WCRP REPORT
World Climate Research Programme

Report of the Extraordinary Session of WCRP Joint Scientific Committee

Cooperative Institute for Research in Environmental Sciences

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1. Opening of the Session

The meeting was opened by JSC Chair, Dr Antonio Busalacchi, at 09:00. Prof. Konrad Steffen, host of the meeting and Director of the Cooperative Institute for Research in Environmental Sciences (CIRES, Boulder, Colorado, USA) welcomed the attending members of the JSC (Annex 1) to the venue. Dr Busalacchi recalled the very successful Open Science Conference (OSC) of WCRP, on 24-28 October 2011 in Denver, Colorado, USA, and congratulated the group with that success. Dr Busalacchi then introduced the agenda of the meeting (Annex 2) and its main objective, which was to take stock of the just finished OSC and consider its outcomes for directing the future WCRP activities and optimizing its structure. JSC agreed with the agenda.

2. Reports by the WCRP Core Projects

Opening the agenda item, Dr Busalacchi asked the projects, in their reports, to focus on their post OSC strategy how it is developed in communication with their project communities of researchers.

2.1 Stratospheric Processes and Their Role in Climate (SPARC)

SPARC report was co-authored by Prof. Ted Shepherd (Univ. of Toronto), co-Chair of SPARC SSG, Prof. Tom Peter (ETH Zürich), outgoing co-Chair of SPARC SSG; Dr Greg Bodeker, incoming co-Chair of SPARC SSG, and Dr Johannes Staehelin, SPARC IPO Director.

As the co-authors reported, SPARC has always been *interdisciplinary* with an equal focus on dynamics and chemistry. The project has a strong focus on *deliverables* (e.g., peer-reviewed SPARC Reports) and *user needs* (e.g., WMO/UNEP Ozone Assessment and space agencies). Its activities are evolving to develop a greater emphasis on stratosphere-troposphere coupling, as this is where the science is currently headed. Correspondingly, new SPARC SSG members that are being appointed have a tropospheric focus in their research. Delivery of SPARC results into climate services would be largely through the various WCRP working groups.

Several recent SPARC activities have made a significant contribution to climate science and major assessments. In 2009-2010 the SPARC CCMVal project had a first-order impact on the 2010 WMO/UNEP Ozone Assessment, with model projections coming from the CCMVal Report. While the Ozone Assessment will continue to be a major driver for SPARC activities, a greater role of SPARC in the IPCC Assessment Reports is anticipated. SPARC affiliated scientists participate in the assessment of CFC lifetimes. SPARC data-oriented activities include assessing satellite-based stratospheric trace gas and aerosol climatologies, extending ozone profile trends beyond 2005, assessing upper troposphere / lower stratosphere water vapour measurements and resulting temperature and water vapour trends. In addition, SPARC works on assessment of observational constraints for gravity wave research and continues research on observational record for spectral solar variability. On the modelling side, SPARC is deeply involved in CMIP5 and is a participant in the Geoengineering Model Intercomparison (GeoMIP).

SPARC identified the following research imperatives:

- Improvement of the models through model-measurement comparison
- Improvement of the use of (imperfect) model information through model assessment and diagnostic analysis
- Improvement of the reanalyzes through assessment of the products

- Improvement of the observational record through assessment of the products and development of climate data records

The emerging SPARC activities are:

- Comparison of different reanalysis products in the stratosphere
- Study of the impact of stratosphere on tropospheric weather prediction (joint with WGNE)
- Research on sulphate aerosols beyond the scope of the SPARC Aerosol Assessment 2006 with the aim to generalize climate – chemistry models (CCMs) by including in them the account of interactive sulphate chemistry and aerosols
- Research on monsoons envisaging a 18-partner European/Indian proposal (presently in review)

SPARC continues its cooperation with IGBP IGAC on the Atmospheric Chemistry & Climate (AC&C) initiative. There is at present a 5-point AC&C action plan agreed with the IGAC leadership. The scope of the CCMVal Workshop scheduled for May 2012 in Davos has been expanded into a week-long "IGAC/SPARC Global Chemistry-Climate Modelling and Evaluation Workshop". The aim is to achieve progress and improve coordination of CCMVal, ACC-MIP, and AC&C hindcast activities.

SPARC envisages the need to improve coordination with CLIVAR on research on mechanisms of climate variability and with GEWEX on research issues related to convection, upper tropospheric water vapour and cirrus clouds.

The following research issues require JSC attention. There is an obvious need to continue the research on direct and indirect aerosol radiative forcing with the objective to limit the existing uncertainty. This requires a revisit of the definitions of the radiative forcing that takes into account all involved processes. Parts of the research directions that pertain to SPARC have been already defined and will be pursued in the future activities of the project. However, it is important to define how to scope the WCRP activities in this area and determine participants. The plan is to start the work with sulphate aerosols within the coordinated CCMVal, ACC-MIP, and AC&C hindcast activities and then expand the scope of work to other aerosols with support from the AeroCom project. Another area that requires a pan-WCRP approach is the development of the WCRP polar initiative.

Planning of the future SPARC activities involves wide and open consultations with the community. A special blog was established to facilitate the consultations, particularly the choice of the future project name. The input of the community will be used by the Scientific Steering Group in their deliberations on the future of the project.

The report concluded with an introduction to the JSC of the new project director, Dr Johannes Staehelin, and the incoming Project Co-Chair, Dr Gregory Bodeker who will start his term on 1 January 2012. During the time since the previous JSC Session in Exeter, UK, the SPARC IPO has moved from Toronto to Zurich. This arrangement will be available until 2015.

The JSC was very pleased with the way SPARC is developing and planning its activities including the new focus and directions of the research that embarks on tropospheric dynamics and chemistry. JSC members highlighted several areas of potential cooperation of SPARC within and outside of WCRP. It was underlined that no duplication with IGBP IGAC should be expected because the main focus of the extended SPARC activities will be on the climate aspects of tropospheric chemistry. Studies of the radiative forcing and upper troposphere/lower stratosphere water vapour would benefit from extended use of GEWEX datasets. JSC also noted that the recent dramatic changes in Arctic ozone should not be overlooked by SPARC. The polar initiative requires involvement of CliC, CLIVAR and GEWEX (i.e., a pan-WCRP initiative). The research on polar tropospheric clouds should take into account the relevant activities of the IASC Working Group on

Atmosphere. The new GEWEX Atmospheric Systems Study (GASS) can add to this work the necessary aspects associated with dynamical processes. The discussion also touched on the role of the SPARC in climate services. It was noted that many aspects of stratospheric research have a direct role in surface climate conditions. For example, water resources on the Southern Hemisphere are affected by the changes in stratospheric ozone and the greenhouse gas build-up. Addressing dynamics of the stratosphere in the mid-latitudes of the Southern Hemisphere would require involvement of both CLIVAR and the SPARC project DynVar.

At the end of the discussion of the SPARC report, the JSC warmly thanked Professor Thomas Peter for his very long and successful service to WCRP and SPARC as a SPARC SSG member since 1998 and as a Co-Chair since 2007. JSC especially acknowledged the leadership by Prof. Peter and his important contributions to the work of WCRP both within and beyond the scope of the SPARC project. JSC gave Prof. Peter a round of applause.

2.2 Climate and Cryosphere (CliC)

The presentation by the CliC project was co-authored by Prof. Konrad Steffen, Chair of CliC SSG, and Dr Gino Casassa, Vice-Chair of CliC SSG. It was noted at the beginning of the talk that to a significant extent the project activities in the recent past have been hampered by lack of staff in the CliC International Project Office (IPO). There is hope now that the CliC IPO Director will be hired very soon, to be followed by hiring a Deputy Director.

At its meeting in Valdivia, Chile, in February 2010, CliC SSG has agreed on the following scientific frontiers for CliC:

- Enabling prediction of the Arctic climate system
- Enabling prediction of the Antarctic climate system
- Enabling prediction of terrestrial cryosphere, and
- Enabling improved assessment of the past, current and future sea-level variability and change

Achievement of these objectives requires long-term efforts, and at its 2011 Session in Tromsø, Norway, CliC SSG agreed that the project should embark on a series of specific immediate activities. Together with SPARC, CliC participates in the development of the WCRP polar climate predictability initiative, with planning based on the outcomes of the October 2010 Bergen Workshop. CliC associates with this initiative its activities aimed at:

- explanation of causes and prediction of the sea-ice changes, both in the Arctic and Southern Oceans
- research on ice sheet dynamics and the role of the major ice sheets in sea level rise, and
- improvement of the regional Arctic climate models and parameterizations of cryospheric processes in them and in global climate models

The CliC Arctic Sea-Ice Working Group and the Group “Antarctic Sea Ice Processes and Climate” (ASPeCt) cosponsored by SCAR are shaping their activities to involve more expertise on modelling and to contribute to the polar climate research. Other CliC initiatives focus on assessing cryospheric components of the Arctic and Southern Ocean freshwater budgets and building up the research on the role of carbon and permafrost in the climate system, in cooperation with IASC and International Permafrost Association.

In March 2011 CliC organized a Sea-Ice Products Community Workshop which focused on the passive microwave sea ice products and discussed available data products, their inter-comparisons, and assessment of uncertainties. The idea of an ‘ensemble’ sea ice product that would combine multiple products was put forward.

Two CliC regional activities address changes in mountain cryosphere and water resources. They include a mature Asia – CliC project and emerging activities in South America. The latter involved the USA-Chile Glacier Mass Balance Workshop on 23-25 August 2011 in Valdivia, Chile, and the "Melting of Snow and Glaciers: Science, Technology and Politics to Face the Challenges of the Andean Region in the Context of Climate Change" Workshop in Santiago, Chile, on 13-15 September 2011. Two more associated meetings are forthcoming.

An important uncertainty of the current research on sea-level rise is related to the contribution of the mass loss of the ice sheets in both hemispheres due to their interaction with the warming oceans. This requires strong collaboration with the ocean community in the Polar Regions. Dynamic response of ice sheets in a warming climate remains a challenging problem of climate science. To address it, CliC joins forces with IASC and SCAR on the Ice Sheet MASs balance and Sea level (ISMASS). An ISMASS workshop is in preparation.

CliC is the youngest project in the WCRP family. Correspondingly, the proposal of the speakers was to go ahead with the same name for the project.

The CliC presentation triggered a discussion on many issues surrounding climate prediction in the Polar Regions, especially the Arctic. It was noted that after the completion of IPY important activities are moving ahead under the leadership of U.S. SEARCH Program. Both WCRP and GOOS are seeking to strengthen their activities in the Polar Regions, WCRP through its emerging polar predictability initiative, and IOC – through reorganizing GOOS and adding to it a polar component. A need to strengthen coordination of observations in the Arctic was stressed. However, the most urgent need and a gap in the WCRP polar activities remains modelling of polar and cryospheric processes, such as sea-ice, and uptake of the results of these activities by global climate modelling, e.g. in WGCM. It was also noted that the CLIVAR WGOMD addresses sea ice in its activities.

The WCRP OSC has once again highlighted the important role of cryospheric research and observation in creating elements of a polar prediction system. Such cryospheric variables as snow cover on land and sea-ice thickness are especially promising.

Several JSC members highlighted the essential role of the mountain cryosphere in terrestrial water balance and water resource management. In the case of Kilimanjaro, the impact of melting of this ice cap on the regional water resources is not so significant, but in other regions there is a need for coordinated activities that would translate climate predictions and projections into assessments of glacier melt, with estimates of changing of corresponding components of the water balance. WCRP is in a good position to step up its contribution to this work, which is important for climate services, for example in South America. Supporting the emerging networks of researchers and involving water resources stakeholders can be instrumental as one of the many ways of addressing the issue. Prediction of the future glacier behaviour will also be useful to engineering applications with respect to threats posed by glacier melt, like Glacier Lake Outburst Flows (GLOFs).

Among several dimensions of climate research that JSC named as relevant for CliC was the role of black carbon in warming of the Polar Regions and, particularly, in the ice sheet melting. Ice mass balance estimates strongly depend on the quality of simulating and predicting solid precipitation, and it remains one of the weakest points in climate and Earth System models.

The discussion also emphasized the fact that many promising early career scientists participated in the cryospheric and polar sessions. Cryospheric science is on the rise, and it is possible now to engage new people in CliC activities, a high priority task for CliC in near future.

2.3 Global Energy and Water Cycle Experiment (GEWEX)

The presentation of the GEWEX project was made by Dr Kevin Trenberth, Chair of the GEWEX SSG, and Dr Peter van Oevelen, Director of the International GEWEX Project Office. Contributions to this talk also came from Drs Dennis Lettenmaeir, Jan Polcher, Christopher Kummerrow, Joe Santanello, Martin Best, Jon Petch, Steve Klein, Bert Holtslag, and Gunilla Svensson, leaders of main GEWEX activities.

The GEWEX Vision is based on the understanding that water and energy are fundamental for life on Earth. Fresh water is a major pressure point for society owing to increasing demand and vagaries of climate. Extreme events such as droughts, heat waves and wild fires as well as floods, heavy rains and intense storms increasingly threaten to cause havoc as the climate changes. Other challenges exist on how clouds and aerosols affect energy and climate. Better observations and analysis of these phenomena and improving our ability to model and predict them will contribute to meeting the continuously increasing information needs by society and decision makers.

The GEWEX mission post 2013 is to measure and predict global and regional energy and water variations, trends, and extremes (such as heat waves, floods, and droughts) through improved observations and modelling of land, atmosphere and their interactions; thereby providing the scientific underpinnings of climate services.

The document "*GEWEX Imperatives: Plans for 2013 and Beyond*" outlines the future directions of GEWEX and is being extensively used by the project panels for planning purposes. The following GEWEX Imperatives have been identified:

1. **Datasets:** foster development of climate data records of atmosphere, water, land, and energy-related quantities, including metadata and uncertainty estimates
2. **Analysis:** describe and analyze observed variations, trends and extremes (such as heat waves, floods and droughts) in water and energy-related quantities
3. **Processes:** develop approaches to improve process-level understanding of energy and water cycles in support of improved land and atmosphere models
4. **Modelling:** improve global and regional simulations and predictions of precipitation, clouds, and land hydrology, and thus the entire climate system, through accelerated development of models of the land and atmosphere
5. **Applications:** attribute causes of variability, trends and extremes, and determine the predictability of energy and water cycles on global and regional bases in collaboration with the wider WCRP community
6. **Technology transfer:** develop diagnostic tools and methods, new observations, models, data management, and other research products for multiple uses and transition to operational applications in partnership with climate and hydro-meteorological service providers
7. **Capacity building:** promote and foster capacity building through training of scientists and outreach to the user community

The renewed post 2013 GEWEX will continue to focus on the "land-atmosphere" interactions in the climate system. It is proposed to keep the acronym "GEWEX" but with the new title of the project "Global and regional Energy and Water Exchanges". GEWEX will continue to embrace the global energy and water cycles following a substantial internal re-organization to facilitate more interactions and more end-to-end approach to embrace activities spanning Earth system domains and other integrating themes.

There has been significant progress in work on the GEWEX future structure. The GEWEX Radiation Panel has changed its name to GEWEX Data and Assessments Panel. The Panel will:

- identify and foster in situ measurements that could be coordinated to produce global data sets
- perform assessments of data products and techniques developed generally by multiple global agencies, and
- maintain a reference set of data sets to monitor the global water and energy budget

There are significant developments and transformation in the organization of the GEWEX modelling activities, particularly related to the formation of the GEWEX Atmospheric System Study (GASS). The Framework for Atmospheric Model Enhancement (FAME) has the mission to improve the representation of physical and dynamical processes in the troposphere in models for all purposes and, especially, for weather and climate services. It involves studies of the planetary boundary layer, clouds and convection, radiation, dynamical processes and model numerical implementation issues. The GEWEX Global Land – Atmosphere System Study (GLASS) mission is to support improved estimates and representation of land states and fluxes in models, the interaction with the overlying atmosphere, and maximize the utilized fraction of inherent predictability. A combination of GASS and FAME provide the umbrella for coordination and integration of modelling activities within GEWEX, and coordination of these efforts with the rest of WCRP projects through the Modelling Council.

GEWEX has been addressing regional climate issues for many years, mostly via the Regional Hydroclimate Projects (RHPs). The new RHP role is to provide regional level science and implementation, and generate corresponding products and tools.

There are several important and new foci emerging for GEWEX that provide greater opportunity for cooperation and coordination with CLIVAR such as climate extremes, monsoons, droughts. The emphasis of GEWEX in these projects will be more oriented towards land-atmosphere interactions. Dr Trenberth cited many open issues in coordination of WCRP research on monsoons.

The GEWEX strategy and structure issues together with the pan-WCRP initiatives will be addressed at the next GEWEX SSG meeting to be held in Rome, Italy, on 14-18 November 2011.

The JSC guidance to GEWEX was as follows. The purpose of WCRP and its core projects is first and foremost to promote and enable research that can only happen through global or at least large-scale coordination, including convincing funding agencies to support such research. Most of this enabling work must happen through the core projects; one task of JSC is to keep an eye on where progress can be enabled or accelerated by coordination across core projects. Finally, WCRP is under pressure not only to deliver but also to be clearly seen as focussing research on societies' needs (food, water, health, energy, risk reduction). This demand forces quite some change upon all of WCRP.

The JSC agreed that the GEWEX Grand Questions might provide the foundation for developing an excellent strategy for the project. If GEWEX SSG could define a handful of priorities for the next 5-7 years to deliver on Grand Questions, this will be a success. The GEWEX "Imperatives" document contains the elements of potential answers. For example, a unified global water and energy product could be one priority. Siegfried Schubert's suggestion of a Global Drought Information System could be another. Howard Wheater's suggestion of a focus on land surface/ground water hydrology could be the third priority. At the same time, JSC found it difficult to glean from the “Imperatives” document such a set of tractable but yet exciting challenges, despite they may be there. Therefore, if the JSC members have trouble recognizing the challenges, the funders and the community at large will have similar difficulties. This means that it is probably the time for GEWEX to simplify and clarify the document. While much, if not all, of what is described in it must certainly continue to happen (e.g., securing and expanding data streams, analysis, model

improvement, etc.), most of these activities, in terms of communication, probably should run in the background and do not overwhelm the document. A relatively short list of priorities fulfilling the above can be compiled by the GEWEX SSG and communicated clearly and concisely.

The same also applies to the GEWEX structure. If we ask, as an example, how to link multi-year prediction to a drought information system, it will be hard to tell how to make contact with the right point within GEWEX. Again, there may well be a clear answer, but it is not readily apparent to an outsider. Optimizing it is a difficult but necessary task.

Lastly, "what's in a name?" A name change has a huge signalling effect. Conversely, keeping a name or an acronym it does signal "business as usual" even though that might not be intended. JSC do not believe that WCRP or GEWEX can afford sending such a signal.

The JSC also concluded that numerous regional projects in GEWEX would benefit from stronger involvement in coordinated capacity development. WCRP is working on a capacity development strategy. Dr Roberta Boscolo of the WCRP JPS is the main point of contact. She could benefit from participation and support from the Projects in further developing the pan-WCRP capacity development strategy and its implementation.

2.4 Climate Variability and Predictability (CLIVAR)

Co-Chairs of CLIVAR SSG, Drs James Hurrell and Martin Visbeck, spoke on the strategy and evolution of their project. Its mission is to observe, simulate and predict changes in Earth's climate system with a focus on ocean-atmosphere interactions, enabling better understanding of climate variability, predictability and change, to the benefit of society and the environment in which we live.

The following questions guide the CLIVAR planning process:

- What research should be the focus of an "ocean - atmosphere" project?
- If this is the time to "downsize" CLIVAR, where do some current (broader) activities fit in the restructured WCRP?
- Is it time to change the name of CLIVAR and what are "pros" and 'cons" of that?
- How to ensure critical and effective interfaces for regional programs (e.g., VACS, VAMOS, AAMP, etc.)?
- How Grand Challenges for WCRP science are defined and which ones should CLIVAR propose?

CLIVAR has proposed seven objectives, which were also called "imperatives". They are:

1. Anthropogenic climate change
2. Intra-to-seasonal variability, predictability and prediction (of climate)
3. Decadal variability, predictability and prediction
4. Improved atmosphere and ocean components of Earth System Models
5. Data synthesis and analysis
6. Ocean observing system, and
7. Capacity building

These "imperatives" represent top priorities for CLIVAR panels and working groups with a 5-year perspective, and they have specific metrics and deliverables. They help to inform ongoing discussion on future evolution of the ocean-atmosphere research in WCRP, they are scientifically important, present an opportunity to achieve considerable progress, and require international coordination. The "imperatives" map across CLIVAR panels and working groups, and WCRP and partner international research programs.

Planning of the future CLIVAR activities is based on the analysis of functions of various project components. Some of them fall under "ocean-atmosphere" focus, e.g. ocean basin panels, ocean observing system development activities, GSOP, WGOMD, or exploit the dominant role of oceans in the climate prediction on time scales from seasons to decades. Some CLIVAR activities have broader nature, e.g. the ones that address extremes; annular modes; sea level rise; earth system modelling; and monsoons. This distinction can be used to shape the new CLIVAR. This work will aim to help WCRP and CLIVAR to identify and address global challenges of climate science. Some of the proposed topics include:

- Regional sea level
- Droughts
- Tropical biases in climate models, and
- Dynamics of ocean-upwelling systems

These issues, the recommendations of the JSC, and the new name for CLIVAR will be discussed at the next SSG Session, which will be held jointly with the Scientific Steering Committee of the IGBP IMBER Project in Mexico, in 2012.

The JSC stressed the importance of adequate positioning of WCRP regional activities, which should involve coordination with GEWEX. Regional sea level rise research represents a genuine challenge. The scope of research on climate in Africa goes far beyond the research on monsoons and this has to be reflected in WCRP activities. Seasonal and inter-annual prediction is a pan-WCRP activity. JSC was of the opinion that CLIVAR should change its name because with the current name the distinction between the WCRP and CLIVAR is not clear. The new name of the project should reflect its focus on ocean (perhaps marine)-atmosphere interaction.

The discussion of CLIVAR restructuring led JSC toward exchanging views on the more general issue of overall WCRP structure. There are two permanent and prominent dimensions of climate research activities. They are domains and their interactions, e.g. "ocean–atmosphere", and enabling capabilities such as process understanding, modelling and observations. Building the new structure around the "pillars" of ocean–atmosphere interactions, land–atmosphere interactions, troposphere–stratosphere interactions and cryospheric linkages may help to self-organize but the "delivery" of WCRP should be organized in a way that fosters communication and supports focus on grand challenges. Recognizing that "climate science is not done", but future research priorities can be organized such that the needs of users of resulting knowledge are considered in the priority setting process.

The JSC also noted that the new structure built along the four pillars aligns better with the current structure of other GEC programs such as IGBP, which may help to strengthen the links with the biogeochemical research.

The overall conclusion on the discussion of the CLIVAR structure was that CLIVAR planning is on the right track because it is progressing as a part of the whole WCRP. The new organization of WCRP should bring community together and facilitate the delivery of the project activity outcomes. Dr Nakajima remarked that the new project names are somewhat "dry" and more interesting names would go a long way in attracting interest of early career scientists and students to climate research.

3. Main Outcomes of the WCRP Open Science Conference

The JSC revisited the WCRP OSC with an emphasis on the summaries of plenary and parallel session discussions presented on the concluding day of the Conference.

The Session A1 highlight was identification of an urgent need for "actionable" climate information based on sound science. Environment/climate related issues and concerns that the public and decision makers are facing are complex and require trans-disciplinary approach to addressing them. There is a need for "symbiotic" relationship between providers and users of climate information to ensure that 'actionable' (timely, accessible, and easy to understand) climate information is developed and used effectively. There is also a need for training and development of next generation of scientists and decision makers who would be able to pursue and promote the use of actionable climate/environmental information.

The opening Session also included strong Sponsor support for WCRP and challenging requirements to WCRP that its three Sponsors posed. For example, WMO considers that WCRP interface with GFCS is critical for GFCS success and this requires a stronger focus on developing countries. UNESCO/IOC stated that capacity building is not an end in itself but a constant condition for successful climate research, communicating the science, and in advocacy for sustained ocean observation. ICSU emphasized the importance of strengthening the link with social sciences, to role of humans and their impact on climate, and the many issues associated with Earth sustainability, including the identified ICSU Grand Challenges. The presentation of USGCRP made a clear and strong de-facto alignment of national US and global WCRP climate science objectives.

Dr Busalacchi, speaking as the JSC Chair, recalled the WCRP successes over the thirty years of its existence, the need for continuing agility in addressing the needs for science-based climate information at regional level, of key sectors of economies, and climate-related risk management. Focusing on applications of climate science cannot be achieved at the expense of excellence in "research", but we should also aim for effective use of the resulting knowledge.

The JSC also discussed the extent to which the WCRP-affiliated science has to reach out to users in terms of provision of climate services under the GFCS. The valuable role of entities translating the users' needs into requirements in climate information, such as IRI, was mentioned. It was noted that one of the undertakings for GFCS should be to establish cooperation with and delivery by such "boundary" organizations. While not providing the services explicitly, WCRP should do all it can to enable them and also will need to be cognizant of how its research results are used. Ethical considerations are key to minimize any misuse of climate information. Development of GFCS will entail an active discussion of responsibilities of key stakeholders, and WCRP sees one of its responsibilities as stating what science can deliver for the GFCS build-up.

Three plenary talks in the plenary Session A6 also focused on the discussion of climate services. According to Dr Maria Lemos, in less developed countries there is a direct relationship between building adaptive capacity and development. Many of the causes of vulnerability are connected to development deficits. This calls for a new paradigm, adaptive development. Countries need to solve the problems that they have had before but in a context of climate change. In such conditions implementation of climate related risk management interplays in a complex way with existing/traditional development policy.

These ideas were further developed in a presentation by Dr Johan Rockstrom. Based on the paper on the ICSU Grand Challenges by (Reid, et al., 2010), he showed that global sustainability is now a prerequisite for poverty alleviation. Several planetary boundary thresholds in the Earth System have been exceeded, and this makes it necessary to look for innovative pathways for a grand transformation of the current tendencies towards global sustainability, which in turn calls for science-based planetary stewardship for human prosperity in the Anthropocene. Climate services are a necessary element of this transformation. According to Dr Bruce Hewitson, they have the potential to bridge communities, language and value systems. However, at present, scientific climate products are misaligned with most users' decision risk framework, in which climate is only one of many factors. The language of uncertainty employed in the climate information provision casts doubts among the users, and there is a merit for informing them based on the concept of likelihood. Information on the exceedence in time, space, and frequency of user-defined thresholds is powerful. The issues of responsibility, accountability, credibility, and values are largely missing from the climate service dialogue. To put them in place, producers and users of climate information need to collectively develop the language that leads to plausible, defendable and actionable messages.

Dr Madeleine Thomson gave an example of such messages in the area of climate and health where projects like Meningitis Environmental Risk Information Technologies (MERIT) are showing significant achievements in implementing health–climate alliance. The basis for joint action is the agreement among the stakeholders on the corresponding evidence, stemming from a strategic approach to the creation of the evidence, together with the development of a cumulative knowledge base, effective dissemination of knowledge, with development of effective means of access to knowledge, and resulting in initiatives to increase the uptake of evidence in both policy and practice.

The three presentations on the various aspects of the Earth System given in the plenary Session A2 by Dr Martin Visbeck, Dr Daniel Rosenfeld and Dr Guy Brasseur were instrumental in revisiting the fundamental questions for the further development of WCRP, for example, to what extent should WCRP become holistic in its scientific perspective? These lectures put on the surface still existing, very difficult problems in the observation, modelling and understanding of the global climate system, such as double ITCZ, radiative forcing by clouds, aerosols, prediction of monsoons and blocking, etc. This calls for a WCRP focus in its research on prediction on all aspects of the Earth System that affect climate, and, in the WCRP research on the impacts, the focus should be on all aspects of the Earth System that are affected by climate. In the development of the WCRP programme and in the communication of the information produced by it, the context of wider environmental change is important.

Organization of the WCRP science should be instrumental for contributing to existing challenges in food production and security, water resources availability and management, climate and health, disaster risk management, and energy and transport. With a complex composition of considered domains (ocean, atmosphere, land) and geographical regions, the advantages of considering phenomena should not be lost. The Number One service to society provided by WCRP is the encouragement and enabling of climate-related research that will likely be needed over the next decades. For example, the WCRP contribution to IPCC is a superb demonstration of a climate service to society. However, for modern practical services to "end users", WCRP should help in developing an interface between climate information and information on a particular application. Understanding of relevant aspects of the climate system and well-established science can often provide the basis for actionable information and enable handling and communicating of uncertainties.

The main issue that the JSC focused on in the discussion of science support to climate services was the optimal balance of fundamental and applied research, and interface with climate information and users components of GFCS. Current calls by funding agencies have a tendency towards allocating only a part of funding to the scientific research; the rest is often intended for the development and use of the resulting knowledge in practical applications. Given the still existing gap between science and policy making,

convincing presentation of the end deliverables of climate research becomes even more important than in the past. In present conditions, climate science should be contributing to the development of the climate information system and user interface of future climate services and the WCRP affiliated community should proactively engage in these discussions. Such engagement will ensure the necessary attention to sound science foundation for the information provided to and delivered by the GFCS to its users, and tempers the undue expectations for the type and timeframe for delivery of the needed information.

Talks by Drs Kevin Trenberth, Peter Gleick, and Susan Wijffels on the observations of climate variables, hydrological cycle and the oceans (Session A3) reported significant progress in all of these domains. The tone of this session was set by one key phrase by Dr Trenberth, namely "we cannot manage what we cannot measure". Growing requirements for data diversity and continuity, emergence of new observations, improved coverage and accuracy of some observations can be noted along with the loss of some key observations, and these are the reasons for both concern and optimism. The following main needs in the work with observations were highlighted by speakers:

- Recovery of historical data
- Bias correction (sea surface temperature, ship winds, radiosonde temperatures, etc.)
- Efficient data management and ease of discovery/access
- Policy development on data sharing and observations in Exclusive Economic Zones
- Linkages with data from impacted societal sectors, for end-to-end systems
- Continued improvement of data assimilation and products including coupled data assimilation and climate system reanalysis, and
- Product inter-comparison and documentation.

Some of these needs are WCRP's core business, and all of them need WCRP's advocacy and support.

Drs Christian Jakob, Adam Scaife and Sandrine Bony spoke in the plenary Session A4 entitled "Assessing and Improving Model and Predictive Capabilities". It can be concluded from the presentations that climate models are getting more realistic, comprehensive and capable to deliver daily-seasonal-inter-annual-decadal predictions and climate projections to users. For example, dynamical prediction of ENSO is now operational, and seasonal forecasting also demonstrates skill. Successful reproduction of the 20th century climate provides a scientific basis for attribution of anthropogenic climate change. Power of multi-model ensemble is being proven for seasonal to climate time scales. However, models are still far from perfect. The list of systematic errors with unknown reasons for them is long. The WCRP agenda of climate modelling research should therefore include continuing model validation and interaction between observation/process studies and modelling. Two outstanding issues in this area are the need to grow a new generation of model developers, who were named by Dr Jakob "endangered species", and the need to "reinforce the foundations", namely the modules for atmosphere, ocean, and land in climate models. The world needs a new step in the development of Earth System models, based on new supercomputer capabilities, deeper understanding and better ability to represent numerically the multitude of involved processes. This challenge was called, after some discussion, a "Denver" project.

Talks by Dr Susan Solomon, Professor Konrad Steffen, and Dr Peter Stott at plenary Session A5 led to three major sets of conclusions on the need for research on the anthropogenic climate change. The priority should be given to assessments of feedbacks on short- and long-time scales, research on regional climate sensitivity, and achieving significant reduction of uncertainties related to account of cloud-radiation and albedo feedbacks for most cloud types in climate models. Having achieved progress in attribution of extreme events and in research on heat waves, tornadoes, extreme precipitation (including their predictability) and tropical cyclones, WCRP is now in a position to improve the scientific basis for their prediction. It was mentioned that the cryosphere was rich on grand challenges and agreed that WCRP must continue addressing large uncertainties of ice sheet mass balance for sea-level rise assessment, and strengthen research focus on

regional sea-level variability and change. The potential of the Arctic turning from carbon sink to a source due to release of carbon stored in permafrost and achieving progress in predicting the Arctic sea-ice loss remain significant science challenges.

Concluding this agenda item, the JSC has expressed thanks to the Scientific Organizing Committee with its Chair, Dr J. Hurrell, and to all others who participated in the Conference preparation. Some proposals were made that the next conference could go further into the actual delivery of climate services. For example it can be organized together with GFCS User Interface Platform. Timing of the next Conference should take into account conferences of WCRP Projects. It should be discussed at the next JSC Session.

4. Establishment of the WCRP Modelling Advisory Council and WCRP Data Advisory Council

Following the decision of the WCRP JSC-32 to establish the WCRP Modelling Advisory Council (WMAC) and WCRP Data Advisory Council (WDAC), their Terms of Reference (ToRs) were discussed by the JSC-33. The agreed objectives, ToRs, composition, and modes of functioning for WMAC and WDAC are given in Annexes 4 and 5. A nomination procedure was agreed to by the JSC Members and Chairs and Directors for the Councils. JSC members were requested to forward their proposal for members of the two Councils. The first appointments will be made in time to organize the first meetings of the two Councils in conjunction with the next JSC in 2012. The JSC decided to transfer the functions of the WCRP Observations and Assimilation Panel (WOAP), cosponsored by GCOS, to the WDAC.

The JSC also agreed that WGSIP and WGCM should report directly to JSC. Their terms of reference should be updated accordingly. These groups will no longer be overseen by CLIVAR.

The WGNE expressed its support to the JSC for the establishment of the WCRP Modelling Council. In a letter, addressed to Dr Busalacchi, WGNE mentioned that they were particularly pleased to see the vision for the Council to be a grass-roots-based and facilitating, rather than a governing, entity. WGNE was looking forward to contributing to the discussions of the Council at its future meetings. WGNE noted that the membership of the Council would require careful consideration and that they would like to caution against the inclusion of too many small modelling projects currently active in WCRP (e.g., PMIP, CFMIP, AMIP_T). Instead WGNE encourages a composition of the Council that remains focussed on the major modelling groups and projects of the WCRP (e.g., GASS, GLASS, WGCM, WGSIP, WGNE, etc.).

In the context of atmospheric modelling as one of the remaining future challenges for WCRP, WGNE welcomes the formation of GEWEX Atmospheric Systems Study (GASS) as a consolidation and extension of existing atmospheric process modelling activities within GEWEX. WGNE is excited by this initiative and is looking forward to working with GASS in the future on strengthening of what is already a very good relationship between GEWEX and WGNE. With the formation of GASS as well as the WCRP Modelling Council, in addition to the coordination already provided by WGNE, WGSIP and WGCM, the atmospheric modelling community within WCRP will be well coordinated. WGNE also stresses it has the necessary links to other important groups within and outside WCRP. Consequently, WGNE sees no need for any additional organizational change.

During its 2011 session, WGNE had a day of joint meetings with WGCM. Both groups considered this experience as extremely positive, and WGNE would like to encourage the JSC to discuss future joint meetings of WCRP's main modelling groups (WGNE, WGCM, and WGSIP), keeping in mind the

practicalities as well as the fact that WGNE also has strong working relationships with CAS activities (e.g., WWRP/THORPEX).

5. WCRP Regional Activities and Establishment of the WCRP Working Group on Regional Climate Science and Information (WGRC)

5.1 WCRP Working Group on Regional Climate Science and Information (WGRC)

Dr G. Flato presented the proposed scope of work and ToRs for WGRC. The JSC discussed how regional activities that are developing under various WCRP projects are going to be coordinated by this group. It was agreed that this group would provide strategic advice on regional aspects of climate science and relevant aspects of climate services. Several proposals were made that could potentially embrace all the mechanisms required. These proposals are reflected in the ToRs of WGRC. The final agreement from the discussion was that the WCRP requires a single body to oversee the interface between communities involved in regional science activities and climate services. It would ensure "pull" of information on the climate service user side and "push" of information on the climate science side. For example, the WGRC could help to provide a unifying framework for the regional WCRP projects in South America and Africa.

Important aspects of climate services on the regional level include downscaling of climate model output, development of regional models, and interpretation and evaluation of ensemble predictions, research capacity development, etc. Some of these activities are coordinated either by Projects or by CORDEX. WGRC should play a major role in coordinating these activities, and, hence, CORDEX should become an activity within WGRC. It was recommended that the WGRC consider joint communication activities with RCOFs. Drs Fred Semazzi and Pius Yanda offered to develop a position paper summarizing the outcome of discussion among the African scientists at the OSC and to provide this as an input for development of the regional activity for Africa.

By coordinating global climate predictions and projections, WCRP creates a foundation for provision of global climate information and services. WGRC is expected to develop guidance on such research activities, beyond the CORDEX efforts.

It was also mentioned that WGRC should address the four near-time priorities of GFCS: food, water, human health, and disaster risk reduction. In addition to addressing regional issues, for example, by identifying regional activities by projects and facilitating their contribution to climate services, the Working Group should also support the development of climate services on the global scale. In that sense WGRC will act as the WCRP interface with the GFCS User Interface Platform.

The WG should also help WCRP Projects responsible for the WCRP Grand Challenges to address their regional aspects. The agreed objectives, ToRs, composition, and modes of functioning for WGRC are given in Annex 6.

A nomination procedure was agreed for the group. JSC members were requested to forward their proposal for members of the WGRC to D/WCRP. The first appointments will be made by the JSC as soon as possible by correspondence.

The D/WCRP should write a letter to CNRS to request secretariat support for the WGCR by the Support Unit at IPSL.

5.2 Regional activities of WCRP Projects including research on monsoons

With the widespread establishment of climate services, the emphasis of WCRP activities on the regional issues should increase. In this connection, Dr Asrar presented to the JSC a document that summarizes the four types of current WCRP regional activities as a basis for further discussion on structure and functions of WGCR. The document is given in Annex 7.

Dr Semazzi complemented this presentation by a brief summary of consultations on WCRP African research agenda that took place in the course of the WCRP OSC. The discussions aimed to achieve better consistency in international funding for local research agenda and stronger engagement of key stakeholders. The current engagement of policy makers in local climate research was assessed as not sufficient. The regional stakeholder community is vast and presently WCRP is able to communicate only with its subsets.

In the discussion that followed, the JSC identified several important issues to consider for regional, including African, research agenda. The major WCRP-led efforts currently are VACS, CORDEX and some projects of AMMA II. A work plan for VACS is in preparation. GEWEX is also contributing to this work. There are, as well, aspects of what is being done under the auspices of WGSIP, WGCM, WOAP, and other WCRP panels and project activities that are relevant to Africa. In particular, there is a need to work on determining products of regional climate modelling that are known to be required by users and to use for model validation and calibration metrics based on the users' needs (e.g., for CORDEX Africa). One mode of work in regional climate service development is through demonstration projects. VACS goals may be used to form an African climate research demonstration project.

In general, for the African continent, there is a need to raise WCRP activities to a higher level; to improve their visibility and support, and also to facilitate coordination across WCRP and with other climate related efforts on the continent. Merit was seen in establishing an *ad hoc* Task Force "WCRP-Africa". The CLIVAR VACS and CORDEX Africa will be in position to inform the Panel at the initial stage and contribute to its work. The Task Force may eventually reform VACS and develop pilot climate services in Africa and the way forward for WCRP in this region. Creating a pan-WCRP Africa Initiative will increase new opportunities for successful capacity building in climate research for the region. This was specifically noted and flagged by the African scientists participating in OSC. In addition, they indicated that they would like to have some specific input to the African research agenda by WCRP projects.

The JSC entrusted Dr Semazzi and Dr Yanda to establish an ad hoc Task Team of not more than 5-6 people to develop the draft paper responding to the needs across the African continent. Experts from Senegal, Nigeria, and Ethiopia could be invited. It is also highly desirable to engage Dr Bruce Hewitson of South Africa in the discussion. Dr Semazzi will liaise with VACS in his capacity as a Task Force member. Most of this work will be preceded by local consultations and by correspondence. This work should strongly rely on the recent African activities of WCRP, which helped the European Commission and the World Bank to conduct a series of regional capacity development workshops in Africa. These workshops generated valuable output for informing the Task Force. JPS will make available to the Task Team all available reports and background information, and in close contact with WMO World Climate Programme, which also has a wealth of activities on the African continent. This work will be one of the first activities to be guided by the newly established WGRC.

Research on monsoons variability, predictability, prediction, and projection is very challenging. Regional specificity of monsoons makes it difficult to determine a common set of activities that would benefit from international cooperation. WCRP is an active proponent and partner in many tropical and monsoon related activities, such as, e.g., YOTC. WCRP also has its own monsoon-oriented projects under CLIVAR and GEWEX.

VAMOS in South America is active, involves GEWEX, helps with capacity development, and makes progress in the research on monsoons. VAMOS funding under CLIVAR is available with the support of the InterAmerican Institute. GEWEX continues guiding the relatively well-supported La Plata Basin (LPB) initiative. The JSC initial guidance on regional activities was that management of pan-WCRP initiatives is to be provided by the Projects in coordination and partnership mode, including appropriate coordination with other related efforts, and with one Project taking the lead on each specific activity. For example, JSC envisions great opportunities for cooperation and partnership between CLIVAR and GEWEX for both the VACS and VAMOS, or any subsequent activity they may transition to in the future. In addition, there will be a need to coordinate with the other WCRP activities, e.g. CORDEX. The fact that VACS is meeting concurrently with a CORDEX workshop in Cape Town, South Africa, 21-23 November 2011, should present an opportunity to explore how these interactions might occur and to begin to develop a joint vision for the future.

The overall conclusion of the discussion on the regional and monsoon-oriented WCRP research was the time is right and there is a significant potential in restructuring regional research under WCRP, encouraging closer coordination between the scientific and service aspects of them, and bridging corresponding communities together, and taking advantage of the guidance to be received from the newly established WGRC and the Task Team on African climate research agenda. For example, new stream funding for research is being provided now by research funding agencies to so called Collaborative Research Networks. WCRP initiatives in regional climate science need to be regrouped to take advantage of such opportunities for research funding.

The research on monsoons in Asia and Australia (AAMP) is highly focused, addressing specific and feasible "bite size"- chunks of problems. The MAHASRI and AMY initiatives helped to coordinate many related activities in Asia but are winding down. Cooperation of CLIVAR and GEWEX on AAMP is fruitful and strong, with CLIVAR being the main host but with GEWEX being actively involved and well informed. Links of AAMP to climate services can be, nevertheless, strengthened.

JSC agreed to request CLIVAR and GEWEX communities associated with VACS and VAMOS panels to work with their constituencies (researchers, institutions, funding agencies and other stakeholders), to develop a list of research priorities and activities for their respective regions for the post 2013 timeframe. JSC would like to encourage a fresh look, independent of prior panel names or structure, starting with anticipated stakeholder needs and developing a research agenda that addresses those needs within the region, the grand challenges and imperatives of CLIVAR and GEWEX, and the overall WCRP future plan and priorities.

6. WCRP Grand Challenges

A session on the WCRP Grand Challenges concluded the extraordinary JSC in Boulder, Colorado. It started with an exchange of views on how the grand challenges can be defined. The JSC took note of the useful definition of a Grand Challenge developed by CLIVAR, namely:

- A Grand Challenge is both **highly specific and highly focused** identifying a specific barrier preventing progress in a critical area of climate science.
- This focus enables the development of **targeted research efforts** with the likelihood of significant progress over 5-10 years, even if its ultimate success is uncertain.

- It should thus enable the implementation of effective and **measurable performance metrics.**
- By being transformative, a Grand Challenge should bring the **best minds** to the table (voluntarily), **building and strengthening communities of innovators that are collaborative**, perhaps also extending beyond "in-house expertise".
- It can **capture the public's imagination**: teams of world-leading scientists working to solve pressing challenges can offer compelling storylines to capture the interest of media and the public.

After extensive discussion, the JSC agreed on a list of WCRP Grand Challenges. It was also agreed to prepare, by 1 March 2012, short descriptions of the Grand Challenges. The writing teams will be led by a JSC member or a WCRP Project Chair and involve all stakeholders. The list of Grand Challenges is given below. Given first and underlined is the name of the writing team leader.

- Provision of skilful future climate information on regional scales (includes decadal and polar predictability)
  Filippo Giorgi, Carolina Vera, Fred Semazzi, CLIVAR, SPARC, WMAC

- Regional Sea-Level Rise
  Konrad Steffen, WCRP/IOC Task Force on Sea Level Variability and Change, CLIVAR, CliC

- Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon)
  Vladimir Kattsov, CliC, GEWEX, Greg Flato, Sarah Gille, WGCM, WGOMD

- Improved understanding of the interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity
  Terry Nakajima, Hong Liao, Graciela Binimelis de Raga, GEWEX, SPARC, WGCM, WGNE

- Past and future changes in water availability (with connections to water security and hydrological cycle)
  Kevin Trenberth, Pius Yanda, Hervé le Treut, GEWEX, CLIVAR, WGCM

- Science underpinning the prediction and attribution of extreme events
  David Karoly, CLIVAR, GEWEX, Modelling Council, ETCCDI, Fred Semazzi

The write-ups should adhere to the standard suggested outline, as follows:

- Scientific frontiers
  - …
- Imperatives
  - …
- Focused science topics;
  - …

Dr Trenberth proposed additional ideas on the outline. He proposed to consider the following criteria in the write-ups:

- Scientific frontiers
- Are expected science results actionable?
- Are the questions behind scientific frontiers tractable?
- Imperatives and opportunities:
  - Observations
  - Models

    - Ideas
- What benefits accrue, what impacts are there?
- Links to food, water, health, disaster risk reduction, and energy (i.e. GFCS near-term priorities)

6.1 WCRP Polar Climate Predictability Initiative

Professor Shepherd presented to the JSC the progress in development of the WCRP Polar Predictability Initiative, which was proposed in the result of the science – driven WCRP Workshop in Bergen in October 2010 with results summarized in the WCRP Informal Report No. 2/2011. In April 2011, JSC-32 endorsed the plan to hold a follow-on workshop to develop an implementation plan for the initiative. It will be held on 2-4 April 2012 in Toronto, Canada. CSA is considering provision of some support for this initiative through SPARC IPO (Dr Diane Pendlebury in Toronto). Links with WWRP/THORPEX (within the WMO GIPPS) have been established. The ideas were further discussed at the IASC Atmosphere Working Group meeting in Denver, USA on 23 October 2011, which is led by Dr James Overland. Specific activities where international coordination makes a difference (the WCRP role) and there is added value with respect to existing activities will be identified. At the Toronto workshop the target group will include 30-35 participants, will represent the required science topics and partner activities, and the meeting outcome will be a draft implementation plan to be considered at the JSC meeting in July 2012.

The science questions/grand challenges considered are:

- Understanding and predicting the rate of Arctic sea ice loss
- Understanding the drivers of change in the Antarctic, including connections to ocean circulation, carbon uptake, and ice shelves.

The imperatives of the initiative will be to:

- Improve models (in coordination with WGNE, GEWEX, etc.), and
- Identify measurement needs, both for initialization and for monitoring of variability and long-term changes, which is of importance to GCOS.

Possible main science topics could be, for example:

- Ocean/ice shelf interactions,
- Response of southern ocean circulation to surface winds, and
- Seasonal predictability of the Arctic summertime sea ice.

Expected implementation mechanisms include targeted workshops, climate process teams, coordinated evaluation/assessment of data sets such as observational data sets, reanalyzes, seasonal predictions (e.g., via CHFP), and coordinated model experiments that may include historical simulations, decadal and longer timescale predictions (e.g., through CMIP), and OSSEs to help in planning observations.

The JSC was pleased to see the progress of the initiative and recommended to use the approach and terminology of this initiative for planning similar activities of the WCRP.

7. Meeting Closure

The JSC approved the WGNE special request for extension of appointment of some of its members whose term will expire at the end of 2011 and prior to the next JSC meeting in July 2012. Dr Busalacchi closed the JSC meeting at 17:00 on 30 October 2011. He thanked the JSC members, WCRP Project representatives and invited participants for fruitful and productive discussion, WCRP Secretariat for supporting the meeting, and Professor Konrad Steffen, the Director of CIRES and host of the session for outstanding hospitality and excellent support for the meeting.

As agreed by the JSC 32nd Session in Exeter, UK, the next 33rd Session of JSC will take place in Beijing, China, on 16-20 July 2012.

Annex 1: List of Participants

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Annex 2: Agenda

(Short) Joint Scientific Committee Meeting
(CIRES, Boulder, 29-30 October 2011)

Day 1

Introduction to interim JSC, JSC Chair- 30min

Each Core Project (30min presentation max, 30 min discussion) - 4h total·
- Overall goals/objective/areas of emphasis
- New directions for the project
- Areas of potential overlap/redundancy with other projects
- Potential gaps/areas of concern
- Name going forward

Recap of OSC Days 1-5 (15 min per day, 2 JSC members to be assigned task for a day with a JPS rapporteur)-1.5h with disc·
- High points
- Emerging areas
- Potential gaps for WCRP

WCRP Themes/Councils (15min presentation, 15 min discussion)-1.5h·
- Observations, analysis and information
- Modelling
- Climate Information, products and services

Initial Discussion on Future Structure (TBC at dinner)-1h

Day 2

Challenges going forward-3h
- Realistic prospect for funding
- Gaps identified at OSC, by Core Projects, and during previous day
- Crosscuts
- Regional implementation
- Atmospheric modelling

Interface with GFCS and WCRP Going Forward-3h
- Agreed upon structure
- Core projects
- Crosscuts
- Councils
- Task forces, etc

Annex 3: JSC-33 Action List

No.	Action	Responsible	Deadline
Core Projects, WGs, Panel, Council, Task Force			
	CLIVAR to provide information to JPS on requirements for scientific research on ocean and climate, with focus on • development of ocean observations (based on the results of OceanObs'09), coastal aspects (beyond sea-level rise), • oceanographic indices of climate change for coastal waters and areas, and • related capacity development.	ICPO	Immediately after the next session of CLIVAR SSG and before the IOC EC in mid-June 2012
	CliC, CLIVAR, GEWEX, and SPARC to jointly develop communications to their respective communities on their post OSC strategy. Community engagement, capacity development, support to early career scientists should be considered as a direct follow-up to the OSC. The communications should be developed in coordination between the projects and have a common 'look and feel'	Project Chairs, IPO Directors	January 2012
	Discuss the frequency and date for future OSCs	D/WCRP, C/JSC	JSC-34
	Update ToRs of memberships of WGCM, WGSIP as working groups reporting to JSC considering the newly established WMAC, WDAC, and WGRC	D/WCRP	January 2011
	Action: JSC members to send nominations to WMAC. WDAC, and WGRC to D/WCRP adhering to the guidance from Annexes 4-6 of this report	All JSC Members	December 2011
	Ensure transitioning of WOAP activities into WDAC activities and conclude the work of WOAP including thanking its members for their work and accomplishments	D/WCRP	December 2011
	Inform GCOS of transitioning of WOAP, establishment of WDAC and invite appointment by GCOS Panels of representatives to WDAC	D/WCRP	December 2011
	Ensure transitioning of corresponding CORDEX activities into WGRC activities and thanking the Task Team on COERDEX for their work and accomplishments, and establishing the small CORDEX Science Advisory Team	D/WCRP	March 2012
	CLIVAR and GEWEX communities associated with VACS and VAMOS panels to work with their constituencies and compile a list of research priorities and activities for their respective regions for the post 2013 timeframe with a view of developing a regional climate research agenda that addresses regional needs, the grand challenges and imperatives of CLIVAR and GEWEX, and the overall WCRP future plan and priorities.	CLIVAR and GEWEX (Co-) Chairs and IPOs	Report to the next JSC in July 2012

No.	Action	Responsible	Deadline
	Develop write-ups for WCRP Grand Challenges following the guidance in section 5 of this report	Identified JSC members and Chairs of WCRP Projects	March 2012
			JSC-33
Cooperation, Communication, Capacity Development			
	Establish an ad hoc Task Team of not more than 5-6 people to develop the draft agenda responding to the needs across the African continent. Identify a JPS person to support its work.	Dr F. Semazzi, Dr P. Yanda, D/WCRP	Report to the next JSC in July 2012
	WCRP should consider a blog and/or social media means for expanding the message and reach of the Programme to the WCRP community and public at large.	D/WCRP	ASAP

Annex 4: WCRP Modelling Advisory Council (WMAC)

Short Preamble

Modelling is a core activity for WCRP. Models are the main climate diagnosis and prediction tool. The three modelling and prediction groups, WGCM, WGSIP and WCRP/CAS WGNE oversee the development of various types of modelling. Every WCRP project has a set of modelling activities. The WCRP Modelling Advisory Council (WMAC) will coordinate high-level aspects of modelling across the WCRP, ensuring cooperation with main WCRP partners such as IGBP and WWRP, and act as a single entry point for all WCRP modelling activities. The WMAC will work with the WCRP Data Advisory Council to promote effective use of models with observations and address aspects of modelling in data assimilation, reanalysis, Observing System Sensitivity Experiments and in paleoclimatic research.

Terms of Reference:

1. To act as a focal point for climate modelling in WCRP.
2. To advise JSC and WCRP Projects on issues pertaining to modelling.
3. To help identify modelling aspects of the Grand Challenges and advance them.
4. To help coordinate modelling activities by identifying gaps and reducing unnecessary duplication.
5. To assess strategic priority aims for modelling across WCRP and to assess current capabilities for WCRP, in collaboration with other partners, to meet these aims.
6. To advise and recommend to JSC and WCRP Projects the activities to be carried out across WCRP projects and programs and collaborations to be developed between WCRP and other partners (including the weather community and IGBP) to meet the priority aims.
7. To facilitate and enhance the communication and the coordination across the various WCRP modelling groups.
8. To act as a clearing house for exchange of information between modelling groups and the JSC.
9. To facilitate the WCRP modelling community speak from a common voice to external bodies such as IPCC, climate services or funding agencies.
10. To convey modelling needs to Earth observing communities.
11. To assist the modelling community deal with supercomputing challenges and advise new supercomputing centers about climate modelling needs.
12. To promote scientific development of modelling aspects of data assimilation, including coupled data assimilation; coordinated development of modelling aspects of global and regional reanalyzes; and paleoclimatic research.
13. Promote seamless prediction system, model evaluation and metrics and use of ensembles.

Membership

Members will be appointed by JSC for a 3-year term with a possibility of two 2-year extensions.
Two Co-Chairs, one being independent (i.e. having no formal affiliation to WCRP modelling groups) and the other being a Co-Chair of one of the three modelling panels and working-groups (WGNE, WGSIP, WGCM). Co-Chairs would have a rotating position with a 2-year term.

The members of the WCRP Modelling Advisory Council should at least include:

- Co-chairs of remaining two WCRP modelling panels and working-groups (WGNE, WGSIP, WGCM)
- Representatives of WCRP projects (GEWEX, CLIVAR, SPARC, and CliC)
- Representative from the WCRP Data Advisory Council
- Representative from the Working Group on Regional Climate Science and Information (WGRC)

Mode of functioning

The WCRP Modelling Advisory Council is expected to:

- Communicate regularly by e-mail
- Meet once a year
- Encourage joint meetings of working groups and/or panels to promote communication or to launch focused joint initiatives
- Avoid duplicating or have overlap with existing working groups or panels

The Council should have the flexibility and resources to promote action within existing WCRP projects and panels or by appointing limited duration task teams to accomplish its tasks.

Annex 5: WCRP Data Advisory Council (WDAC)

Preamble

A combination of climate observations and models are resulting in significant amount of data and information. Research on and development of Earth observing systems, models and field experiments comprise an intrinsic part of WCRP activities and contribute to continuation and expansion of global environmental monitoring. Every WCRP project develops data and information and has a set of observation activities. The WCRP Data Advisory Council (WDAC) will act as a single entry point for all WCRP data, information, and observation activities with its sister programmes, and will coordinate their high-level aspects across the WCRP, ensuring cooperation with main WCRP partners such as GCOS and other observing programmes. WDAC will work with the WCRP Modelling Advisory Council to promote effective use of observations with models and to address issues related to the coordinated development of data assimilation, reanalysis, Observing System Sensitivity Experiments, and paleoclimatic data and their assessments.

Terms of Reference:

1. To serve as a focal point for observations and data in WCRP.
2. To advise JSC and WCRP Projects on issues pertaining to observations and climate data.
3. To promote research using sustained observations and data from process studies across the WCRP.
4. To promote assessment of the adequacy of sustained observations and derived products to support climate research.
5. To promote assessment of gaps in the global observing system in cooperation with observation programmes.
6. To promote coordinated assessment and comparison of climate-data products, including those from reanalyzes.
7. To promote research for continuing improvement in the processing and reprocessing of fundamental climate data records
8. To promote development of mechanisms for archival of, access to and analysis of data, and associated meta data, across the research community.
9. To promote standards for product generation, including global and regional reanalyzes.
10. To promote scientific development of coupled data assimilation and a coordinated approach to reanalysis across all domains.
11. To liaise with GCOS, CEOS and CGMS, as required.

Meeting schedule

The Data Council meets annually. Dates to be chosen by consensus of membership, but likely to be six months out of phase with GCOS Science Steering Committee.

Membership

Members will be appointed by JSC for a 3-year term with a possibility of two 2-year extensions.

- Chair and vice-chair (both independent)
- Representative from each of the 4 projects
- Representative from each of the 3 GCOS panels (chairs or their nominees)
- Representative of the WCRP Modelling Advisory Council
- Representative from the Working Group on Regional Climate
- Representative of IGBP
- Representative of SOLAS
- Representatives of CEOS and CGMS

Other international agencies and observations coordinating bodies may participate as observers' members of the Council.

Mode of functioning

The WCRP Data Advisory Council is expected to:

- Communicate regularly by email
- Meet in person, as needed
- Encourage joint meetings of working groups and/or panels to promote communication or to launch focused joint initiatives

WDAC should have the flexibility and resources to promote action within existing WCRP projects and panels or by appointing limited duration task teams to accomplish its tasks.

Annex 6: Working Group on Regional Climate (WGRC)

Preamble

The demands for scientifically-based climate information is growing rapidly, spurred by the increasing recognition that human-caused climate change is a serious issue for all countries, that it will continue even with intense mitigation efforts, and that adaptation to changing climate is necessary in order to minimize negative impacts and capitalize, where possible, on positive impacts. Detailed regional climate information (both historical and future) is required to develop policies, to assess impacts and risks, and to plan adaptation measures (e.g. changes to building codes or infrastructure planning). In addition, recent progress in climate prediction, on time scales from months to years, offers the possibility to implement better near-term decision making in climate-sensitive areas such as agriculture, transportation, tourism, energy production and water resource management. Furthermore, coordinated regional modelling and observational studies can lead to an increased understanding of, and ability to simulate, processes that are important in determining regional climate variability and change, and in realizing the potential for improved regional-scale climate predictions.

In order to better equip countries with suitable regionally-specific climate information, the WMO is implementing the Global Framework for Climate Services (GFCS). An important aspect of this Framework is the research that underpins climate information products and services. It is the role of the World Climate Research Programme (WCRP) to coordinate this research internationally; the WCRP is therefore taking steps to ensure that its research is informed by and responsive to the needs of climate service providers and the users they serve. The research activities that the WCRP has been involved in have contributed in important ways to improving our knowledge of the climate system, and to our ability to make quantitative predictions of future climate at global and regional scales.

Over the past two or three years, the WCRP Joint Scientific Committee (JSC) has been deliberating on ways to improve communication with, and connection to, the GFCS. A white paper of the role of the WCRP in climate services was prepared for the JSC XXXII meeting in Exeter, and the WCRP Task Force on Regional Climate Downscaling has been actively discussing the issues of improving regional climate science and information. Following on from these deliberations, it was agreed that the WCRP should institute a working group dedicated to this topic. This would serve to prioritize and coordinate regional climate research within the WCRP and serve as the conduit for two-way information exchange between the WCRP, the rest of the GFCS, and the various institutions and coordinating bodies that provide climate services in various regions.

Terms of Reference

The roles of the WGRC are as follows:

1. To facilitate coordination of WCRP research activities relevant to the provision of regional climate information and related climate services.
2. To foster communication between the WCRP and the GFCS and ESSI, and to serve as the point of contact to regional climate information/service entities. Ensure that the research needs of end users are understood and that new developments in climate science are communicated to users. This is fundamentally a two-way communication and development activity.
3. To provide advice to the WCRP regarding prioritization of research activities directed at supporting and improving regional climate science and prediction.
4. To provide advice regarding the provision of information for impact assessment, decision making and climate services, particularly as related to water, health, food and disaster risk reduction.

5. To oversee specific WCRP regional climate research initiatives such as the Coordinated Regional Downscaling Experiment (CORDEX), and other activities as may be established in the future, either independently or in collaboration among the WCRP Projects or with other sister research programmes (e.g. IGBP, IHDP, WWRP, etc.).
6. To ensure that regional climate science is a visible activity within the WCRP and that research results are communicated effectively to climate service institutions. This may involve preparation of web-based information, publication of reports, organization of targeted workshops, etc.
7. To liaise as appropriate with other relevant weather, oceanographic, climate and global change research programmes sponsored by the WMO, IOC, and ICSU, and communicate science priorities to funding agencies, NGOs and development agencies.

Membership

Members will be appointed by JSC, based on nominations, for a 3-year term with a possibility of two 2-year extensions.

Co-Chairs – appointed by JSC, based on advice from the Working Group members. One co-chair is to be from regional climate science (i.e. providers of climate information) and the other from climate information systems (i.e. users of climate information).

At least one member drawn from each of the core projects, plus 6 others chosen so as to provide representation from the priority areas of the GFCS and ESSI, geographic balance, and representation of the following scientific areas:

- Regional climate downscaling;
- Regional climate process research;
- Regional climate observations;
- Climate prediction research or operation;
- Regional climate change impact assessment;
- Climate service provision;
- The adaptation/vulnerability and/or socio-economic community;

Ex-officio: JSC member serving as JSC liaison.
Ex-officio: chair of the CORDEX Science Steering Group.
Ex-officio: representative of WCSP.
Ex-officio: representative of WCRP Modelling Advisory Council.
Ex-officio: representative of WCRP Data Council.

List of example bodies with which the WGRC would endeavour to promote active communication:

- WMO Commission on Climatology
- World Weather Research Programme (WWRP) which has established an activity on Societal and Economic Research Applications;
- United Nations Development Programme (particularly their Environment and Security Initiative);
- WMO Disaster Risk Reduction Programme;
- WMO World Climate Programme, particularly the Global Producing Centres of Long Range Forecasts (GPCs), the Regional Climate Centres (RCCs) and the Regional Climate Outlook Forums (RCOFs);
- ICSU new initiative of ESSI and Regional Offices
- IOC regional activities and organization

Annex 7: Examples of Current Regional Projects and Organizations: Lessons Learned

There a several different types of regional projects/organizations with different foci and approaches that have been implemented over the past several decades. We provide several examples below with some subjective assessments of the approaches used and effectiveness of their implementation.

The examples provided below fall into four categories with their attendant attributes;

1. **Scientific**
2. **Organizational**
3. **Capacity development**
4. **Science-Policy Assessments and Communication**

The majority of examples described below fall into the first category. This is an area where WCRP and affiliated Projects and partners have the most experience. The best examples of second category include the ICSU, WMO and IOC regional offices and associations. The third category includes a variety of different approaches developed by independent regional organizations such as the Asia-Pacific Network for Global Change Research and the Inter-American Institute for Global Change Research. WCRP has some experience in working collaboratively with these sister organizations. These organizations have an excellent regional network of institutions and experts in the region and WCRP offers access to its network of scientists and Projects for conducting training and development on topics of interest to these regions, e.g. seasonal climate prediction, droughts, etc. The fourth category of activities are usually organized through sponsorship / partnership with national and international organizations and centers in form of research dialogue, science-policy dialogue, and/or public communication and outreach (e.g. the EU sponsored Project in partnership with IPCC, START and three national centers in Tanzania, Ghana and Nepal). A brief description of each is provided below. The description of these activities and their assessment follow three themes; 1) Background; 2) Key reasons for success; and 3) Major shortcomings.

I. Regional Science Projects

VAMOS

Background:

After several years of focus on the Asian monsoon, the US under the NRC Panel GOALS, which preceded CLIVAR, recommended a focus on the Americas. Subsequently GOALS became part of CLIVAR and there was both an international and a US CLIVAR. Further, VAMOS got off the ground because key scientific leaders rallied the regional climate community and were able to tap into significant support from NOAA through US CLIVAR channels. VAMOS organized the successful SALLJEX field campaign, VOCALS and NAME, each of which addressed important shortcomings in our understanding of climate dynamics in the region.

The La Plata Basin (LPB) project is much broader and has an interdisciplinary approach that addresses climate and hydrology with direct societal implications, and it has been successful in garnering support from international agencies like EU (CLARIS-LPB), IAI, CIC/GEF, and more than two dozen regional projects.

VAMOS has a regional “extremes” focus which has some momentum.

Key reasons for success:

a) Considered a priority owing in part to past neglect, following on from TOGA
b) highly motivated science leadership
c) US /EU funding

d) Local IPO staff person
e) Relatively small community of researchers who were ready to work together and who see the advantage of being part of a CLIVAR (and/or GEWEX) project
f) Strong participation by young scientists
g) Capacity building and outreach elements in all projects

Major shortcomings:

a) VAMOS has lost a considerable amount of its original momentum due largely to a shift in funding priorities in the USA and focus on funding climate-change/ IPCC – related activities in Latin American countries.

Opportunities:

a) Climate services
b) Closer links with global modelling groups

AMMA

Background:

AMMA built on strong engagement of France in the region, as a follow up to a series of successful field experiments in North America and Europe. A few individuals from outside the region worked very hard to garner significant funding support from several additional developed countries. AMMA focused on poorly understood hydrology and climate/weather dynamics of the region, but also had many cross disciplinary efforts that addressed societal issues.

Key reasons for success:

a) scientific leadership and motivation from the onset
b) good field programme
c) many opportunities for local researchers to be involved and to get advanced degrees
d) involvement of local universities, as well as met services
e) good outreach

Major shortcomings:

a) AMMA does not seem to have overcome the problem of data sharing
b) Despite large number of recent Phd students in the region, climate research limited, due in part to limited funding
c) In AMMA II central countries are off limits to westerners due to security concerns and AMMA II will not develop a strategy for the African monsoon.

Asia – CliC

Background:

Asia-CliC is a regional project of CliC focusing on alpine cryosphere in mountainous Asia and on permafrost in Mongolia and China.

Key reasons for success:

a) steady progress towards scientifically sound monitoring of glaciers and their change in high elevation regions of Asia

Major shortcomings:

a) Active in China and Japan, not so active in other countries in the region

CEOP-High Elevations Project

Background:

Global project of CEOP with focus on energy and water cycle in mountainous regions

Major shortcomings:

a) Has not really taken off

NEESPI

Background:

NE Eurasia project of CEOP and ESSP with focus on every aspect of Earth System science in the region

Key reasons for success:

a) helped to support Earth System science in the region, especially in Russia
b) generated significant funding, visibility, achieved recognition
c) well funded by NASA and other agencies
d) partnership between IGBP and WCRP

Shortcomings:

a) was a collection of individual sub-project without over arching science strategy
b) was unable to meet CEOP accepted standards for RHPs
c) Could use more interactions with CliC

BALTEX

Background:

Has grown from a focused GEWEX project into an integrated regional study:

a) BALTEX Phase II (2003-2012) objectives are:
    1. Better understanding of the energy and water cycles over the Baltic Sea basin.
    2. Analysis of climate variability and change since 1800, and provision of regional climate projections over the Baltic Sea basin for the 21st century.
    3. Provision of improved tools for water management, with an emphasis on more accurate forecasts of extreme events and long-term changes.
    4. Gradual extension of BALTEX methodologies to air and water quality studies.
    5. Strengthened interaction with decision-makers, with emphasis on global change impact assessments.
    6. Education and outreach at the international level.

Key reasons for success:

a) existence of focused and highly developed science community in the region
b) strong support and interest from the national governments in the region

c) BALTEX addressing issues of direct interest to governments/society and of direct importance for the regional (Helsinki) Commission
d) close links to hydromet services in the region as well as university researchers
e) many scientific publications
f) regional science conferences every two years

Major shortcomings:

a) The project seems to have a life of its own – not sure this is a shortcoming, but could be seen as such if WCRP wanted to redirect it
b) The next phase of BALTEX is going in different directions and may not be an RHP.

Monsoon Crosscut

Background:

Top down idea initiated years ago by JSC, D/WCRP

Key reasons for success:

a) CLIVAR AAMP modelling focus and Indian ocean Panel development of ocean observing network in the region (both efforts independent of the crosscut):
    1. AMY 2007-2012 has been deemed a success in the Asian region and has built bridges between AAMP and MAHASRI
    2. There has been some learning of how to do things from other RHPs.

Major shortcomings:

a) Focus has been only on Asia; lack of focus and inadequate scientific leadership for global effort
b) Many competing/overlapping national and regional efforts with strong links to national funding
c) Attempts to focus the effort, for instance on monsoons in a changing climate or monsoon breaks, have not developed into any coordinated scientific approach – no leaders found; researchers in the regions seem happy to focus on their national/regional projects. They attend many monsoon meetings where they all meet, but no new directions/coordination/synthesis emerges from these efforts.

Opportunities:

a) link AMY reanalysis with global efforts
b) iIITM Pune conference to focus on monsoons in a changing climate

VACS

Background:

CLIVAR attempted to develop a climate research programme for Africa since its inception, but with limited success. Many important climate questions of importance to the region and globally, but no coordinated studies under a WCRP banner (excepting AMMA which was more oriented toward land rather than the ocean and quite independent of VACS).

Major shortcomings:

a) Too few scientists both in the region and outside who have time/interest to organize a coordinated climate research effort
b) Lack of funding for research in the region

c) Specific scientific foci that are ripe for research (and funding) have not been identified and/or developed into coordinated research efforts
d) Inadequate cross fertilization with GEWEX RHPs

II. Regional Organizations/Project Offices

The three WCRP sponsors support regional activities through different mechanisms, but their intent is to serve their Members and constituencies at the regional level.

For example, six WMO Regional Associations operate under the WMO Regulations. They are responsible for the coordination of meteorological, hydrological and related activities in Region I (Africa), Regional II (Asia), Region III (South America), Region IV (North America, Central America and the Caribbean), Region V (South-West Pacific) and Region VI (Europe). WMO Executive Council Expert Team on Polar Observations, Research and Services (PORS) coordinated WMO activities in the polar region.

WMO Regional Offices and WMO Offices mobilize resources, build partnerships and are responsible, together with WMO scientific and technical departments and other partners, for the implementation of regional technical cooperation, and support to developing countries. They also support regional associations, develop and implement technical cooperation projects and programmes in support of National Meteorological and Hydrological Services, liaise with regional institutions and organizations. There are the following Regional Offices at the WMO Secretariat:

1. Regional Office for Africa (RAF)
2. Regional Office for Asia and the South-West Pacific (RAP)
3. Regional Office for the Americas (RAM)
4. Regional Office for Europe (EUR)

In addition, WMO operates eight other offices in different regions, globally:

1. WMO Office for North, Central and West Africa (Lagos, Nigeria)
2. WMO Office for Eastern and Southern Africa (Nairobi, Kenya)
3. WMO Office for West Asia (Manama, Bahrain)
4. WMO Office for the South-West Pacific (Apia, Samoa)
5. WMO Office for South America (Asunción, Paraguay)
6. WMO Office for North America, Central America and the Caribbean (San José, Costa Rica)
7. Brazil Project Office (Brasilia)
8. Mexico Project Office (Mexico City)

ICSU has three regional offices, in Africa, Asia-Pacific, and Latin America and Caribbean. They have certain regional science priorities, as follows:

1. **Africa:**
    - sustainable energy
    - natural and human-induced hazards and disasters
    - health and human wellbeing
    - global environmental change (including climate change and adaptation)
2. **Asia and the Pacific:**
    - sustainable energy
    - ecosystem approach
    - hazards and disasters
    - earthquakes, floods and landslides
    - special vulnerability of islands
3. **Latin America and Caribbean:**
    - sustainable energy

- natural disasters
- education in mathematics
- biodiversity

The recent review of the ICSU Regional Office for Africa (available from a password-protected member's part of the ISCU website) highlighted several issues concerning the Office performance which resulted in some re-organization of this office.

IOC of UNESCO also has some regional activities, which include two regional sub-commissions, in Caribbean and West Pacific, regional committees including Central Indian Ocean, Western Indian Ocean, Central Eastern Atlantic and the Black Sea. There are two Regional Programme Offices: GOOS Office in Rio-de-Janeiro and IOC Perth Office.

Under the Earth System Science Partnership (ESSP) a concept of Integrated Regional Studies (IRS) was proposed. MAIRS Monsoon Asia Integrated Regional Study is the first IRS. The WCREP/GEWEX/CEOP BALTEX project is effectively fulfilling a role of IRS encompassing not only climate studies but issues dealing with environment protection, governance, etc.

The IOC/WMO/UNEP/ICSU GOOS (Global Ocean Observing System) implements its coastal module through GOOS Regional Alliances, which are all at different stages of development including:

- IOCARIBE-GOOS
- GRASP (Regional Alliance for the South Pacific)
- OCEATLAN (Upper Southwest and Tropical Atlantic)
- US GOOS
- PI-GOOS (Pacific Islands)
- NEAR GOOS (North East Asia)
- IOGOOS (Indian Ocean)
- SEA-GOOS (South East Asia)
- EuroGOOS
- Black Sea GOOS
- MedGOOS
- GOOS-Africa
- WAGOOS (western Australia)

UNEP is facilitating a system of regional conventions focussing on regional environmental protection and is also running a number of different regional activities in line with its sustainable development mandates.

III. Regional research and analysis capacity development

Climate Observations and Regional Modelling in Support of Climate Risk Management and Sustainable Development in the Greater Horn of Africa

Project Objectives:

1. Networking of regional and global climate experts and the adaptation community through the organization of three phased workshops.
2. Recommendations on how to improve and increase the data available from the region, particularly as a means to improve the regional and global analyses.
3. An assessment of how well global and regional climate model outputs for the region agree with available data, and guidelines on best practices in evaluating the available modelling techniques for use in making climate change projections.
4. Final report including guidelines and best practices in the use and interpretation of climate observations and model outputs for the adaptation and climate risk management communities.

Lessons Learned:

The project was designed and implemented around 3 linked workshops to provide the GHA participants including users with the tools for adaptation analyses. The concept is sound, though we identified some areas of practical improvements.

Organizing the workshops proved to be challenging because of politics and processes that emerged during the course of the Project implementation, though they were completed. Coordinating the schedules of the experts with the regional activities was difficult and led to delays and changes in the original plan. An extension in the duration of the project would have been beneficial to allow more time to apply impact models to specific sectoral applications, but this was not granted by the sponsoring organization.

No follow activities are currently planned thus this Project similar to other ones conducted by many other organizations would not have the desired long-term impact due to its limited duration, even though it was a conducted over three years.

We were successful in adopting the materials and process developed for the Horn Africa and apply the to regional capacity development in West Africa with the help from some African scientists and through a partnership with UNDP and WMO Regional Program.

IV. Regional science-policy assessments and communication

Baseline knowledge assessment for the Integrating Climate Change Mitigation and Adaptation in Development Planning Project-Ongoing

Project Focus and Expected Outcome:

Regional knowledge assessments will be conducted in West Africa, East Africa, and South Asia in 2011 and 2012 through a partnership between the WMO/WCRP, IPCC, UNEP, START, the University of Ghana, University of Dar es Salaam and the Bangladesh Centre for Advanced Studies. The effort is being supported through a European Commission, UNEP, USAID and USGCRP-funded project entitled '*Understanding the Findings of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, Climate Change 2007 - Integrating Climate Change Adaptation and Mitigation in Development Planning'*.

The regional knowledge assessments will utilize key findings of the IPCC 4th Assessment Report, *Climate Change 2007*, as the basis upon which to frame issues of climate change impacts, vulnerability, adaptation and mitigation, and will draw upon a wide array of additional sources, including peer reviewed literature published since the 4th Assessment Report pertaining to regional issues, grey literature (i.e. institutional or technical reports, working papers, theses, conference proceedings, statistical bulletins, etc.), and peer-reviewed literature published in non-English languages, which are not normally assessed by the IPCC. The assessments will collect and synthesize available knowledge on region and country specific issues of relevance to climate change adaptation and mitigation decision-making, identify knowledge gaps that are critical to decision-making, and prioritize research and assessment needs for adaptation and mitigation decision support.

The results, which will be presented in regional knowledge assessment reports as well as in peer-review articles, can be used to guide planning and implementation of regional vulnerability and adaptation research, and they will lay important groundwork for more extensive and insightful treatment of regional scale issues in the IPCC 5th Assessment Report. It is furthermore expected that the reports will be valuable documents for policy deliberations that can provide information that is more regionally and nationally specific than is provided by the 4th Assessment Report. This is critical for enabling science-

based decision-making that is responsive to and appropriate for national circumstances, policies and development goals.

Summary

The description of regional projects, organizations and activities that are provided in the previous section is intended to convey the diversity of foci, objectives and implementation approaches used and lessons learned from them during the past few decades. As the focus for the majority of regional activities is shifting from mainly science to greater applications of the resulting knowledge by a wide range of users and decision makers a need for greater cooperation and partnership with global, regional and national entities with different mandates is evident. These kinds of interactions have been present in several RHPs. Such arrangements offer great opportunities for partnership and access to their existing networks and resources to carry out these activities successfully and realize efficiently their desired outcome and impact. Such partnerships also present the challenge of competing priorities and mandates that may not be congruent entirely with science priorities, per say, and the activities become more applications and policy prescriptive than purely motivated by science. However, based on the limited number of cases during the past few years the interest and support for such efforts is very strong and we do not see any sign of this support diminishing in the near- to mid-term. We also observe that most of the solicitations for funding research at the national and international level will emphasize availability and use of science knowledge as compared with generating the knowledge at least during the next several years. However it should not be either/or, but rather a more end to end approach to ensure the applications of the science and technology transfer occur.

The greatest challenge in the near-, mid- and long-term is the lack of available scientific and technical experts who can spearhead these efforts to establish sound scientific foundation for organizing and conducting such regional activities to develop and deliver the requisite science-based analysis and assessments for the decision makers. Training and development of research capacity must be an integral part of WCRP coordinated regional efforts, especially for the regions that are most vulnerable to the adverse impacts of climate variability and change.

The newly established WCRP Working Group on Regional Climate Information and Application can make significant contributions in this area by facilitating and coordinating some activities in this regard, especially through partnership with WCRP regional and international programs such as the APN, IAI, START, etc. in the near future. There is a strong interest on part of the NGOs and other international organizations for investing in the capacity development aspect of such activities.

Annex 8: Acronyms

AAMP	Asian – Australian Monsoon Panel
AC&C	Atmospheric Chemistry and Climate
ACC	Anthropogenic Climate Change
AIMES	Analysis, Integration and Modelling of the Earth System
AIP	Atlantic Implementation Panel
AMMA	African Monsoon Multidisciplinary Analysis
AMY	Asian Monsoon Years
AOPC	Atmospheric Observation Panel for Climate
ASPeCt	Antarctic Sea Ice Processes and Climate
BGS	British Geological Survey
CCl	Commission for Climatology (WMO)
CEH	Centre for Ecology and Hydrology
CFC	Chlorofluorocarbon
CIRES	Cooperative Institute for Research in Environmental Sciences
CliC	Climate and Cryosphere
CLIVAR	Climate Variability and Predictability
CMIP	Coupled Model Intercomparison Project
CNRS	Centre National de la Recherche Scientifique
COP16	Conference of the Parties
CORDEX	Coordinated Regional Climate Downscaling Experiment
DynVar	Modelling the Dynamics and Variability of the Stratosphere – Troposphere System
EA	Environment Agency
EC	European Commission
ENSO	El Nino Southern Oscillation
ESA	European Space Agency
ESSI	Earth System Sustainability Initiative
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FAME	The Framework for Atmospheric Model Enhancement
GASS	GEWEX Atmospheric System Study
GCM	General Circulation Models
GCOS	Global Climate Observing System
GEWEX	Global Energy and Water Cycle Experiment
GFCS	Global Framework for Climate Services
GLASS	GEWEX Global Land – Atmosphere System Study
GSOP	Global Synthesis and Observations Panel
IASC	International Arctic Science Committee
ICPO	International CLIVAR Project Office
ICSU	International Council for Science
IGAC	International Global Atmospheric Chemistry
IGBP	International Geosphere-Biosphere Programme
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change

IPSL	Institut Pierre Simon Laplace (de recherché en sciences de l'environnement)
IRI	International Research institute for Climate and Society
ITCZ	Intertropical Convergence Zone
JPS	Joint Planning Staff
JSC	Joint Scientific Committee
ISMASS	Ice Sheet MASs balance and Sea level
MAHASRI	Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative
NASA	North American Space Agency
NCAR	National Center for Atmospheric Research
NSF	National Science Foundation
NOAA	National Oceanic and Atmospheric Administration
OOPC	Ocean Observations Panel for Climate
OSC	Open Science Conference
OSSE	Observing System Sensitivity Experiment
RCOF	Regional Climate Outlook Forum
RHP	Regional Hydroclimate Project
SCAR	Scientific Committee on Antarctic Research
SEARCH	Study of Environmental Arctic Change
SOLAS	Surface Ocean Lower Atmosphere Study
SPARC	Stratospheric Processes and their Role in Climate
SSG	Scientific Steering Group
TFRCD	Task Force on Regional Climate Modelling and Downscaling
US GCRP	US Global Climate Research Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VACS	Variability of the African Climate System
VAMOS	Variability of the American Monsoon System
WCRP	World Climate Research Programme
WMAC	WCRP Modelling Advisory Council
WDAC	WCRP Data Advisory Council
WGCM	Working Group on Coupled Modelling
WGNE	Working Group on Numerical Experimentation
WGOMD	Working Group on Ocean Model Development
WGRC	Working Group on Regional Climate Science and Information
WGSIP	Working Group on Seasonal to Interannual Prediction
WMO	World Meteorological Organization
WOAP	WCRP Observation and Assimilation Panel
WWRP	World Weather Research Programme