlands

Gerard VAN DER STEENHOVEN	Principal Delegate
Arnout FEIJT	Alternate
Hans ROOZEKRANS	Alternate
Peter SIEGMUND	Delegate
Myriam VAN ROOIJ (Ms)	Delegate

New Caledonia

Quoc Phi DUONG	Principal Delegate

New Zealand

Peter LENNOX	Principal Delegate
Norm HENRY	Alternate
James LUNNY	Alternate
Meredith DAVIS (Ms)	Delegate

Nicaragua

Nestor CRUZ TORUNO	Principal Delegate
Jenny ARANA VIZCAYA (Ms)	Delegate
Mariele PAGANINI (Ms)	Delegate

Niger

Ado ELHADJ ABOU	Alternate
Kountche M. GAZIBO (Ms)	Delegate

Nigeria

Anthony ANUFOROM	Principal Delegate
Ifeanyi NNODU	Alternate
Ernest AFIESIMAMA	Delegate
Anthony N. ALONWU	Delegate
Moses BECKLEY	Delegate
Peters S. O. EMUZE	Delegate
BENITA OBAZEE (Ms)	Delegate
Olayinka OGUNWALE	Delegate
Juliana UKEJE (Ms)	Delegate

Norway

Anton ELIASSEN	Principal Delegate
Jens SUNDE	Alternate
Øystein HOV	Delegate
Morten JOHNSRUD	Delegate
Steffen KONGSTAD	Delegate
Heidi LIPPESTAD (Ms)	Delegate
Inger G. NAESS (Ms)	Delegate
Thor Erik NORDENG	Delegate
Eugenia TAPIA (Ms)	Delegate

Oman

Mohammed AL-ZAABI	Principal Delegate
Abdulrahim ALHARMI	Alternate
Amer AL AMRI	Delegate
Abdulla N. AL RAHBI	Delegate
Juma Said AL-MASKARI	Delegate
Khalid ALNAJAR	Delegate

Pakistan

Muhammad Usman JADOON	Alternate
Irfan MAHMOOD BOKHARI	Alternate

Panama

Edilberto ESQUIVEL MARCONI	Principal Delegate
Gustavo Adolfo BERNAL GONZALEZ	Delegate
Gloribeth del Carmen PITTI QUIROS (Ms)	Delegate

Papua New Guinea

Samuel MAIHA	Principal Delegate
Kasis INAPE	Delegate

Paraguay

Julian BAEZ BENITEZ	Principal Delegate
Raquel CARRILLO (Ms)	Delegate
Jorge Anibal SANCHEZ GARCIA	Delegate

Peru

Amelia DIAZ (Ms)	Principal Delegate
Grinia AVALOS (Ms)	Delegate
Ana T. LECAROS TERRY (Ms)	Delegate
Esequiel VILLEGAS	Delegate

Philippines

Cecilia REBONG (Ms)	Principal Delegate
Flaviana HILARIO (Ms)	Alternate
Vicente MALANO	Alternate
Sharon J. AGDUMA (Ms)	Delegate
Hosanna Dela CRUZ (Ms)	Delegate
Michelle EDUARTE	Delegate
Arnel TALISAYON	Delegate
Neil Aica TINTERO (Ms)	Delegate
Marivil VALLES (Ms)	Delegate

Poland

Mieczyslaw S. OSTOJSKI	Principal Delegate
Remigiusz HENCZEL	Alternate
Janusz FILIPIAK	Delegate
Agnieszka HARDEJ-JANUSZEK (Ms)	Delegate
Pawel WILK	Delegate
Edyta WOZNIAK-DUDZINSKA (Ms)	Delegate

Portugal

Pedro NUNO BARTOLO	Principal Delegate
Jorge Miguel MIRANDA	Alternate
Ana H. PINHEIRO MARQUES (Ms)	Delegate
Antonio P. VITERBO DE SOUSA AZEVEDO	Delegate

Qatar

Abdulaziz M. AL-NOAIMI	Principal Delegate
Ahmed ABDULLA MOHAMMED	Alternate
Abdulla M. A. M. AL MANNAI	Delegate
Faisal Abdulla AL-HENZAB	Delegate
Ghanem A. M. A. AL-MARRI	Delegate
Monikumar RAMAKRISHNAN	Delegate

Republic of Korea

Yunhwa KO	Principal Delegate
Hongsang JUNG	Alternate
Woojin LEE	Alternate
Yeonchul YOO	Alternate
Dongeon CHANG	Delegate
Yeunsook CHOI (Ms)	Delegate
Sangwon JOO	Delegate
Miok KI (Ms)	Delegate
Sewon KIM	Delegate
Hoesung LEE	Delegate
Jengeun LEE (Ms)	Delegate
Tae-Won LEE	Delegate
Jaecheol NAM	Delegate
Seungkyun PARK	Delegate
Duek SHIN (Ms)	Delegate
Jaegwang WON	Delegate

Republic of Moldova

Anatolie PUTUNTICA	Principal Delegate
Victor MORARU	Alternate
Iuliana VASCAUTAN (Ms)	Delegate

Romania

Ion SANDU	Principal Delegate
Elena MATEESCU (Ms)	Alternate
Gheorghe CAUNEI-FLORESCU	Delegate

Russian Federation

Alexander FROLOV	Principal Delegate
Alexei BORODAVKIN	Alternate
Alexander NURULLAEV	Alternate
Rinat ALYAUTDINOV	Delegate
Vasily ASMUS	Delegate
Alexander BEDRITSKY	Delegate
Anatoly BOGUSH	Delegate
Ilia DEMIDOV	Delegate
Alexander GUSEV	Delegate
Vladimir KATTSOV	Delegate
Alexander KUCHKOV	Delegate

Maria MAMAEVA (Ms)	Delegate
Natalia ORESHENKOVA (Ms)	Delegate
Marina PETROVA (Ms)	Delegate
Natalia RADKOVA (Ms)	Delegate
Eduard SARUKHANYAN	Delegate
Yuri SIMONOV	Delegate
Grigory USTINOV	Delegate
Roman VILFAND	Delegate
Alexander ZAYTSEV	Delegate

Rwanda

François Xavier NGARAMBE	Principal Delegate
Jean de Dieu BUDUREGE	Delegate

Saint Lucia

David FARRELL	Principal Delegate

Samoa

Paolelei LUTERU	Principal Delegate

Saudi Arabia

Ayman Salem GHULAM	Principal Delegate
Mohammed BABIDHAN	Alternate
Shaher ALHAZMI	Delegate
Jamal A. BAMAYLEH	Delegate
Sameer A. I. BUKHARI	Delegate
Saad MOHALFI	Delegate

Senegal

Aida Diongue NIANG (Ms)	Principal Delegate
Chérif DIOP	Delegate

Serbia

Jugoslav NIKOLIC	Principal Delegate
Milica ARSIC (Ms)	Delegate
Irena BASALIC (Ms)	Delegate
Vladislav MLADENOVIC	Delegate
Dragana MLADENOVIC NESTOROVIC (Ms)	Delegate
Goran PEJANOVIC	Delegate

Seychelles

Wills AGRICOLE	Principal Delegate
Selvan PILLAY	Alternate
Vincent AMELIE	Delegate
Nelson LALANDE	Delegate

Singapore

Chin Ling WONG (Ms)	Principal Delegate
Lesley CHOO (Ms)	Delegate
Felicia SHAW (Ms)	Delegate

Slovakia

Martin BENKO	Principal Delegate
Branislav CHVILA	Delegate
Ján PLAVCAN	Delegate
Jana POÓROVÁ (Ms)	Delegate

Slovenia

Klemen BERGANT	Principal Delegate
Urska CAS-SVETEK (Ms)	Delegate
Spela KOSIR (Ms)	Delegate
Zlatko MIKULIC	Delegate
Andrej ZITKO	Delegate

Solomon Islands

Lloyd TAHANI	Principal Delegate

South Africa

Edna Bomo Edith MOLEWA (Ms)	Principal Delegate
Linda MAKULENI (Ms)	Alternate
Abdul Samad MINTY	Alternate
Gaborekwe KHAMBULE (Ms)	Delegate
Nomhiki LUDIDI (Ms)	Delegate
Mark MAJODINA	Delegate
Ziyanda MAJOKWENI QWALELA	Delegate
Simbongile MANCOTYWA-KUMSHA (Ms)	Delegate
Zoleka MANONA (Ms)	Delegate
Francis MOSETHLO	Delegate
Claude Mogambrey NADASEN	Delegate
Tshepho NGOBENI	Delegate
Ncumisa NOTUTELA (Ms)	Delegate
Eugene POOLMAN	Delegate
Nosisi POTELWA (Ms)	Delegate

South Sudan

Mojwok OGAWI MODO	Principal Delegate
Akech C. A. AYOK	Alternate
Gloria LOMODONG (Ms)	Delegate

Spain

Miguel Angel LOPEZ GONZALEZ	Principal Delegate
Julio GONZALEZ BRENA	Alternate
Carmen RUS JIMENEZ (Ms)	Alternate
Sara BASART (Ms)	Delegate
Fernando BELDA ESPLUGUES	Delegate
Xavier BELLMONT ROLDAN	Delegate
Ana CASALS CARRO (Ms)	Delegate
Antonio CONESA MARGELI	Delegate
Emilio CUEVAS AGULLO	Delegate
Francisco ESPEJO GIL	Delegate
José A. F MONISTROL	Delegate
Sergio GARCIA DOMINGUEZ	Delegate
Manuel PALOMARES CALDERON	Delegate
Fernando PASTOR ARGUELLO	Delegate
Francisco PEREZ PUEBLA	Delegate
Ernesto RODRIGUEZ CAMINO	Delegate
Gemma SANCHEZ FERNANDEZ (Ms)	Delegate
Jorge TAMAYO CARMONA	Delegate
Enric TERRADELLAS JUBANTENY	Delegate
Pascual TOMAS HERNANDEZ	Delegate
Amadeo URIEL GONZALEZ	Delegate

Sri Lanka

Ravinatha ARYASINHA	Principal Delegate
Samantha JAYASURIYA (Ms)	Alternate
Chathura PERERA	Delegate

Sudan

Ahmed M. ABDELKARIM ABDELRAHMAN	Principal Delegate
Amar DAOUD	Delegate

Swaziland

Njabuliso B. GWEBU (Ms)	Principal Delegate
Almon Mahlaba MAMBA	Delegate

Sweden

Rolf BRENNERFELT	Principal Delegate
Bodil AARHUS ANDRAE (Ms)	Alternate
Ilmar KARRO	Alternate
Cristina ALIONTE EKLUND (Ms)	Delegate

Switzerland

Peter BINDER	Principal Delegate
Alexandre FASEL	Alternate
Christof APPENZELLER	Delegate
Jörg KLAUSEN	Delegate
Olivier OVERNEY	Delegate
Alex RUBLI	Delegate
Christoph SCHMUTZ	Delegate
Lukas SCHUMACHER	Delegate
Gabriela SEIZ (Ms)	Delegate
Stefan SIGRIST	Delegate
Gerhard ULMANN	Delegate

Syrian Arab Republic

Hussam EDDIN AALA	Principal Delegate
Ali DAGHMAN	Delegate
Khawla YOUSSEF (Ms)	Delegate

Tajikistan

Anora KARIMOVA (Ms)	Principal Delegate

Thailand

Songkran AGSORN	Principal Delegate
Thada SUKHAPUNNAPHAN	Delegate

The former Yugoslav Republic of Macedonia

Oliver ROMEVSKI	Principal Delegate

Timor-Leste

Sebastiana BARROS (Ms)	Principal Delegate

Togo

Nakpa POLO (Ms)	Principal Delegate
Mounto AGBA	Delegate
Komlan A. NARTEH-MESSAN	Delegate

Tonga

'Ofa FA'ANUNU	Principal Delegate

Trinidad and Tobago

Marlon NOEL	Principal Delegate
Mariella FONROSE (Ms)	Alternate

Tunisia

Walid DOUDECH	Principal Delegate
Raja YOUSFI (Ms)	Alternate
Hatem BACCOUR	Delegate
Chadly BEN MHAMED	Delegate
Fadhel GRAMI	Delegate
Mohamed HAJJEJ	Delegate
Ahmed HMAM	Delegate
Cherifa Eyssar KOCHLEF	Delegate

Turkey

Ismail GUNES	Principal Delegate
Ercan BUYUKBAS	Alternate
Mehmet Ferden CARIKCI	Alternate
Haci Murat PULLA	Alternate
Murat ALTINYOLLAR	Delegate
Ozlem KURAL (Ms)	Delegate
Aydin TOPÇU	Delegate

Turkmenistan

Atageldi HALJANOV	Principal Delegate

Uganda

Michael Z. NKALUBO SEVUME	Principal Delegate
Christopher A. ONYANGA	Delegate

Ukraine

Mykola KULBIDA	Principal Delegate
Yurii KLYMENKO	Delegate
Volodymyr KOVALYSHYN	Delegate

United Arab Emirates

Abdullah A. ALMANDOUS	Principal Delegate
Obaid Salem AL ZAABI	Alternate
Khaled Ali A. AL HAMOODI	Delegate
Abdulla S. H. AL KHATHRI	Delegate
Saeed AL MARZOUQI	Delegate
Omar A. AL YAZEEDI	Delegate
Abdulla A. ALHAMMADI	Delegate
Ebrahim K. ALHOSANI	Delegate
Yousef N. ALKALBANI	Delegate
Alya Saeed ALMAZROUEI (Ms)	Delegate
Mohamed S. ALMEHEIRI	Delegate
Abdullatif FAKHFAKH	Delegate

United Kingdom of Great Britain and Northern Ireland

Robert VARLEY	Principal Delegate
Steve NOYES	Alternate
Paul DAVIES	Delegate
Harry DIXON	Delegate
Wayne ELLIOTT	Delegate
Julia EVANS (Ms)	Delegate
Baden HALL	Delegate
Gavin ILEY	Delegate
Alan JENKINS	Delegate
Claudia KELLER (Ms)	Delegate
Karen MCCOURT (Ms)	Delegate
Sophie PURDEY (Ms)	Delegate
Mark RUSH	Delegate
Fiona TOVEY (Ms)	Delegate
Bruce TRUSCOTT	Delegate
Jane WARDLE (Ms)	Delegate

United Republic of Tanzania

Agnes KIJAZI (Ms)	Principal Delegate
Modest MERO	Alternate
Hamza KABELWA	Delegate
Deusdedit B. KAGANDA	Delegate
George LUGOMELA	Delegate
Naomi Zegezege MPEMBA (Ms)	Delegate
Celestine MUSHY	Delegate
Mohamed NGWALI	Delegate
Wilbert TIMIZA	Delegate

United States of America

Laura FURGIONE (Ms)	Principal Delegate
Caroline CORVINGTON (Ms)	Alternate
Courtney DRAGGON (Ms)	Alternate
Jared BANKS	Delegate
Fredrick BRANSKI	Delegate
Caroline BROUN (Ms)	Delegate
Edwin BROWN	Delegate
James BUTLER	Delegate
Christopher FIELD	Delegate
Mary GLACKIN (Ms)	Delegate
Jack HAYES	Delegate
Elliott JACKS	Delegate
Richard JEFFRIES	Delegate
Katharine MACH (Ms)	Delegate
Robert MASON	Delegate
Meredith MUTH (Ms)	Delegate
Mark PAESE	Delegate
James PERONTO	Delegate
Robert RUTLEDGE	Delegate
Kevin SCHRAB	Delegate
Kari SHEETS (Ms)	Delegate
Kelly SPONBERG	Delegate
Andrew STERN	Delegate
Mathew STRAHAN	Delegate
Charles WOOLDRIDGE	Delegate
Martin JESSUP	Observer
John K. LONGENECKER	Observer

Uruguay

Ricardo GONZALEZ ARENAS	Principal Delegate
Raul Lazaro GARCIA IGORRA	Alternate
Agustina CAMILLI (Ms)	Delegate

Uzbekistan

Ulugbek LAPASOV	Principal Delegate
Bakhriddin NISHONOV	Alternate

Venezuela, Bolivarian Republic of

Jose SOTTOLANO	Principal Delegate
Fabio DI CERA PATERNOSTRO	Delegate
Kleiver GARCIA	Delegate

Viet Nam

Linh Ngoc NGUYEN	Principal Delegate
Van Tue NGUYEN	Delegate

Yemen

Mohamed Mohamed ALQASEMY	Principal Delegate

Zambia

Jacob NKOMOKI	Principal Delegate
Joseph K. KANYANGA	Delegate
Miyanda M. SYABWENGO (Ms)	Delegate

Zimbabwe

Amos MAKARAU	Principal Delegate
Pearson CHIGIJI	Delegate
Nomsa Michelle NDONGWE (Ms)	Delegate

3. Representatives of non-WMO Members

Holy See

Giovanni GIUDETTI	Observer
Richard GYHRA	Observer
Stefano SALDI	Observer

4. Presidents of constituent bodies and chairpersons of other bodies reporting to Congress

Amos MAKARAU	President of RA I
Ahmed ABDULLA MOHAMMED	President of RA II
Julian BAEZ BENITEZ	President of RA III
Juan Carlos FALLAS	President of RA IV
Andi Eka SAKYA	President of RA V
Ivan CACIC	President of RA VI
Fredrick BRANSKI	President of CBS
Bertrand CALPINI	President of CIMO
Øystein HOV	President of CAS
Chi Ming SHUN	President of CAeM
Byong Lyol LEE	President of CAgM
Johan STANDER	Co-President of JCOMM
Harry LINS	President of CHy
Thomas PETERSON	President of CCl
Jens SUNDE	Chairperson of IBCS

5. Invited experts

Alex BAKER
Guy BRASSEUR
Stephen BRIGGS
Saniy Gusler CORAT (Ms)
Philip L. DE COLA
Mark DRINKWATER
Ismail ELGIZOULI
Oystein GODOY
Sarah JONES (Ms)
Thomas JUNG
Jeff KEY
Paolo LAJ
Rodney MARTINEZ
Tillmann MOHR
Rupa MUKERJI (Ms)
Shanna PITTER (Ms)
Mikael RATTENBORG
Henry REGES
Federica ROSSI (Ms)
Arlex SANCHEZ TORRRS
Bruce STEWART
Alberto TROCCOLI
Ap VAN DONGEREN
Bernhard VOGEL

6. Representatives of international organizations and other bodies

AfDB

Justus J. KABYEMERA	Observer

ASECNA

Moïse BETOLE ADA	Observer
Claire J. OBAME-EDOU (Ms)	Observer
Simeon ZOUMARA	Observer

AU

Jean-Marie EHOUZOU	Observer
Faouzi GSOUMA	Observer
Susan ISIKO STRBA (Ms)	Observer
Claude KANA	Observer
Georges Remi NAMEKONG	Observer

CEMAC

Isidore EMBOLA	Observer

CMO

Tyrone SUTHERLAND	Observer

EAC

John MUNGAI	Observer

ECMWF

Alan J THORPE	Observer

ECOMET

William A. MCCAIRNS	Observer

EUMETNET

Stefan KLINK	Observer
Sergio PASQUINI	Observer
Eric PETERMANN	Observer

EUMETSAT

Yves BUHLER	Observer
Paul COUNET	Observer
Vincent GABAGLIO	Observer
Alain RATIER	Observer
Joachim SAALMUELLER	Observer
Anne TAUBE (Ms)	Observer

GEO

Dominique D. BEROD	Observer
Wenbo CHU (Ms)	Observer
Patricia GEDDES (Ms)	Observer
André OBREGON	Observer

HMEI

Ahmed H. M. AL-HARTHY	Observer
Brian DAY	Observer
Alan DECIANTIS	Observer
Bryce L. FORD	Observer
Jack HAYES	Observer
Andy MCDONALD	Observer
K. Liz NIELSEN (Ms)	Observer
Romy OLAISEN (Ms)	Observer
Ashish RAVAL	Observer

IABM

Kevin O'LOUGHLIN	Observer

ICAO

N. HALSEY	Observer
Yong WANG	Observer

ICSU

Lucillla SPINI (Ms)	Observer

IFRC

Elhadj As SY	Observer
Chang Hun CHOE	Observer
Hilary MOTSIRI (Ms)	Observer
Mohammed MUKHIER	Observer
Joy MULLER	Observer
Susil PERERA	Observer
Marjorie SOTO FRANCO (Ms)	Observer

IPCC

Jesbin BAIDYA	Observer
Annie COURTIN (Ms)	Observer
Joelle FERNANDEZ (Ms)	Observer
Jonathan LYNN	Observer
Nina PEEVA (Ms)	Observer

IUGG

Arthur ASKEW	Observer
Charles FIERZ	Observer

JIU

Cihan TERZI	Observer

League of Arab States

Salah AEID	Observer
Ashraf N. A. SHALABY	Observer
Youcef TILIOUANT	Observer

SADC

Bradwell Jonathan GARANGANGA	Observer
Bruno Tseliso Morapeli SEKOLI	Observer

UNEP

Pascal PEDUZZI	Observer

UNISDR

Luna ABUSWAIREH (Ms)	Observer
Vanessa BUCHOT (Ms)	Observer
John HARDING	Observer
Neil MCFARLANE	Observer
Muthoni NJOGU (Ms)	Observer
Letizia ROSSANO (Ms)	Observer
Irina ZODROW (Ms)	Observer

UNITAR

Valeria DRIGO (Ms)	Observer
Angus MACKAY	Observer
Francesco PISANO	Observer

UNWTO

Zoritsa UROSEVIC (Ms)	Observer

WFEO

Yvette RAMOS (Ms)	Observer

WFP

Katiuscia FARA (Ms)	Observer
Brian LANDER	Observer

WIPO

Joe BRADLEY	Observer

World Bank

Barzin ARYAN	Observer
Marjory A. BROMHEAD (Ms)	Observer
Manuela CHIAPPARINO (Ms)	Observer
Francis GHESQUIERE	Observer
Defne GONENC (Ms)	Observer
Corinne GRASSLE (Ms)	Observer
Daniel KULL	Observer
Atsushi MATSUSHITA	Observer
Michel PRE	Observer
Christoph PUSCH	Observer
David ROGERS	Observer
Jamal SAGHIR	Observer
Prashant SINGH	Observer
Claire SOMERVILLE (Ms)	Observer
Makoto SUWA	Observer
Maria Cristina TRAVAGLIO (Ms)	Observer
Alina TRUHINA (Ms)	Observer
Vladimir TSIRKUNOV	Observer
Maarten VAN AALST	Observer

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