

WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

OPAG ON REMOTE SENSING AND NEW TECHNOLOGIES

AND

COMMISSION FOR BASIC SYSTEMS

OPAG ON INTEGRATED OBSERVING SYSTEMS

JOINT MEETING OF

CIMO EXPERT TEAM ON OPERATIONAL REMOTE SENSING (ET-ORS)
(First Session)

AND

CBS EXPERT TEAM ON SURFACE-BASED REMOTE SENSING
OBSERVATIONS (ET-SBRSO)
(Second Session)

Geneva, Switzerland

05-09 December 2011

FINAL REPORT

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GENERAL SUMMARY

1. ORGANIZATION OF THE SESSION

1.1 Opening of the session

1.1.1 The Joint Meeting of the CIMO Expert Team on Operational Remote Sensing (ET-ORS) 1st Session and CBS Expert Team on Surface-Based Remotely-Sensed Observing Systems was held in Geneva, Switzerland, 05-09 December 2012. The meeting was opened by Dr Carolin Richter, acting D/OBS, WMO.

1.1.2 Dr Richter welcomed the participants, who are listed in Annex 1. She observed that this was the second joint meeting of respective CIMO and CBS Expert Teams: early in the cycle for CIMO, late in the cycle for CBS, and that the two groups have come together to learn from each other and to solve some problems. Dr Richter commended the two groups on this approach, noting that it is in line with the WMO principle of creating partnerships, for which integration is the key word.

1.1.3 Dr Richter went on to describe WIGOS as a major challenge in WMO at present which, like WIS, would comprise one of the backbone cross-cutting programmes of WMO. GCOS/WCRP have called for peer review of climate data sets, for which an important question is how to integrate them, so it will be important for the two Expert Teams to sit together and address these issues for the remote sensing systems. WIGOS will provide a major contribution to GCOS by delivering the data for the atmospheric domain, so will need to be well-managed and based on an integration effort. Dr Richter then described how GCOS, WIGOS and these initiatives in the data domain are all overarched by GFCS, which has been endorsed by Cg-XVI. Observations and Monitoring is one of the pillars of GFCS, so all efforts towards WIGOS will benefit GFCS.

1.1.4 Dr Richter closed by noting that the work of the two Expert Teams is complementary to each of these major WMO initiatives and that WMO is grateful for the engagement of the experts on some of the more pressing issues confronting remote sensing systems. She wished the meeting a successful outcome and the participants an enjoyable stay in Geneva.

1.2 Adoption of the agenda

1.2.1 The Joint Meeting adopted the modified [Agenda](#) for the meeting, which is reproduced at the beginning of this report.

1.3 Working arrangements for the session

1.3.1 It was agreed that Mr Li Bai, Chair of ET-ORS, and Mr Stuart Goldstraw, Chair of ET-SBRSO, would share the chairing responsibilities. The meeting plan included breakout sessions on Wednesday, each breakout group to discuss a specific matter raised during the general sessions on Monday and Tuesday that would require more detailed consideration by those with a particular interest. The topics to be discussed and the breakout leaders would be selected on Wednesday morning prior to commencement of the breakout sessions. For the parallel sessions on Thursday, Mr. Li would chair the ET-ORS session, while Mr Goldstraw would chair the ET-SBRSO session. The two groups would meet together again on Friday for a summary session, during which reports would be provided on the Wednesday breakout sessions and Thursday's parallel sessions of the individual Expert Teams.

1.3.2 The tentative working hours for the meeting were agreed upon.

2. REPORTS OF CHAIRS

2.1 Report of the Chair of ET-ORS

2.1.1 The ET-ORS Chair welcomed the participants at the meeting. He reported on his activity since 2010 and on the ET-ORS approved work plan achievements to date. In his introductory

speech the ET Chair recalled the role of the ET after the approval of the new working structure of CIMO (CIMO-XV, 2010), the Mission/ToRs statements of the ET and the key elements of its work plan. The ET chair also recalled the relevant items and decisions of the 9th Session of CIMO Management Group (CIMO MG-9, 2011) concerning the ET's role and work plan. Those relevant items and decisions have been reflected in this report and possible actions identified accordingly.

2.2 Report of the Chair of ET-SBRSO

2.2.1 Workplan: Mr Stuart Goldstraw (United Kingdom), recalled the terms of reference of the Expert Team, the work plan that was agreed at the first meeting of the ET in November 2009 and progress to date in a number of areas had been limited, nevertheless some progress had been made and in the subsequent six months it was hoped a number of important outputs could be delivered. It was noted this was the second and most likely final time the ET members would meet during the current inter-sessional period. During the meeting it would therefore be important for the ET to consider how best to meet the requirements of the workplan and report to ICT-IOS in June 2012 and then CBS in the Autumn of 2012.

2.2.2 ICT-IOS: Mr Goldstraw represented ET-SBRSO at the 6th session of ICT-IOS in June 2010 where the work and challenges of the IOS OPAG were discussed and particular attention was given to how IOS OPAG ETs would support the ambitions of WIGOS and how WIGOS would enable IOS OPAG ETs to become more effective in providing advice to the wider WMO community.

2.2.3 Resourcing: The urgent need for a member of the ET to be called away at the last minute to attend an important national meeting highlighted the ongoing challenge ET members have to be able to dedicate sufficient time to ET tasks. Nevertheless some real progress had been made against the workplan tasks and one of the main goals of the meeting would be to revisit the ET work plan and determine exactly what further components of the tasks could be realistically delivered during the remaining time in the intersessional period. The updated workplan (Annex IV) reflects a revised workplan given the most likely commitments that ET members could make in the next 6 months

2.2.4 Future plans: Mr Goldstraw proposed the ET should focus attention on particular aspects of the terms of reference, specifically ensuring we:

- Understand the expectations of WIGOS on operational SBRSO systems
- Maintain an awareness of the likely future SBRSO technologies from CIMO
- Capture and record centrally the latest status of operational SBRSO systems
- Work with ET-EGOS to ensure the capabilities and potential of operational technologies to meet requirements are understood
- Support the wider needs of IOS and CBS for advice on operational SBRSO systems

2.2.5 Joint meetings: Mr Goldstraw also noted that joint meetings with the partner ET in CIMO should now be considered the norm as for most surface based remote sensing system there is only a very fine line between sensors and systems or capabilities and operational configurations. Indeed perhaps a deliverable from WIGOS will be the implementation of improved integration of appropriate CIMO and CBS activities.

2.2.6 Mr Goldstraw concluded that whilst many challenges lay ahead he was sure the ET could deliver many pieces of valuable work for CBS as part of its work plan.

2.3 Review of the Status of the Work Plans

2.3.1 The status of the respective work plans were reviewed by the combined group, and strategies were developed for updating the work plans during the split sessions on Thursday.

3. WEATHER RADAR OPERATIONS, STATUS, ISSUES, REQUIREMENTS FOR DATA EXCHANGE AND PLANS

3.1 International and regional network status.

3.1.1 Report on RADAR survey results and establishment of the metadata database.

3.1.1.1 A global survey on weather radars has been conducted since 2009, in scope of CIMO Expert Team on Remote-Sensing Upper-Air Technology and Techniques work plan to establish a fully comprehensive database of the global use of weather radars. Web page studies of the weather radar database have been carried out by Turkish Meteorological Service in scope of CIMO Expert Team on Operational Remote Sensing (ET-ORS) work plan. First version of the web page completed in 2011. The URL address of the web page is <http://www.dmi.gov.tr> and the site is hosted by the Turkish Meteorological Service. Features like basic search, search based on countries, parameters of individual radars, materials, statistics with graphs are currently active in Version 1. Statistics are updated automatically from the database and radar Images from the radars can be obtained from links. WMO has sent a letter to PRs to assign a responsible focal point who would be responsible for initial metadata entry and routine maintenance of the database under instruction from WMO and the database administrator. Accounts will be provided for each focal point so that they will be able to update the metadata for their own networks. Although replies to the questionnaire, which was prepared with the aim of establishing a comprehensive web-based weather radar database, were very encouraging, there are still gaps to be filled. Sharing principles of the database in the case of requests from Members and other persons or organizations would need to be defined in the future. User authorization levels should also be determined. A second version of the WMO Radar Database will later be developed taking into account feedback, remarks and opinions of experts and focal points.

3.1.1.2 Although it is obvious that the weather radar database may need some further development and improvement based on the requirements of the users, Mr Ercan Buyukbus, noted that it should be kept in mind that this database, as a unique source of radar metadata, provides users with access to information about the operational radars included in that database via a convenient, internet-based interface and, therefore, all Members and other radar operators should be encouraged to contribute to it. It was suggested that the development of the WMO Radar Database provides a successful developmental process that might be replicated for the other remote sensing observations systems if and as needed.

3.1.1.3 The meeting noted that the radar database appears ready for transition to operations, but that first there would be a need for a management protocol to be developed. It was agreed that one of the Wednesday breakout sessions would document a database management protocol describing the purpose of the radar database, the proposed responsibilities of TSMS in operating and managing the database, and of users in accessing it, prior to it being cut-over to operational status. Dr Ondras, Dr. Dibbern and Mr Sireci volunteered to participate in this breakout group.

3.1.2 Report on BALTRAD

3.1.2.1 Daniel Michelson presented the BALTRAD project. This is the first time EU funding is being used to network existing radars, not as a prototype or proof-of-concept but as an element of regional infrastructure. The project started in February 2009 and ends in January 2012, delivering an Open Source system for exchange of radar data, and processing of all data using an open "toolbox" product generation framework. All data in BALTRAD are being exchanged using EUMETNET OPERA's ODIM_H5 standard format for representing polar data. BALTRAD is a decentralized network concept, where partners exchange data in their most basic polar (spherical) form and then process them locally with the common toolbox according to local needs. End-to-end treatment of data quality is part of this concept, where the one end is the data leaving the radar site, and the other end is delivering products to end users for their purposes. Dual-polarization data are already being exchanged internationally in real time in this system, and algorithms to process

these and conventional data are available in the toolbox. BALTRAD is registered in the WIS as a Pilot DCPC, and the Swedish BALTRAD node was integrated into the German GISC (and Chinese and Japanese GISCs) in November 2010 at the CBS TECO. EUMETNET OPERA's data centre (Odyssey) and BALTRAD are currently trialing the BALTRAD toolbox in an effort to introduce quality control into Odyssey's production chain, thereby improving the quality of European-wide composite products. Starting in January 2012, the BALTRAD+ project will carry on where BALTRAD left off, introducing new partners (Germany, Lithuania, Norway, and two Danish partners). BALTRAD+ will focus on adding more functionality to the toolbox, transferring its system to X-band systems supporting urban hydrology, and overall operationalization.

3.1.3.2 It was pointed out that the model and arrangements made in relation to BALTRAD should be studied to ascertain the degree of wider international applicability and that the data agreements associated with the project were of paramount importance. BALTRAD has demonstrated that a data exchange and standards framework without strict obligations allows for protection of data ownerships according to the data agreements that are established between participants. The question was raised as to whether the format utilized for data exchange within the BALTRAD framework, ODIM-H5, the OPERA standard using HDF5, might be made an international and WMO-adopted standard for global exchange of radar data.

3.2 Requirements for data and metadata exchange.

3.2.1 Mr Sireci raised the topic of standardization of radar calibration techniques. He noted that Radar Quality Control and Quantitative Precipitation Intercomparison (RQCI) is underway and will provide valuable information on optimal calibration procedures for radar data. The meeting's attention was also drawn to a paper by Baldini and Chandrasekar (Radar calibration procedures and scanning strategies for ground validation" Luca Baldini, CNR -Institute of Atmospheric Sciences and Climate, Rome, Italy, V. Chandrasekar, Colorado State University and Finnish Meteorological Institute, to be presented at the 7th European Conference on Radar in Meteorology and Hydrology in Toulouse (June 2012)) concerning radar calibration procedures and scanning strategies for satellite validation, which may provide valuable input for consideration. It was suggested that once RQCI is complete and the report available, a WMO guidance paper could be prepared on standardized radar calibration, based on a combination of the guidance provided in the two documents.

3.2.2 Mr Goldstraw provided a general presentation on radar data and metadata requirements and the associated issues for data quality and exchange, operational practice and standardization. For high resolution Numerical Weather Prediction (NWP), there is a requirement to provide precipitation rate and volume integrated precipitation at a minimum resolution of 50km with a target resolution of 15km, a maximum delay of 30 minutes with an hourly update cycle. Such a requirement for integrated or quantitative precipitation provision has important implications for continuous operation and the requirement for provision of metadata and quality information for use by data users and application areas. For high resolution NWP, the required resolution is reduced to 1km to 5km with requirement for provision of precipitation variables and radial winds, latency less than 30 minutes and an update cycle better than hourly, however, there would appear to be less requirement for global data exchange with the chief application being input to regional and mesoscale NWP systems.

3.2.3 The data requirements for nowcasting and aeronautical meteorological applications, which support functions such as model divergence detection, flooding and airport forecasting and safety, are similar to those for high resolution NWP but with update cycles of the order of 10 minutes or less.

3.2.4 Mr Goldstraw pointed out that, there is a requirement for the provision and maintenance of both static and dynamic meteorological data, with the latter made available with or within the data message.

3.2.5 It was pointed out that the increasing demands of applications on radar operations was significant as there was a requirement to aim to provide data at or near 100% availability and with low uncertainties. This has implications for operational practices associated with maintenance, calibration and network availability necessitating additional expense and more complex network solutions.

3.3 Operational developments

3.3.1 Development of dual polarization technology.

3.3.1.1 Mr Ice advised the meeting that dual polarization technology is sufficiently mature to support weather forecasting and warning operations as evidenced by the operational deployments underway in a number of countries including Germany, France, and the United States. Some challenges remain. These include areas of calibration and system maintenance as well as operational integration of polarimetric variables. Accurate determination of the radar system bias with respect to differential reflectivity remains the prime systems engineering and maintenance issue. A close second for maintenance issues is estimation of the system noise level, errors of which directly impact system sensitivity and accuracy of the correlation coefficient. Much work remains in development of mature QPE algorithms, including proper attenuation and non-uniform beam filling corrections. Finally, the issues of effects of clutter filtering and overlaid echo contamination remain to be properly addressed. However, early experiences indicate that forecasters can make effective use of the base variables in spite of known shortcomings in bias estimation and effects of undesirable artifacts.

3.3.1.2 Mr Champeaux described a number of existing issues with algorithms for dual polarization radars:

- Attenuation corrections are necessary for X and C bands (and also for S bands): algorithms must be evaluated in operational mode;
- There is a need for very robust calibration / correction procedures;
- There is a need to monitor very carefully the polarimetric indicators in terms of stability and precision;
- The introduction of dual polarization requires a re-think of each module of the QPE processing chain: Polarimetry & Beam Blocking, Polarimetry & VPR Correction, Polarimetry & Quality Codes, Polarimetry & Rain Gauge Adjustment;
- Intelligent mosaicing between S,C and X-bands radars needs to be tested and also between polarimetric and non-polarimetric radars;
- Evaluation of the different relationships is needed using the polarimetric variables (Z_h , Z_{dr} , K_{dp} , $Phidp$,...) in order to produce the best radar QPE; validate of the robustness of these relations in an operational context is also required;
- Evaluation of the different algorithms of hydrometeors discrimination is needed as is the robustness of this discrimination during a long period (particularly for hail where ground observations are available).

3.3.1.3 Mr Buyukbas noted that the latest developments in the polarization technology seem to promise advanced features and better use of weather radars, particularly for the identification of hydrometeors. WMO Members should be informed regarding the usefulness of polarization technology for improving the capacity of the weather radars for more accurate weather forecasting. It was also suggested that some study and quantification of the costs, in terms of updating or replacing radar infrastructure to provide dual polarisation, versus the benefits to monitoring and forecasting skill might be made in order for WMO Members to be able to gauge both the viability and advantages of implementing dual polarization technology in their own radar networks.

3.3.2 Development of quantitative precipitation estimation.

3.3.2.1 Dr Joe provided the meeting with a presentation on RQQI. In updating the meeting on its status, he briefly described the difficulty that had been experienced in communicating the first

announcement of the intercomparison to WMO Members, and agreed to provide an emailed copy of the announcement to all meeting participants, including HMEI.

3.3.2.2 Mr Buyukbas suggested that by considering that the quality concept is a total approach including all process stage from the beginning to the end, accuracy of rain gauges (precipitation gauges) is becoming more important for the quality of the radar products because they have been used as the reference for the validation of radar data. This is why type, features and maintenance procedures of the rain gauges operated by the members who use the rain gauges for radar data validation should be defined and followed more seriously.

3.3.2.3 Concern was expressed that there was insufficient and inadequate traceability for rain gauges and no international reference standard available. The lack of traceability of the rain gauges in turn leads to questions over the ability to reliably reference radar quantitative precipitation data.

3.3.2.4 Mr Li Bai noted that the most commonly used means of obtaining rainfall information are raingauges, satellites and weather radars. He suggested that raingauges are the simplest and most accurate, but representative of only a very limited area around the gauge. At the opposite end of the range, a radar provides spatial information but radar QPE is not as accurate as raingauge measurements. So the relationship between the different systems requires investigation. In particular, the following is required:

- Investigaton of measurement uncertainties errors of each type of measurement (radar, gauge, satellite);
- Quality control of raingauge measurements;
- Data intercomparisons under different weather regimes;
- Techniques for data fusion to improve the quality of QPE.

3.3.3 Application of Doppler velocity.

3.3.3.1 Mr Ice provided a presentation on the use of velocity data in operations, which is fairly mature and, in which the effects of known artifacts such as clutter contamination are well understood and managed in radar operations. A number of enhancements addressing the range velocity ambiguity have been fielded in large networks, especially for the US WSR-88D network. Clutter filtering has been addressed with use of spectral filtering coupled with real time clutter identification. Challenges remain in the use of non uniform sampled systems such as dual PRT or multiple PRF waveform designs. The prime issue here is clutter filtering as modern spectrally based filters require uniform samples. The United States is considering at least two options for staggered PRT methods, which will be operationally tested in the next couple of years. Improvements in velocity azimuth display derived wind profiles have been deployed recently and the WSR-88D program is gaining operational experience with new volume scan strategies employing combinations of phase coded and multiple PRF methods.

3.3.3.2 Mr Mizushima made a presentation to the meeting on Hybrid Multi-PRI dealiasing method, which was developed at Japan Meteorological Agency (JMA) and Meteorological Research Institute (MRI) of JMA. HMP can de-alias folded Doppler velocity in sparsely distributed velocity fields, even if the fields have large random noise and/or large velocity gradients. This method is robust and operationally used at JMA, and the data is used in the assimilation module of the NWP system at JMA.

3.4 Quality control issues.

3.4.1 Inter-comparison of processing algorithms.

3.4.1.1 Dr Joe spoke further about the Radar Quality Control and Quantitative Precipitation Estimation Inter-comparison (RQEI). RQEI is a CIMO sponsored project. The outcome will contribute to the ability to exchange radar data. A kick-off meeting was hosted by the UKMO in

Exeter, UK, in April 2011. Based on the advice of the International Organizing Committee of RQI, the project plan was revised to include considerations of dual-polarization, nowcasting and numerical weather prediction requirements. The change in scope impacts data quality description, the segmentation and sequence of the data processing chain and the workshops that will be required. The project participation modalities include the provision of data sets, processing algorithms, inter-comparison metrics, analysis and recommendations. A pilot project (a small set of cases, a small set of algorithms) was conducted to exercise the critical project concepts: (i) data parameter availability, (ii) metadata availability, (iii) use of short datasets, (iv) testing of the variance metric. It demonstrated that, among others, (a) not many data sets include total reflectivity and therefore it will be difficult to evaluate the impact of the doppler notch filter; (b) short data sets to produce uniform fields are viable and length of data set is dependent on the weather; (c) uniformity is a weak constraint, (d) light precipitation events are preferred and (e) the variance metric is effective but could be improved to have greater sensitivity. At the kick-off meeting, a project team was created that will review the results of the inter-comparison and draft the final results. A new data protocol has been developed, the (live) project plan has been updated and letters of invitation have been issued to WMO members. The project is following the plan set out by the IOC though slightly behind schedule. The project team is scheduled to meet in June 2012 in conjunction with ERAD.

3.4.2 Radar at high altitude sites.

3.4.2.1 Dr Li Bai gave a presentation on radar scanning strategy for high altitude sites in China and the issues associated with negative elevation radar scanning. Dr Li Bai pointed out that China's radar coverage over the eastern coast below 3000m was significantly reduced due to the siting of radars at higher altitudes and the restriction on scanning below zero degree elevation. This leads to reduced ability to monitor some weather systems in the mid to lower troposphere when under surveillance by high altitude radars, of which 27 of more than 160 are sited above 1500m. CMA has been investigating at two sites (ChangLe and LongYan in the coastal area of FuJian province) a new scanning strategy, VCP22, which applies zero and negative elevation angles in order to enhance low level observation from high altitude radar sites. Preliminary results have indicated a 20-30% improvement in observing capability below 6000m using the VCP22 scanning process and leading to demonstrable increases in low-level reflectivities and horizontal range. The benefits of implementation were expected to be improved monitoring capability of severe weather systems such as typhoons and tropical storms. However, the results also indicate some negative effects such as an increase and intensification in ground and wave clutter, which will need further investigation and reduction or removal via appropriate filtering algorithms. Further work will include investigation of:

- Detection ability for mesoscale weather systems below 2000m amsl;
- New quality control algorithms for the removal of wave and ground clutter;
- Improved antenna design to reduce side-lobe effects.

3.4.2.2. The Joint Meeting was informed that some countries, including Canada, had already implemented zero and negative scanning strategies for radar and had resolved both the perceived and real issue of public health and safety through consultation and regulation. It was suggested that the WMO position and guidelines on this issue might be revised and updated taking into account the processes and regulations that have been implemented in countries that use such scanning methods. Members undertook to review relevant documentation and regulatory material and submit it to the ETs for further consideration and input to the review process (see ET-ORS Work Plan, Item 6 in Appendix VI).

3.4.3 Interference issues.

3.4.3.1 Whilst interference issues related to radar systems were mentioned in several papers and presentations, this topic was not dealt with as a specific agenda item.

3.4.4 Standardisation and requirements for calibration and maintenance.

3.4.4.1 Mr Sireci submitted a document on the importance of standardization and requirements for calibration and maintenance of weather radars, which has become an increasingly significant aspect of radar network management as radar data becomes more important as an input to NWP and other application areas such as flood warning and prediction. Regular maintenance and calibration of radar systems is one of the critical aspects of operating a radar network so as to maintain the availability of data at required quality standards. Whilst the issue of calibration of weather radars for maintenance of accurate volumetric rainfall measurements has been a matter of concern for many years, little progress has been made in this area because of weather radar complexity and the diversity of systems and modes of operation. The weather radar survey carried out in 2009 by CIMO revealed that radar operators carry out mainly receiver, transmitter and antenna calibrations only, which are insufficient to provide the level of system calibration required to support and maintain adequate data quality standards. The fifteenth session of the Commission for Instruments and Methods of Observation (CIMO) requested the CIMO Expert Team on Operational Remote Sensing to establish a document on standardization and requirements for calibration and maintenance of weather radars. This document will include maintenance and calibration techniques, procedures and recommendations and training activities to improve NHMS's weather radar calibration and maintenance information and capacity.

4 REMOTE SENSING SYSTEMS ROLE IN THE EVOLUTION OF THE GOS AND THEIR INTEGRATION INTO WIGOS

4.1 WIGOS Concept of Operations and Implementation Plan.

4.1.1 Dr Roger Atkinson gave a presentation on the WMO Integrated Global Observing System (WIGOS) focusing on the Concept of Operations and draft Implementation Plan. The WIGOS concept was initially developed during the 2007 to 2011 period, accompanied by a number of Pilot Projects targeted at specific aspects of WIGOS, to explore the way ahead. With the overall success of the Pilot Projects and early planning, in 2011 Congress decided to implement WIGOS during the coming session with the objective of it becoming fully operational by 2015. Part of the role of the CIMO and CBS ETs during the coming years will be to support this migration to full operations, however their initial role will be to help to ensure clarity of purpose of WIGOS from their respective perspectives and to ensure that the WIGOS concept and planning are communicated more widely via a series of short technical documents describing how each ET will contribute to the success of WIGOS. A specific work plan action item has been included in the work plans of each ET to facilitate this improved understanding.

4.2 Introduction to implications and issues associated with integration of remote sensing systems into WIGOS.

4.2.1 The Chair of ET-SBRSO provided a presentation on what he considered to be some of the interactions between well established existing global observing components as reflected in the WMO Manuals & Guides, Vision for the GOS, EGOS-IP and partner organisation implementation plans and WIGOS. However the true test will come in the development of the WIGOS Implementation Plan. Until these WIGOS plans are published the engagement of the CIMO & CBS ETs will be limited to providing guidance and support on specific issues rather than contributing to the successful delivery of the WIGOS Vision.

4.3 Evolution of the Global Observing System

4.3.1 The Joint Meeting was reminded that part of the work programme of each ET is to assist the ET-EGOS in relation to the activities associated with the evolution of the Global Observing Systems and their contribution to the delivery of WIGOS. One of the work tasks given to ET-SBRSO is: *In collaboration with ET-EGOS, assess the contribution of SBRSO observing systems to meeting the user requirements for observations for all application areas represented by WMO and WMO-sponsored programmes.* The Joint Meeting was addressed on this subject by Mr Etienne Charpentier from the Secretariat who provided a brief presentation on processes associated with

the Rolling Review of Requirements for the GOS that is undertaken and managed by CBS/ET-EGOS. The Joint Meeting determined that this aspect of the meeting agenda is addressed specifically by each ET as part of its workplan (Annexes IV and V)

4.4 Addressing the Vision for the GOS in 2025 and review of the draft Implementation Plan for Evolution of Global Observing Systems

4.4.1 Dr Atkinson advised the meeting of the development of the draft Implementation Plan for the Evolution of the GOS (EGOS-IP) and the request from CBS to Chairs of CBS and CIMO ETs to review the document. He noted that the draft Implementation Plan for the Evolution of the Global Observing Systems (EGOS-IP) contains a series of actions that if undertaken successfully will, along with the continuation of many existing activities, enable the Vision for the GOS in 2025 to be realized. However the EGOS-IP is in draft form and Dr Atkinson advised the meeting that ET-SBRSO and ET-ORS have been asked to review draft Version 10 and provide feedback to ET-EGOS to ensure the action plan is technically realistic and to identify any apparent gaps. The meeting made a preliminary examination of the document during the breakout group session, and an annotated version of the document with comments from the Expert Teams was forwarded through the WMO Secretariat to the Chair of CBS ET-EGOS, Mr John Eyre. The meeting participants were requested to forward any additional comments or suggestions via the WMO Secretariat after the meeting.

5 RADAR WIND PROFILERS

5.1 International and regional network status.

5.1.1 Dr Volker Lehmann, Germany submitted a document and also made a presentation outlining the status, issues and the principles behind the deployment of the European wind profiler network, CWINDE. It was pointed out that, in contrast to other national programmes, the European wind profiler network is made up of a number of national sub-networks, which makes it a diverse observing network with great variation in hardware, manufacturers, processing systems, configurations and other parameters. The network is managed by the E-WINPROF Programme which has various technical objectives including: classification of systems, operation of a network hub, network monitoring, provision of technical expertise and data management and exchange.

5.1.2 Dr Dominique Ruffieux summarized the procedures undertaken within CWINDE for wind profiler technical maintenance. A wiki page was developed with information on [1\) Frequency management](#), [2\) System setup: Sampling and processing](#), [3\) Maintenance](#), [4\) Data handling](#), and [5\) Siting](#) (http://wiki.eg-climet.org/index.php?title=RWP_Practical_aspects).

5.1.3 Whilst the CWINDE network currently has no common deployment principles due to the fact that the planning strategies are based on national requirements and considerations, Dr Lehmann pointed out that the following points should always be evaluated in network planning: the ambient electro-magnetic frequency situation at the site (potential sources of RF interference) and related issues including licensing constraints (sharing with other services); potential ground clutter targets in the vicinity of the site; as well as infrastructure requirements of the profiler hardware.

5.1.4 Mr Amaury Carruzo made a presentation on the work that has been completed to date by ET-SBRSO towards developing a questionnaire and survey of Members on surface-based remotely-sensed systems implementation status including radar wind profilers (RWP). Mr Carruzo highlighted that several decisions were required to be made by the ETs in order to define and finalise the strategy to be taken, in particular, whether to conduct a more general survey on several systems or to concentrate on one particular system, e.g. WPR, per survey. A plan for proceeding was proposed for consideration.

5.1.5 The Joint Meeting discussed the need to undertake a questionnaire and survey on RWP that would incorporate both a determination of the status of global deployment of RWP and also be

the starting point for the establishment and maintenance of a global RWP metadata set. This exercise would be carried out under the work programme of the ET-SBR SO in consultation and collaboration with ET-ORS, taking heed of the lessons learned and the successful processes conducted in the establishment of the WMO Radar Database (WRD) that was developed and is hosted by Turkey. The matter of the RWP survey and questionnaire and the strategy to be taken was further addressed as one of the topics considered within the breakout sessions (see Annex III, Breakout Session 4) conducted during the Joint Meeting and was also considered within the context of the ET-SBR SO work programme (see Annex IV).

5.2 International data exchange

5.2.1 The Joint Meeting discussed the fact that there were two different BUFR formats in use by Members for the exchange of WPR data on the GTS and that this could be standardized into a single universal BUFR template.

5.3 Status of Operational Guidance and Regulatory Material.

5.3.1 Mr Yoshihisa Kimata submitted a document and made a presentation that contained a submission by JMA on draft guidance material for radar wind profilers (RWP), which is under the procedure to be published as an IOM report. The guidance is based on the requirements for installation, quality management and the operation of the Wind Profiler Network of JMA (WINDAS). These contents are commonly related to other Wind Profilers and will be a useful reference to establish a new Wind Profiler Network.

5.4 Quality and interference issues

5.4.1 Dr Volker Lehmann submitted a document and made a presentation to the Joint Meeting on the quality issues and methods of mitigation employed for the European wind profiler network, CWINDE. Dr Lehmann pointed out that, whilst RWP relied on backscatter from inhomogeneities in the refractive index of clear air and also from particulates (e.g. hydrometeors) for measuring the vertical profile of the horizontal wind components, these systems, like all radars, require some efforts to deal with clutter echoes and interfering RF signals from other transmitters. Both clutter and RF interference can significantly affect data quality if no or insufficient mitigation measures are employed. Practically most relevant are echoes from airborne objects (birds and airplanes) and side-lobe backscatter from ground clutter. Other, rather exotic effects, like scattering from electrical charges (e.g. plasma in lightning) are of lesser importance.

5.4.2 A particular issue of concern for RWP is that of the echoes created by side-lobe scattering from wind farm installations (wind turbines), which show a very complex signal structure due to rotor movement that can not easily be filtered. This is likely to become an increasing concern due to the increasing investment in renewable energy which NMHSs need to be aware of and mitigate for. Whilst it is possible that signal processing systems and physical system improvements could provide some mitigation against interference from wind turbines, it is clearly best to avoid co-location if at all possible. Whilst the clearance requirements for WPR from wind farm turbines are yet to be fully verified and established, the European CWINDE Programme is further investigating this problem, with initial research by DWD and experience in France suggesting a separation in the range of 5–10km. It was suggested that WMO might work within the CIMO framework to formulate a statement of guidance for Members in relation to both avoidance of co-location and mitigation of the effects of interference from wind farm installations.

5.4.3 The issue of radio frequency (RF) allocation and availability is an ongoing concern for WPR networks. It was stressed that Members need to continue to be vigilant in relation to commercial and government competition for RF spectrum that effect meteorological observing systems and to be active in national and international processes and organizations that allocate and license the radio frequency spectrum.

5.4.4 Mr Yoshihisa Kimata submitted a document and made a presentation on the currently analyzed impact of wind turbines on weather radar observation in the case of the JMA weather radar network. The JMA uses the following two type of data measures; “Compositing PPIs at several elevation angles (Quasi-CAPPI)” and a “Clutter Map” applied on JMA radar data processing, and these measures are effectively functioning to eliminate the interference of Wind Turbine Clutter from the radar product. Although further research and review would be needed to make clear how Wind Turbine Clutter affects other processing in JMA (e.g., meso-cyclone detection), JMA does not have serious problems in the practical use of composite radar data and QPE products so far.

6 LIGHTNING DETECTION

6.1 It was acknowledged by the Joint Meeting that none of the participants at the meeting had members with sufficient expertise or experience with lightning detection to speak on the subject and there were no documents submitted or issues raised in relation to these systems, so this detailed discussion of this topic was deferred.

7 OTHER REMOTE SENSING SYSTEMS

7.1 Dr Werner Thomas provided a presentation on the use of Light Detection and Ranging systems (LIDARs) and ceilometers for volcanic ash monitoring and detection. Dr Thomas explained that the use of ceilometers operating in the near-infrared spectrum was complicated by the fact that light is scattered by all types of atmospheric particles and the signatures differ only with respect to the geometric structure of the particles and the intensity of the backscattered signal.

7.2 Whilst ceilometers are effectively a simple LIDAR system usually configured for the limited purpose of detecting cloud-base levels, many of these systems are potentially capable of providing information on vertical profiles of an atmospheric particulate such as volcanic ash. However, if an aerosol extinction profile and, further, an estimation of the mass extinction coefficient is to be derived from the measurements, the critical issue of correct calibration of the instruments must be resolved. Standard methods such as the “molecular calibration” applied for LIDAR typically fail due to the wavelength and the low power of the lasers used in ceilometers, however it is possible to calibrate such instruments by using either additional measurements (e.g., from LIDARs or sun-photometers nearby) or to perform a self-calibration technique, provided that the instrumental constant is known, so as to derive an aerosol retrieval functionality that might be utilized, for example, in volcanic ash monitoring.

7.3 In the wake of the serious and costly disruption to aviation services and operations due to volcanic events in recent years, an assessment of the viability of this mode of operation might be given consideration by WMO Members that operate candidate ceilometer networks. A remaining problem will be the assumption of the extinction-to-backscatter ratio (also called LIDAR ratio, LR), which is needed to derive the extinction coefficient from the measured backscatter coefficient. The extinction-to-backscatter ratio differs markedly for different aerosol types, making it necessary to make assumptions on the prevailing aerosol type (e.g., ash, dust, smoke, urban, background) in the atmosphere.

7.4 A survey of existing ceilometers and LIDAR systems in mostly Europe (available as google earth animation) revealed about more than 1000 instruments (950 ceilometers, ~100 LIDAR, as of February 1st 2012) operated by mainly NMHSs and the research community. For about half of the instruments the operators keep the instrumental raw data which is a prerequisite for the retrieval of aerosol parameters. Whilst there are around a dozen different ceilometer types currently operated in Europe, the vast majority (> 90%) of installed systems are composed of five instruments only. At the European level there is work in progress concerning the harmonization of data and products as well as quality assurance policies and data exchange between NMHSs. A missing element is an assessment of existing sounding capacities of different instrument types with respect to different atmospheric parameters (cloud recognition in different atmospheric levels, cloud base height,

planetary boundary height, aerosol parameters). WMO Members are invited to consider a corresponding inter-comparison of state-of-the art instruments and retrieval algorithms.

8 PLANNING AND REPORTING

8.1 Review of the meeting and highlighting of key issues: Breakout Sessions

8.1.1 Leading into revision of the work programme of each ET, which would be considered by each ET separately, the Joint Meeting identified a range of key topics to discuss within breakout groups, and then report back to the plenary group. The topics of these sessions were:

1. WMO RADAR Database management protocol (see Annex II).
2. Joint Meeting input to and review of EGOS-IP (separately provided to the Chair of ET-EGOS).
3. Expert Team input to the CBS Rolling Review of Requirements.
4. Requirements for surface-based remote sensing metadata (see Annex III).
5. Data formats and codes for international exchange of RADAR data (see Annex III).
6. Statement on interference issues associated with meteorological RADAR systems.

8.2 ET Work Plan Update

8.2.1. The revised work plan of CBS ET-SBRSO in the lead up to ICT-IOS is provided as Annex IV.

8.2.2 The updated work plan of CBS ET-ORS is provided as Annex V.

8.2.3 Proposal for Work Plan 2013-2016 for CBS ET-SBRSO

8.2.3.1 The proposed work plan for 2013-2016 to be submitted to ICT-IOS by the Chair of ET-SBRSO was discussed by the ET within the context of the revised work plan developed during the session. It was determined that the Chair of ET-SBRSO would prepare the proposed work plan to be submitted in consultation with the ET, based on the outcomes of the work completed over the coming six months and taking into account those additional potential tasks that were identified.

8.3 Review of ET ToRs

8.3.1 A brief review of the ToR for CIMO ET-ORS led to the conclusion that while the ET was initially formed to deal with all types of surface-based remote-sensing observations, the ToR precluded activity related to anything other than weather radars, wind profilers and lightning detection systems, yet new technologies such as lidars are approaching operational implementation. It was agreed that this issue should be raised by the Chair of ET-ORS with the Chair of OPAG-RSNT for possible consideration by CIMO Management Group at MG-10.

8.3.2 The ToR for ET-SBRSO were not reviewed during the session. It was decided that the ToR would be reviewed by the Chair of ET-SBRSO in consultation with the ET Members in the lead up to ICT-IOS.

8.5 CBS-SBRSO report to OPAG-IOS (achievements, issues, recommendations)

8.5.1 The various achievements, issues and recommendations to be made in the report to the OPAG-IOS were discussed by the ET whilst reviewing and revising the work program and will be taken into account when the Chair of the ET compiles the report in consultation with the ET Members in May 2012.

9 OTHER BUSINESS

No other business was raised for discussion.

10 CLOSURE OF THE SESSION

The session was closed on 09 December 2011 at 1200h.

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Principles of the Operation and Maintenance of the Web-based WMO Radar Database (WRD) operated by Turkish State Meteorological Service (TSMS) on behalf of WMO

1. Operation & Maintenance of RDB

- a. TSMS ensures uninterrupted operation of RDB (7/24) on the TSMD website <http://wrd.dmi.gov.tr>
- b. Information is provided on the main page that the WRD is operated by TSMS on behalf of WMO
- c. WRD is accessible from a link placed on WMO World Weather Watch website (<http://www.wmo.int/pages/prog/www/ois/ois-home.html>)
- d. Planned interruptions is communicated beforehand to WMO (mabayasekara@wmo.int or dlockett@wmo.int)
- e. Maintenance is performed by TSMS with a view of 7/24 operation

2. Upgrades of WRD

- a. Software upgrades (visualization, search, access, etc,) are performed based on recommendation of the relevant CBS and CIMO ETs and by the approval of the WMO Secretariat (dlockett@wmo.int)
- b. Upgrades of the WRD (structure, fields, etc.) are performed based on recommendation of the relevant CBS and CIMO ETs and by the approval of the WMO Secretariat (dlockett@wmo.int)

3. Updates of data fields in WRD

- a. TSMS ensures interactive access to RDB to all WMO Members to update their respective metadata
- b. Access to perform updates of the metadata is granted only to Members' Focal Points that are authorized by WMO (mabayasekara@wmo.int)
- c. Updates provided by Members on hard copies have to be authorized by WMO (mabayasekara@wmo.int) before it is performed by TSMS system operator
- d. TSMS provides weekly information on updates performed by Members on the WRD website
- e. TSMS provides access to WMO authorized person(s) (mabayasekara@wmo.int and dlockett@wmo.int) to verify and update any metadata fields
- f. Regular updates may be provided through a link to OPERA Radar Database

4. Export of WRD metadata

- a. Any metadata submitted WRD become public domain and this information should be clearly stated on the main page of the WRD
- b. TSMS provides capability to export metadata (MS Excel sheets, XML) to other WMO DBs, such as Country Profile DB
- c. TSMS provides capability to export (MS Excel sheets, XML) basic metadata (name, band, type of radar and coordinates) to any third party
- d. TSMS provides capability to export expanded metadata (other than basic) to any third party only after prior approval of the WMO Secretariat (dlockett@wmo.int)

REPORTS FROM BREAKOUT SESSIONS

Breakout Session 4 Requirements for surface-based remote sensing metadata.

This breakout session focused on answering the questions and issues relating to the most appropriate strategy for commencing the process of requesting and gathering the required metadata for surface-based remote sensing systems and networks in support of CBS implementation of WIGOS.

The key outcomes from this session were the following:

- The breakout group considered that any survey and questionnaire of members should be undertaken on a system-by-system basis and there should not be an attempt to undertake a single, all-inclusive survey of all remote sensing systems;
- Before activating the survey and questionnaire of WMO Members, a letter should be sent to Permanent Representatives (PRs) to request nomination of an expert person (focal point) for contact. This focal point should be the recipient of the questionnaire;
- The questionnaire should ask what the experience with the remote sensing system is and identify the members who intend to have an operational network in the future (i.e. without specific definition of "operational network");
- The aim should be to develop an online questionnaire (website) and, for those members with insufficient technology or on request, allow for provision of a copy of the survey in text format (MS Word).

Breakout Session 5 Data formats and codes for international exchange of RADAR data.

Attendees: Paul Joe, Volker Lehman, Dominique Ruffieux, Kimata, Mikka Kurri, Jean-Louis Champeaux

The objective of the break out section was to discuss the steps needed to progress the creation and adoption of radar and wind profiler data exchange formats. OPERA has created a new data model and implemented in two data formats - HDF5 and BUFR. At the Namibia CBS meeting, The OPERA data model plus HDF5 implementation is known as ODIM_H5. WMO has agreed to extend their exchange format to more modern formats such as netCDF, HDF5, among others. Outside of Europe where the prototype OPERA data hub is being developed, widespread exchange of radar data has been limited. Therefore, it is timely for WMO to promote a reference or standard radar data exchange format that would consider the wider variety of radar volumes being created, as well as, additional data quality concept. Note that in the past, it is radar products have been exchanged.

ECMWF will be assimilating Stae IV products from the WSR88D network in the U.S. With the operationalization of high resolution models, there will be a need for Level II data. These are not quite in wide spread deployment and so there is still some time to promote a WMO reference for radar data exchange.

With its use in NWP and small data volumes, WP is already being widely exchanged. Unfortunately, while the data format is often the same (BUFR), there are several implementations of the BUFR. While even some use the same data model, usage of descriptors has not been consistent even when using the same data model. From an implementation perspective, the descriptors were ambiguous or mis-used in some cases.

A clear distinction should be noted that the discussion is about an "exchange" format. This does not imply nor impose any restrictions on the native format of the data which may contain more information, nor on any other internal data formats, nor on communications modalities. Specifically, related to the latter point, some radar systems transmit rays of moment data, packets of rays or single sweeps of data from the data processor to the product processor. This topic does not concern itself with those requirements at this time though extensions can be contemplated if WMO members indicate such a requirement. It is envisioned that three dimensional volume scans are "exchanged". The PPI is considered a degenerate case of the 3D volume and that this also considers partial volumes that may be inadvertently or purposefully collected.

To be comprehensive, the radar data model should include concepts of scalar, vector or multi-parameter data; multi-dimensional data such as point, line, volumes and even continuous time volumes. It should also encompass concepts of data quality (overall, individual values) or uncertainty estimates. Data quality and uncertainty concepts need development. For example, consider describing the quality of a bin of multi-parameter radar (Z, vr, sigma, ZDR, rohi hv, phi dp, etc) data. Should it be a single data quality index for the entire bin (valid/non valid), or for each parameter in the bin in a binary way (good/bad) or in some quantitative error value (quality index of 0.8). Or should the overall quality be qualitatively indicated by knowledge of the signal and data processing scheme (e.g., zero notched filtered with reflectivity thresholding of 12 dBZ). In the RQQI project, the processing change is described as a series of steps, the data quality could coarsely be associated with the processing step (i.e., stage 2a, 2b, 2c). In addition, it could be described also by maturity level (e.g. climatologically biased adjusted, rain-gauge adjusted hourly, etc).

In the discussion of radar data, it was noted that there may an inadequate description of the exchange of traditional and new radar products on a global basis. OPERA has been exchanging radar products for many years. These consist of a few low level products in degraded quantization levels or as images or pseudo images. However, it can be anticipated that regional composites may be required to be exchanged.

There is a commonality between wind profiler and weather radar in the exchange of wind profiles. In both cases, they are inferred products from the base data. It would be beneficial if they shared the same format.

In the discussion of managing the variety of wind profiler formats. It appears that the recommended format by WMO (i.e. CWINDE) has not been broadly adopted. It may be because the ready availability of software libraries (e.g. OPERA). Regardless of the variety of implementations, it would still be valuable for WMO to promote standard data models and implementation formats. Focusing on the minimum set of meta data may be possible when revisiting this issue.

While BUFR is the current WMO data format for a wide variety of data and while it is quite flexible and expandable, it is considered unwieldy - both in terms of making changes, the global-local table issues, the reliance on libraries, the inability to update or redefine descriptors, etc. BUFR was also an efficient transmission format where data was specified at the bit level. With data compression and encryption technologies, the bit level programming of BUFR is no longer a requirement.

Actions:

1. Weather Radar: A white paper proposal should be formulated for discussion within the CIMO-ET and prepared by radar experts. This should include experienced data model experts. Major radar organizations or nations such as OPERA, U.S., China, Japan, Australia, Canada should be engaged and consulted. Recommendations should then be formulated for CBS/IPET-DRC. Attendees + Daniel Michelson.
2. Wind Profile: A small team should be formed to review the situation and identify and articulate the issues and how to suggest a way forward.

3. Since there is some commonality, mutual consultation between interested Members is needed.

ET-SBR SO 2nd Session, DECEMBER 2011, REVISED WORK PLAN

No.	Task	Deliverable/Activity	Due	Responsible	Status	Comment
1	To contribute to the development and implementation of concept of WIGOS and provide relevant advice and support to the chairperson of ICT-IOS.	<p>Address relevant items of WIGOS Implementation Activities. Agreed by EC-WG/WIGOS-WIS-2.</p> <p>2012 Work Plan</p> <p>Task 1</p> <ol style="list-style-type: none"> 1. Review WIGOS-IP, produce a Commentary Document re. Implications for ET, circulate to ET. [Chair, 2 days, Feb 2012] 2. Review of by ET members and provide feedback to Chair [ET Members, 1 day, Apr 2012] 3. Compilation of report to ICT-IOS [Chair, 1 day, May 2012] <p>Task 2</p> <ol style="list-style-type: none"> 1. Identify candidate systems operated by 3rd party organizations that provide data to NMHSs and points of contact [, 2 days, Feb 2012]. 2. Identify NMHSs that have established agreements for data exchange with particular organizations and obtain copies or information regarding the arrangements and how they operate. [, 2 days, Jun 2012] 3. Review agreements to identify common, vital, desirable elements or aspects that can be more generally applied by other NMHSs. [, 4 days, Oct 2012] 4. Generate guidance document, review, finalise for WIGOS Manual. [, 2 days, Feb 2013] 	<p>Task 1: May 2012</p> <p>Task 2: Feb 2013</p>	<p>Stewart Goldstraw</p> <p>(Seth Gutman)</p>		

2	<p>Assess the new potential capabilities of SBRS observing systems, in terms of their operational implementation.</p>	<p>Review available studies and document provide CIMO with a view of advising Members of their operational implementation.</p> <p>2012 Work Plan</p> <ol style="list-style-type: none"> 1. Obtain information from CIMO as to the status of developing remote-sensing, surface-based technology with regard to potential for candidacy for operational implementation: <ul style="list-style-type: none"> • Attend conferences (AMS, EMS); • Attend TECO; • Review IOMs (http://www.wmo.int/pages/prog/www/IMOP/publications-IOM-series.html). <p>[ET?, 10 days (per year), Mar 2012]</p> <ol style="list-style-type: none"> 2. Compile report, ET review, finalise, provide to CBS. [Ercan + ET , 2 days, Apr 2012] <p>Potential Future Task for CBS Develop a definition of what constitutes an “operational” system. (Practical considerations and requirements to be met before a system can be considered ready for operational implementation.)</p>	April 2012	<p>Russell Cook (Ercan Büyükbas)</p>		
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3	Assess the status of implementation of and plans for SBRS observing systems by WMO Members.	<p>Review and document the status and plans of WMO Members.</p> <p>2012 Work Plan</p> <ol style="list-style-type: none"> 1. Finalise draft WPR survey. [Amaury, 2 days, Feb 2012] 2. Draft, review, finalise and send letter to PRs requesting Focal Points for (each) system survey completion. [Secretariat, 1 day, Feb 2012] 3. Develop and implement web-based survey method. [Amaury, 5 days, Apr 2012] 4. Review WPR survey questionnaire content. [ET, 1 day, Mar 2012] 5. Test survey. [ET, 1 day, Apr 2012] 6. Finalise WPR survey. [Amaury, 1 day, May 2012] 7. Launch survey (Email to FPs) [Amaury, 1 day, Jun 2012] 8. 1st analysis of survey results [Amaury, 5 days, Sep 2012] <p>Potential Future Task</p> <ol style="list-style-type: none"> 1. Develop metadata DB for WPR. 2. Develop draft surveys for GNSS, M-W Radiometers, LIDAR [ET, 3 days, Dec 2012] <p>Issue</p> <p>Approach Turkey re possibility of expansion of WMO RADAR DB to house WPR metadata.</p>	Sep 2012	<p>Amaury Caruzzo</p> <p>(Ercan Büyükbas & Stuart Goldstraw)</p>		
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4	<p>Document the above capabilities and implementation status/plans, through updates to the WMO/ CEOS database of observing system capabilities.</p>	<p>Represent the information documented above in terms of appropriate updates and additional entries within the WMO/ CEOS database of observing system capabilities.</p> <p>2012 Work Plan</p> <ol style="list-style-type: none"> 1. Develop a plan and a process for undertaking the task of updating the capabilities for ORS systems including: <ul style="list-style-type: none"> • Systems: W-RADAR, WPR, Lightning, GNSS • List of data parameters for each system • List of capability parameters (uncertainty, v. res., h. res., etc) • Processes for gathering capability metadata. <p>[Hiro Secretariat, 10 days, Apr 2012]</p> 2. Consult with Russell Stringer and Etienne Charpentier re parameters for RADAR and for capabilities. 3. Produce a proposal and methodology document for undertaking the capabilities definition process [Hiro, , May 2012]. <p>Potential Future Tasks</p> <p>Undertake the defining of capabilities for W-RADAR.</p>	May 2012	Hirofumi Mizushima		
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5	In collaboration with ET-EGOS, assess the contribution of SBRS observing systems to meeting the user requirements for observations for all application areas represented by WMO and WMO-sponsored programmes.	<p>Review the Statements of Guidance for accuracy and completeness in relation to SBRS observing systems, referring to user requirements as captured by the WMO/ CEOS database as necessary.</p> <p>2012 Work Plan</p> <ol style="list-style-type: none"> 1. For the recently-updated SoGs (2011+) review each with respect to ORS systems; [Dominique, 4 days, Apr 2012] 2. Attend ET-EGOS session (May 2012) and provide/present feedback on reviewed SoGs and agree on future interactions between the ETs on this activity. [Dominique, 4 days, May 2012] 	May 2012	Dominique Ruffieux		
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6	<p>Make recommendations on how the integration of such observing systems within the GOS might be taken forward.</p>	<p>Review the Implementation Plan for the Evolution of the GOS and propose changes and additions for SBRS observing systems.</p> <p>2012 Work Plan</p> <ol style="list-style-type: none"> 1. ET to review Joint Meeting input to review process (email from Roger Atkinson) and provide feedback (cc to ET). [ET, 1 day, Dec 2011] <p>Potential Future Work Monitoring and Assessment of progress on implementation of EGOS-IP in relation to ORS systems.</p>	Dec 2011	ET		
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7	Assess the systems for collection and distribution of data from SBRS observing systems, and make appropriate recommendations.	<p>Review systems for collection and global distribution of SBRS observational data and make recommendations for their improvement in response to stated user requirements.</p> <p>2012 Work Plan</p> <ol style="list-style-type: none"> 1. Contact centres that are currently operating data and product exchange programs of WPR and obtain information on the infrastructure, processes and arrangements, issues, advantages, disadvantages, agreements, comms systems, data formats, etc that facilitate their operation: <ul style="list-style-type: none"> • USA • Europe • Canada • Japan <p>[Volker, 2 days , Feb 2012]</p> <ol style="list-style-type: none"> 2. Contact BALTRAD regarding their RADAR data exchange processes. [Chair, 1 day, Feb 2012] 3. Produce a draft report summarizing the various studied WPR and RADAR data and product exchange programs in operation and make recommendations and proposals relating to developing guidelines. [Volker, 2 days, Mar 2012] 4. Review and refine report. [ET, 1 day, Apr 2012] 5. Provide report to ICT-IOS. [Jun 2012] 	Jun 2012	Volker Lehmann		
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8	<p>Monitor the status of operational networks of SBRS observing systems and provide technical advice on such systems, including both operational and R&D systems, to WMO Members and RAs.</p>	<p>Report on the operational networks and on key developments in SBRS observing systems to ICT-IOS, drawing attention to actions required by CBS to promote the development of such systems within the WIGOS. Respond to requests for advice on SBRS observing systems from other CBS entities, as necessary</p> <p>2012 Work Plan</p> <ol style="list-style-type: none"> 1. Work Plan review [Chair -> ET, 1 day, Mar 2012] 2. Work Plan review [Chair -> ET, 1 day, May 2012] 3. Chair compile report to ICT-IOS [Chair, 1 day, May 2012] 4. Recommendations on ToR and Work Plan for next CBS I-S Session to be compiled [Chair, 4 days, May 2012] 	May 2012	Stuart Goldstraw		
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WORKPLAN
B1: CIMO Expert Team on Operational Remote-Sensing
2011-2014

No.	Task description	Person responsible (lead in bold)	Action	Deliverable	Deadline for deliv.	Status [%]	Comments
1.	Guidance on the operation of wind profilers	V. Lehmann Y. Kimata R. Ice Li Bai	<p>1. Investigate: WPR type selection; configuration of the Radar Site (RASS, AWS, microwave radiometer and GPS/MET); deployment principles of the Site Network; site Location Requirement (based on the surrounding site environment and electro-magnetic requirements etc.)</p> <p>2. Investigate the impact of wind turbines on wind profilers in a manner similar to the weather radar paper. [In collaboration with Dominique Ruffieux (CBS ET-SBR SO)]</p> <p>3. Investigate quality problems which have been encountered in wind profiler data application in numerical weather prediction, discuss the new quality control methods for removal of bird and insect echo, ground clutter and electromagnetic interference etc.</p> <p>4. Liaise with CBS on</p>	<p>1. Document on the deployment principles of wind profiler network and site selection principles (V. Lehmann, R. Ice, , Y. Kimata)</p> <p>2. Guidance statement on the siting of wind profilers with respect to wind turbines (V. Lehmann lead, Y. Kimata)</p> <p>3. Document on quality problems of wind profiler and operational signal and data processing schemes for wind profiler (V. Lehmann, Y. Kimata, R. Ice)</p> <p>4. Contact with CBS</p>	<p>First draft Dec 2012</p> <p>Final Rep Dec 2013</p> <p>Dec. 2012</p> <p>First draft Dec 2012</p> <p>Final Rep Dec 2013</p> <p>Dec.</p>	<p>In progress</p> <p>In progress</p> <p>In Progress</p> <p>Done, Ongoing</p>	<p>Technical reqs and general network reqs, what should be there. etc. R. Ice determine contacts etc. Statement of general principles related to the instruments.</p> <p>Issue: lack of studies on effects on wind profilers - contact D. Ruffieux, connect with radar if appropriate (P. Joe)</p>

No.	Task description	Person responsible (lead in bold)	Action	Deliverable	Deadline for deliv.	Status [%]	Comments
			implementation of wind profiler networks	ET-SBR SO	2011		Caruzzo questionnaire
2.	Data exchange of weather radar	P. Joe R. Ice O. Sireci	<ol style="list-style-type: none"> 1. Develop a clear definition of weather radar level II data for data exchange over the GTS to ensure consistent level of data processing before the exchange on the GTS. (P. Joe lead, D. Michelson. M. Kitchen) 2. Work closely with Turkish Meteorological Service in the design and implementation of the weather radar database. 3. Progress RADMON. 	<ol style="list-style-type: none"> 1. Document on the definition of weather radar level II data 2. Operational radar metadata database. 3. To be arranged 	Draft by Jun 2012 Final Rep Apr 2014	In progress Nearing completion. Expected delivery end 2011.	Take into consideration the OPERA format definitions: http://www.knmi.nl/opera/

No.	Task description	Person responsible (lead in bold)	Action	Deliverable	Deadline for deliv.	Status [%]	Comments
3.	Investigation into weather radar data quality control methods	P. Joe D. Michelson	<ol style="list-style-type: none"> 1. Define methods and procedures for RQQI, focusing on radar decoding software, metadata and measurement uncertainty 2. Conduct intercomparison 3. Publish results of the analysis 	<ol style="list-style-type: none"> 1. Document on inter-comparison rules 2. Report of IOC Mtg 3.1 IOM report on the results of the intercomparison 3.2 Update CIMO Guide Chapter on weather radar 	IOC met in April 2011 Q1-2 2012 June 2012 (TECO/ MG-10) 2013	done done In progress	Meeting report done, project plan updated, Invitation letter issued. Dec 15 deadline. Intercomparison to follow early 2012.
4.	Identify the tools and techniques to evaluate the accuracy of weather radar, wind profilers and lightning detection systems	Li Bai O. Sireci V Lehmann, J Haapalainen	<ol style="list-style-type: none"> 1. Identify issues related to conformity and traceability. <ol style="list-style-type: none"> a) radar is being handled under item 8 (O. Sireci), b) wind profiler (V. Lehmann), c) lightning (J Haapalainen) 	<ol style="list-style-type: none"> 1.1 Collect information 1.2 Report on issues identified 	Sep 2012 Draft in 2013 Final Rep Apr 2014	In progress	First step to ensure moments are correct, reflectivity calibration e.g., traceability, in US for example is NIST. Note issue of accuracy of radar QPE. Lightning will present difficulties.

5.	Designing evaluation method for the performance of lightning detection systems	J. Haapalainen R. Ice P. Joe	<ol style="list-style-type: none"> Review proposed modifications to the lightning detection chapter of the CIMO Guide. Design an evaluation method for the performance of lightning detection systems. 	<ol style="list-style-type: none"> Updated chapter of the CIMO Guide <ol style="list-style-type: none"> Document on the evaluation method Update CIMO Guide if appropriate 	<p>June 2012</p> <p>2013</p> <p>April 2014</p>	<p>In progress</p> <p>In progress</p>	<p>Document now being revised by Vladimir Rakov (U Florida). Will be reviewed by previous reviewers on completion.</p> <p>The method should be able to evaluate the efficiency and accuracy of lightning location, and as a scoring method. R. Ice will contact NSSP, WDT etc for input. Perhaps use multiple systems as a general principle for item 2? Contact Steve Goodman TRMM program?</p>
6.	Improvement of the weather radar performance in mountain regions	Li Bai O. Sireci P. Joe Y. Kimata	<ol style="list-style-type: none"> Investigate observation modes of mountain radars using low or negative elevation scanning strategies. 	<ol style="list-style-type: none"> Report on strategies for improving low level performance and enhancing vertical resolution of mountain radars 	<p>Draft Rep Sep 2012</p> <p>Final Rep Apr 2014</p>	<p>In progress</p>	<p>Include consideration of contributions from EC, JMA, NOAA, MeteoFrance, TSMS.</p>
7.	Investigation into dual polarization technology on weather radar	R. Ice J-L. Champeaux	<ol style="list-style-type: none"> Evaluate the realizable benefits of polarization technology on weather radar 	<ol style="list-style-type: none"> Report on benefits of polarization technology 	<p>Draft Rep Sep 2012</p> <p>Final Rep Apr 2014</p>	<p>In progress</p>	
8.	Investigate best practices for ensuring uniform performance of weather radars (calibration)	O. Sireci R. Ice	<ol style="list-style-type: none"> Investigation on the weather radar automatic check methods for sustainable performance 	<ol style="list-style-type: none"> IOM Report on the best practices 	<p>Dec. 2013</p>	<p>In progress</p>	<p>Hardware, reflectivity, ZDR etc</p> <p>Make contact with other users to develop consensus of radar community</p>
9.	Investigate the relationship between different precipitation observation systems	Li Bai R. Ice P. Joe J-L Champeaux Y. Kimata	<ol style="list-style-type: none"> Evaluate issues related to comparing and adjusting precipitation observations from weather radars with satellites and rain gauges observations 	<ol style="list-style-type: none"> Report on issues identified 	<p>Draft Rep Sep 2012</p> <p>Final Rep Apr 2014</p>	<p>In progress</p>	
10.	Contribute to the	Li Bai	<ol style="list-style-type: none"> Address relevant items of 	<ol style="list-style-type: none"> ET Chair to provide 	<p>End 2011</p>		<p>Strategy approved by Cg-XVI</p>

	implementation of WIGOS and provide relevant advice and support to the CIMO-MG	All	WIGOS Implementation	<p>comments to Chair CBS ET-EGOS on EGOS-IP. (Dec 19 2011)</p> <p>1.2 Sec to forward WIGOS-IP to ET members.</p> <p>1.3 ET Members to provide suggestions on how ET can assist with WIGOS Implementation.</p> <p>Proposal for consideration for WIGOS</p>	<p>Once available</p> <p>Sep 2012</p>		for WIGOS IP
11.	Implementation of 2nd version of weather radar metadata database web page	O. Sireci Plus CIMO ET	Turkish State Meteorological Service will continue with the design and implementation of the 2nd version weather radar database.	Version 2 of DataBase, with increase functionality and/or content.	April 2014	In progress	