WCRP REPORT

World Climate Research Programme

Report

World Climate Research Programme (WCRP)

Report of the twenty-ninth session of the Joint Scientific Committee for WCRP (Arcachon, France, 31 March-4 April 2008)

June 2008

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WORLD CLIMATE RESEARCH PROGRAMME (WCRP)

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Table of contents

1. Introduction 1
2. Opening of the JSC's twenty-ninth session 1
3. Review of WCRP cross-cutting activities 2
3.1 Atmospheric chemistry and climate (AC&C) 2
3.2 Anthropogenic climate change (ACC) 3
3.3 Seasonal prediction 4
3.4 Decadal prediction 5
3.5 Monsoons 6
3.6 International Polar Year 2007-2008 8
3.7 Sea-level rise 9
4. Climate extremes 10
5. Review of WCRP projects 16
5.1 GEWEX 16
5.2 CLIVAR 19
5.3 SPARC 21
5.4 CliC 23
6. Review of WCRP panels and working groups 27
6.1 WCRP Modelling Panel and the Modelling Summit for Climate Prediction 27
6.2 White paper on revolution in weather, climate and Earth System prediction 287
6.3 WGCM 29
6.4 WGNE 29
6.5 Regional climate downscaling 30
6.6 WGSF and SOLAS 32
6.7 WOAP 33
6.8 GCOS/AOPC/OOPC/TOPC 34
7. Review of other activities of WCRP and its partners 34
7.1 ESSP 34
7.2 START 35
7.3 WWRP/THORPEX 35
8. World Climate Conference 3 37
9. Geoengineering 39
10. WCRP strategy and development before and beyond 2013 41
11. WCRP budget 44
12. Summary of actions to be taken 44
13. Composition of committees 44
13.1 JSC composition 44
13.2 Composition of project SSGs and working groups/panels 45
14. Scientific lectures 49
15. Closure of the session 50
16. Expression of appreciation, acknowledgement 51

Appendices
Appendix 1. Meeting participants
Appendix 2. Final agenda
Appendix 3. List of documents submitted to the session
Appendix 4. JSC-29 recommendations, decisions, action items
Appendix 5. List of used acronyms

1. Introduction

At the kind invitation of Dr H. Le Treut, a member of the Joint Scientific Committee (JSC), the 29th Session of the JSC took place at the Convention Centre, Arcachon, Region Aquitaine, France, from 31 March to 4 April 2008. Local organisation, support and input to cover the meeting expenses came from the WCRP Strategic Support Unit at IPSL.

Several French organisations cosponsored the event. They are:

- Agence de l'Environnement et de la Maîtrise de l'Energie
- Centre National d'Etudes Spatiales
- Centre National de la Recherche Scientifique
- Région Aquitaine
- Mairie d'Arcachon
- Mairie de Bordeaux
- Météo-France

The Meeting had two main objectives:

- to discuss the future direction of the WCRP development focussing :
    - in the intermediate-term on implementing the WCRP's Strategic Framework "Coordinated Observations and Prediction of the Earth System" (COPES), and
    - in the long-term on strategic direction and organisation of WCRP; and
- to prepare for the ICSU-sponsored review of WCRP in 2008-2009.

2. Opening of the JSC's twenty-ninth session

The JSC Chair, Dr J. Church, opened the meeting on Monday, 31 March 2008. He welcomed the participants (listed in Appendix 1), thanked the local hosts for hosting the JSC in Arcachon, and particularly thanked Herve Le Treut and Catherine Michaut for the local organisation. He then gave the floor to Dr P. Delecluse who welcomed the Committee on behalf of the French hosts and sponsors of the session and the French meteorological and climate research community.

Drs L. Barrie, L. Goldfarb, and P. Bernal welcomed the JSC on behalf of the three Sponsors of WCRP, WMO (World Meteorological Organization), ICSU (International Council for Science), and IOC (Intergovernmental Oceanographic Commission) of UNESCO (United Nation Educational, Scientific and Cultural Organization).

Dr Barrie welcomed the JSC on behalf of the WMO Secretary-General, Mr M. Jarraud, and introduced to the JSC the new WMO Secretariat structure and the new position of the WCRP Secretariat, the Joint Planning Staff (JPS), which is now a part of the Research Department together with the Atmospheric Research and Environment Branch. The WMO new strategy is founded on results-based management, and WCRP should contribute to the Expected Result no. 2: "Enhanced capabilities of (WMO) Members to provide better climate predictions and assessments".

Dr Goldfarb welcomed the JSC on behalf of ICSU Executive Director and provided an update on the WCRP and IGBP reviews and the plans to complete them. The WCRP review is co-sponsored by ICSU, WMO, IOC, and IGFA, and the IGBP review is co-sponsored by ICSU and IGFA. The main goal of the reviews is to determine the added value of the programmes for the international global change and climate research communities and how to further assist the programmes in fulfilling their respective mission in the future. The final report of the WCRP review should be available in February 2009. On behalf of ICSU, Dr Goldfarb encouraged direct input of WCRP to this review process. She also informed the JSC that ICSU had completed a review of ESSP, which reconfirmed a need for a strong ESSP with WCRP being a highly enthusiastic partner in it. She invited WCRP to participate in the 29th General Assembly of ICSU (21-24 October 2008 in Maputo, Mozambique), especially in the session to be devoted to global environmental change research (23 October 2008).

The Executive Secretary of IOC and Assistant Director-General of UNESCO Dr Bernal attended the entire session of JSC. His participation and feedback provided to the JSC during the meeting conveyed the importance of climate system research that WCRP coordinates on behalf of IOC/UNESCO. At the opening session he stated that IOC believes in the critical role that WCRP plays in guiding science for the Commission and that IOC depends on WCRP for developing the ocean science component of the climate system. Climate change has become an integral part of the IOC agenda, and the overall tendency is now to move towards climate services. A major issue of concern for IOC is that a large part of the ocean observing system is financially supported using research funding, which is not an adequate base for its reliable and sustained operation.

The JSC Chair, Dr Church, opening remarks included the WMO Secretary-General's congratulations to the many Nobel Peace Prize winners present in the room. He stated that the WCRP received strong support from the 15th WMO Congress. He then outlined tasks and challenges for the meeting. JSC should focus on discussion of the future path for the WCRP, ways of implementing its Strategic Framework and ensuring that WCRP has adequate support (commitment, people, funds, etc) to implement COPES. Continuation of the good work by the projects is important, but not sufficient. WCRP also needs to synthesise regularly the state of scientific knowledge in Earth's climate system and deliver this to the decision makers and users. JSC needs to discuss the future of WCRP, post 2013. Dr Church was aware of a concern regarding the consequences of the restructuring of the WMO Secretariat and its perceived negative impact on climate programmes at WMO. He stressed that he received assurances that WMO sees *climate* as an important element of its forward strategy and intends to communicate the importance of climate information services to a broader community.

Dr Church then introduced to the JSC the new WCRP Director, Dr G. Asrar, who took the post of D/WCRP at the end of March 2008. Dr Asrar welcomed the participants and expressed his excitement about taking up the role of D/WCRP and a wish to work as part of the great team of researchers and their supporters. He said that WCRP is at a critical crossroad. It needs to assess more precisely what the knowledge it generates means to society, to organise and strengthen WCRP to move the research forward but also to make the resulting scientific knowledge readily available and accessible to those who need it. The good news is that climate science has the attention of the world community; but at the same time it represents an organisational challenge for timely dissemination of climate information and services.

The JSC warmly welcomed Dr Asrar and wished him every success in serving the climate science as D/WCRP.

The session then approved its agenda (see Appendix 2) and started the main discussions of the session by reviewing the WCRP cross-cutting activities. The subsequent chapters review the reports, presentations and their discussions. Appendix 3 contains a list of working documents submitted to the Session. Actions resulting from the discussions are given in Appendix 4. Appendix 5 contains a list of used acronyms.

3. Review of WCRP cross-cutting activities

3.1 Atmospheric chemistry and climate (AC&C)

Dr A.R. Ravishankara presented the Atmospheric Chemistry and Climate crosscut on behalf of his co-authors, Drs P. Rasch and S. Doherty.

The presentation started with the motivation for AC&C, which was illustrated by the IPCC radiative forcing diagram showing the main radiative forcing agents. The main objectives of the initiative are: 1) understanding the role of emissions on atmospheric composition, 2) linking the concentrations to radiative forcings and climate change, and 3) improvement of representation of related processes in models. AC&C builds on existing/ongoing activities like AeroCom, CCMVal, HTAP, and ACCENT but adds value to all of these activities. A new activity will be TropChem, which will focus on key tropospheric chemistry processes. The emphasis in Phase 1 of the initiative is on modelling of aerosols (formation, transformations, cloud interaction, photolysis, and reactivity), ozone and deposition processes and emissions (the latter mostly with GEIA). At the AC&C workshop on 9-13 June 2008 in Washington, DC, USA, details of the model runs for each AC&C activity will be decided upon with the active engagement of the community.

AC&C has already found solutions for data storage and exchange, and a way to provide observational data for comparison with models (a NASA project with the participation of other agencies). It is in the process of establishing a "Measurement Evaluation Panel". Funds from US agencies to support AC&C are being solicited and the European funding depends on the evolution of the ACCENT project. The major challenge for AC&C is a need to enhance its visibility through briefing of national program coordinators and funding agencies to ensure the needed attention and support in various countries.

The discussion covered a wide range of issues. There was general recognition that AC&C was working very well. This view was reinforced by IGBP representatives who were very enthusiastic about AC&C from both a scientific and organizational perspective. The JSC was of the opinion that AC&C provided a good model for a WCRP/ESSP crosscut.

Other subjects covered during the discussion included:

- should AC&C consider models driven by observed meteorology;
- the timelines by which uncertainties will be reduced to feed into assessments, e.g., the next ozone depletion assessment and possible AR5;
- the need for AC&C to consider capacity building;
- what the end point of AC&C will be in 3-5 years from now and how it will feed into coupled climate models;
- the fact that the structure of the aerosols can affect seasonal and intra-seasonal predictability and hence the need for a dataset on aerosol structure for the community to use;
- the difficulty of dealing with high pollution episodes;
- overlap with ACC in the area of concentrations of chemically active greenhouse gases and cloud effects on aerosols;
- the potential for co-operation with SOLAS; and
- links with the human health issues which may be important, e.g., for the next IPCC report.

Several proposals were made on how AC&C could interact with other groups. Possible candidates were the iLEAPS/IGAC/GEWEX initiative on "Aerosols, Clouds, Precipitation and Climate" (ACPC) and the Global Atmosphere Watch (GAW). Having noted all expressions of support and interest, the crosscut leadership expressed the strong belief that, noting the very limited resources available, it was very important to keep the existing level of commitment of the scientists involved. It was recognized that AC&C is a small focused cross-cutting activity and hence does not have the ability to cover all the possible research areas. It was suggested that one way to overcome this limitation is to coordinate these activities with national programmes/initiatives.

3.2 Anthropogenic climate change (ACC)

Dr H. Le Treut presented the Anthropogenic Climate Change crosscut and identified two key issues: regional aspects of climate change and sea level rise. He also reported that the WCRP Strategic Support Unit at IPSL in Paris helped to organise several WCRP meetings including the JSC session in Arcachon. The Unit was willing to continue its work for the WCRP and COPES, and Dr Le Treut offered to host up to two workshops every year focussed on anthropogenic climate change. The JSC warmly thanked IPSL, Dr Le Treut, the office staff, and the Centre National de la Recherche Scientifique for the excellent support provided to WCRP.

Dr Le Treut's talk was followed by a presentation by Dr V. Ramaswamy on the WCRP/GCOS/ IGBP Workshop "Learning from IPCC AR4" (Sydney, 4-6 October 2007). The workshop report is available at http://www.wmo.int/pages/prog/gcos/Publications/gcos-117.pdf. The workshop gives the highest priority to scientific developments in the following areas:

- Impacts, Adaptation and Vulnerability
- Ice Sheets and Sea Level Rise
- Hydrological Cycle
- Carbon Cycle
- Role of aerosol-cloud interactions in climate change
- A Climate Information System

In a short talk, Dr S. Planton proposed a workshop (Toulouse, February 2009) to discuss needed improvements of prediction skills for regional climate models, validation issues, conduct of group prediction evaluations, and identification of key uncertainties in all types of regional climate predictions.

The series of talks on ACC was concluded by Ms R. Lichte who reviewed research on climate change under the UNFCCC process. She referred to the decision of SBSTA to develop and maintain a dialogue with Global Environmental Change programmes and welcomed participation in this dialogue by ESSP Partners. SBSTA acknowledged the independence of research programmes and organisations in setting research priorities and highlighted the importance of the dialogue for developing countries so that they identify research gaps and capacity constraints. SBSTA invites the research communities to regularly inform SBSTA of new developments in research activities relevant to the UNFCCC. An informal meeting with relevant research programmes will take place on 5 June 2008 during SBSTA 28th Session. Ms Lichte also presented the Nairobi Work Programme (NWP). WCRP is expected to be the NWP leading partner in developing the science behind regional climate predictions and the first opportunity to engage in a dialogue on these matters will be a climate modelling, scenarios, and downscaling workshop during SBSTA-28 in Bonn on 7 June 2008.

In the discussions that followed, Prof. J. Mitchell reviewed the outcomes of the IPCC scenarios workshop held 19-21 September 2007, Noordwijkerhout, the Netherlands, which brought together the science, impacts and scenarios communities. The participants agreed on a set of four base scenarios with specified greenhouse gas concentrations. The idea was to ensure a viable approach for future IPCC assessments, which would not change from report to report, thus enabling continuity of scientific developments.

Mrs V. Detemmerman briefly reviewed a new project jointly supported by the GCOS, WCRP, the Climate Prediction and Adaptation Branch (CLPA) of WMO, and the IGAD Climate Prediction and Applications Centre (ICPAC), with the aim to assist the developing and least developed countries of Eastern Africa in producing and appropriately using climate projections in adaptation planning (see Document 8.2 for more details). The four participating programmes are collaborating to develop and implement this project with the support of the World Bank. A series of three linked workshops will be organized to demonstrate the key elements of an effective climate risk management strategy for the region. The overall objectives of the workshop series are to ensure that attention is given by countries in the Eastern Africa region to observation and data needs, to demonstrate the use and value of regional models, to provide advice on model limitations, and to improve regional capabilities for using data records and model projections for adaptation planning.

The JSC agreed that research on regional climate modelling and downscaling should be a very high priority for WCRP. Information about attributes and limitations of currently available methods is somewhat disperse and perhaps not as widely known to the community at large as it should be. Considerable research remains to be done in order to reduce uncertainties in regional climate change projections. Further research by WCRP could contribute to developing decision tools required for sustainable development and poverty reduction.

Some representatives of WCRP projects expressed disappointment that they had not been involved in the preparations of the Sydney Workshop and had not taken part in it. JSC members also felt that they would have liked the opportunity to review the Workshop report before it was published. However, in the course of discussions, the JSC members agreed that the role of the workshop was fundamentally to start the process of planning future research and the main purpose of the Workshop, which could accommodate only a limited number of participants, was to identify the research needs, mostly from IPCC WG I and WG II authors. It was agreed that WCRP projects should review this report and identify additional gaps in knowledge, see which of them may be addressed by existing activities and which require new activities. The emphasis should be on turning the ACC into a vibrant cross-cutting activity of WCRP with contributions from all the community, the projects and working groups, including WGCM.

3.3 Seasonal prediction

Dr T. Palmer reported on the WCRP Seasonal Prediction crosscut. The WCRP Position Paper on Seasonal Prediction, which constitutes the report from the First WCRP Seasonal Prediction Workshop held 4-7 June 2007 in Barcelona, Spain, was made available to the Session.

Dr Palmer presented main results of the Barcelona Workshop. The Workshop, organised by CLIVAR was attended by approximately 180 participants and covered scientific progress, future developments and use of seasonal forecasts. Additional information on the workshop is available at the following URL http://www.clivar.org/organization/wgsip/wgsip.php. The Position Paper resulting from the Workshop discusses the potential uses, achieved quality and value of seasonal forecasts. There is consensus that the existing potential of seasonal forecasts is not yet fully realised due to model errors and inadequate inclusion in forecasting schemes of interactions in the areas of science covered by GEWEX, SPARC, and CliC. It is anticipated that adequate inclusion of these components would likely improve predictive skill. While the multi-model methodology is useful for creating ensembles, it is an ad hoc approach and other, more substantive methods need to be explored to represent the model and forecast uncertainty. The participants also agreed that the use of numerical seasonal forecasts in a variety of applications provides valuable additional information on forecast skill, and that there is considerable potential for much wider application of seasonal predictions than is the case now.

The former WCRP Task Force on Seasonal Prediction initiated the design of a series of experiments to explore seasonal predictability in the wider coupled climate system. This activity is now called the Coupled Historical Forecast Project and is continuing under the auspices of the Working Group on Seasonal to Interannual Prediction. Ten modelling groups are currently involved. The experiments will provide a reference for the skill of today's seasonal forecasts, help the development of multi-model forecasting techniques, enable users to start working with numerical seasonal forecast data in a broader context, and will serve as a control for certain sensitivity experiments. The experiments are expected to conclude in 2008 and a workshop (not before autumn 2009) will review the results. Community access to model results is being elaborated and community diagnostic subprojects are encouraged. The importance of the experiments is to identify currently untapped predictability for seasonal forecasting. Running fully coupled climate system models in seasonal forecasting mode will also help in their validation.

There is significant progress in hydrological applications based on medium-range precipitation predictions, and there are prospects for obtaining successful results at monthly time scales. The quality of seasonal precipitation prediction still limits the possibilities of its extensive use in hydrological applications but once the progress in seasonal forecasting has been achieved, they will be able to serve as a platform for building skill on decadal scales.

As well as GEWEX, Dr Palmer called on SPARC and CliC to provide input to the experiments. There are large errors in representation of the stratosphere and sea ice in current seasonal predictions (usually based on the use of climatological information only). Interaction and guidance are needed to develop and interpret appropriate additional model experiments. He also stated on behalf of the participants in the experiment that an 18-month schedule of WGSIP meetings slows down work progress.

The JSC was interested to know if WGSIP was taking into account the record low ice cover in the Arctic and its possible impact on seasonal forecasts. The position of the speaker was that the only truly useful approach to answer this question would be to use fully-coupled models with sea ice, which was not generally the current practice.

3.4 Decadal prediction

Dr J. Marotzke presented the progress of the WCRP study on decadal predictability. The talk by Dr Marotzke was co-authored by Dr H. Cattle.

Dr Marotzke stated that decadal prediction requires understanding of climate system variability, predictability and anthropogenic climate change. Progress on the two overall WCRP objectives is therefore a precondition for developing decadal prediction, a meeting ground for weather and climate research communities and an area which should strongly benefit from the developments in seamless forecasting systems. Decadal prediction research represents a huge scientific challenge.

WCRP research on decadal predictability is a vibrant effort. A significant part of it is organised through a WGCM/WGSIP ad-hoc group, which benefits from participation of Drs T. Stockdale and G. Hegerl (lead), T. Palmer and other scientists. The group is planning to assess the skill of decadal predictions and is pursuing two main pathways to achieve this: namely to organise experiments on short-term prediction of climate for the next 30 years, to 2030 or 2035, which requires predicting natural modes of atmospheric variability, and to develop the science of multi-decadal prediction in the context of a changing climate. There is a strong motivation for shorter (30-year long) and relatively high-resolution climate simulations, in addition to centennial runs. Early results show that prediction skill is still marginal but in some cases beats persistence.

A key aspect of decadal predictions is to provide data assimilation and initialisation of coupled models with weather, cryospheric, biogeochemical, and oceanic variables including the oceanic meridional overturning circulation (MOC). However, the science of coupled data assimilation and initialisation is not yet developed, and requires a strong WCRP-wide effort. Significant work is already ongoing in the development of ocean initialisation, especially in the Atlantic Ocean but, as can be seen from existing comparisons of ocean syntheses under CLIVAR, the spread in the representations of the modelled MOC at 25^0N is still very large and it is not yet possible to obtain a robust estimate of MOC from the reanalyses. The research also needs to be broadened to include areas other than the Atlantic, and initialisation of soil moisture, cryosphere and stratosphere. Also, it might be possible to study predictability associated with persistent patterns in initial conditions in the coupled system potentially leading to some predictable long-term anomalous variations in climate. Continuous improvement of predictive model dynamics was understood as being absolutely crucial and necessary.

The view presented by Dr Marotzke on the importance of producing decade-long climate predictions was generally supported by the JSC. Several JSC members expressed the view that the work on decadal prediction might become a flagship activity of the WCRP. Because it is not clear in principle whether 30-year prediction is scientifically possible, some JSC members advised focussing on shorter runs.

Involvement of projects and relevant WCRP and CLIVAR groups was seen as a key factor for the eventual success of decadal forecasting, as was a need to entrain more young scientists in this work.

3.5 Monsoons

The JSC discussion on monsoonal research including the WCRP Integrated Monsoon Study (IMS) was initiated by three talks given by Prof. G. Wu and Drs P. van Oevelen and T. Yasunari. The proposals for the Year of Tropical Convection (YOTC), Asian Monsoon Years 2007-2012 (AMY) were parts of the same agenda item. In addition to the above speakers, Dr J.L. Redelsperger, the Chair of the African Monsoon Multidisciplinary Analysis (AMMA) International Scientific Steering Committee, presented a comprehensive report on AMMA.

Following the JSC-28 decision taken in Zanzibar to establish a WCRP Monsoon cross-cut, a meeting on monsoon research was organised in Bali in September 2007. The meeting came up with the following goals for the IMS:

- Improve forecasts from intra-seasonal to inter-annual time-scales in monsoon regions;
- Improve understanding of the relative role of land and oceans on diurnal to interannual (decadal) timescales;
- Improve understanding of (natural and anthropogenic) climate change on monsoons;
- Enhance the observational networks and data utilization;
- Enhance the collaboration among regional monsoon research communities; and
- Facilitate the use of knowledge on monsoon climate in societal impact studies.

The workshop also recommended to establish an IMS scoping group under the JSC with potential membership from the JSC Monsoon Oversight Group, from CLIVAR/GEWEX Monsoon Panels and WGs, CEOP, THORPEX (YOTC), MAIRS and other regional monsoon projects, the WMO monsoon study committee, and including the directors of CLIVAR and GEWEX IPOs.

A concept document for IMS is currently being developed and it is proposed that the initial focus for IMS be centred on the multi-scale interactions essential for the dynamics and prediction of intra-seasonal variations and the seasonal march of the monsoons. The JSC was asked for comments on the conceptual structure for IMS. One view was that IMS should take a well-developed science plan (e.g. the one for AMY) and extend it to the globe using some common science issues. Another view suggested that we should develop a global framework based on the interactions of regional monsoons and the ITCZ and focus on better understanding the interactions of these processes and associated teleconnections.

The AMY initiative forms an integral part of IMS. Its goal is to improve Asian monsoon prediction for societal benefits through the coordination of a variety of efforts aimed at a better understanding of the monsoon's variability and predictability. The specific objectives of AMY are:

- to better understand the ocean-atmosphere-land-biosphere interactions, the multi-scale interactions among timescales ranging from diurnal, intraseasonal to interannual, and the aerosol-cloud-water cycle interactions in the Asian monsoon system;
- to improve the physical representations of these interactions in coupled climate models, and to develop data assimilation of the ocean-atmosphere-land system in the Asian monsoon region;
- to determine predictability of the Asian monsoon on intraseasonal and seasonal time scales, and the roles of land initialisation in continental seasonal rainfall prediction;
- to better understand human-environment dependencies in the monsoon Asia region.

AMY is based on the assumption that coordination and cooperation are key for reaching its goal and objectives. AMY seeks therefore to coordinate some 21 regional projects over the Asian-Australian Monsoon region together with existing WCRP activities under CLIVAR and GEWEX, establish links to a number of other programmes including MAIRS, and integrate some activities where necessary and possible. A science plan for AMY was developed by CLIVAR (lead Prof. Bin Wang) and GEWEX (lead Dr Jun Matsumoto), and work is ongoing on an implementation plan. These plans were the main subject of the first three AMY workshops that took place in Beijing in April 2007, Bali in September 2007, and Yokohama in January-February 2008.

To move the plans forward, a 2nd Pan-WCRP Monsoon Workshop was proposed in conjunction with the 4th WMO Monsoon Conference to be held in October 2008 in Beijing, China, including joint sessions, a meeting of the IMS Scoping Group, and the 4th AMY Workshop.

Inadequate representation of tropical convection and its multi-scale organization in global atmospheric models continues to limit the success of numerical weather forecasts and global climate predictions, in particular for monsoons. Progress in this long-standing weather-climate prediction issue requires strong collaboration between the operational prediction and academic communities. To move the issue forward WCRP and WWRP/THORPEX proposed a year of coordinated observing, modelling and forecasting of organized tropical convection and its influences on predictability (YOTC). This effort intends to exploit the vast amounts of existing and emerging observations and computational resources in conjunction with the development of a new high-resolution modelling framework. YOTC expects to advance the characterisation, diagnosis, modelling and prediction of multi-scale convective/dynamic interactions and processes, including the two-way interaction between tropical and extra-tropical weather/climate. WCRP and WWRP/THORPEX completed a YOTC Science Plan from drafts prepared with input from the planning group and are working on a YOTC Implementation Plan to include an observation/data period and initial analysis phase. The "Year" would extend from approximately May 2008 to September 2009 in order to capture two boreal summer monsoon cycles and complement the AMY program.

To enable YOTC studies, ECMWF has agreed to supply it with high-resolution (25km) analysis and deterministic forecast data with all relevant quantities (with financial help from NSF and ONR). A similar dataset will come from NCEP. YOTC is in the process of requesting additional diagnostic fields from the THORPEX TIGGE archive (http://tigge.ecmwf.int). Selected data from multi-sensor satellite platforms should also be made available for the YOTC analysis.

There are prospects that seed money to kick-start the YOTC database will be available from (NSF/NOAA), via small grants for exploratory research. There is also potential inter-agency support to stimulate exploration of the YOTC database by early-career scientists. YOTC would benefit from collaboration with countries and regions directly impacted by tropical weather and climate e.g., Japan, India and S.E. Asia. Contacts are being established with the Co-Chairs of the Asian and Southern Hemisphere THORPEX regional committees.

With the many diverse activities in several regions, some of them ongoing like CLIVAR/VAMOS, AMMA and some planned, and with the need to interact with projects outside WCRP, it was important for JSC to agree on the main coordinating mechanism for WCRP monsoon research. Dr C. Vera suggested that global coordination could emerge from the modelling perspective and Dr S. Gadgil proposed to focus on regions where prediction skill was especially low. Dr Yasunari stressed that regional downscaling was particularly important for monsoon regions but the monsoon modelling had serious problems with boundary conditions. Going into high-resolution models requires huge computer resources. This discussion led to a tentative conclusion that it was important primarily to efficiently and adequately address all issues related to the dynamics and physics in models before embarking on extended types of prediction. For example, intra-seasonal and diurnal time-scales still cause many problems. Because cloud-resolving models do better for diurnal cycle, focussing on high resolution was a way forward. Prof. Slingo reminded the participants that high resolution modelling was reviewed at recent workshops and there was already a good plan developed among the groups that were involved in it. However, there was no clarity on how observations should be handled and how they could be efficiently processed to provide a sound basis for model validation.

Prof. S. Sorooshian stressed the need for unrestricted access to data from regional studies by everyone involved in the experiments. This discussion reflected the complexity of monsoon research and the difficulties of its coordination.
The JSC then decided that a group of participants should continue the discussion on monsoon research outside the plenary session and agree on an approach to improve coordination of monsoon research, projects and activities. Proposals developed by the group form the basis for the JSC decisions on this agenda item.

3.6 International Polar Year 2007-2008

Dr B. Goodison presented the report on WCRP IPY activities and provided an overview of the scope and size of the IPY campaign. IPY is believed to have added an equivalent of US$400M to the previously existing investment of US$800M in polar observations, research and modelling. These investments are from countries traditionally active in polar research and also from other countries that have realised the importance of polar regions and their contribution to the Earth's climate. WCRP contributed significantly to the IPY programme. From some 200 IPY projects, 23 projects are affiliated with WCRP and its core projects, and 12 are related to them.
The expected scientific achievements from WCRP IPY activities include:

- first "virtual" satellite constellation under the umbrella of the Global Interagency IPY Polar Snapshot Year (GIIPSY) proposed by CliC and IGOS Theme on Cryosphere. It involves all major space agencies, and has the emphasis on the Synthetic Aperture Radar sensors;
- establishment of a basis for an innovative Arctic Ocean Observing System;
- Intensification of observations in the Arctic Ocean;
- unprecedented survey of the Southern Ocean;
- understanding the state of the cryosphere, and its past, present and future variability and change across a range of time and space scales;
- advances in the establishment of an Arctic hydrological cycle observing system and advances in polar hydrology;
- a strong step forward in permafrost monitoring;
- record-long (~1Mln years!) ice-core based climate history (Chinese contribution in Antarctica);
- new developments of SPARC/IPY data assimilation component;
- advances in studies of impact of aerosols on the hydrological cycle in the Arctic, in association with GEWEX; and
- advances in communication and outreach, education and capacity building, more involvement of and support to young scientists.

A crucial issue at the moment is the creation of conditions for leaving an IPY legacy in form of sustained observing systems. WCRP therefore actively cooperates with a number of projects such as, Sustained Arctic Observing Network (SAON) including Arctic-HYCOS, integrated Arctic Ocean Observing System (iAOOS), Pan-Antarctic Observing System (PANTOS), Southern Ocean Observing System (SOOS). All these systems and IPY activities benefit from the recommendations of the IGOS-Cryosphere Theme developed by WCRP/CliC and SCAR. IPY is also expected to contribute to the formation of climate services in polar regions. The Russian Federation and WMO/WCRP-CliC/IPY are organising a Workshop on CLIPS in polar regions during 8-12 September 2008 in St. Petersburg, Russia.

It will lay the groundwork for regular polar Regional Climate Outlook Forum(s) and produce recommendations for gaining commitments of polar countries and socio-political mechanisms to sustain the IPY legacy. It is also proposed to hold a joint WMO-GEO-WCRP Workshop "Building an IPY Legacy: Observations and Data Products for a Global Cryosphere Watch (GCW)", 3-5 December 2008, at the WMO Secretariat in Geneva. The primary objective of this Workshop is to identify, review, and prioritise projects/activities selected through IPY that are "vital" in establishing the GCW, and to solicit potential sponsors for these projects/activities. The WMO IPY Task Group invited the WMO Technical Commissions with vested interest in polar regions to be actively involved in this process, and to help secure the ownership and sustained support for these projects/activities within their areas of interest. For effective coordination of these activities, it is recommended that the WMO Executive Council (EC) establishes an EC Panel on Polar Observations, Research and Services that will consist of experts on atmospheric, oceanographic, hydrological and cryospheric processes in polar regions and work in close collaboration with WIGOS.

One of IPY major challenges is the integration and preservation of its legacy data and information. IPY arrangements regarding the required metadata and standards are not fully in place. The task of achieving an IPY data legacy in terms of a full dataset of observations, which will be open to, and accessible by, the global research community, is thus threatened by a lack of such a facility or facilities, and by potential reluctance of researchers to contribute QA/QC'd data and metadata in a timely manner to such system(s). Dr Goodison invited the JSC to consider how the new field experiment observations, results of the ongoing massive polar snapshot from space, and data resulting from building polar observing systems should be used by the WCRP for developing and validating models, climate projections, studies of climate variability and change, and how these data can be used in reanalysis studies.

The main issues raised during the subsequent discussion were as follows. The transition of IPY observations into an ongoing sustained observing system was seen as a crucial task. In some cases in the past it proved difficult to obtain governmental agreements to contribute to sustained observations in polar regions. To overcome this challenge, it is important to have National Meteorological and Hydrological Services (NMHSs) working together with other operators of observing systems; this model is being effectively pursued within SAON.

The JSC agreed that data management/availability is a broader problem than just for IPY. Some successful examples include having funding agencies insist on data quality, preservation and availability. A broader discussion on data management was recommended as part of the WOAP upcoming meeting in September 2008.

The JSC anticipated a very significant IPY achievement in science associated with polar regions and their influence on the climate system. For example, one major remaining question is related to the predictability of climate in the polar regions. High-resolution coupled models still experience major difficulties in simulating polar regions. A status report on these issues would be of great interest.

The JSC was impressed with IPY achievements in the areas of training and outreach, especially with the involvement of young children and schools, and requested Dr M. Béland to take this comment back to the IPY Joint Committee.

3.7 Sea-level rise

Dr Church reviewed ongoing and planned activities in the area of sea-level rise (SLR). His talk was co-authored by Drs P. Woodworth, S. Wilson and T. Aarup.

Since the interdisciplinary workshop held at IOC, Paris, in June 2006, the Workshop statement has been widely distributed and the white papers prepared for the workshop are being turned into chapters of a book that will be published in 2008/2009. Dr Church called on WCRP and especially CliC to actively work on ice-sheet model development and listed relevant activities and milestones to be achieved in this area including

- an IASC, SCAR, CReSIS, WCRP/CliC workshop on ice sheet-models (St. Petersburg, Russia, July 2008),
- a NAS proposal on ice sheet stability,
- an Arctic Council report on the Greenland ice sheet to be delivered to COP-15, Copenhagen, Denmark, in 2009.

Plans for 2008/2009 were to complete the above book and organise a small sea-level extremes workshop. Dr Church referred to the IOC Strategy, which calls for "Periodical policy briefs on sea level to be established and regularly updated" and asked the JSC to comment on what WCRP would need to achieve in the area of SLR research and assessment, and how any future activity would be led.

The JSC view was that WCRP definitely needs to remain engaged in SLR research. The SLR science is highly multi-disciplinary and should not only involve WCRP's drive in the thermal and cryospheric contributions, but also the assessment of water storage and links to geodetic changes. Dr Church also drew attention to the fact that despite good progress on the upper ocean thermal expansion problem, deep ocean warming was not addressed adequately at the moment. In his opinion, GEWEX should take more responsibility in research related to terrestrial water storage in addition to what GWSP is doing in this area. Geodetic issues remain outside the scope of WCRP, but WCRP should coordinate and communicate with the geophysical community. Despite active research on the spatial distribution of thermal expansion, the uncertainty in our knowledge is still very high. Dr Bernal said that IOC must play a leading role in sea-level work (e.g. via the observing networks and tsunami warning systems) and that it needs policy briefings based on integrated assessments. IOC promotes the leadership of WCRP in climate change aspects of SLR and is willing to support this activity. A short discussion also touched on the GOOS and GCOS in-situ networks related to SLR, especially GLOSS. Dr Church stated that the networks of opportunity were insufficient to support requirements of SLR assessments, especially with respect to measuring its extremes.

4. Climate extremes

A half-day special session on climate extremes was held in the morning of Wednesday, 2 April 2008. The goals of the session were to contribute to the determination of the steps WCRP should take to meet user requirements, and what WCRP should do to further contribute in an effective manner to the research agenda on extremes.

Prof A. Busalacchi opened the session. The agenda contained several talks to review user requirements (review of a relevant stakeholder meeting by Dr Busalacchi, a talk on climate related re-insurance needs by Prof. Slingo, and a report on the joint WMO Commission for Climatology (CCl)/CLIVAR/JCOMM efforts on climate extremes by Dr P. Bessemoulin). Several additional presentations were on WCRP research priorities vis-à-vis extremes through CEOP/GEWEX by Dr Sorooshian, studies of droughts by Dr Hurrell, related modelling by Dr Palmer, and a summary of proposals for the cross cut to date by Dr Cattle. The session was concluded with a panel discussion on how to make further progress on climate extremes and where WCRP should focus its research efforts. Prof. G. McBean was the panel discussion moderator and the panel was composed by Drs M. Béland, G. Flato, T. Koike, J. Marotzke, J. Mitchell, and C. Vera.

Prof. Busalacchi noted the existence of significant ambiguities in defining extreme events. Combining analyses from different sites complicates attempts to determine whether the frequency of extreme events is changing. Requirements for long-term and homogeneous observations are considerably more stringent for estimating changes in extremes than they are for monitoring changes in means of variables. They should be addressed by both WCRP and GCOS. So far most of the attention has been focused on trends in extreme temperatures, but the challenge is to go beyond temperature. The phenomena of interest include droughts, tropical cyclones, El Niño, heavy or extended rainfall events, mid-latitude storm systems, small-scale weather extremes, storm-surge and coastal erosion, late/early onset of rains, breaks or bursts in monsoons, and some others. We need to assess the capability of present data products, reanalyses, climate models to determine trends and decadal variability of extreme events. The statistical nature of extremes and their changes need to be explored. Typical questions are: do the extreme events under study have a non-stationary stochastic behaviour, how much do extreme events cluster, and how is this likely to change in the future?

In order to meet the above challenges, communication between the science community and the users that require information on extreme event(s) needs to be enhanced in both directions. Research to address the difficulties of comparing observations made at high spatial resolution with models that provide limited spatial resolution should be encouraged. This requires substantial increases in computational capability. Modelling centres should place a higher priority on retaining high-resolution data output needed for the study of extreme events, and related data management issues.

The following possible issues could be addressed to a WCRP task team on climate extremes:

- to summarise, compare and assess definition(s) of climate extremes and develop a common language with other activities;
- to develop a framework for coordinating the study of extreme events, including observations and data, modelling, simulation, various intercomparisons, predictability of extremes and determining how extremes are changing/varying and why,
- to recommend, refine/focus research priorities and requirements, identify 1-3 pilot projects (if not already in place), serve as clearinghouse for information, develop communication/ outreach plan.

The activity would build on existing WCRP activities, IPCC AR4, and ongoing national assessments. CLIVAR and GEWEX will be asked to continue to host and support this work with the oversight of the JSC. The work would culminate with a WCRP Workshop on Extremes.

Prof. Busalacchi completed his talk on the climate extremes theme by reviewing the outcomes of two very relevant meetings.

A Forum on Extreme Events in a Changing Climate was held as part of the fall 2007 Meeting of the U.S. National Academies of Sciences Climate Research Committee in Washington, DC, USA. It focussed on research challenges and strategies for better understanding and predicting extreme events in the context of a changing climate. Speakers and other participants were encouraged to consider a broad definition of extreme events that includes not only changes in the frequency or intensity of low-probability events but also how subtle changes in the mean (or other statistics) of climatologically important variables on a variety of timescales may lead to extreme impacts. Other important topics considered include mechanisms that could lead to changes in extreme events, the extent to which changes in extreme events might be predictable, and theoretical, observational, and modelling advances needed to improve predictive capabilities.

The second meeting was a U.S. National Workshop on “Climate Information: Responding to User Needs (Bringing Observations, Data Management, Modelling and Prediction into the Decision Process)” held at the University of Maryland in October 2007. The meeting was unique in that it successfully engaged managers at a variety of levels and from private sector and government who critically reviewed the practical value of climate information that they require, request, and receive. The meeting confirmed a need for a regional/local focus of climate services and the importance of data and information on extremes and abrupt changes for a range of time scales. The approach for providing such information should be built on a system perspective, considering multiple stressors and going from a climate model to business model. The information should be accessible to diverse user groups. The meeting recommended to establish a National Climate Information Clearinghouse.

The talk of Prof. Slingo was devoted to the reinsurance industries’ interest in climate extremes. It was partially based on material from Willis Research Network, a long-term partnership between leading international scientific institutions and Willis – a major reinsurance broker. Prof. Slingo reviewed a catastrophe model typically used in insurance studies of natural disasters and their implications for the industry. Every such model has a hazard component. Other components of the model typically deal with exposure, vulnerability and loss. Stochastic hazard models based on historical catalogues assume that the climate system is stationary. Neglecting climate variability and change leads to failures of the historical approach. The main question addressed by Prof. Slingo was how the dynamical modelling and weather/climate research can be integrated into catastrophe modelling so that the natural climate variability and the impact of climate change on weather-related hazards are properly represented in these models.

Dr P. Bessemoulin, President of the WMO Commission for Climatology (CCl) reviewed the activities of the Joint CCl/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETCCDI), which facilitates international collaboration on climate change detection, develops and helps to use indices of climate variability and change, and, together with relevant programmes (e.g. GCOS/WCRP Atmospheric Observation Panel for Climate) and WMO Technical Commissions identifies observational needs for climate change detection. ETCCDI had a planning meeting in November 2006 and produced a work plan for 2006-2009. It sponsored seven regional climate change workshops in 2002-2007, which analysed changes in extremes, produced a number of published peer-reviewed papers on climate change, contributed to a global extremes indices paper, IPCC AR4 and capacity building activities. ETCCDI is organising another workshop entitled “Extremes in a Changing Climate“, which will be held in De Bilt, The Netherlands, 13-16 May 2008. WMO is organising a Climate Watch: a warning advisory for climate-related hazards, using climate monitoring output and

climate anomalies forecasts, with an emphasis on their possible impacts. Dr Bessemoulin invited WCRP to consider ETCCDI work as a component of WCRP strategic thrust in climate extremes. He encouraged both CCl and WCRP to prioritize their actions towards implementing practical tools to deal with climate extremes. WMO/CCl Climate Watch workshops are good examples and WCRP was invited to take part in them. He also called on UNFCCC to use this knowledge in implementing the Nairobi Work Programme for adaptation to climate change in close collaboration with WMO and WCRP.

Prof. S. Sorooshian outlined a GEWEX Perspective on "Extremes", with emphasis on hydrologic extremes and North American experiences. He focussed his talk on the prediction and management of consequences of droughts and floods. So far, according to studies of NCDC, there is no overwhelming evidence of long-term trends towards more extreme droughts, but there is a certain increase in heavy rainfall events. However, the patterns are more diverse in the regional perspective. The issues of high importance are the development of adequate practices in water management, with emphasis on building resilience. The main issue is the non-stationarity of extremes, which calls for a development of stochastic approaches to hydrological forecasting. Immediate needs exist in dam construction and operation, city planning, road drainage, and some other areas of applications.

Dr J. Hurrell reviewed drought research in CLIVAR, and the U.S. CLIVAR. He described the potential social impacts of multi-year droughts expressed by the Palmer Index that shows the frequency of droughts seems to be increasing in the tropics and subtropics. The possible causes include the role of the oceans and land-atmosphere interactions. Dr Hurrell described the U.S. CLIVAR Drought In Coupled Models Project (DRICOMP). Its goal is to identify and characterize physical and dynamical mechanisms leading to drought and the mechanisms through which drought may change as climate changes. U.S. CLIVAR and in particular DRICOMP, look forward to coordinating their efforts with relevant international partners. A significant event in terms of studying droughts will be the 33rd Climate Diagnostics and Prediction Workshop from 20 to 24 October 2008 in Lincoln, Nebraska, USA. This event is jointly sponsored by NOAA and U.S. CLIVAR. Its science foci are on

- Drought across multiple time scales (weekly through centennial and longer),
- Droughts across the Americas and other continents (Africa, Asia, etc.),
- Assessments of the role of ocean, land, and seasonal cycle in multi-year droughts as clearly seen in coupled models (especially from IPCC Coupled Model Evaluation Project 3), and
- Linkages between drought research and society needs.

Dr Hurrell concluded his presentation by reviewing the activities of the U.S. CLIVAR Drought Working Group (http://www.usclivar.org/Organization/drought-wg.html), which undertakes extensive studies required to understand and predict the droughts on seasonal, interannual,up to decadal time scales.

Dr T. Palmer reviewed issues and requirements associated with numerical modelling of extreme events. At seasonal scales, there is a need to have very large ensembles to make robust conclusions for events with long return period. ECMWF is currently extending ensembles to 100 members for their case studies. While results do suggest some predictability of extreme seasons, model biases make it difficult to realise the full potential of seasonal prediction skill. For example, so far, the models strongly underestimate blocking frequency at seasonal timescale. At timescales of interest to IPCC, one useful result would be to assess how multi-model PDFs are affected by increased greenhouse gases. However, the predicted change in a multi-model PDF, due to greenhouse forcing, is comparable in magnitude, with biases in the multi-model PDF (measured against observations). In Dr Palmer's view, as climate is a nonlinear system, such predictions are not reliable. The significant model biases (not only in means, but in variance, skewness, kurtosis of PDFs) are linked to failure of models to sufficiently simulate key modes of climate variability. There is some evidence of improvement in seasonal forecasts with models run at spectral resolution of T511. Higher resolution is important, but not sufficient for resolving the issues. There are definitely other issues to consider, for example, a well-resolved stratosphere. The need for larger ensembles and higher resolution creates a demand for substantially more powerful computers than are currently available, and PetaFLOPS computing power is urgently required.

Dr H. Cattle reviewed the JSC-28 assignments to CLIVAR and GEWEX in the area of climate extremes and reported on those activities that were not presented by previous speakers. For example, WCRP representatives met with two major reinsurance companies and studied their corresponding interests.

Swiss Re was interested in:

- Regional downscaling experiments to help understand climate change risk;
- Coordinated experiments at sufficient resolution to reduce uncertainties in future projections of tropical cyclones, floods, winter storms, droughts and floods;
- Determination of how extremes are changing, varying and why;
- Participation in WCRP “key events”.

Munich Re was interested in:

- Detection of extreme events in the Munich Re catastrophe loss database;
- Studies of “extreme event clustering”;
- Information on rainfall probabilities for their “capacity building” efforts;
- Collaboration on a map projecting global climate-related risk towards the future.

The International CLIVAR Project Office participated in several workshops (including CIRUN workshop, see above) and helped reinsurers to better define their requirements. A discussion on climate extremes took place at the fall 2007 Session of the American Geophysical Union meetings in San Francisco, USA.

The CEOP/GEWEX Extremes Workshop in May 2008 in Vancouver had been planned with a goal to advancing CEOP/GEWEX Extremes effort as a significant contribution to WCRP. Its focus was on droughts, heavy precipitation and floods. Its expected primary outcome was an overall assessment of current extremes studies and an improved plan to realise GEWEX and WCRP objectives
The written submission on extreme events contains several potential areas of future WCRP research including:

- Continued development of the CEOP extremes activity,
- Coordination of drought research with US drought programme,
- Attempting to understand how modes of variability influence extremes and what the dynamical situations are that lead to them,
- Research to reduce uncertainties of model simulation of extremes,
- Improvement of methods used for interpreting model output, reanalyses and satellite products,
- Development of consistent definitions of extremes between models and observations, scientists and practitioners,
- Establishment of regional projects - workshops bringing together observationalists, regional modellers and planners/decision makers aiming at improvement of region’s ability to reduce risk from climate-related disasters.

At present WCRP is involved in the following activities in climate extremes:

- CCl/CLIVAR/JCOMM ETCCDI;
- Decadal cross climate experiments aiming to give guidance on the changing risk of extremes;
- WGCM International detection and attribution group on design of C20 simulations for next IPCC that includes detection of extremes;
- CEOP extremes study;
- U.S. CLIVAR-led activity on drought (see above);
- A GEWEX/UNESCO global heavy rainfall product at 24- and 48- hour accumulation periods funded by NASA, NOAA and UNESCO;
- Sea level extremes, sea ice extremes, etc.

WCRP needs to include the existing and planned activities into a coordinated cross-WCRP effort that has added value. To do so, existing activities require effective support. One possible model for organising this work is to establish limited-lifetime focussed Working Groups (following US CLIVAR model). One such group could consider combining observations and modelling of extremes and prepare a CCl/WCRP Guidance Statement on assessing probabilities of extremes in a changing climate. Another option could be to set up a working group on droughts, building on US CLIVAR and GEWEX efforts. WCRP should take advantage of CIRUN follow-on and GEWEX/CEOP workshops and use the cross membership of these activities to further integrate the extremes crosscut.

A further option suggested by Dr Cattle was to set up a Task Force on Climate Extremes to define ways forward and build links with WMO Climate Watch.

Dr G. McBean concluded the series of presentations on climate extreme by introducing the ICSU Programme "Integrated Research on Disaster Risk (IRDR)", which intends to address the challenges posed by natural and human induced environmental hazards. This programme which proposes an integrated approach to research on disaster risk through an international, multidisciplinary (natural, health, engineering and social sciences, including socio-economic analysis) collaborative programme is proposed to last a decade or more. Its legacy will be an enhanced capacity around the world to address hazards and make informed decisions on actions to reduce their adverse impacts. This legacy implied a strong commitment from IRDR to development of science and broadly-based capacity. The programme will be implemented in partnership with national and international development assistance agencies, national and international science institutions, and funding councils.

Research foci of IRDR are:

- Hydrometeorological and geophysical trigger events which include floods, storms (hurricanes, cyclones; typhoons, etc.), heat waves, droughts and fires, landslides, coastal erosion, climate change related increases of extreme events and related events such as wild fires and locust outbreaks;
- Effects of human activities on creating or enhancing disasters, including land-use practices;
- Space weather and impact by near-Earth objects; and
- Mitigation and Preparedness

IRDR process envisages identifying hazards and vulnerabilities leading to risks and their forecasting and dynamic modelling of risk. This should lead to understanding of decision making in complex and changing risk contexts, and improving its quality. At its final stages, the programme anticipates working on reducing risk and curbing losses through knowledge-based actions, including vulnerability assessments and use of developed approaches to risk reduction.
Based on the presentations, a panel, consisting of selected participants in the meeting, discussed the issue of climate extremes. It discussed what the focus of WCRP research should be. Dr McBean convened and chaired the Panel. A condensed representation of Panel Members views is as follows:

Dr C. Vera underlined two aspects of the issue. The first being related progress in monitoring, understanding, and modelling of extremes. It creates opportunities, and WCRP has to define specific initiatives to move forward. The second aspect is that WCRP has to provide input for practical applications. To make this work efficiently, the end users must be clearly identified and engaged early on. We need to identify how to focus our activities, with a proper balance on the global scale versus regions. We must also recognise that regional needs are quite different. South America has been pursuing these issues very actively. For example, the VAMOS project has established a task force on extremes and already has strong links with the US CLIVAR Working Group on Droughts. Another example is the La Plata Basin Project, which will be supported by the EU 7th Framework Programme. Under this project, we should expect significant progress on climate extremes in the next three years. With support of GEF, and with WCRP's guidance to five national groups, an alert system for LPB will be developed. NMHSs and civil protection agencies from the region are also involved in this work.

Dr G. Flato highlighted the wide range of existing extremes and recommended to push more in areas where society is vulnerable, at all time scales. He stressed four WCRP requirements ::

- prepare a definition of extremes and develop meaningful indices;
- evaluate the ability of the current suite of models to capture extreme events (one problem is the need for very long time series of observations to obtain reliable statistical estimates) – in that regard paleo-data can help;
- think about the relative merits of making predictions by brute force (high resolution, big ensembles) versus other "clever" ways; and
- translate resulting knowledge/information into products useful to end users.

Dr J. Marotzke noted significant progress in the research on extremes and that we now know more about how the extremes are changing. At the same time, most of the work described in the written document is focussed on droughts. Extremes, due to excessive wind and/or precipitation, seem to receive less attention. He recalled the workshop on extremes held in Hawaii in 2007, where the focus was on the understanding of whether extremes were linked to "extreme" physics or only represented a superposition of events with smaller rates of occurrence. WCRP would be expected to address such fundamental science questions. WCRP could also focus on assessment of emerging risks associated with changing climate. Technically, this is indeed a demanding initiative, which will require high-resolution models runs and use of large multi-models ensembles. He expressed some caution on

concentrating too much on the needs of reinsurance because it was not clear if this could generate adequate investment into the work leading to fundamental understanding of climate extremes.

Dr M. Béland added that the WCRP activities on climate extremes seem to pose requirements in terms of need for supporting observations to verify and validate model forecasts, which are similar to ones in THORPEX. As regards the discussion, if the physics is "extreme", he confirmed that some model predictions of extreme events with lead times of 24-36 hours exhibit dynamics, which are not observed in practice, and that research is therefore needed to reconcile these differences from both weather and climate time scales. For decision-making, the ability to adequately predict the probability of an extreme may be even more important than actual forecast of the extreme (because no one will know how certain the forecast is). This justifies extensive use of ensemble-based forecasting systems. Dr Béland concluded his intervention by emphasising a need for a more integrated multi-hazard, multi-timescale approach, which could be pursued in cooperation with the ICSU-developed IRDR.

Prof. J. Mitchell stated that we have to address events of small probability and high intensity. Attention to high *impact* events such as thick fogs at major airports that can create significant consequences in several sectors of economy and massive inconvenience for people is strongly required. Indeed, different scales are involved, from inter-hemispheric to local. Small-scale features may be especially important for an extreme event, not only large-scale modes of variability. With respect to the longer-term climate change, WCRP is in a very good position to provide some very useful information for decision making despite the wide range of associated uncertainties, because expected climate change will then exceed natural variability. However, we need to focus on systematic work to reduce the uncertainties in predictions and also focus on representing clouds and radiation feedback and the full carbon cycle in models. Extremes in precipitation are very important, but winds even more so. Another area of great interest is predictions of heat waves and their probability of occurrence. WCRP should not underestimate the importance and value of providing information on extremes, even if it is far from perfect.

Prof. T. Koike emphasised that the approach to climate extremes should involve consideration of several time and space scales. The damage usually occurs at the local level but predictions to avoid it are made at the regional scale level. Therefore, the predictive system will require global, regional and local models, working in seamless mode and corresponding downscaling techniques. Prof. Koike underlined the importance of early end-to-end planning from research to operations and user involvement. He also reminded of the need to store huge amount of data, which requires more skill in data integration, fusion, analysis and visualisation.

The subsequent discussion had been inspired by the insight of the panellists' interventions. The points raised by JSC members were as follows:

- High-end computing power requirements for addressing climate extremes may be realistic, noting the current progress in this field;
- Need for improvement of climate models physics ensuring the capability of capturing the processes involved in the formation of extremes;
- Possible link of extreme events to "extreme" physics (reiterated);
- Extreme events may be considered as opportunities to attract governments' attention to the need of developing the science and investing into corresponding services;
- Some extreme events are so rare that the current observing system is not suitable for observing them. For example, tropical cyclones in the Southern Hemisphere;
- Increasing model resolution represents a valid area of scientific research and involves many nontrivial issues. There is also a need to properly simulate the background fields of meteorological elements.

The Panel was given a chance to reflect on suggestions and comments by the JSC members. Its members agreed that there was a need for more computing capacity, but because users need our best assessment now, it was felt essential to ensure there was adequate use of existing tools. Progress will be dependent on our ability to overcome fundamental problems in climate prediction, including physics of clouds and radiation, refining our models, securing needed observations and obtaining adequate computing power.

Many speakers recommended increasing communication in the area of extremes, e.g., to ensure input of all WCRP projects to ETCCDI and cross membership from projects in forthcoming workshops. We need to engage with the WMO hydrological department, have closer relations with IGBP, especially in dealing with extremes like pollution and air quality, continue to strengthen links with THORPEX, and fully involve WGNE and GMPP in the work on climate extremes.

5. Review of WCRP projects

At its 28th Session JSC decided to have one core WCRP project reviewed in more detail. Implementation of this practice started at the 29th JSC Session, at which the GEWEX project was reviewed in detail.

5.1 GEWEX

The introduction of overall activities of GEWEX was presented by Prof. S. Sorooshian. Dr P. van Oevelen reviewed major GEWEX activities, with focus on the GEWEX newly developed roadmap. Prof. T. Koike reported on the GEWEX CEOP, and the series of talks was concluded by Prof. Sorooshian.

Having introduced the project office and structure, Prof. Sorooshian thanked NASA and NOAA for their support of IGPO, and several Japanese government agencies for their support to CEOP.

GEWEX Phase I objectives were to:

- determine the hydrological cycle and energy fluxes by means of global measurements of atmospheric and surface properties;
- model the global hydrological cycle and its impact on the atmosphere, oceans and land surfaces;
- develop the ability to predict the variations of global and regional hydrological processes and water resources, and their response to environmental change; and
- advance the development of observing techniques, data management, and assimilation systems for operational application to long-range weather forecasts, hydrology, and climate predictions.

The work of GEWEX Phase I resulted in:

- 10-25 year global data sets of clouds, precipitation, water vapour, surface radiation, and aerosols,
- implementation of the land surface and cloud parameterisation upgrades suggested for most regional and global models leading to improved precipitation estimates, and
- near to achieving closure of the regional water and energy budgets for the GEWEX Continental-Scale Experiments and determining the importance of recycling and diurnal processes for regional predictions.

At present, GEWEX is in Phase II (2003-2012/13), which in the context of the original objectives, is addressing the following principal scientific questions:

- Are the Earth's energy budget and water cycle changing?
- How do processes contribute to known climate feedbacks and causes of natural variability?
- Can we predict these changes on up to seasonal to interannual scales?
- What are the impacts of these changes on water resources?

At the beginning of GEWEX Phase I, the project identified NWP Centres as its main stakeholders. For the Phase II, the additional stakeholders will be operational hydrologic services. The current objectives of the project are:

- produce consistent research quality data sets complete with error descriptions of the Earth's energy budget and water cycle and their variability and trends on inter-annual to decadal time scales, for use in climate system analysis and model development and validation;
- enhance the understanding of how energy and water cycle processes function and quantify their contribution to climate feedbacks;
- determine the geographical and seasonal characteristics of the predictability of key water and energy cycle variables over land areas and through collaborations with the wider WCRP community determine the predictability of energy and water cycles on a global basis;

- develop better seasonal predictions of water and energy cycle variability through improved parameterisations encapsulating hydro-meteorological processes and feedbacks for atmospheric circulation models; and
- undertake joint activities with operational hydro-meteorological services and hydrological research programmes to demonstrate the value of new GEWEX prediction capabilities, data sets and tools for assessing the consequences of global change.

The new GEWEX structure strives towards a minimal number of panels and working groups whilst ensuring maximum cohesion and coordination, historical perspective and legacy, human interaction and communication. The reporting structure will evolve to help keep track of all changes whilst minimising the input required.

The GEWEX Roadmap is a living document that should provide linkages to COPES and crosscuts; outlining possible deliverables and timeline of their production. It also shows clearly that the overarching questions will remain valid and should continue to be addressed, even after 2013. The Roadmap requires great initial effort and needs to be supported community-wide to stay effective. Linkages with non-GEWEX parts need to be incorporated.

The speakers reviewed in detail several activities of GEWEX, including production and analysis of global and regional datasets, and various assessments. One of the key activities of GEWEX is reprocessing of satellite data. Reprocessing is no longer limited to computer technology but is rather hampered by the haphazard nature of the historic data archives. The issues relate to storage media, formats of data, ancillary information, lack of ancillary information, etc. Data not only needs to be preserved, but also preserved in such a way that the reprocessing of long time series can be properly executed in the future.

A major recent effort of GEWEX is to consolide activities of its former GEWEX Hydrometeorology Panel and Coordinated Enhanced Observation Period. They have been merged into the GEWEX Coordinated Energy and water cycle Observations Project (CEOP). Its main goal is to understand and predict continental to local-scale hydro-climates with applications. The main science questions of CEOP are:

- What are the average hydro-climate conditions over various regions and seasons?
- How do water and energy flow into and through individual regions as well as redistributed within these regions by local mechanisms?
- How do extremes occur and what is their role in the hydro-climate?
- How do aerosols affect the hydro-climate?
- Does knowledge of water isotopes help us to understand the water cycle?
- Can we simulate and predict the hydro-climate?
- What is the benefit of this increased knowledge about the hydro-climate for society?

A strategic implementation plan for CEOP is now nearing completion. It unifies the work of 8 regional hydro-climate projects, such as AMMA, BALTEX, CPPA, LBA, LPB, MAHASRI, MDB, and NEESPI with four regional science studies for cold regions, high-elevations, semi-arid zones, and monsoons. The new CEOP also includes studies of water and energy budget, extremes, aerosols, isotopes. Its data management component deals with in-situ and satellite data, model output ensuring data integration and storage at the Global Data Centres. CEOP also has a modelling component.

Among the challenges identified by GEWEX are:

- creation of new and reprocessing of existing global datasets that can be used for climate and trends analysis,
- production of high-quality global data sets including ones for sea- and land- fluxes,
- need for datasets in high-latitude regions (including in-situ data for validation purposes), and
- resources to maintain the level of involvement both in the panels at several levels including regional bodies.

In the subsequent discussion, JSC members highlighted the following points.

GEWEX has been in existence for twenty years. Some very difficult but fundamental questions still remain unanswered and require continuation of the research. How will GEWEX continue it? Will it adjust to contribute more directly to COPES? Is there a real connection between WCRP cross-cutting activities and similar activities by GEWEX?

The view of Prof. Sorooshian was that the water and energy cycle research was fundamental and adding more tasks would made it challenging for GEWEX scientists to do all the work. Illustrating the key role of GEWEX studies, he referred to the article written by Prof. P. Morel in one recent issue of the GEWEX Newsletter. Nevertheless, the WCRP strategy COPES has to move forward. Thus, there needs to be an agreement on how to plan and launch activities related to COPES. Either direction will be given by JSC, or GEWEX will decide itself how it will move forward to implement some appropriate tasks outlined in the COPES document.

It was felt essential to ensure that GEWEX datasets were promoted for the next IPCC assessment. In some areas, such as studies of aerosols and climate change, linkages to other bodies such as IGBP were suggested. Some of such linkages are already in place. For example, the IGAC/iLEAPS/GEWEX Aerosol - Cloud - Precipitation - Climate project represents an area of active interaction of the WCRP and IGBP projects. GEWEX and iLEAPS are preparing a joint science conference, to be held in August 2009.

GEWEX has built a solid foundation in both modelling and producing related data sets. With the advent of seamless prediction, with numerical weather and climate prediction joining forces, GEWEX's work on cloud parameterisations and cloud modelling at high resolution is becoming even more important, and the modelling efforts of GEWEX have to continue to concentrate on delivering at essential time scales of interest to both weather and climate communities. Precipitation remains a high priority area of research. Combination of various sources of precipitation data for producing more comprehensive datasets with focus on the extended use of radar data by GEWEX was supported strongly by the JSC. There is a need to concentrate on abilities of current models to reproduce precipitation climatology and its changes.

One current challenge/opportunity will be to use modelling and datasets for generating applications of high societal value, for example for assessment of implications of climate change for energy and water sectors. Another challenge/opportunity is to build adequately datasets that will contribute, as much as possible, to the development, validation and assessment of climate models and their output. This requires strengthening of coordination between GEWEX Panels, and with other WCRP core projects and Panels. For example, initialisation of the soil moisture potentially represents a valuable source of additional predictability to be explored. These studies are already ongoing within GMPP. In particular, this is one of the essential foci of the GLASS working group of GEWEX, which cooperates on these with other parts of WCRP and WWRP (e.g. WGNE) but also with IGBP, for example, through LUCID, which is part of iLEAPS.

The focus of GEWEX Phase II on hydrological applications is very instrumental for developing practical applications of climate science with high societal value. Recognising this potential, JSC encouraged GEWEX to embark on preparing a dataset, representing changes of water storage on land as a contribution to studies of SLR.

The JSC engaged in a short discussion on drought indices and their adaptation for use by operational meteorological agencies and what further requirements are needed to extend their use. The indices largely come from the community engaged in agricultural research in several countries, especially in the USA, and they are receiving more and more attention and use in various types of climate prediction. The next generation of drought indices will be potentially even more useful because they will include the "memory" aspect in terms of soil moisture and water availability. GEWEX was requested to consider what could be done to produce more informative and useful drought indices and facilitate their use in various types of climate forecasting including seasonal forecast of droughts.

The JSC urged GEWEX to discuss, with its SSG,and constituency, how it will evolve as a part of WCRP intermediate implementation of COPES, and its long-term strategic plan during the next decades.

At the conclusion of the "GEWEX" agenda item, the JSC warmly thanked the outgoing GEWEX SSG Chair, Prof. Sorooshian for his leadership of GEWEX over many years.

5.2 CLIVAR

Dr J. Hurrell presented the CLIVAR report which was co-authored by H. Cattle, T. Palmer and V. Detemmerman.

CLIVAR's objectives are to:

- understand the physical processes responsible for climate variability and predictability on seasonal and longer time-scales;
- improve the accuracy of seasonal to inter-annual climate prediction;
- extend the record of climate variability; and
- to understand, predict and detect the anthropogenic modification of the natural climate signal.

Dr Hurrell highlighted the prominent contribution of CLIVAR science to IPCC AR4. Many CLIVAR associated scientists were Contributing Lead Authors, Lead Authors and Contributing Authors. WGCM coordinated the IPCC climate prediction experiments and, using the facilities of PCMDI, organised the CMIP3 archive of forecast model runs. Key inputs were provided through the activities of the joint CCl/CLIVAR/JCOMM ETCCDI. The Atlantic Implementation Panel (AIP) made a key contribution to the analysis of possible abrupt climate change and together the AIP, Pacific Implementation Panel (PIP) and Indian Ocean Panel (IOP) contributed to the analysis of the impact of climate change on natural modes of atmospheric variability.

WGCM is co-sponsored by CLIVAR and its report is considered in section 6.3 of this report. Dr Hurrell also referred to CLIVAR's leadership of the WCRP's activities, aimed at decadal and seasonal prediction, as well as shared responsibility with GEWEX for research on monsoons and climate extremes. All these activities are reviewed in this report. The text below focuses on CLIVAR's own contribution to these activities.

There is progress in understanding of the role of the ocean in formation of decadal anomalies, for example, in the generation of the Sahel droughts and decadal anomalies of precipitation in Africa. In September 2007, GSOP held a second Ocean Data Synthesis Evaluation Workshop (Boston, USA). In all the ocean data synthesis products, there are relatively robust estimates of the inter-annual variability of upper 300m tropical ocean temperature anomalies in the Pacific. Uncertainties for the Indian Ocean and Atlantic remain high. Ocean salinity estimates are uncertain everywhere. Accumulation with time of the Argo data will help to resolve these uncertainties.

As described above,, under the decadal cross cut, to make further progress in decadal predictability studies, a group of scientists associated with WGSIP and WGCM have developed a plan for a series of experiments (a part of the future CMIP5). These will include 70 year-long initialised runs for 1965-2035, with a single scenario, at as high-resolution as possible and with a 10-member ensemble. This work is carried out in coordination with IGBP AIMES and other groups.

Dr Hurrell continued his talk by describing the contribution of CLIVAR panels to planning for the seasonal prediction experiments described under the seasonal prediction crosscut. He summarised some of the studies results presented and discussed at the WCRP Workshop on Seasonal Prediction, in Barcelona in June 2007. The analysis presented in this section of the report concerns additional contributions by CLIVAR panels relevant to this area.

The PIP is actively working on prediction of El Niño/Southern Oscillation (ENSO) at seasonal time scale and beyond. An ENSO prediction forecast web site was set up to provide probabilistic forecasts of ENSO and data needed to assess skill of different forecast techniques. A simple two-predictor regression model was developed to estimate the relative influence of large-scale low frequency ocean-atmosphere dynamics and high frequency atmospheric forcing on peak sea surface temperature (SST) anomalies associated with ENSO variations for the period 1980–2005. One predictor is equatorial warm water volume, which is an index for the role that upper ocean heat content plays in regulating ENSO variability. The other predictor characterizes high frequency atmospheric forcing in the western Pacific linked to the Madden-Julian Oscillation (MJO). The two-predictor model accounts for about 60–65% of peak Nino3.4 SST anomaly variance at 2–3 season lead times and suggests about equal influence (on average) of low frequency dynamical processes and the MJO on peak ENSO SST anomalies over the past 25 years (M. McPhaden et al., 2006).

Intra-seasonal and MJO forecasts are an important component of the future seamless suite of predictions on a range of time scales. MJO prediction is a focus for the US CLIVAR WG on MJO. They have developed diagnostics for assessing MJO simulation fidelity and forecast skill in a suite of coupled and uncoupled model simulation. These MJO metrics have been operationally implemented.

The Pacific Panel has been active in helping to develop the science plan, published in May 2007, for the South Pacific Ocean Circulation and Climate Experiment (SPICE), and is now working on an implementation plan. The panel is also coordinating links between SPICE, the VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS) and the North-western Pacific Ocean Circulation Experiment.

Seasonal prediction in the Atlantic sector (and probably beyond) is being hampered by our very limited ability to predict tropical SST anomalies there. This is partially due to the inherent level of predictability which is lower than in the Pacific basin, but better understanding, models and data are sorely needed to exploit the predictability which may be possible. WGSIP sees coupled model systematic errors in the tropical Atlantic as a major impediment to improved seasonal-to-interannual prediction. The Tropical Atlantic Climate Experiment (TACE) proposal is CLIVAR's response to this challenge. It has two objectives: to advance understanding of the key processes in the eastern tropical Atlantic and improve climate prediction in this region, with a specific goal of contributing to the design of an enhanced and sustained observing system. A TACE WG is in the process of writing a position paper on what determines the mean position of the Atlantic ITCZ and its variability. A recent paper by Chang et al. (Nature 2006) underlines the importance of better observations and removing biases in the models for the tropical Atlantic. If TACE is successful in building a climate prediction system for the tropical Atlantic region, comparable (in terms of data coverage, model fidelity, and - subject to physical limits - forecast skill) to that in the tropical Pacific, it will be possible to use it in the development of useful systems for decadal climate prediction by incorporating both initial condition constraints and transient boundary forcings. The Atlantic climate community is well positioned to taking a lead in this area. because of the key role played by the Atlantic Ocean in the global overturning circulation,

CLIVAR is actively engaged in a number of monsoonal research activities. It coordinates the WCRP monsoons crosscut together with GEWEX.
CLIVAR's Asian-Australian Monsoon Panel's (AAMP) goal is to improve predictions of the Asian-Australian monsoon. It evaluated DEMETER hindcast experiments to determine current skill in monsoon prediction and participated in the organisation of the Asian-Pacific Economic Cooperation Climate Center (APCC) Climate Prediction and its Societal Application (CliPAS) project through its 25-year (1981-2005) hindcast experiments.

Modelling activities are focused on the American sector as a part of the Variability of the American Monsoon System (VAMOS) project, which, in collaboration with GEWEX, is extending our understanding of the monsoons of both North and South America. VAMOS recently formed a modelling group. It plans to feed field program data into model development and validation and generate capacity for assimilation, analysis and operational forecasting of monsoon maturation, onset and demise, and prediction of droughts and floods. A key research area in this connection is representation in models of the diurnal cycle of clouds and precipitation. Another focus of VOCALS is ocean processes in the southeastern Pacific.

WGOMD activities have focussed on the completion of an inter comparison of seven global ocean-ice models runs for 500 years, using a fixed seasonal cycle of inputs to derive the atmospheric forcing. A joint paper that documents the experimental design and simulation results of these CORE-I (Coordinated Ocean-ice Reference Experiment - I) integrations is in preparation for publication in the open literature. The CORE-II protocol is also being prepared. It will include inter-annually-varying forcing(s) based on the analysis of products. A web-based repository of ocean simulation evaluations should be available in 2009.

GSOP is developing a pilot project to incorporate carbon data into ocean synthesis products. It will encourage a special IPY ocean synthesis, which includes assimilation of ice data, in collaboration with CliC. GSOP is now working on preparations for the OceanObs'09 conference, and together with OOPC and other partners is planning its third ocean synthesis workshop in 2008.

The CLIVAR/CliC/SCAR Southern Ocean Panel leads the IPY CASO umbrella project and participates in the development of the Southern Ocean Observing System (SOOS). CLIVAR strongly advocates that WCRP has a major presence in WCC-3. Its SSG, which met in Geneva in September 2007, agreed there was an urgent need for vision of WCRP beyond the project sunset dates. It plans a 2nd

CLIVAR Science Conference in 2011, with a final project celebration meeting in 2013. The SSG will strive to engage all CLIVAR panels and working groups in providing assessments of achievements and identification of major outstanding questions for input to the 2nd CLIVAR Science Conference.

The CLIVAR SSG was strongly concerned with the severe WCRP project budget cuts but decided not to restructure itself because a major organisational change would have disrupted its scientific progress. The present ICPO Director plans to retire on 31 March 2010.

In the course of the discussion, the JSC called on CLIVAR to strengthen its collaboration with PAGES. It expressed a keen interest in the success of the forthcoming OceanObs09 Conference, because it will set plans for a decade of ocean measurements. A one-year task force was proposed to solicit input from various groups and bodies, e.g. IMBER, PAGES, CLIVAR (all its membership), CliC, SOLAS, WOAP, and those involved in research on surface fluxes, etc. The JSC Chair was of the opinion that deep ocean observations were inadequate both in space, and time and determination of the deep ocean heat content was still very problematic. He stated that the ocean observations need new technology to complement ship surveys. This should be reflected in the planning of the joint IOCCP/CLIVAR/IGBP IMBER GO SHIP panel in terms of requirements for deep hydrography and carbon.

The JSC urged CLIVAR to discuss with its SSG and constituency how the project would evolve as WCRP implements COPES and start preparing its long-term strategic plan during the next decades.

5.3 SPARC

Professors T. Peter and T. Shepherd presented the SPARC report.

SPARC develops and brings knowledge of the stratosphere to bear on relevant issues in climate variability and climate prediction. It has evolved according to a long-term plan, but works through identifying and addressing “bite-sized” deliverables. The SPARC Newsletter is highly cited (194 citations in the WoS citation index). SPARC Reports have had a particularly important role in past scientific assessments. They are also highly cited (105 citations in the WoS citation index, 14 citations in the WMO/UNEP 2006 Scientific Assessment of Ozone Depletion, and 7 citations in the AR4). So far four reports have been completed on:

- Ozone profile trends
- Stratospheric temperature trends
- Water vapour trends
- Aerosol assessment

SPARC was initially oriented towards studying the dynamics of the stratosphere, but recently generated activities in the field of atmospheric chemistry, initiated links to IGAC, involved the academic community in its research on development of data assimilation for climate studies, and brought sophisticated cloud-resolving models to bear on the Tropical Tropopause Layer (TTL) in the interpretation of high-resolution measurements.

The IPCC AR4 had an unprecedented level of “SPARC-friendly” authorship. Nevertheless, there is a discrepancy between the level of understanding of the role of the stratosphere for climate prediction and its actual implementation in the models used for IPCC runs. The gaps are:

- the stratospheric ozone forcing data was not updated since the IPCC TAR,
- solar effects on chemistry were not evaluated, and
- stratospheric water vapour remains a key area of uncertainty.

Over the past three years, the Chemistry-Climate Model Validation Activity for SPARC (CCMVal), a core component of AC&C, has engaged in a comprehensive assessment of the current generation of chemistry-climate models (CCMs). Key CCMVal results were documented in two refereed journal articles (Eyring et al., 2006, 2007, JGR, Parts 1 and 2) and provided the basis for major recommendations in the WMO/UNEP 2006 Scientific Assessment of Ozone Depletion. In particular, its Chapter 6 “The Ozone Layer in the 21st Century”, and IPCC AR4, in particular its Chapter 7 “Couplings Between Changes in the Climate System and Biogeochemistry”. CCMVal’s process oriented model validation led to a marked progress in model performance since the previous WMO/UNEP Scientific Ozone Depletion Assessment undertaken in 2002. The CCMVal series of transient experiments from 1960s to 2100 cover past and future state of the climate system. The

forcing data sets (e.g. SSTs, GHGs, halogens) and output are available to the wider community for further analyses.

In 2009, SPARC is planning to complete a report on evaluation of CCMs, which will constitute a comprehensive, up-to-date assessment of their ability to represent the coupled ozone-climate response to natural and anthropogenic forcing. It will be a very useful and timely contribution to the 2010 WMO/UNEP Scientific Assessment of Ozone Depletion and IPCC AR5, particularly because ozone recovery may have a significant impact on polar atmospheric circulations. For example, it will likely change the sign of the trend in the Southern Annular Mode.

Dynamics and Variability (DynVar) is a new SPARC activity, which has a significant theoretical component. It aims to improve stratospheric representation in climate models but has a strong emphasis on the models' ability to simulate stratospheric influence on tropospheric variability and change. The focus is on processes that do not hinge on coupled chemistry feedbacks or solar influences. The program of experimentation includes comparison of high top and low top models, and investigation of ocean-atmosphere coupling. SPARC has rejuvenated its gravity-wave initiative,because gravity waves are key elements in the dynamics of the middle atmosphere, and improving gravity-wave drag parameterisations continues to be a critical modelling issue. This will be synergistic with DynVar. The links of DynVar to CCMVal will be also strong because of the important role of dynamics in chemistry-climate coupling. For example, CCMs consistently show a strengthening of the Brewer-Dobson circulation because of climate change, and a major component of the trend appears to be from orographic gravity-wave drag.

Following on from the SPARC/GEWEX/IGAC workshop on modelling of deep convection and chemistry and their roles in the TTL (June 2006, Victoria, BC, Canada), SPARC is developing a series of related studies. They include studies of overshooting convection and different microphysical processes affecting the H_2O budget in the TTL (for example using experimentation with a cloud-resolving model (CRM)) and a hygrometer intercomparison campaign. Results of many of these studies will be summarised in an updated Assessment of Tropospheric and Stratospheric Water Vapour, which will constitute another SPARC report or a review paper. While there is progress in the activities associated with the tropopause in the tropics, steps are required toward development of a broader tropopause activity. SPARC initiated a discussion on this issue. There was a summary article in SPARC Newsletter No. 29, a website at http://www.acd.ucar.edu/sparctrop has been set up, and several AGU and EGU sessions will take place on research on the Upper Troposphere – Lower Stratosphere (UTLS).

In their presentation the SPARC SSG Co-chairs raised the question, whether WCRP in general, and SPARC in particular, should address the issue of geoengineering. In addition, should SPARC proceed to assess P. Crutzen's proposal as to approach other scientific problems, at least for theoretical and modelling studies? Read more on this subject in Section 9.

Another major open issue for SPARC is climate change in the polar stratosphere. The strongest coupling between ozone depletion/recovery and climate change (and between troposphere and stratosphere) is expected to take place in the polar regions. At the same time, models show no convergence around the poles, and show high sensitivity to parameters that are difficult to estimate properly. Strong low-frequency variability in the polar regions makes it a challenge to detect any trends, and represent an opportunity for emerging research.

The SPARC Fourth General Assembly will take place in Bologna, Italy, on 31 August–5 September 2008. The General Assembly is prepared in close coordination with the IGAC Conference, which will take place in Annecy-le-Vieux in France on 7-12 September 2008, one week after the SPARC General Assembly.

The General Assembly will cover the following topics:

- stratosphere-troposphere dynamical coupling,
- stratospheric variability and climate change,
- extra-tropical upper troposphere/lower stratosphere,
- detection, attribution and prediction of stratospheric change,
- tropical tropopause layer,
- atmospheric chemistry and climate,
- stratospheric data assimilation,
- gravity-wave processes and their parameterisation, and

- stratospheric and upper tropospheric water vapour.

More than 400 abstracts were submitted to the General Assembly and many of them are from scientists from developing countries. It is very important therefore to obtain a certain level of financial support for the General Assembly so that it can provide support to young scientists from around the world, especially from developing countries.

Drs T. Peter and T. Shepherd concluded their presentation by conveying the challenges that SPARC management will face in the near future. Most of all, SPARC IPO funding from CFCAS ends in 2010 with no current prospect for renewal. SPARC science will likely need a new long-term "home" post-SPARC, while new scientific issues will continue to arise.

The JSC was impressed by the progress in various SPARC activities and particularly its work on modelling. It called on WGCM to make sure that SPARC CCMVal results and recommendations — e.g. the representation of the tropopause, a comprehensive treatment of atmospheric chemistry, and especially a good representation of stratospheric ozone — are being fully exploited.

The issue of adequate model metrics was also brought up and it was clear from the SPARC experience that different applications may require different metrics. However, considerable caution is needed in this process for climate models. Due to a lack of direct verification, the metrics are currently based on the ability of the models to simulate the current climate, but, taking into account, for example, possibilities to improve the representation of current climate by applying flux-corrections, some metrics may not tell us much about the model's ability to simulate the future climate system and associated changes. Some experience suggests a strong link between the ability to reproduce climate variability and model sensitivity. Due to a huge spread in the initial CCMVal simulations of ozone recovery, the 2006 Ozone Assessment authors could not avoid considering metrics and assigning weights to various models; results from some models were even excluded from the analysis. Because there is a lack of reliable and sufficient data coverage in the stratosphere, CCMVal developed a validation system based on process representation in models, and this approach has been shown to be promising. The Hadley Centre uses the same approach to evaluate its climate model. SPARC was invited to participate in the corresponding discussions and share its experience to enrich the emerging IPCC-class and other climate model metrics. A suggestion was made to have a WCRP workshop on best practices in developing (climate) model metrics. It was generally agreed that discussions at the Modelling Summit could offer some required guidance on the development of model metrics and their use in future climate assessments.

The JSC urged SPARC to discuss with its SSG and constituency how the project would evolve as WCRP implements COPES, and to start preparing its long-term strategic plan for the next decade.

5.4 CliC

Dr B. Goodison, Chair of the CliC SSG, reported on CliC. His presentation was co-authored by Drs A. Prick and V. Ryabinin.

The principal goal of the CliC project is to assess and quantify the impacts that climatic variability and change have on components of the cryosphere and the consequences of these impacts for the climate system. CliC also seeks to determine the stability of the global cryosphere. It is the youngest core project in the WCRP family and its "sunset" is envisioned in 2015.

CliC activities focus on the following themes:

- Terrestrial cryosphere and hydrometeorology of cold regions (TCHM)
- Ice Masses and Sea Level (IMSL)
- Marine Cryosphere and Climate (MarC)
- Global Prediction of the Cryosphere (GPC)

There are many active players in cryospheric and polar research. CliC has established cooperations with many partners that will contribute to its objectives. Some significant results have already been achieved. There is now a special chapter on cryosphere in the IPCC AR4 with contributions from and co-authored by many CliC scientists. CliC has strongly influenced and enriched the programme of IPY, which in turn will help CliC to advance research in many areas.

CliC (together with SCAR) was the lead author of the IGOS Theme on Cryosphere, which proposed a comprehensive plan for development of cryospheric observations. This document was approved by IGOS Partners at their 14th meeting in Paris in May 2007, and the report was published by the WMO. Dr Goodison expressed deep appreciation to Dr Jeffrey Key of NOAA NESDIS, the Chair of the IGOS Theme on Cryosphere, for his leadership, tireless efforts devoted to Theme preparations and the successful completion of the Report. The IGOS Theme on Cryosphere has already achieved significant results, such as an improved coverage of cryospheric elements in the GCOS Implementation Plan and the GCOS-CEOS plan of development of satellite-based products for UNFCCC, support to the CryoSat-2 re-launch in 2009, impact on the ESA Earth Observation Programme leading to the acceptance of the CoreH2O mission and some others. The Theme report serves now as an excellent basis for specifying user requirements in the ESA GlobIice, GlobGlacier, and GlobSnow projects. The IGOS Theme on Cryosphere serves as the basis for CliC's cooperation with several organisations developing observing systems in the polar regions, such as SAON, iAOOS, PAntOS, and SOOS.

CliC is also pursuing its goals by involving other cryospheric scientists. Recently, cooperation has been established in Asia where scientists from over a dozen countries decided to establish an Asia-CliC project. Through regional workshops and conferences, activites have been initiated to support the determination of the 'state and fate' of the Asian cryosphere. A high priority activity of Asia-CliC will be the development of cryosphere datasets and data rescue. An initial step is to create a snow-cover data-archive for the region. The Asia-CliC project is the first opportunity for scientists from different countries to meet, exchange knowledge and ideas, and to plan how they can work together to create a cohesive picture for the region. An Asia-CliC Committee and SSG are being finalised to oversee the regional programme of activities. CliC expects that this model will lead to the formation of other regional groups, such as in South America.

Another important regional activity is being developed in the Arctic. The Artic Council is planning a cryosphere project to focus on arctic sea ice, the Greenland ice sheet and arctic snow, permafrost, glaciers, and hydrology. CliC-affiliated scientists are among the organisers and it is expected that this project makes a significant contribution to CliC goals in advancing crysopheric research in the Arctic.

Activities in the area of terrestrial cryosphere and hydrometeorology of cold regions are outlined in the science plan of the International Conference of Arctic Research Planning WG 7 "Terrestrial Cryosphere and Hydrometeorology (TCHM)". The hydrological part of the science plan is closely linked with the IPY Arctic-Hydra project initiated by CliC and its partners several years ago. Core activities of TCHM will be focussed on the integration of model output and observations to produce high-quality datasets for the analysis of relevant processes and to enable predictions and assessments in support of the Arctic Council "Climate Change and Cryosphere Project". A significant contribution to TCHM will come from a project entitled "Improved Process Parameterisation for Prediction in Cold Regions (IP3)", which is aimed at understanding water supply and weather systems in the cold regions of Canada and will contribute to a better prediction of regional and local weather, climate, and water resources in cold regions, including ungauged basin stream-flow, changes in snow and water availability, and the calculation of freshwater inputs to the Arctic Ocean. IP3 was recently endorsed by CliC. These results will also contribute to the establishment of SAON.

The THCM Theme is of great interest to GEWEX and it will be an area of intensive cooperation between the two WCRP projects by focussing their efforts on cold region/cold season precipitation/snowfall, snow cover observation based on remote sensing, glacier and ice sheets hydrology, frozen ground dynamics, and cold region hydrologic system modelling, including river-ice processes and human effects.

The IMSL Theme identified major challenges in determining the cryospheric contribution to sea-level rise (SLR). They are largely related to the rapid changes occurring in marginal regions and the Greenland and West Antarctic ice sheets, where glaciers show acceleration and thinning. So far, ice-sheet models have not been capable of capturing the observed glacier speed-ups in Antarctica or Greenland. Furthermore, there is not enough understanding of basal melting, which affects glacier dynamics and calving rate, due to changes in ocean circulation and temperatures. The current contribution of the cryosphere to SLR is estimated to be about 2.2 mm per year, and if the ice loss continues at current rate, SLR in 2100 could exceed 0.5 m.

As part of the MarC Theme, CliC has established an Arctic Sea-Ice Observations WG co-chaired by Drs Don Perovich (USA) and Sebastian Gerland (Norway). Its objectives are:

- to develop, standardise, implement observation and measurement protocols for Arctic sea ice in coastal, seasonal, and perennial ice zones with a focus on surface-based observations,
- to direct research activities towards characterizing the state of the ice cover, enhancing the retrieval of sea ice remote-sensing parameters, and improving the treatment of sea ice in models,
- to develop an integrated, international approach to implementing surface-based sea-ice observation components for an evolving Pan-Arctic Observing System.

The WG plans to organise a workshop on "Integrated protocols and observations for Arctic sea ice".

The CliC GPC workshop held 8-9 October 2007 in Cambridge, UK, identified major challenges in predicting the evolution of the cryosphere in the 21st century. For example, higher resolution atmospheric forcing data is required to drive cryospheric models, because the reanalysis data were thought to be too coarse to be used in many applications. Representing properly the contributions of the oceans in coupled climate models is essential, since this affects projections of many aspects of the cryosphere, such as sea ice and melting of ice sheets and glaciers, leading to iceberg calving. These processes are not adequately represented in the current models, despite the fact that they are critically important in the ocean freshwater balance, especially in the Southern Ocean. Further investigation of the calving processes is needed. There is a need to understand why sea-ice projections by current ice-ocean models are so variable. In models, a better coupling between ice sheets, ice shelves, sea ice and the ocean is needed. An intercomparison of permafrost models would be also valuable.

The role of the cryosphere in shorter-term climate predictions remains largely undiscovered and studies of feedbacks on seasonal time scale may provide a useful input to predictions for the 21st century. This calls for assessing the predictability of cryosphere components, and polar regions in general, at seasonal time scale, and for estimating the contribution from cryosphere variability to seasonal prediction skill in extra-polar regions.

Stronger focus of CliC on integrated models for cryosphere elements (e.g. sea ice, snow cover, river and lake ice) will be required in the near future. The current CMIP3 models do not properly represent these elements.

CliC plans for 2008-2009 include:

- Alignment of CliC activities with COPES goal/objectives;
- Planning for contributions to the IPCC AR5;
- Continued support to the IPY projects and implementation of the IPY legacy, especially GCW and SAON;
- Concerted efforts on developing more realistic ice-sheet models, involving data collection and interpretation, improved process understanding and incorporation into numerical models (a first workshop will be led jointly by SCAR and IASC, in partnership with CliC in St. Petersburg, Russia, in July 2008);
- Continued development of the Asia-CliC Regional Group;
- TCHM and GPC workshop on integrating atmospheric and cryospheric-hydrologic models for application in cold-regions basins;
- A GPC workshop on generating high horizontal resolution atmospheric fields to drive cryospheric models (late 2008);
- MarC initiatives on sea ice include:
  - development of a Southern Ocean Observing System (jointly with SCAR, SCOR and other partners),
  - ongoing involvement with development of Arctic Observing Systems; a workshop for early career scientists on sea-ice field techniques to be hosted by the University of Alaska,
  - ongoing development of the sea-ice data portal and data mining activities, and
  - work towards making sea ice a fully interactive part of IPCC-class GCMs;
- Continuing integration with other WCRP core project offices.

The 15th WMO Congress supported the proposal from Canada to WMO to create a Global Cryosphere Watch (GCW). Congress requested the WMO Inter-commission Task Group on IPY to establish an ad hoc expert group to explore the possibility of creating such a global system and prepare recommendations for its development. This was approved in January 2008. An *ad hoc* expert

group on GCW led by the CliC Chair, Dr B. Goodison, will ensure widespread consultation, reaching across all WMO Programmes and Technical Commissions, while engaging other organizations and agencies, and the cryosphere scientific community. The proposal is largely resulting from CliC activities, and CliC now has to continue its efforts to turn the GCW vision into reality. GCW will contribute to WMO integrated observing and information systems and to the Global Climate Observing System network (like the Global Atmosphere Watch does). It will cover all aspects of the cryosphere and be an intergovernmental mechanism for supporting key cryospheric *in-situ* and remote-sensing observations - while implementing the recommendations of the IGOS Cryosphere Theme. A GCW goal would be to establish a one-stop portal for authoritative cryosphere data and products/information, helping existing elements to be better integrated and contributing to a global data system. GCW will provide the integrating mechanism needed to ensure better quality of data and metadata, and ensure comparison of algorithms and the evaluation of products. GCW will use this information to aid the prediction of climate and cryosphere, and the detection of climate change, and to organize assessments of changes in regional and global components of the cryosphere to support decision-making and policy development. WCRP will host Dr Goodison during his secondment to WMO to focus on developing the GCW strategy.

CliC leadership was recently engaged in consultations with IASC and SCAR on a potential co-sponsorship of CliC by IASC, which will require an extension of 2004 WCRP/SCAR Memorandum of Understanding to include IASC. The rationale for this extension will be a better coordinated establishment, development and maintenance of long-term climate observations in the Arctic and Antarctic, on land and in the ocean; modelling efforts to synthesise observations, enhance the representation of the polar regions and the cryosphere in climate models, and studies of the impact of climate change on polar regions. This proposal will give SCAR and IASC a global voice when cooperating with WCRP, while for WCRP this cooperation will help to strengthen links to polar research coordinators. Under this proposal, the CliC SSG would include members representing interests of SCAR and IASC. IASC Council approved the proposal for IASC to become a co-sponsor of CliC, together with WCRP and SCAR. JSC was requested to endorse the concept for WCRP.

During the subsequent discussion, JSC revisited the issue of WCRP activities in polar regions, which was raised in the report by SPARC. A need was expressed to organise a small WCRP WG working by correspondence to scope the research topics focused on atmosphere and cryosphere interactions over the polar regions, in particular extra-poles interactions, climate predictability and manifestations of global change in the polar regions, involving not only cryospheric aspects but also atmospheric chemistry, stratospheric processes, etc. Existing activities, for example, the AMAP-led initiative of the Arctic Council on a study of future Arctic climate could benefit from WCRP active participation. This activity would be also very relevant for ACC and the WMO Executive Council WG on Antarctic Meteorology. Current high interest in the Arctic as a source for oil and gas may help to build momentum for observations and research in this region.

The proposed focus on modelling by CliC was strongly supported by the JSC. It was generally understood that CliC would require one to two years to build its modelling studies. CliC was already trying to increase its expertise in various aspects of modelling, for example by involving more specialists in this field as SSG members. CliC was encouraged to invest serious efforts in the development of ice sheet modelling, to not only cooperate with others but take the lead and address issues that would not otherwise happen.

A need to advance monitoring of ice sheets and tropical glaciers was also raised in the discussion. While the recommendations in the IGOS Theme on Cryosphere report do cover this topic, real commitment is needed to address this requirement and ensure at least minimal sustainability of observations. The expectation is that the GCW would help to generate some commitment. Considerable expertise in this area exists in NASA.

The JSC was supportive of the idea to extend the MoU with SCAR and include IASC in the group of sponsors of CliC, but requested D/WCRP to review the specific details of this agreement to make sure that the time and resources invested in such partnership are mutually beneficial to all organisations and scientists involved.

The JSC urged CliC to discuss with its SSG and constituency how the project would evolve as WCRP implements COPES and to start preparing its long-term strategic plan during the next decades.

At the conclusion of the “CLIC” agenda item, the JSC warmly thanked the outgoing CLIC SSG Chair, Dr Barry Goodison for his leadership of CLIC over many years.

6. Review of WCRP panels and working groups

6.1 WCRP Modelling Panel and the Modelling Summit for Climate Prediction

Dr J. Shukla reported on the WCRP Modelling Panel (WMP).

The organisation of the World Modelling Summit for Climate Prediction, 6-9 May 2008, Reading, UK has been the most important activity of WMP. The Summit is expected to address the main questions on model development and produce recommendations on metrics and model intercomparisons, supercomputer requirements and a strategy to augment computing resources. According to Dr Shukla, the Summit will focus on capabilities and resources required for IPCC class models to run at ~10km resolution. He called on JSC to support the idea that climate modelling community needs TeraFLOPS computing capacity. He also proposed a potential flagship project for WCRP, aimed at producing a best possible detailed 30-year outlook of climate, assessed by all WCRP teams, and in cooperation with other partners such as IGBP, to deliver the best climate prediction that evolving science can offer.

The discussion followed with a question on how the Summit would deal with confronting models with observations, which was expected to be a subject of a special session organised by WOAP. The view of the JSC was that having such a session was necessary and that it should address the question what observations we need to improve and validate high-resolution regional climate models. Dr Shukla's view was that there were many observations that modellers were not using today. Other JSC members' stated that the Summit has to focus on the development of a comprehensive strategy for model validation and it may be premature to define concrete requirements for observations. A related point was made that the Summit might also consider how to better use and extend reanalyses.

Representatives of the WWRP reminded the JSC that the Summit is also a collaborative effort with WWRP and that there should be a serious discussion on the development of the seamless approach to modelling and forecasting, and what the weather and climate prediction communities can promise to society as a result of implementing the seamless approach.

The JSC agreed that it was extremely important that the opportunity provided by the Summit should be fully exploited to reach a consensus on the way climate models will be developed and used, and that the involved communities would start speaking with one voice about the priorities emerging from the summit. JSC therefore recommended that the Summit develops a Statement with support and endorsement of the participants.
The JSC who was directly involved in the Summit preparations explained that it intended to focus on the "physical" aspects of the climate system. This clarification resulted in extensive discussions on the need of considering the entire Earth system in the development of climate models. The agreement was that the Summit takes a stepwise approach and defines first a strategy for "the way forward", recognising strategically and tactically the need to include biogeochemical elements, and acknowledging the need for addressing economic and social issues in the future.

Some participants stressed the need to quantify demands for resources and computing power in terms of direct benefit to society and involve high-level decision makers in the process. It was also proposed to organize a series of workshops with the broader ESSP community to frame recommendations for WCC-3 on the development of modelling and prediction. Other participants urged WCRP to be very careful and first focus on demonstrating what we can offer to society before making a commitment to their routine provision. The best balance should be between proposing various options for "the way forward" and the expected achievements with the available resources and time towards meeting the expectations of the global community.

The JSC also discussed a need to examine all existing modelling panels/groups within WCRP towards achieving greater integration and coordination among them, and to avoid duplication of efforts and provide resources and time for supporting meetings and events by the same scientists. The need for continued coordination with IGBP/AIMES and to further simplify the overall oversight structure was also noted. The agreement was that the future of WMP and other modelling panels/groups and their relationship to other organisations such as WWRP, IGBP, etc. should be determined after the Summit.

6.2 White paper on revolution in weather, climate and Earth system prediction

Dr M. Béland presented to the JSC a major proposal to develop an end-to-end system encompassing the full range of activities from Earth observations to generating meteorological products for various sectors. The focus of such an effort will be a seamless prediction of today's weather to future climate projections and predictions on time scales from seasons to decades and centuries. The White Paper describing this concept (entitled "The Socioeconomic and Environmental Benefits of a Revolution in Weather, Climate and Earth-System Prediction") was presented at the GEO-IV Plenary and Ministerial Summit on 28-30 November 2007 in Cape Town, South Africa. The White Paper and a document presenting it to the JSC were made available to Session.

The proposal represents a major and very ambitious 10-year research, development, implementation, communication project, which calls for serious commitment from countries with investments of the order of billions US$ annually with expectations of very high return on these investments. There are implications for infrastructure and a significant need for more human resources. The scope of the project is so large that one country cannot do it, thus a global effort is foreseen. At the same time, given regional and local impacts of climate change and the need for useful information/products at this level, the involvement of local scientists and experts are absolutely essential.

The feasibility of this proposal depends on the availability of high-resolution observations, and of weather and climate models that use them to provide the integrated assessments and predictions at local/regional scales. So far, many required observables are lacking, and for example ecological data assimilation systems do not exist. Dr Béland estimated the required computer power increase of the order of 10^4 relative to current systems, leading the number crunching speeds into HexaFLOPS and corresponding increase in data transfer speeds. Research will represent a very important part of the project leading to new parameterisations and learning about unknown processes. He also highlighted the need for establishing the needed cooperation between environmental, economics and social sciences to provide the information/knowledge for risk identification, management and decision-making.

The proposal received positive feedback from the GEO Ministerial Summit. Dr Béland proposed preparing a resolution for the WMO Executive Council LX (Geneva, June 2008) that would form a panel of experts from multiple disciplines and organizations to produce a scientific infrastructure framework and identify steps need to implement this plan. The proposal would also be discussed at the Modelling Summit and presented to WCC-3. Dr Béland sought for JSC support and ideas expressed in the White Paper.

JSC discussed and commented on the proposal. Dr K. Noone supported the idea in general and said that ESSP had to be involved in it. Some participants also felt positive regarding the possibility to propose the project to WCC-3 but warned that the main interest in terms of climate change research was shifting from producing projections to supporting adaptation to climate change. At the same time, climate change was not the only issue for governments. If the project is seen only as a meteorological/climate programme, it will be difficult to generate the necessary support for it. What is really required is to clearly express the benefit of running models at high resolution in economic terms and demonstrate the benefits of resulting products, scenarios, projections, etc. for use by the decision makers, managers, businesses, governments, etc. There have been examples of successful programmes breaking the barriers, for example, GARP, but the programme has to have a central piece to be successful. JSC stated that it is important to develop a good marketing strategy for this proposal. One possible approach would be to frame it in terms of security.

A balance between emphasis on technology and scientific understanding was seen as a crucial metric for the proposal. During the last 15-20 years, the progress has been significant in terms of computing power and the ability to run climate/weather models at greater resolution, for longer periods at shorter computer times. We need now more progress in representing the physics, chemistry, and biology of the climate system in these models. Some JSC members expressed concern that this grand idea may be too big for discussions at the Modelling Summit, which is supposed to be highly focussed on climate prediction.

Overall, the JSC was positive with respect to the proposal, and stated that it had to be both strategic and tactical. The agreement was that the Modelling Summit should focus on modelling for climate prediction. After the Summit is held, the White Paper should be moved forward along with the Summit's recommendations (Statement). The idea of an end-to-end system based on excellent

science, encompassing weather, seasonal, decadal, centennial predictions, and meeting identified user requirements was extremely attractive and indeed worth presenting to WCC-3 as a potential major outcome.

6.3 WGCM

Prof. J. Mitchell reported on WGCM.

Key recent WGCM achievements are associated with its leading role in the IPCC AR4. Specifically, the WGCM PCMDI AR4 model run archive has strongly stimulated regional climate research. WGCM has led the formulation of new scenarios for an IPCC AR5.

The WGCM priority remains to coordinate climate prediction experiments under the agreed scenarios. Work on climate model improvements will focus on cloud feedbacks, for example through CFMIP, on the carbon cycle, in cooperation with AIMES, and on development of climate model metrics. WGCM will continue to serve the community that studies climate change impacts and this work will have emphasis on decadal time scales and provide input to climate projection downscaling. WGCM will extend its scope of work to contribute to the development of ice sheet models (contributing, with CliC, to studies of SLR), regional models, and prediction of air quality (together with AC&C). All this work will require strengthening links with the rest of WCRP and the wider community.

In order to achieve its goals, WGCM requires access to high-end computing. It has established close links with the IGBP/AIMES and it is worth considering greater integration of the two groups. Reducing uncertainty remains a key priority for WGCM. Summarising his report, Prof. Mitchell called on WCRP and especially ACC to focus less on programmes and more on the outcomes from them.

The priority of reducing uncertainty was discussed. One should really speak about characterising uncertainty and increasing reliability. It is possible that taking into account additional Earth system processes will increase the spread of model climate predictions. The importance of reducing known biases, especially at regional level, was recognised. The JSC also noted value of the decadal crosscut in bringing together WGCM and WGSIP.

6.4 WGNE

Dr M. Miller presented the report of WGNE. Part of the talk by Dr Miller was co-authored by Prof. C. Jakob.

Dr Miller stressed the role of WGNE in supporting the WMO Commission for Atmospheric Sciences (CAS) and WCRP, its fundamental role in developing atmospheric models (dynamical cores and physical processes) and data assimilation. Special attention is paid to both limited area and global models, and progress made in estimating systematic errors of models.

The main trend in developing numerical forecasting systems is the continuously increased resolution. Main forecasting centres are planning to run their global models at horizontal resolutions from 16 to 25 km. This poses additional requirements for physical parameterisation development. These issues were discussed at a joint session of WGNE with the GMPP in Shanghai, China, on 22-26 October 2007. The groups also reviewed and discussed several special scientific topics:

- Convection-permitting models in NWP;
- Land data assimilation;
- Year of Tropical Convection (YOTC);
- Forecasting the MJO.

WGNE also reported on progress in model verification. New developments include the verification of precipitation forecasts using national high-density data at several NWP Centres, and of typhoon tracks for all ocean basins at JMA. There are attempts to start considering intensity and possibly genesis of tropical cyclones. Together with WGSF, WGNE reinvigorated the SURFA project in comparing NWP surface flux data, presently from ECMWF and DWD, which are routinely archived at NCDC, with buoy and ship observations.

WGNE is systematically approaching the development of model metrics to assess performance and quantify some model characteristics. Performance assessment metrics have a long history in NWP. They are used to monitor changes in the performance, gauge relative skill of forecasting systems, and

grade forecasts. Climate model metrics will likely be more oriented towards representation of corresponding processes. Potential uses of climate performance metrics are to assess model fidelity in simulating the present and past climate and determine reliability of future projections (potentially leading to assigning weights to individual models), and to promote healthy competition among modelling centres.

One way of assessing climate model quality is to try to perform short-medium range forecasts from operational analyses/reanalyses using climate models and compare forecasts to climate scale component of operational analyses and reanalyses over regions where the analyses can be shown to represent the atmosphere. For some variables, the forecasts can be compared to results of specialised field campaigns such as ARM.

WGNE and PCMDI organised the third Workshop on Systematic Errors in climate and NWP models held in San Francisco in 2007, with partial WMO support. The workshop conclusions include:

- importance of metrics,
- the value of running short-range forecasts from NWP analyses,
- the value of running suitably initialised coupled models in forecast mode over seasonal timescales,
- existence of persistent errors linked to limited understanding in the diurnal cycle, MJO, monsoons including onset and breaks,
- benefits of substantially increased resolution (noting however that increased resolution does not 'solve' everything),
- recommendation to work on systematic error reduction at high resolution (because otherwise tuning can be made for wrong reasons),
- need to balance complexity versus basic physical realism, and
- need for major increases in computing power but with balanced investment in manpower.

Dr Miller proposed that WCRP initiate an activity on climate model metrics to be led by a formally established WGNE/WCRP task group.

Drs Miller and Jakob drew the attention of the JSC to the need to revitalise parameterisation research and development in WCRP and CAS/WWRP. There is a widespread perception that general model development progresses are slower than computer power. Parameterisation research requires team efforts but many modelling centres have reduced their efforts in this area. This type of research lacks visibility within WMO, and only GMPP and WGNE represent principal coordinating bodies for this activity. GMPP and WGNE therefore put forward a proposal on the restructuring of WGNE to bring together parameterisation development activities within WCRP and CAS without changing the existing structure of GMPP and, hence, GEWEX. The proposal should help to promote and stimulate parameterisation development, strengthen dialogue between model developers and users, set priorities, facilitate activities like workshops, and ensure a critical expert mass within WGNE to make real progress in the coming years. WGNE would have a co-chair responsible for the parameterisation component and Dr Jakob, current Chair of GMPP, was nominated to become the Co-Chair. Chairs of GCSS, GLASS and GABLS will become WGNE members. In the future, WGNE will start to extend its expertise by involving specialists in microphysics, oceanography, cryosphere, etc. JSC was in full agreement with this proposal and requested D/WCRP to approach WMO CAS and seek their approval of this WGNE restructure.

6.5 Regional climate downscaling

Dr F. Giorgi provided an update on the state of current knowledge in regional climate downscaling (RCD). A White Paper on this issue was prepared by a group of authors with initial draft by Dr G. Flato.

The interest in the use of RCD techniques has tremendously increased because of the need of high-resolution climate information for assessing impacts and developing adaptation strategies. There are several techniques for RCD:

- Uniform high resolution GCM time-slices
- Variable resolution GCMs
- Limited area Regional Climate Models (RCMs)
- Statistical downscaling methods

Most of uniform resolution time slice experiments to date were at ~50-100 km mesh size. In some experiments the resolution was as high as 20 km. Efforts are under way to develop cloud resolving global atmospheric GCMs.

In variable resolution GCMs, the highest resolution achieved in the region of interest was of the order of a few tens of kilometres. The Stretched Grid Model Intercomparison Project (SGMIP) included four participating models (CSIRO C-CAM, Environment Canada GEM, Météo-France ARPEGE, and NASA-GSFC GEO-3).

A number of RCMs are currently available and some of them are "portable" and used by a wide range of communities (e.g. RegCM, PRECIS, RSM, WRF). The current "state-of-the-art" grid spacing is 10-30 km (higher for some models). RCMs are being upgraded to non-hydrostatic, cloud-resolving frameworks in order to go to sub-10 km resolutions. Decadal to centennial simulations with RCMs have become the accepted standard. A number of review/guidance papers and reports are available on this topic. There are encouraging results from first experiments with two-way nesting of global and regional models. Coupled RCMs are emerging that include representations of the atmosphere, ocean, aerosol, and biosphere components. RCMs are used in seasonal prediction and climate change impact studies. These models are used in regional intercomparison studies in all regions of the world except Antarctica.

Use of SD techniques for climate change impact applications has increased considerably due to their computational efficiency. Many different techniques are available, often tailored to local specific issues. Several coordinated projects have been carried out or are under way including STARDEX, MICE, PRUDENCE, ENSEMBLES, and AIACC.

The ICTP and WCRP organized a workshop on regional models (Trieste, Italy, March 2007) and their use as RCD tools in developing countries. It was recognised that local scientists could help to formulate a developing country perspective on climate change by conducting regional climate model experiments. Dr Giorgi asked JSC whether it was worth creating a panel to oversee and optimise regional climate change research. The Panel's mandate could be developed in consultation with the broad scientific community. The Panel would create a framework for the coordination of regional climate change research and RCD. Participation in the Panel by developing country scientists would lead to a sense of ownership and facilitate communication with the end-user community involved in impact assessment and work on adaptation and mitigation. The Panel would have strong ties with the global modelling community, which will facilitate the provision of global forcing data. Its work would benefit from a PCMDI-like data centre helping to develop regional observed and simulated datasets. Two workshops on RCD are being planned in 2008 in Toulouse, France and Lund, Sweden that could provide an opportunity for further discussing this proposal.

The JSC recalled the ACC recommendations that coordination of regional downscaling activities was urgently needed. Various approaches to modelling regional climate have to be assessed to ensure that use of these predictions by countries to address adaptation needs does not outstrip their inherent capabilities. There are fundamental questions about how regional models should be used and the degree to which they provide a solution. Some relevant activities already exist in WCRP. For example, WGNE has an activity on assessing stretched grid global models versus nested regional models. Results suggest significant potential and may indicate the way forward in the longer term. However, WGNE cannot take sole responsibility for regional modelling activities and welcomes proposals for a joint activity with WCRP.

Dr G. Flato complemented the talk by F. Giorgi. He referred to the recommendation of ACC to make RCD a topic, in which WCRP would be active and visible. Specifically he proposed to significantly extend the RCD presence on the WCRP web site so that users would have a starting point (as part of broader WCRP outreach, education, and capacity-building efforts). Also, he joined Dr Giorgi in recommending to WCRP to establish a small task group under WGCM and WGNE to:

- develop a synthesis document summarising and updating existing information about different regional downscaling methods, their scientific basis, shortcomings, difficulties, etc., to serve as guidance for the climate change impacts assessment community (this would help to disseminate the knowledge already amassed by the regional downscaling community and ensure that full advantage is taken of this knowledge),
- develop a longer-term vision for WCRP activities in regional climate downscaling, or more generally, in methods that provide regional-scale climate change information (building on the recommendations of the Modelling Summit), and

- establish a framework for the evaluation and intercomparison of regional downscaling methods (along the lines of AMIP and CMIP) to foster more critical analysis of these methods and more quantitative documentation of the uncertainties involved (this would be an ongoing activity aimed at promoting research and at informing users of regional climate information. The goal here would be to raise the profile of such activities and thereby make results more widely known).

JSC noted that WCRP has a duty to respond in this area because rapidly increasing demands for regional information are already occurring. WCRP needs stronger communication between the relevant groups in the field of RCD, for example the WCP applications group is to be engaged to ensure proper communication of current capabilities.

The JSC agreed to form a Task Group under WGNE, WGSIP and WGCM to address RCD with specific goals to prepare a synthesis document and a longer-term vision for WCRP activities and establish a framework for evaluation and intercomparison of regional downscaling methods.

6.6 WGSF and SOLAS

Dr S. Gulev presented the WGSF report on behalf of its Chairman, Dr C. Fairall, and started it by quoting the COPES document, as follows: "…Quantitative analysis and understanding of the underlying physical mechanisms as well as intercomparison and validation of surface energy and mass fluxes are needed in a wide range of WCRP projects... WCRP's continuing interests in surface fluxes are now being served by its co-sponsorship of SOLAS with its focus on the physical and biogeochemical fluxes at the air-sea interface,… which deals with WCRP's wider requirements and efforts on all relevant fluxes resulting from the interaction of the atmosphere with the underlying surfaces."

Dr Gulev reported the following WGSF's accomplishments in 2004-2008:

- development of new parameterisations (turbulent heat exchange in calm and strong wind conditions, wind stress under strong winds, albedo of the rough sea and radiative),
- success of VOSClim in validation data set for ICOADS and re-evaluation of WMO observational practices for VOS,
- publication by F. Bradley and C. Fairall of a "Guide to making climate quality meteorological and flux measurements at sea",
- progress on the ocean reference sites and their use in flux science, and
- production of new generation global flux fields.

He stated that combined satellite flux products for the first time achieved the resolution of NWP.

WGSF and SOLAS also made progress in two major review articles on gas transfer physics (lead G. de Leeuw) and particle transfer (lead W. McGillis); launched the operation of gas exchange measurements and new parameterization of exchange under strong winds (C. Garbe 2007), and developed a joint WGSF-SOLAS data management strategy.

WGSF publishes a newsletter entitled FluxNews. Five issues have been published under the editorship of Dr N. Kovaleva. Results of WGSF-affiliated authors have been also published in more than 30 peer-reviewed papers, and included in the IPCC AR4. WGSF with partners have established considerable web-based resources for flux science, including (together with WGNE) a SURFA data base.

Dr Gulev proposed a WCRP air-sea flux workshop in 2009 and substantiated a need for further co-ordination of surface flux science within WCRP, including fluxes over land. He proposed to establish, jointly with IGBP, a renewed WG on Surface Fluxes that would benefit climate prediction and understanding climate variability and change by:

- reviewing the requirements of the WCRP projects in surface flux products including fluxes over land and planning the activities to meet these needs;
- ensuring effective co-ordination between research activities of WCRP and IGBP on surface fluxes over sea and land;
- encouraging research and operational activities aimed at the development of new and the evaluation of existing flux products (including the facilitation of access to them) and the improvement of knowledge on surface fluxes; and
- keeping the scientific community and the JSC informed of their progress.

He also proposed to prepare a White Paper on the optimal approach to the issue of surface fluxes answering the questions “what is required from the “flux science” for climate research and prediction?“ and “what is feasible and what should be the WCRP approach to this problem?”.

In the discussion, representatives of GEWEX stated that GEWEX SSG did not support the proposal to reinstate WGSF. Dr Ryabinin, who attended the GEWEX SSG meeting referred to above, recalled a that discussions on this issue were not comprehensive. CliC and SPARC representatives did not have an opinion at this stage. A CLIVAR representative said that there was a need to see how WGSF could contribute to the improved evaluation of models and how one could use its products to force component models. In particular, WGSF would need to show what its benefits to a broader WCRP science are and how it adds value to already existing products by other organisations. The WGNE Chair commented that WGSF was successful in helping to reinvigorate the SURFA project but this was achieved mostly through efforts of WGNE.

Some JSC members expressed appreciation for WGSF achievements to date, but stated that WGSF was at a critical point and needed to demonstrate relevance to WCRP science aims given in the COPES document. JSC requested WGSF members led by Dr Gulev to prepare a White Paper (with input from the WCRP Core Projects and WGNE) that would address these points to aid further discussion and enable a decision on the future of surface flux research.

6.7 WOAP

Dr S. Gulev presented the report of WOAP on request of the Panel Chairman, Dr K. Trenberth.

WOAP is a coordination Panel in WCRP but it enjoys attention, co-sponsorship and secretariat support by GCOS and is a channel for interactions between GCOS and WCRP. It helps WCRP to coordinate its work with GCOS panels and contributes to the GEO Work Plan.

One of WOAP subgroups, chaired by Prof. N. McFarlane is on data management in WCRP. It has a wide list of issues to consider including:

- Identification of problems;
- Observations data and model data, access to them;
- Archival of research data and needs for it;
- Best practices;
- Need for a WCRP data policy;
- Resources;
- IPY links;
- CEOP experiences;
- Continuing data after the projects’ sunsets.

The subgroup is composed of one member from each of the core-projects and includes representatives of GCOS and WMP.

WOAP prepared three formal WCRP letters to CEOS, which emphasize WCRP strategic views on the importance of taking observations of climate quality, and generating climate data records through better homogeneity and reprocessing. The letters encourage CEOS to implement their plan of action and express the need for a higher priority of climate observations, continuity, and concern over the consequences of NPOESS de-scoping for climate observations. A need for coordination among agencies and variables for reprocessing was also indicated.

WOAP also established a joint subgroup with AOPC on the “development of improved observational data sets for reanalyses” and appointed Dr R. Vose as its Chair. This subgroup and the whole WOAP contributed to the success of the Third WCRP International Reanalysis Conference held from 31 January to 4 February 2008 in Tokyo, hosted by JMA. 260 participants presented 61 oral and 73 poster at the Conference. The Conference Statement is attached to the WOAP written report. After the Conference, a letter was sent to several countries and lead agencies involved in reanalysis seeking their support for further activities.

WOAP is engaged in a number of outreach activities. For example, the 6 December 2007 issue of *Nature* had a special issue on Earth monitoring, including many statements on WCRP/WOAP achievements.

The main concern raised by WOAP was that due to a lack of funding, WOAP did not meet in 2007. WOAP's opinion was that it should meet at least once every two years. The plan is to meet in Boulder on 29 September-1 October 2008.

JSC congratulated WOAP to its work and especially the success of the Reanalysis Conference, which has provided a major input to WCRP strategic planning, and encouraged WOAP to continue its planning as an ongoing key activity in WCRP in consultation with GCOS. The JSC agreed that key issues to be addressed by WCRP/WOAP are future data streams and archives after the sunset date of the WCRP Projects. In the discussion several opinions were expressed on the way forward in this area. This topic will be discussed at the upcoming WOAP meeting in Boulder, Colorado, USA.

6.8 GCOS/AOPC/OOPC/TOPC

Dr J. Zillman, Chair of the GCOS Steering Committee, reported on GCOS priorities. Working through its three major panels, AOPC, OOPC and TOPC, GCOS has tried to support all requirements of WCRP research. GCOS also acts as the climate observing component for GEOSS. Noteworthy recent advances under AOPC are the development of the GCOS Reference Upper Air Network, which would benefit from cooperation with SPARC, and a focus on extreme precipitation events. GCOS expects that observational requirements for the latter will be produced in cooperation with GEWEX. TOPC pays great attention to observations of terrestrial ice sheets, which require substantial input form CliC, and terrestrial carbon storage. For OOPC, an important issue is that most ocean observing networks, which are expected to work operationally and be sustained into the future, are in fact funded through research programmes for fixed periods and their continuity is uncertain. There is progress in the OOPC/AOPC WG for securing the continuity of SST and sea ice measurements.

There is excellent cooperation between OOPC and CLIVAR's GSOP on ocean reanalysis and ocean data synthesis. With the successful completion of GODAE, and demonstration of the potential to produce ocean analyses and reanalyses, sustaining and completing in situ ocean observing systems becomes a major issue that needs to be pursued in cooperation with relevant organisations. The upcoming OceanObs09 Conference will be important for defining future needs for climate observations. Specific challenges of extending the monitoring of the thermohaline circulation beyond North Atlantic were also noted by Dr Zillman.

The JSC noted that data stewardship and management of observations are not currently addressed by GCOS but remain a major issue at national level. This is a major component of the WCRP strategy and needs to be reinforced at national and international levels.

The JSC congratulated GCOS and its Panels to their activities and noted especially progress on satellite observations. The JSC acknowledged the excellent support that many WCRP activities receive from GCOS. Among new major challenges, the JSC identified the need to move towards producing much higher resolution observations and datasets for process understanding and model development and validation.

7. Review of other activities of WCRP and its partners

7.1 ESSP

Dr K. Noone introduced ESSP to the JSC. Its goals are to undertake an integrated study of the Earth system, the ways that it is changing, and the implications for global and regional sustainability. The Partnership involves:

- The four global changes programmes (IGBP, IHDP, DIVERSITAS, and WCRP);
- Joint Projects (Global Carbon Project (GCP), Global Environmental Change and Food Systems (GECAFS), Global Water System Project (GWSP), and Global Environmental Change and Human Health Project (GEC&HH));
- Integrated Regional Studies (e.g. MAIRS);
- Capacity Building (e.g. START);
- Open Science Conferences (e.g. Beijing 2006);
- Other types of ESSP-wide collaboration.

ESSP was reviewed by an ICSU and IGFA sponsored Panel. The review was intended to assist the ESSP in identifying strategic options for its future development by constructive, in-depth discussions of its role, structure, scope and functioning. The results of the review will be published in the coming months. A vision for ESSP was emerging as a platform for providing high-level (cross-programme) synthesis of Earth system science and identifying problems with user communities and developing solutions. ESSP was planning a retreat to draft a strategy document in May 2008.

ESSP has established four major Joint Projects. In terms of science policy most of its attention is focussed on conveying the best scientific knowledge available on climate change to the IPCC assessments process, to the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA), and other NGOs and decision makers.

The inaugural ESSP Scientific Committee meeting was convened at the National Centre for Scientific Research, 23-25 October 2007, in Paris, France. The second ESSP Scientific Committee Meeting will be held on 30 June-2 July 2008 at the Environmental Change Institute, Oxford University, UK.

The JSC Chair, Dr Church, strongly urged WCRP to actively engage in ESSP at all levels, from strategic planning to implementation of its projects. For example, GEWEX involvement in GWSP could be stronger. Different modes of engagement of WCRP in ESSP activities were then discussed and the importance of developing an active communication between WCRP with various components of ESSP was emphasized by the JSC members. JSC agreed to discuss WCRP's engagement in ESSP in considerable detail at its next session and come up with a position statement on this matter.

Dr V. Ramaswamy informed JSC of an invitation to WCRP to participate in a Roundtable of the IHDP Open Meeting on social challenges of climate change in New Delhi, India, in October 2008. The main interest of IHDP was to consider how to adapt institutions to climate change. WCRP was requested to share with the participants what we learnt from AR4, present the new emission scenarios, analyse the suitability of available scientific results for an analysis of climate change impacts on, e.g. food systems, population management, etc. The main goal of these discussions for IHDP will be to determine how they can use scientific assessments and climate information to fulfil their mission. The JSC supported the proposal to accept the invitation and requested Dr Ramaswamy to coordinate WCRP's input to the IHDP Open Meeting. Contributions from ACC, AC&C, and monsoon and climate extremes crosscuts are excellent candidates for this forum.

7.2 START

Dr G. McBean reported on START activities. The objective of START's research-driven capacity building activities is to engage the scientific communities of developing regions in international collaborative scientific research and policy discussions related to global change. Recent highlights include a project on industrial transformation in Asia and an "Assessment of Impacts and Adaptations to Climate Change". Focus of START activities is mostly on impacts and vulnerability and risk assessment. START works closely with international assistance funding agencies on a wide spectrum of issues. The position of the START Director will soon be advertised. WCRP was invited to attend the next session of the START SSC, which will take place in September 2008 in Washington DC, USA. JSC emphasised the significant role that START can play in WCRP capacity building activities. The JSC congratulated START on its progress noting especially the value of successful conferences organised by START for young scientists.

7.3 WWRP/THORPEX

Dr G. Brunet presented the report of WWRP/THORPEX. His talk was co-authored by Dr D. Burridge.

The long-term objectives of WWRP are to:

- demonstrate improvements in the prediction of weather, with emphasis on high-impact events, through the exploitation of advances in scientific understanding, observational network design, data assimilation and modelling techniques and information systems; and to
- improve understanding of atmospheric seamless processes from minutes to weeks of importance to weather forecasting through the organization of focused research programmes.

A White Paper entitled "Toward a Seamless Process for the Prediction of Weather and Climate" was prepared by a joint WWRP-THORPEX/WCRP team comprised of: G. Brunet, M. Shapiro, B. Hoskins, A. Lorenc, M. Moncrieff, D. Rogers, B. Kirtman, R. Dole, G. Kiladis, R. Morss, J. Schaake and

S. Polaravapu. It was a collaborative effort between the WWRP-THORPEX and WCRP on the advancement of prediction on sub-seasonal to seasonal scales. The paper will be presented at the Modelling Summit in Reading, UK, May 2008. Four major research areas for collaboration between the WWRP and WCRP are proposed in this paper.

The first area is the development of seamless weather/climate Ensemble Prediction Systems (EPSs). It requires a collaboration agreement between TIGGE and the Climate-system Historical Forecast Project (CHFP) on experimentation and data sharing for sub-seasonal to seasonal historical forecasts (weeks to season). Methods need to be developed for improving probabilistic estimates of the likelihood of high-impact events based on EPSs' output. Ensemble predictions at greatly increased spatial resolution imply substantial requirements for computational power and for data storage and delivery capacity.

The second area of research is the multi-scale organisation of tropical convection and its two-way interaction with global circulation. Failure to include their predictable features in EPSs is seen as a major reason for low predictive skill at longer time scales. The proposed way forward is to start producing a high-resolution operational global analysis and 10-day forecast of basic parameters and physical processes and subject them to a detailed diagnostic and verification study. This approach requires access to very high-performance computing. Satellite observations of tropical cloud and precipitation systems should provide a long-term capability for process studies, data assimilation and prediction. Cooperation with GCOS will be needed to support observational requirements. Collaboration between YOTC and T-PARC will be for diagnostics and verification of forecasts.

The third area of joint investigation will be interdisciplinary weather-climate research into the coupled assimilation. Operational forecasting systems with their intrinsic data assimilation components will continue to develop but they have to be complemented by coupled aspects of data assimilation oriented towards the use of (dynamically adjusted) climate system initial conditions in seamless prediction and its validation. The next generation re-analysis is progressing towards fully coupled Earth-system assimilations.

The fourth area of research will be aimed at maximising social and economic benefits of sub-seasonal and seasonal predictions. The key for success here will be the understanding of how information at the weather/climate interface, including uncertainty, links to decision-making. Massive and easier access to forecast data by the wide user community is essential for achieving this. User-tailored products will need to be generated and made available and accessible. The post-processing techniques that are needed by many users may require an archive of past forecasts (e.g. for water cycle applications). Some user applications may require an archive of re-forecasts from fixed models for periods of up to 20 years or longer.

The JSC, in its discussion of WWRP and THORPEX activities and proposals for joint work agreed that WCRP should embark on the development of science for coupled system data assimilation, which is required to start to produce, eventually, a climate system reanalysis. There are plans at ECMWF to embark on a 75-year reanalysis for atmosphere but considering coupling with the underlying surface. WCRP's support of this initiative would be appreciated. GEWEX confirmed that the extension of data assimilation to include more parameters characterising the water cycle would be of significant interest for hydrologists.

The JSC also tried to clarify the concept of seamlessness. For some JSC members it meant closer ties between weather and climate research but not using the same models for predicting weather and climate. One has to use always the best model for the job. Big difference in timescales between TIGGE (2 weeks) and CHFP (seasons) were recalled. Others stressed that predictive models for weeks and seasons have to be sufficiently close so that the same diagnostics can be run on both types of models. The discussion again highlighted the great value of making forecasts and hindcasts available. This helps scientists, especially in developing countries to build up expertise. ECMWF does make its multi-model ensemble forecasts available free of charge, and WCRP expressed appreciation to ECMWF for doing so.

Dr D. Burridge reminded JSC of the most recent developments in THORPEX by stating that T-PARC addresses tropical cyclones in the Pacific. The Continental African Plan receives a lot of support from AMMA. TIGGE paves the way towards a global interactive forecasting system. There are ten providers of real time forecasts, and three major data portals. They make available lots of data for research and could possibly accommodate provision of longer range forecasts. WWRP looked forward to WCRP's support in promoting these developments and also to cooperation of WWRP and WCRP in

achieving synoptic scale forecasting improvements. Dr Burridge was asked by JSC to help determine the next steps in this area.

The JSC thanked the authors of the White Paper and noted that it identified specific areas where WCRP and WWRP could and should work together. It is anticipated that the discussion of the White Paper at the Modelling Summit would lead to real progress both in strategic planning and implementation of the outcome of the Summit. Among new major challenges, JSC determined the need to move towards producing much higher resolution observations and datasets.

8. World Climate Conference 3

Dr L. Barrie presented the status of preparations for World Climate Conference-3 (WCC-3). It will be held 31 August-4 September 2009 in Switzerland.

The WMO 15th Congress established the WCC-3 Theme: "climate prediction for decision-making focusing on seasonal-to-interannual time scales taking into account multi-decadal prediction". The International Organising Committee (IOC) for WCC-3 met at its First Session in the WMO Secretariat in Geneva in February 2008. It agreed to develop a plan of what has to be accomplished to organise and implement a successful WCC-3. It also devised organising structure(s) for carrying out the work of the IOC, which is composed of

- Programme Committee (Chair, M. Visbeck, Germany),
- High Level Committee (Chair, A. Massacand, GEO),
- Linkage and Interactions Committee (Chair, J. Romero, Switzerland),
- Resources Mobilization Committee (Chair, M. Power, WMO).

The Programme Committee has defined a timeline with monthly milestones such as the finalisation of the Agenda, call for «White Papers» and poster sessions for a Side Event.

The Conference will include three days of scientific discussions and a 1.5-day long high-level segment.

The expectations from the High-Level Segment of WCC-3 are as follows:

- Advancing Climate Information and Prediction Science:
  - Developing a statement of the current climate system and how it will change on timescales up to multi-decadal;
  - Promoting the development of seasonal to inter-annual to multi-decadal climate information and prediction science;
  - Enhancing our understanding of the needs for climate information and prediction by the socioeconomic sectors;
  - Facilitating a global infrastructure for strengthening regional and national capacity for a seasonal to inter-annual to multi-decadal prediction system;
  - Promoting the free and open exchange of past, present, and future climate data and ensuring sustained observing systems;
  - Promoting the development of seasonal to decadal assessment and prediction science; and
  - Promoting (facilitating) infrastructure and best practices to strengthen regional capacities for seasonal to decadal climate information systems.
- Embedding Climate into Hazard Early Warning Systems / The Climate Dimension of Hazard Early Warning Systems:
  - Establishing the mechanisms and opportunities for sharing climate information and prediction products;
  - Developing an effective climate Early Warning System, e.g., by recommending a menu of practical response actions to climate risks on timescales up to multi-decadal, including the use of indigenous practices of early warning;
  - Establishing the mechanisms and opportunities for sharing climate information and products to improve existing hazard early warning systems; and
  - Developing or improving Climate Early Warning Systems on seasonal to multi-decadal timescales
- Applications and Socio-economic Benefits of Climate Information and Prediction:
  - Developing seasonal to inter-annual climate information and prediction goals for WMO, its Members, and public and private sector entities;

  - Climate information and prediction products as a tool for disaster risk reduction and for adaptation to climate variability and change;
  - Defining strategies for the enhancement of application of climate information and prediction products for climate risk management;
  - Climate risk management strategies and information needs;
- Mainstreaming Climate Information for Development:
  - Strengthening the regional and national response systems to climate variability, especially in the developing and least developed countries frequently affected by natural disasters caused by climate extremes;
  - Extending available climate products to include annual prognostic analyses at the regional / global levels as well as to enhance the use of existing products by decision makers in key sectors throughout society;
  - Optimising the global, regional, and national institutional mechanisms for using climate information and predictions in decision-making;
  - Enhancing the integration of climate information and prediction products into sustainable socio-economic development.

Opportunities offered for international linkages by WCC-3 are seen as follows:

- High-level political engagement with the climate regime (UNFCCC) and the Bali Road-map.
- All relevant actors are involved and engaged in the climate regime and the Bali agenda.
- A significant body of knowledge has been accumulated on climate, climate variability and climate change. This knowledge is available to be used.
- Moving from discrete assessments of the state of climate to a continuous, real or quasi-real time flow of weather and climate information, relevant for policy decisions.
- Development of Weather and Climate related “services”.

The following challenges for the WCC-3 were identified:

- A large body of international commitments and engagements have not translated into actions at the country level, building a huge credibility gap.
- A wide variety of users, with specific needs occurring in different contexts (natural, institutional).
- No obvious (single?) mechanism exists to connect available demand with the offer available.
- Each sector is planning independently its own response to climate change and obtaining the information they need likewise (major coordination gap).
- Each user needs the information tailored (by somebody) to specific needs.

Needed commitments for the WCC-3 include:

- Participating Organisations (UNEP, FAO, UNCBD, UNCCD, UNDP, UNWTO, WHO, UNESCO-IOC, ISDR, IFRC, IUCN, GCOS, ICSU, IRI, and probably some others) will take responsibility of articulating their constituencies’ priority needs as they relate to climate science and the associated knowledge base.
- A limited number of white-papers (to be determined), summarising the highest priorities per major sectors, to be prepared and circulated to the conference participants to inform their contributions to WCC-3.
- Scientific contributions/sessions to WCC-3 should have/produce, as much as possible, a clear policy advise “take-home” message.
- A series of continuous dialogues to be organised between the different types of partners (data and information providers and users) to identify the mechanisms of delivering the new services and to build capacity to use them.

The JSC discussed how WCRP could be engaged in preparations and conduct of WCC-3. It was noted that several WCRP-affiliated scientists were on the organising committee, and Dr M. Visbeck was the chair and Dr Ramaswamy is a member of the Programme Committee. Nevertheless, the JSC felt that it should have independent input to the Programme Committee. Dr Bernal who also attended the organising committee meeting encouraged WCRP to interact with the Programme Committee. Dr Barrie was asked to pass to the WCC-3 Secretariat a request to keep JSC informed of the programmatic timeline, so that JSC could contribute proactively to the development of the WCC-3 programme.

Dr Slingo expressed a general concern about the low number of young people joining the field of climate science and urged JSC to try to ensure that WCC-3 is used to promote excitement in climate

science and that considerable attention is devoted to generate opportunities of a career for early career scientists in climate science.

The JSC also expressed an opinion that the existing lists of expected results of WCC-3 are too broad and they would benefit from consolidating and linking them with a focus on a major identified outcome.

As WCC-3 main goal is to pave the way for the establishment of climate services, the JSC was pleased to have an opportunity to be briefed on the developments in the USA in this area. Dr Ramaswamy presented a talk entitled "US Views on Developing a National Climate Service", which was kindly provided to the JSC by Dr C. Koblinsky. NOAA is a leading provider of reliable weather, water and climate information to the Nation. Its products are the result of a vigorous research programme and a growing operational capability. Products and services are currently provided in a distributed manner, however, the demand for relevant and reliable climate information is growing. Federal, regional, States, and local decision makers need credible climate information at finer scales. The general public and the private sector need a clearly identified, credible point of access to the Federal government's climate resources. The Nation's scientific community also needs a comprehensive, reliable, high-quality network of authoritative information. Thus, the US Federal Government is confronted with a need for a coherent, comprehensive strategy to provide authoritative climate information in an integrated and focused manner to meet evolving National requirements. US Congress is developing a legislative basis for the provision of such services. Its Global Change Research Improvement Act of 2007 establishes a National Climate Service within NOAA that "shall produce and deliver authoritative, timely and usable information about climate change, climate variability, trends, and impacts on local, State, regional, national, and global scales."

Specific climate services by the National Climate Service within NOAA will be to:

- provide comprehensive and authoritative information about the state of the climate and its effects, through observations, monitoring, data, information, and products that accurately reflect climate trends and conditions;
- provide predictions and projections on the future state of the climate in support of adaptation, preparedness, attribution, and mitigation;
- utilise appropriate research from the United States Global Change Research Program activities and conduct focused research, as needed, to enhance understanding, information and predictions of the current and future state of the climate and its impacts that is relevant to policy, planning, and decision making;
- utilise assessments from the Global Change Research Program activities and conduct focused assessments as needed to enhance understanding of the impacts of climate change and climate variability;
- assess and strengthen delivery mechanisms for providing climate information to end users;
- communicate climate data, conditions, predictions, projections, indicators, and risks on an ongoing basis to decision- and policy- makers, the private sector, and to the public;
- coordinate and collaborate on climate change, climate variability, and impacts activities with municipal, state, regional, national and international agencies and organizations, as appropriate;
- support the Department of State and international agencies and organizations, as well as domestic agencies and organizations, involved in assessing and responding to climate change and climate variability; and
- establish an atmospheric monitoring and verification programme utilising aircraft, satellite, ground sensors, ocean and coastal observing systems, and modelling capabilities to monitor, measure, and verify greenhouse gas levels, dates, and emissions throughout the global oceans and atmosphere.

Expected benefits of a National Climate Service to society and the economy, nationally and internationally, are seen as follows:

- improved understanding of the causes and impacts of climate change will enable sound adaptation and mitigation strategies;
- more accurate climate predictions will improve preparation for and response to heat waves, drought, coastal inundation, and other phenomena;
- policy makers and business leaders will be equipped with the most accurate and credible information to inform their decisions, and
- relevant and reliable climate data will stimulate the private development of technologies and applications.

Leveraging partnerships to unite the full capacity of the US Federal, regional, States, and local efforts to meet public needs will be central to the development and implementation of a National Climate Service.

The JSC felt very strongly that the process of establishing a national climate service presented in the paper by Dr Koblinsky was extremely exciting and instrumental for WCC-3 providing an example of an information service that WCC-3 would be aiming to create in many nations and regions. JSC congratulated NOAA and warmly thanked Drs Koblinsky and Ramaswamy for offering JSC the opportunity to familiarise itself with the development of a climate service program in the USA.

9. Geoengineering

Prof. Peter introduced the subject by describing several examples including a geoengineering project proposal to distribute sulphur in the lower stratosphere to stimulate formation of extra clouds and cause additional cooling of the planet. This proposal has a long history and is seriously discussed now by several groups based on a paper by the Nobel Prize Laureate Paul Crutzen.

Prof. Peter identified several options for WCRP:

- do not do anything now;, wait until there is a body of work to assess;
- define experimental protocols so that ongoing work can be meaningfully compared.

JSC added to these options a fourth one, to issue a WCRP statement that before engineering activities are contemplated/attempted, there is a need for assessing their benefits/risks by international experts. In that context, SPARC representatives recalled that the SPARC SSG did not agree on such a statement, in part because it could easily appear to be self-serving. Dr Noone, speaking on behalf of IGBP, also recalled that IGBP considered such a statement about a need for comprehensive research before embarking on geoengineering solutions. For example, the SOLAS project did make a statement on iron fertilisation of the ocean. He expressed a view that ESSP should be the leadership in this area and if we ignored this area of science, we were doing society a disservice. Dr Kaye also noted that geoengineering is an emotional area and if WCRP sits out, only the loudest voices on this subject will be heard. So, the community will need to do an assessment of geoengineering proposals and express its expert opinion authoritatively on their benefits/risks.
A concern was expressed that WCRP's support to international geoengineering research would be seen as an expression of serious interest by many sectors and this will lead to admitting that there are other ways of mitigating climate change than reducing greenhouse gas concentrations. At the same time it was clear that WCRP does not control climate research. There are already groups focused on modelling geoengineering options and the next ozone assessment might include questions about geoengineering. International science will then be mandated to assess the options and if this becomes the task, it would be better to have a good body of work in place to support it. Another dimension of geoengineering is that it competes for resources with other types of climate science.

Prof. Busalacchi informed the JSC that the U.S. National Academy of Sciences has discussed the issue at a high level. A study is proposed that would look at costs, efficiency, pros and cons of various geoengineering options. A US$ 6M study of mitigation including geoengineering is now funded from the NOAA budget. Prof. Peter added that the European Commission was also going to support five one million Euro projects on geoengineering.

What the decision making may need is a balanced portfolio of options including mitigation, adaptation, and possible geoengineering solutions. Any WCRP statement should reflect this balance. However, if WCRP produces an assessment (WCRP statements are mostly viewed as authoritative), then it has to be credible. The work on geoengineering will go on. It is only developing and it seems unlikely that at the current stage we know enough to set up a protocol but it is clear that at some stage WCRP will have to respond. For example, the WGCM could poll modelling groups to make an inventory of who is doing what and ask for more detail about what is planned.

A consensus among JSC members was emerging that there was a need to review the subject in a more comprehensive way before determining the WCRP approach to it. It was therefore decided to invite authoritative speakers on this subject to the next JSC session. The JSC agreed to set up a small group to work by e-mail and gather information, document ideas, inform JSC, and think about how WCRP might go forward in this area. WCRP should also try to brief its three sponsors on geoengineering. All WCRP WGs, panels, and project SSGs are asked to put the issue of

geoengineering on their agenda and report the outcomes of the discussion to the JSC and the above task group.

10. WCRP strategy and development before and beyond 2013

The main objectives of this session were to define WCRP strategy, consider current and future goals, and development of the programme with respect to two time horizons, mid term (before 2013) and long term (beyond 2013). The JSC assembled several times throughout the week, with invited participants, to discuss these topics. The discussion on the future direction for WCRP has continued among the JSC members beyond its meeting in March, but this report presents only a summary of the discussions during the meeting in Arcachon.

For the near-term perspective, the general consensus among the JSC was that the strategy outlined in the so-called COPES (Coordinated Observations and Prediction of the Earth System) document, is the desirable way forward. WCRP will continue to build activities of its projects and use their potential to implement the objectives of the cross-cutting initiatives that either require contributions from more than one project, or were serving the goals (deliverables), which were more appropriate for the whole WCRP rather than its individual projects. WCRP crosscuts were designed to serve the needs of society, and therefore the success of WCRP needs to be assessed against the COPES goals.

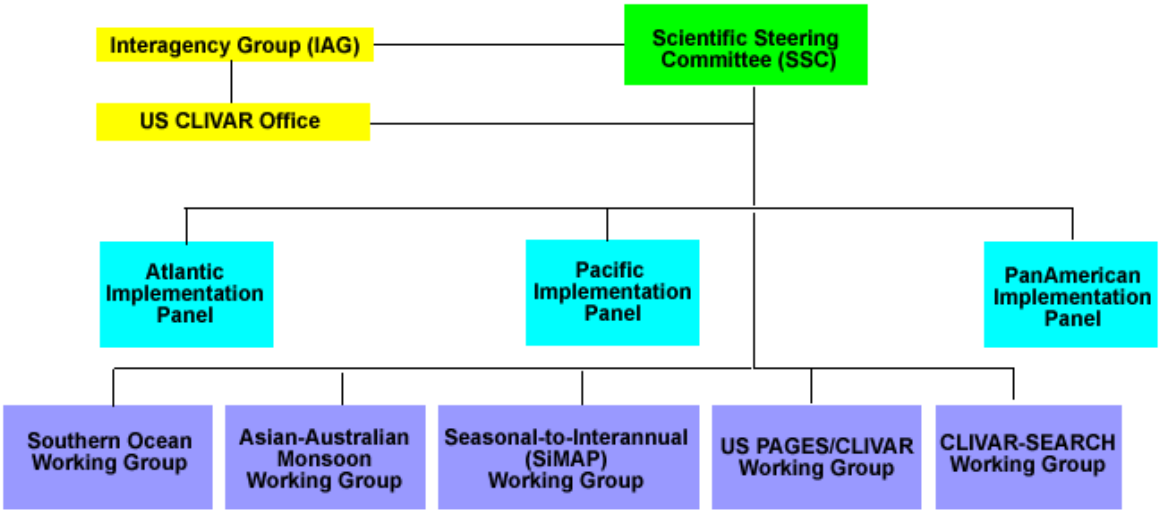
JSC decided to prepare a document, with active involvement of the Projects, summarising achievements of WCRP in implementing the COPES strategy. This document will help the programme in its attempts to obtain additional support to implement the cross-cutting research activities and continue research by core projects and groups. The document should contain references to recent results and identify potential future opportunities that can be realised if additional resources are secured. It was recognised that achieving the common WCRP goals through cross-cutting activities was essential for demonstration of WCRP value for society, and because of that, cross-cuts should not be considered as competing with projects for funding. Rather, they should be instrumental for getting support for project activities. A summary of recent WCRP achievements will also be useful for presentation at WCC-3 and other climate fora.

An important question is whether the existing WCRP governance is adequate to achieve what is planned. Any transition of WCRP from its current configuration into the future has to be explained to the science community to obtain their consent and support. An active dialogue among the JSC officers, project Chairs and Directors, and JPS is needed to review in more detail the ongoing changes in projects and for developing a transition plan from the current to a future WCRP configuration. The view of the JSC members and project representatives was that in the longer term, the current WCRP structure was not ideal. WCRP has to evolve and adjust towards what the society at large needs in terms of climate information, products and services. A structure supporting more end-to-end activities that begins with observations, research and models to create the scientific knowledge on climate change and variability and the necessary mechanisms for transferring this knowledge to those who need it for decisions on managing benefits/risks and developing adaptation and mitigation strategies is required in the future. This will be the focus of discussion and deliberation among the JSC towards developing a long-term strategy for WCRP for the next decades. The role of the broader scientific community, WCRP sponsors and partners in developing such a long-term strategy was emphasised by the JSC.

One of the three WCRP sponsors was Dr Bernal. He was representing IOC and acknowledged the healthy discussion by the JSC on the future direction for WCRP. He urged WCRP to consult with sponsors as it develops the possible changes in the programme structure. Maintaining the ownership by sponsors will also be essential for the viability of WCRP over the long term.

At the request of JSC, Dr Hurrell gave a presentation on the evolution of U.S. CLIVAR. It was considered a useful model for reviewing potential changes in the WCRP.

The following sketch shows the previous structure of U.S. CLIVAR.

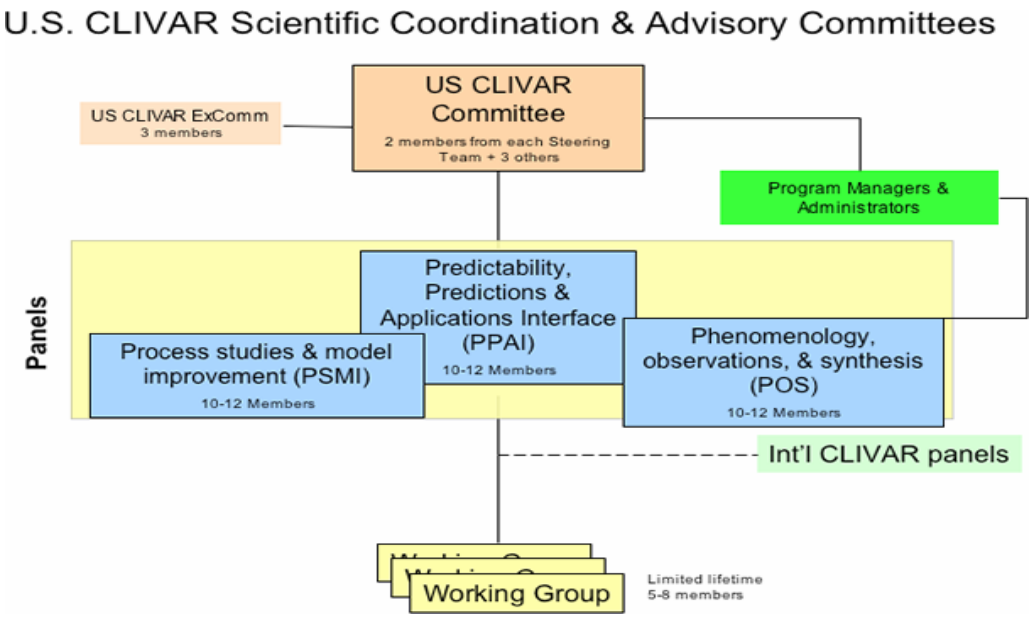


Its advantages were that it was built on regionally-based and well established communities. It worked well for developing regional science plans and observation systems and matched across to the international CLIVAR structure to some extent. At the same time, there was a tendency for panels/working groups to proliferate. The structure made it difficult to address global issues. It did not map well onto agencies' structures or plans and required many meetings to coordinate the work.

There were several events and processes that led to a decision to modify the structure. They included the assessment of International CLIVAR, development of WCRP COPES, the Review of the US CLIVAR Project Office by the US National Research Council, development of US CCSP Strategic Plan and Infrastructure, and new strategic plans and management structures in NOAA. A new structure was proposed that would more closely link climate research to improved climate predictions, strengthen U.S. CLIVAR ties to agency and CCSP plans and objectives, increase transparency of the U.S. CLIVAR program, expand the U.S. CLIVAR research community, and lead to improved CLIVAR's linkages to other programs and research enterprises.

The process of transition into the new structure was extremely important. It had to avoid alienation of existing panels/members, delay of projects, panel activities and proposals that were under way as well as duplication of effort and reinvention. It had to be transparent and help to engage new communities into CLIVAR. Activities from each of the basin panels had to be remapped to new panels, while activities not adequately addressed by the previous structure had to also to be planned.

The following chart shows the new U.S. CLIVAR structure.



The new structure allows U.S. CLIVAR to more closely link climate research to improved climate predictions, strengthen ties to agency and CCSP plans and objectives, increase transparency of the program, and expand the research community. It helps to improve linkages to other programs and research enterprises. The working groups' element in the structure has been a success: U.S. CLIVAR has become more focused and selective in engaging the wider community.

Dr Hurrell's view was that there was a strong need for a clearer vision of how WCRP will evolve because this will affect core projects as their sunset dates approach. The current strategy is not clear enough. In order to devise an organisational structure to coordinate researchers, one has to identify questions and the scope of activities to coordinate. The WCRP projects can and should keep the community "on board" and preserve what is working. Science needs to remain the goal of WCRP and deliverables will be its output. The U.S. CLIVAR structure is a helpful straw man. It is already in place, working, and successful, but it is not perfect. For example the scope of the panels is large and this would be even more the case under WCRP. The restructuring lost regional focus and expertise, while they were still desirable.

Overall, there was a general impression that restructuring has served U.S. CLIVAR well. It seems that the U.S. CLIVAR structure is well-mapped onto the seamless prediction strategy. It was also noted that ECMWF was also organised like that. It was not very clear to JSC how national structure of a single project translates to international WCRP, but it was seen useful to learn the principles used in restructuring of the CLIVAR project. The need to retain regional structures was noted for an international program like WCRP.

Dr Shukla thought of a similar structure, which would have the following tentative elements: process studies and model development, observations and synthesis, prediction and applications interface, and climate change scenarios and assessment.

Dr Shepherd's opinion was that WCRP could use one principle in restructuring: to select a structure that resonates best with funders who are interested in development of applications. A structure with the following five elements would probably meet the requirement:

- Long-term climate change
- Decadal predictability
- Regional climate downscaling
- Model improvements
- Air quality and biosphere impacts

Several participants indicated that a process and a structural element to enable WCRP to identify comprehensively its users and their requirements and deliver the scientific knowledge that the WCRP generates to the users would benefit WCRP immensely over the long-term. Given that WCRP and its constituency are not experts in this area, identifying existing and/or future partnerships such as ESSP to achieve this, appears to be a logical model to examine.

Dr Noone was requested by the JSC to present his opinion on successes and failures of the IGBP restructuring. He shared his experiences with the JSC. Any reorganisation should be built on leadership, guidance, vision, and support of the community. However, scientists in principle are not very good at organising themselves. It was possible to anticipate that in planning the new structure, the science would be done in projects, being the "heart" of the programme. But to have a living programme, it has to have a soul, which is in collective contribution.

The IGBP reorganisation was made on the principle that form must fit the function. But, in reality an efficient sketch of the structure came first, based on the concept of reservoirs (land, sea, atmosphere and their interfaces), and the supporting idea came second..

A most difficult part of the reorganisation was the process itself. IGBP had seven fairly independent projects, and some of them were older than IGBP itself. In the process of reorganization, some of them were merged, some disappeared, and some became co-sponsored. The new structure is based on long-term projects and fast track initiatives. It seems that the danger of losing the community in the course of restructuring did not materialise.

The JSC Chair reminded participants that the JSC 28th session in Zanzibar decided to form a WG to look into IGBP/WCRP relations and invited comments on the development of this relationship. Dr Noone responded by saying that IGBP membership has expressed a lot of support for closer links and

cooperation with WCRP. IGBP is very interested in exploring a common future with WCRP and even a potential eventual merger, but again, we must firstly agree on the function. Some of our projects are leading the cooperation, such as AIMS/WGCM, IGAC/SPARC, and GEWEX/iLEAPS.

Prof. McBean's view was that WCRP goals are much more specific and focussed than those of IGBP. IGBP is the leading program in research on carbon cycle and biogeochemistry. But, for the next 20 years, emissions will not be very important for the climate evolution. We will need to address issues related to the natural variability and that is where the WWRP connection comes in. Partnership with WWRP is therefore just as important for WCRP as partnership with IGBP. Some participants called for revitalisation of the WG on WCRP-IGBP interactions. Other participants called for focussing more on current problems existing within WCRP and trying to resolve them first. The JSC was, however, in full agreement that it was important to keep elements of the program that were working well. It also agreed to discuss the development of relations/cooperation with IGBP at the next JSC.

The WCC-3 was mentioned as a major milestone in planning of climate research, generating commitments and setting new goals. Therefore, WCRP needs full understanding of requirements, capabilities, wishes of the community, and pros and cons of cooperative agreements with IGBP before it goes to WCC-3. It was agreed that a JSC-led group will work on a WCRP Statement to WCC-3. That Statement should present a strategic vision of WCRP development that would be based on the results of deliberations at the Modelling Summit, the White Paper on Revolution in Weather, Climate and Earth System prediction, and WCRP-wide discussion of its future as led by the JSC.

Prof. A. Busalacchi requested projects to generate a timetable by which they can produce the project legacy documents. They were asked to consider which functions need to be retained by the Projects and which science questions need to be addressed in the future. He also asked JSC to reread the COPES document and propose three main functions or capabilities of the future WCRP and a structure with no more than five elements that would serve the three functions.

The JSC resolved to reinstate JSC Officers, Project Chairs and IPO Directors meetings and discuss other possible mechanisms for broader consultation on the future of WCRP. The WCRP will require an intermediate plan for implementing the COPES strategy, which should be spearheaded by projects. It will be a subject for monthly telephone conferences with IPO directors and the JPS.

11. WCRP budget

Mrs V. Detemmerman presented the WCRP budget to the meeting. The talk included a review of anticipated JCRF funds available for activities in 2008, expected and possible sources of income, existing uncertainties, and needs for additional expenditures if positive expectations for a small increase in budget materialise. JSC agreed on a set of investment priorities for expenditures in 2008 and identified potential areas of investments (i.e. communications, commitment to AOPC, OOPC, and SPARC General Assembly), as funds become available. The JSC agreed that day-to-day management of the JPS budget, and its allocation based on the agreed priorities, should remain the responsibility of the JPS. The JSC also felt that WCRP had to use more videoconferencing to save resources. The JSC Chair encouraged JSC members to meet formally each year with WMO Permanent Representatives, IOC representatives and ICSU members, to demonstrate the value of WCRP, promote its activities and their outcomes and seek support to WCRP.

12. Summary of actions to be taken

A table summarising action items following on from the JSC meeting is given in Appendix 4.

13. Composition of committees

13.1 JSC composition

At the 29th Session of JSC, the term of service of its Chair, Dr. Church had come to its end. Elections were held for the new JSC Chair, Vice-Chair, and two new Officers. Prof. Antony Busalacchi of the Earth System Science Interdisciplinary Center, University of Maryland, USA was elected JSC Chair. Dr David Griggs of the Monash University, Australia was elected JSC Vice-Chair. Professor Venkatachalam Ramaswamy of the NOAA Geophysical Fluid Dynamics Laboratory, Princeton

University, USA and Professor Jochem Marotzke of Max Planck Institute for Meteorology, Hamburg, Germany were elected as new JSC Officers. Terms of service of the newly elected JSC executive members started on 4 April 2008. Professor Carolina Vera of the University of Buenos Aires, Argentina, and Professor Guoxiong Wu of the Chinese Academy of Sciences, China, continued their services as JSC Officers.

13.2 Composition of project SSGs and working groups/panels

The JSC reviewed the composition of the WCRP working bodies. In general, it was dissatisfied with the submitted proposals in terms of adequacy of proposed membership with respect to the geographical and gender balance of members and the small number of younger scientists among the candidates to WCRP constituencies. It strongly urged core projects and working groups to make a greater effort to increase representation of scientists from developing countries, women and younger scientists.

The JSC approved the nominations of new members and several renewals of appointment of current members, as appropriate, with effect from 1 January 2009. The lists below provide the composition of the scientific and working groups effective on 1 January 2008. Decisions regarding changes of membership and renewals are summarised below the corresponding tables.

CliC Scientific Steering Group

Membership as of 1 January 2008	Expiry of appointment	
B. Goodison (Chair)	31 December	2008
G. Casassa	"	2009
M. Drinkwater	"	2008
V. Kattsov	"	2011
T. Ohata	"	2008
T. Prowse	"	2010
Qin Dahe	"	2008
A. Rinke	"	2011
V. Romanovsky	"	2011
K. Steffen	"	2009
J. Turner	"	2008
A. Worby	"	2008

Drs B. Goodison, M. Drinkwater, T. Ohata, D. Qin, and J. Turner whose terms end in 2008 will leave the SSG. Drs H. Rott (Austria), A. Abe-Ouchi (Japan), C. Xiao (China), David Bromwich (USA), Sebastian Gerland (Norway) were appointed as new SSG Chair/members with an initial term of four years, effective 1 January 2009. The term of Dr A. Worby was extended for another two years. Drs D. Bromwich and A. Worby will be representing SCAR on the SSG. Prof. K. Steffen and Dr A. Worby were appointed Co-Chairs of the SSG effective 1 January 2009.

CLIVAR Scientific Steering Group

Membership as of 1 January 2008	Expiry of appointment	
T. Palmer (Co-Chair)	31 December	2009
J. Hurrell (Co-Chair)	"	2010
W. Dong	"	2010
L. Goddard	"	2009
B.N. Goswami	"	2011
B. McAvaney	"	2008
R. Mechoso	"	2010
T. Tokioka	"	2009
M. Visbeck	"	2010
D. Waliser	"	2008

Drs B. McAvaney and D. Waliser whose terms end in 2008 will leave the SSG. CLIVAR Panel Chairs were appointed as ex-officio members of the CLIVAR SSG. JSC recommended to CLIVAR SSG to invite leaders of relevant WCRP cross-cutting activities to their sessions. Dr M. Visbeck was appointed a Co-Chair of CLIVAR SSG, with immediate effect.

GEWEX Scientific Steering Group

Membership as of 1 January 2008	Expiry of appointment
S. Sorooshian (Chair)	31 December 2008
T. Ackerman (Vice-Chair)	" 2010
A. Beljaars	" 2010
F. Einaudi	" 2008
A. Gaye	" 2010
J. Matsumoto	" 2009
J. Polcher	" 2010
K.D. Sharma	" 2010
R. Stewart	" 2011
K. Trenberth	" 2011
R. Yu	" 2009
O. Zolina	" 2011

Prof. S. Sorooshian and Dr F. Einaudi whose terms end in 2008 will leave the SSG. Drs H. Wheather (UK) and W. Lau (NASA) were appointed as new SSG members with initial terms of four years, effective 1 January 2009. The term of Dr T. Ackerman was extended for three years and he was appointed Chair of the SSG, effective 1 January 2009.

SPARC Scientific Steering Group

Membership as of 1 January 2008	Expiry of appointment
T. Peter (Co-Chair)	31 December 2008
T. Shepherd (Co-Chair)	" 2010
G. Bodeker	" 2010
J.P. Burrows	" 2009
P. Canziani	" 2008
P.C.S. Devara	" 2011
D. Fahey	" 2011
D. Hartmann	" 2008
S. Hayashida	" 2008
P. Haynes	" 2008
E. Manzini	" 2008
A. Thompson	" 2010
V. Yushkov	" 2008

Drs P. Canziani, D. Hartmann, S. Hayashida, V. Yushkov whose terms end in 2008 will leave the SSG. The terms of Drs P. Haynes, E. Manzini and Prof. T. Peter were extended two years. Drs V. Eyring (Germany) and M. Shiotani (Japan) were appointed as new SSG members, with initial term of four years, effective 1 January 2009. Dr Eyring will act as a liaison between the SPARC SSG and WGCM. JSC requested Prof. Rawaswamy to discuss additional appointments to SPARC SSG with the project leadership.

JSC/CLIVAR Working Group on Coupled Modelling

Membership as of 1 January 2008	Expiry of appointment
J. Mitchell (Co-Chair)	31 December 2008
G. Meehl (Co- Chair)	" 2009
S. Bony	" 2009
P. Braconnot	" 2009
G. Flato	" 2008
M. Giorgetta	" 2008
F. Giorgi	" 2008
S. Griffies (ex-officio, Chair, WGOMD)	" 2008
A. Hirst	" 2009
D. Karoly	" 2008

M. Kimoto	"	2008
C. Le Quéré	"	2008
N. Nakicenovic	"	2009

Drs G. Flato whose term ends in 2008 will leave the Working Group. Dr S. Griffies' membership on the group was as an ex-officio as long as he remains the Chair of WGOMD. The terms of Drs J. Mitchell, M. Giorgetta, F. Giorgi, D. Karoly, M. Kimoto, and C. Le Quéré were extended two years. Drs V. Eyring (Germany) and B. Wang (China) were appointed as new SSG members with an initial term of four years, effective 1 January 2009. The JSC resolved to designate its liaisons to WGCM.

WCRP/ WMO/CAS Working Group on Numerical Experimentation

Membership as of 1 January 2008	Expiry of appointment	
M. Miller (Chair)	31 December	2007
P. Gauthier	"	2010
J. Hack	"	2009
M. Iredell	"	2009
D. Majewski	"	2009
K. Puri	"	2008
F. Rabier	"	2011
A. Brown	"	2011
P.L. Silva Dias	"	2008
Y. Takeuchi	"	2009
M. Tolstykh	"	2009
Xueshun Shen	"	2011

Dr K. Puri whose term ends in 2008 will leave the Working Group. The appointment of Dr M. Miller was extended for one year and a new WGNE Chair will be proposed in 2008. The appointment of Dr P.L. Silva Dias was extended for two years. Dr G. Dietachmayer (Australia) was appointed as a new SSG member with an initial term of four years, effective 1 January 2009. The JSC endorsed inclusion of Chair, GMPP as Co-Chair of WGNE and appointed Chairs of GCSS, GLASS and GABLS as ex-officio WGNE members.

WCRP Modelling Panel

Membership as of 1 January 2008	Expiry of appointment	
J. Shukla (Chair)	31 December	2008
T. Arbetter	"	2008
D. Burridge,	"	2008
S.M. Griffies	"	2008
B. Kirtman,	"	2008
R. Koster	"	2008
V. Meleshko,	"	2008
M. Miller	"	2008
J.F. Mitchell	"	2008
S. Pawson	"	2008
J. Polcher	"	2008
D. Schimel	"	2008
K. Trenberth,	"	2008
C. Jakob	"	2008

JSC resolved to consider the Panel composition and organization following the outcome of the Modelling Summit for Climate Prediction (Reading, May 2008).

WCRP Observations and Assimilation Panel (cosponsored by GCOS)

Membership as of 1 January 2008	Expiry of appointment
K. Trenberth (Chair)	31 December 2008
A. Belward	" 2008
G. Duchossois	" 2008
G. Flato	" 2008
J.L. Fellous	" 2008
Ed Harrison	" 2008
E. Kent	" 2008
J. Key	" 2008
T. Koike	" 2008
A. Lorenc	" 2008
M.J. Manton	" 2008
W. Randel	" 2008
W. Rossow	" 2008
J. Shukla	" 2008
A. Simmons	" 2008
D. Stammer	" 2008

JSC 29 could not take up the discussion of WOAP composition due to lack of time. All discussion and decisions took place by email/mail correspondence, in consultation with relevant JSC members, organisations such as GCOS, and individuals affected by the decision.

GCOS/GOOS/WCRP Ocean Observations Panel for Climate

Membership as of 1 January 2008
D.E. (Ed) Harrison (Chair)
T. Dickey
J. Johannessen
R. Keeley
A. Piola
R. Reynolds
Toshio Suga
F. Schott
R. Weller

Ex officio members:
- CLIVAR Atlantic Panel representative
- CLIVAR-GOOS Indian Panel representative
- CLIVAR Pacific Panel representative
- CLIVAR-CliC-SCAR Southern Ocean Panel representative
- CLIVAR Global Synthesis and Observations Panel representative
- International Ocean Carbon Coordination Project representative

The JSC endorsed the composition of the Panel.

GCOS/WCRP Atmospheric Observations Panel for Climate

Membership as of 1 January 2008

A. Simmons (Chair)
J. Butler
M. Goldberg
E. Harrison
R. Heino
P. Jones
K. Onogi
D. Parker
T. Peterson
T. Fuchs
M. Rusticucci

J. Schmetz
F. Zhao
M. Verstraete

The JSC endorsed the composition of the Panel.

14. Scientific lectures

Two lectures were presented to JSC by French scientists.

The talk by Dr S. Planton, co-authored by M. Déqué, S. Somot, and H. Douville, was entitled “Regional climate modelling over Europe: some recent results on key uncertainties”. It focussed on causes of uncertainties in the regional climate projections and the impact of coupling of atmosphere with the ocean at the regional scale.

Based on a variety of simulations and, to a significant extent, on the results achieved during the course of the PRUDENCE project, differences between the simulated European climates for 2071-2100 and 1961-1990 were analysed. An attempt was made to assess variations in the results and their sensitivity to the choice of the RCM, emission scenario, type of GCM, and the composition of the ensemble. An important conclusion is that the uncertainty introduced by the choice of the driving GCM is generally larger than the other three sources. However, for summer precipitation, the choice of the RCM is a source of uncertainty of the same magnitude as the choice of the GCM. Higher resolution models generate more information on extremes and for impact studies, but the simulated large scale patterns of change tend to be similar for resolutions of 50km and 20km (Gao et al., 2006). Further investigation of the added value of improved resolution might be limited due to the lack of appropriate datasets. Representation of some physical processes by RCMs might be a major source of uncertainty in climate change projections, in particular for extreme precipitation events during summer (Frei et al., 2006; Beniston et al., 2007).

A comparison of coupled and uncoupled global climate change simulations shows that the future precipitation change is sensitive to the coupling. This sensitivity is much higher over Asian monsoon region than over Europe. The impact of regional coupling for the winter season resembles a positive NAO pattern. During summer, it exhibits an increase of the land-sea contrast with a lower humidity and cloudiness over the continent. Irrespective of the season, climate change scenarios over the Europe/Mediterranean Sea area appear to be sensitive to the regional coupling (Somot et al., 2007).

A recommendation was made to further investigate an efficient estimation of the uncertainties that require a sufficient number of GCMs, which should not be less than the number of RCMs (Déqué et al., 2007). Some other sources of uncertainties will be investigated in the context of new European projects. It will be possible to use the results of ENSEMBLES to study the effects of resolution based on ENSEMBLES, and CIRCE that is instrumental in studying the coupling between the atmosphere - mediterranean sea regions.

Previous studies based on the use of a single model helped to identify “mechanisms” leading to specific features of simulated climate regimes at regional scale. Similar experiments with multi-model ensembles and the definition of “mechanism”-oriented metrics will be instrumental for a better characterisation of climate change uncertainties at the regional scale.
Dr S. Bony’s lecture was entitled “Clouds in the climate system: New prospects for an old problem”. She started the lecture by presenting the transient climate responses simulated by CMIP3/AR4 coupled GCMs and showing that by far the largest differences between the models were associated with treatment of clouds and their radiative feedbacks. This is not a new research problem and Dr Bony cited several prominent scientists, starting with A. Arakawa (1975) and finishing with the statement in the Summary for Policymakers in AR4 that highlighted limited progress in addressing it during the past 20 years.

Cloud physical processes and cloud-climate interactions are at the interface between observations, process understanding, and modelling of natural climate variability and climate change. As stated in the AR4 WG1 Chapter 8, the short-wave radiative response of clouds is the most uncertain and low-level clouds are the main contributors to the spread of cloud feedbacks as represented in the current climate models. However, we do not yet know the type(s) of low-level clouds (stratocumulus, shallow cumulus) that contribute the most to the uncertainty and the reasons for inter-model differences in (low-level) cloud response.

The Cloud Feedback Model Intercomparison Project – Phase 2 (CFMIP-2) was an attempt to address these issues through coordinated research. This effort was also aiming at improving prediction of the effect of anthropogenic aerosols on climate, changes in precipitation, and changes in daily extremes and diurnal temperature range.

Confidence in the representation of cloud processes by large-scale models can be gained by identifying biases in the simulation of clouds through process-based evaluations, large-scale and NWP assessments and subsequent improvement of the physical representation of these processes in large-scale models. There are new opportunities for the evaluation of cloud models using satellite observations from Calipso, Cloudsat and the A-Train constellation of satellites. This strategy of model development has proved to be effective in improving climate models. For example, it was possible to show that systematic efforts of the GEWEX Cloud System Study (GCSS) led to much improved cloud fraction in simulating cloud climatology by removing underestimation of stratocumulus clouds in some areas.

Dr Bony analysed possible approaches to address the cloud feedback problem and formulated two important questions:

- What are the large-scale constraints on the large-scale cloud response (e.g. energetic constraints, role of level clouds in deep convection?
- What is the role of multi-scale interactions in global cloud feedbacks (e.g. small-scale microphysics vs large-scale circulation vs global energetic constraints)?

To address these questions, we need to develop:

- methodologies of comparison and analysis of the GCM cloud responses (CFMIP)
- process-oriented analyses of the GCM cloud responses (e. g. CFMIP-GCSS initiative to analyse point-wise GCM outputs on ARM sites and regions of large inter-model spread,
- a hierarchy of climate models of different complexity including high-resolution models, Earth System models, coupled GCMs, slab GCMs, atmospheric GCMs, one-dimensional models and various types of experiments with them.

With the new research opportunities proposed by Dr Bony, both on the modelling and observations, it is possible to expect substantial progress in the next few years. Particularly thanks to developing collaboration between various research communities. WGCM-CFMIP and GEWEX-GCSS are very well-positioned to tackle these problems.

Two types of activities should be promoted to benefit cloud feedback research and modelling activities within WCRP:

- A bottom-up activity: the improvement of physical parameterizations related to clouds, convection, boundary-layer turbulence, etc., and
- A top-down activity: the development and use of a hierarchy of climate models, learning from them, and providing guidance for the design of observational and modelling strategies.

Both lectures created a great deal of interest among the attendees and generated significant discussions. The recommendations by the speakers were positively received by the JSC. On behalf of the JSC, Dr Church warmly thanked the speakers for their time, effort and excellent presentations of great interest and value to WCRP.

15. Closure of the session

The JSC closed with a further brief discussion on the future direction for WCRP and the Chair invited further comments and discussion among the members through email exchange. There was also a brief discussion on the frequency, number and type of meetings that JSC members should attend/support. Some suggestions were offered to make greater use of tele- and video-conferencing in between JSC meetings. The Director suggested accomplishing most of the business and organisational discussions/decisions in between the JSC meetings, in order to have more time during JSC to devote to strategic, scientific and technical discussions. Canada and the USA offered to host the next JSC meeting. The Chairman, Dr Church, closed the session at 16:45 on 4 April 2008. Before doing so, he thanked the team of local organisers for offering an excellent venue for a very successful JSC meeting. The JSC warmly thanked Dr Church for his leadership and contributions in guiding the WCRP during a very difficult time.

16. Expression of appreciation, acknowledgement

Several individuals have left the WCRP since the 28th Session of the JSC in Zanzibar or will step down from leadership positions in the WCRP in 2008.

Dr. John Church was Chair of the Joint Scientific Committee in 2006-2007. For many years he has served WCRP in various positions, as JSC member, Officer, and Vice-Chair of the JSC. Dr Ann Henderson-Sellers was Director, WCRP in 2006-2007. Prof. Venkatachalam Ramaswamy was the JSC Vice-Chair in 2006-2008. Dr Venkataramaiah Satyan was Director for World Climate Modelling and Deputy Director, WCRP, in 2002-2008. Dr Soroosh Soroshian served as Chair of GEWEX SSG in 1999-2008. Dr Barry Goodison served as Chair of CliC SSG in 2002-2008. Dr. Sergey Gulev served as JSC Officer in 2004-2008. Ms Valery Spalding worked at the WCRP JPS as a consultant in 2006-2007. The JSC would like to acknowledge with great appreciation their valuable contribution to international climate research in general and success of WCRP in particular and wish them every success in their new endeavours.

APPENDICES

Appendix 1

Meeting participants

1. Members of the JSC

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Appendix 2

Final agenda

Opening Session

1. Review of WCRP cross-cuts
- Atmospheric chemistry and climate
- Anthropogenic climate change
- Seasonal prediction
- Decadal prediction
- Monsoons
- International Polar Year 2007-2008
- Sea-level rise

2. Special session on climate extremes

3. Review of WCRP projects
- GEWEX
- CLIVAR
- SPARC
- CliC

4. Review of activities of WCRP panels, working groups
- WCRP Modelling Panel and Modelling Summit for Climate Prediction
- White paper on revolution in weather, climate and Earth System prediction
- WGCM
- WGNE
- Regional climate downscaling
- WGSF
- SOLAS
- WOAP
- GCOS and AOPC, OOPC, and TOPC

5. World Climate Conference 3

6. Review of other activities of WCRP and its partners
- ESSP
- START
- WWRP/THORPEX

7. Geoengineering

8. WCRP strategy and development before and beyond 2013

9. WCRP budget

10. Scientific lectures

11. Executive Session
- Administrative matters
- WCRP Committees Memberships

Closure of the JSC session

Appendix 3

List of written reports submitted to the Session
(with their numbers if they were assigned)

1. WCRP Review of Cross-cutting Activities

1.1 ACC
1.2 AC&C
1.3 Monsoons/YoTC
1.4 Decadal Prediction
1.5 IPY
1.6 Extreme Events
1.7 Sea-Level Rise
1.8 Seasonal Prediction Position Paper

2. 'Climate Extremes Day' special session

2.2 Climate Extremes: NMHSs needs for climate information, including for disaster risk reduction

3. Review of WCRP Core Projects, Working Groups & Panels
3.1 GEWEX
3.2 CLIVAR
3.3 SPARC
3.4 CliC
3.5 WGCM
3.6 WGNE
3.7 WGSF
3.8 WMP
3.9 WOAP

4. Review of WCRP activities

4.1.1 ESSP
4.1.2 ESSP GCP
4.1.3 ESSP GWSP
4.1.4 ESSP GECAFS
4.1.5 ESSP GECCHH
4.1.6 MAIRS
4.2 START
4.3 SOLAS

5. Review of Partner activities

5.1 GCOS (AOPC/OOPC/TOPC)
5.2 GEO
5.3.1 WCRP/WWRP White Paper
5.3.2 WWRP/THORPEX

6. WCRP Sponsors' and Others' Inputs

6.1 WMO
6.3 IOC
6.4.1 WMO Cg-XV doc 3.2.7 WCRP
6.4.2 WMO Restructure
6.5 WCC3

7. (a) Administrative Matters

7.1 WCRP Committees
7.2 Actions and recommendation of JSC-28
7.3 WCRP Publications

7. (b) Executive Matters

Summary of finances

8. Strategic Implementation

8.1 RCM White Paper
8.2 World Bank Project Paper

9. Future of WCRP

Future of WCRP

Documents on JSC Session organisation

Inf. 1 Agenda and explanatory memorandum
Inf. 2 List of submitted documents
Inf. 3 Logistics
Inf. 4 Timetable

Appendix 4

JSC-29 recommendations, decisions, action items

Doc no.	Topic	Recommendations, decisions, action items	Deadline	Responsible
1.2	AC&C	1. Thank SPARC and IGAC for the successful development of the AC&C initiative. Support the current thrusts of the crosscut and the proposed objectives of the AC&C modelling experiments. Agree that AC&C has to focus its activities on a limited number of high priority "bite-sized" problems, so that its coordinated model simulations can be completed in time to be useful for the upcoming Ozone Assessment and expected IPCC AR5.		D/WCRP
		2. Note that there is a need for effort to further raise the visibility and profile of the AC&C initiative. Request JSC members to consider ways to achieve this.	Continuous	JSC, JPS
		3. Endorse the forthcoming AC&C workshop to be held in Washington DC. Invite representatives of WGCM to the Workshop, in order to take up the results of AC&C in future climate predictions.	April-May 2008	Crosscut leadership
		4. At the next JSC meeting consider a presentation on organising a joint WCRP/IGBP activity on reviewing the state of knowledge on deposition processes (or an initiative addressing both emissions and deposition)	Jan 2009	Ravishankara D/WCRP
		5. Ensure cross-representation of AC&C and WGCM.	End of JSC29 session	D/WCRP
		6. Make JSC recommendations to AC&C known to and agreed by IGBP/IGAC	July 2008	D/WCRP
1.1, 1.1.1-1.1.3 8.2	ACC	1. Note with appreciation the considerable effort behind the ACC initiative and the support provided to the ACC initiative and WCRP as a whole by the WCRP Unit at IPSL in Paris.		
		2. Endorse the WCRP/GCOS/WCP/IGPAC initiative on a series of capacity building regional seminars to be supported by the World Bank. In the future, work on this initiative give sufficient attention to the issues associated with poverty reduction.	2008	D/WCRP
		3. Acknowledge with interest the positive outcomes of the WCRP Workshop "Learning from IPCC	2008	D/WCRP,

		AR4" organised together with GCOS and IGBP. Noting that participation was limited primarily to IPCC AR4 authors, recommend to WCRP projects and JSC to review the Workshop report, in order to identify how the recommendations can be accommodated in current and future WCRP activities.		project directors
		4. Recommend that the ACC group is extended to include representatives of the projects, WMP, WOAP, and other relevant expertise.	June 2008	D/WCRP, project directors, Le Treut
		5. Consider how ACC can strengthen the work on achieving progress in regional climate projections with the eventual goal to make them capable of providing meaningful scientific support to regional adaptation measures. Engage UNFCCC, SBSTA, regional organisations and funding organisations in this process.	Continuous	D/WCRP, Le Treut and the rest of the ACC group
		6. Explore WCRP acquiring an observer status to IPCC, or, based on the existing invitation, participate in relevant IPCC meetings as part of delegation of sponsors who have an observer status.	2008	D/WCRP
1.8	Seasonal prediction	1. Note the successful development of the WCRP seasonal prediction crosscut. Endorse with appreciation the successful workshop on seasonal prediction (Barcelona, June 2007) and approve its outcomes. Recommend wide distribution of the WCRP Position Paper on Seasonal Prediction to WCRP scientists and communities involved in development and use of seasonal prediction, through WCRP and project websites.	2008	D/WCRP
		2. Resources permitting, hold WGSIP meetings more frequently than once in 18 months	From 2008	D/WCRP
		3. D/WCRP to write a letter to ECMWF expressing appreciation for provision of data management support and the archiving of the WCRP experimental seasonal forecasts, thus making made a major contribution towards enabling international community to build capacity in the area of seasonal predictions.	2008	D/WCRP
1.4	Decadal prediction	1. Endorse the continuing development of the WCRP decadal predictability crosscut. Recommend to the CLIVAR regional panels for Indian, Pacific Oceans and CLIVAR / CliC Southern Ocean Panel to join the CLIVAR Atlantic Panel and GSOP in actively contributing to the development of scientific basis for decadal prediction and engage relevant partners in the regions in this process.	Continuous	Crosscut leadership, chairs of Panels
		2. Recommend a WCRP-wide effort focussing on the development of science of data	2008/2009	Crosscut

		assimilation into coupled models and their initialization focussing on issues related to soil moisture (GEWEX), cryosphere (CliC), and stratosphere (SPARC), involve young scientists in all areas of this work.		leadership, project directors WOAP, WMP, WGCM, WCRP core projects
1.3, 4.1.6	Monsoons/ YOTC	1. Recommend to form a WCRP/WWRP monsoon and tropical meteorology coordinating panel to improve communication amongst the various WCRP and related monsoon activities. The panel should operate by correspondence only. Suggest Prof. Yasunari and Dr Chang as co-Chairs. Enrol members from the JSC monsoon oversight group, CLIVAR/GEWEX monsoon panels and working groups, CEOP, WWRP-THORPEX (YOTC), MAIRS, WWRP tropical meteorology group. Establish exchange between members of this group by email and create a web site to be hosted by GEWEX IPO. 2. Hold the Second Pan-WCRP Monsoon Workshop, tentatively in Beijing in October 2008 in conjunction with the WMO Monsoon Conference. 3. Keep under review data management issues pertaining to monsoon studies and modelling.	2008 2008 JSC-30	Yasunari, D/CLIVAR, D/GEWEX Yasunari, D/CLIVAR, D/GEWEX Yasunari, D/CLIVAR, D/GEWEX WOAP
1.5	IPY	1. WCRP to review availability, accessibility, preservation of data, including IPY data, particularly in view of sunsets of some of its projects (beyond IPY).	2009	CliC with respect of IPY data, WOAP for all other data
1.7	Sea level rise	1. Continue the sea-level crosscut to integrate across relevant WCRP projects and cross-cuts (especially IPY). This should include cryospheric factors, ocean thermal expansion issues (including warming of the deeper ocean), issues related to water storage on land and geodetic factors (noting that they are outside the scope of WCRP) in estimating the SLR rate and predicting its future changes. In the future, activities should give particular attention to prediction of the geographical distribution of future sea level, evaluation of SLR extremes, and provide scientific contribution to integrated assessments required by IOC. Consider updating observational requirements as a part of this activity.	2008	D/WCRP, crosscut leadership, OOPC

		2. CliC to lead WCRP activities aimed at reviewing the requirements for ice sheet models and facilitate their development in cooperation with relevant partners.	Report at JSC-30	CliC IMSL Theme
3.1	GEWEX	1. Organise a workshop with WGNE focussing on contribution of surface layer wetness to predictive skill at various time scales and advances in exploiting it through improvements in land surface data assimilation. 2. Encourage continuation of the efforts aimed at reprocessing of observations and engagement of new international partners in it. 3. GEWEX to consider way of making a contribution, in cooperation with GWSP, to sea-level-rise studies with regard of estimation of terrestrial water storage.	2008-2009 Continuous Include in report to JSC-30	D/GEWEX, C/WGNE D/GEWEX C/WOAP D/GEWEX
3.2	CLIVAR	1. Form a CLIVAR-led group to prepare WCRP's input to OceanObs09, ensuring adequate participation of CliC, GEWEX (e.g. SeaFlux), SOLAS, WOAP, and SLR crosscut.	Report to JSC 30	D/CLIVAR, C/GSOP, C/OOPC
3.3	SPARC	1. Endorse SPARC's 2007 results and plans for 2008 and note especially the most valuable contribution of the project to the 2006 WMO/UNEP Scientific Assessment of Stratospheric Ozone Depletion. 2. Welcome the increasingly close collaboration between SPARC and IGBP/IGAC including coordination of the SPARC General Assembly and IGAC Conference in 2008, and possible joint SPARC SSG / IGAC SSC meetings in 2009. 3. Ensure that the results of CCMVal are taken up by WGCM and that SPARC provides guidance to WGCM with respect to specification of ozone in climate models and effects of vertical resolution and inclusion of stratospheric levels on the quality of numerical climate prediction. 4. SPARC requested additional funding to support greater participation of young scientists from developing nations in its General Assembly 2008.	2008 July 2008 June-July 2008	C/WGCM, D/SPARC D/WCRP, JSC members D/WCRP
3.4	CliC	1. Form a WCRP-wide group (from projects and WGCM) with involvement of IGBP representative(s) to work, initially by correspondence, on a topic of climate and polar regions, to scope the scientific issues pertaining to this topic (including predictability of Arctic, relevant biogeochemical processes), and present to the next JSC session a proposal for WRCP way	JSC-30	D/CliC, Ravishankara, Ramaswamy, CliCTheme on

		forward in this area. Recommend an effort aimed at using IPY results and other available knowledge and capacity to undertake an assessment of polar predictability at various time scales.		Global Prediction of Cryosphere
		2. Review the proposed WCRP/IASC/SCAR MoU on sponsorship of CliC to assess associated costs/benefits of the proposed partnership.	June 2008	D/WCRP, D/CliC
1.6, 2.2	Extremes	1. GEWEX and CLIVAR to engage each other to participate in forthcoming workshops on climate extremes	2008	D/CLIVAR, D/GEWEX, Busalacchi
		2. Form a Task Force on Climate Extremes including representation not only from GEWEX and CLIVAR but also from CliC and SPARC, WOAP, IGBP, WWRP (THORPEX) and IRDR to further determine scope, focus and deliverables for this crosscut. Establish links and consider cooperation with the WMO Climate Watch.	2008	Busalacchi, D/CLIVAR, D/GEWEX
		3. Consider participation of representatives of all WCRP projects in ETCCDI.	2008 to be proposed to CCl-XV	D/WCRP in consultation with President CCl
3.8	WMP/Modelling summit	1. Reaffirm a need for continuing coordination of WCRP, WWRP and IGBP modelling activities with major emphasis on the seamless prediction. The modelling coordination should be designed so that the work of WCRP core projects and modelling groups has maximal benefit for / impact on development of climate models that support scientific assessments and other societal needs. The actual arrangements to be worked out based on the outcomes and recommendations emerging from the Modelling Summit in May 2008. JSC recommended to JSC Chair and members to participate actively in the Modelling Summit and convey to its participants a unified view of WCRP's priorities/expectations.	May 2008	C/JSC, D/WCRP, C/WMP, C/WGCM, C/WGNE
		2. Form a team to develop a vision/mission statement based on the Modelling Summit discussion and what needs to be done to implement this vision and use it as input to WCC3. Consider concept of a WCRP "flagship" activity.	May 2008	Shukla, Béland, Palmer, Mitchell, C/JSC, D/WCRP, Burridge, Nobre, Ramaswamy
		3. Ensure a discussion at the Modelling Summit on defining ways for climate model evaluation paving the way to prepare suitable climate model metrics.	May 2008	D/WCRP, C/WMP, C/WGNE

3.5	WGCM	1. D/WCRP, in cooperation with chairs of the modelling groups and WGSIP, to seek support for storage of numerical experiment outputs, including continuation of PCMDI archive for CMIP runs, and identification of a single archive for seasonal forecast experiment runs and decadal ones, if possible. 2. D/WCRP to write to PCMDI expressing gratitude for their hosting of the AR4 climate model output archive and acknowledging their key role in IPCC AR4, and expressing a recommendation for continuing support.	June 2008 July 2008	D/WCRP, C/WGCM, C/WGSIP, C/WOAP. D/WCRP
3.6	WGNE	1. Welcome progress to date, support vigorous assessment, including development of metrics, of climate models, as a near future priority, with participation of other projects and groups of WCRP and IGBP. 2. Subject to approval by WMO Commission for Atmospheric Sciences (CAS), endorse the proposal by C/WGNE and C/GEWEX GMPP to restructure WGNE. Propose to the CAS to include a specialist subgroup focussing on parameterisation into WGNE. Approve the inclusion of the chairs of GMPP and the GMPP subgroups (GCSS, GLASS and GABLS) as members of the new WGNE. Nominate the current GMPP chair, Dr Christian Jakob, as the inaugural co-chair of WGNE responsible for the parameterisation effort. Endorse continuing WGNE efforts aimed at improving parameterisations and encourage WGNE to progressively expand its expertise in related fields (e.g., microphysics, oceanic and cryospheric processes. Seek WMO CAS approval of the above decisions.	2008 immediate	C/WGNE D/WCRP
8.1	Regional climate modelling and downscaling	1. Form a task group on Regional Climate Modelling and Downscaling to undertake assessment of all available techniques, for time scales from seasonal forecasts to IPCC time scales, bring into it all appropriate expertise, including scientists using RCMs in the regions, involve WGNE, WGSIP, WGCM, WCP, regional START activities. Request the Task Group to ▪ work on establishment of a framework for evaluation and intercomparison of regional downscaling methods; ▪ develop a synthesis document to promote WCRP activities in this field; ▪ prepare a longer-term vision for WCRP activities vis-à-vis regional modelling; and ▪ work with WMO to identify mechanisms making regional downscaling models and techniques and as well techniques specific for certain applications available to scientists and users at regional level ▪ create visibility for the WCRP regional modelling and downscaling effort, particularly on the WCRP website. 2. Review and, if required, update the WCRP statement on the Nairobi Work Program before	July 2008 Report to JSC-30 April 2008	D/WCRP D/WCRP, Flato, F. Giorgi

		SBSTA. Provide the updated Statement to SBSTA meeting in June 2008.		
3.8.1, 3.8.2, 5.3.1, 5.3.2	White Paper on a Revolution in Prediction, WWRP / THORPEX,	Thank authors of the White Paper and use it at the Modelling Summit to inform discussions of specific areas where WCRP and WWRP can and should work together. Based on the outcomes of the Modelling Summit and taking into account the White Paper, prepare a submission to the WMO EC-60 and, subsequently, to WCC-3 that would contain a proposal leading to a major outcome from WCC-3.	May 2008 June 2008	D/WCRP, D/WCRM D/WCRP
3.7	WG Surface Fluxes	1. Note with appreciation and congratulate WGSF on several substantial outcomes of its work including revitalisation of SURFA (in cooperation with WGNE), support to SOLAS Focus Two activities, and preparation of a Guide to flux measurements at sea. 2. Prepare a white paper on the need for a WCRP/IGBP mechanism for coordinating (global) surface fluxes, value to be added by it, products to be improved as the result of this coordination; seek input from all WCRP core projects, WGCM, WOAP and IGBP.	2008	Gulev
3.9	WOAP	1. Thank WOAP for work to date including the preparation of a successful 3rd WCRP Reanalysis conference, endorse the Conference Statement. 2. Focus the future WOAP work on data issues associated with completion of WCRP projects and preservation of their data legacy in the post-2013 WCRP.	Report to JSC-30	C/WOAP
5.1	GCOS	1. Express appreciation to GCOS for fruitful and successful cooperation on a number of important matters, including cosponsoring the Sydney workshop and providing financial and staff support to WOAP and BSRN 2. Endorse the continuing role of the joint observing system panels (APOC, OOPC, and TOPC) in contributing the research perspective to the planning of further development of GCOS.		D/WCRP
4.1.1-4.1.5	ESSP/Joint projects	1. JSC to continue work on how to better engage with ESSP, IGBP and joint projects. Accept invitation for WCRP to participate in the ESSP retreat. The way forward to be defined taking into account the ICSU review of WCRP and IGBP and the results of the retreat. Capabilities of IGBP, benefits of extended cooperation and coordination with IGBP should be given consideration in implementation of COPES, and future strategic planning process. 2. Continue to contribute to and engage with ESSP GECAFS on the CGIAR initiative.	2008	JSC Chair D/WCRP
4.1.1	IHDP	1. Endorse the proposal of IHDP to participate in their OSC, provide co-chair, 2-3 speakers for a joint IHDP/WCRP session/ roundtable (involve WGCM-AIMES, AC&C, monsoon extremes).	June 2008	Ramaswamy

4.2	START	1. Send a letter to Roland Fuchs thanking him for his services over the years.	July 2008	D/WCRP
6.2, 6.3	WCC3	1. Recommend that JSC WCRP should have direct input to and influence on the WCC3 programme and outcome(s). To make this happen, Chair JSC to send letter to WIOC and Conference chair, offering JSC help in developing WCC3 programme, outlining what WCRP might see as a single major outcome, suggesting consolidation of current list of anticipated outcomes, using WCC3 to promote excitement and opportunities of career in climate science for young persons. To seek for and include IGBP's input into this process. Reconfirm Ramaswamy as WCRP representative to WIOC. 2. To provide WCC 3 programmatic timeline to JSC once it is available, with updates if required.	Summer 2008 Once timeline is available	Ramaswamy Shukla, Béland, Busalacchi, Nobre D/WCRP Len Barrie
	Geoengineering	1. Setup a working group on geoengineering to work by email to gather info, document ideas, think about how WCRP might respond to the challenge. Invite a talk on this issue at the next JSC Session. 2. Recommend to all relevant WCRP working groups, panels and SSGs to consider the issue of geoengineering on their agendas, and submit outcomes of the discussion to the WG on geoengineering.	Group by August 2008 Report to JSC-30 2008/2009	Bussalacchi, Flato, Shepherd, Peter and representatives from projects and WGCM Projects SSGs, SOLAS SSC, WGCM
	Future of WCRP, programme structure	1. Reinstate, budget permitting, WCRP Officers, Chairs and Directors (OCD) meetings. Ensure that JSC views on the priorities and WCRP future are delivered to OCD. 2. Cross-cuts should be fully integrated in the projects' work. All aspects of WCRP work should be measured against the COPES goals. 3. Start preparing a WCRP Accomplishment report that would explain the value of COPES deliverables, promote them and generate support for the on-going and planned work from Sponsors and other potential supporters. 4. Agree on approach to develop an implementation plan for the intermediate term based on the COPES Strategic Framework by the WCRP Projects' leadership and with active involvement of	2008/2009 From now on 2008 2013-2015	D/WCRP All D/WCRP with support of all All, projects, JSC

		JSC members. All the core projects, to assess and identify what activities need to be further emphasised and which can be de-emphasised in the intermediate term. Projects will be requested to summarise their assessment and plans in form of a WCRP legacy document. JSC Chair and members will provide the leadership to develop a long-term vision for WCRP in consultation with the Projects, Sponsors, supporters and the scientific community at large. ▪ Projects to provide to JSC Chair and D/WCRP an estimate of when they can prepare such legacy document. ▪ JSC to take the lead to develop and provide to D/WCRP an outline of long-term strategy in time for further discussion by the next Officer's teleconference. ▪ To have first draft of the Implementation and Strategic plans prepared in time for the next JSC meeting.	11 April 2008 11 April 2008 2009	Project Directors and Chairs All JSC Members
	Budget and 2008 expenditure priorities	1. Agree on a set of investment priorities for expenditures in 2008 and identified potential areas of investments (i.e. communications, commitment to AOPC, OOPC, and SPARC General Assembly), as funds become available. 2. The day-to-day management of JPS budget and its allocation based on the agreed to priorities should remain the responsibility of JPS. 3. Produce a budget table, which shows national contributions to the broader WCRP support structure, including IPOs and Paris Support Unit. Provide this to national contributors who seek this information. 4. Use more videoconferencing to save resources. 5. Find a prominent member of the community to chair a WCRP fund raising group 6. Encourage JSC members to meet formally each year with WMO PRs, IOC representatives and ICSU members to explain the value of WCRP, promote its activities and their outcomes and seek support for WCRP.	2008 or 2009 From now on 2008 From now on 2008 Report at JSC-30	D/WCRP D/WCRP D/WCRP All D/WCRP All JSC members
	Venue and date for JSC30	North America (Toronto or Washington, DC), Date TBD		/WCRP JSC/Chair

Appendix 5

List of used Acronyms

AAMP	CLIVAR Asian-Australian Monsoon Panel
ACCENT	Atmospheric Composition Change – the European Network of Excellence
ACC	Anthropogenic Climate Change
ACPC	Aerosols, Clouds, Precipitation and Climate (ACPC) Initiative
AC&C	Atmospheric Chemistry and Climate
AeroCom	Aerosol Comparisons between Observations and Models
AIP	Atlantic Implementation Panel
AMAP	Arctic Monitoring and Assessment Program
AMMA	African Monsoon Multidisciplinary Analyses
AMY	Asian Monsoon Year
APCC	Asian-Pacific Economic Cooperation Climate Center (APCC)
ARM	Atmospheric Radiation Measurement
AR4	IPCC Assessment Report no. 4
BALTEX	Baltic Experiment
CAS	Commission for Atmospheric Sciences (WMO)
CASO	Climate of Antarctic and Southern Ocean
CCl	(WMO) Commission for Climatology
CCM	Chemistry - Climate Model
CCMVal	Chemistry-Climate Model Validation Activity
CCSP	Climate Change Science Program (USA)
CEOP	GEWEX Coordinated Enhanced Observing Period (prior to 2007)
CEOP	GEWEX Coordinated Energy and water-cycle Observations Project (since 2007)
CFCAS	Canadian Foundation for Climate and Atmospheric Sciences
CHFP	The Climate-system Historical Forecast Project
CliC	Climate and Cryosphere Project
CLIVAR	Climate variability and predictability Project
CLIPAS	Climate Prediction and its Societal Application
CLIPS	Climate Information and Prediction Services
CLPA	Climate Prediction and Adaptation Branch
COPES	Coordinated Observation and Prediction of the Earth System
CORE	Coordinated Ocean-ice Reference Experiment
COREH20	Cold Regions Hydrology High-resolution Observatory mission
CPPA	Climate Prediction Program for the Americas
CReSIS	Center for Remote Sensing of Ice Sheets
CRM	Cloud Resolving Model
DRICOMP	Drought In Coupled Models Project
DUE	Data User Element (ESA)
D/WCRP	Director, WCRP
DWD	Deutsche Wetterdienst
EC	WMO Executive Council
ECMWF	European Centre for Medium-Range Weather Forecasts
ENSO	El Niño-Southern Oscillation
ETCCDI	CCl/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices
ESA	European Space Agency
ESSP	Earth System Science Partnership
HTAP	Hemispheric Transport of Air Pollution
GABLS	GEWEX Atmospheric Boundary Layer Study
GARP	Global Atmosphere Research Programme
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GCP	Global Carbon Project
GCSS	GWEX Cloud System Study
GCW	Global Cryosphere Watch
GECAFS	Global Environmental Change and Food Systems
GECHH	Global Environmental Change and Human Health
GEIA	Global Emissions Inventory Activity
GEF	Global Environment Facility
GEO	Group on Earth Observations
GEOSS	Global Earth Observations System of Systems
GEWEX	Global Energy and Water Cycle Experiment
GIIPSY	Global Interagency IPY Polar Snapshot Year
GLASS	GEWEX Land-Atmosphere System Study
GODAE	Global Ocean Data Assimilation Experiment
GSOP	Global Synthesis and Observations Panel (CLIVAR)

GPC	Global Prediction of Cryosphere
GWSP	Global Water System Project
iAOOS	integrated Arctic Ocean Observing System
IASC	International Arctic Science Committee
ICPAC	IGAD CLIMATE PREDICTION AND APPLICATIONS CENTRE
ICPO	International CLIVAR Project Office
ICSU	International Council for Science
IGAC	International Global Atmospheric Chemistry
IGAD	Intergovernmental Authority on Development (IGAD) in Eastern Africa
IGBP	International Geosphere – Biosphere Programme
IGOS	Integrated Global Observing Strategy
IGOSP	Integrated Global Observing Strategy Partnership
IGPO	International GEWEX Project Office
IMS	International Monsoon Study
IMSL	Ice Masses and Sea Level
IOC	Intergovernmental Oceanographic Commission of UNESCO
IOP	Indian Ocean Panel
IPCC	Intergovernmental Panel on Climate Change
IPO	International Project Office
IPSL	L'Institut Pierre-Simon Laplace
IRDR	Integrated Research on Disaster Risk
ITCZ	Intertropical Convergence Zone
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JMA	Japan Meteorological Agency
JPS	Joint Planning Staff for WCRP
JSC	Joint Scientific Committee
LBA	Large Scale Biosphere-Atmosphere Experiment in Amazonia
LPB	La Plata Basin
MAHASRI	Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative
MAIRS	Monsoon Asia Integrated Regional Study
MarC	Marine Cryosphere and Climate
MJO	Madden-Julian Oscillation
MOC	Meridional Overtuning Circulation
NAS	National Academies of Sciences, USA
NASA	National Aeronautics and Space Administration, USA
NCDC	National Climatic Data Center, USA
NEESPI	North-Eurasia Earth Science Partnership Initiative
NESDIS	National Environmental Satellite, Data, & Information Service, NOAA, USA
NOAA	National Oceanic and Atmospheric Administration, USA
NSF	National Science Foundation, USA
NWP	Nairobi Work Programme
NWP	Numerical Weather Prediction
ONR	Office of Naval Research, USA
PAntOS	Pan-Antarctic Observing System
PCMDI	Program for Climate Model Diagnosis and Intercomparison
PDF	Probability Density Function
PI	Principal Investigator
PIP	Pacific Implementation Panel
RCD	Regional Climate Downscaling
SAON	Sustained Arctic Observing Network
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCAR	Scientific Committee for Antarctic Research
SGMIP	Grid Model Intercomparison Project
SLR	Sea-Level Rise
SOOS	Southern Ocean Observing System
SPARC	Stratospheric Processes and Their Role in Climate Project
SPICE	South Pacific Ocean Circulation and Climate Experiment
SST	Sea Surface Temperature
SURFA	Surface Flux Analysis Project
TACE	Tropical Atlantic Climate Experiment
TAR	Third Assessment Report (IPCC)
TCHM	Terrestrial cryosphere and hydrometeorology of cold regions
TIGGE	Tropical Tropopause Layer
TPARC	
TTL	Tropical Tropopause Layer
UTLS	Upper Troposphere – Lower Stratosphere
VAMOS	Variability of the American Monsoon Systems
VOCALS	VAMOS Ocean-Cloud-Atmosphere-Land Study
VOSClim	Voluntary Observing Ship Climatology
WCRP	World Climate Research Programme
WG	Working Group
WGCM	Working Group on Coupled

	Models
WGOMD	Working Group on Ocean Model Development
WGSIP	Working Group on Seasonal and Interannual Prediction
WG I	Working Group I of IPCC
WG II	Working Group II of IPCC
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization
WMP	WCRP Modelling Panel
WOAP	WCRP Observation and Assimilation Panel
WoS	Web of Science
WWRP	World Weather Research Programme
XBT	eXpendable BathyThermograph
YOTC	Year of Organised Tropical Convection