WCRP REPORT

World Climate Research Programme

ANNUAL REVIEW
OF THE
WORLD CLIMATE RESEARCH PROGRAMME

AND

REPORT
OF THE TWENTY-SEVENTH SESSION
OF THE
JOINT SCIENTIFIC COMMITTEE

(PUNE, INDIA, 6-11 March 2006)

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A. LIST OF PARTICIPANTS

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ANNUAL REVIEW OF THE WORLD CLIMATE RESEARCH PROGRAMME

AND

REPORT OF THE TWENTY-SEVENTH SESSION OF THE JOINT SCIENTIFIC COMMITTEE (Pune, India, 6-11 March 2006)

1. ANNUAL SESSION OF THE JOINT SCIENTIFIC COMMITTEE FOR THE WORLD CLIMATE RESEARCH PROGRAMME

The principal task of the annual session of the WMO/ICSU/IOC Joint Scientific Committee (JSC) for the World Climate Research Programme (WCRP) is to review the scientific progress in the programme during the preceding year. The kind and welcome invitation to hold the 2006 session of the JSC, the twenty-seventh, at the Indian Institute of Tropical Meteorology (IITM), Pune, India from 6-11 March, had been made through JSC Member, Dr G.B. Pant, former Director and now Faculty of the Institute. The session was called to order by the Chair of the JSC, Professor P. Lemke, at 0830 hours on 6 March. The list of participants is given in Appendix A. This report summarizes the information presented to the JSC on the progress in the WCRP during the preceding year and records the recommendations by the JSC for the further development of the programme. These recommendations are given in Appendix B.

The session was formally opened by Dr P.C.S. Devara, Acting Director of the Indian Institute of Tropical Meteorology, who welcomed all the participants to Pune and, in particular, to IITM. In this, he was joined by Dr G.B. Pant, former Director and now Faculty of the Institute, who expressed gratitude to all on behalf of the Institute and on his own behalf for accepting his offer to host the meetings. The Institute felt privileged to hold a meeting of this magnitude with the large gathering of distinguished scientists.

The Chair of the JSC thanked Drs Devara and Pant for their welcome and the highly appropriate and inspiring remarks. It was a pleasure and privilege for the JSC to meet in India, in particular Pune, for the first time and to therefore have the first-hand opportunity to acknowledge the outstanding contributions of Indian scientists to the WCRP. The Chair thanked Dr G.B. Pant and his colleagues for their substantial efforts and support in arranging for this JSC session to be held at IITM. In doing so, he acknowledged the encouragement and direct support that had been given to Dr Pant by Dr Devara, Acting Director of the IITM.

The Chair continued by extending his greetings to all the participants in the session. He noted with regret that five JSC members Professor P. Cornejo R. de Grunauer, Dr D. Griggs, Dr J. Marotzke, Dr I. Wainer and Dr M.T. Zamanian could not be present on this occasion.

The Chair further acknowledged with appreciation the representatives from two of WCRP's sponsors, Professor T. Rosswall, Executive Director, ICSU and Dr B. Nyenzi, Director, World Climate Department, WMO. He noted with regret that a corresponding representative from IOC could not be present on this occasion. The Chair regretted the absence of a representative from the International Human Dimensions Programme on Global Environmental Change (IHDP) on this occasion.

The Chair expressed his gratitude for the participation of the chairs or representatives of WCRP steering and working groups who would brief the JSC on activities in their respective fields and advise on future actions to be taken. These included: Dr K. Trenberth, JSC Officer and Chair, WCRP Observations and Assimilation Panel (WOAP); Professor J. Shukla, JSC Member and Chair, WCRP Modelling Panel (WMP), Drs A. Busalacchi and T. Palmer Co-chairs of the CLIVAR Scientific Steering Group; Dr B. Goodison, Chair of the CliC Scientific Steering Group; Professors. A. O'Neill and A.R. Ravishankara, Co-chairs of the SPARC Scientific Steering Group; Dr M. Miller, Chair of the CAS/JSC Working Group on Numerical Experimentation (WGNE); Dr J. Mitchell, Co-Chair, Working Group on Coupled Modelling (WGCM); Professor S. Sorooshian, Chair of the GEWEX Scientific Steering Group and Dr C. Fairall, Chair, Working Group on Surface Fluxes (WGSF). The Chair expressed his gratitude to Professor. B. Kirtman, Chair, Task Force on Seasonal Prediction, for his participation. The Chair noted with regret that Dr G. Meehl, Co-Chair, Working Group on Coupled Modelling (WGCM) could not be present on this occasion.

The Chair was pleased to note the attendance of Project Office Directors: Dr H. Cattle, International CLIVAR Project Office; R.G. Lawford, Director, International GEWEX Project Office; Dr N. McFarlane, Director, SPARC International Project Office; Dr V. Lytle, Director, International CliC Project Office. The Chair was gratified by the participation also of Dr J. Zillman, the new Chair of the GCOS Steering Committee, as well as Dr D.E. Harrison, Chair of the Ocean Observations Panel for Climate (jointly sponsored by WCRP, GCOS and the Global Ocean Observing System, GOOS), Dr M. Manton, Chair, Atmospheric Observation

Panel for Climate (jointly sponsored by WCRP and GCOS), Dr H. Virji, Deputy Director, WCRP/IGBP/IHDP Global Change System for Analysis, Research and Training (START), Professor G. McBean, Co-Chair, START SSC, Dr M. MacCracken, representing IAMAS, IUGG and the Scientific Committee on Oceanic Research (SCOR).The Chair noted with regret that a representative from IPCC could not be present on this occasion.

Finally, the Chair looked forward with anticipation to the scientific lectures that would be given later in the JSC session; i.e. "South Asian Monsoon: Variability and Prediction", Dr R. Rajeevan, Director, India Meteorological Department, Pune, and "Recent climate research initiatives in India", by Dr R. Kolli, Head, Climatology and Hydrometeorology Division, Indian Institute of Tropical Meteorology, Pune.

2. MAIN DEVELOPMENTS AND EVENTS SINCE THE TWENTY-SIXTH SESSION OF THE JSC

The overall progress in the various components of the WCRP over the past year, and the issues on which the advice and guidance of the JSC were required, are summarized in detail at the appropriate parts of this report. At this point, only a few of the major highlights are reviewed.

The past year saw good progress in the implementation of the WCRP Strategic Plan. The WCRP Modelling Panel held its first session at the Met Office, Exeter, UK, 3-5 October 2005 with a half-day joint session with WGCM. The meeting was highly stimulating as the panel debated some of the most important questions facing the modelling community. WCRP and THORPEX will prepare a joint paper on the grand challenge of establishing a multi-national coordinated research initiative to develop next-generation unified models for prediction of weather and climate. The First meeting of WCRP Observations and Assimilation Panel (WOAP) was held at GISS, New York, 1-3 June 2005. WOAP has taken the initial steps for the coordination of global reanalyses and of the preparatory activities for the reprocessing of global data sets. Preparations are underway for the upcoming Workshop on Reanalysis at ECMWF in June 2006. WOAP plans to organize a major International Reanalysis Conference in the fall of 2007. The Task Force on Seasonal Prediction (TFSP) held the second joint TFSP-WGSIP-THORPEX workshop at ICTP in August 2005 in which the details of the seasonal prediction experiment were finalized. TFSP is planning a climate community wide seasonal prediction workshop for the middle of 2007. Preparations for a Workshop on Sea-Level Rise organized by the Task Force on understanding Sea-Level Rise and Variability were progressing well. This WCRP Workshop is in support of the WCRP Strategic Initiative and is a WCRP contribution to the Global Earth Observation System of Systems (GEOSS) and will be held in Paris, 6-9 June 2006. Preparations for the Earth System Science Partnership (ESSP) Open Science conference in Beijing, 9-12 November 2006, were progressing very well.

CLIVAR's contributions to WCRP's new strategy are facilitated by the activities of its Panels and Working Groups, the CLIVAR Scientific Steering Group (SSG) and the International CLIVAR Project Office (ICPO). Over the past year these have continued to develop their activities, links and interactions, and input to COPES. In particular, CLIVAR's global and regional activities are making direct contributions to the COPES cross cutting initiatives. The CLIVAR SSG is seeking to integrate its regional and global activities by encouraging regional analysis of global model outputs from its modelling panels and links to user applications. In particular, CLIVAR's Working Group on Seasonal to Interannual Prediction (WGSIP) has a number of such activities focussed on seasonal to interannual prediction skills. Consequently, CLIVAR also has the lead on the WCRP Task Force on Seasonal Prediction, which has developed plans for an experiment to utilize advances, understanding and assessment skills across all WCRP projects. In addition, CLIVAR's Global Synthesis and Observations Panel (GSOP) provides a key focus for integrating regional needs for ocean observations and their use in ocean reanalysis. As such, it seeks to make a key contribution to the aims of the WOAP in the area of coupled reanalysis. GSOP's own terms of reference were also instrumental in guiding the WOAP's own mission.The CLIVAR SSG had no 2005 meeting (a response to the pressure on WCRP funding). However, the SSG Executive did meet in September at ECMWF to review progress and set the agenda for CLIVAR SSG-14, which will take place in Buenos Aires from 19-22 April 2006. SSG-14 will, in particular, seek to assess the progress in CLIVAR against its four science themes, the role of the oceans in climate and global modelling, observations and synthesis. In doing so, it will also seek to further scope and refine the CLIVAR input to COPES. Plans will also be consolidated for a CLIVAR International Workshop on Multidecadal to Centennial Global Climate Variability (Honolulu, USA, November 2006) and initial plans scoped for a CLIVAR SSG International Workshop on the Role of the Oceans in Climate.

The Global Energy and Water Cycle Experiment (GEWEX) had an active and successful year in 2005 both in terms of scientific advances and project development. Highlights of the year included the 5th International Scientific Conference on the Global Energy and Water Cycle held in Costa Mesa, California (20-24 June), the launch of the African Monsoon Multidisciplinary Analysis (AMMA) Project, the

development of proposals for Monsoon Asia Hydro-Atmospheric Science Research Initiative (MAHASRI) [the follow on to the GEWEX Asian Monsoon Experiment (GAME)], and the second phase of the Coordinated Enhanced Observing Period (CEOP). The seventeenth session of the GEWEX SSG was held in Kunming, China 31 January - 4 February 2005. The roster of scientists leading the GEWEX Panels and Projects remained relatively stable with changes in only one subproject, the Global Land-Atmosphere System Study (GLASS) where Dr A. Pitman replaced Dr P. Dirmeyer as Chair. Also in 2005, Dr R. Yu joined the SSG in place of Dr G. Wu. Other changes arising from the latest GEWEX SSG meeting include the completion of the Water Resources Applications Project (WRAP) and the International Land Surface Climatology Project (ISLSCP) and the approval of two new related projects: the Hydrological Applications Project (HAP) and LandFlux. Although progress has been slow, GEWEX is fostering greater integration across projects, closer links with other WCRP projects as part of activities directed towards the new Strategic Framework (particularly CLIVAR) and is also looking for collaborations with other international activities such as the International Land Ecosystem-Atmospheric Processes Study (iLEAPS) within the International Geosphere-Biosphere Program (IGBP), the Integrated Global Observing Strategy–Partnership (IGOS-P), the Global Climate Observing System (GCOS) and the Group on Earth Observations (GEO).

The Stratospheric Processes and their Role in Climate (SPARC) project has continued to facilitate stratospheric research and highlight the importance of stratospheric processes in the climate system. Upcoming SPARC results are the Assessment of Stratospheric Aerosol Properties (ASAP) and the SPARC Polar Stratospheric Cloud (PSC) Assessment (SPA). The main current thrust of the SPARC Detection, Attribution and Prediction of Stratospheric Changes Theme is to provide an update of the observed stratospheric temperature record (through 2004), and to improve the understanding of past changes and predictions of future stratospheric temperature changes. The Stratospheric chemistry–climate Interactions Theme is epitomized by the CCMVal (chemistry-climate model validation) activity. It has proposed reference simulations for ensemble predictions to support upcoming ozone and climate assessments. The second CCMVal workshop was held at NCAR, Boulder, USA, 17-19 October 2005. Activities within the SPARC Stratosphere–Troposphere Dynamical coupling Theme are relevant to task forces and coordinating bodies that have been established within the WCRP. The timescales considered are medium range to seasonal, interannual (involving internal variations as well as responses to 'external' forcings such as the QBO and ENSO), and interdecadal and longer (involving changes in the Brewer-Dobson circulation and in the polar vortex). The GCM-Reality Intercomparison Project for SPARC (GRIPS) formally concluded with its tenth and last workshop, which was held in Toronto, Canada in March 2005. Efforts are under way within the SPARC community to develop a follow-on activity.

The First CliC Science Conference "Cryosphere, the Frozen Frontier of Climate Science: Theory, Observations, and Practical Applications" was held in Beijing, China, 11-15 April 2005. The CliC community actively participated in the Second International Conference on Arctic Research Planning (ICARP II 10-12 November 2005). CliC was recognised as one of lead programmes coordinating research on the cryosphere system in the Arctic, including the terrestrial cryospheric and hydrologic processes. The International Project Office and JPS for WCRP, with help from the CliC SSG, completed the CliC Implementation Strategy Document. Cooperation with the Scientific Committee on Antarctic Research (SCAR) is expanding. CliC has agreed to co-sponsor, along with SCAR, the Antarctic Sea Ice Processes and climate (ASPeCt) programme. An Antarctic Sea-Ice Thickness International Workshop is being planned for 5-7 July 2006 in Hobart, Tasmania, Australia. Two SCAR research programmes of direct relevance for CliC are "Antarctica and the Global Climate System (AGCS)" and "Antarctic Climate Evolution (ACE)". CliC is organising a workshop on polar reanalysis in April 2006. One of key foci will be a reanalysis in the Southern Hemisphere, in data sparse areas. The Integrated Global Observing Strategy Partnership (IGOS-P) Theme on Cryosphere is progressing. CliC, in cooperation with the International Glaciological Society and the IUGG Commission for Cryospheric Sciences, is organising a major International Symposium on Cryospheric Indicators of Global Climate Change, Cambridge, UK, 21-25 August 2006.

WCRP's climate modelling activities are centred on two main groups: the CAS/JSC Working Group on Numerical Experimentation (WGNE) and the JSC/CLIVAR Working Group on Coupled Modelling (WGCM). Particular attention continues to be given to the two principal intercomparison projects: the Atmospheric Model Intercomparison Project (AMIP) overseen by the WGNE, and the Coupled Model Intercomparison Project (CMIP) overseen by the WGCM. In data management, WGNE has asked to be represented on the data oversight committee together with someone from the land surface modelling community. AMIP-type studies will continue as a subset of CMIP in the future and the Programme for Climate Model Diagnosis and Intercomparison (PCMDI) has offered to receive high resolution NWP AMIP-type runs to complement their ongoing CMIP activities. PCMDI and WGNE, with input from WGCM and GMPP, will be organizing a pan-WCRP workshop on Model systematic errors in February 2007. A joint WGNE/GCSS model intercomparison study of a Pacific cross section (GPCI) to evaluate physical parameterizations along the atmospheric cross- section following the trade winds is in progress, with excellent support from both

NWP and climate modelling groups. At the 21st WGNE meeting (St Petersburg, Russia, 7-11 November 2005), there was a session devoted to THORPEX, which reviewed the status and plans of THORPEX and the wide-ranging opportunities for collaboration and synergy with WCRP and other bodies. The ninth session of WGCM was held in Exeter, UK, 3-5 October 2005 with a half-day joint session with WMP. A major achievement in the past year was the successful international Workshop on Analyses of Climate Model Simulations for the IPCC AR4 convened by US CLIVAR, hosted by IPRC (Univ. of Hawaii) March 1-4, 2005 and overseen by the WGCM Climate Simulation Panel. This was the largest, most comprehensive, highest profile and the most successful project ever organized by WGCM. PCMDI has collected, archived and distributed the model data; the WGCM Climate Simulation Panel has overseen and coordinated collection, archival, and analysis of model data for the IPCC AR4; over 400 scientists have registered to analyze the IPCC model data; over 200 papers submitted to peer-reviewed journals.

3. MATTERS RELATING TO THE WCRP SPONSORING AGENCIES, WMO, ICSU AND IOC

3.1 World Meteorological Organization

Fifty-seventh session of the WMO Executive Council

At its fifty-seventh session (EC LVII, Geneva, 21 June –1 July 2005) the Executive Council of the WMO noted with approval the progress being made in the implementation of the WCRP. In particular, the Council endorsed fully the introduction of the new WCRP strategic framework for 2005-2015, called Coordinated Observation and Prediction of the Earth System (COPES), with the stated aim to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society. The ultimate objective was to provide the soundest possible scientific basis for a predictive capability for the total climate system to meet society's needs, including an assessment of what was, and what was not, predictable on various temporal and spatial scales. Key research challenges were to: address the prediction problem as 'seamless' across all time-scales, from weeks to centuries; address prediction of the broader Earth system; and demonstrate the use and value to society of WCRP-enabled predictions. The Council recognized that close research collaborations would be needed with, in particular, the International Geosphere-Biosphere Programme and the International Human Dimensions Programme on the broader Earth system aspects, THORPEX on weather-related aspects, satellite agencies and numerical weather/climate prediction centres, and the global change System for Analysis, Research and Training (START) on developing-country involvement. Collaborations should also be actively pursued in applications, in particular with those involved with seasonal prediction, the other components of World Climate Programme (WCP), and the new Natural Disaster Prevention and Mitigation (DPM).

The Council emphasized that WCRP activities were fundamental for IPCC to make progress on the IPCC Fourth Assessment Report. WCRP-coordinated model evaluation and intercomparison projects were being used directly in the assessment. In particular, for the first time, WCRP had arranged for the global modelling predictions using IPCC emissions scenarios to be made available to researchers around the world, enabling the largest ever analysis of regional climate change and changes in extreme events. Also, issues raised in previous IPCC assessments had been addressed in WCRP activities, leading to improvements in climate models and the understanding of climate change.

Further points to emerge in the Council's discussion of the WCRP progress report included: recognition of the highly successful Climate and Cryosphere (CliC) First Science Conference, held at the China Meteorological Administration in Beijing in April 2005; the suggestion that a WCRP data information and management policy would be of value, especially for developing countries; the need to consider intraseasonal variability, predictability and prediction for monsoon systems; affirmation that the WCRP Climate Variability and Predictability (CLIVAR) and the Global Energy and Water Cycle Experiment (GEWEX) had endorsed the African Monsoon Multidisciplinary Analysis (AMMA) project and that the Secretary-General had designated the Director, Regional Office for Africa, assisted by the WMO Programme Manager for North, Central and West Africa, to represent WMO on the International Governing Board for AMMA.

Dr Buruhani Nyenzi, Director, World Climate Programme (WCP), WMO and representative of WMO at the session, made a statement on behalf of WMO. He congratulated Professor Ann Hendersen-Sellers on her appointment as the new Director of the WCRP and noted that her extensive experience in climatology and climate research is an assurance that the programme has knowledgeable and forward-looking leadership. He assured Professor Henderson-Sellers that WMO will assist her and provide the support needed to successfully carry out her responsibilities. Dr Nyenzi noted that WMO programmes, through expert teams, have continued to interact with various groups of WCRP that are carrying out related activities. For example, the Commission for Climatology Expert Team on Climate Change Detection and Indices has

members appointed by CLIVAR. As well, the WCRP work on Variability of the African Climate Systems (VACS) is jointly carrying out some activities with the WCP/Climate Information and Prediction Services (CLIPS) project. The VACS activity AMMA is addressing monitoring and prediction strategies to improve studies that relate climate to health, water resources, food security and demography for West African Nations. WMO looks forward to continued and improved collaboration in implementing these and other related activities.

It is important to note that the WMO EC-LVII endorsed the new WCRP strategy COPES, thus recognizing the need for close collaboration with other climate research activities. These including the WCP and the new WMO Natural Disaster Prevention and Mitigation programme, and emphasized that WCRP activities were fundamental for the IPCC assessment reports.

Furthermore, recently the WMO Executive Council Advisory Group on Climate and Environment (EC-AGCE) met in Geneva to review implementation of various climate related activities as recommended by the previous session of the EC. The Director of WCRP briefed the group on the WCRP activities. The meeting noted with appreciation the various initiatives being implemented by the WCRP and the activities in support of the new WCRP strategy. In this regard, the group was pleased to note that the Director's vision is to link the research work of WCRP to benefit various stakeholders, especially, the operational work of National Meteorological and Hydrological Services. This is a very important aspect from WMO's point of view.

Currently, WMO is in the process of strengthening coordination among climate activities. Through this coordination, it is expected to encourage joint implementation of certain activities by the core programmes of the secretariat that are carrying out climate related activities, that is, IPCC, WCRP, GCOS and WCP. Such joint initiatives would include conferences, meetings and participation at UNFCCC Sessions. Furthermore, the Commission of Climatology through WCP welcomes the ESSP conference, which is co-sponsored by WCRP and will urge its members to contribute papers and posters, especially on health and food security climate related topics. More important, it is also planned to improve internal communication between the core WMO climate programmes and externally with other bodies. It is intended that these joint activities will strengthen, not undermine or duplicate each programme's mandate.

The JSC thanked Dr Nyenzi for his statement. The JSC was pleased to note WMO's continuing strong support for WCRP and the strengthening links with other WMO programmes, including components of the World Climate Programme, and the Atmospheric Research and Environment Programme, in particular, THORPEX. JSC was informed of planning for World Climate Conference-3 in 2008 (or 2009). JSC should define at an early opportunity what it might wish to see as an outcome of the World Climate Conference–3. JSC was informed of the UN Declaration of 2008 as the International Year of Planet Earth. WCRP agreed to pursue both of these opportunities.

3.2 International Council for Science (ICSU)

Professor T. Rosswall, Executive Director, ICSU, represented on behalf of ICSU. His presentation was made in the joint session with IGBP-SC (see section 12.5).

3.3 Intergovernmental Oceanographic Commission (IOC)

The IOC representatives Drs M. Hood and U. Umlouta were unable to attend. The JSC considered the Discussion Document on Climate Impacts on the Marine Environment submitted by IOC.

At the 23rd IOC Assembly held this June 2005, the issue of WCRP support and engagement was put on the agenda in order to re-establish Member States' interest in the programme, and to have this interest reflected in the programme and budget priorities.

One of the outcomes of this discussion was that the Member States expressed concern over the small IOC Regular Program contribution to WCRP, emphasizing that a stable commitment cannot be achieved through unreliable extra-budgetary funds. The Member States also expressed concern that the IOC community has not been as engaged as it should be in the WCRP.

The following statement is the decision on WCRP from the 23rd Session of the IOC Assembly: "*The Assembly reaffirmed its continued co-sponsorship and its support of the WCRP. The Assembly instructed the Executive Secretary to find ways to support the WCRP at a proposed level of at least US $125,000 per year through Regular Program funds. The Assembly urged Member States to redouble their efforts to contribute to the IOC Special Trust Fund for the WCRP.*"

Along with this new commitment to regular programme budget support, the IOC is committed to re-engaging in WCRP activities and to improving the visibility and direct communication between WCRP and the IOC Member States.

Following the advice of the IOC Advisory Group to the Ocean Sciences Section, several IOC Officers have agreed to pursue the possibility of putting WCRP programmes and activities back on the agenda of the IOC Assembly, where, normally, only issues requiring a decision or resolution of the Assembly are discussed. The IOC will keep the WCRP secretariat informed of any follow-up of these issues.

IOC Needs

As part of IOC's commitment to re-engaging in the WCRP as a sponsor, the IOC was asked to consider the Member States' needs for ocean climate research, and to determine if those needs were being fully met. IOC Member States, when taken as a whole, have an interest in climate issues close to home. They also need clear, unbiased information about climate issues adapted to their regions and concerns.

One theme that encompasses these concerns is that of Climate Impacts in the Marine Environment – issues such as climate and climate-change driven alterations to sea level rise, circulation patterns, storm intensity and frequency, regulation of atmospheric CO_2, ocean acidification, perturbations to the marine ecosystem and fisheries, and biodiversity. To stimulate discussion at JSC 27, the IOC secretariat prepared a discussion document on Climate Impacts in the Marine Environment, outlining some of the major impacts and societal questions that need to be addressed. This document is not a complete or comprehensive overview of the subject, but rather a mechanism to stimulate further discussion on these issues.

There are already a number of research programmes at national, regional and global levels dealing with specific aspects of climate drivers or climate impacts. However, there may be a need for a more comprehensive approach to focus these individual lines of research around these themes, and there is almost certainly a need for better, clearer and more regular communication about these issues to governments and the general public from authoritative and unbiased sources.

In order to determine if there are needs for better coordination and communication, we need to:

- Identify current research programmes on climate drivers and impacts in the marine environment at national, regional, and global levels;
- Identify gaps in research surrounding these issues;
- Identify the needs of national programmes for international coordination or partnerships;
- Determine a way forward for facilitating any needed research, coordination, and development of communication activities.

IOC would like to ask the WCRP to consider ways it may assist in addressing these concerns.

JSC was pleased to note the strong supportive statement from IOC, and also its request to WCRP to engage with it more closely. JSC needs to be more active in consideration of climate of the ocean and its impacts. As a first step CLIVAR was asked to liaise with IOC in planning the PICES / ICES / IOC symposium "Effects of Climate Change on the World's Oceans", to be held in Gijon, Spain, in May 2008.

4. THE WCRP STRATEGIC FRAMEWORK 2005-2015: COORDINATED OBSERVATION AND PREDICTION OF THE EARTH SYSTEM

4.1 Report on the WCRP Workshop on understanding Sea-Level Rise and Variability

Dr J. Church made a presentation on the WCRP Workshop on understanding Sea-Level Rise and Variability in support of the Coordinated Observation and Prediction of the Earth System (COPES) and a WCRP contribution to the Global Earth Observation System of Systems (GEOSS). The Workshop will be held in Paris, 6-9 June 2006. Preparations for the Workshop were progressing well. The organizers have attempted to maintain a workshop rather than allow it to drift into a mini-conference. To accomplish this, there will be an introductory half-day followed be a series of plenary sessions focused on the following topics:

- What have we learned from the Paleo/Historical Records?
- 20th Century Sea-level Rise and Variability Estimates from Tide Gauges and Altimeters
- Ocean Thermal Expansion
- Contributions from the Cryosphere to Sea-level Change
- Reference Frames of Sea Level Observations
- Responses to Changes in Surface Mass Loading
- Terrestrial Water Storage

- Past and Future Changes in Extreme Sea Levels and Waves
- Summary and Integration session

Outputs of the Workshop:

Originally it was planned to have a full report from the workshop as a WCRP Report (including the finalized position papers, a summary and recommendations, abstracts for posters and a CD/DVD with the full poster pdf-files) and a smaller summary report. However, the National Academy of Sciences produced in 1990 a book on Sea-level Change; it reports on a similar sea level workshop. It is clear that there has been much progress since then and the possibility of getting the report published as a book is being considered.

A summary report for EOS or similar newsletters will be prepared and possibly a manuscript for a major scientific journal will be considered.

Following the Workshop there is likely to be a briefing of Permanent Representatives to UNESCO and IOC and possibly an associated press release.

The possibility of briefing the IOC Executive Council on the results of the Workshop is also being considered.

The workshop is well in hand with no major issues. The Co-Chairs of the Science Steering Committee of the workshop would welcome the JSC members' views on the value of producing a peer-reviewed book instead of/as well as a WCRP Report. The JSC was requested to:(i) note the progress on the workshop to bring together all relevant WCRP science on sea-level rise with a view to identifying uncertainties and proposals for narrowing these uncertainties; (ii) express their views on the appropriate type of report they would like to see result from the workshop; and raise any other issues of relevance.

The JSC thanked Dr J. Church for the brief on the Workshop preparations. JSC was pleased to note that preparations were progressing well and that the possibility of getting the Workshop report published as a book was being considered.

4.2 WCRP Observations and Assimilation Panel (WOAP)

Dr K. Trenberth, chair, WOAP, made a presentation of WOAP activities. The First meeting of WOAP was held at GISS, New York, 1-3 June 2005, at the invitation of Dr W. Rossow. Topics covered include the Terms of Reference and the domains implied, the scope of WOAP, the management issues and the timetable. All presentations are available on the WOAP web site:
http://copes.ipsl.jussieu.fr/Organization/COPESStructure/WGOA.html

In the discussion it was mainly emphasized that the new WCRP panel structure with WOAP and WMP is laid down to prevent duplication of projects within WCRP and to facilitate connections and synergies, respectively, for observational and modelling aspects. There is a risk of overlap between GCOS and WOAP, and the presence of the three GCOS panel chairs is welcome in order to help delineate their respective domains of action. The GCOS implementation plan will be used as a reference document for the definition of WOAP activities. WOAP will have to help define observational requirements for WCRP.

The terms of reference of WOAP were adopted with a minor change (§a. *to identify* instead of *to define*), in order to clearly delineate the border between GCOS and WCRP.

Terms of reference for the WOAP are:

a. to identify observational requirements for climate system analysis and prediction and assist in optimization of observational strategies for sustained observation and to act as a focal point for WCRP interactions with other groups and programmes
b. to promote and coordinate synthesis of global observations from the atmosphere, oceans, land and cryosphere, and for the fully-coupled system, through analysis, reanalysis and assimilation activities across WCRP, including the Modelling Panel;
c. to promote and coordinate WCRP information and data management activities, including development of web sites, in liaison with WCRP projects.

GEO

Following an update on GEOSS activities, the discussion recommended that efforts be made to include WCRP priorities in the 2006-2007 GEO workplan. The need to include continuity of WCRP global data sets, introduce reanalyses coordination and reprocessing projects in 2-year tasks was expressed by the

committee. Under GEOSS there seem to be opportunities, if known about, to make proposals. Hence, there is an action on the GEOSS and WCRP representatives to keep projects informed about proposals and possible opportunities. This has been done and is continuing. WCRP has also actively participated in the preparation of 2005 and 2006 GEO work plans.

GCOS

Following briefing from chairs of AOPC, OOPC, and TOPC, a one page summary of issues for WOAP was prepared: these issues include how to ensure WOAP-GCOS coordination without overlap and what to expect from WCRP with respect to implementation of the GCOS plan (GCOS IP).

Reanalyses

There is a need for WCRP to establish a clearinghouse for reanalyses (built on CLIVAR material), and also to develop the strategy of staggering analyses, how to advocate it, and how to progress in building the basic dataset (given additions and ongoing development, plus results from reanalyses).The outstanding issue for reanalysis was identified as the continually changing database, as well as changes that disrupt the climate record:

- There is no baseline reference network to anchor the data
- Radiosondes improve and change type over time
- Satellites started in 1979, last of the order of 5 years, drift in orbit, change instruments, calibration
- Bias corrections are applied but remain imperfect
- Continuity is a key issue, especially for climate change
- Further technological development, change and improvement is expected
- A major challenge is to deal with changing observations

A reanalysis task group prepared a short document on rationale for reanalyses and this was posted on the WOAP web site. This summarizes the merits of reanalyses (not just atmospheric) as an essential part of the observing system, and the benefits to be gained from ongoing activities (including avoiding stop-start and loss of personnel). This includes the need to exploit new data (such as ocean ARGO observations) in order to make them into useful products. This is followed by a greater focus on atmospheric reanalyses and coordination of their scheduling, as well as staggering of activities across the 3 major groups involved (EC, US, JMA), especially the development of the basic data and improvements in homogeneity. This document can be used to promote the reanalyses, in justifying a workshop and conference, and in furthering activities, for example in the USA.

In addition, Dr A. Simmons volunteered to explore a proposal for a reanalysis workshop to be tentatively held at ECMWF at the end of June to the beginning of July 2006. This should lead to a WCRP policy and a letter sent to major potential reanalysis centres. This workshop is now planned, although details are still being developed. Furthermore, WOAP discussed the next international reanalysis conference. A proposal to hold the next major reanalysis conference in Japan was passed on by Professor T. Koike and JMA has officially accepted to host it in the third quarter of 2007. This conference, under the auspices of WCRP and WGNE, should embrace ocean and coupled reanalysis, with a specific session on the second subject.

Reprocessing

Following several presentations on issues with datasets, especially those from satellites, it became evident that reprocessing of many satellite-based datasets was needed and timely. A set of principles for when reprocessing is appropriate owing to both identified problems and fixes or advances has been developed. A reprocessing task group was asked to query each WCRP project concerning variables suitable for reprocessing in terms of both need and readiness, and commitments. They will make a proposal of principles, to be circulated within the panel. This topic has now been included in the GEO 2006 work plan and an exchange of letters with space agencies via the Committee on Earth Observation Satellites (CEOS) emphasized a recommendation to support this activity.

Coordinated Enhanced Observing Period (CEOP)

WOAP undertook a partial review of CEOP and Professor T. Koike provided a presentation of the Phase 1 experiment which displayed impressive results. CEOP, initiated by GEWEX, has evolved and come a long way but the evolution may have created some disconnects within the WCRP framework. It is the first COPES observation-oriented project and represents a prototype for a climate data management system. Presentation of scientific objectives for Phase 2 revealed a research phase 2005-2006, and an observation phase 2007-2010. Phase 2 proposes an extension of initial CEOP objectives in areas where some activities are already going on within WCRP. This is an opportunity to fix any disconnects. In particular, it is necessary to avoid duplication of efforts in the following areas: aerosols (GEWEX Radiation Panel (GRP)); watershed

hydrology (GEWEX Hydrometeorology Panel (GHP)), monsoon studies (pan WCRP, CLIVAR, GEWEX), and model analysis intercomparison projects (WGNE). The panel noted the strong involvement and support from CEOS and that major CEOP aspects are embedded in the GEO plan, as part of the water resources societal benefit area. This implies transition to operations. Because CEOP is a research programme, it develops prototypes, and CEOP is urged to think about the legacy it will leave behind or how it transfers the technology to operational or ongoing programmes. A CEOP task group was established to formulate a summary and commentary on potential overlap, and recommendations for how to ensure better integration of CEOP within WCRP. This report was written and disseminated, and discussed at the OCD meeting in October 2005. Phase 2 objectives were further reviewed at the GEWEX SSG session, January 2006.

Data Assimilation

A task group on assimilation was set up and asked to write short report on issues to be taken up by WOAP. The written report is posted on the WOAP web site. Specific recommendations are to:

(i) Foster GSOP/CliC ocean and sea ice assimilation as a contribution toward the IPY (especially with respect to ice thickness and other characteristics);

(ii) Foster CliC, GEWEX and TOPC interactions on water cycle parameters including subgrid water surfaces (lakes), and address how to provide a focus on cryosphere parameters including snow cover and permafrost (possibility of a cryosphere assimilation workshop?)

(iii) Request that the project representatives report back at the next meeting.

THORPEX

Concern was expressed that any targetted or adaptive observation strategy may deteriorate the continuity of climate observations, and WOAP recommends maintaining the observing system for climate. Professor Shukla represents WOAP concerns and interests in climate observations within the THORPEX scientific steering group.

Data Management (DM) in WCRP

DM should be a fundamental part of any activity, not an afterthought. WOAP examined several web sites of WCRP projects and sub-projects for DM policy and visibility. Dr K. Knapp (National Climatic Data Centre, NCDC) described NCDC data activities. A data management task group will review existing WCRP web structure and sites, and make recommendations for WCRP-wide over-arching structure and site contents. It will also propose a data policy for WCRP based on existing project documents. After final comments by projects, such a policy will be adopted (WOAP secretariat will help in the process).

Letter to CEOS

A letter was sent on 30 June 2005 signed by Professor P. Lemke, on the need to exploit existing satellite data and to continue observational streams, to CEOS members and GEO co-chairs. This letter noted:

a) need for *continuity* of established capabilities;
b) need for *continuity* and *homogeneity* of observations for climate purposes;
c) need for more attention to data synthesis, *reprocessing*, analysis and *re-analysis* of existing data sets; and
d) recognition of the need for a complementary *in situ* observation strategy.

A response was received from CEOS on 15 August 2005 but was not satisfactory. Individual responses (i) from NASA missed the point and emphasized the great single missions occurring, which WCRP recognizes and is thankful for; (ii) from Japan Aerospace Exploration Agency (JAXA) simply referred to the GCOS IP; and (iii) from EUMETSAT did recognize the issues but suggested WCRP needed to set priorities. In fact, the letter was an attempt to sharpen the priorities in the GCOS IP on the need for continuity, reprocessing, reanalysis and establishing of climate data records, and to identify specific needs of the research community. This was subsequently taken up with Dr J. Kaye, NASA, at the NRC meeting in October in Washington, DC, who did recognize the inadequacy of the NASA response, and also at the EUMETSAT meeting in Nuremberg in September 2005, and again at the GCOS meeting in Geneva in January 2006. In addition, CEOS invited WCRP to reflect further on the benefits for research and for societal applications expected from the improvements of the climate observing system.

NRC meeting, October 2005, Washington, D.C.

The chair gave a WOAP/COPES presentation to the Climate Research Committee and participated in discussions with US program managers.

WMP meeting, October 2005, UK Met Office

The chair participated in the WMP and joint WMP WGCM sessions and gave WOAP presentations in each.

List of Task Groups

Reanalyses: Drs A. Simmons, D. Stammer, G. Flato
Reprocessing: Drs G. Duchossois, W. Rossow, A. Belward, G. Sommeria
CEOP: Drs Manton, A. Belward, E. Kent, W. Rossow, G.Flato, (Polavarapu)
Data assimilation: Drs A. Lorenc, J. Key, D. Stammer, A. Simmons
Data management: Drs T. Koike, Ed Harrison, W. Rossow

The next meeting will be held on 28-30 August 2006 in Ispra, Italy, kindly hosted by Dr A. Belward and the Joint Research Centre (JRC).

Issues for the JSC

i) To increase the visibility of WCRP, WOAP strongly recommends to JSC and WCRP that a much stronger presence on the Internet should be established for all projects, in a linked and coordinated way. This includes the WCRP web pages and the links to projects and working groups. This will likely require substantial centralized resources and time. Special topics to be featured include: activities, meetings, reports, newsletters, access to datasets (observational and model), data management, IPCC links, ESSP links, and so on.

ii) The WOAP cross-cutting links to the projects are through promotion and improvement of datasets, reprocessing and reanalysis, and interactions with the GCOS panels and GEO. One specific data issue is the sharing of high frequency data (e.g., hourly precipitation), in order to improve analysis and forecast of extreme events. This permits improved analysis of extreme events and how they are changing. The projects should take note of WOAP recommendations and task their representatives accordingly.

iii) JSC is invited to take note of and comment on the activities of WOAP.

The JSC thanked Dr K. Trenberth for his presentation. The JSC noted with appreciation the initial steps taken by WOAP for the coordination of global reanalyses and of the preparatory activities for the reprocessing of global data sets. The JSC was informed about the upcoming Workshop on Reanalysis at ECMWF in June 2006 and approved the plans to organize a major International Reanalysis Conference hosted by the Japanese Meteorological Agency in the fall of 2007. The JSC endorsed the recommendations of WOAP to improve the presence of WCRP projects on the internet, including easy access to and adequate information on available datasets. It supported WOAP's effort to define a research strategy for data assimilation in climate models. In order to ensure the efficiency of WOAP's coordination role, JSC reaffirmed the importance of the relay of WOAP's recommendations to projects and of a good follow up of actions in preparation for next meeting scheduled at JRC-Ispra, Italy, 28-30 August 2006. The JSC also commended the WOAP for taking the lead on recommending a way forward on CEOP with regard to the WCRP, and also for the letter stating the WCRP position on satellite observations to CEOS. The JSC noted that a response to the CEOS reply is being coordinated through GCOS.

The JSC urged projects to encourage the sharing of high frequency data for the analysis of extreme events and how they are changing.

4.3 WCRP Modelling Panel (WMP)

Professor J. Shukla, Chair, WMP, presented the activities of WMP in the period since the last JSC session.

First meeting of the WCRP Modelling Panel

The first meeting of WMP was held at the UK Met Office, Exeter (5-7 October, 2005). The meeting was highly stimulating as the panel debated some of the most important questions facing the modelling community. On October 5, WMP and WGCM had a joint session for a half-day, which included presentations from WGNE, AMIP, TFSP, WGSIP and GMPP. Comprehensive papers by Drs J. Kinter and M. Wehner (Computing Issues), J. Kinter and K Taylor (Data Issues), T Palmer (Computing Requirements), M. Miller

(High Resolution Models), and M. Shapiro and J. Shukla (Unified Models) are available on the WMP website http://copes.ipsl.jussieu.fr/Organization/COPESStructure/ModellingPanel.html.

Since the aim of the new Strategic Framework (COPES) is to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society, WMP will focus on those modelling and prediction activities that will have practical applications for the benefit of society. WMP will also coordinate WCRP-wide modelling activities to enhance the ability of the existing modelling panels to accomplish the ultimate goal of COPES, which is to facilitate prediction of weather and climate variability for the benefit of society, and, to advance the understanding of weather and climate science. WMP will coordinate international activities in common modelling infrastructure, and management of WCRP-wide modelling data sets.

Terms of Reference

The terms of reference of WMP were adopted. These are:

- to coordinate modelling activities across WCRP and facilitate collaborations where appropriate;
- to focus on the prediction and projection aspects of COPES and effective use of coupled models for identification of climate system predictability;
- to act as a focus for the development of new generation models;
- to liaise closely with the WCRP Observations and Assimilation Panel
- to oversee data management in WCRP modelling activities;
- to coordinate international efforts to move to a common modelling infrastructure;
- to liaise with the modelling activities of IGBP, IHDP and THORPEX.

The WMP will report to the JSC.

List of WCRP Modelling Groups (arranged according to time scale).

1. Weather Prediction (1-10 days):	WGNE
2. Intra-Seasonal Prediction (1-30 days):	WGNE, GMPP, TFSP
3. Seasonal Prediction (1-100 days):	WGSIP, TFSP, GMPP, CliC, SPARC, WGOMD
4. Interannual Prediction (1-1,000 days):	WGOMD, WGSIP, TFSP, WGCM
5. Decadal Prediction (1-10,000 days):	WGCM, WGOMD
6. Climate Change (1-100,000 days):	WGCM

Major questions

Major questions relevant to WMP and WCRP discussed at the meeting are briefly summarized below:

Causes of model errors.

What are the main causes of models' inability to simulate the current climate realistically? resolution? parameterization? insufficient understanding?

Evaluation and validation of models

A large effort is required to build and operate computing facilities and develop and integrate models, post-process and archive data sets. Is there a corresponding appropriate level of effort to diagnose, evaluate and validate the models?

High Resolution versus Low Resolution Models

During the past 30 years, computing power has increased about one million fold. However, most of this power has gone towards integrating low resolution "cyclone resolving" models for hundreds and thousands of ensembles and years. It is easy and straightforward to make runs with low-resolution models than to build high resolution "cloud system" resolving models. Should WCRP initiate a discussion within the modelling community to define an optimum strategy for utilization of computing resources for cloud-system resolving high resolution models for predicting regional weather and climate variations, and cyclone-resolving low resolution models for understanding the mechanisms of climate variability?

Computing power

Is the lack of sufficient computing power an obstacle in making advances in modelling and prediction?

Resolution

If a model cannot describe or simulate a given phenomenon, it cannot predict its behaviour. The state of technology puts a constraint on the highest possible resolution models that can be utilized for seamless prediction of weather and climate. The dominant role of tropical convection in determining global climate variability at all time scales clearly suggests that one of the major challenges for meeting the goals of COPES is to improve the treatment of tropical convection. Since cloud resolving global models of about 1km spatial resolution are not possible because of the constraints of computer technology, should coordinated modelling efforts be initiated to build cloud system resolving models with 3-5 km resolution?

What is the optimum resolution of models that can provide societally relevant predictions of extreme events?

Utilization of space observations

Can substantially enhanced efforts in building high resolution models and data assimilation systems help realize more value from space and in-situ measurements, which are made at a cost of billions of dollars?

Seamless prediction of weather and climate

The traditional boundaries between weather and climate are somewhat artificial and a unified approach should be adopted to produce a seamless prediction of weather and climate variations. Predictions of daily, monthly, seasonal, interannual, decadal and longer variations should adopt, to the extent possible, a unified approach to initialize the models of the atmosphere, ocean, biosphere and cryosphere. This means that a coordinated modelling effort should be initiated to extend the NWP models from days to seasons, and climate models should be subjected to data assimilation and NWP. Can weather prediction models be expanded to predict seasonal interannual and decadal variations? Can climate models be subjected to data assimilation and prediction of weather and short-term climate variations?

Realism versus Complexity

If a physical climate system model cannot simulate reasonably well the space time structure of the climate system (viz, rainfall in the tropical forests, the ITCZ and monsoon regions; the absence of rainfall over deserts etc.), is it necessary to improve the simulation of the mean climate before introducing complex biological and chemical processes in the physical climate system model? A coordinated discussion within the modelling community is required to determine the best strategy for advancing the skill of seamless prediction of weather, climate and other Earth-system processes. Since models with increased complexity are required to be integrated for a longer period of time, the introduction of additional complexity can consume a large fraction of computing resources without advancing the skill of societally relevant predictions. How to utilize the computing resources optimally to improve models and introduce complexity?

Limits of Parameterizability

Cyclone resolving models with parameterizations for deep moist convection have played a major role in improving the skill of NWP and advancing our understanding of the mechanisms of climate variability and its predictability. However, it is becoming increasingly clear that differences in parameterizations of physical processes are a major factor in determining the predictability of climate. This is especially true for seasonal predictability, which is highly sensitive to parameterizations of deep moist convection, and anthropogenically forced climate change, which is highly sensitive to cloud-radiation parameterizations. Should WCRP initiate coordinated modelling experiments with high-resolution models that do not require explicit parameterization of deep moist convection? It should be noted, however, there will always be a need to parameterize some processes such as shallow convection, boundary larger turbulence and cloud microphysics.

Scientific Justification for Enhanced Computing

(From a paper by T. Palmer)

Computing requirements for climate prediction can be delineated into the four "dimensions":

1) Earth-system complexity
2) Long-timescale integrations
3) Ensemble prediction
4) Horizontal and vertical resolution

Murphy et al. (2004; Nature, 768-772) show a distribution of climate sensitivity estimates from ensemble members generated by perturbing parameters in the underlying climate model (HADCM3), parameters that were deemed, by parameterization experts, as especially uncertain. Most of the perturbations were applied to parameters associated with "fast" physics, that is to say, to clouds, convection,

boundary-layer mixing and the like. In particular, since the ensemble integrations were not made using an Earth-System model, no account was taken of uncertainties in bio-geochemical feedbacks that will broaden the distribution further.

The breadth of the distribution was somewhat alarming, and was rather greater than the spread of IPCC models, e.g. as reported in the Third Assessment Report (TAR). Although none of the ensemble members warm less than those in TAR, a significant number warm more than the TAR range. If some of the more extreme forecasts were to be verified, there would be little doubt that the major ice caps of the world would melt, with catastrophic increases in sea level, leading to the forced displacement of a substantial fraction of the human population. Even though uncertainty in predictions of climate change is inevitable, there can hardly be a more important problem for than that of reducing uncertainty, not least to quantify better the likelihood of these more extreme climate responses.

It has been argued that higher resolution will lead to a reduction in uncertainty in climate change. This is particularly so because deep convection can be simulated rather than parameterized, and the higher the resolution, better the observational constraints on the model simulations. It is therefore recommended that the community make the strongest possible case for substantially-enhanced computer resources. Clearly this will be of value for exploring better all four of the climate dimensions, but, in particular, it will be of special value in allowing us to apply more of the known laws of physics to the climate-change problem, a problem which many politicians recognise as being the most important problem facing humanity as a whole in the coming century.

Next Generation Models

Based on discussion at the JSC meeting (2004, Ecuador) and the THORPEX meeting (2005, Melbourne), WCRP and THORPEX will prepare a joint paper on the grand challenge of establishing a multi-national coordinated research initiative to develop next-generation unified models for prediction of weather and climate. JSC will be asked to recommend an appropriate strategy to go forward including possible institutional arrangements for such a global endeavour. For example, should the world community collaborate to establish a single global effort or several distributed multi-national efforts?

A draft Executive Summary of the proposed White Paper is given here:

Executive Summary

It is the opinion of the global scientific community that there is a great potential to realize major advances in the skill of weather and climate forecasts and in their use and benefit to socio-economic planners, natural-hazard managers and environmental policy makers of global societies. This potential has arisen as the result of recent advances in physical, biological, geochemical and socio-economic sciences, Earth observations and computer technology. It is recognized that the scientific and technological infrastructure required to achieve this potential resides in no one nation. Therefore, this paper proposes the initiation of a multinational endeavour to design and implement a global research effort to advance the skill and utilisation of weather and climate forecasts.

This document is based upon contributions from leading scientists within the weather, climate, Earth-system and socio-economic science communities. It describes recent advances in modelling and prediction of weather, climate and complex Earth-systems, and the opportunities for further advancement. It identifies the benefits to be derived from a unified multi-national and multi-disciplinary approach, and summarizes the research, computational and the human resource requirements necessary to achieve these advances. The document is intended to inform heads of state, national weather and climate prediction centres, national academies of science and their academic research constituency, and users of weather and climate information, of the extraordinary benefits to be derived from a unified and concerted multi-national approach to the prediction of weather, climate and its interactions with the complex Earth system.

Important ingredients of this effort will include:

- *An international institutional framework for the design and implementation of a unified approach toward weather, climate, Earth-system and societal-economic research* that encompasses modelling, data assimilation and data management. This includes setting requirements for model-data synthesis and retrospective analysis of weather, climate and complex Earth-system observations, predictions and societal impact applications.

- *Development of high-resolution models of the atmosphere, ocean, land and biogeochemical processes* for data assimilation and seamless prediction of weather and climate and its interaction with the complex Earth system. The computational resolution of the models must be consistent with the spatial scale of the societal applications.

- *The development of high-resolution global and regional data-assimilation systems* that enhance the utility of the full spatial and temporal resolution of observations from space, land and ice surfaces and oceans. This multi-sensor observing system is used for the analysis, prediction and monitoring of weather, climate and biogeochemical properties of the Earth system. This effort will contribute to the design of Global Earth Observing System of Systems (GEOSS) that satisfies the observational requirements spanning short-term weather warnings, numerical forecasts from days to decades, and the prediction and assessment of climate variability and change.

- *Enhancement of supercomputing capability* for weather, climate and Earth System research by about a million fold within the next 10 years. This is a critical requirement for achieving the proposed advances in the utilization of Earth observations and prediction on all time scales.

- *Field campaigns* to advance knowledge of the modes of regional and global weather and climate variability, and to improve and evaluate the parameterizations of physical processes in weather and climate models.

- *Cooperation and collaboration among the scientific community* that generates weather and climate forecast products, public and private users of products and services, and policy makers and decision makers.

Issues for the JSC:

(i) Reorganization of WCRP Modelling

The JSC should initiate a comprehensive discussion on the organization of its activities. In particular, JSC should conduct a review of the scope and the goals of WGNE and WGCM in the context of COPES, and its underlying theme of seamless prediction of weather and climate.

The existence of two groups in WCRP, one for weather (WGNE) and the other for climate (WGCM), seems to be inconsistent with the new WCRP strategy of seamless prediction of weather and climate.

For a successful implementation of the WCRP strategy, it may be more appropriate to have one working group for assimilation and prediction *at all times scales* (initialization of atmosphere for NWP, upper ocean for ENSO, and deeper ocean for "initial value" prediction of decadal variations); and another working group for model development and numerical experimentation for all time scales. It is eminently sensible to assume that coordinated numerical experimentation (including sensitivity and predictability studies) for seasonal, interannual and decadal time scales are mutually beneficial to all time scales.

(ii) Institutional Infrastructure for WCRP Modelling (White Paper)

WCRP/COPES and CAS/THORPEX have launched the concept of multi-national joint efforts to build the next generation of unified models for seamless prediction of weather and climate. JSC should recommend an appropriate strategy to go forward including possible institutional arrangements. For example, should there be a single global collaborative effort, or should there be several multi-national regional efforts (for example one for North and South America; one for Europe, Africa, Russia and neighbouring countries; and one for India, China, Japan, Australia and neighbouring countries)?

The JSC thanked Professor Shukla for his presentation. The JSC noted the joint efforts of WMP and THORPEX to prepare a joint white paper on the grand challenge of establishing a multi-national coordinated research initiative to develop next-generation unified models for prediction of weather and climate. The JSC encouraged the THORPEX and WMP leaders to develop an appropriate strategy to go forward including possible institutional arrangements for such an endeavour, the need for computing power and data management strategies. The JSC debated intensely on the central issue of seamless prediction. The JSC encouraged working groups and projects to interact with WMP in order to unify our stand and move forward.

4.4 Report of the WCRP COPES Task Force on Seasonal Prediction (TFSP)

Professor B. Kirtman, Chair, TFSP, presented the activities of TFSP.

Joint TFSP-WGSIP-THORPEX Workshop August 2005

A second joint TFSP-WGSIP-THORPEX workshop was held at ICTP in August 2005. The purpose of the workshop was:

(a) To finalize the details of the seasonal prediction experiment and formulate the implementation of the experiment
(b) To develop a strategy for sharing the seasonal prediction data
(c) To establish linkages with the THORPEX community for sharing of real-time seasonal prediction data
(d) To coordinate with the ENSEMBLES and APCC activities
(e) To draft documents/letters announcing the seasonal prediction experiment
(f) To start planning a climate community wide seasonal prediction workshop for the middle of 2007. The workshop will necessarily include strong participation from the applications community

The main outcomes of the workshop include:

(a) A revision of the experimental design to include two levels of participation. The first level constitutes the minimum level of participation, that is, seasonal retrospective forecasts initialized from 1979-present four times a year (February, May, August and November). Each retrospective forecast is run for 7 months so that two full season leads can be assessed. The second level of participation includes two different directions for expansion of the experimental design. The first direction of expansion of the experimental design is to include each month of each year in the 1979-present retrospective forecast experiment. The intent of this expansion is to better interface with the operational seasonal prediction community. The second direction is to add additional years (1960-present) to the retrospective forecasts. This aligns the TFSP experiment and the ENSEMBLES project.
(b) Finalized list of data to be saved.
(c) A strategy for the sharing of both the retrospective forecast data and in collaboration with THORPEX the sharing of real-time data.
(d) Draft letter to be sent by the JSC chairperson announcing the TFSP experiment and inviting international participation. The letter includes web links for the experimental design and the data distribution strategy.
(e) A strategy for workshops to assess the seasonal prediction experiments.

Seasonal Prediction Experiments

The Total Climate System Prediction Experiment

The TFSP proposes a comprehensive seasonal prediction experiment that is designed to test the following hypothesis:

> *There is currently untapped coupled predictability due to interactions and memory associated with all the elements of the climate system (Atmosphere-Ocean-Land-Ice).*

The core experiment is an 'Interactive Atmosphere-Ocean-Land-Ice Prediction Experiment' emphasizing the use of a comprehensive coupled general circulation model that includes realistic interactions among the component models. The experiment is to perform seven-month lead ensemble (10-members) predictions of the total climate system. If possible, longer leads and larger ensembles are encouraged. The initialization strategy is to use the best available observations of all the components of the climate system.

While the emphasis in on comprehensive coupled general circulation models, uncoupled component, intermediate, simplified and statistical models are encouraged to participate where appropriate. The fundamental experimental design is to mimic real prediction in the sense that no "future" information can be used after the forecast is initialized. For example, the DEMETER or DSP experiments would be excluded because they use observed SST as the simulation evolves, whereas the SMIP/HFP experiment could be included as a subset since no future information is used as the forecast evolves.

The component models should be interactive, but this is left open to encourage a wider participation, e.g. for groups without sea-ice or vegetation model. The only requirement is that no "future" information is

used once the prediction is initialized This requirement necessarily includes any tuning or training for either the component models or the development of statistical prediction schemes.

Thus, the component models are:

- Ocean – Open but interactive (e.g., slab mixed layer or GCM)
- Atmosphere – Open but interactive, most likely a GCM
- Land – Open but interactive, e.g. SSiB, Mosaic, BATS, CLM, Bucket ...
- Ice – Open but interactive (e.g., thermodynamic or dynamic)

The results of these experiments provide a framework for future experiments, specifically these prediction results will:

(i) Provide a baseline assessment of our seasonal prediction capabilities using the best available models of the climate system and data for initialisation.
(ii) Provide a framework for assessing of current and planned observing systems, and a test bed for integrating process studies and field campaigns into model improvements
(iii) Provide an experimental framework for focused research on how various components of the climate system interact and affect one another
(iv) Provide a test bed for evaluating IPCC class models in seasonal prediction mode

The TFSP recognizes that certain elements of the proposed experiment are already part of various WCRP activities. The intent here is to leverage these ongoing activities and to coordinate and synthesize these activities into a focused seasonal prediction experiment that incorporates all elements of the climate system. These experiments are the first necessary steps in developing seamless weekly-to-decadal prediction of the complete climate system. The parameters of the experiment have been set up.

Examples of Potential Diagnostic Sub-Projects

In order to maximize collaboration and duplication of effort, the proposed experiment will include a diagnostic sub-project approval process. The following is an abbreviated list of potential sub-projects. It is anticipated that a large number of addition sub-projects will be implemented as the experimental results become available.

- Limit of Predictability Estimates: One potential estimate for the limit of predictability is to determine when a particular forecast probability density function (pdf) is indistinguishable from climatological pdf of the forecasts.
- ENSO mechanism diagnostic: Recharge oscillator versus delayed oscillator, role of stochastic forcing, westerly wind events.
- Impact of the AO on seasonal predictability
- Regional predictability
  - Local land surface predictability
  - Extreme events
  - Monsoon predictability
  - Diurnal cycle in ocean
  - Diurnal cycle in the atmosphere
- Coupled Feedbacks
  - Intra-seasonal oscillations
- The diagnostic sub-projects will also include extensive interactions with the applications community and the regional panels within CLIVAR, GEWEX, SPARC and CliC. These interactions and collaborations are viewed as critical elements of the implementation plan and are strongly encouraged.

TFSP Seasonal Prediction Time-Line

- Experiment announcement from JSC March 2006.
- Experiment to be completed by March 2007
- TFSP-WGSIP-SMIP First Seasonal Prediction Workshop Mid-2007
- Second TFSP-WGSIP Workshop 2009

The JSC thanked Professor Kirtman for his presentation. The JSC noted the ongoing efforts on the design and implementation of the seasonal prediction experiment and plans for a climate community wide seasonal prediction workshop for the middle of 2007. The JSC commended the Task force on progress to date and recommended the transition of the TFSP to CLIVAR's charge after the workshop. As requested by

the TFSP Chair, JSC agreed to send letters to: (i) all relevant panel chairs and operational centres regarding project announcement including numerical experiment, assessment process and proposed workshop schedule and (ii) all JSC members to explore with their national funding agencies support to small seasonal assessment grants.

The need for a consistent definition of ENSO was emphasized. The WMO/WCP has a group looking at this issue and WCRP (CLIVAR) needs to be actively included in this activity.

In general, for all WCRP Task Forces, the JSC recommended that all TFs should be charged before beginning to define plans towards a 2-year sunset or how a transition to mainstream WCRP activities will be effected. WMP should have oversight of modelling part of all TFs' activities and WOAP oversight of observational and analysis activities and both be empowered to recommend changes to JSC.

5 CROSSCUTTING TOPICS

5.1 Monsoons: including report and recommendations of the Monsoon Workshop, June 2005

Professor T. Yasunari led the discussion on this agenda item and Drs T. Palmer and R. Lawford made presentations on this topic. For many years CLIVAR and GEWEX interests and activities related to monsoons have been converging. This has been evident in the joint planning and management of projects under the North American Monsoon Experiment (NAME), the Monsoon Experiment South America (MESA), and in the La Plata Basin (LPB) and more recently the African Monsoon Multidisciplinary Analysis (AMMA). The role of GEWEX in monsoons was further expanded with the launch of the CEOP Inter-Monsoon Model Study (CIMS). To address concerns about scientific issues as well as perceived communication and overlap issues, the JSC requested CLIVAR and GEWEX hold a pan-WCRP workshop. The workshop took place at the University of California, Irvine, from 15-17 June 2005. It addressed a number of common CLIVAR and GEWEX interests, especially in the area of monsoon modelling. At the twenty-sixth JSC meeting it was agreed that this first Pan-WCRP Workshop on the Monsoon Climate Systems should assess: 1) the current WCRP monsoon related activities and 2) the range of available observations and analyses in monsoon regions. It was also requested to propose 3) the essential elements of a pan-WCRP monsoon modelling strategy, 4) the procedures for producing this strategy and 5) the procedure for making any necessary improvements in monsoon observations and analyses with a view to their adequacy and addressing any undue redundancy or duplication. JSC also noted that the East African monsoon had still to be addressed. The recommendations arising from the workshop and the URL for the full report are given below. The following account summarizes the reactions of CLIVAR and GEWEX to the workshop and identifies issues where JSC decisions are needed.

As noted in the report on WCRP monsoon research presented at JSC-26, monsoon research is addressed through a range of activities within both CLIVAR, and GEWEX. In addition, CliC also incorporates monsoon-relevant efforts, although this is primarily limited to the role of the snow and ice cover of the Tibetan Plateau.

CLIVAR Monsoon Activities

CLIVAR monsoon activities are one of its two main regional thrusts. These activities are coordinated by monsoon panels for the three main monsoon areas including 1) the Variability of the American Monsoon System (VAMOS) Panel in the Americas, 2) the Variability of the African Climate System (VACS) Panel (covering the West African Monsoon), and 3) the Asian-Australian Monsoon Panel (AAMP).

The *Variability of the American Monsoon System (VAMOS) Panel* addresses NAME, MESA and the VAMOS Ocean Cloud Atmosphere Land Study (VOCALS). The North American Monsoon Experiment (NAME) and Monsoon Experiment for South America (MESA) have both had successful field campaigns and are in the data analysis and interpretation phase. A VOCALS field campaign is planned for late 2007. Both NAME and MESA are being undertaken as joint CLIVAR/GEWEX initiatives and the latest plans for MESA are included in the GEWEX LPB CSE.

The *Variability of the African Climate System (VACS)* activities for the monsoon are focused on the African Monsoon Multidisciplinary Analysis (AMMA) programme which is jointly sponsored by CLIVAR and GEWEX, though VACS is seeking to extend its activities to the East African Monsoon also. AMMA aims to improve understanding of the West African Monsoon (WAM) and its variability with an emphasis on daily-interannual timescales. AMMA objectives are being addressed through the international coordination of ongoing activities, basic research, and a multi-year field campaign over West Africa and the tropical Atlantic including a special observing period in spring/summer 2006. AMMA builds on existing surface hydrological

measurements available through the GEWEX CATCH project and CLIVAR Atlantic Panel observational projects over the ocean.

The *Asian-Australian Monsoon Panel (AAMP)* has concentrated to date on improving seasonal prediction skill for monsoon activities and applications of these predictions in the Indian monsoon and Indian Ocean region. Their activities focus on the MJO and its association with monsoon active/break cycles and model intercomparison studies. The joint CLIVAR/GOOS Indian Ocean Panel has also prepared a plan for sustained observations over the Indian Ocean.

GEWEX Monsoon Activities

GEWEX monsoon activities are a central component of the research under the Hydrometeorology Panel as part of five of its Continental Scale Experiments (CSEs). GEWEX focuses on observing the variability of monsoons on time scales from diurnal to interseasonal, climate variability of monsoons and modelling the role of land in the development, maintenance and decay of monsoons. CSE monsoon studies focus on regional and local processes and regional modelling and generally have strong collaboration with CLIVAR regional activities. Sensitivity studies on vegetation and soil moisture processes using regional and global models have also proved to be important for determining the nature of land processes that affect monsoons. In addition, the unique long-term global (ocean and land) data sets derived from satellite data by the GEWEX Radiation Panel (GRP) and the simulations from the Global Soil Wetness Project (GSWP) provide insights about processes in the monsoon areas. GEWEX is also planning a follow-on to the GEWEX Asian Monsoon Experiment (GAME) known as the MAHASRI Project that will address the Asia monsoon over all of East Asia. The group planning MAHASRI has invited CLIVAR AAMP participation in its deliberations.

CIMS was formed to use CEOP data to better understand the role of water and energy cycles in regional and global monsoon systems, their driving physical mechanisms and possible physical connections, with the ultimate aim towards improved predictions. CEOP provides data that it believes will help in the development of more reliable quantitative descriptions of the multi-scale energy and water cycle processes of the monsoon systems, their interactions with the surface and possible physical interconnections among the monsoon systems of the world. The CEOP monsoon initiative focuses on observational and modelling efforts in diagnostics, validation, intercomparison and predictability studies on four of the major monsoon regions around the globe: (1) Asian-Australia monsoon, (2) North American Monsoon. (3) South American Monsoon and (4) West African monsoon.

The Pan-WCRP Monsoon Workshop

As noted above, the Pan-WCRP Monsoon Workshop was an important step towards improving communications between scientists in CLIVAR and GEWEX. It identified many critical scientific issues where the efforts of both projects are needed to provide a comprehensive approach. The workshop also provided some assessment of the available observations and analyses in monsoon regions, particularly ocean observations. The workshop recommendations were less mature in the areas of procedures for producing a WCRP monsoon modelling strategy, the procedure for making any necessary improvements in monsoon observations and analyses with a view to their adequacy, and in addressing any undue redundancy or duplication.

In the view of CLIVAR and GEWEX this workshop was successful in providing a comprehensive review of the current WCRP monsoon related modelling activities and in identifying many of the essential elements of a pan-WCRP monsoon modelling strategy. However, through the follow-on actions it will be necessary to broaden the discussions from this workshop to consider the issues identified above. There was concern that remote sensing provides opportunities for monsoon studies that are not being fully exploited.

Recommendations from the Pan-WCRP Monsoon Workshop

The following recommendations emerged from the Workshop:

- Targetted workshops are envisioned as an important mode of interaction for sustaining CLIVAR and GEWEX interactions. These can be held in conjunction with existing panel meetings, as sessions at conferences, or independently.
- The near-term (1-2 years) goal is to improve the simulation of the diurnal cycle of precipitation and convection in global models by making use of regional climate models and cloud-resolving models that have more comprehensive physics. This is seen as the primary near-term goal that will crosscut the expertise of CLIVAR and GEWEX.
- Improved modelling of surface fluxes, the planetary boundary layer and clouds.

- Improved modelling of the intraseasonal oscillation, which affects large-scale convection in the tropics on a time scale of ~30-70 days. This phenomenon straddles numerical weather prediction and climate, and is a potential source of predictability that has not been realized due to its poor representation in models.
- Need for more process studies and modelling of the Maritime continent and the Indian Ocean.
- Better understanding of the atmospheric moisture distribution and transport.
- Improved representation of the planetary boundary layer, including an integrated approach to evaluating physics parameterizations and their interactions.
- Sensitivity testing to determine the resolution necessary in global models to simulate multi-scale interactions that dominate the Earth's monsoon systems.
- The simulation of the equatorial cold tongue in the Pacific Ocean, the sea surface temperature in the tropical Atlantic Ocean and the western boundary currents need to be improved.
- In the medium-term (~2-5 years) the role of land-atmosphere coupling needs to be benchmarked against observations.
- The decay of the present observing system needs to be reversed.
- Improved (and sustained) observations are needed over sparsely sampled regions of the tropical oceans, especially the Indian Ocean.
- Better observations of land surface conditions are needed (e.g., soil moisture, snow cover, snow depth) for understanding processes, and because these quantities can serve as boundary conditions for model simulations.
- The role of aerosol and dust and its impact on the development of monsoon precipitation should be investigated, though at present these may be secondary to errors in the basic structure of monsoon simulations.
- In regional climate models (RCMs), a better understanding is needed of the limitations imposed by having to specify lateral boundary conditions. Alternative nesting techniques, such as two-way nesting, need to be explored. This may help in understanding scale interactions across the different resolved spatial scales.
- The importance of air-sea interaction for modulating intraseasonal variability and for capturing the monsoon-ENSO teleconnection suggests that experiments with prescribed sea surface temperature and two-tiered forecasts of monsoon rainfall requires an interactive ocean.

Barriers to Progress

- The decay of the observational network needs to be reversed, and expanded into regions where observations are scant.
- Raise the profile of model and parameterization development. This calls for a sustained funding commitment from agencies.
- Lack of adequate computer facilities for the sensitivity testing to understand complex processes and their feedbacks. Testing the spatial resolution and temporal resolution and physics dependencies should be considered a "Grand Challenge" problem to the modelling community in terms of scientific effort and computing.

The agenda with links to the presentations can be found at:
http://www.clivar.org/organization/aamon/WCRPmonsoonWS/agenda.htm

The URL for the full report of the workshop is:
http://eprints.soton.ac.uk/19335/01/icpo_pub_103.pdf

The Way Forward

The Pan-WCRP Monsoon Workshop report was the basis of discussions at the 18th GEWEX SSG meeting in Dakar. Based on this meeting and interactions with CLIVAR representatives, it is evident that both CLIVAR and GEWEX endorse the findings of the workshop as they relate to regional observations and scientific priorities although GEWEX is concerned that the workshop did not explore the role of its global data sets in analyzing and monitoring monsoons.

Subsequent discussions after the workshop have suggested two ways of proceeding.

Proposal I:

In order to ensure that these efforts related to the monsoon advance, the following steps have been proposed:

1) Incorporate the monsoon modelling activities into the WCRP Modelling Panel (WMP).

2) Establish a task force on global monsoons (TFGM) under the JSC to coordinate monsoon activities as well as other WCRP activities on monsoon modelling and predictions.

Proposal II:

In order to ensure the monsoon activities including observations, process analysis and modelling are planned within a consistent framework, CLIVAR and GEWEX would proceed by establishing focal points within each of their projects and these focal points would work together to develop a plan for how the activities of the projects could be more effectively integrated.

Recommendations to the JSC

(i) Based on the findings and recommendations of the Pan-WCRP Monsoon Workshop, GEWEX and CLIVAR strongly support the idea of a monsoon workshop focused on the diurnal cycle. It is recommended that CLIVAR and GEWEX along with a JSC representative form a planning committee and draw up a proposal for this workshop.

(ii) Due to their concerns about a unified approach to monsoons, GEWEX and CLIVAR endorse Proposal II as a way to proceed in monsoon coordination. As a first step, GEWEX and CLIVAR would identify focal points within their projects for their monsoon activities. These focal points would be asked to prepare a plan for the next JSC meeting showing how they will bring together the diverse monsoon activities within a coordinated programme. This assessment should identify how each project will address the gaps identified in the Pan-WCRP Monsoon Workshop.

(iii) The possible contributions of global data products (e.g. GPCP, ISCCP) in the analysis of monsoon systems need to be explored. In addition, the possibility of addressing some of the data gaps identified at the Pan-WCRP Monsoon Workshop by using new satellite data sets expected to come on-line over the next decade should be reviewed.

(iv) In order to promote cross-project dialogue related to monsoons, it is recommended that the CLIVAR SSG be invited to review and comment on the MAHASRI Science and Implementation plan.

The JSC thanked Professor Yasunari for leading the discussion and Drs Palmer and Lawford for the presentations. The JSC expressed the view that the CLIVAR and GEWEX monsoon panels should work more closely together. CLIVAR and GEWEX (with SPARC and CLIC) should establish focal points (with a JSC Representative) to define how to bring the monsoon studies into a more coordinated programme for discussion at the next JSC meeting. WMP should coordinate the modelling parts of the two projects together with SPARC and CEOP. JSC strongly supported WGNE and THORPEX participation in these activities, particularly in the focus on the diurnal cycle.

5.2 Atmospheric Chemistry and Climate

This agenda item was taken up in the JSC-IGBP SC joint session (See section 12.6.1).

5.3 Anthropogenic Climate Change (ACC)

Professor V. Ramaswamy led the discussion on this agenda item and Drs J. Mitchell, T. Palmer, S. Sorooshian and N. Mcfarlane made the presentations.

5.3.1 WGCM Contributions

Key Uncertainties

Climate sensitivity

Recent work using model ensembles or models and observations indicates that we have a better idea than ever before regarding the actual value of equilibrium sensitivity with a possible range, though there is evidence that higher values of sensitivity cannot be ruled out. Uncertainty is likely to be greater at regional scales and for other variables. Much of this uncertainty is manifested through differences in cloud feedbacks, particularly low cloud in lower latitudes, though recent work has been able to convey climate change uncertainty in more probabilistic terms.

Carbon cycle

The first coupled carbon cycle climate intercomparison experiment (C4MIP) has revealed a range of response between models in the response of the carbon cycle to climate change, though all show that carbon cycle feedback is positive (i.e. more carbon dioxide in the atmosphere with the inclusion of the carbon cycle).

Others

There are uncertainties in many other processes (sea-ice, treatment of the land surface, oceanic mixing, boundary layer etc.) which either contribute directly to uncertainty in climate response or (e.g. in the case of the boundary) indirectly through uncertainties in cloud feedback.

Uncertainty in the historical radiative forcing (natural and anthropogenic aerosols and solar output) continues to limit the constraints that can be deduced from the historical record.

A major issue is how/whether/when to include new dynamically coupled components to AOGCMs involving carbon cycle, vegetation, aerosols and chemistry. All introduce new and poorly understood feedbacks to the climate system that are poorly constrained by observations. However, they provide feedbacks considered to be great importance to the magnitude and nature of future climate change.

How do we reduce these uncertainties

"Physics" ensembles (climateprediction.net and the Hadley centre's Quantifying Uncertainty in Model Prediction (QUMP) project) provide the opportunity to determine which processes in that model formulation are important in determining climate sensitivity. The use of observational constraints (on present day climate or recent climate trends) may help discriminate between those that are plausible and those that are unrealistic. Those processes that are important but not well constrained can be investigated more thoroughly using appropriately designed observational experiments with a view to further reducing uncertainty.

Cloud feedbacks

CFMIP and related work are attempting to use satellite observations to establish relationships between variables (e.g. cloud cover, surface temperature and vertical velocities) in order to evaluate feedbacks in the present day climate. Early work shows that models capture these relationships poorly. Another possible approach is to use climate models in NWP mode with data assimilation to determine how errors in cloud develop on the short time scale.

Carbon cycle

C4MIP and its successors will help identify processes which need to be more accurately defined to reduce uncertainties. This is as much an issue for IGBP as for WCRP.

What are we doing/ not doing in the projects

A lot of good work is going on in the projects on processes *per se*. From an ACC perspective, what is missing is a greater emphasis on reducing uncertainties on feedbacks relevant to climate change. The key processes for climate may not be the same as for climate change.

How do we develop and implement strategies?

This needs a more careful analysis by modellers to define what the key mechanisms and processes in models are, and to define collaboration with those in the projects in order to determine if these processes occur in the real world, and can be refined through observational or experimental work.

It would help projects to focus better if they had ACC related metrics against which their performance is assessed (e.g. for GEWEX, quantifying and reducing uncertainty in low cloud feedback). At a more basic level, we in WCRP need to enthuse the cloud radiation community about this problem (to date this has not been successful) and make sure funding bodies are aware of the importance of this work and support it. As climate change starts to bite, adaptation will become more important and accurate regional predictions will become more important, particularly in planning long-term infrastructure such as sea defences and water storage and distribution. In this case, probabilistic climate change information presents a new way of conveying uncertainty that is potentially powerful for interfacing with user communities.

Issues and possible Timescale for AR5 (if commissioned).

1. There is an increasing trend towards probabilistic predictions, with increasing evidence at the regional level. Major issues are finding probability distribution functions, which are (relatively) insensitive to prior assumptions, and allowing for missing processes.

2. There will be a larger number of earth system models – in order to help the IPCC assessment, there will be a need to make sure components are calibrated in standard experiments (such as CMIP, C4MIP, CFMIP) beforehand.

3. Specification of standard "scenario" experiments will need consideration well in advance. A major concern here is that new emissions scenarios will not be agreed in time - the SRES scenarios are looking increasingly dated. Ideally, one would like to have standard emissions scenarios for WGI, back engineered to socio economic scenarios for WGII, III.

4. Assuming a 2013 report, science will probably be frozen by mid 2011. Scenarios and data collection need to be specified before the Zero order draft, say 2009 with a workshop 2 months before the Zero order draft.

5. Defining metrics to enable us to demonstrate progress between assessments

5.3.2 CLIVAR Contributions

The topic of anthropogenic climate change (ACC) forms one of the three streams of CLIVAR. Under it, two Principal Research Areas are identified:

(i) Climate change prediction
(ii) Climate change detection and attribution.

CLIVAR effort on climate change prediction and aspects of attribution is embodied in the activities of WGCM to which a CLIVAR co-chair (Dr G. A. Meehl, NCAR) has been appointed following the decision of JSC XXVI. The prime focus of work on climate change detection is through the work of the CLIVAR/CCI Expert Team on Climate Change Detection, Monitoring and Indices (ETCCDMI), though climate change detection is a topic of consideration by WGCM also. In addition, assessment of the ocean component of IPCC-class coupled models forms a key element of the work of the Working Group on Ocean Model Development (WGOMD) which reports to both WGCM and the CLIVAR SSG. To a large extent, the WGCM has presented the face of both CLIVAR and WCRP to the IPCC process, though the ETCCDMI has focused much of their efforts on contributing to the Fourth IPCC Assessment (AR4). In addition, CLIVAR/PAGES has made a contribution through its past workshop with IPCC on drought.

In addition, and as an outcome of the 2004 CLIVAR assessment, CLIVAR is seeking to provide a renewed focus on ACC as one of its four key science foci additional to its responsibilities within WCRP for the role of the oceans in climate. CLIVAR is seeking to do this in particular by encouraging its regional panels to promote, both within the scope of the panels and beyond, diagnostic analysis of these global datasets from IPCC AR4 global model runs at the regional level. In addition, the CLIVAR Working Group on Seasonal to Interannual Prediction (WGSIP) has been asked to consider the impacts of climate change on seasonal predictability, including assessment of the seasonal prediction capability of the IPCC-class models.

WGCM Activities and Regional Analysis of IPCC AR4 Runs

Current WGCM activities are summarised in detail in section 10.2. The primary activity has been the major international global coupled model experiment and multi-model analysis coordinated by the WGCM Climate Simulation Panel to provide input to the IPCC AR4. 14 modelling groups from around the world with 21 models have participated in this experiment, the largest ever to involve coupled models. Considerable resources have been devoted to this project with PCMDI, which has played a key role, archiving more than 27 terabytes of data so far. Over 200 papers have been submitted to peer-reviewed journals from the analysis phase which has attracted over 400 analysis projects being registered at PCMDI. Results from the experiment are thus now feeding directly into the IPCC process. In support of these efforts, US CLIVAR convened a major International Workshop in Honolulu, USA on "Analyses of Climate Simulations for the IPCC AR4" from 1-4 March 2004. Of the current 400 or so diagnostic subprojects analysing the AR4 simulations, some 30% relate directly to issues of the impact of climate change on climate variability and the oceans. CLIVAR, through VAMOS, has helped to initiate a contributing subproject from South America in particular. US CLIVAR also provides an important contribution to the development of IPCC-class models

through the work of the Climate Process Teams (CPTs), the activities of which are attracting international participation. The CPTs provide a comprehensive framework for linking theory, process studies and experiments, diagnostics, process model development, climate and prediction models, and observations.

WGOMD Activities

These have largely revolved in the past around the concept of an Ocean Model Intercomparison project (OMIP) for IPCC-class models against a climatological forcing. A pilot OMIP (P-OMIP) started in 2001 as a feasibility study with limited (6-7 groups) participation. There were significant problems with specification of forcing for P-OMIP. The CLIVAR Workshop "Evaluating the Ocean Component of IPCC-class Models" addressed this and other issues, from which the concept of "Coordinated Ocean Reference Experiments" (COREs) emerged and modelling groups are now being encouraged to participate in the CORES exercise.

Because they include interannually varying as well as annual mean forcing, the CORES runs will help to meet the requirements of CLIVAR's basin panels for regional analysis of IPCC-class ocean model runs linked to studies of ocean processes. The CORES framework also includes provision for a freshwater perturbation experiment with enhanced meltwater along the Greenland coast, complementary to the CMIP water hosing experiments.

ETCCDMI Activities

ETCCDMI activities relevant to ACC have centred around a series of regional workshops to further global assessment of climate extremes and changes as follows:

- South Africa, 31 May – 4 June 2004, for southern Africa (New et al. 2005),
- Brazil, 9-14 August 2004, for South America (Vincent et al. 2005, Haylock et al. 2005),
- Turkey, 4-9 October 2004, for southwest Asia (Zhang et al. 2005, Aguilar et al. 2005),
- Guatemala, 8-12 November 2004, for Central America (Aguilar et al. 2005), and
- India, 14-19 February 2005, for southern Asia.

These workshops have produced analyses of changes in indices of extremes from daily data in their regions of interest, and they have increased regional research synergies by sharing insights and improving analyses between neighbouring countries, contributing to capacity building. Standard software was developed for the workshops and has been made available to provide a basis for further development of user applications. A significant number of papers related to climate change have been produced and contributions have been made to a global extremes paper. These were included in IPCC AR4.

Other ETCCDMI activities have encompassed development and publication of indices and indicators of climate variability and change and input on these to IPCC and others. The ET also interacts with a number of international projects and organisations and has developed an indices web site at: http://cccma.seos.uvic.ca/ETCCDMI/.

Following completion of its period of mandate with CCl and agreement from CCl that it continue, the joint CLIVAR/CCl ETCCDMI is being reconstituted with JCOMM as an additional co-sponsor.

5.3.3 Anthropogenic Climate Change in the Stratosphere

Stratospheric Ozone depletion and its recovery: What to expect and what are the needs?

Stratospheric ozone depletion is a major environmental issue that has been recognized and diagnosed. Based on the scientific findings and predictions, policy decisions have been made to eliminate or restrict ozone-depleting substance (ODS) via the Montreal Protocol and its many amendments. The "recovery" of the stratospheric ozone levels to pre-chlorofluorocarbon levels in response to the Montreal Protocol is expected in the coming decades, with the abundances of ODS peaking during the present decade. Detecting the early signs of the recovery, shepherding the ozone layer through the transition period and finally seeing it through the consequences of the protocol are the major societal issues.

There are key issues that have emerged in terms of the ozone layer, its depletion and recovery. The first and foremost is the influence of the changing climate on the future of the ozone layer. The ODS amounts in the atmosphere have peaked and are slowly decreasing. At the same time, the climate is changing. Therefore, correct attribution of the ozone changes to policy actions on ODS as opposed to

changes in stratospheric climate is a key need (see below). Also, predicting how the climate change hastens or delays recovery is an important issue. The second important issue is how the changes in the tropospheric abundances of ODS translates to changes in the ozone-depleting active chemicals in the stratosphere. Dynamical processes that control the transport and distribution of the time scales involved need to be quantified. Dynamical issues related to vortex formation and sustenance needs to be carefully taken into consideration, especially when predicting the future of the polar ozone. Such a prediction is important because of societal concerns. Third, the importance of the naturally occurring short-lived halogen containing species on the active halogens in the stratosphere has to be carefully assessed. Such an assessment is key for the possible introduction of short-lived species as substitutes for the longer-lived ODSs as well making decisions on current exemptions on some chemicals. Fourth, the influence of the changes in stratospheric ozone and composition to the Earth's climate needs evaluation. These changes in the stratosphere can influence the composition of the troposphere. Intrusion of stratospheric ozone to the ground level can influence the air quality at the surface.

In addition to the scientific needs and issues noted above, the very task of assessments of the ozone layer, required by the Montreal Protocol every four years, relies on the "footwork" of organization such as WCRP and IGBP through their projects. It provides the basis for assessments and the pool of scientists to carry out the assessments.

Attribution of stratospheric changes, role of natural variability and modelling the system

One of the clear issues that arise in attributing the changes in the stratosphere is accounting for the natural variability in the coupled system. Modelling the changes and attribution of the changes to specific effects is important. In this regard, a few issues have emerged.

1. *Stratospheric change as part of attribution and detection of climate change*: If stratospheric changes are anthropogenic and not natural variability, we should expect our models to reproduce the changes and, to the extent that they do, we gain confidence in our models and in our understanding of the relevant processes. A key question concerns how to characterize the statistics of natural variability in the stratosphere. This is particularly challenging for the Arctic stratosphere where both observations and model results show a great deal of long-term variability, not just from year-to-year but on decadal timescales. This is similar to the timescale of the changes in ODS forcing, and also of the satellite observational record. Thus, for example, although chemical ozone loss attributable to ODSs occurs in the Arctic and can be very considerable in anomalously cold winters, this loss is strongly modulated by dynamical variability which also affects ozone transport. The two effects may act in concert, with years with low transport being associated with lower temperatures and enhanced chemical ozone loss. Thus the Arctic stratosphere ozone layer is potentially sensitive to changes in temperature and transport in response to changes in planetary wave forcing/dissipation, sometimes referred to as planetary wave drag (PWD), associated with ACC. The comparison of Austin et al. (2003) indicates considerable scatter in model results in this regard, with some predicting an increase and some a decrease of PWD over the next several decades resulting from climate change. These differences may reflect differences between the models, but they may also reflect insufficient statistical sampling. A major modelling challenge is to characterize the variability statistics sufficiently well to enable detection and attribution of ACC in the stratosphere. Such modelling efforts have been initiated in the SPARC programme.

2. *Changes in the stratosphere affecting meteorological (dynamical) variability in the troposphere*: There is evidence that the state of the stratosphere can have an impact on the troposphere on a variety of timescales (medium-range to seasonal, for example). It is has been suggested that ozone depletion over Antarctica can influence the variability of the so-called southern annular mode, and it has been shown that changes in PWD in the stratosphere can change the variability associated with the northern annular mode. Although the component of the ACC response that projects onto the annular modes may have a relatively large amplitude, its detection may be challenging because, by definition, the annular modes are patterns of internal variability. A major challenge for SPARC will be to understand the nature of this stratosphere-troposphere coupling, as well as to determine the spatial (in particular, vertical) resolution needed in climate models to capture the relevant dynamical processes.

5.3.4 GEWEX Contributions

GEWEX provides data, analyses and modeling studies that contribute to the assessment of trends in the global energy and to an understanding of the three main factors of anthropogenic change:

(i) Global changes arising from fossil fuel emissions to the atmosphere;
(ii) Regional and global changes arising from aerosol emissions to the atmosphere;

(iii) Regional and global changes arising from disturbances to surface conditions including land cover changes.

To address these issues GEWEX develops and maintains data sets and products that are useful in determining trends and the processes of change over a range of scales; undertakes field studies to better understand the processes responsible for feedbacks and forcings that lead to change; and initiates modelling studies that lead to better representation of these processes in climate models. These activities are described below in relation to climate variability and change and the factors causing ACC.

Assessing trends in the global climate system:

GEWEX, through its GEWEX Radiation Panel (GRP), coordinates the production and/or compilation and analysis of global observations of the energy and water cycle. This activity contributes directly to climate change detection and prediction by fostering the needed compilation of climate observations. It involves the production of global data sets for some key climate variables: clouds (International Satellite Cloud Climatology Project - ISCCP), precipitation (Global Precipitation Climatology Project - GPCP), surface radiative fluxes (Surface Radiation Budget (SRB) Project), and aerosols (Global Aerosol Climatology Project - GACP). GRP is now completing the description of the variations at weather-scales to global-decadal-scales of the energy and water cycle and fostering the analysis of the results to determine the causes of climate variation within the length of time observed. A recent initiative, SeaFlux, undertakes an assessment and possible re-processing of global data sets of ocean surface turbulent fluxes of heat and water (and momentum) to complement the surface radiative flux data sets. A similar activity, called LandFlux, for the land surface fluxes is being organized and coordinated with the Climate and Cryosphere project, which could provide surface fluxes over sea ice. Through better coordination of the physical consistency of these data sets GEWEX has contributed to the definition of necessary characteristics of "climate data records". Furthermore, through compilation of a complete description of the atmospheric energy and water cycle, GEWEX plans to produce products for a two-decade period to help examine climate variations in sufficient detail to diagnose the causes (forced or unforced) of these changes.

1) Global changes arising from fossil fuel emissions to the atmosphere

Relevant research related to this issue is led by GRP which (1) reviews and coordinates research to improve understanding and modeling of radiative transfer in the climate system and (2) reviews and coordinates research to advance remote sensing capabilities (another use of radiative transfer models). The first activity focuses on the critical role of radiative processes in the climate, while the second focuses on the application of radiation physics knowledge to improve and expand the range of measurements that can be obtained from satellites (and ground- and aircraft-based) remote sensing.

2) Regional and global changes arising from aerosol emissions to the atmosphere

Within the research area of aerosols, clouds, and climate change the lead is shared between the GEWEX Cloud System Study (GCSS) of the GEWEX Modeling and Prediction Panel (GMPP) and the GRP. GRP collaborates with three working groups (Intercomparison of Radiation Codes used in Climate Models, Working Group on Clouds and Aerosols Profiling, and the Working Group on Precipitation Radar Networks) addressing this topic by providing expertise on radiation codes. It also has a strong connection to the IRC working group on 3D radiation that focuses on advancing cloud, aerosol and precipitation remote sensing. GCSS has contributed to a position paper on cloud-aerosol-precipitation-climate interactions which has been adopted as a cross-cutting activity between the International Geosphere-Biosphere Program (IGBP) and WCRP. In the past, Continental Scale Experiments have also provided evidence of indirect effects of aerosols. For example, the Large-scale Biosphere Atmosphere Experiment in Amazonia has provided very useful observational data and process studies related to biomass burning in the Amazon basin and its role in the generation of aerosols and consequent influence on cloud and lightning development.

3) Regional and global changes arising from surface disturbances including land cover changes:

GEWEX studies of land cover change focus on two central issues: 1) does land cover change affect global and/or regional climates? 2) Does taking land cover change into account help detection and attribution studies of other drivers of the climate system? Studies to assess the impacts of land surface change are being undertaken by the Global Land-Atmosphere System Study (GLASS) complement of GMPP. Many modelling studies have suggested that changes in the global temperature and rainfall regime will occur and some studies have tested these changes statistically. However, since there is relatively little overlap between these study groups, GEWEX-GLASS and IGBP-iLEAPS (International Land Ecosystem-Atmospheric Processes Study) are launching a study of multiple-realizations of 20th Century simulations to estimate the

land cover change signal regionally and globally. About six climate models have agreed to conduct this experiment and follow the experimental protocol (for details contact: apitman@els.mq.edu.au). Regional studies have been undertaken by the GEWEX Hydrometeorology Panel (GHP) to assess the role of land surface change over the US on trends in temperatures over the last century and the effects of Amazon deforestation on temperature and precipitation changes. These studies indicate that, in the medium term, the consequences of land use change may be as large in some areas as those arising from changing atmospheric composition.

GEWEX also addresses the question, "How do land-surface processes and land-atmosphere interactions contribute to the predictability of weekly-monthly-seasonal-decadal climate variability?", which has implications for climate change studies. To address this question at least on timescales of two months and shorter, the Global Land Atmospheric Coupling Experiment-2 is being proposed by GLASS and the CLIVAR Working Group on Seasonal to Interannual Prediction. While this time scale does not resolve climate trends it does contribute to the ability to resolve changes on the weather time scales as they are modulated by longer-term change. A draft science plan has been developed and modeling groups are invited to join the experiment. GEWEX is also collaborating with the Global Water System Project to assess the cumulative consequences of changes to water distribution and storage on the Earth's surface (i.e. the construction of dams and reservoirs) for regional climates.

The JSC thanked Professor V. Ramaswamy for leading the discussion on this agenda item and Drs J. Mitchell, T. Palmer, S. Sorooshian and N. Mcfarlane for the presentations. The JSC noted that a great deal of effort is going on in various ACC activities of WCRP but that WCRP needs to raise its ACC visibility to a higher profile.

The JSC agreed that an initial roadmap for ACC Activity be developed by a JSC task team recognizing the existing work of the WGCM (with contributions by the projects, groups, task teams etc.). The roadmap should propose how WCRP can deliver on its objective to determine the effect of human activities on climate. (JSC Task Team Members: V. Ramaswamy (Lead), J. Mitchell, H. Le Treut, J. Marotzke; Timeline - first draft available for the next OCD meeting). Terms of Reference (TOR) for this Task Team are, with the aid of the Projects and Working Groups:

-To document current major activities being undertaken by WCRP that relate directly to ACC

-To identify major gaps in WCRP activities that are required to narrow uncertainties regarding ACC

-To propose new activities that could fill these gaps and thus reduce existing uncertainties

The JSC also encouraged holding workshops with other WCRP groups on ACC e.g. with IPCC (ETCCDMI). The JSC endorsed a recommendation that WCRP's co-sponsorship of ETCCDMI should be continued through CLIVAR.

5.4 Extreme events

Dr K. Trenberth led the discussion on this agenda item and Drs T. Palmer, S. Sorooshian and A. O'Neill made presentations. There is a general consensus within the climate community that any change in the mean climate is likely to feature significant changes in frequency or severity of extreme climate events and that this would have profound impacts on nature and society. It is thus very important to analyze and model extreme events. Indeed, the recent Report of the Steering Committee for the "International Symposium on the Stabilisation of Greenhouse Concentrations – Avoiding Dangerous Climate Change" (Exeter, UK, 1-3 February 2005) emphasizes that in assessing the consequences of increased levels of greenhouse gases "we should not focus temperature change alone but on anticipated shifts in climate variability, for example, with increase in the frequency and severity of extreme events". It notes that many climate impacts, particularly the most dangerous ones, will be associated with an increased frequency or intensity of extreme events and identifies this as an important area for further work since many impacts studies do not explicitly take the effects of extremes into account, although it is well known that such extremes pose significant risks to human well being. It quotes the heat wave that affected Europe in 2003 as an example.

The monitoring, detection and attribution of changes in climate extremes often requires daily, or preferably hourly, resolution data. However, the compilation, provision and update of a globally complete and readily available full resolution daily dataset, being promoted by the GCOS Implementation Plan, is a very difficult task. This comes about, in part, because not all National Meteorological and

Hydrometeorological Services (NMHS) have the capacity or mandate to freely distribute the daily data that they collect.

This account summarises current WCRP efforts on the issue of "extreme events" and suggests some coordination needs and activities. Many of the efforts on this topic across WCRP are relatively uncoordinated and so there may be (and undoubtedly are) aspects of work on this topic that are not covered by this short account.

5.4.1 Project foci on extreme events

CLIVAR

The primary CLIVAR effort on extreme events comes, from a monitoring perspective, through the work of the joint CLIVAR/Commission for Climatology (CCl) Expert Team for Climate Change Detection, Monitoring and Indices (ETCCMDI). The work of ETCCDMI is considered in more detail below. In addition, the CLIVAR regional panels maintain oversight of relevant extreme events (for example: extreme monsoon events such as the 2002 Asian monsoon) and all CLIVAR ocean basin panels have been tasked with development of relevant ocean indices for feed in to OOPC and the ETCCDMI. Many CLIVAR scientists are also engaged in the IPCC fourth assessment (AR4) where these topics are being assessed. The CLIVAR Indian Ocean Panel has participated in the Indian Ocean Tsunami Warning and Mitigation System to capitalise on potential synergies in data collection from the perspective of the tide gauge network and moored buoy deployment.

Future changes in extremes from an ACC perspective have been addressed through analysis of the JSC/CLIVAR WGCM IPCC scenario simulations. Here, attention has been given, for example, to model outputs for the Frich et al. extremes indices for temperature (e.g. number of frost days, interannual extreme temperature range, growing season length, heat wave duration index and warm nights) and precipitation (e.g. number of days with precipitation greater than 10 mm, maximum number of consecutive dry days; maximum 5-day precipitation total etc.). Of the 400 or so diagnostic subprojects analysis in the IPCC AR4 simulation, some 24 deal directly with extremes.

In addition, WGCM IPCC scenario simulations have also been analysed with respect to predictions of extreme climatic events due e.g. to rapid climate change (the focus of the CLIVAR-sponsored RAPID programme) and drought. Aspects of the work of the CLIVAR/PAGES (IGBP Past Global Changes) Panel also contribute in terms of our understanding of climate variability over past millennia and rapid climate change and drought events. An example was the CLIVAR/PAGES workshop, co-sponsored with IPCC, on "A multi-millennia perspective on drought and implications for the future" (Tucson, USA, 18-21 November 2003), aimed at investigations of the full range of past drought variability revealed by paleoclimate data and studies of future drought conditions associated with global warming. Issues such as rapid climate change and drought, are, of course usually considered separately from extreme events (in the sense that they are defined in the introduction) since they have their own set of issues, timescales, definition problems etc., and thus bring their own, separate, foci and agendas.

ETCCDMI

The ETCCDMI and its predecessor, the CCl/CLIVAR Working Group (WG) on Climate Change Detection, have been coordinating an international effort to develop, calculate and analyse a suite of indices so that individuals, countries and regions can calculate the indices in exactly the same way so that their analyses can fit seamlessly into the global picture. The aim has been to allow all interested parties, including the index contributors, to benefit from improved monitoring of change with broader spatial coverage that is currently unavailable. As an example, the European Climate Assessment and Data website at:http://eca.knmi.nl/ provides access to information on extremes across Europe using, for each location, a set of 40 descriptive indices representing (changes in) the mean and extremes of climate. The indices follow definitions recommended by the CCl/CLIVAR ETCCDMI.
The ETCCDMDI focus on extremes has been threefold:

1. To further develop and publicize indices and indicators of climate change and variability, with particular emphasis on the creation of indices of daily to seasonal extremes covering the global land surface using standardized software packages;
2. To compare modelled and observed indices, and report on the comparisons, with some emphasis on changing extremes;
3. To maintain plans for capacity building in developing countries, particularly through Workshops. In particular, to work closely with START on capacity building through its Monitoring Extreme

Climate Events (START-MECE) group.

Workshops and the development of user-friendly analysis software and a software manual have been key features of the work of the Expert Team. The Team has organized 5 capacity-building workshops in South America, Africa and Asia. These have analysed regional changes in extremes, produced a wealth of published or in press peer-reviewed papers, contributed to a global extremes indices paper and were completed in time to contribute to IPCC AR4. Much of the work of ETCCMDI focused on indices of extremes, with a view toward detection of external influences on extremes, evidence for which is now becoming clear. The ETCCDMI maintains a website at http://cccma.seos.uvic.ca/ETCCDMI/; further information can also be obtained from: http://www.clivar.org/organization/etccdi/index.htm#ACTIV. The mandate and membership of the Expert Team is currently being renewed by CCl with JCOMM also joining as a 3rd sponsor.

GEWEX

Within GEWEX, extremes have always been a concern of the GEWEX Hydrological Programme (GHP) and a GHP "Extremes Workshop" was held on 6 October 2003: http://www.ofps.ucar.edu/ghp/extremes/extremes_workshop2.html. Building on GHP interests, a formal working group, chaired by Dr R. Stewart, under the title "Worldwide Integrated Study of Extremes (WISE)" was established in 2005 within GHP to promote extremes-related efforts within GHP and GEWEX. The group's focus is "to better understand and model the occurrence, evolution and role of extremes within the climate system and to contribute to their better prediction". It is expected that the exact nature of the group's objectives will evolve somewhat as the effort proceeds. The initial focus is on droughts and extended wet periods. The effort is only just beginning and systematic activities are being started. These include development of extremes activity in the CEOP Phase II Science Plan, focusing on the occurrence, understanding and inter-connections between extremes occurring around the world. CEOP-II will consider:

- What extremes occurred during CEOP across the world?
- What are their characteristics?
- What factors led to these individual extremes?
- To what degree were the extremes inter-connected?
- How typical and/or unusual is the CEOP period and why?
- What are the implications for extremes and the climate system?

Future plans under the WISE activity include, in the short-term (~ 1 year):

- WISE session in conjunction with the 2006 CEOP workshop
- Proposed WISE session at the 2006 spring AGU or at another major conference

and in the longer term (1-4 years):

- Inventory of events and studies of their evolution in each CSE
- Study of trends in the occurrence of extreme events
- Study of the predictability of extremes
- Study of the role of extremes in the climate system
- Synthesis-review article on extremes within the climate system

A web site (accessible through the GHP website) has been developed at UCAR. It summarises WISE plans and also lists numerous other web sites that contain information on extremes and hazards. The address is: http://www.ofps.ucar.edu/ghp/extremes/.

CliC

Climate extremes related to the cryosphere are identified as a component of the CliC science plan, and are becoming increasingly reported in the news and in scientific publications. For example, Arctic sea ice in late summer 2005 was the lowest extent on record and has implications for such things as transportation, marine organisms and Arctic settlements. The shattering of the Larsen B ice shelf was the largest single disintegration event in 30 years of ice shelf monitoring. Preliminary studies of sediment cores suggest that it may have been this ice shelf's first collapse in 12,000 years. The total area of surface melt on the Greenland Ice Sheet shows a record extent in 2005 for the 27-year long time data set and exceeds the previous record in 2002. During July 1999 and August 2002, the Kuparuk River basin in the Arctic had the largest runoff events seen in the past 21 years. These extremes may be associated with larger, regional weather patterns. For example, exceptionally heavy sea ice seen in the Weddell Sea in the summer of

2001/02 was associated with other climate extremes such as exceptionally warm temperatures at Vostok. Other examples of extremes include snowfall or snow cover. Extreme events are of high interest to the CliC community, the project does not yet have a specific activity in this area; although extreme events are distributed within the different sub-disciplines (or CliC project areas) within CliC.

SPARC

Areas of extremes clearly relevant to SPARC include extremes of stratospheric temperatures and winds and of ozone depletion as well as of other trace gases and stratospheric clouds. Monitoring of these is a key activity. A detailed *Bulletin on the Antarctic ozone hole* is issued through WMO/GAW (see http://www.wmo.int/web/arep/ozone.html).

There is evidence that high potential vorticity anomalies in the upper troposphere and lower stratosphere contribute to the development of intense storms in the troposphere. This possibility is being investigated by SPARC as one aspect of its research theme on stratosphere-troposphere coupling. A related issue under investigation by SPARC is the impact on tropospheric variability, including cyclogenesis, of the representation of the stratosphere in numerical models (e.g. the number of model levels in the stratosphere).

Global Water System Project (GWSP)

At the moment the GWSP is not involved in any activities directly related to extreme events though apparently the GWSP SSC might consider working on issues such as floods in the future.

WGNE

WGNE has no specific activity in extremes but obviously it is a very important issue for WGNE's operational forecast centre 'members' and for WGNE links to THORPEX which has clear interests in severe and/or high impact weather.

WOAP

Reanalysis datasets in the atmosphere provide 6 hourly analyses of many fields that can also be used to assess extremes, and several analyses have been performed of changes in atmospheric circulation, storms, storm-tracks, and relationships to precipitation, sea state and waves, and so on. However, the integrity of reanalyses for determining trends and decadal variability is questionable. Consequently, further reprocessing of data and reanalysis of it are high priority issues for WOAP in further developing climate data records that can be used for this task.

5.4.2 Coordination needs and activities

There is clearly effort across WCRP on extremes. As yet, however, this is relatively uncoordinated except where it is a single project activity. The theme is ripe for further development and focus across the programme. Key actions which the JSC might wish to consider include:

- As a first action, to cross-link all activity identified above published on projects websites via the COPES website, and feature the topic on the COPES website.
- Task each WCRP project to further review and draw together its activities on extremes onto a dedicated web page, to be linked across through the COPES web page as above.
- Ask projects to consider the implementation of explicit coordinated activity on extremes, building on existing efforts.
- Developing a specific cross-WCRP extremes activity, to be identified through a pan-WCRP workshop in the 2007 time frame
- Identifying any key project activity on extremes being fed into IPCC AR4 with consideration of actions for AR5.
- Building links to THORPEX for shorter weather forecasting and upwards timescales in relation to extremes.
- Assessment of predictive skill in relation to climatic extremes on seasonal to interannual timescales in the context of the proposed TFSP pan-WCRP experiments.
- Assembling a key bibliography of direct outputs from WCRP workshops and adding to the web site.

The JSC thanked Dr Trenberth for leading the discussion and Drs T. Palmer, S. Sorooshian and A. O'Neill for the presentations. The JSC observed that WCRP needs to address this nascent and increasingly important area. It recommended that WCRP set up a framework for studying the extreme events to address data, modelling, simulation and predictability needs of extremes. An initial step is a session on extremes at the seasonal prediction workshop in 2007. The JSC will continue to address the crosscut between Extremes and ACC in its future sessions.

Through GCOS, WCRP must continue to stress the need for access to high frequency data for analysis of extreme events. The JSC urged the projects to encourage the sharing of high frequency data for the analysis of extreme events and how they are changing.

WCRP activities on extreme events should be brought together on a single WCRP web page.

5.5 Special topics for JSC consideration

Two proposals received in response to call for proposals in the WCRP Strategic Plan document (see its Appendix F) were tabled for JSC's consideration:

1. A Moroccan proposal on "Project Study on climate change impacts and adaptation in North Africa" by Abdelkader Allali

2. An Indian proposal on "Monsoon Stability and Global Change", by G.B. Pant, G. Beig, M. Rajeevan and C. Sharma

The JSC was pleased to consider both proposals. To set a strategy in place to deal with such proposals, the JSC recommended that such proposals be delegated to relevant core and joint projects/programmes of the ESSP family for review. In the case of proposal # 1 it should be forwarded to Mediterranean-CLIVAR and START for a joint review.

For proposal # 2, JSC expressed the view that it should be considered in the Monsoon cross-cutting activity and the ESSP MAIRS Project.

The JSC reiterated that WCRP should be proactive in soliciting proposals under the new strategic initiative.

WCRP should have a more visible web presence (including activities, meetings, reports, newsletters, access to data sets etc). WCRP should also engage in periodic announcements/highlights about its activities and plans in prominent and high-visibility journals. The JSC recognized the need for a more effective connection of WCRP activities to ESSP partners.

6. CLIMATE VARIABILITY AND PREDICTABILITY (CLIVAR)

Dr T. Palmer, Co-Chair of the CLIVAR Scientific Steering Group (SSG), made a presentation on the status of CLIVAR. CLIVAR has, over the past year, made significant contributions to advancing the implementation of the new WCRP 10-year strategy (COPES). As reflected in CLIVAR's mission statement, itself well aligned to COPES objectives, CLIVAR provides important and key inputs to meeting the aims of COPES. Indeed, CLIVAR's mandate within WCRP to pursue the objective of understanding the role of the ocean in climate and long-term ocean variability enables it to make a unique contribution to COPES' objectives. In addition, following CLIVAR SSG-13 and the CLIVAR assessment, CLIVAR's programmatic re-emphasis on the four major themes of ENSO and other tropical modes of variability, monsoons, decadal variability and the thermohaline circulation and anthropogenic climate change emphasize its focus on exploring the interactions between the ocean and atmosphere and their role in climate variability and change.

6.1 CLIVAR contributions to the WCRP 10-year strategy

CLIVAR's contributions to WCRP's new Strategic Framework were outlined in Section 2. Further details on specific cross-cutting issues provided below.

Through COPES, CLIVAR seeks to work with the WCRP community and others to bring wider areas of expertise to play. In particular, CLIVAR and GEWEX are seeking to scope other areas of interaction beyond their present joint activity on monsoons to encompass a wider range of issues. Potential interactions

with SPARC have been scoped and links with CliC activities encouraged through the interaction of CLIVAR's Atlantic Panel with the CliC Arctic Climate Panel.

CLIVAR also has activities and interactions with WCRP sponsor organisations, in particular with IOC through joint activity with GOOS, OOPC and the International Ocean Carbon Coordination Project (IOCCP) (see below). It also has joint activity with IGBP Past Global Changes (PAGES) through the CLIVAR/PAGES Panel, and is developing links to IGBP IMBER and GLOBEC. CLIVAR will also contribute to the GEO workplan

6.1.1 Sea level change

Contributions to sea level change studies are provided through CLIVAR-related hydrographic observations, relevant satellite data and synthesis activities. CLIVAR GSOP activities in promoting 50-year ocean reanalyses are expected to provide high quality information on changes in ocean heat content and related thermal expansion. WGCM predictions will additionally provide information on future sea level rise associated with ACC. It is anticipated that a number of CLIVAR scientists will participate in the forthcoming WCRP COPES-sponsored Workshop on Understanding Sea level Rise and Variability (Paris, France, 6-9 June 2006).

6.2 CLIVAR contributions to cross-cutting topics

This section identifies the key areas in which CLIVAR provides input on cross-cutting topics. Progress in aspects of these, and wider CLIVAR activities, are provided within Section 6.3.

6.2.1 Monsoons

Monsoon activities form a major component of CLIVAR and the three CLIVAR monsoon panels provide one of the two main regional thrusts within CLIVAR (the other being the work of the CLIVAR ocean basin panels). The CLIVAR monsoon panels comprise: the Variability of the American Monsoon (VAMOS) Panel; the Variability of the African Climate System (VACS) Panel (covering the West African Monsoon and wider African climate variability including the East African monsoon) and the Asian-Australian Monsoon Panel (AAMP). There continues to be increasing interaction on monsoons between GEWEX and CLIVAR (see section 5.1). Of all the WCRP core projects, the collaboration between CLIVAR and GEWEX is among the strongest. In this context, GEWEX and CLIVAR jointly organised and hosted the 1st pan-WCRP Workshop on Monsoon Climate Systems (University of California, Irvine, USA, 15-17 June 2005). Under VAMOS, the North American Monsoon Experiment (NAME) and Monsoon Experiment South America (MESA) are both joint with GEWEX. Following SALLJEX (the South American Low Level Jet Experiment), the new focus for MESA is on the hydroclimate of the La Platin Basin (VAMOS/PLATIN), its interactions with the Amazon Basin and the role of SST anomalies. The La Plata Basin Project (LPB) is a Continental Scale Experiment again with joint involvement of GEWEX and CLIVAR. Leverage of CLIVAR research through the PLATIN SSG was a key component in the successful bid in 2003 to the Global Environmental Facility (GEF) for funds for LPB planning and for implementation of strategic actions to be taken by the governments in countries in LPB for the environmentally and socially sustainable economic development of the basin. The key VACS activity in relation to the monsoons is through the African Monsoon Multidisciplinary Analysis (AMMA) programme jointly sponsored by CLIVAR and GEWEX. Potential future monsoon coordination currently proposed is for joint CLIVAR/GEWEX effort in the VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS) (which could also potentially attract IGBP involvement through links with aerosol studies) and joint activity on studies of the Asian-Australian monsoon system. In the context of the AA monsoon, the observing system designed by the joint CLIVAR/GOOS Indian Ocean Panel (see below) is targetted on the intra-seasonal timescale in particular, addressing a critical issue in monsoon research.

6.2.2 Atmospheric chemistry and climate

This is not an area in which CLIVAR currently has direct activity. However, CLIVAR and SPARC have begun to explore related potential interactions in the area of modes of atmospheric variability and their change in a changing climate which themselves may be influenced by changes in atmospheric chemistry. A joint SPARC/CLIVAR session was held at the AMS Joint Middle Atmosphere, Fluid Dynamics and Climate Variations Conference (Cambridge, Ma, USA, June 2005). A number of topics were identified as ripe for collaboration, including the NAO in the fully coupled climate system; a joint workshop is being developed.

AMMA, as well as being sponsored by GEWEX and CLIVAR, is also endorsed by two projects in IGBP including IGAC (International Global Atmospheric Chemistry). AMMA includes observations and research on atmospheric chemistry including the key role of aerosols (which may also have importance in an

AA monsoon context). AMMA considers interactions with aerosols and also the transport by the monsoon of ozone and other trace gases.

6.2.3 Anthropogenic climate change

The topic of anthropogenic climate change (ACC) forms one of the three streams of CLIVAR. Under it, two Principal Research Areas are identified: Climate Change Prediction and Climate Change Detection and Attribution.

CLIVAR effort on climate change prediction and aspects of attribution is embodied in the activities of the JSC/CLIVAR Working Group on Coupled Modelling (WGCM). Under WGCM, a major activity has been the major international global coupled model experiment and multi-model analysis coordinated by the WGCM Climate Simulation Panel to provide input to the IPCC AR4 (see Section 5.3.2 above and Section 10.2).

The prime focus of work on climate change detection is through the work of the CLIVAR/Commission for Climatology (CCl) Expert Team on Climate Change Detection, Monitoring and Indices (ETCCD), though climate change detection is an activity of WGCM also. In addition, assessment of the ocean component of IPCC-class coupled models forms a key element of the work of the Working Group on Ocean Model Development (WGOMD), which reports to both WGCM and the CLIVAR SSG. To a large extent, the WGCM has presented the face of both CLIVAR and WCRP to the IPCC process, though the ETCCD is making important contributions to the Fourth IPCC Assessment (AR4), especially through published papers from its regional workshop activities. In addition, CLIVAR/PAGES has made a contribution through its past workshop with IPCC on drought.

6.2.4 Extreme events

See section 5.4.1.

6.3 Highlights of progress since JSC XXVI

CLIVAR Ocean Basin Panels

CLIVAR's ocean basin panels oversee the implementation of CLIVAR in their respective oceanic regions. Particular foci are on atmosphere-ocean regional modes of variability and the status of the sustained observing system in relation to requirements for CLIVAR research. These requirements feed into OOPC, which both ocean basin panel and GSOP representatives attend. In addition, the basin panels maintain an overview of current process study activities and seek to facilitate and encourage plans to develop such activities. Following the direction set by CLIVAR's SSG-13, a number of links are developing between the basin panels and CLIVAR's global activities. In particular, sets of metrics appropriate to each ocean basin have been specified for GSOP reanalysis assessment efforts and analysis of the Working Group on Ocean Model Development (WGOMD) Coordinated Ocean Reference Experiments (COREs). Panels are also seeking to specify appropriate indices to input to GSOP and OOPC. To link with IOC's International Ocean Carbon Coordination Project (IOCCP) and other ocean carbon activities, membership of each of the panels includes a carbon representative agreed with IOCCP. CLIVAR is also seeking to develop its interactions with IGBP Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) (Dr W. Hazeleger, CLIVAR Atlantic Panel Co-Chair is also a member of the IMBER SSG). Furthermore, the IOC/SCOR/IGBP GLOBEC Programme has, through the Atlantic Panel, provided CLIVAR with a number of challenging questions linked to applications in ecosystem research.

Atlantic Panel and MedCLIVAR

- The concept of the Tropical Atlantic Climate Experiment (TACE), to advance understanding of coupled ocean-atmosphere processes and improve climate prediction for the eastern tropical Atlantic region, has been under development by CLIVAR's Atlantic Panel. A TACE "white paper" setting out the concept of TACE has been developed and feedback provided by the CLIVAR SSG. TACE will provide coordinated observational, modelling and synthesis studies of the region in the 2006-2011 timeframe with primary focus on the ocean. A key component of TACE is extension of the observational network in the region, including the PIRATA array. TACE complements plans both for an Atlantic Marine ITCZ programme and the AMMA experiment that is currently under way.
- A Tropical Atlantic Climate Variability Experiment in the southwestern Atlantic is being promoted as a joint VAMOS/Atlantic Panel activity.

- The Atlantic Panel and US NOAA co-sponsored a Atlantic Ocean Dynamics Workshop (Venice, Italy, 17-19 October 2005) aimed at taking stock of our understanding of the ocean's role in tropical Atlantic variability and to compare state of the art ocean and climate models with observations in the region.
- The Atlantic Panel has maintained an overview of a wide range of observational studies in the Atlantic region, including the Arctic-SubArctic Ocean Flux Study and the RAPID Climate Change programme. CLIVAR will co-sponsor the RAPID Climate Change Conference to be held in Birmingham from October 2006.
- The Mediterranean CLIVAR activity (MedCLIVAR), which seeks to provide opportunities for regional engagement in CLIVAR, has received approval as a European Science Foundation programme. MedCLIVAR (http://clima.casaccia.enea.it/MedCLIVAR/) is seeking to develop and integrate CLIVAR-relevant activities in regional observations, paleoclimatic studies, prediction and synthesis.

Pacific Panel

- The scope and membership of CLIVAR's Pacific Panel has been reviewed. The reconstituted panel will have its first meeting from 15-17 February 2006. An update on planned activities was provided as part of the CLIVAR presentation to the JSC.
- The Panel organised a joint CLIVAR/OOPC/GOOS/Argo/CPPS Workshop on the South Pacific, held at the University of Concepción, Chile, on 11-14 October 2005. It was aimed in particular at assessing the status of both modelling and monitoring of the region and at seeking ways to supplement its observing networks.
- Key CLIVAR-related Pacific observational studies in progress are SAMFLOC (Sub-Antarctic Mixed layers, Fluxes and Overturning Circulation), which contributes to Southern Ocean Panel objectives also, and KESS, the 2-year US-funded Kuroshio Extension System Study. Planning for PUMP, the Pacific Upwelling and Mixing Physics experiment, is continuing under US CLIVAR.

CLIVAR/GOOS Indian Ocean Panel

- The key focus of the joint CLIVAR/GOOS Indian Ocean Panel has been the development of an implementation plan for sustained observations in the region. This has been carried out in cooperation with the Tropical Buoy Implementation Panel (TIP). The Plan, entitled "The role of the Indian Ocean in the climate system – implementation plan for sustained observations", is currently in press. Part 1 identifies the research issues that call for observations. Part 2 provides the technical implementation issues. The plan was presented to OOPC-9. The Panel convened a review of the plan by the 3rd meeting of the Indian GOOS Regional alliance, carried out by high-level agency representatives.
- Potential synergies between the CLIVAR/GOOS IOP activity and the Indian Ocean Tsunami Warning and Mitigation System were identified at the first meeting of the Intergovernmental Coordination Group.
- Enhancement of the Indian Ocean observing system continues. In collaboration with the TIP, there are 9 surface and 3 deep equatorial moorings. These have provided new data and information on the dynamics of the upper ocean including the mixed layer. When fully implemented, meteorological measurements will provide valuable input to initialisation of weather forecasting models. The Indian Ocean XBT network has been enhanced and Argo advised of special needs for the Indian Ocean. Data management issues for Indian Ocean oceanographic data are currently being addressed.
- Two key research-based process studies on the role of ocean-atmosphere interaction for intra-seasonal variability in the Indian Ocean are the Japanese Mirai Indian Ocean Cruise for the study of MJO convection (MISMO), to take place in the in the eastern part of the basin in late 2006, and the French VASCO-CIRENE campaign in the western Indian Ocean. The Indian Ocean Panel will hold a workshop on MISMO/CIRENE as part of its 3rd meeting (La Réunion, 1-4 March 2006).

Southern Ocean Panel

- The Southern Ocean Panel held a workshop on Modes of Southern Hemisphere Climate Variability in Cambridge, UK on 27-28 June 2005. This resulted in a CLIVAR Exchanges special issue (October 2005) with 33 contributed papers. The workshop was followed by the 3rd meeting of the panel. A major focus of the meeting was planning for the International Polar Year, especially the CASO (Climate of Antarctica and the Southern Ocean) umbrella programme, which the panel is coordinating. Other themes covered included sustained observations and interactions with OOPC/GSOP, Southern Ocean Argo, Southern Ocean process studies (of which a number are proposed under the IPY umbrella) and Antarctic/Southern Ocean reanalysis.
- The panel are involved in a number of other studies proposed under the IPY umbrella such as SAMFLOC (see above) and DIMES ((Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean). The IPY provides a special opportunity for enhancing CLIVAR Southern Ocean activities in the coming years.

• A new focus for the panel for its next meeting (Buenos Aires, November 2006) is a review or assessment of IPCC models in the Southern Ocean region articles on which were published in the October 2005 Exchanges issue. This activity will link to available WGCM modelling datasets.

CLIVAR Monsoon Panels

A key event for CLIVAR's monsoon panels (AAMP, VACS and VAMOS, see Section 6.2.1) was the 1st pan-WCRP Workshop on Monsoon Climate Systems in which representatives of all 3 panels took part. This Workshop also formed the CLIVAR SSG's theme focus workshop for 2005. The role of all three panels is to investigate the variability and predictability of their monsoon regions with the aim of developing improved predictive systems and relevant links to applications, though, as noted, VACS also has a wider role in terms of African climate variability. From an applications perspective, all three groups include an applications expert/link as part of their membership. As noted in Section 6.2.1, monsoon panel activities provide strong links to GEWEX.

Variability of the African Climate System (VACS) Panel

• AMMA, co-sponsored by CLIVAR and GEWEX provides the primary contribution to VACS panel objectives on the West African Monsoon. An update on AMMA progress was provided in a separate presentation to the JSC (see section 12.2.3). Information on the AMMA programme can also be seen at http://www.amma-international.org. The website includes linkages to: the international science plan which was completed in 2005; the international implementation plan that describes the multi-year field observations and the special observations in 2006; national and pan-national projects; pages that describe activities in the international working groups. The first International AMMA Conference was held in Dakar from 28 November to 2 December 2005. It attracted around 255 participants with close to 100 Africans taking part.
• Development of the VACS African Climate Atlas by the University of Oxford, UK continues. The Atlas can be viewed at: http://www.geog.ox.ac.uk/~clivar/ClimateAtlas/
• VACS is planning a workshop in Tanzania to address prediction and predictability of the climate of east and southern Africa. Funding has been confirmed from START and is anticipated from WMO (CLIPS) and WCRP. Other avenues are also being pursued.

Variability of the American Monsoon System (VAMOS) Panel

• Considerable progress has been made under VAMOS NAME on modelling and data assimilation activities that leverage the enhanced observations gathered during the NAME 2004 Field Campaign. Several NAME publications that highlight recent progress have been published A special issue of the Journal of Climate on NAME was organized with some 20 papers (due out in mid-late 2006).
• VAMOS MESA has made considerable progress in integrating the different projects in South America (SALLJEX, PLATIN, LBA) into a unified programme to facilitate the understanding, simulation and prediction of the South American Monsoon System (SAMS), its variations and its links with the extratropics. MESA is being organized in three main priority research areas: Diurnal and mesoscale variability; Intraseasonal variability and Interannual and longer timescale variability (including climate change), with SAMS evolution and variability as a cross-cutting theme.
• A La Plata Basin (LPB) implementation steering group has been appointed to design and accelerate progress on the GEWEX-CLIVAR LPB CSE.
• Planning for VOCALS, which is aimed at improved understanding, model simulations, and predictions of the southeastern Pacific (SEP) coupled ocean-atmosphere-land system, on diurnal to interannual timescales, has continued with preparation of a revised VOCALS Science and Implementation Plan and development of logistical arrangements.

Asian-Australian Monsoon Panel

• A meeting of the reconstituted AAMP met in Irvine California from 18-19 June 2005, following the pan-WCRP meeting. Key issues addressed included future panel activities, panel links to COPES TFSP seasonal prediction experiment outputs, the role of ENSO on monsoons (links to the Pacific Panel) and how to coordinate with GEWEX monsoon activity. There are clear prospects for collaboration with GEWEX on AA activities post GAME with CLIVAR taking a lead on the role of the ocean for the monsoons through the activities of AAMP and the CLIVAR IOP.

CLIVAR's global panels and working groups

These comprise the JSC/CLIVAR Working Group on Coupled Modelling (WGCM), the Working Group on Ocean Model Development (WGOMD), the Working Group on Seasonal to Interannual Prediction, the Global Synthesis and Observations Panel (GSOP), the CLIVAR/CCI Expert Team on Climate Change Detection, Monitoring and Indices (ETCCD) and the joint CLIVAR/PAGES Panel.

Modelling Panels

- As already noted (section 5.3.2), a major WGCM activity has been the major international global coupled model experiment and multi-model analysis coordinated by the WGCM Climate Simulation Panel to provide input to the IPCC AR4. Other WGCM activities are described in section 10.2.
- WGSIP involvement in COPES TFSP continues. WGSIP is in the process of cataloguing current seasonal prediction activities (see section 4.4). WGSIP met in Wellington, New Zealand from 13-16 February 2006.
- WGOMD held a workshop on Southern Ocean Modelling in Hobart Australia from 9-10 November 2005 in conjunction with its last meeting held on either side of the workshop. Progress with the concept of Coordinate Ocean Reference Experiments and review of the current status of global ocean modelling formed key foci for the Working Group meeting.

Observation and Synthesis panels

- A key focus of GSOP activity has been ocean reanalysis, in particular the development of an "white paper" setting out the basis for a CLIVAR/GODAE reanalysis evaluation framework with inputs on standard outputs needed for evaluation from CLIVAR's ocean basin panels. A Workshop on a Pilot Evaluation Effort of Global Ocean Reanalyses is being held at ECMWF, Reading, UK from 31 August to 1 September 2006.
- An International Repeat Hydrography and Carbon Workshop was held in Japan from 14-16 November 2005, co-sponsored by GSOP, IOC's International Ocean Carbon Coordination Project (IOCCP) and JAMSTEC.
- Following completion of its period of mandate with CCI, the joint CLIVAR/CCI ETCCD is being reconstituted with JCOMM as an additional cosponsor.

CLIVAR/PAGES Panel

- A joint CLIVAR/PAGES Workshop on Past Millennia Climate Variability is planned to take place in Mürren-Wengen, Switzerland from 7-10 June 2006. A joint CLIVAR Exchanges/IGBP PAGES Newsletter on "Climate Forcings" was issued in December/January. Further CLIVAR/PAGES activities are described in Section 12.6.4

Support of the International CLIVAR Project Office (ICPO)

- UK Natural Environment Research Council (NERC) funding of the ICPO has been renewed for a further 3 years (from 1 April 2005) with potential extension for a further 2 years subject to review. The Office is additionally supported by substantial funding by US NOAA, NASA and NSF through US CLIVAR. Funds have also been provided by the CSIRO Division of Marine and Atmospheric Research (Hobart, Tasmania). Over the past year support has also been received for printing of the CLIVAR Exchanges Newsletter, by the Chinese Meteorological Agency through the Chinese Academy of Meteorological Sciences. Funding by all parties is gratefully acknowledged.

Issues for the JSC

The JSC was invited to consider the following issues and to provide guidance and recommendations:

- CLIVAR performance metrics and opportunities for increased visibility.

- CLIVAR is due to sunset in 2013. Other WCRP projects have similar sunset dates. At present under COPES, there is no stated strategy or vision as to what will take their place and how this will be formulated. Funding agencies therefore see a blank wall in terms of ongoing WCRP projects and activity both for science and support of IPOs. The JSC need to consider this matter with urgency.

- There could be clear advantage in greater programmatic coordination, cooperation and information exchange between project offices. The JSC may wish to consider and advise how best to achieve this.

6.4 World Ocean Circulation Experiment (WOCE) - Hydrographic Programme Atlas Series

During the WOCE Hydrographic Programme (WHP) field phase (1990-1998), an unprecedented set of ship-based observations of ocean temperature, salinity, nutrients and other natural and anthropogenic tracers was collected. Collaboration with the IGBP JGOFS programme delivered observations of carbon dioxide distributions in the ocean. The data (along with all other data from WOCE) were made available online and in final version on a set of DVDs issued in 2002.

The WHP data consisted of approximately 10,000 stations of the one-time survey and a similar number of repeat stations (without the full suite of chemical measurements). These data represent an unprecedented baseline data set of guaranteed high quality against which past and future (for instance as measured by the global Argo array of profiling floats or from re-occupations of WOCE sections) may be assessed.

These data are being published in a set of four atlases.

Vol 1	Southern Ocean	Prepared by Alex Orsi and Thomas Whitworth III, Texas A and M, USA
Vol 2	Pacific Ocean	Prepared by Lynne Talley, Scripps Instn. of Oceanog., USA
Vol 3	Atlantic Ocean	Prepared by Peter Koltermann, Kai Jancke and Viktor Gouretski BSH, Germany
Vol 4	Indian Ocean	Prepared by Lynne Talley, Scripps Instn. of Oceanog., USA

A grant from British Petroleum (BP) has allowed the atlases to be printed and distributed with recipients bearing only mailing costs. The series is edited by Drs M. Sparrow (ICPO), P. Chapman (former US WOCE Director) and J. Gould (former WOCE IPO Director), with administrative support from J. Haynes. The Southern Ocean Atlas was published in April 2005 in a print run of 800 copies of which 555 have been distributed to recipients in 34 countries. The final plates of the Pacific Atlas are now being completed with publication scheduled for Spring 2006.

Most vertical sections for the Indian Ocean have been produced and horizontal maps should be completed before the end of 2006.

The Atlantic Ocean Atlas had been delayed by staffing problems in BSH, Hamburg, but funding has now been found that will run to mid-2006. However, the editors feel that it is unlikely that all plates will be completed before present German funding ends. In order to complete the Atlantic volume, the German PI has requested that some of the funds reserved for editorial costs and for printing be used to pay for the final drafting of the figures. This is likely to result in a charge (in addition to the mailing costs) having to be made for the last three volumes.

An example of the Southern Ocean volume was made available to the JSC in Pune. The covers of the next volumes will have the new WCRP logo and will include the logos of the co-sponsors of WCRP.

The JSC thanked Dr Palmer for his presentation. The JSC was pleased with CLIVAR's visibility profile and its list of success measures. The JSC welcomed CLIVAR's engagement with African activity and in particular, the VACS's upcoming workshop in Tanzania, jointly with WMO and START, to address prediction and predictability of the climate of east and southern Africa. The JSC requested results from this workshop be brought to the JSC prior to the next JSC meeting in east Africa next year.

The JSC thanked WGCM for its organisation of the major international global coupled model experiment run in support of IPCC AR4. This has been the largest, most comprehensive, highest profile and the most successful climate modelling project ever. JSC also expressed its grateful thanks to the Program for Climate Model Diagnosis and Intercomparison (PCMDI) for their invaluable contribution to the collection, archival and distribution effort for the IPCC multi-model analysis activity and to US CLIVAR for acting as convenor of the successful international Workshop on Analyses of Climate Model simulations for the IPCC AR4 which was hosted by the IRPC,(University of Hawaii) and oversesn by the WGCM Climate Simulation Panel.

7. THE GLOBAL ENERGY AND WATER CYCLE EXPERIMENT (GEWEX)

Professor S. Sorooshian, Chair of the Global Energy and Water Cycle Experiment (GEWEX) Scientific Steering Group (SSG) presented the main developments in GEWEX during the past year, including the main items and recommendations from the seventeenth session of the GEWEX SSG held in Kunming, China 31 January - 4 February 2005. The GEWEX had an active and successful year in 2005 both in terms of scientific advances and project development. Highlights of the year included the 5th International Scientific Conference on the Global Energy and Water Cycle held in Costa Mesa, California (20-24 June), the launch of the African Monsoon Multidisciplinary Analysis (AMMA) Project, the development of proposals for MAHASRI [the follow on to the GEWEX Asian Monsoon Experiment (GAME)] and the second phase of the Coordinated Enhanced Observing Period (CEOP). The roster of scientists leading the GEWEX Panels and Projects remained relatively stable with changes in only one subproject, the Global Land-Atmosphere System Study (GLASS) where Dr A. Pitman replaced Dr P. Dirmeyer as Chair. Also in 2005, Dr R. Yu joined the SSG in place of Dr G. Wu. Other changes arising from the latest GEWEX SSG meeting include the completion of the Water Resources Applications Project (WRAP) and the International Land Surface Climatology Project (ISLSCP) and the approval of two new related projects: the Hydrological Applications Project (HAP) and LandFlux. Although progress has been slow, GEWEX is fostering greater integration across projects, closer links with other WCRP projects as part of WCRP's new strategy (particularly CLIVAR) and is also looking for collaborations with other international activities such as the International Land Ecosystem-Atmospheric Processes Study (iLEAPS) within the IGBP, the Integrated Global Observing Strategy–Partnership (IGOS-P), GCOS and GEO. The following report outlines the progress made by each of the Panels and addresses the issues raised at the last JSC meeting.

7.1 The GEWEX Roadmap

During the past year GEWEX has worked towards the development of a roadmap that will lay out the direction for GEWEX research over the next 7 years. This roadmap has defined five to eight milestones for each GEWEX objective. In most cases the milestones are mutually supportive leading to major results relative to the objective in the 2011 to 2013 time frame.The purpose of the roadmap is to focus the use of the intellectual and financial resources available to GEWEX and to provide a basis for communicating the coherent nature of GEWEX plans to funding agencies and the science community at large. GEWEX plans to achieve these objectives in the context of specific science questions that are critical for the COPES strategy. The milestones will be achieved by building on the heritage of research results, models and data products that have been developed during the first phase of GEWEX.

The GEWEX Panels are now reviewing the roadmap and clarifying what actions they will take to contribute to these milestones. A pan-GEWEX meeting will be held in Italy from 9-13 October 2006, to enable the three panels to interact as they finalize their implementation plans for the roadmap.

7.2 GEWEX contributions to the WCRP Strategic Plan

The main contribution of GEWEX to the WCRP strategic framework is the revision of the objectives of GEWEX Phase II and their use as guidelines for the above-mentioned roadmap, which is intended to lead GEWEX activities for the next 7 years. GEWEX projects can be presented as contributions to those objectives, with some activities responding more directly to COPES priorities than others. Objectives central to COPES are repeated here for emphasis.

Objective 1. Produce consistent research quality data sets.

This objective directly responds to the main aim of COPES and provides input to the required "analysis of Earth System variability and change" for all variables related to the water and energy cycle. The results already achieved for clouds, precipitation, aerosols (over the oceans), surface and top of the atmosphere radiation are recognized as being the reference for climate analyses. This work will be pursued and complemented by data sets for turbulent fluxes over sea and land.

Objective 2. Better understand climate feedbacks.

This is a basis for expected improvements in climate models and for advances in climate prediction and climate change scenarios. Studies undertaken for this objective include the main physical climate processes, which are still not properly formulated in GCMs, clouds, radiative processes, surface turbulent fluxes and aerosols. They will make use of a number of new satellite missions expected in this domain and aim at an increasing interaction with the climate modelling community.

Objective 3. Address the predictability of the water and energy cycle.
This is a direct contribution of GEWEX to the climate prediction objective of COPES. It will allow model improvements on one side, taking into account the representation of land surface processes primarily in seasonal forecasts, and to develop on the other side the use of regional models to refine climate forecasts and climate change scenarios. The Global Land Atmosphere Coupling Experiment (GLACE-2) will make a major contribution to the COPES predictability goals.

Objective 4. Improve parameterization schemes.
This objective builds on results of predictability studies in Objective 3 as well as process studies that lead to better process parameterizations in climate models, with a view to improving both seasonal predictions of events related to the water cycle, such as monsoon characteristics, as well as wet and dry extreme events, and of global change scenarios

Objective 5. Contribute to the main aim of the Strategic Framework.
GEWEX will contribute to societal benefits of climate research by developing practical applications of water cycle research for society, with respect to the management of water resources, both at the seasonal, intraseasonal and interannual timescales with a primary focus on benefits for operational hydrometeorological services.

In summary, the main contributions of GEWEX to COPES can be summarized as follows:

- To the observational component of COPES, with the provision of climate records, and of guidance on the improvements of the climate monitoring strategy and the development of observation systems.
- To climate modelling with regional models, with research on process studies and modelling leading to improvements in parameterizations.
- To the main COPES objective regarding contributions to society, by playing a lead role in the development of applications focused on water resources.
- To CEOP, which was initiated by GEWEX, but is operating with a wider scope, which provides a framework for a pan-WCRP demonstration experiment in preparation for future advanced climate observation networks.

GEWEX participates in WCRP's Panels and Working Groups. Feedback from these Panels has been mixed. GEWEX has a natural leading role in the WOAP activities, more specifically in the formulation of WCRP's observation strategy, space-based and in-situ, and more precisely in some actions such as the reprocessing of global data sets. The WCRP Observation and Assimilation Panel (WOAP) is viewed as a valuable avenue for providing input to WMO satellite coordination via the WMO satellite programme. As regards the WCRP Modelling Panel (WMP), GEWEX could derive more benefit from WMP if regional models and parameterization issues were actively considered. With respect to task forces, GEWEX plans to bring specific expertise to the task force studying seasonal prediction through GLACE II and with the formulation of land surface boundary conditions, of parameterization schemes and the provision of validation techniques and data sets.

7.3 GEWEX Radiation Panel (GRP)

All of the global data products (except SeaFlux and LandFlux) are available through 2004, providing more than two decades of global determinations of clouds, precipitation, aerosols (ocean only) and surface and top-of-atmosphere radiation. Formal international assessments of the products from the International Satellite Cloud Climatology Project (ISCCP), the Global Precipitation Climatology Project (GPCP), the Global Aerosol Climatology Project (GACP) and the Surface Radiation Budget (SRB) Project were started last year. These assessments provide a critique of GEWEX products, as well as any other alternatives that provide similar long records. Three of the four assessments are well under way, having completed at least one workshop and having plans for more workshops in 2006. Funding for the continuation of the global data projects appears to be in place, so the Working Group on Data Management and Analysis (WGDMA) began planning at its most recent meeting for a coordinated reprocessing of all the products to take place in 2007-2008.

The Baseline Surface Radiation Network (BSRN) recently became the GCOS surface radiation reference network. The Continuous Intercomparison of Radiation Codes (CIRC) Project is nearly ready to release a website that will provide both synthetic and observation-based tests for any radiative transfer code calculating broadband fluxes (like those used in Global Climate Models (GCMs)). After reviewing current activities, the GRP decided against restarting the Global Water Vapour Project (GVaP) because, with the exception of the development of microwave water vapour profile retrieval methods over land, sufficient activity is already under way to produce new global products within the next few years. New funding and

new groups interested in participating have led to the reactivation of SeaFlux, beginning with a workshop in March 2006. A working group will be formed to help develop plans for a GRP-led LandFlux activity, associated with a possible broader data collection activity under the ESSP. Landflux will assess the feasibility of deriving land surface fluxes from satellite data. When combined with SeaFlux products, it is expected that Landflux will allow GEWEX to address the global water and energy budget. Precipitation activities include the development of snowfall algorithms (a workshop was held in October 2005) and the formation of a precipitation radar network working group. A GRP plan of action for aerosols was also adopted at the latest GEWEX SSG meeting. In addition, Dr J. Curry, the GEWEX contact for the International Polar Year (IPY), has submitted a proposal dealing with aerosols in northern areas.

The major goal of GRP for the next several years is to complete, analyze and refine the quantitative description of the global energy and water cycle. This goal involves several interdependent activities. The first is a compilation of the current description from available data products, where the land surface turbulent fluxes must be taken from the model outputs produced by Global Soil Wetness Project-2 (GSWP-2). The second is the completion of the formal data product assessments to identify improvements in preparation for reprocessing. The third is a set of focused activities to bring precipitation, aerosols, and ocean and land surface fluxes up to the same quality level as clouds and radiation. All of this activity is to culminate in a coordinated reprocessing of all products to produce a more complete and improved description of the global energy and water cycle.

By the 2007 JSC meeting, three of the four global data product assessments (precipitation, radiation and clouds) should be nearly complete and the aerosols assessment should be nearing its midpoint. The coordinated reprocessing will also be completed. Plans are for CIRC to have a radiation code test website and hold a workshop to encourage its use. The Working Group on Clouds and Aerosols Profiling (WGCAP) will release a set of common products from continual measurements by cloud radar-lidar at about nine sites for a common time period. The first meetings to start the new SeaFlux and LandFlux activities will be held in 2006, as well as the first meeting of the Working Group of Precipitation Radar Networks (WGPRN).

7.4 GEWEX Modelling and Prediction Panel (GMPP)

The GMPP coordinates the activities within GEWEX for improving the representation of the global water and energy cycle processes within Earth System models. The following three groups exist to cover these activities: the GEWEX Cloud System Studies (GCSS) Project, the Global Land/Atmosphere System Study (GLASS) and the GEWEX Atmospheric Boundary Layer Study (GABLS). Furthermore, GMPP keeps a close link with large scale models in order to ensure that the activities within the studies are relevant to atmospheric models and that the global modelling community is aware and can take advantage of the improvements proposed in cloud, land-surface and Atmospheric Boundary Layer (ABL) conceptual models. The biannual meeting with the Working Group on Numerical Experimentation (WGNE) facilitates a close collaboration with the Numerical Weather Prediction (NWP) community.

The first focus of GABLS has been on stable boundary layers (SBLs) over ice and land. On the basis of the first GABLS benchmark case, eight articles have been compiled and submitted to a special issue on GABLS in the journal of *Boundary Layer Meteorology* (February 2006). At present GABLS is focusing on the diurnal cycle of the clear boundary layer over land. As such a new intercomparison case for column models has been set up based on CASES99. At present, about 40 scientists are actively participating within GABLS, including members of university groups seeking international cooperation. Given the GABLS findings thus far, there is still a clear need for a better understanding and a more general description of the ABL in particular, under stably stratified conditions in atmospheric models for weather, climate and earth system studies.

GCSS has had a very active and productive year culminating in the 3rd Pan-GCSS meeting held in Athens, Greece in May 2005. The meeting supported several major new GCSS activities. These include new efforts on cloud microphysics, moist process metrics in climate models and a new collaboration with Stratospheric Processes And their Role in Climate (SPARC) on issues related to the Tropical Tropopause Layer (TTL). The new GCSS Pacific Cross-Section Working Group, which evaluates the simulation of tropical and subtropical cloud systems in GCMs, is proving to be a major success. So far more than 10 GCM groups have submitted their contributions to the project and 10 more are expected. Collaboration with WGNE on this project provides a strong GCSS link to the NWP community. Also, with its tighter links to the GCM community and its major new initiatives, GCSS believes that it is in a good position to face the challenges ahead – old and new – to support the development of better representation of clouds in climate and NWP models.

GLASS consists of the Project for the Intercomparison of Land-Surface Parameter Schemes (PILPS) (local uncoupled), the Global Soil Wetness Project (GSWP) (global uncoupled), the Local Coupled Project (LoCo) (local coupled), and the Global Land Atmospheric Coupling Experiment (GLACE) (global coupled). PILPS has several active projects; PILPS-C1 nears completion as it explored the performance of Land Surface Schemes (LSSs) in representing the carbon cycle and the accumulation of biomass at a forest site; Isotopes in PILPS (iPILPS) has completed preliminary simulations and validation of LSSs that trace stable water isotopes; and PILPS-San Pedro in Arizona is the first validation of LSSs in a semi-arid environment. PILPS-San Pedro has completed the baseline simulations – multi-criteria calibration exercises and tests of spatial transferability of parameters are beginning. The Snow Models Intercomparison Project-2 (SnowMIP-2) is a similar local uncoupled action that tests the ability of snow models to simulate snow accurately under canopies, on canopies and in clearings. GSWP-2 has completed model simulations and produced a multi-model analysis (DVD and online) that provides a demonstrably superior simulation of land surface states compared to any other global model product. Interest in LoCo is growing, as evidenced in the joint LoCo/GABLS workshop held to kickoff efforts to simulate and understand coupled land-PBL (Planetary Boundary Layer) processes. GLACE analysis has been extended beyond the "hot-spot" map to show why different GCMs exhibit such different coupling behaviour, and to compare the GCMs to observations, showing poor local representation of observed flux-state variable relationships, but better large-scale climate behaviour.

GMPP will now turn its focus to the coupling of the systems for which the diurnal cycle was chosen as a theme. It is very likely that the climate offers many situations in which the feedbacks between the surface, ABL and clouds are at least as important as the details of how each of them is reproduced. Furthermore, one may wonder how relevant evaluations of land-surface models or cloud systems are without the coupling with the ABL for instance. It is anticipated that diurnal cycle research will address some of the strongest interactions between the land-surface, ABL and clouds. Another major future direction for GMPP involves building stronger links with the general circulation and regional climate modelling communities.

7.5 GEWEX Hydrometeorology Panel (GHP)

GHP coordinates the regional Continental-Scale Experiments (CSEs) and other relevant global hydrometeorological projects and is a contributor to the Global Runoff Data Centre (GRDC), the International Satellite Land Surface Climatology Project (ISLSCP), the Global Precipitation Climatology Project (GPCC) and the Coordinated Enhanced Observing Period (CEOP). GHP also has activities that are closely linked to the International Association of Hydrologic Sciences (IAHS). The International Atomic Energy's Water Resources Department is a relatively new global contributor that is helping with the Stable Water Isotope Intercomparison Group (SWING) activities described below. The Hydrologic Ensemble Prediction Experiment (HEPEX) is also planning to become a global contributor to the emerging GHP Hydrologic Applications Project (HAP) described below.

GHP held its annual meeting in September at the Bureau of Meteorology Research Centre in Melbourne, Australia. The meeting reviewed the past year's progress and aligned the GHP objectives with the revised GEWEX Phase II objectives and, by association, with the Coordinated Observation and Prediction of the Earth System (COPES) strategy. Future GHP activities are being increasingly focused on developing a regional to global hydrometeorological analysis and predictive capability, and developing applications of GEWEX science for operational hydrology.

The GEWEX Asian Monsoon Experiment (GAME) and Mackenzie GEWEX Study (MAGS) ended in 2005. A follow-on project for GAME, named MAHASRI, is being planned for 2006-2012 with the objective to improve the prediction of the Asian monsoon and its hydrological cycle. If the Northern Eurasian Earth Science Partnership Initiative (NEESPI) can meet the Continental Scale Experiment (CSE) criteria, it may be proposed at the next GHP meeting as the newest CSE. Both the Baltic Sea Experiment (BALTEX) and the Large-scale Biosphere Atmosphere Experiment in Amazonia (LBA) have now completed their first Phase and have begun Phase II activities. The La Plata Basin (LPB) Project and the Murray Darling Basin (MDB) Project have submitted implementation plans. The GEWEX Americas Prediction Project (GAPP) plans to continue its participation in GHP as part of the Coupled Prediction Project for the Americas (CPPA). Through GAPP, numerous operational model upgrades have improved the Environmental Modelling Center global forecast system, resulting in reductions to the model's high precipitation bias. An operational centre has been established for the African Monsoon Multidisciplinary Analysis (AMMA) Project and the field campaign will be launched in the summer of 2006. The AMMA implementation plan was presented at the highly successful First International AMMA Conference on the West African Monsoon held in Dakar, Senegal in November 2005. AMMA represents the new breed of CSEs which are expected to address a broader range of issues and have stronger links with CLIVAR and CliC as well as ESSP projects.

The GHP Data Management Working Group (DMWG) is continuing to focus on CEOP by gathering station data from the CSEs during the CEOP timeframe. The Water and Energy Budget Study (WEBS) is assessing the uncertainties in observing and simulating water and energy budgets over the CSEs in particular, and global land in general, using model output and GEWEX global data sets. The Worldwide Integrated Study of Extremes (WISE) Working Group is determining the extent to which processes responsible for extremes are similar in different regions in order to understand the processes that link extremes in different regions, and to assess how they may be changing. One of the first tasks for WISE is to develop a database of extreme events starting with the CEOP time period and extending back in time using the WEBS data set. The Stable Water Isotope Intercomparison Group (SWING) has almost completed its analysis of the first common SWING simulations under present-day boundary conditions using three different state-of-the-art isotope global circulation models. The Transferability Working Group (TWG) is facilitating the development of regional models and climate simulations. Of particular note, is the Inter-CSE Transferability Study (ICTS), a joint project under TWG and CEOP, which will study the performance of regional climate models over all of the CSEs. The TWG agreed at the last GHP meeting to participate in the ongoing GCSS Pacific Cloud Transect Study. Applications work in GHP is being refocused as new initiatives such as HEPEX provide ways to strengthen the links between research and the operational hydrologic community, thereby enabling GEWEX to implement projects with more meaningful contributions to society. The Water Resources Application Project (WRAP) has been redefined as the Hydrologic Applications Project (HAP). Examples of initiatives with promising links to HAP include HEPEX, the Project for Ungauged Basins (PUB), and THe Observing system Research and Predictability EXperiment (THORPEX).

7.6 Coordinated Enhanced Observing Period (CEOP)

CEOP has now embarked on Phase II, which will run from 1 January 2005 to 31 December 2010. Most of the data sets from Phase I will be completed in 2006. At its January 2006 meeting, the GEWEX SSG endorsed the CEOP Phase II Implementation/Science Plan in principle. CEOP Phase II will extend existing data and observation systems and place greater emphasis on the use of these data in its research activities. The data management and coordination components will contribute to the CEOS/IGOS-P Water Theme, COPES and Global Earth Observation System of Systems (GEOSS). Three new areas of research are being added for Phase II. Under the Water and Energy Simulation and Prediction Working Group new activities will be established to deal with semi-arid river basins and with cold region hydroclimate processes (together with CliC). To this end CEOP has submitted a preproposal for a CEOP Polar Observations Project to be undertaken jointly with Climate and Cryosphere (CliC) and the International Polar Year (IPY) 2007-2008 in Part 2 of CEOP Phase II. The CEOP Monsoon research activities will be expanded to deal with the contributions of aerosols to monsoon circulations. Phase II plans also call for a small set of hydrological reference sites, possibly chosen from the existing CEOP reference sites, that could have dual roles as validation sites for the land-surface parameterizations in coupled land-atmosphere-ocean models, essentially at a point or small area scale, and as "tie points" or ground truth reference sites for remote sensing products. In its review of the CEOP Phase II plan, the GEWEX SSG pointed out that there is a need to ensure that these activities are harmonized with other activities in GEWEX and within WCRP.

Key agreements were reinitiated to maintain continuity in the collection of in-situ data from 35 of the globally distributed "reference" stations. All nine of the operational numerical weather prediction centres and two data assimilation centres currently supporting CEOP Phase I have agreed to continue, at least at their current level of commitment, through 2010. The Max-Planck-Institute for Meteorology with the ICSU World Data Center for Climate (WDCC) in Hamburg, Germany, which earlier undertook to serve as the CEOP model output archive centre, has agreed to continue in this capacity through CEOP Phase II.

Recognizing the overwhelming amount of data collected in CEOP Phase I data (around 300 terabytes) and the need for data management systems for the collection, sharing and provision of the data in formats familiar to the science community, the University of Tokyo, the Japan Aerospace Exploration Agency (JAXA), and the Committee on Earth Observation Satellites (CEOS) have begun working together to create a distributed "data mining" system for the CEOP data archive.

Not surprisingly, given the overlap in science communities, there are similarities between the work being undertaken in GHP and in CEOP. CEOP was able to take advantage of the GHP/Data Management Working Group (DMWG) and other GHP activities to launch its globally coordinated effort. Many of these GHP activities have an ongoing connection with CEOP in that they are using CEOP data and are active in planning CEOP Phase II activities. For example, the GHP Worldwide Integrated Study of Extremes (WISE) is working with CEOP to determine the extent to which processes responsible for extremes are similar in different regions in order to understand the processes that link extremes in different regions and to assess how they may be changing. WISE has developed a database of extreme events starting with the CEOP time frame and extending back in time using the WEBS data set. GHP/Inter-CSE Transferability Study, a joint project under

Transferability Working Group (TWG) and CEOP, will study the performance of regional climate models over all of the CSEs. On occasion, these similarities result in problems in communicating CEOP and GEWEX activities and in clearly establishing accountabilities. For this reason, GEWEX believes that the time has come to develop a plan for harmonizing future CEOP and GHP activities

7.7 GEWEX interactions with other groups

GEO, GCOS, CEOS and IGOS

GEWEX plays a central role in the interaction of WCRP with the various international entities or initiatives dealing with climate observations. This role is channelled through its project office, through WOAP and through other channels that GEWEX has developed through its projects.

As part of WCRP's input to the GEO 10-year Implementation Plan, GEWEX brings its unique expertise in two specific societal benefit areas: climate and water. With respect to climate, WCRP's role is complementary to GCOS: it provides guidelines for the longer term with the WCRP strategy and contributes to a number of tasks scheduled for 2006-2007. Those tasks have been jointly defined with GCOS, and also respond to the priorities of the GCOS Implementation Plan. Among those tasks, GEWEX is taking the lead in the development of plans for the global data reprocessing effort and on the observation strategy and serves as a demonstration project of future climate observational networks in GEOSS.

When one deals with the observation strategy, it is difficult to separate climate from water priorities. A number of major space missions being planned for launch in the near future relate to GEWEX objectives (e.g., observation of clouds, precipitation and soil moisture). GEWEX has expressed its support for a strong international Global Precipitation Measurement (GPM) commitment and for a new global hydrology mission. GEWEX is also significantly contributing to the definition of the in-situ observation strategy including the development of a surface radiative network initiated with BSRN, a soil moisture validation network and a hydrology network for which CEOP will play a leading role. Another priority expressed by GEWEX is a consolidated strategy for ground networks building on the existing research expertise.

Global Water System Project (GWSP)

GEWEX has been interacting with GWSP on several levels. Drs D. Lettenmaier, T. Oki and J. Marengo represent GEWEX on the GWSP Science Committee. In addition, the project offices frequently interact on issues related to Integrated Global Water Cycle Observations (IGWCO) and the World Water Forum. Most GWSP initiatives remain in the planning stages; hence the commitment of scientists to project implementation has not been large. As a result GEWEX data sets are viewed as a significant potential contribution to the GWSP electronic atlas and the data assessment projects.

Integrated Land Ecosystem - Atmosphere Processes Study (iLEAPS)

iLEAPS has a strong interest in GEWEX activities related to atmospheric boundary layers (ABL) and land-atmosphere interactions (GLASS). iLEAPS is planning a joint activity with GABLS that could extend the current GABLS case studies. A new case study will include tracer transport for tracers such as CO_2. iLEAPS's cooperation with GLASS will focus on land-atmosphere interactions in the global hotspots (see GLACE). Other areas of co-operation might be within the area of Landflux. GEWEX expertise in providing physical descriptions of hydrometeorological and climatic processes are of value to iLEAPS while iLEAPS's focus on the carbon-cycle is of potential use to the GEWEX community.

IGOS Global Water Cycle Observations (IGWCO) Theme

The GEWEX Project Office has continued to provide leadership for IGWCO. Many of the GEWEX priorities are expressed within the IGWCO Theme. These include the development of an Intercomparison Project for Precipitation products that will serve as a contribution to an emerging precipitation cross-cut activity in GEWEX. Other linkages between IGWCO and GEWEX include work related to the use of GEWEX products in GWSP, the development of soil moisture products and work related to capacity building. CEOP also plays an important role in providing data services for IGWCO activities related to the development of integrated precipitation products that are being integrated with GEWEX precipitation activities.

7.8 GEWEX Outreach

GEWEX has been undertaking outreach as a regular part of its project implementation. During the past year, the following steps were taken:

- In response to a request to WMO from the United Arab League, GEWEX worked with UNESCO (and WCRP) to organize a workshop on the Application of Climate Research for Water Resource Management in Semi-arid and Arid Regions. The workshop was held in Cairo, Egypt during April 2005.
- The GEWEX Accomplishments brochure was completed and distributed,
- *GEWEX News* was produced on a quarterly basis,
- The GEWEX website, http://www.gewex.org, realized a significant increase in usage with the number of hits averaging 300 per day.

During the coming year GEWEX plans to:
- Organize the distribution of GEWEX and WCRP literature at the World Water Forum IV,
- Develop a new brochure on GEWEX Phase II,
- Continue producing *GEWEX News* on a quarterly basis and regularly updating www.gewex.org,
- Produce a special issue of the *Journal of Hydrometeorology* with papers submitted to the 5th International Scientific Conference on GEWEX.
- Collaborate with CEOS and IGOS-P in a possible side event at Commission on Sustainable Development (CSD).

International GEWEX Project Office (IGPO) Activities

IGPO is funded primarily by the USA (NASA) through a grant to the UMBC (University of Maryland, Baltimore County) GEST Center as part of the US contribution to the WCRP. The central IGPO office currently has a full time director, two near full-time support staff, two senior advisors (each working at approximately 10-15% time). In 2004, The European Space Agency committed itself to hiring a part-time European GEWEX Coordinator and in,2006, the Chinese Meteorological Administration will begin supporting a Beijing based Chinese GEWEX Coordinator. The European GEWEX Coordinator has been successful in increasing the visibility of GEWEX in Europe although this has yet to translate into increased funding for European initiatives that address GEWEX priorities. Given the increasingly distributed nature of the office, IGPO is considering the possibility of having an affiliated US GEWEX Coordinator.

During the past year the IGPO has supported the 5th International Scientific Global Energy and Water Cycle Science Conference, as well as the GEWEX Panel meetings. IGPO has provided many of the outreach activities described in this report, published the accomplishments brochure and contributed to the preparation of GEWEX reviews. The office has documented and tracked action items arising from GEWEX SSG and Panel meetings, organized scientific sessions at AGU, AMS and EGU, organized visits of WCRP colleagues to Washington, DC, and organized meetings with agencies regarding US funding of specific projects. In addition, IGPO supports the GEWEX SSG Chair, responds to requests for reviews and inputs for WCRP and elsewhere, and has given more than 65 presentations at meetings and workshops. These presentations were primarily on GEWEX, but also included IGWCO and NEESPI. Finally, IGPO has provided oversight for IGWCO activities, including the organization of a capacity building workshop in South America, and also has provided input to the GEO planning process and coordination activities for NEESPI.

Recommendation for the JSC

The JSC was invited to consider the following recommendations by GEWEX:

1. GEWEX recommends that the MAHASRI project be approved subject to it successfully meeting the CSE criteria outlined by the GHP and subject to a review by the CLIVAR SSG.
2. GEWEX recommends that CEOP Phase II be adopted by the JSC subject to a technical review of the science plan by experts from each WCRP project. These experts could be asked to identify areas where CEOP overlaps with other WCRP projects and propose ways to harmonize CEOP with other related WCRP activities.
3. In order to effectively manage the wide range of activities that GHP and CEOP undertake in common it is recommended that the JSC ask GEWEX to develop a plan to be tabled at the next JSC meeting for harmonizing or possibly merging these activities.
4. GEWEX asks the JSC to recognize the GEWEX/SPARC workshop on cloud systems and the transport of water vapour through the tropopause as a first step towards a combined project in this area. JSC is encouraged to reaffirm its commitment to aerosols as a priority for cross-project collaboration
5. GEWEX asks the JSC to recognize the progress that has been made in identifying the needs for monsoon research and its efforts to work closely with CLIVAR to identify ways to advance this research agenda.
6. GEWEX invites JSC comments on its roadmap (www.gewex.org/roadmap.pdf) and on its contributions to COPES.

7. GEWEX asks the JSC to recognize the successes of the International Satellite Land-Surface Climatology Project (ISLSCP) in popularizing global data sets and to comment on the value of a proposed broad-based global data set development initiative under ESSP.

The JSC thanked Professor Sorooshian for his presentation. The JSC would like GEWEX to accelerate progress on role of land surface processes in the predictability of intraseasonal, seasonal and longer time scales.

The JSC urged GEWEX to contribute to predictability and prediction studies. JSC recommended that a representative from the Global Land Atmospheric Coupling Experiment (GLACE2) (global coupled) be included on the WCRP Modelling Panel.

The JSC noted with appreciation the roadmap presented by GEWEX in response to WCRP's strategic framework and established a group for review of objectives, implementation, milestones, and timeline. This group includes Drs T. Yasunari, G. Wu, D.J. Griggs, J. Shukla and L.A. Ogallo. The JSC endorsed GEWEX plans for the coming year subject to review group's recommendations. Terms of Reference for the review group are:

- To review the draft objectives and milestones of the GEWEX Roadmap
- To identify major gaps in these objectives and milestones
- To identify potential difficulties in achieving these milestones within the lifetime of GEWEX

The JSC encouraged GEWEX to increase its contribution to predictability and prediction studies.

The JSC requested GEWEX to consider how to make progress on aerosol and cloud-related feedbacks, including linkages to climate models and sensitivity to human-induced climate change, to improve projections for the IPCC AR5.

The JSC considered the MAHASRI proposal and recommended that GEWEX request CLIVAR to review it and that it meet the CSE criteria.

The JSC gave its approval to the plan for CEOP phase II, subject to a technical review of the science plan by experts from each WCRP project, in order to propose ways to prevent potential overlaps with existing WCRP activities. The JSC reiterated the recommendation that the science issues be reviewed and reported by GEWEX and the data management aspects through WOAP. It recommended that GEWEX propose to next JSC session a plan to reorganize its structure in order to better integrate the CEOP agenda in its panels.

8. THE CLIMATE AND CRYOSPHERE (CliC) PROJECT, INCLUDING WCRP PARTICIPATION IN THE INTERNATIONAL POLAR YEAR (IPY) 2007-08

The Chair of the CliC Scientific Steering Group, Dr B. Goodison, presented the activities of CliC and the planned International Polar Year 2007-08 (IPY). Results of and plans for the project activities were considered at the second Session of the CliC SSG, in Copenhagen, Denmark, 6-9 November 2005. Many project activities are being prepared in association with the IPY.

8.1 First CliC Conference

The most important project event in 2005 was the *First CliC Science Conference* "Cryosphere, the Frozen Frontier of Climate Science: Theory, Observations, and Practical Applications". It was held on 11-15 April 2005 in Beijing, China. The goals of the Conference were to highlight the crucial role of cryosphere as an integral part of the climate system, to identify gaps in our abilities to observe, understand and model the cryosphere, to examine and develop ideas for collaborative studies in cryospheric and climate research, and to engage the international community in contributing to a coordinated programme. 245 participants from 22 countries contributed 137 oral presentations and 125 poster papers. The Conference host, the China Meteorological Administration, offered unparalleled conference facilities and warm hospitality.

The Conference demonstrated significant ongoing progress in understanding the complex nature of cryospheric processes. Many new results were presented and discussed there including findings how the cryosphere could induce an abrupt climate change, accelerated contribution of glaciers to sea level rise towards the end of the 20th century, ability of modern Earth System models to simulate Ice Age cycles, and advances in specialised cryospheric observations, both remotely-sensed and in situ. Deliberations at the Conference showed that more attention should be paid to the development of data assimilation systems for cryospheric variables. Integration of studies of hydrological, biogeochemical and physical processes in cold climate regions was seen necessary for the success of future climate and Earth System models. Suggested

new large-scale initiatives include a reanalysis of the cryosphere as part of the overall climate system, establishment of polar ocean observing systems, development of multidisciplinary supersites covering regions with cryosphere, activities aimed at improved knowledge of the alpine cold processes, and creation of joint models able to simulate evolution of hydrological, biogeochemical and physical processes in cold climate regions. CliC was encouraged to continue its strong leadership in data management, including data rescue, standards, access and exchange and the linking of distributed archives ("network of networks").

A strong outreach and education component within CliC was suggested to serve scientists, educators, policy makers and the general public from all parts of the globe in several languages. To make CliC more relevant in practical terms, its co-operation with the impacts and assessment communities should be strengthened. Many participants stressed that the future CliC would depend on its ability to engage and develop the talents of young scientists.

The Conference supported the implementation of the WCRP CliC project in the four project areas as was outlined in the draft Implementation Strategy Document and strongly encouraged the wide and active participation of the cryosphere and climate science community in the project implementation. National and regional CliC activities and research conducted by partner projects, programmes and organisations were seen as providing building blocks for the project implementation. The Conference urged national and international funding agencies to provide adequate support for these activities.

CliC subsequently initiated discussions with other programmes, such as the World Climate Programme and the International Arctic Science Committee, aimed at strengthening co-operation particularly with the impacts and assessment communities.

8.2 CliC Implementation Strategy

The International Project Office and JPS for WCRP, with help from the CliC SSG, completed the *CliC Implementation Strategy Document*. It is available on the project website at the following URL: http://clic.npolar.no/introduction/wcrp_inf_2005_126.pdf. Many recommendations received from the participants at the CliC Conference were incorporated into the final version of the document. The document will continue to evolve as the project develops.

8.3 Arctic Research Planning

The CliC community actively participated in the *Second International Conference on Arctic Research Planning* (ICARP II 10-12 November 2005). The CliC Chair was a member of the ICARP II Steering Committee. ICARP II planning documents outlining main directions of Arctic research with a 10-15-year perspective contain many elements of importance to CliC. The plan will be presented at the Arctic Summit Science Week 2006 to be held in Potsdam, Germany, on 22-29 March 2006. CliC was recognised as one of lead programmes coordinating research on the cryosphere system in the Arctic, including the terrestrial cryospheric and hydrologic processes and systems.

8.4 CliC Project Area 1 (CPA1: "The terrestrial cryosphere and hydrometeorology of cold regions")

The draft plan of the *ICARP II Working Group 7 on terrestrial cryospheric and hydrologic processes and systems* is available at http://www.icarp.dk/WGreports/WG7report.PDF. CliC has contributed to this plan and, if it is successfully implemented, many CliC objectives will be met. In accordance with the MoU between CliC and the *International Permafrost Association* (IPA), IPA continues to actively and productively contribute to CPA1 goals. A European Conference on Permafrost took place in Potsdam, Germany, on 12-16 June 2005. A cluster of permafrost-centred proposals is coordinated by IPA. CliC has agreed to cosponsor the Regional International Permafrost Conference in Lanzhou, China, in August 2006.

The *CliC – IPA – Global Carbon Project (GCP) initiative on carbon stocks in permafrost* is actively developing. The ICSU approved an application for holding a seminar on this topic, which was prepared by IGBP on behalf of the three partners. Dr P. Kuhry of Sweden is leading the initiative. Several groups are participating. The objective is to assess carbon stocks that have the potential of being released to the atmosphere from permafrost thawing up to a certain depth. The outcomes of the project will be available in a database and it will be possible to use these estimates in the climate and Earth System modelling. An IPY submission on this item is being prepared.

CliC's cooperation with the *North Eurasia Earth Science Partnership Initiative* (NEESPI) is developing. Both the ACSYS/CliC SSG – IV (St. Petersburg, Russia, November 2003) and CliC SSG – I

(2004) and SSG – II (2005) endorsed NEESPI as a valuable potential contributor to CliC goals. CliC participants will attend the first NEESPI science meeting in Vienna (22-24 February 2006). The Northern Eurasia Water-energy Cycle Study Group in Japan, which used to be the core of the GAME-Siberia and Mongolia group, is considering an activity similar to NEESPI for the coming ten years. It will be related to cryosphere, atmosphere, biosphere interaction and changes.

After many years of efforts, the plans of ACSYS to initiate an Arctic component of the World Hydrological Cycle Observing System (*Arctic-HYCOS*) have started to materialise under CliC. Using the opportunity created by the IPY planning, CliC, in cooperation with the WMO Hydrology and Water Resources Department, was able to establish a consortium of interested participants. Dr Á. Snorrason of the Hydrological Service of Iceland very ably leads the project. The Arctic-HYCOS is a part of a larger IPY project entitled IPY- HYDRA, the Arctic Hydrological Cycle Monitoring, Modelling and Assessment Program. The activity contemplates the establishment of Long Term Hydrological Observatories (LTHOs) or "supersites". They will collect basic hydrologic data such as precipitation, stream flow, groundwater levels etc. as well as meteorological and biogeochemical data; be used to improve atmospheric, hydrological and cryospheric process representations and also to evaluate meso-scale representations in models and assess model performance and sensitivity in multi-criteria prediction; build the platform for developing the "supersites" of monitoring and research activities identified by the ICARP II programme.

Studies of the cold region hydrological cycle cannot be organised separately from the GEWEX activities. CliC Chair took part in the eighteenth Session of the GEWEX SSG in Dakar (9-13 January 2006). CliC is attempting to involve more reference stations in the WCRP Coordinated Enhanced Observing Period (CEOP). A *Coordinated Enhanced Polar Observing Period (CEPOP)* idea is being investigated by the CEOP Team jointly with CliC. A related IPY project proposal is being prepared. Establishing one or two CEOP reference stations in Antarctica and several stations in the Arctic are being considered.

Precipitation, especially *solid precipitation*, is a key component of the cryosphere. Yet, its accurate measurement in cold climate regions – high latitudes, ice covered regions and alpine areas globally – has been an elusive task. CliC initiatives have included development of a long-term bias adjusted monthly precipitation dataset for the Arctic, which is being used for climate model (ERA40) validation and hydrology model (VIC) analysis over the Arctic regions. CliC is discussing with Global Precipitation Climatology Centre (GPCC) the production of precipitation datasets in cold climate regions, as was done for the ACSYS datasets. The challenges, issues and gaps identified at the CliC-GEWEX workshop on precipitation form the basis for future action. However, the prospect of a satellite capability to measure snowfall and light precipitation at high latitudes faces a significant setback with the decision not to proceed with EGPM. CliC will continue to work with the satellite community on the contribution from Cloudsat and GPM and with the International Precipitation Working Group and the GEWEX Radiation Panel on the approach for modelling and retrieval of snowfall, including validation, from satellites. And it will work with GEWEX on the continuing effort to validate precipitation products produced by the Global Precipitation Climatology Project (GPCP) at high latitudes and over mountain regions. Dr Daqing Yang has agreed to serve as CliC precipitation rapporteur to lead the development, in consultation with others, on a strategy for developing and validating precipitation products in cold climate regions. CliC supports precipitation issues being addressed on a WCRP-wide basis. The best mechanism for this remains to be defined.

Dr R. Essery coordinates activities of the second Snow Model Intercomparison Experiment (*SNOWMIP2*). SnowMIP2 is coordinated by a working group of the IUGG Commission for the Cryospheric Sciences (CCS) and is jointly sponsored by WGNE, GEWEX and CliC. It is an intercomparison of simulations and observations of snow and energy fluxes beneath coniferous forest canopies and in nearby clearings.

CliC is trying to develop a branch of research focussed on *climate and alpine cryosphere*. In 2005, first meetings took place between WCRP CliC and the Mountain Research Initiative (MRI). The representatives of CliC and MRI identified the following areas of potential mutual interest: establishing a Pole – Equator – Pole network of alpine cryosphere monitoring stations, conducting WCRP CEOP type research in an alpine region and establishing high altitude research stations, e.g. in Himalayas. Professor. R. Barry, Director of the U.S. National Snow and Ice Data Center has been nominated the CliC Alpine Rapporteur. CliC Chair and the Rapporteur intend to work with the new WCRP Director exploring the idea of proposing a chapter on mountains for the fifth IPCC Assessment Report.

8.5 CliC Project Area 2 (CPA2: "Glaciers, ice caps and ice sheets, and their relation to sea level")

The CPA2 leading group of scientists met in Beijing during the CliC Conference. They discussed the most important directions for activities aimed at assessing the cryospheric contribution to sea-level rise.

Increased uncertainty of the current thermal expansion estimates is an additional factor adding interest to the estimates of cryospheric contribution. The group realised that a new level of accuracy in estimates of ice sheet and glacier mass balance was required. Open questions concern iceberg calving, the importance of basal melt, the need to downscale using climate models, the need to give account to the post-glacial rebound and to consider the effects of subglacial hydrology. The CPA2 group continues to work with satellite data. Two workshops are proposed for 2006/2007 focusing on assessment of ice calving and bottom melt of floating ice tongues/ice shelves from large ice sheets and on modelling and observations of solid precipitation over ice sheets, ice caps and ocean surfaces. CPA2 issues will comprise an essential part of the WCRP Workshop "Understanding Sea-level Rise and Variability" to be held in Paris, France, on 6-9 June 2006.

A contribution to CPA2 (and CPA4) is expected also from a new project "Assessment of modelling uncertainties in long-term climate and sea level change projections (ASTER)". It started in 2005 and is funded by the Belgian Federal Science Policy Office's Research Programme on Science for a Sustainable Development.

8.6 CliC Project Area 3 (CPA3: "The marine cryosphere and its interactions with high latitude oceans and atmosphere")

CliC is acquiring momentum in studies of sea ice. Dr C. Haas of the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany, succeeded Professor. P. Wadhams at the technical Coordinator for the WCRP/SCAR *International Antarctic Buoy Programme* (IPAB). The fifth meeting of the Programme participants took place in Dunedin, New Zealand, on 3-4 December 2005. Plans for more active buoy deployments are in preparation. CliC has agreed to co-sponsor, along with SCAR, the Antarctic Sea Ice Processes and climate (ASPeCt) program. An organisational meeting for ASPeCT IPY activities was held in Dunedin, New Zealand on 4 December 2005 and was attended by CliC representatives.

An *Antarctic Sea-Ice Thickness International Workshop* is being planned for 5-7 July 2006 in Hobart, Tasmania, Australia. CliC representatives participated in a *European Science Foundation Workshop on new perspectives of sea-ice research* for the next 10 to 20 years. Contacts have been established with the Ocean – Atmosphere - Sea Ice – Snowpack (*OASIS*) and Air – Ice Chemical Interaction (*AICI*) initiatives.

CliC representatives are active in the new major project entitled *Developing Arctic Modelling and Observing Capabilities for Long-term Environment Studies* (DAMOCLES). The first meeting of the project took place on 19 and 20 December 2005 in Paris, France. The goal of DAMOCLES is to develop an integrated ice-atmosphere-ocean monitoring and forecasting system designed for observing, understanding and quantifying changes in the Arctic lower atmosphere, sea-ice and the upper ocean.

The "*GlobIce*" project started in 2005. It is funded by the European Space Agency (ESA) with CliC being the "champion user" and aims at a very high resolution sea-ice motion, deformation and flux mapping using 14-year archive of ERS and ENVISAT data (more than 500 000 SAR/ASAR scenes) combined with available in-situ data.

The fate of sea ice in the Arctic Ocean and surrounding seas attracts ongoing media attention. The sea ice is expected to continue its marked decline through the 21st century, yet the research on sea ice remains largely unfocused. CliC aims to review sea-ice modules of IPCC-class of climate models, provide a platform for intercalibration of various sea-ice retrieval algorithms, provide support for more intensive and coordinated development of sea-ice data assimilation techniques and generation of sea-ice climate data products. Participation of the many groups involved in sea-ice observations, services, modelling, data handling and processing is sought. Organisation of the next *large international conference on sea-ice* needs to be considered.

Expectations were high for progress in sea-ice and land-based cryosphere associated with the planned start of operations of the *CryoSat*, an ESA Earth Explorer series satellite. Unfortunately, its October 2005 launch failed, and the satellite was lost. The WCRP JSC, CliC SSG, and IGOS-Cryosphere Theme Chairs wrote a letter in support of the satellite rebuild and re-launch. The ESA Council at ministerial level (Berlin, Germany, 5-6 December 2005) approved funds for a replacement mission for CryoSat. It may fly as early as 2009. The silver lining is that much more effort has gone into analysis of other altimeter data from ERS satellites and IceSat, and results on sea ice thickness has been presented at several meetings. NASA is considering a possibility of an *ICESat-2* mission. This mission would be very much welcomed by CliC.

The CLIVAR/CliC/SCAR *Southern Ocean Implementation Panel* met in Cambridge on 27-30 June 2005 and held a workshop on modes of Southern Hemisphere Climate Variability. CliC (and "cryospheric" expertise) is now better represented on the Panel.

8.7 CliC Project Area 4 (CPA4: "Links between the cryosphere and global climate")

CliC received and discussed the constructive comments offered by the JSC last year on the broad scope initially proposed by CPA4. It has since focused on more specific actions to meet its broader objectives. The *CliC Arctic Climate Panel* (ACP) will contribute to meeting both CPA3 and CPA4 objectives. ACP will soon become officially co-sponsored by CLIVAR. A meeting of the ACP took place during the CliC Beijing Conference. The Panel will work in cooperation with the International Study of Arctic Change (ISAC), U.S. Study of Environmental Arctic Change (SEARCH), the Arctic – Subarctic Ocean Fluxes (ASOF) and in coordination with the Arctic Ocean Sciences Board and some other international bodies. The scope of ACP intended activities is wide and includes both theoretical studies of Arctic climate and the role of Arctic in global climate as well as recommendations on field (observational) activities in the region. The group proposes to SPARC and CLIVAR to hold a joint workshop on arctic modes of atmospheric variability. There are several opportunities to organise the workshop in close cooperation with interested parties and to ensure a strong composition of contributors. Development of sea-ice models, Arctic Ocean circulation models and their implementation in the IPCC-class of climate models is also an important focus for the Panel. Another issue of high priority is the development of the Arctic Ocean Observing System. ACP was involved in the preparation of several IPY proposals and is taking part in proposals prepared by others.

Cooperation with SCAR is expanding. Two developing research programmes are of direct relevance for CliC. They are "*Antarctica and the Global Climate System* (AGCS)" and "Antarctic Climate Evolution (ACE)". The AGCS encompasses studies of decadal variability, global and regional signals in ice cores, natural and anthropogenic forcing of the Antarctic climate system, and the export of Antarctic climate signals. The program concerns the links between the Antarctic and the rest of the climate system and fits to the Earth System approach. It is hoped that it will be able to provide advice to assessments such as IPCC and address questions of serious public concern, such as the Antarctic Peninsula warming. Within the AGCS the studies of the Southern Annular Mode are continuing.

CliC is organising a mini-workshop on *polar reanalysis* in April 2006. One of the key foci will be a reanalysis in the Southern Hemisphere, in data sparse areas. The scope of the workshop is under discussion. This workshop is a step towards realising the idea of cryospheric reanalysis as a part of the global climate reanalysis.

8.8 Cryospheric Observations

The Integrated Global Observing Strategy Partnership (*IGOS*-P) *Theme on Cryosphere* is progressing. The first draft of the report is expected at the end of April 2006. JAMSTEC has offered to host a meeting of the core writing group and some potential contributors from Asia. It will take place in Yokohama on 24-25 April 2006. JAXA and JAMSTEC are providing financial support.

The GCOS Implementation Plan relies on CliC and the IGOS-P Theme on Cryosphere as main implementation agents for several key actions in its Oceanic and Terrestrial domains.

8.9 Cryosphere as Indicator of Climate Change

CliC, in cooperation with the International Glaciological Society and the IUGG Commission for Cryospheric Sciences, is organising an International *Symposium on Cryospheric Indicators* of Global Climate Change, Cambridge, UK, 21-25 August 2006. The Symposium programme will include:

- observed historical changes in the cryosphere;
- processes that lead to changes in the cryosphere and how these make interpretation difficult;
- actual records of climate in cryospheric regions, and their relation to changes in the cryosphere including statistical/model interpretation;
- extension of climate records back in time, using observations of cryospheric changes;
- synthesis of records by geographical region, and ultimately globally;
- linkage of historical cryospheric records to palaeo-records of climate; and
- modelling of all of the above.

Selected papers from the symposium will be published in the IGS Annals of Glaciology.

8.10 Data and Information Management

A meeting of the CliC *Data Management and Information Panel* (DMIP) was convened on 9-11 June 2005 in Boulder, USA. DMIP will continue the development of the Data Information Service for CliC. CliC is ready to share the solutions of its data and information service with the rest of the WCRP. CliC's proposals on data management served as the basis for those proposed in the Framework document for the International Polar Year 2007/2008. It is recognized that there is a need for improved data management, in particular for in situ data. The IPY will provide momentum to help improve the amount and quality of data submitted to data centres. Funding agencies need to be encouraged to adequately fund data management activities.

8.11 CliC Structure

The project structure continues to evolve. While the CliC project areas (CPAs) will have oversight to most of the project, different groups and panels will be formed and dissolved as required.

CPA1 and CPA2 Panels will oversee implementation of respective project areas. The CliC/CLIVAR Arctic Climate Panel (after its sponsorship has been approved by the CLIVAR SSG) and CLIVAR/CliC/SCAR Southern Ocean Implementation Panel will focus on issues mostly related to CPA3 and CPA4.

The modelling activities will likely be further divided into terrestrial and marine domains on different time scales to better fit with the COPES activities. Discussions have been initiated about the best way to implement additional cryospheric processes into GCMs and RCMs, including polynyas, ice sheets and ice shelves. Dr D. Verseghy has been nominated as rapporteur for terrestrial cold climate processes.

8.12 CliC's contribution to WCRP's Strategy and cooperation within and beyond the WCRP

The snow cover in Eurasia and, potentially, due to its high interannual variability, the Arctic sea-ice may lead to the existence of predictability at seasonal scales, which would be additional to the predictability exploited in currently existing schemes. However, a well calibrated and commonly accepted data set on snow and sea ice is lacking. This data set would be an important CliC contribution to activities of the *Task Force on Seasonal Prediction,* (TFSP). CPAs 1 and 3 and DMIP will address this issue. Cooperation with GEWEX and CEOP is essential for the success of these plans.

In addition, through the South Ocean Implementation Panel (SOIP), Arctic Climate Panel (ACP) and Antarctic and the Global Climate System (AGCS), CliC is able and willing to contribute to studies of polar variability that are the subject of CLIVAR and SPARC investigation.

CliC is a key direct contributor to the WCRP *sea-level change* studies.

Advances in ice-sheet modelling are central for simulation of Ice Age cycles and hence contribute directly to the *development of the new generation of* more capable *Earth System models*.

CliC is building a wide network of partners within and outside WCRP. Some of them are indicated above. CliC strongly relies on cooperation, especially in the CPA1 and CPA3. A very important partnership is with the strengthening IUGG Commission for Cryospheric Sciences (CCS). The next CCS Bureau meeting will be hosted by the WCRP JPS.

Links are getting stronger with the Ocean Observations Panel for Climate and the Terrestrial Observations Panel for Climate.

SCAR is now a recognised co-sponsor of CliC, Southern Ocean Implementation Panel, International Programme for Antarctic Buoys. CliC and SCAR lead the IGOS-P Theme on Cryosphere. However, the financial contribution of SCAR to all these activities is extremely modest.

8.13 CliC's national and regional activities

National Committees for CliC exist in China, Japan and Russia. A regional grouping is being developed in Asia with the second Asia CliC to be held in Tokyo, Japan, on 20-22 April 2006, organised by Dr T. Ohata, and co-sponsored and hosted by JAMSTEC. Some national projects (like the Cryosphere System in Canada (CRYSYS)) consider themselves parts of the CliC community.

Operation of the CliC International Project Office (CIPO)

The Norwegian Polar Institute (NPI) continues to host and support the CliC International Project Office (CIPO) in Tromso, Norway. Support for its operations comes from several other sources, but augmented resources are required. Dr V. Lytle of USA/Australia was selected to succeed Dr C. Dick, the previous director of CIPO who resigned in summer 2005. She started her four-year appointment in September 2005. CliC is interested in expanding the office and is ready to operate it in a "distributed mode" with staff located in different countries.

Main questions for the JSC

- The most effective way to best organise CliC modelling, which needs to focus both on ocean and terrestrial issues.
- Engagement of leading centres in the coordinated development of cryospheric modules suitable for modern climate models and/or NWP schemes.
- Facilitation of the involvement of all interested parties in the development of sea-ice observations, data assimilation, and production of quality controlled and calibrated data sets for sea-ice parameters, with a perspective to start the production of reanalysis.
- Global precipitation as a WCRP-wide issue.
- Data management as a WCRP-wide issue.
- Engagement of more countries in CliC, both developed and developing. Resources for WCRP, CliC activities, and functioning of the project office.
- Further contribution of CliC to WCRP Strategic Framework: 2005- 2015.

8.14 WCRP participation in IPY 2007-08

At its 25th session in Moscow, March 2004, the JSC gave an assignment to CliC to stimulate and coordinate the preparations for IPY on behalf of the WCRP. WCRP representatives were instrumental in building links between the WMO and ICSU in their approaches to the IPY, participated in the discussions of IPY ideas and plans and solicited substantial input to the IPY planning from the WCRP community.

All WCRP core projects were active in proposing projects in their area of interest. WCRP is a leading international agency of 20 proposals. In general, these proposals reflect the bi-polar nature of IPY and the concentration within WCRP on the physical environment. The WCRP proposals are in the ocean, atmosphere, data and ice sections of the chart. There are no WCRP proposals in Education, Outreach, Earth or People categories, although some projects will cross-cut these topics.

The proposed activities if they receive funding should comprise a very significant effort in 2007-2008. Many of these projects will be executed with partners and other organizations. The results should be expected not only in the area of interest of core projects. Indeed, IPY may very strongly contribute to several cross-cutting WCRP activities such as studies of predictability on different time scales, atmospheric chemistry and climate, anthropogenic climate change, sea-level rise etc.

Future Activities and Meetings

Future IPY activities will include preparation and publication of a Science Plan for IPY by May 2006; conducting of the IPY Consultative Forum meetings during the Arctic Science Summit Week (Potsdam, Germany, 21-28 March 2006) and SCAR Open Conference (Hobart, Australia, July 2006); organization of a JC meeting linked with Project Coordinators Meeting and Open Forum (November 2006) and opening a Science Symposium highlighting the IPY planned work (March 2007, at the beginning of IPY).

The JSC thanked Dr B. Goodison for his report on the progress of the CliC project. The JSC urged CliC to take steps to provide inputs to modelling groups with a view to improving collaborations and the transfer of new modules to WGCM, WGNE, WGSIP, WMP and TFSP.

9. STRATOSPHERIC PROCESSES AND THEIR ROLE IN CLIMATE (SPARC)

Professor. A. O'Neill, Co-Chair of the SPARC Scientific Steering Group (SSG), presented the main recent developments in SPARC since the last JSC meeting, including the principal items and recommendations from the thirteenth session of the SPARC SSG held in Oxford, United Kingdom, 26-29 September 2005.

9.1 Project objectives and approach

The goals of the SPARC programme are encapsulated within three main themes: (1) detection, attribution and prediction of stratospheric changes, (2) stratospheric chemistry and climate, and (3) stratosphere – troposphere coupling. These main themes are complemented by a number of projects that have a specific focus.

9.2 Upcoming SPARC results

(a) Assessment of Stratospheric Aerosol Properties (ASAP). The final version of this report is in the hands of the SPARC IPO. Printing will be completed by the end of February 2006.

(b) SPARC Polar Stratospheric Cloud (PSC) Assessment (SPA). The motivation for initiating this assessment activity is the existence of significant gaps in understanding that are relevant to stratospheric chemistry: the lack of consensus on how to describe PSCs and denitrification in global models, the limited and selective use of PSC observations, and the risk of instrument-dependent climatologies since intercomparisons are rare, as well as the lack of a large-scale consistent and evaluated data set for model testing. A lead authors kick-off meeting was held May 2005. A report on this meeting was published in SPARC Newsletter No. 25 (July 2005), available from the SPARC IPO and posted on the SPARC web site at: (http://www.atmosp.physics.utoronto.ca/SPARC).

9.3 Status of the three main streams of SPARC activities

Detection, Attribution and Prediction of Stratospheric Changes

The main thrust of this theme at the moment is the updated trend assessment. The scope is to provide an update of the observed stratospheric temperature record (through 2004), and improve the understanding of past changes and predictions of future stratospheric temperature changes, especially by reducing uncertainties in the predictions. The first meeting occurred in March 2005 in Reading, UK, to plan the scope of the project and to take an initial look at the updated observations. It was decided that the group would first write a paper on the updated observations, with a focus on satellites, radiosondes and lidar data.

Key features of the updated temperature trends are summarized in the report on the thirteenth session of the SPARC SSG published in SPARC Newsletter No. 26 (January, 2006). Key issues in preparation of the updated assessment are (1) that the stratospheric temperature record is highly dependent on SSU data (currently, there is only one analysis of combined SSU record), and (2) that there are small trends in tropical lower stratosphere in MSU4 and SSU15x data, which are very different from the ones obtained using radiosonde data.

Stratospheric Chemistry – Climate Interactions

This theme is of major importance for SPARC, and is epitomized by the CCMVal (chemistry-climate model validation) activity, now the umbrella for chemistry-climate modelling, interactions with other agencies such as IGAC, and for the role of SPARC in the Atmospheric Chemistry and Climate Task Force. These considerations have prompted SPARC to broaden its mandate to include the upper troposphere within its scientific scope (and, perhaps even the lower troposphere). A key concern for this theme is identifying and addressing the needs for future assessments by the community. The CCMVal activity is a response to the need for a consistent evaluation and validation of coupled chemistry-climate models (CCMs) with detailed descriptions of the stratosphere, which have been developed over the last 5-10 years. These CCMs provide valuable indications of how stratospheric ozone will evolve, in the presence of a changing climate, as halogen concentrations decline in an atmosphere (e.g., WMO, 2003). The high complexity of CCMs requires a process-based systematic evaluation in order to determine whether the models are representative of the atmosphere and to help quantify the uncertainty of the model results.

In consultation with the CCM community, CCMVal has proposed reference simulations for ensemble predictions to support upcoming ozone and climate assessments (published in SPARC Newsletter No. 25). In order to serve the CCM community, and to facilitate the set-up and encourage the use of the reference simulations, a website from where the forcings for the simulations can be downloaded has been established. The proposed scenarios were developed to address key questions identified by the WMO/UNEP Scientific Assessment of Ozone Depletion 2006 Steering Committee to be of significance to the assessment. A significant fraction of the conclusions in the upcoming assessment of the impact of climate change on the future of the ozone layer will be derived from the CCMVal runs and their analyses.

The second CCMVal workshop was held at the National Center for Atmospheric Research (NCAR), Boulder, USA, on 17-19 October 2005. The goals of the workshop were to assess the progress in the validation of CCMs following the guidelines developed in the first CCMVal workshop, and to assess how CCMs can support the upcoming WMO/UNEP and IPCC Assessments. Approximately 90 members of the atmospheric and climate communities from Europe, the United States, Canada, Japan and New Zealand attended the workshop to take stock of the progress and to identify near-term and long-term goals within the validation framework. The attendees included representatives from nearly all the major stratospheric CCM groups in the world. A detailed report on this workshop is published in SPARC Newsletter No. 26 (January 2006).

A large number of SPARC members are the lead authors for the WMO/UNEP 2006 Ozone Assessment and Drs T. Shepherd, M.-L. Chanin and A. Ravishankara are on the scientific steering committee. CCMVal runs will be a major input. Additionally, many of the SPARC assessments (ASAP, temperature trends, PSC report) and the joint SPARC/IGAC UTLS workshop in May 2005 have provided basic input.

Stratosphere–Troposphere Dynamical Coupling

Several of the activities within this SPARC theme are relevant to task forces and coordinating bodies that have been established within the WCRP to facilitate implementation of new Strategic initiatives. The Task Force on Seasonal Prediction (TFSP) aims to determine the seasonal predictive skill achievable with today's models and observations. Of particular interest to SPARC is the role of the stratosphere in weather and climate prediction. The timescales considered are medium range to seasonal (10 days to several months), interannual (involving internal variations as well as responses to 'external' forcings such as the QBO and ENSO), and interdecadal and longer (involving changes in the Brewer-Dobson circulation and in the polar vortex). Recent work on predictability and downward propagation of the Northern Annular Mode is indicative of the potential importance of stratosphere-troposphere dynamical coupling for long-term prediction.

9.4 Crosscutting and supporting activities

Data Assimilation

The activities of the SPARC Data Assimilation (DA) Working Group (SPARC-DAWG) focus on dynamical, physical and chemical aspects of middle atmosphere data assimilation and on science issues that drive the need to improve assimilation techniques and draw on experts in SPARC themes. Middle atmosphere data assimilation has to deal with problems such as bias, accumulation of errors over long time scales, large mesospheric variability and vertical coupling. The goals of the SPARC-DAWG are achieved through holding thematic workshops, preparation of reports and review articles, and intercomparison/collaborative projects. A recent Joint SPARC Workshop on DA and Stratospheric Winds was held in Banff, Alberta, Canada, in September 2005 and was very successful. A report of this workshop is published in SPARC Newsletter No. 26 (January 2006). The next SPARC-DA workshop will be hosted by KNMI (the meteorological service of the Netherlands), and will be held in Noordwijk, the Netherlands, in conjunction with a workshop on the European Space Agency's forthcoming Atmospheric Dynamics Mission, from 26-28 September 2006.

The GRIPS Project

The GCM-Reality Intercomparison Project for SPARC (GRIPS) formally concluded with its tenth and last workshop, which was held in Toronto, Canada in March 2005. For the preceding decade GRIPS has had the role of evaluating and comparing different dynamical models of the stratosphere developed by the international community. A report on the final workshop is published in SPARC Newsletter No. 25 (July 2005) and a wrap-up article will be published in Newsletter No. 27 (July 2006). The chemistry-climate modelling component of GRIPS has been incorporated into the CCMVal activity, in which the main focus is processes-oriented validation, and the solar influences aspects have continued as the SOLARIS activity in collaboration with SCOSTEP (see below). There remain a number of first-order questions about GCM performance that were also part of the GRIPS mandate. These include modelling issues - such as the ability of GCMs to represent polar vortices, sudden warmings and final breakdowns, stratosphere-troposphere relationships, tropical dynamics and stratosphere-troposphere exchange - that are not directly addressed within the CCMVal and SOLARIS activities. Efforts are under way within the SPARC community to develop a new activity that will continue to address these issues

SPARC Data Center

The Data Center (DC) underpins many of SPARC's activities. In the coming years it will have to serve the increasing needs of the CCMVal projects as well as the demands associated with SPARC's involvement in the IPY (summarized below). The DC has been operational since July 1999 at Stony Brook University, NY, and was until recently supported by NASA. Professor M. Geller, founding Co-Chair of SPARC, has continued as director of the DC. Dr S. Liess from Stony Brook University is serving as the SPARC DC Scientist. A request has been made for renewed funding including support for upgrading of capacity. Currently the SPARC DC has a total of approximately 40 Gb of data holdings. Proposed upgrades would increase this capacity to 3.0 Tb plus seven cartridge slots for a capacity up to 1.1 Tb on tapes. This upgrade is critical for expected future needs of the CCMVal project and for the data archiving anticipated for SPARC-IPY. Additional features, which the SPARC DC hopes to provide in the future, include an online plotting capability and enhanced security. Last year, the SPARC Scientific Steering Group requested that the SPARC scientist become a full-time position. Thus, the position for the research scientist is proposed to be 50% DC administrator and 50% research scientist within SPARC.

SPARC Project Office

The SPARC International Project Office moved to the University of Toronto in 2004 and currently operates within the Department of Physics with a full-time Office Manager (V. De Luca), a part-time Project Scientist (Dr D. Pendlebury) and the Director (Dr N. McFarlane – also part time and also Scientist Emeritus at the Canadian Centre for Climate Modelling and Analysis, University of Victoria). The operation of the SPARC IPO is supported by contributions from the Canadian Foundation for Climate and Atmospheric Science (CFCAS), the Canadian Space Agency (CSA) and Environment Canada.

Since it was established at the University of Toronto, the SPARC IPO has continued to pursue its traditional activities which include (a) maintaining ongoing contacts and interaction with the SPARC SSG, the JPS of WCRP, WCRP projects, IGBP, other partner programmes, and with the SPARC community of scientists; (b) organization and support of SPARC meetings and workshops; (c) compiling, editing and publishing of SPARC Newsletters (2 per year - Newsletters 24, 25, and 26 have been produced in Toronto to date); (d) routine activities such as updating the SPARC mailing list, maintaining the SPARC website; and (e) preparation of SPARC reports for publication (the ASAP report is the most recent). In addition, within the last year the SPARC IPO has organized production of an article for the WCRP 25th Anniversary collection in the WMO Bulletin and has prepared an Expression of Intent and an activity proposal for SPARC's participation in IPY.

9.5 Linkages with programmes and projects within and outside WCRP

Interactions within the WCRP

In the context of the WCRP Strategic Framework: 2005- 2015, a wider range of questions will be considered in future SPARC activities and this will increasingly involve closer ties and collaborations with other projects and groups within the WCRP. The SPARC themes and activities emphasising prediction, predictability and observations map directly onto COPES and complement corresponding activities within the other WCRP projects, working groups and panels. In addition to mandating a leading role for SPARC in establishing the joint WCRP-IGAC Task Force on Atmospheric Chemistry (see the report on this activity), the JSC has also encouraged and endorsed other new collaborative activities between SPARC and other projects within the WCRP.

SPARC/CLIVAR Interactions

At the 2005 meeting in Guayaquil, the JSC strongly encouraged SPARC and CLIVAR to collaborate. Opportunities to collaborate were explored further at the joint SPARC-CLIVAR session at the AMS meeting in June 2005, which served to highlight a number of overlapping SPARC and CLIVAR interests:

- Stratosphere-troposphere coupling and the North Atlantic Oscillation (NAO)
- Detection, attribution and prediction of stratospheric changes and the CLIVAR themes of climate change detection, attribution and prediction
- Chemistry-Climate Interactions (IGBP/IGAC)

A joint CLIVAR/SPARC Workshop on the NAO in the "Fully" Coupled System was proposed, probably in 2007. This workshop will focus on mechanisms, and NAO predictability and timescales. A goal of the workshop is production of a reader-friendly review article on the state of knowledge and prospective future activities.

SPARC/GEWEX Interactions

At the Guayaquil meeting the JSC encouraged partnering of SPARC and GEWEX to develop a new initiative to exploit cloud-resolving models to understand processes in the tropopause transition layer. Further discussion at the Pan-GCSS workshop in Athens, May 2005, has led to the organisation of a workshop entitled: Modelling of deep convection and its role in the tropical tropopause layer (TTL). This workshop will be jointly sponsored by SPARC, GEWEX/GCSS and IGAC. The purpose of the workshop is to bring together expertise from the SPARC, GEWEX and IGAC communities to initiate collaborative activities to study key processes within the TTL. The goals of the workshop are to discuss key scientific questions and recent results, develop research strategies and evaluate modelling and observational capabilities and constraints. This workshop will be held in Victoria, BC, Canada, 12-16 June 2006.

SPARC/IGAC Interactions

IGAC activities address two important questions: (a) what is the role of atmospheric chemistry in amplifying or damping climate change? and (b) within the Earth System, what effects do changing regional emissions and depositions, their long-range transport and chemical transformations have on air quality and the chemical composition of the planetary boundary layer? The science involved in dealing with these questions has much in common with SPARC themes, particularly that of chemistry-climate. SPARC-IGAC interactions that have taken place or are in progress include: (a) the SPARC/IGAC Chemistry-Climate Workshop (Giens, 2003); (b) the SPARC/IGAC Workshop on processes controlling mid-latitude UTLS chemical composition (Mainz, 2005); (c) the forthcoming SPARC-GEWEX-IGAC workshop on modelling of deep convection and its role on the TTL; (d) the POLARCAT (IPY) Project; (e) parts of the IGAC AICI project, i.e. ice phase chemistry; and (f) discussions on next steps at both SPARC/IGAC and WCRP/IGBP level.

The SPARC/SCOSTEP Joint Theme on Solar Influence on Climate

The SPARC initiative on Solar Influences on Climate has until recently been a component of the GRIPS project. However, although the GRIPS project has ended, this initiative has continued as the SOLARIS Project (Solar Influence Study for SPARC), a follow-on project from the GRIPS solar influences activity, in collaboration with the SCOSTEP CAWSES program. Dr K. Kodera is the leader on behalf of SPARC. There are currently 13 participating modelling groups, and there are new aspects that go beyond the original GRIPS comparisons. These include modelling solar influences using fully coupled models with oceanic components, chemistry, resolved mesosphere and, for some groups, extensions into the thermosphere. A SOLARIS planning meeting was held in Toulouse in July 2005. Several coordinated studies are currently under way: (i) TMST-model (thermospheric and mesospheric response - coordinated by Dr V. Fomichev); (ii) CCM Ozone and temperature response (continuation from GRIPS coordinated by Dr U. Langematz); (iii) AGCM Dynamical response and the role of the QBO (coordinated by Dr L. Gray).

9.6 Participation of SPARC in the International Polar Year 2007-2008 and International Geophysical Year

The IPY programme offers a unique opportunity for SPARC to assemble a range of scientific expertise to study the Antarctic and Arctic Polar Vortices, the loci of key chemical and physical processes associated with ozone depletion and its eventual recovery, as well as of key features of the dynamical coupling between the troposphere, stratosphere and mesosphere in polar and sub-polar regions. (See the summary article by Baldwin et al. in SPARC Newsletter No. 25).

In April 2005 The IPY Joint Committee (JC) awarded preliminary recognition of the Expression of Intent (SPARC-IPY, EoI #807), submitted on behalf of SPARC, and identified it as a lead EoI for Cluster 7.1 (IPY SPARC). A full activity proposal entitled *"The Structure and Evolution of the Polar Stratosphere and Mesosphere and Links to the Troposphere During IPY"* (IPY Activity 217, listed on the International IPY web site) was subsequently submitted in late September 2005 and has been awarded recognition by the IPY JC. The central goal of the SPARC-IPY programme is to document as completely as possible the dynamics and chemistry of the polar vortices and physical properties relevant to processes such as the formation of polar stratospheric clouds. SPARC-IPY will produce a comprehensive picture of the dynamics, chemistry and microphysical processes within the polar vortices during the IPY, supported by a well-organized data set of measurements and analyses of the polar stratosphere. SPARC-IPY will also co-ordinate the production of this data set and facilitate archiving of key components at the SPARC DC. The synthesis that will be provided by SPARC-IPY will emphasize the linkage between the current structure of the atmosphere in polar and sub-polar regions and its historical evolution and possible future states. The SPARC-IPY activity will be coordinated through the SPARC International Project Office and carried out in the context of the SPARC Project programme with the oversight of the SPARC Scientific Steering Group (SSG). Where possible,

individual projects that contribute to the programme will be affiliated with existing SPARC theme and group activities. National funding for specific sub-projects within this activity will be promoted. If needed, a separate working group will be organized to deal with overall management of the SPARC-IPY programme and facilitate interaction of the project teams. Key results will be presented under the auspices of the SPARC programme through production of reports, SPARC Newsletter articles and peer reviewed research publications. Also SPARC-IPY will establish links with the POLARCAT Activity (Activity No. 32, which has been endorsed by SPARC and IGAC), the ORACLE-O3 activity (Activity No. 99), the PANSY activity (Activity No. 9) and the IASOA activity (Activity No. 196).

Issues for consideration of the JSC

The JSC's attention was invited to the following issues of concern to SPARC:

1. How can SPARC, through the new WCRP Strategic Framework: 2005- 2015 (COPES), link more effectively to agencies, institutions and programmes that address the needs of the climate prediction user community?

Background: The WCRP programme does not deal directly with the delivery of climate predictions. Its role is to develop the scientific underpinning needed for climate prediction. COPES is an integrating framework for achieving this broad objective. Its stated aim is to facilitate prediction for use in a range of practical applications of direct benefit to society. (See WCRP Strategic Plan at http://www.wmo.ch/web/wcrp/copes.html).

But how is the WCRP going to ensure that its results are used by the agencies that provide weather and climate predictions (for example the major analysis and prediction centres)? For example, how is WCRP organized to deliver results to the IPCC? More specifically, how does SPARC respond to key IPCC questions? For example, how do stratospheric processes affect the surface climate? How can/should SPARC, and the WCRP in general, establish links and collaborations with IGBP and other components of ESSP to enhance its impact on climate predictions and address the requirements of the users' climate analyses and predictions (including medium range and seasonal predictions)?

2. How should SPARC reorganize its activities that deal with dynamical aspects of climate variability and change in the context of the Strategic Framework and in partnership with the other projects and programmes within the WCRP?

Background: CCMVal and SOLARIS are spin-off programmes from GRIPS with more focused programmes and mandates. However, much of the GRIPS programme dealt with dynamical aspects of climate variability in the context of climate modelling. This aspect of GRIPS has not yet been subsumed into a new programme. It is clear that this aspect of the GRIPS programme must be reorganized with a broader scope and closer links and partnerships with other relevant projects and activities within the WCRP. For example how can such a programme within SPARC mesh with the programme of the WCRP Modelling Panel?

3. How can SPARC address questions concerning the impact of stratospheric processes on biological systems?

Background: SPARC has developed effective partnerships with IGAC to address a range of chemistry-climate issues. However, the impact of stratospheric processes on biological systems has not hitherto been addressed in an organized way by SPARC. For example, how is photosynthetically active radiation (PAR) affected by changes in stratospheric ozone and other constituents?

Should SPARC partner with other IGBP programmes (e.g. AIMES) to address these questions?

4. Should SPARC realign or alter its plans to evaluate the role of chemical processes in the climate system, in light of the upcoming atmospheric chemistry and climate joint activities? If so, how should the realignment/alteration be oriented?

The JSC thanked Professor O'Neill for his presentation of the SPARC report. The JSC was pleased with the progress by SPARC, particularly progress in moving forward with the Chemistry and Climate initiative. The JSC agreed to set up, in consultation with SC-IGBP, a Task Force led by SPARC and IGAC as the core-organizers, determine its membership and its terms of reference on "Chemistry and Climate" in a two phased manner:

Phase 1: An initial modelling strategy to identify key tractable experiments designed to highlight the important processes concerning short-lived species.

Phase 2: long term vision (involving climate models and observations)
The time frame would be 3 years initially.
The JSC supported the new dynamic modelling initiative and expressed the view that there should be increased coordination of SPARC modelling with WMP. The JSC encouraged linkage of this initiative with the new IOC effort on marine chemistry and climate.

10. CLIMATE MODELLING

The fundamental unifying and integrating theme in the WCRP is the development of comprehensive global models of the full climate system, pulling together and building on the results provided by the other supporting discipline-oriented WCRP projects. Such models are the fundamental tool for understanding and predicting natural climate variations and establishing projections of climate change. Activities in this area in the WCRP are centred round two main groups: the CAS/JSC Working Group on Numerical Experimentation (WGNE) and the (WCRP) Working Group on Coupled Modelling. The Chair of WGNE, Dr M. Miller, summarized activities being undertaken under the auspices of WGNE concerned with the development of the atmospheric component of climate models, including a number of model intercomparison projects, the evaluation and intercomparison of surface flux fields produced operationally by NWP centres, reanalyses, NWP topics of interest such as verification and comparison of precipitation forecasts and developments in ensemble prediction and WGNE's role in THORPEX. Professor J.F.B. Mitchell, Chair of WGCM, reported on the wide range of WGCM initiatives, notably the Coupled Model Intercomparison Project and organization of carbon-cycle experimentation (jointly with IGBP/GAIM) that were leading to steady progress in the development of fully coupled atmosphere/ocean/land/cryosphere models fundamental to WCRP.

All the WCRP core projects have modelling working groups. In recognition of the central role of modelling in the new Strategic Framework, and the overriding need for coordination of this activity (including linking process modelling to GCMs), the JSC has established WCRP Modelling Panel (WMP). Its prime role is to promote, coordinate and integrate modelling activities across WCRP with the purpose of meeting the WCRP objectives, especially in the context of COPES. It will be necessary to assess models against metrics and periodically evaluate progress. The activities of this Panel during the past year have been described in section 4.3.

10.1 Report of Working Group on Numerical Experimentation (WGNE)

The following paragraphs briefly review the main activities of WGNE in support of WCRP objectives, emphasizing items arising at its twenty-first session, which was kindly hosted by the Voeikov Main Geophysical Observatory, St Petersburg, Russia, 7-11 November 2005.

10.1.1 Role of WGNE in support of WCRP

WGNE, as a joint working group of the JSC and CAS, has the basic responsibility of fostering the development of atmospheric models for use in weather prediction and climate studies on all space and timescales. In the WCRP, WGNE is at the core of the global modelling effort. There is clearly a need for co-ordination between WGNE, WGCM and WGSIP. Currently, the Chair of WGNE participates in an ex officio capacity in WGCM sessions. WGNE also works in close conjunction with the WCRP Global Energy and Water Cycle Experiment (GEWEX) in the development of atmospheric model parametrizations. WGNE sessions are held jointly with those of the "GEWEX Modelling and Prediction Panel" (GMPP).

WGNE is playing an active role in the planning and implementation of THORPEX, a Global Atmospheric Research Programme. WGNE now has specific THORPEX sessions at its meetings.

Beyond this, the close relationship that exists between WGNE and operational (NWP) centres underpins many of the activities by WGNE and it is the work of these centres that provides the major impetus for the refinement of atmospheric models. As usual, WGNE sessions include reviews of progress at operational centres in all aspects of NWP including data assimilation, numerical methods, physical parametrizations, ensemble predictions, seasonal prediction, and verification of precipitation and tropical cyclone track forecasts. WGNE also follows progress in various relevant national initiatives such as the Frontier Research Programme for Global Change in Japan. The need for good metrics for climate-type models is under discussion. WGNE will discuss this further also in the context of the new 'unified' prediction systems.

Reports on the new WCRP Panels are reported elsewhere with the WGNE Chair a member of WMP, with WGNE also represented on WOAP.

10.1.2 Studies and comparisons of atmospheric model simulations

Model intercomparison exercises are a key element in meeting a basic WGNE objective of identifying errors in atmospheric models, appreciating their causes and reducing or eliminating these errors.

AMIP, CMIP, WGCM and a proposed Workshop on Model errors

The Atmospheric Model Intercomparison Project (AMIP), conducted by the Programme for Climate Model Diagnosis and Intercomparison (PCMDI) at the Lawrence Livermore National Laboratory, USA, with the support of the US Department of Energy, has been the most important and far-reaching of the WGNE-sponsored intercomparisons. WGNE congratulated PCMDI for undertaking and successfully completing the AMIP projects (AMIP-II is now complete) and for creating a valuable infrastructure for processing model outputs at PCMDI and establishing efficient data formats etc. for such exchanges of model simulations. The recent outstanding achievements in the context of the IPCC AR4 were of particular note.

Acknowledging the lead role played by PCMDI and WGCM in this data management, WGNE felt that, in view of its own problems in this area, there was a need to widen this activity further. WGNE asked to be represented on the data oversight committee together with someone from the land surface modelling community.

AMIP-type studies will continue as a subset of CMIP in future and PCMDI has offered to receive high resolution NWP AMIP-type runs to complement their ongoing CMIP activities. WGNE thanked PCMDI for this suggestion and confirmed its interest in this. PCMDI have offered to be the local hosts for a pan-WCRP workshop on Model systematic errors in February 2007. This will be organized by PCMDI and WGNE with input from WGCM and GMPP.

"Transpose" AMIP

Transpose AMIP is a WGNE proposal for the intercomparison of weather forecasts made by climate models. The goal of the approach is to obtain the benefits for climate model development and evaluation that have been invaluable for weather prediction model development by applying climate models to weather forecasting. The method allows direct comparison of parametrized variables such as clouds and precipitation with synoptic observations, satellite and field programmes. Development of a complete analysis system is not needed. Initial conditions can be obtained from NWP reanalyses. The method allows direct comparison of parametrized variables such as clouds and precipitation with observations from field programmes such as ARM, early in the forecast while the model state is still near that of the real atmosphere. This is in contrast to the more traditional climate model statistical analysis based on the model simulated climate balance. In that approach the parametrizations see the erroneous climate model state rather than the true observed state. This WGNE initiative was initially prototyped/developed jointly by NCAR and PCMDI. The goal of the intercomparison is to encourage climate modelling groups to implement this forecast strategy into their development process and to compare the characteristics of current models.

The formal proposal for Transpose AMIP was ready and will be sent to climate modelling groups as soon as the AMIP mailing list at PCMDI is updated.

Aqua-Planet Experiments

WGNE continues to recognize the value of applying atmospheric models to simplified surface conditions for examining the behaviour of physical parametrizations and the interactions of parametrizations with the dynamical cores. In particular, "aqua-planet" experiments with a basic sea surface temperature distribution offer a useful vehicle in this regard. Thus WGNE had endorsed an intercomparison, the Aqua-Planet Experiment (APE), being led by staff from the University of Reading, NCAR and PCMDI. The details of the experiment and schedule are available at http://www.met.reading.ac.uk/~mike/APE.

The experiment is designed to provide a benchmark of current model behaviour and to stimulate research to understand differences arising from: (1) different subgrid-scale parametrization suites, (2) different dynamical cores, and (3) different methods of coupling model dynamics and parametrizations. A Workshop was held 20-22 April 2005 at the University of Reading, UK to discuss the results, summarize current model behaviour and produce a summary of research questions arising from the experiment.

Fourteen groups have now submitted their simulations to the APE database. Analysis of the APE experiments is continuing for another year. A second workshop is planned to discuss the more complete analyses in the fall of 2006 or spring of 2007 at the University of Tokyo.

The models show a wide range of behaviour with resolution and parameter changes, both within a single modelling environment, and across different models. The basic experiments are deliberately done at "climate model" resolutions but a few groups are examining convergence with resolution and more resolution work is needed. The discussions at the workshop led to plans for further diagnosis and journal papers to be developed before the next workshop.

Regional Climate Modelling

The potential uses of Regional Climate Models (RCMs) include areas such as: regional climate change projections, seasonal prediction and parametrization development. The GEWEX Transferability Working Group (TWG) aims to assess the global applicability of RCMs in regions remote from their home domain of development. Particular emphasis is being placed on the simulation of regional scale water and energy cycles in a wide variety of climatic regimes. TWG has sponsored the Inter Continental Scale Experiment Transferability Study (ICTS). In ICTS participating RCMs will run their model unchanged over 7 distinct regions around the globe, where each model domain is centred on a GEWEX Continental Scale Experiment site that is contributing data to the CEOP central archive. Presently 7 RCMs are contributing to ICTS and results are to be archived at the CEOP central facility early in 2006.

WGNE also discussed results from SGMIP (Stretched Grid Model Intercomparison Project) noted that this was a very promising approach to higher resolution regional simulations. It will continue to monitor the developments in this area in its future sessions.

10.1.3 Climate Model Metrics

WGNE has been involved in developing standard climate model diagnostics and metrics for some years. The goal of such metrics is to objectively measure model quality or skill and suitable metrics depend on the intended applications. For NWP models the application is weather forecasts and seasonal forecasts. The application for climate models includes the prediction of future climates for which no verification data will be available within the lifetime of the model. Possible substitutes are to use the current climate, but there are no independent data sets for verification, or to use past climates, but these have insufficient data for a thorough evaluation. Therefore, for climate models, the processes creating the climate should also be evaluated, not just the climate itself.

NWP has a long history of forecast metrics such as the S1, RMS and anomaly correlation skill scores. NWP generally assumes that errors in the verifying data are unimportant but this may not be the case with climate verification data.

The difficult aspect for climate models is not the definition of the metrics, but the definition of fields to be assessed. They should be standard and used during model development in the same way as NWP uses anomaly correlation. WGNE discussed the issue of climate model metrics at some length with many questions and issues resulting. As a way forward, WGNE requested PCMDI to liaise with WGCM and it was agreed to set up a sub group with a member from each of PCMDI, WGCM, WGNE, GMPP and the JWGV (Joint Working Group on Verification). This group will help define the climate model metrics and standard verification data sets. In due course WGNE would take this to WCRP, through WGCM, with the intention of asking WCRP to encourage usage of these metrics for climate models.

It was decided to have a session on climate model metrics in the February 2007 model systematic errors workshop.

10.1.4 Physical parametrizations in models

WGNE's close working relationship with GMPP (the GEWEX modelling and prediction panel), provides the focus for the development, refinement and evaluation of atmospheric model parametrizations, notably those of cloud and radiation, land surface processes and soil moisture, and the atmospheric boundary layer. The discussions at the joint meetings of WGNE and GMPP, encompassing the GEWEX Cloud System Study (GCSS), the Global Land-Atmosphere System Study (GLASS), the GEWEX Atmospheric Boundary Layer Study (GABLS), and the progress of CEOP, are described in sections 7.4 and 7.6 The WGNE community provides comprehensive gridded output from global data assimilation systems for CEOP and an increasing number of modelling groups are utilizing CEOP data in research and development activities. This should lead to model intercomparisons during the CEOP period.

WGNE confirmed the value of the interaction with GMPP for parametrization work, particularly with GCSS. A pan-GCSS meeting was held in May 2005 in Athens. This addressed clouds in the climate system,

methodologies and metrics in assessing models, the fundamental role of precipitation in cloud systems, and advances in the representation of clouds in large-scale models. A joint WGNE/GCSS model intercomparison study of a Pacific cross section (GPCI) to evaluate physical parametrizations along the atmospheric cross-section following the trade winds is in progress, with excellent support from both NWP and climate modelling groups. WGNE suggested that there might be a follow up exercise over land (e.g. the AMMA region), and noted that the study provides an excellent opportunity to bring together NWP and climate modellers.

In addition to the above, WGNE routinely reviews progress and outstanding issues in parametrization in general. The next meeting of WGNE and GMPP will review what various Centres are doing in the area of land surface data assimilation and will consider having a joint workshop on this topic in the 2007/8 timeframe.

WGNE received the report on the Monsoon workshop (Irvine, CA, USA, 15-17 June 2005). WGNE noted with some disappointment the monsoon community's apparent lack of interest/understanding of the important role of NWP in monsoon studies as evidenced by the workshop's programme. Many of the studies presented use models as 'black boxes', which discourages progress in general.

WGNE was invited to give its response to the GEWEX road map of activities.

The need for a specific action on 'convection'

Recognizing that convection is central to many problems in WCRP modelling research on almost all space and time scales, WGNE/GMPP are jointly proposing a high resolution modelling experiment specifically directed towards aiding and accelerating parametrization development. This effort would be part of a proposed coordinated WCRP effort on 'convection' under the auspices of the new Strategic Framework, an effort expected to benefit the entire WCRP community.

10.1.5 Numerical weather prediction

Reanalysis projects and data assimilation

The ERA-40 reanalysis at ECMWF is complete and an "interim reanalysis" has begun. This is running from 1989 onwards. It contains improvements that greatly alleviate deficiencies identified in ERA-40. The ERA-40 publication series now comprises more than 20 reports covering documentation of the data and of the data-assimilation system and its performance, and results from users of the ERA-40 data. The reports are available on-line for outside users at: http://www.ecmwf.int/publications/library/do/references/list/192.

A comprehensive atlas of the atmospheric general circulation as depicted by ERA-40 has been produced in collaboration with the Meteorology Department of the University of Reading.

The Japanese 25-year Reanalysis Project (JRA-25, 1979-2004) is now finishing. Comparison of JRA-25 with other completed reanalyses shows that the known problems of excessive tropical ocean precipitation seen in ERA-40 are not present. In general, precipitation in JRA-25 has much higher correlation with precipitation in CMAP than ERA-40 and NCEP reanalyses.

WGNE reiterated its strong support for the reanalysis work, the desirability of maintaining a core of experts without excessive duplication of effort and ensuring efficient phasing of these efforts. Regional reanalyses such as for N. America and possibly Europe are also reviewed by WGNE.

Earth System assimilation

The new developments in the assimilation of parameters pertinent to the Earth System but not routinely analysed by current data assimilation systems are being monitored by WGNE. These include analyses of greenhouse gases, aerosols and reactive gases. Earth system science such as the GEMS (Global and regional Earth-system Monitoring using Satellite and in-situ data) project will increasingly demand cross-project liaison within WCRP and CAS.

Model developments

WGNE noted the substantial improvements in the resolution of global (40 km or less) and deep convection permitting forecast models (5 km or less) in progress or planned in the next few years. There exists a range of opinion regarding the use and interpretation of gridlengths of several kms for forecasting. These resolutions will become affordable for GCM use in the coming years, and the prospect of climate

simulations with grids of order one kilometre is an issue of international activity and debate, and WGNE will continue to monitor such developments.

Recent results showing the need for model resolutions of 100 km or better to properly define the statistics of extra-tropical storm tracks were noted. This contrasts with typical climate model resolutions substantially poorer than this, a matter of serious concern to the group.

WGNE noted the plans for unified (coupled) forecast systems that will provide forecasts from days out to seasons, typically by progressively degrading the resolution with forecast range. Such developments will provide new opportunities for ensemble techniques, including initial perturbations, stochastic parametrizations and metrics, and bring even closer collaboration between the NWP and climate communities.

Performance of the main global operational forecasting models

WGNE routinely reviews the skill of daily forecasts from a number of the main operational centres in terms of verification scores (such as anomaly correlation and root mean square error) for various fields at different lead times. For most centres, a distinct increase in skill is apparent over the last few years.

Model Verification

Scores such as rms errors and anomaly correlations provide good objective measures of large-scale model performance. However, with global models attaining much higher resolutions and mesoscale models being routinely run at most operational centres, consideration is being given to additional skill scores more appropriate for such resolutions. Furthermore, there is an increasing requirement to provide measures of model performance for predicting weather elements and severe weather events. The joint WGNE/WWRP working group on verification (JWGC) is now considering this important subject.

There are a number of WGNE projects involved with the validation of deterministic forecasts. These include the compilation of the standard skill scores, verification of quantitative precipitation forecasts, validation of tropical cyclone tracks and verification of stratospheric analysis and forecasts. A number of important issues and new developments were discussed including the development of methods to verify high resolution spatial forecasts; verification methods for rare events; incorporation of scaling methods into verification processes; approaches to account for observational uncertainty in verification measures and analyses; development of methods that are customer dependent and appropriate for studies of forecast value; and verification of probability distribution functions.

Following a request from WGNE, the JWGV has prepared a set of recommendations for the verification and intercomparison of QPFs from operational NWP models. This first report focuses on deterministic forecasts; a future one will outline methods for probabilistic/ensemble forecasts. The JWGV is interested in collaborations with other WMO verification projects and groups.

Intercomparison of typhoon track forecasts

The intercomparison of forecasts of typhoon tracks in the western North Pacific has been an ongoing project that has been conducted by the Japan Meteorological Agency on behalf of WGNE for a number of years. The project has recently been extended to include all ocean basins. Relevant data from operational forecasts are now available from eight Centres. The overall gradually improving performance of these models in predicting cyclone tracks and intensity over the past few years has been maintained. A significant milestone was the opening of a web site for WGNE international tropical cyclone comparisons. Many results related to typhoon track forecast including a multi-model ensemble are presented on the web site: (http://nwp-verif.kishou.go.jp/wgne_tc/index.html (user id and password are required)).

Verification and intercomparison of precipitation forecasts

This WGNE initiative is being conducted at the DWD, NCEP, BMRC, CMA, JMA, CMC, the Met Office and Météo-France. Quantitative global precipitation forecasts from the above are being verified against surface stations in these relatively data rich areas (some Centres also include their limited area model forecasts in the verification). A series of scores such as bias, Heike skill score, equitable threat score are used.

Model-derived estimates of ocean-atmosphere fluxes

Evaluation and intercomparison of global surface flux products (over ocean and land) from the operational analyses of a number of the main NWP centres (the "SURFA" project) remains a priority for WGNE. The atmospheric and coupled modelling communities and oceanographers have very strong interests in advancing SURFA, which could provide a good opportunity for progress in estimating and determining the quality of surface fluxes. Efforts are continuing through liaison with the WCRP Working Group on Surface Fluxes (WGSF) to address the requirements of research, observations, analysis and modelling of surface fluxes within WCRP and closely-related programmes such as GODAE and GCOS. The importance of adhering to data standards are noted with PCMDI and GODAE being active in this area. It is intended to have a session on this at the 2006 WGNE meeting.

10.1.6 THORPEX

At the 21st WGNE meeting there was a session devoted to THORPEX, which reviewed the status and plans of THORPEX and the wide-ranging opportunities for collaboration and synergy with WCRP and other bodies.

WGNE recognized that the THORPEX sub-structure of a) predictability and dynamics, b) observing systems, c) data assimilation and observing strategies, and d) societal and economic impacts, neatly encompassed much of the interests of WGNE, and it was agreed that WGNE will maintain a THORPEX session in its future meetings and would also make every effort to provide WGNE representation at the THORPEX workshop in March 2006 and the joint THORPEX/WCRP workshop on the MJO (also in March 2006)

WGNE discussed the results from THORPEX-related targeting and data denial forecast experiments. Both types of experiment focus on the 'value' or impact of observations in a specific region. WGNE felt that while these are stimulating experiments, THORPEX should nevertheless encourage more in-depth scientific investigations before promoting more (and expensive) experiments.

In the context of AMMA-THORPEX it was WGNE's advice not to attempt a targetting campaign as the scientific basis for such work was almost non-existent for this part of the world. However, the extensive additional observations will provide excellent opportunities for impact studies of various kinds. The provision of targetting information for the driftsondes to be launched during the hurricane season later in the campaign, was, however, an interesting possibility.

The use of ensemble methods now forms a cornerstone of forecasting on all timescales. Recent years have seen progress in the application and use of ensemble prediction systems underpinned by the availability of supercomputer resources and rapid advances in the science of initial condition and model perturbations etc. However, WGNE remained concerned at the rather slow progress being made at a number of operational NWP centres in the effective use of ensemble forecasting information, and hoped that THORPEX, and particularly the TIGGE project, will help accelerate this. WGNE includes ensemble prediction as a regular discussion item at its meetings.

Finally, WGNE noted that its preliminary plans for more coordinated action (probably within the WCRP Strategic Framework) to address the wide-ranging difficulties in forecasting convection or in representing convection in GCMs were important to THORPEX, and that the proposed very high resolution (1 km) studies under consideration would be of particular relevance.

WGNE responded positively to the request that it should be represented at THORPEX Working Group meetings where possible. The planned THORPEX–WCRP meeting on the MJO, 13-17 March 2006, Trieste was welcomed.

10.1.7 AMMA: progress and developments

WGNE welcomed and fully supported the proposal to prepare a Forecaster's Handbook. This included workshops in March and June-Sept 2006, reviews by editorial board, external review of all chapters and editing process, and publication by the end of 2008. WGNE considered that the Forecasters handbook was a unique opportunity for capacity building. Furthermore, WGNE suggested that the possibility of a relevant WMO training programme should be explored. It also suggested that experts of the Nowcasting Workshops arranged by WMO/WWRP should be invited to the AMMA workshop.

10.1.8 Workshops and publications

- An International Workshop on "Aqua Planet Experiment" was held 20-22 April 2005 at the University of Reading, UK, to discuss the results, summarize current model behaviour and produce a summary of research questions arising from the experiment.
- A joint WGNE/WWRP training workshop, at ECMWF, January 2007.
- THORPEX –WCRP meeting on MJO, 13-17 March 2006.
- A second International Workshop on "Aqua Planet Experiment" is planned to discuss the more complete analyses in the fall of 2006 or spring of 2007 at the University of Tokyo.
- A Pan-WCRP Workshop on model systematic errors is being organized for February 2007 in San Francisco, USA.

A key WGNE publication for many years has been the WGNE "blue cover" numerical experimentation report series which continues to be popular with the modelling community. The report has been prepared on behalf of WGNE by Recherche en Prévision Numérique (RPN), Montréal since its inception and the latest annual summary of research activities in atmospheric and oceanic modelling (No. 35) has been released. This publication is facilitated by use of e-mail contact and the website at RPN (www.cmc.ec.gc.ca/rpn/wgne).

The JSC thanked Dr Miller for his presentation of WGNE activities. The JSC appreciated the continued progress by WGNE and reiterated its support to the Systematic Errors Workshop planned for February 2007 in San Francisco, USA. The JSC encouraged WGNE to carry out predictions beyond 10 days up to a season to know its impact on intraseasonal and seasonal timescales. The JSC strongly endorsed the WGNE/GCSS proposal on a coordinated effort on convection (and associated physics). The JSC observed that convection is central to many problems in current modelling efforts on almost all space and time scales and that it cuts across most WCRP groups. Climate Process Teams (CPTs) would be interested. As a next step, the JSC suggested that a small group consisting of the Chair of WGNE, the Co Chairs of WGCM and Dr T. Palmer should discuss this proposal. The JSC supported WGNE's proposal to strengthen membership in ensemble prediction and/or coupled modelling.

10.2 Report of Working Group on Coupled Modelling (WGCM)

The following paragraphs summarize the principal activities being undertaken by the JSC/CLIVAR Working Group on Coupled Modelling (WGCM) including the main items of interest and recommendations from the ninth session of the group, held at the Met Office, Exeter, UK, 3-5 October 2005 with a half-day joint session with WCRP Modelling Panel (WMP) on 5 October 2005. The joint session was given presentations on objectives and scope of WMP, WGCM, and reports on WGNE, GEWEX, CliC, TFSP, Monsoon modelling, WOAP and AMIP.

10.2.1 Relevant Recommendations for the development of WGCM activities

Recommendations from the twenty-sixth session of the JSC

At its twenty-sixth session (Guayaquil, Ecuador, March 2005), the JSC had made several recommendations with regard to WGCM. Since most members of the WG were overcommitted with the anthropogenic climate change (ACC), the JSC observed that WGCM had devoted most of its time to the ACC issue. Acknowledging that members of WGCM are already overcommitted, the JSC recommended that a Co-chair of WGCM should be appointed to deal with the issue of natural climate variability in the context of ACC. Also, the membership of WGCM should be expanded to provide additional expertise in this area. The JSC reiterated that WGCM should continue as an overarching WCRP group with no change in its dual parentage of the JSC and CLIVAR. The JSC recognized that attention was needed to improve communications between WGCM and the other activities of WCRP; responsibility for this rested with JSC, WMP, the projects and WGCM. The JSC also recommended that WGCM should interact closely with THORPEX.

The JSC recognized and encouraged the need for stronger interaction between observational and modelling capabilities, particularly in GEWEX, WGNE and WGCM, for improving understanding and modelling of cloud-radiation feedback processes. The JSC requested WGNE, WGCM and the wider CLIVAR

community to consider how they could collectively accelerate, jointly with CliC, and in close cooperation with the WGOMD, progress in the important areas of sea-ice modelling and related data assimilation.

The JSC noted that SPARC and WGCM (with IPCC in mind) needed to pursue jointly some aspects of solar forcing, including the effect of solar forcing variability on atmospheric composition (e.g. ozone). SPARC should take on the updating of solar forcing at the top of the atmosphere. The JSC decided to consider at a later date whether SPARC's Chemistry-Climate Modelling Validation project should lead to another AMIP-like experiment, which would need to involve PCMDI.

The JSC strongly supported the proposal to have a workshop on Model Errors sometime in late 2006 or 2007 organized by WGNE possibly jointly with at least CLIVAR (WGCM) and GEWEX.

The JSC noted with approval the issues that WGCM planned to address in the next few years. The JSC expressed satisfaction that the topic of climate forcing now had a clear place within the WCRP structure. It encouraged WGCM to increase its consideration of natural climate variability in the context of ACC and to move forward towards comprehensive Earth System Modelling. The JSC reiterated that the WGCM should continue to be a pan-WCRP modelling group. The international Workshop on Analyses of Climate Model Simulations for the IPCC AR4, convened by U.S. CLIVAR and hosted by the IPRC, University of Hawaii, 1-4 March 2005, was highly praised.

Finally, the JSC stressed the need for strengthening links between GCP and WGCM.

10.2.2 *Thirteenth session of the of the CLIVAR SSG*

The CLIVAR Conference and Assessment included several key issues. CLIVAR progress will be assessed annually against four major global themes: ENSO, Monsoons, THC/Decadal and ACC. Each year, a topical workshop will be held for one of the four themes. The representation of ACC will be increased on SSG. GSOP, WGSIP, WGCM, WGOMD and CCD will be required to provide global perspective/framework. The Monsoon Panels for VAMOS, VACS, AAMP and Ocean Basin Panels for Atlantic, Pacific, Indian and Southern Oceans will be required to provide global to regional perspective. The regional panels will be replaced by three topical panels which include:

- Predictability, Prediction and Applications Interface Panel
- Process Studies and Model Improvement Panel
- Phenomena, Observations and Synthesis Panel

10.2.3 Review of WGCM initiaitves

Coupled Model Intercomparison Project (CMIP)

The IPCC model analysis project was approved by WGCM in October 2003. The WGCM Climate Simulation Panel (Drs G. Meehl (Chair), J. Mitchell, B. McAvaney, M. Latif, C. Covey, R. Stouffer) has overseen and coordinated collection, archival and analysis of model data for the IPCC AR4. 2005 marked the 10th anniversary of CMIP. During the year, significant accomplishments related to CMIP included: PCMDI has collected, archived and distributed the model data (and will do so for next few years). A successful international IPCC model analysis workshop was held in March 2005 and overseen by the WGCM Climate Simulation Panel (see below for details). All CMIP2+ data are available for analysis from PCMDI

The Catalogue of MIPs is maintained with cooperation of WGCM and IGBP/AIMES, and is maintained on the WCRP web page with a link from the CMIP web page (http://www-pcmdi.llnl.gov/projects/cmip/index.php). Publications issued include: Report of the CMIP Workshop, September 2003 by Meehl, G.A., C. Covey, B. McAvaney, M. Latif, and R.J. Stouffer, 2005, and Overview of the coupled model intercomparison project. *Bulletin of American Meteorological Society, 86, pp 89-93.* CMIP subprojects have produced 47 peer-reviewed publications, 6 other publications, 4 PCMDI publications, and produced significant contributions to IPCC AR4; there are 43 CMIP2+ subprojects currently active, in addition to 10 completed subprojects from CMIP1 and 22 from CMIP2.

Though the IPCC deadlines have passed, sign-up for access to the multi-model dataset and data download rate remain almost constant. This indicates that the multi-model dataset is continuing to be used and will have ongoing utility over the next few years.

Dr D. Karoly proposed a CMIP coordinated experiment for detection/attribution purposes that would involve 3-4 member ensembles of 20th century climate with GHG-only and natural-only forcing experiments. his met with general approval. Dr Karoly will write up a proposal for vetting by the CMIP Panel, and then this will be sent to the modelling groups. PCMDI has agreed to collect these additional data.

CMIP and IPCC

The IPCC AR4 motivated the formulation of the largest international global coupled climate model experiment and multi-model analysis effort ever attempted, and is being coordinated by the WGCM Climate Simulation Panel (see above). Fourteen modelling groups from around the world are participating with 21 models. Considerable resources have been devoted to this project. PCMDI has archived >30 TeraBytes of model data so far.

Results from analyses of the multi-model dataset were presented by 125 scientists at a workshop convened by US CLIVAR and hosted by IPRC (Univ. of Hawaii) March 1-4, 2005, and are feeding directly into the AR4 assessment process. Due to the large number of participants, the format of the workshop was "short presentation/poster". Feedback from participants indicated this was a successful workshop. 125 scientists participated in the workshop. This is more than triple the most optimistic estimate for participation. To date, there are over 400 analysis projects registered at PCMDI. Several more are being added every week. This is the largest, most comprehensive, highest profile and, arguably, most successful project ever organized by WGCM. The Coupled Model Evaluation Project (CMEP) set up through US CLIVAR and funding awarded for 18 PIs to analyze, at a minimum, 20th century IPCC runs from US models in IPCC model dataset at PCMDI; US CLIVAR is promoting CMEP for its Climate Change Science Program (CCSP) reports.

WGCM, the WGCM Climate Simulation Panel and the international climate science community wish to formally thank PCMDI for their invaluable contribution to the collection, archival and distribution effort for the IPCC multi-model analysis activity.

WGCM has received many emails expressing thanks to WGCM for organizing this activity. This is by far the most unsolicited response we have had to any WGCM project.

During its session, the WGCM addressed several issues relating to CMIP and IPCC:

a) Issue: ENSEMBLES wishes to set up a mirror site for PCMDI IPCC-data to match the ENSEMBLE requirement but also to satisfy the IPCC-DDC needs. Data access will be restricted to the ENSEMBLES participants.

WGCM response: ENSEMBLES researchers can either access the multi-model data through the WGCM Climate Simulation Panel in the usual way, or a representative from ENSEMBLES can travel to PCMDI and download multi-model data on discs to be carried back to Hamburg.

b) Issue: What is the relationship between CMIP and the IPCC? (IPCC WG1 suggests having a person from WG3 familiar with scenario development on WGCM).

WGCM response: Clearly, CMIP and IPCC are inextricably linked, though CMIP (and WGCM) still have as a high priority the scientific understanding of processes and responses of the AOGCMs. WGCM recognized the need to invite a representative from WG3 to brief WGCM at annual meetings regarding developments in the area of scenarios that would eventually impact the modelling groups regarding future assessments. WGCM co-chairs will also write letters to IPCC chair and WG co-chairs regarding scenario development emphasizing linkage to previous scenarios and a small number of new scenarios.

c) Is WGCM/CMIP going to be a provider of model data in the future (AR5 and beyond)?

WGCM response: Yes, the community WGCM represents must continue to take ownership over this activity for the mutual benefit of the community.

d) Is the oversight of data similar between CMIP and the IPCC, and how to best manage access to the model data?

WGCM response: Yes, oversight is similar, and we will continue to have the WGCM Climate Simulation Panel have a look at all submitted analysis and data access requests, but Panel members need only respond if they have specific comments.

e) CF-netCDF very successful- demanding of resources?

WGCM response: WGCM will form a steering group. Drs R. Stouffer and K. Taylor will write up terms of reference and suggest members.

f) What about commercialization of data?

WGCM response: WGCM Climate Simulation Panel will keep an eye out for commercial applications, and advise such requests that the model data are for academic research applications only for publication in the peer-reviewed literature. Any commercial applications would have to contact the modelling groups directly. The U.S. groups noted that they would have to make their model data available for such uses.

g) Radiative Transfer model Intercomparison Project (RTMIP) and Forster results show large differences in forcing and radiation codes-this needs to be addressed.

WGCM response: Co-Chairs Drs J. Mitchell and G. Meehl agreed to contact the GEWEX Radiation Panel to alert them to this issue, and request guidance regarding possible actions.

International Cloud Feedback Model Intercomparison Project (CFMIP)

CFMIP is a WCRP sponsored research project specially focused to provide a systematic intercomparison of cloud feedbacks in climate models. CFMIP is part of a programme to provide continuing documentation of the strength of cloud feedbacks in climate models and an evaluation of the performance of climate models in simulating aspects of clouds that are important in cloud feedback. The project leaders are Drs B. McAvaney (BMRC) and H. Le Treut (LMD), but recent progress has been driven at the Hadley Centre mainly by Drs M. Webb and K. Williams. The CFMIP experiment protocol is +/-2K atmosphere only and $1xCO_2$ and $2xCO_2$ 'slab' experiments.

The key features and issues of CFMIP include:

- It's a MIP, but differs from the 'normal' MIP. Acceptance of process oriented diagnostics e.g. ISCCP simulator into main stream; high temporal sampling of data etc
- Low cloud has been identified as the main source of uncertainty in climate sensitivity
- Studies to 'evaluate' important feedbacks are in progress
- 'Metrics' based on the key feedbacks are being developed
- CFMIP is heavily quoted in IPCC AR4
- Participation has been a struggle. This may be due to co-incident timescales with AR4 and prioritisation of groups to produce coupled runs for AR4
- Lack of use of data on sub-projects. Individuals have used CMIP transient data where the absolute requirement of e.g. ISCCP diagnostics not needed

Future plans for the project aim at:

- Re-activating other sub-projects on water vapour, surface radiation etc. The advantage of using CFMIP data is to make the link with cloud feedbacks
- Holding a second CFMIP meeting in 2007. This will deal with data availability and the further work needed for AR5.
- Migrating data to PCMDI. Data would be open to everyone and analogous to CMIP data.
- Incorporating CFMIP protocol into AR5 (ISCCP simulator mandatory)
- Further developing links with NWP/Process community (e.g. through GCSS)

Historical Forcings

There is a need to organize collection of radiative forcing constituents and involve experts in evaluating the inputs. Groups were required to submit these time series to PCMDI as part of the AR4 activity. It is unclear whether groups have responded to this request or if experts know or are interested in evaluating these data sets.

Initialization of coupled models

Most groups involved in the AR4 process use some variant of the Stouffer et al. (Stouffer, R.J., A.J. Weaver, and M. Eby, 2004: A method for obtaining pre-twentieth century initial conditions for use in climate change studies. Climate Dynamics, 23, 327-339) method to find ca. 1850 control climate state. Many

groups are now experimenting with prediction of the first kind using ocean data assimilation. These efforts typically use data obtained from the 1960s and later.

Decadal Variability

One of the key emerging themes in decadal variability and predictability is an emphasis on the Atlantic Multidecadal Oscillation (AMO) and its impact on climate. The AMO is characterized by a pattern of Atlantic SST anomalies of one sign north of the Equator, and opposite sign south of the Equator. Results were presented in the session from several recent studies demonstrating the impact of the AMO on features such as the Sahelian and Indian summer rainfall, the tropical wind shear related to hurricane intensity and the summer climate over both Europe and North America. Research also highlighted that discussed aspects of decadal scale predictability of such phenomena, with at least one model showing decadal scale predictability of temperatures for continental locations. It was also pointed out that decadal scale fluctuations in the Indian and Pacific sectors have strong impacts on climate fluctuations. For example, recent work has related decadal scale changes in Pacific sea surface temperature to persistent patterns of drought over North America.

Detection and attribution of climate change

The official link for this activity is through the WMO CCl/CLIVAR Expert Team of Climate Change Detection, Monitoring and Indices. This Team typically meets once every 3 years. The unofficial link is with IDAG (International Ad hoc Detection and Attribution Group) jointly funded by DoE and NOAA in US. The IDAG typically meets every year and reviews methods and results in attribution of climate change. Recently published review papers include: IDAG paper, J Climate, 2005; CLIVAR D&A paper, G. Hegerl et al., 2006 and; IPCC AR4 chapter 9, G. Hegerl and F. Zwiers, 2007.

Detection and Attribution: (i) quantifies relative importance of different forcing factors in observed climate change, (ii) evaluates performance of climate models in simulating climate variations over the 20th century and (iii) can be used to constrain future global or regional climate projections and to estimate uncertainties.

Detection and Attribution studies are difficult using existing IPCC 20C runs because they do not isolate different forcings. WGCM was asked to consider the following requests:
Additional runs and data from AR4 models with

- ALL forcings runs generally provided, some groups provided GS runs
- New runs with individual forcings: GHG (or ALL *minus* GHG), NAT, in addition to ALL
- Must have 3-4 member ensembles for each forcing
- Already available from GFDL2.1, MIROC Med, HadCM3, PCM but data not available at PCMDI
- Include land-use, land-cover changes.
- longer control run data, where available, and monthly mean values of maximum and minimum temperatures.

Palaeo-climate modelling

In its second phase, the Paleoclimate Modelling Intercomparison Project (PMIP2) had to face the constraints of the AR4, to have sufficient analysis of the new simulations that could be used as a basis for AR4 chapter 6 on paleoclimate. The first results of the new simulations for the mid-Holocene (6000 years ago) and last glacial Maximum (21000 years ago) arrived in March in the database. Several sub-projects were launched. The rules to participate to a subproject follow those for CMIP, and are straightforward. Each sub-subject should favour model-data comparisons and consider all the model simulations in the database. Information is provided on the website (http://www-lsce.cea.fr/pmip2), as well as the list of the 36 ongoing projects.

There are now 9 model simulations for 6ka and 7 for 21ka with coupled ocean-atmosphere models. For most of the groups the model version is the same as the one used in AR4. This offers the possibility to evaluate climate models under different forcings. Most of the groups also faced difficulties with interactive vegetation modules. They will join the database in a second step. At the moment only two of these simulations are available for 6ka. Other models will join the database in the coming months. An important milestone of the year was the first meeting of PMIP2 organised last April in Giens, France. The meeting was supported by French institutions (CNRS, CEA), WCRP/CLIVAR and IGBP/PAGES.

C4MIP: Coupled Climate Carbon Cycle Model Intercomparison Project

Coupled climate-carbon cycle GCMs are still a relatively young field just 5 years since the first model published their results. There are now 10 models (6 GCMs, 4 EMICs) in the intercomparison. The results show a unanimous consensus of positive feedback (i.e. climate change will weaken the natural carbon sink and hence increase CO_2 in the atmosphere), but the strength of this feedback is very uncertain – with almost an order of magnitude range across models. The first paper on C4MIP (by Friedlingstein et al.) has just been accepted for publication in Journal of Climate. It shows a feedback analysis of the C4MIP transient (A2 emissions scenario) runs. The conclusion is that most of the spread between models comes from different terrestrial behaviour rather than different ocean behaviour. It also shows that even the models with similar net feedback strength have a different balance of mechanisms which contribute to it. In summary, the feedback will be stronger for:

- climate model higher sensitivity to CO_2
- stronger sensitivity of terrestrial or oceanic carbon cycle response to climate changes and smaller for:
- stronger sensitivity of terrestrial or oceanic carbon cycle response to CO_2 increase.

A sensitivity study with a simplified model has shown that vegetation uptake of carbon response to climate may be the most important of the carbon cycle parameters (rather than CO_2 fertilisation or respiration response to temperature - the two factors which may have been highlighted to date). Sensitivity of the feedback strength to climate sensitivity is possibly more important still. It also turns out that the historical record of CO_2 changes is only a weak constraint on future feedback strength. Parameter perturbations in the simple model that match the historical record can give very different future projections.

C4MIP "phase 1" was intended to be a terrestrial carbon cycle simulation of the 20th century forced by observed SSTs and CO_2. However, only 2 of the 10 groups (Hadley and NCAR) have performed it. One reason is that it is thought that the absence of a formal treatment of land-use change in these models makes comparison with the observations difficult. It is thought that vegetation recovery from past land-use has played a significant role in the 20th century carbon balance, and so simulations without it can't be expected to reproduce the observations (in much the same way that early climate models did not include aerosol forcing). Instead it is hoped that validation against regional or process based observations (such as Fluxnet towers) may be able to constrain model behaviour. This has still to be investigated.

The main conclusions of the C4MIP paper (by Friedlingstein et al.) are:

- the climate-carbon cycle feedback is positive (10/10 models)
- climate impact on the biosphere is negative (10/10), overall effect (climate + CO_2) is negative (10/10)
- climate impact on ocean carbon uptake is negative (10/10) but overall effect is unclear (some models have greater CO_2 than climate increase, others have greater climate than CO_2 effect).
- we need an intelligent design of experiment to help constrain the models with relevant observations
- some key mechanisms are still missing in these models, but are being developed (e.g. land-use change, fire, nitrogen cycling).

Regional Climate Modelling

A review was presented of the status and recent developments in regional climate modelling. After a review of basic modelling issues recent developments in the field were highlighted. These included:

- The increase in resolution (10-20 km or even less) and simulation length (multi-decadal) for regional climate modelling experiments.
- The inception of a number of coordinated intercomparison experiments involving multiple RCMs (e.g. Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects (PRUDENCE), Ensembles-Based Predictions of Climate Changes and Their Impacts (ENSEMBLES), Project to Intercompare Regional Climate Simulations (PIRCS), Regional Climate Model Inter-Comparison (RMIP)-ASIA, RMIP-ARCTIC).
- The increased emphasis towards coupling atmospheric RCMs with models of other components of the climate system, such as regional ocean, biosphere and/or chemistry/aerosol. In other words, the greater emphasis towards the development of regional Earth System models.
- Encouraging results have been obtained from preliminary two-way nested GCM-RCM experiments. This approach appears to improve the global model simulation when applied to

some key regions, such as the western Pacific warm pool area. More testing for other regions and modelling frameworks is needed to fully evaluate its potential.

- Greater application and testing over tropical regions and greater use by scientists in developing countries, mostly because of the development of powerful but inexpensive PC and hard disk technology.

It was also noted that the use of variable resolution atmospheric models and statistical downscaling techniques has considerably increased in the last years. Relative merits of these different regionalization methodologies should be better elucidated. In fact, it would be useful to provide "guidance" material on the use of different techniques.

Data management

WGCM discussed the challenges faced in sharing model output with a wide community of researchers. The focus was largely on model output served in support of the IPCC's Fourth Assessment Report. Modelling groups rewrote their model output in compliance with strict requirements that were agreed upon, in scope, at the seventh session of the WGCM. The output was then sent to a repository at the PCMDI where it was made available to a wide community of researchers.

As the value of coordinated modelling activities becomes more apparent and benchmark experiments such as AMIP and CMIP become routine parts of the model development cycle, it is desirable to establish a common approach to the sharing of model output. The IPCC exercise offered an opportunity to continue taking steps toward that goal. In contrast with previous intercomparison projects, a larger burden was placed on the modelling groups to satisfy precisely defined requirements for both the format and structure of the output, as well as the metadata to be included. Model documentation was also required in a uniform format. The scientific payoff for all the effort is that more than 300 users are analyzing model output from 21 different models, and more that 100 (possibly 200) manuscripts have been already written, based, at least in part, on the IPCC database. The database will likely attract continued scientific interest for several years.

There are several reasons why scientists found it relatively easy to analyze model output in the IPCC database. The variables collected and the experiments performed were precisely defined, and nearly all the model output was passed through a common set of output routines, which ensured compliance with strict requirements for metadata and data structure. This output software, called the Climate Model Output Rewriter (CMOR), was designed for easy adaptation to the needs of other model intercomparison projects, so that the investment in learning how to meet the IPCC requirements will facilitate participation in future projects.

The output in the IPCC database is accompanied by considerable metadata that have been written in accord with the increasingly popular Climate and Forecast (CF) Metadata Conventions for netCDF files. These conventions ensure that the data are largely "self-describing" so that scientists can automatically extract both the data and other information needed to perform analyses. As a simple example, the CF conventions make it possible to automatically recover the geophysical location of the data values, as well as any other coordinate information.

Although the collection and distribution of model output in support of the IPCC AR4 has gone relatively smoothly, several lessons have been learned that should improve future exercises of this sort. The planning process needs to begin much earlier next time to allow for more thoughtful examination of model results. Based on the uses made of the current suite of output, the list of standard output should be modified, especially to help in the diagnosis of the ocean simulations. Several suggestions have been made to better serve the analysts, including refinement of the registration procedure and automated notification of errors identified in the database. It would be particularly useful if an ability were added to subset or aggregate data at the request of the user. It was noted that tools need to be developed to process data stored on non-standard grids (e.g., tripolar, geodesic, "thin" grids) so that mapping ocean output to Cartesian latitude/longitude grids could be avoided. The attractiveness of moving toward a more distributed database is also becoming recognized. If the groups producing the model output were able to serve it, some of the bandwidth and logistical problems transmitting data to a central repository would be avoided. The groups could also immediately correct their output when errors are found. In order for such a distributed database to work as well as the present one, quality control would have to be run across the network, and the current rudimentary capability to make it look like distributed data comes from a single location would need to be improved.

Action items:

a) It was recommended that the WGCM formally recognize and thank the individuals who rewrote the model output and sent it to PCMDI, along with the groups carrying out the simulations, as a small gesture of appreciation for their roles in making the IPCC exercise successful.
b) It was also suggested that other model intercomparison projects be encouraged to adopt the model output requirements established for the IPCC output.
c) It was specifically recommended that the WGCM nurture and promote the CF conventions by endorsing a "white paper" describing the governance and development of these conventions.
d) It was recommended that an oversight committee be established.
e) It was recommended that a committee be set up to oversee the development of future variable lists for the IPCC exercise.

10.2.4 Interactions with other programmes

There were presentations at the WGCM session on Carbon cycle modelling (Dr C. Le Quéré), ESSP/Global Carbon Project (Dr C. Le Quéré), Biosphere Modelling (Dr C. Le Quéré), C4MIP (C. Jones), THORPEX (Dr D.S. Richardson) and CliC (Dr V. Lytle). In a discussion session, the topic, 'Future Perspectives of WGCM' was revisited and there were discussions on 'Earth System Modelling' and 'next-generation modelling'.

The JSC thanked Professor Mitchell for his report on WGCM activities. The JSC was pleased to note the great success of the WCRP/IPCC multi-model analysis activity. The JSC expressed the view that synergy between WGCM and WGSIP will lead to fundamental advances in WCRP science and encouraged close collaboration. The JSC would like to see more collaborative research efforts between the other projects and WGCM, particularly in connection with modelling of climate change. The JSC would like WGCM to lead a Pan-WCRP effort on decadal predictability as well as the development of a WCRP Task Team on ACC.

11. WORKING GROUP ON SURFACE FLUXES (WGSF)

The working group was not formally convened in 2005, although some limited groups of its members had a number of short meetings during relevant scientific conferences and workshops. Dr W. McGillis has proposed a joint workshop in Heidelberg in the third quarter of 2006 for WGSF and SOLAS/IMP2 to discuss activities, future collaborations, data intercomparisons and data management between WGSF and IMP2.

The WGSF has started to produce a newsletter. The intention is to publish it twice a year with the intention of providing a tool for informing the community about the working group activities and a valuable forum for the discussion of sea-air flux scientific issues.

Construction has begun on a website for the WGSF. The website will reside at www.etl.noaa.gov/et6/wgsf/ and will overlay the present *ftp* site used by the Chair of the WG. The site will include background information, meetings, reports, and other documents from the WG; material on flux measurement, parameterization and dataset; plus links to other relevant flux sites. The flux section will include the Handbook on ship-based flux estimation, computer codes, publications and selected *in situ* datasets. The electronic versions of the upcoming Bulletins will also appear on the WGSF web site.

At the WGSF meeting in Halifax in October 2004, Dr R.A. Weller presented results from consultation with Dr P. Gleckler, which included a proposal for a scaled-down SURFA. The WGSF was concerned that the new plans were overly restricted and felt more could be done. Dr P. Taylor and E. Kent agreed to consider how data from the VOS climate programme, VOSClim, might be used within SURFA. It has been pointed out that WGSF should closely cooperate with WGNE in supporting SURFA; the possibility of a joint meeting/workshop of the WGSF and WGNE in the future was brought up at the JSC meeting in 2005. Within WGNE the SURFA issue reemerged recently with a meeting at a THORPEX conference. This resulted in a plan to re-invigorate SURFA by presenting some thoughts at the upcoming JSC meeting, contacting the WGSF and OOPC Chairs, and undertaking some modest pilot intercomparisons of NWP surface stresses. In November 2005 Dr S.Gulev attended the annual WGNE meeting in St. Petersburg and discussed with the WGNE members the potentials for WGNE-WGSF cooperative activities on SURFA. In December 2005 WGNE and WGSF began discussions of how to proceed, which included an agreement for a SURFA meeting in association with the WGNE meeting planned for late 2006 in Boulder, CO. Dr Weller generated a new and expanded proposed list of data sources.

The WGSF chair also contacted the SEAFLUX principals for an update and discussion of joint interests. SEAFLUX has new funds from NASA, and Curry and Clayson are starting a project (NEWS) on

blending NWP and satellite data to improve forcing of coupled air-sea models. WGSF agreed to send representatives to the upcoming SEAFLUX workshop planned for 2-3 March 2006, near Tallahassee, USA.

WGSF proposed to make SURFA a major focus for the WGSF over the next year. The Tallahassee meeting will allow us to clarify the overlap and different roles of SEAFLUX and SURFA in facilitating the development of new and validation of existing sea-air flux products. The fall meeting with WGNE would have the following goals:

- review what has been done recently with in situ/VOS/ NWP comparisons
- discuss the overall strategy of the endeavour (including the spectrum of SEAFLUX aspects)
- debate strengths and weaknesses of different in situ, NWP and satellite data sets
- discuss the requirements of the flux data management and possibly identify the appropriate archiving modes
- initiate arrangements and responsibilities for the archiving
- develop a plan for researchers to work with the data

The topic of gas and particle transfer parameterizations is being carefully researched, and the results will appear in the form of two review articles submitted to the *Reviews of Geophysics* (or some other appropriate journal). Dr W. McGillis will be the lead author of the gas transfer article, and Dr G. De Leeuw will be the lead author of the particle transfer review.

The WGSF has begun compiling a toolbox of computer routines for bulk flux calculations that will reside on the WGSF website for the SOLAS/WCRP community. Presently, 'beta release' routines are available at ftp://ftp.etl.noaa.gov/user/cfairall/bulkalg/gasflux/ for CO_2, ozone and DMS. The routines run in concert with the COARE meteorological bulk flux routine.

Drs F. Bradley and C. Fairall devoted several months of work on the Handbook on best practices of ship/buoy flux measurements and in November 2005 distributed chapters to selected members of the WGSF for their input. The aim of the Handbook is meet the needs of flux researchers of different experience, including students, in the standardized comprehensive description of observational practices. The Handbook is essentially complete except for the Appendices. Following input from WGSF members, the Handbook will be presented at the 1st Joint GOSUD/SAMOS Workshop to be held in Boulder, CO, 2-4 May 2006. We anticipate a public version by the end of summer 2006. The draft is available at ftp://ftp.etl.noaa.gov/user/cfairall/wcrp_wgsf/flux_handbook/.

A separate report "Handbook of Physical Constants and Functions for Use in Atmospheric Boundary Layer Studies" was written by Dr Ed Andreas and now resides on the WGSF website. This is a reference for formulas, constants etc. that are required for computing air-sea fluxes.

The WGSF is of the opinion that radiative fluxes might offer the most potential for measurement and/or estimation improvements in the near term. COADS-based products do not use radiative measurements but estimate the radiation from measurements of temperature, humidity and cloud cover. Also, present seagoing flux instruments are not usually pitch/roll stabilized and do not use the most accurate methods (i.e., sun trackers and diffuse radiation sensors) now in service in the ARM program and BSRN. The WGSF sees the need for evaluating present buoy and ship measurement methods against a BSRN standard (perhaps a site on an offshore platform) and developing a seagoing radiative flux standard for a research vessel.

Because of the urgent needs of the ocean reanalysis and assimilation community, the WGSF addressed at length the issue of flux products, their accuracy and the possible creation of an optimal blended product. A great deal of work was done and reported on by the original SCOR/WCRP Working Group on Air-Sea Fluxes. The WGSF is considering an update of that report but it was decided that more is required. Because different products cannot be optimally blended without knowledge of their properties, it is clear that biases and error-covariance properties for the flux components of each product are needed. This is a large undertaking that requires a database at least as comprehensive as the SeaFlux project and a lot of resources for careful processing and analysis. This should be a funded project.

Currently, there are several new generation sea-air flux products, which are either under development or their first versions have been already issued. These are WHOI Atlantic combined daily 1-degree sensible and latent turbulent fluxes, which were recently updated and extended by one more decade by Drs L. Yu and R.A. Weller (http://oaflux.whoi.edu/), a 1-degree version of FSU winds and air-sea fluxes that includes uncertainty estimates (release for Indian and Atlantic Oceans in early 2006), and new sets of surface flux parameters for forcing ocean general circulation models developed at NCAR and Laboratoire des Ecoulements Geophysiques et Industriels (LEGI), France and PP Shirshov Inst. of

Oceanography Russian Academy of Science (IORAS). IORAS is going to finish their new climatology of surface turbulent fluxes based on new averaging approach.

WGSF will support (consider) possible cooperative applications to different funding agencies for developing the improved flux products. Recommendations of the JSC on how to proceed with several issues concerning flux products, including their evaluation, maintaining a global WCRP product which will best effectively meet the requirements of different WCRP programmes and activities, are requested. WGSF unavoidably considers the development of the strategy for the creation of such a product (or ensemble of the products) as a contribution to WCRP's Strategic Framework.

Long-term air-sea flux products and the climate changes in air-sea interaction characteristics were reviewed for IPCC Fourth Assessment report (IPCC 2007) in two chapters. Dr S. Gulev in the capacity of the IPCC Leading author for Chapter 5 and contributing author for Chapter 3 and Dr S. Josey as the Contributing author for both Chapters 3 and 5 were responsible for this.

The JSC supported joint meeting of WGSF with WGNE on SURFA in Boulder (November 2006) and the joint meeting of WGSF representatives with SOLAS in Heidelberg (September 2006). JSC approved that WGSF start to negotiate with IGBP (iLEAPS), and other WCRP activities, regarding potential cooperation on the WGSF transition to the sea/land mode and hoped that this discussion would lead to some synergies in the number of meetings and groups.

12. WCRP-IGBP JOINT SESSION

In accordance with the JSC-XXIV decision to hold joint sessions of WCRP JSC and Scientific Committee of the IGBP (SC-IGBP) in alternate years, the Second joint session was held for 1.5 days during 6-7 March 2006. The session started with a joint lunch and included overviews by Professor P. Lemke, Chair, JSC, and Professor C. Nobre, Chair, SC-IGBP, followed by discussions on ESSP joint projects, SOLAS, Integrated Regional Studies, START, NEESPI, AMMA, GEO, and a presentation by ICSU. A good part of the session was devoted to WCRP/IGBP collaborations which included items such as atmospheric chemistry and climate, WCRP/IGBP modelling strategy, GEWEX-iLEAPS collaboration and CLIVAR-PAGES collaboration followed by a brainstorming session on "Roadmap for joint IGBP/WCRP activities". The joint session ended with a discussion on the ESSP issues including the Preparations for Open Science Conference, 2006.

The JSC and the IGBP SC welcomed their second joint session. The two research agencies noted that there are many problems, which they cannot address alone but that can only be tackled jointly. Both offer their knowledge, ideas and enthusiasm for a shared view of joint future towards a common, holistic view of the Earth System. The IGBP SC alluded to linkage of global environmental change to regional changes and the pursuit of Millennium Development Goals to eradicate poverty. The JSC noted that environmental change has long been a concern of the ESSP and its joint projects.

The main intention behind the joint session was to highlight several of the interfaces for increasing IGBP-WCRP collaboration, and to help take advantage of the very positive movement towards closer collaboration. The joint session provided a possible way to focus our discussions of increased collaboration, and allow us to concretize some plans for joint activities. It was noted that discussions were already underway for a workshop/activity on chemistry-climate interactions in the context of an IGAC-SPARC collaborative activity.

Opening of the Joint Session

Dr P.S. Goel, Secretary, Department of Ocean Development (DOD), Government of India, and chief guest on the occasion expressed his pleasure and gratitude for the invitation to address the joint session. He affirmed that the Government of India would be happy to extend any assistance to the WCRP and IGBP communities in addressing the challenging problems of understanding climate. He noted that India is unique because of its diversity of climates, the large variation of rainfall in the country and its many rivers. Dr Goel stressed the important role of oceans in climate. Recognizing the importance biosphere and geosphere, India became a part of IGBP. The Department of Science and Technology, Government of India, has taken up the climate part. The speaker drew attention to the challenging task of addressing country's development in the context of environmental concerns and of achieving sustainable development. He noted that there was need for more focused research in the country. In this context, India is setting up an Earth commission. Dr Goel alluded to India's Oceansat-1 and Oceansat-2 programmes, and the Megatropique project with France. Dr Goel assured India's sustained support to WCRP and IGBP programmes.

Professor T. Rosswall, Executive Director, ICSU, spoke on the occasion. He expressed gratitude to India for hosting the IGBP and WCRP meetings. He referred to IGBP and WCRP as major jewels in the ICSU crown. It was important for science to be participatory in its approach to society and it was important for science that society perceives research programmes as relevant. Professor Rosswall observed that extremely positive changes had taken place in IGBP and WCRP in India since his last visit here some 12 years ago. ICSU was establishing 4 regional offices. This represented a move from global to regional changes: regional focus had become very important. Governments were focusing on Millennium Development Goals, not on Conventions. In this context, this meeting was very important. 2008 will be National Development Year of the UN. He eagerly looked forward to discussions of the joint meeting.

12.1 ESSP joint projects

The collaboration between IGBP, IHDP, WCRP and DIVERSITAS in the field of Earth System Science is a manifestation of working together in a co-operative approach on issues of major relevance to society and global sustainability. The ESSP should provide the common platform required by the increasing emphasis on broad-scale integration in international Earth System science and on which programmes could collaborate on crosscutting activities. In addition to the earlier sponsorship of START by three of the Programmes, at his early stage of its development, the ESSP is also undertaking three other types of activity: joint projects; regional activities (Integrated Regional Studies); and global change open science conferences. The pressure for more emphasis at the regional scale of Earth System science has been growing steadily and such studies would respond to this by fostering collaboration between regional scientific communities and drawing on input from these, and establishing the necessary regional-global links. The type of studies envisaged was beyond the scope or expertise of any one of the global environmental change programmes and thus logically should be co-ordinated under the ESSP.

Both JSC and SC discussed shared issues, especially governance, concerning the joint ESSP Core Projects and also START. The discussion centred on the life span of the ESSP projects. It was felt that a review and direction assessment are needed to done by the end of decade. As regards the models of governance, it was felt that an approach would be improvement at two levels: 1) chairs and directors, 2) accountability and excellence.

12.1.1 Global Carbon Project (GCP)

Dr J.G. Canadell, Executive Director, GCP, reported on the progress of the ESSP Global Carbon Project (GCP). The largest focus and activity of the GCP revolves around four major themes:

- Global and regional carbon budgets
- Vulnerabilities of the carbon cycle and feedbacks to climate
- Urban and regional carbon management
- Supporting the establishment of a global carbon observation system with IGCO of IGOS-P

The 7th International CO_2 Conference held at Broomfield, CO, USA, 26-30 September 2005 was a great watershed of science on the carbon cycle. For the first time the conference, exclusively made up natural scientists, had a session on "Managing the carbon cycle". Dr D. Ojima (co-authored by P. Tschakert and M. Raupach) gave probably the most valuable talk in the session, a science framework developed during the GCP meeting last year in Beijing on carbon budgets. A side meeting between the GCP and several representatives of the US Carbon Cycle Science Program took place to explore stronger interactions. Several options and project developments were discussed including a focus on the Northern Hemisphere net carbon sink. Other meetings of interest in 2005 include: Open meeting of the Human dimensions Community, 9-13 October 2005, Bonn, Germany and a Training workshop on Southeast Asia Regional Carbon & Water,15-28 November, Taiwan. Publications issued include Science and Journalism, Proceedings of the conference on Science-Journalism Partnerships in Tokyo in June, 2005; Social Network Approaches to Urban and Regional carbon management, the proceedings of the 1st International Workshop on "Social Network Approaches to Urban and Regional Carbon Management" held in Tsukuba 4-6 April 2005. Meetings planned for 2006 include: Vulnerability of Carbon in Tropical Peatlands, 23-26 January 2006, Sumatra, Indonesia; Networks of Community Action for Decarbonizing Japan, 9 February 2006, Tokyo, Japan; Asia-Pacific Terrestrial Carbon Sink Dynamics in a Global Context, 13-15 March 2006, Beijing, China; Climate Variability and the Carbon Cycle (Past, Present and Future), EuroCLIMATE open session in European Geosciences Union (EGU),2-7 April 2006, Vienna, Austria; Second ESSP Open Science Conference, Global Environmental Change: Regional Challenges 9-12 November, Beijing, China. Other ocean carbon activities for which the GCP provided coordination include International Ocean carbon Coordination Project (IOCCP).

Dr Shobhakar Dhakal, currently Senior Policy Researcher at the Institute for Global Environmental Strategies (IGES), will replace Dr. Penelope Canan as Executive Director of the Tsukuba, Japan office on April 1st.

The JSC and the SC thanked Dr P. Canadel for his report on the Global Carbon Project. The first term of the project (2001-2005) was over and mid-term review of the project was due and new activities for the second term needed to be considered.

12.1.2 Global Environmental Change and Food Systems (GECAFS) project

Dr J. Ingram, Executive Director, GECAFS, presented the progress of the GECAFS joint project. Several notable workshops conducted in 2005 included: GECAFS DSS workshop, 10-11 January, Gainesville; Seminars to USAID & World Bank, 12 January, Washington DC; GECAFS Exec7 Meeting, 18 Jan, London; GECAFS representing ICSU at IAASTD, 29 Jan-2 Feb, Bangkok; SANREM Caribbean Planning workshop, 30-31 August, Kingston; GECAFS Food Systems/Vulnerability Network Planning workshop, 13 October, Bonn; GECAFS/CPW&F IGP Food Systems Description workshop 13-15 December, Kathmandu. The following publications were issued in 2005: GECAFS Science Plan and Implementation Strategy, ESSP Rpt 2; Gregory P. J., J. Ingram and M. Brklacich. 2005. Climate Change and Food Security. Phil. Trans. R. Soc. B (2005) 360, 2139–2148. Publications Drafted: Conceptualizing Food Systems for GEC Research (paper); A Conceptual Framework Describing Food Systems–GEC Interactions (paper); A Review of Global Scenarios for Food Systems Analysis (paper); Prototype GECAFS Scenarios for the Caribbean (GECAFS Report); GECAFS Science Plan for southern Africa (GECAFS Report); Southern African food systems in the context of global environmental change (paper). The Outlook for 2006 includes: Conceptual and Methodological Projects: publication of food systems concepts and completion of case study in IGP; establishment of GECAFS network on "Food Systems and their Vulnerability to GEC"; development of research linking prototype scenarios with decision making for the Caribbean; establishment of GECAFS network on scenarios development; refinement of scenarios for European food systems research. In regional projects: the Indo-Gangetic-Plain (IGP) activities include further project funding and follow-up research activities including initial analyses of water-related GEC impacts on IGP food systems and publication of the GECAFS IGP Science Plan. In the Caribbean region, activities include: publication of the GECAFS Caribbean Science Plan, initial project funding for research activities and publication of a paper on Caribbean food systems and GEC. Challenges facing GECAFS are: securing funds for regional projects, securing funds for the Scenarios Science Officer post in the IPO, identifying the new GECAFS Vice-Chair with effect from 1 June 2006 and establishing collaboration with other Joint Projects and Core Projects of IGBP, IHDP & WCRP.

The JSC and the SC thanked Dr J. Ingram for his report on the Global Environmental Change & Food System Project. In the context of this project, the JSC noted that regional scenarios will be part of the next IPCC assessment (AR4).

12.1.3 Global Water System Project (GWSP)

Dr E. Craswell, Co-Chair GWSP, briefed the JSC on the status of the GWSP. Activities in 2005 included: publication of the GWSP Science Framework and Implementation Plan; establishment of contacts within and outside the ESSP community; development of some basic communication tools (brochure, briefing notes, newsletter) and an overall communications strategy in cooperation with IHDP and IGBP; participation in the preparation of an EU proposal (6th Framework) for an Integrated Project about the 'Vulnerability of the Integrated Earth Water System (VIEWS)' under the direction of Professor P. Kabat (Wageningen University and Research Centre, The Netherlands) and Professor Z. Kundzewicz (Polish Academy of Sciences); participation in the preparation of an EU proposal for a Specific Targeted Research Project (STReP) about twinning European and Asian river basins ('Governance of European and Asian Rivers – GEAR') under the direction of Professor C. Pahl-Wostl. There was also participation in several workshops. Publications include: Framing Committee of the GWSP, 2005: The Global Water System Project: Science Framework and Implementation Activities. Earth System Science Partnership, Endejan, M. (2005): The Global Water System Project in: WaMRI Newsletter No. 8, WHO Collaborating Centre for Health Promoting Water Management and Risk Communication, Endejan, M. (2005): Das Global Water System Project in: WaMRI Newsletter No. 8, WHO Kollaborationszentrum für Wassermanagement und Risikokommunikation zur Frderung der Gesundheit (German), Craswell, E.T. and Braimoh, A.K. (2005): Global Water System Research: Current programmes and future needs. Submitted to EOS. Vorosmarty, C.; Lettenmaier, D.; Leveque, C.; Meybeck, M.; Pahl-Wostl, C.; Alcamo, J.; Cosgrove, W.; Grassl, H.; Hoff, H.; Kabat, P.; Lansigan, F.; Lawford, R.; Naiman, R. (as members of the Framing Committee of the GWSP) (2004): Humans Transforming the Global Water System. Eos, Transactions, American Geophysical Union, 85:48 (30 November 2004) Canadell, P.; Carson, D.; Craswell, E.; Gbel, B.; Ingram, J.; Larigauderie, A.;

Steffen, W.; Virji, H. 2004: Towards a holistic approach to global change research: The Earth System Science Partnership (ESSP). APN Newsletter, Vol. 10, No. 3 (July 2004). Asia-Pacific Network for Global Change Research.

The JSC and the SC thanked Dr E. Craswell for his report on the Global Water System Project. The JSC noted that there are no climate models in the most recent IPCC assessment that give the correct rainfall distribution. This challenge provides an excellent opportunity for joint WCRP and IGBP research.

12.1.4 Global Environmental Change and Human Health (GEC&HH) project

A fourth ESSP Joint Project on Global Environmental Change and Human Health is in the development phase. This project will provide a focus of convergence for the other three ESSP Projects, each of which addresses major human-induced changes in the Earth's natural systems that underpin the long-term viability and health of human populations. The GEC&HH Project Scoping Team have identified a set of key types of global environmental change that are known or suspected to have significant consequences for human health. The evolving Science Plan explores priorities and settings for the future coordinated international study of these relationships, taking into account the complexities of concurrently acting environmental changes and the importance of socio-economic and cultural contexts as modifiers of community vulnerability. The discussion currently centres on the health related consequences of changes in atmospheric composition, changes in the hydrological cycle, changes in food and fibre producing ecosystems, urbanization, as well as biodiversity changes. Understanding the human health dimension of GEC highlights the immediacy of the biological impacts of the changes in the Earth Systems, and can help motivate human responses to global environmental change that include mitigation and adaptation measures and policies to address underlying forces and the impacts of GEC. The GEC&HH Project Scoping Team had its first meeting in February 2003, a second meeting in January 2004, and have since worked on the Draft Science Plan. The team is also involved in constructive cooperation with the WHO. Chairs of the GEC&HH Scoping Team are Drs A. McMichael (National Centre of Epidemiology and Population Health, Australian National University, Canberra, Australia) and U. Confalonieri (National School of Public Health, Rio de Janeiro, Brazil).

The JSC and the SC was informed that GEC & HH would launch science implementation plan at the ESSP conference.

12.2 Global Change System for Analysis, Research and Training (START)

Dr H. Virji presented the report on START. Currently, START has over 70 ongoing collaborative regional research projects on the following themes (many of the projects directly contribute to ESSP's core and joint projects):

- Land Use Change and its Impacts on Terrestrial Ecosystems;
- Regional Climate Variability and Change;
- Regional Changes in Atmosphere;
- Coastal Zones;
- Global Change and Water Resources; and
- Assessments of Impacts of and Adaptations to Climate Change.

During 2005, around 1000 scholars from developing countries were involved in various START activities, including regional science planning and research workshops, collaborative research networks, short term fellowships, visiting scientist and lecturer awards, African dissertation/PhD fellowships programme, small grants programme, and young scientist awards. During the past several years there has been an extraordinary growth in regional activities initiated and coordinated through START's regional centres and networks. With only modest support they have succeeded in stimulating activities on a scale far exceeding expectation. Several have already been cited by national or international organizations for their work. A highlight this past year was the conference organized together with IRI and WMO on "Climate Prediction and Agriculture: Advances and Challenges". This meeting brought together specialists from many disciplines and institutions to consider our current understanding of the relation of climate variability to agricultural production, including the application, utility and limitations of seasonal climate forecasts. The CLIMAG conference was preceded by the synthesis workshop of our first advanced institute on the same topic; participants were thus able to contribute to and benefit from participation in the larger conference and to broaden their personal and professional networks. Proceedings of the International Workshop are being published in a book volume; keynote papers from the workshop are also being published in the journal "Climatic Research". The project on Assessment of Impacts and Adaptations to Climate Change (AIACC) is now in its final year and its regional scientific and capacity building activities nearly complete. START, at the request of the ESSP, is fostering the Monsoon Asia Integrated Regional Studies (MAIRS) project. START

and APN co-sponsored the February 2005 International Workshop on Enhancing South-Central Asian Climate Change Monitoring and Indices at IITM-Pune, India and January 2006 follow-on workshop at Islamabad, Pakistan. Reports are available with the CLIVAR Expert team on Climate Change Detection Monitoring and Indices. START has funded several AMMA-related projects of African scientists; a CLIVAR-Africa-related workshop (to be held during July 2006 in Daressalaam, Tanzania); and an ARGOS free-drifting profiling floats workshop for West Africa (also to be held during early 2006 in Ghana). In addition a number of other small grant and PhD fellowship awards have been made to African scientists.

The JSC and the SC thanked Dr H. Virji for his report on the Global Change System for Analysis, Research and Training. The JSC and the SC were pleased to note that START is organizing the 2nd International Young Scientists' Conference just prior to the Second ESSP Open Science Conference. START was invited to hold a Workshop for young scientists in conjunction with the next JSC session in Tanzania during March 2007.

Integrated Regional Studies

12.2.1 The Monsoon Asia Integrated Regional Studies (MAIRS) project

Dr Frits Penning de Vries, Executive Director MAIRS-IPO, presented the report on the project. In October 2005, the International Project Office (IPO) for MAIRS became fully operational. It is hosted by the Institute for Atmospheric Physics in Beijing, PR China. START, TEA-RC and ESSP were instrumental in implementing the IPO. The sponsorship by the Chinese Academy of Sciences and the Ministry of Science and Technology created the proper conditions for the IPO, while APN funded crucial start-up research activities in the region. Contacts with many ESSP-partners are being made. MAIRS aims to provide a framework for many of the activities and specific projects of all GEC-Projects and Programmes in the Asia Monsoon Region (as well as for relevant projects that are not connected to the GEC-Programmes or ESSP). In addition to facilitation, MAIRS will promote and initiate regional research projects that deal specifically with the interactions between human activities and the Asia Monsoon System, and that collaborate with or build on GEC-projects as well as other relevant activities. One step towards developing a framework for synthesis and interaction at the regional level is to develop an inventory of the GEC and ESSP projects in Asia. MAIRS IPO has approached all other IPOs for information about such projects, and will share the results once these are available.

The JSC and the SC thanked Dr F. Penning de Vries for his report on the Monsoon-Asia Integrated Regional Study. The JSC pointed out that there is so far no scientific evidence demonstrating that the monsoon is changing because of human activities. The JSC expressed that MAIRS should interact with the modelling groups of WCRP projects CLIVAR and GEWEX. ICSU expressed the view that MAIRS should be coordinated with ESSP, not START.

12.2.2 The Northern Eurasian Earth Science Initiative (NEESPI)

Dr R. Lawford reported on this project. Following the discussions at the JSC-XXVI, WCRP contacts with NEESPI have been developing, mostly through GEWEX and CliC. At the request of NASA, Dr Lawford has been acting project coordinator for NEESPI. The possibility of NEESPI operating like a GEWEX Continental Scale Experiment (CSE) is being considered. CliC has been considering a MoU with NEESPI. NEESPI has established links with IGBP and has a potential to grow and become a foundation or a major contributor for an ESSP Integrated Regional Study in Northern Eurasia. The NEESPI and WCRP share common goals in trying to understand recent environmental and climate change and variability in Northern Eurasia and its Arctic coastal zone and to develop corresponding modelling and predictive capabilities. They also both aim to understand the climate links between the high latitudinal land areas and the rest of the globe and to foster establishment of better long-term observations for monitoring of change. Several of NEESPI's projects acquire data from the large relatively unsampled climate-sensitive area of northern Eurasia. GEWEX and CliC may benefit from research directed at the hydrometeorological components of NEESPI to provide data and insights that will facilitate the better modelling of vegetation-atmosphere interactions in the large areas of larch and boreal forests, and to help in modelling the major north-flowing rivers that supply freshwater to the Arctic Ocean. At the same time, the NEESPI, in its current stage, seems to operate more like a network of projects rather than a consolidated focussed programme. NEESPI has still to put in place working data management arrangements and observing practices that follow international standards. Compatibility of current NEESPI practices with those of GEWEX CSEs, GCOS etc. may be an issue. Developing such features require time and effort. While the overall goals of NEESPI are very favourable for the ESSP, joint activities of NEESPI-related projects and WCRP elements, e.g. such as leading climate modelling centres, may require additional resources and time.

The JSC and the SC thanked Dr R. Lawford for his presentation on Northern Eurasian Earth Science Initiative (NEESPI). Both the WCRP and IGBP expressed interest in the NEESPI.

12.2.3 The African Monsoon Multidisciplinary Analysis (AMMA)

Professor S. Sorooshian presented the report on AMMA from the GEWEX point of view as a Continental Scale Experiment. The AMMA's request for CSE status was approved at the GEWEX SSG meeting in February 2005. AMMA-Africa is taking the lead in GEWEX in order:

- to increase the visibility of African science;
- to help African scientist secure funding; and
- to open new international collaborations.

AMMA GEWEX representative is now Dr Amadou Gaye (Director of the Laboratory for Atmospheric Physics, Simeon Fongang, Cheikh Anta Diop University, Dakar). The aims of AMMA are:

- To improve understanding of the West African Monsoon and its physical, chemical and biological environment.
- To provide the underpinning science that relates climate variability to issues of health, water resources and food security and defining the relevant monitoring strategies.
- To ensure that the multidisciplinary research is efficiently integrated with prediction and decision making activities.

It has been observed that significant reductions in precipitation occurred in West Africa during the 20th century. Fluctuations in rainfall have profound impact on African societies.

AMMA International (Leaders: Drs J.-l. Redelsperger/C. Thorncroft) tries to coordinate the different AMMA projects. An international structure has been put into place:

·International Scientific Steering Committee (ISSC): leaders of AMMA projects and experts.
·International Governing Board: Representatives of funding agencies.

The two main coordination tools of the ISSC are:
·Working groups are tasked with the coordination of the integrative science, impact studies and the collaboration with THORPEX.
·Task Teams for the various deployment tasks have been established to ensure an optimal use of the means available.

The first AMMA International conference was held at Dakar during 28 November - 2 December 2005. The EU contribution provides the integration of national programmes and ensures the application of the gained knowledge. Four African partners ensure the link with AMMA-Africa. The most recent GEWEX SSG meeting took place in Dakar (January 2006). The current status of AMMA is:

- AMMA has started well;
- Its subset of GEWEX-Related activities is in line with GEWEX CSE Requirements and CEOP;
- Coordination with CLIVAR has been on track since the beginning; and
- Coordination with other projects is evolving (Recently approved as an "iLEAPS-Recognized" project).

The JSC and the SC thanked Professor Soorooshian for his report on African Monsoon Multidisciplinary Analysis (AMMA).

12.3 Surface Ocean-Lower Atmosphere Study (SOLAS)

Dr P. Liss presented the report on SOLAS. SOLAS is co-sponsored by WCRP, IGBP, the Scientific Committee on Oceanic Research (SCOR), and the Commission on Atmospheric Chemistry and Global Pollution (CACGP). The three Implementation Groups, each responsible for implementing one of the SOLAS Foci, have completed their task of writing an Implementation Plan for each SOLAS Focus, and these Plans have been posted on the SOLAS website (http://www.solas-int.org). These contain the details of the science that SOLAS will conduct over the coming years in order to achieve the goals established in the SOLAS

Science Plan and Implementation Strategy (2002). The Implementation Plans will be treated as 'active documents', subject to periodic review and update. Other major activities include the IGAC/SOLAS Task Team on Halogens in the Troposphere (HitT) and the Ocean-Atmosphere-Sea Ice-Snowpack (OASIS) project. SOLAS is also aiming to capitalise on IPY and use it as a platform from which to make measurements of trace gases (CO_2, DMS, organo-halogens etc.) in the undersampled Southern Ocean and in Arctic regions. Future plans include:the Second SOLAS Open Science Meeting to be held in Xiamen (Fujian Province) China on 6-9 March 2007 and a session for the November 2006 ESSP Conference in Beijing, and the proposed content of this session is the intersection between the WCRP Working Group on Surface Fluxes (WGSF) and SOLAS Focus 2.

SOLAS addressed some issues to the JSC. The main question is how SOLAS will contribute to WCRP other than to the planned activities of WGSF. SOLAS could lead on the incorporation of the sulphur cycle into climate models and the role of biogenic aerosols in clouds and radiation. SOLAS continues to be concerned with the shortage of funding for the WGSF activities particularly given the extensive agenda of the group. This Working Group provides significant synergistic cooperation with SOLAS Focus 2. Will the Atmospheric Chemistry and Climate theme involve chemical and other expertise from SOLAS? How else can SOLAS contribute to the WCRP Strategic Framework and how to ensure the adequate marine biogeochemical expertise be gained on the JSC?

The JSC and the SC thanked Dr P. Liss for his presentation of SOLAS activities. The JSC noted that this was an important joint project with IGBP and others dealing with the role of atmosphere in affecting ocean biogeochemistry and vice versa. The JSC noted the excellent interaction between WGSF and SOLAS and how WGSF benefited from this interaction. Dr Liss expressed the view that SOLAS looked forward to continued interaction with WGSF. He also pointed out that SOLAS is linked to AIMES through global emission inventory activity.

12.4 Group on Earth Observations (GEO) and Global Earth Observation System of Systems (GEOSS)

Dr G. Sommeria presented a summary of GEO activities since JSC-XXVI. This included a general outline, prepared with the GEO Secretariat, of GEO recent developments and its role for the scientific community, and a summary of issues more specific to WCRP and IGBP. Contributions of WCRP to GEO during the last year can be summarized as follows:

- WCRP's input to the 10 year implementation plan has been significant, to both the climate and water chapters, and to some of the general principles and guidelines on scientific matters and user requirements.
- WCRP's input to the 2005 GEO tasks and 2006 workplan has also been significant, again mostly in the two societal benefit areas related to climate and water.
- As WCRP participates in GEO along with its three sponsors WMO, ICSU and IOC, its major inputs are, as far as possible, prepared in consultation with them in order to ensure the required coordination.
- As part of the preparation of 2006 workplan, WCRP has volunteered to co-lead the three following tasks:

(1) Maintain sustained climate data reprocessing and reanalysis effort (with GCOS)
(2) Secure key data for climate studies and forecasting from satellite systems (with WMO space programme, GCOS, CEOS, ESA and USA)
(3) Develop demonstration project(s) on the use of hydrological ensemble forecast for water resource management (with GEO secretariat and IGWCO)

In addition, it is involved in eight other tasks related to ocean observations (CLIVAR), the International Polar Year (CLIC), development of expertise acquired with CEOP, and priorities expressed by IGWCO with GEWEX expertise.

WCRP is represented in GEO at the Plenary level and in the four specialised committees on Architecture and data, Science and Technology, Users' interface, Capacity building and outreach.

The JSC and the SC thanked Dr. G. Sommeria for his presentation on Group on Earth Observations (GEO). It encouraged an increased coordination with IGBP on GEO matters and recommended the strengthening of the representation of WCRP in the Scientific and Technical Committee. It requested to be more fully informed of WCRP's commitments in the assimilation and associated modelling effort needed to process the GEO data, and the support expected for it.

12.5 ICSU Review of IGBP, WCRP and ESSP

Professor T. Rosswall, Executive Director, ICSU, representing one of WCRP's sponsors, presented the aim and scope of review of IGBP, WCRP and ESSP and the Draft Terms of Reference and Work plan.

It is expected that reviews of ICSU Interdisciplinary Bodies will be a component in the developments of future strategic plans, and the 28th General Assembly requested the Executive Board to "present plans to the 29th ICSU General Assembly (2008) for the development of a Second Strategic Plan for ICSU 2012-2017". A review of the ICSU Interdisciplinary Bodies would be part of any such process. A review of the Global Environmental Change Programmes is specifically called for in the Strategic Plan 2006-2011: "ICSU will conduct individual reviews of its global environmental change research programmes. Special attention will be given to the development of the Earth System Science Partnership, which brings together the four programmes to address issues that are integral to sustainable development. The links between this Partnership and other ICSU Interdisciplinary Bodies and Members will be considered as part of these reviews."

Review of the Global Environmental Change Research Programmes in 2006-2009

The Global Environmental Change (GEC) Research Programmes have been reviewed in the past: WCRP was reviewed in 1995 and IHDP in 2005. ICSU will review DIVERSITAS, IGBP, WCRP and ESSP over the next few years. ICSU has suggested to the International Group of Funding Agencies for Global Change Research (IGFA) that reviews be conducted by the two organizations jointly. In addition, other cosponsors must also be involved in the reviews for DIVERSITAS (IUBS, IUMS, SCOPE and UNESCO) and WCRP (IOC/UNESCO and WMO). The reviews should be both reflective and forward-looking. They should evaluate past performance of the Programmes, review operational structures and assess future plans. The GEC Programmes are vital for advancing our understanding of the functioning of Planet Earth. Such understanding is essential if we are to predict future trends in the development of the Earth as a system. Research findings underpin many international Assessments such as the IPCC, the Millennium Ecosystem Assessment (MA) and the planned biodiversity assessment (IMoSEB). Through such assessments, scientific research is supporting several global conventions such as the UN Convention on Climate Change (UNFCCC), the UN Convention on Biodiversity (CBD) and the Convention to Combat Desertification (CCD). Thus, they provide excellent examples of policy relevant science. The GEC Research Programmes have also been pivotal in breaking ground for interdisciplinary and international science. As such, they face challenges of systems that have been built up to foster disciplinary excellence and to fund the best disciplinary research. In developing the ESSP, based on the Amsterdam Declaration from the First Global Change Open Science Conference in 2001, they have taken on the challenge of truly integrating natural and social sciences around common research questions and educating a new generation of scientists to address complex issues outside of disciplinary research structures.

The WCRP has existed since 1980, IGBP since 1987, DIVERSITAS since 1991, and IHDP in its current form since 1996. The Programmes have developed over time and continue to attract many of the world's leading scientists. However, the world has also changed and political interest is today primarily on issues broader than reducing the scientific uncertainties in relation to global change processes. The focus has, for example, shifted to the Millennium Development Goals and the outcomes of the World Summit on Sustainable Development. The discussion currently centres on how research could be relevant for poor people and help alleviate poverty. However, global environmental change in general, and climate change in particular, will have large impacts on the population in the poorest countries. This has been recognized by the ESSP through projects on water, food and health, but the Programmes are still perceived as focusing on reducing scientific uncertainties in relation to predicting the future of the Earth System and thus being primarily of scientific interest.

The IGFA and ICSU have identified the need to bring the global change community together with development community. Thus, a conference was organized in 2005 that brought the scientific and funding communities together to discuss common interests and possibilities for increased collaboration. It seems clear that the GEC Research Programmes offer insights that address development issues. Reference is made to the presentation by Sara Farley at the IGFA Annual Meeting 2005 on "Rethinking Global Change & Development Research".

There are many issues that could be addressed and it is important that the Terms of Reference provides clear guidelines to the Review Panels, so that the reviews will provide useful guidance to the Programmes as well as to the sponsors and funders.

Draft Terms of Reference

The review will focus on both internal and external interactions. The major questions to be considered by the review are given below. The overriding objective of these reviews should be to evaluate the extent to which the character of the international programmes adds value to their area of research and the national programmes that contribute to them. The primary question that the review should answer is: "What do scientists, sponsors and the end-users get out of participating in and supporting these international programmes that they would not have got if the international programmes did not exist?

IGBP and WCRP

1. Scientific impact, balance and relevance

1.1 What are the indicators of success against which a Programme can be evaluated? Has the existence of the Programme made a difference?
1.2 Has the Programme developed strategic scientific and implementations plans that address key issues perceived as priorities by the scientific community?
1.3 Has the Programme augmented intrinsic scientific merit, including its effectiveness in attracting the best relevant disciplinary research?
1.4 Has the Programmes been effective in planning, networking, connecting and orchestrating the different parts of the Programme?
1.5 Has the Programme been able to provide an enabling environment for high quality interdisciplinary and international research addressing the mandate of the Programme?
1.6 Has the Programme been effective in building on, and integrating the results from, relevant national programmes?
1.7 Has the Programme provided syntheses and integration of its results, both internally and with its sister Programmes?

2. Policy relevance

2.1 Has the Programme developed strategic plans that address key issues perceived as priorities by the policy communities? If so, how has the policy relevance been asserted?
2.2 Has the Programme developed appropriate mechanisms for ensuring that its results are policy relevant? How has the Programme interacted with the assessment and policy communities? How can the policy relevance of the research be strengthened?
2.3 Is the mandate adequate for addressing issues relating to science for the Millennium Development Goals and Science for Sustainable Development? Has the Programme fulfilled its original mandate and should a closing date be decided on? If not, should the Programme continue to focus on the original mandate or should this be changed?
If a change is proposed, suggest wording for a mission statement.

3. Organization and governance

3.1 Has the governance structure been sufficient to ensure appropriate priority setting and efficient coordination for the overall Programme, Core Projects, cross-cutting initiatives (where appropriate) and ESSP?
3.2 Is the representation of the governing body of the Programme representative in terms of scientific expertise and geographical and gender balance?
3.3 Is the attention of the Programme between the Core Projects and the ESSP balanced?
3.4 Is the hybrid model on a non-governmental/governmental Programme (WCRP) appropriate and are there ways to make better use of the distinctive features of the sponsors? For IGBP, would there be any merit with a governmental co-sponsor, such as UNEP or UNESCO? How are the links to regional networks (e.g., IAI, APN)?
3.5 In view of the increasing collaboration between IGBP and WCRP, should they merge? If so, when?
3.6 Are the Secretariats organized in such a way as to optimize the use of scarce personnel and financial resources?
3.7 Are funds used in an optimal way in support of priority activities?
3.8 Is the Programme adequately funded?
3.9 What impediments can be addressed to increase the efficiency of the Programme?

4. Visibility and communication

4.1 Are the Programme's visibility and communication efforts sufficient?

5. Interaction with other bodies

5.1 Has the Programme developed appropriate links with ICSU Interdisciplinary Bodies and how has the Programme benefited from the expertise within ICSU Scientific Unions and National Members? For WCRP, how has it contributed to and benefited from other components of the World Climate Programme?

5.2 Are the links to the global observing systems (GCOS, GOOS, GTOS, IGOS-P, and the GEOSS process) adequate?

6. Capacity Building

6.1 Has the Programme succeeded in involving the scientific communities in all parts of the world, including developing countries, in the enterprise? Has it been able to attract the interest of young scientists and fostered a new generation of scientists working in a truly interdisciplinary research environment?

ESSP

1. Scientific impact, balance and relevance

1.1 Is the mandate of ESSP clearly stated? If so, is this sufficiently different from the sponsoring Programme so that the relative roles of ESSP and the sponsoring Programmes are sufficiently clear?

1.2 What are the indicators of success against which the ESSP can be evaluated? Has the existence of the Partnership made a difference?

1.3 Has the ESSP developed its activities based on strategic considerations? Have scientific and implementations plans been developed for the component parts that address key issues perceived as priorities by the scientific community?

1.4 Is the balance between Projects, Regional Studies and START adequate? What is the relationship between the component parts? Is the balance between natural and social sciences appropriate?

1.5 Are the ESSP Projects seen as building on, and contributing to, the activities of the Core Projects of the sponsors?

1.6 Has the Partnership developed in such a way that it involves the global change as well as the development communities?

1.7 Has the Programme been effective in building on, and integrating the results from, relevant national programmes?

1.8 Has the Partnership provided plans for syntheses and integration of its results, both internally and with its sister Programmes?

2. Policy relevance

2.1 Have the Joint Projects developed strategic plans that address key issues perceived as priorities by the policy communities? If so, how has the policy relevance been asserted?

2.2 Have the Joint Projects developed appropriate mechanisms for ensuring that their results are policy relevant? How have the Projects interacted with the assessment and policy communities? How can the policy relevance of the research be strengthened?

2.3 Is the mandate adequate for addressing issues relating to science for the Millennium Development Goals and Science for Sustainable Development?

3. Organization and Governance

3.1 Do the sponsoring Programmes provide sufficient guidance for an effective development of the Joint Projects?

3.2 Has the governance structure been sufficient to ensure appropriate priority setting and efficient coordination for the overall Programme, Joint Projects, Integrated Regional Studies and four GEC Programmes?

4. Visibility and communication

4.1 Are the Programme's visibility and communication efforts sufficient?

5. Capacity Building

5.1 Has the Partnership succeeded in involving the scientific communities in all parts of the world, including developing countries, in the enterprise? Has it been able to attract the interest of young scientists and fostered a new generation of scientists working in a truly interdisciplinary research environment?

What are the major accomplishments of START?

Has START functioned as the capacity building arm of the ESSP?

The review process

This draft document has been developed by CSPR, with preliminary input from IGFA. It is now sent to the Sponsors, the Programme and IGFA for review. The Sponsors and the Programmes may wish to appoint a Working Group with representatives of Sponsors, Programmes and IGFA to:

- consider which types of information and data the Review Panels would need;
- refine the Terms of Reference;
- recommend the process and format for the evaluations;
- propose the order in which the reviews would be conducted, i.e., either first ESSP and then IGBP and WCRP in parallel or *vice versa*; and
- propose a slate of names for members of the Review Panels.

After appropriate consultations, CSPR and IGFA would appoint Review Panels. It is envisioned that there would be 6-8 Panel members, three meetings for each review and telephone conferences, as needed. CSPR and IGFA representatives would also be expected to attend the Panel meetings. The IGBP and WCRP Panel should have at least one member in common and a joint meeting should be convened between the two Panels before the reports are finalized. Final reports would be delivered to the Sponsors and IGFA by March 2008.

The JSC and the SC thanked Professor T. Rosswall for his presentation of ICSU review of IGBP, WCRP and ESSP. The JSC noted the upcoming ICSU review of all of the global change programmes including WCRP and ESSP. The review would take place over the next 6 years and will be conducted by sponsors and IGFA. The overarching question for the review would be what do scientists, the sponsors and the end-users get out of participating in and supporting the programmes. The JSC welcomed ICSU's views. The JSC noted that such a review process helps focus WCRP's activities. The JSC agreed that the ESSP should be reviewed first. The SC expressed that a success criterion for review should be defined first. Secondly, an estimate what resources would be available should be provided. The JSC needs to form a small team to prepare for the review of WCRP in particular and ESSP more generally (including nomination of reviewers).

The JSC noted with interest that ICSU was currently considering co-sponsoring THORPEX in consultation with WMO. The JSC welcomed this and pointed out that WGNE was already deeply involved with THORPEX and that WCRP's new Strategic Framework proposes close collaboration with THORPEX.

12.6 WCRP-IGBP Collaborations

12.6.1 Atmospheric Chemistry and Climate

Drs A.R. Ravishankra and P. Rasch made presentations on this agenda item. Following the request of WCRP and IGBP, a group of WCRP JSC and SPARC and IGBP IGAC scientists proposes to establish a joint IGBP-WCRP Task Force (TF) on Atmospheric Chemistry and Climate (AC&C).

Background

A large part of human-induced climate forcing occurs through chemically active species, i.e. species relevant to climate and climate change are created, removed and altered via chemical processes in the atmosphere. Furthermore, impact of changes in climate are felt also via changes in the chemical composition of the atmosphere. Lastly, the chemically active species are most amenable to short-term manipulations through changes in emissions. Therefore, the studies of climate–chemistry interactions represent one of the most important and, at the same time, difficult foci of global change research. Provision of high-quality, policy-relevant information on the current state of climate and its possible future states, as well as options for mitigation / control / change / adaptation are strongly dependent on the progress in AC&C studies.

The IGBP and WCRP are two leading international global environment change research programmes, and these should be addressing the challenges posed by the complexity of AC&C science.

Chemistry/climate interactions are extremely complex, involve a broad range of processes, and occur on a wide range of space and time scales. Most efforts within the WCRP and IGBP have focused primarily on an understanding of particular components of the climate system. We believe that an increase in interactions between the two communities with a goal of integrating complementary areas of expertise would be beneficial in understanding the interactions taking place in the Earth's chemistry-climate system. A vision for the way forward started to take shape following the joint SPARC-IGAC Workshop on Climate-Chemistry Interactions (Giens, France, 3-6 April 2003). The discussions at and after the workshop identified several major uncertainties in the knowledge base of atmospheric chemistry. Examples include:

- Rates of chemical transformations that lead to production and removal of tropospheric ozone and aerosols;
- Transport of species from local to regional to global scales and extent of mixing occurring from this transport;
- Distributions of natural and anthropogenic emissions of constituents relevant to climate change;
- An accurate characterization of the processes that control the deposition of constituents relevant to climate change.
- Quantification of processes that occur at scales smaller than those resolvable in current climate models (e.g., convection, lightning, aerosol formation) and their representation and the associated transformations (e.g., microphysics, lightning production rates and non-linear nucleation, respectively, for the three examples noted) in global models.

The above list is certainly incomplete. The atmospheric science community's understanding of the above processes is limited by its ability to adequately observe and model these processes. Observations characterize the Earth System at both small and global scales. This characterization leads to revisions to the understanding of the processes that control the Earth System, and at some point influence the representation of those processes in models, which are, after all, our best (albeit flawed) statement of how the Earth System works. Only modelling can help to simultaneously quantify and predict the impacts of emissions on global and regional climate and, in turn, the influence of climate on the atmospheric composition (and hence our understanding of issues such as air quality).

Current efforts within WCRP and IGBP have focused primarily on an understanding of the components of the chemistry/climate system. It is believed that an increase in interaction between the two communities is merited. Individual modelling centres have begun to expand the scope of their modelling efforts (for example, to include biogeochemical processes at the surface, chemical processes in the troposphere, chemical processes in the middle atmosphere, and the impact of these on climate). However, the IGBP (with the exception of AIMES) has remained more centred on component processes, with identifiable programmes focusing on, for example, the coordination of activities for a particular region (for example only the troposphere or only the stratosphere) or a particular class of processes (for example, only chemistry and transport or only the physical climate system). On the other hand, WCRP had a focus on modelling activities but with less emphasis on chemistry and chemical processes. It is the opinion of the IGAC and SPARC co-chairs that the first line of IGBP/WCRP actions should be built on a coordinated modelling effort that brings a larger community of expertise to bear on these larger set of processes and thus builds on the strengths of the two organizations. A phased increase in the level of interaction between these programmes is suggested, with a goal of helping in:

(iii) the integration of these component model activities,
(iv) the coordination of the modelling activities encompassing the integrated components, and
(v) contributions to characterizing the source of the uncertainties in more comprehensive coupled chemistry/climate models.

Global-level climate changes will be felt via local/regional level changes in both climate and chemistry. There is a current tendency in atmospheric modelling to explicitly resolve more and more processes, e.g. transport on warm-front conveyor belts or tropopause folding events, and this may require higher spatial resolution.

A large number of modelling centres have already built, or are building, high-resolution global models with interactive chemistry in an attempt to include the most essential feedbacks important to the climate system. For IGBP and WCRP, it will be important to help the centres to systematically address the scientific issues that are relevant for predicting far enough into the future and with uncertainty levels that make the predictions policy-relevant. This is notable in part because such modelling efforts are necessary to provide meaningful input to international and national assessments, deliver decision-support information, identify gaps in knowledge and set policy priorities.

The joint IGBP-WCRP AC&C venture should aim at this, still largely missing, cost-effective, high-value outcome via coordination of model evaluation, development and data analyses. Following this initial venture, other key areas such as coordination of chemistry/climate relevant topics related to intensive field campaigns, long-term monitoring activities (especially in regions that are currently data-poor), controlled process studies (in the laboratory and in the atmosphere) and direct connections to other Earth System Modelling studies can, and should be, addressed.

IGBP and WCRP modelling groups and on-going activities, such as AIMES (process oriented) Chemistry - Climate Model Validation (CCM-Val), WGCM, C4MIP, TRANSCOM, should be vital participants in the AC&C studies.

Proposal:

1. Form a joint IGBP-WCRP Task Force on AC&C (TF-AC&C). (Already initiated.)

2. Start to develop modelling activities that encompass the Earth System from the land/ocean surface to the mesosphere, making sure to include relevant processes, e.g. such as those that control
   Gas phase species;
   Aerosols;
   Water vapour/relative humidity;
   Radiation;
   Clouds;
   Atmospheric dynamics and transport, including subgrid processes like convection and turbulent exchange; and
   Surface emissions.

3. Include extensive interaction between the various WCRP and IGBP projects that address the specifics identified above, as well as interactions with IGBP and WCRP groups focused on surface processes (SOLAS, iLEAPS) and the water cycle (GEWEX, GCSS) as well as modelling components and other working groups. Also, coordinate with other projects from AIMES and IHDP that address emissions and future scenarios. (In particular, dynamic emission inventories are a component to the success of this endeavour.)

4. Coordinate modelling calculations, archive the results, and provide "data stewardship" so that needed information is in pre-agreed formats with easy access.

5. Coordinate analyses to address key, specific issues.

6. Provide expert advice and input to assessments and scientific research planning.

7. Carry out focused workshops and dissemination of data/information.

8. Report findings via review papers, reports and other means.

Specific tasks and timeline:

Drs Ravishankara and Rasch outlined a proposal for the focal areas of this endeavour. Our current belief is that the optimal areas (in terms of common interests, complementary expertise and orthogonality with other WCRP and IGBP projects) are chemistry/climate interactions involving: 1) aerosols, 2) ozone and 3) deposition processes.

They defined phase one of the project to take place in the years 2006-2009. The end date is designed to coincide with the scheduling requirements for the next IPCC assessment and the WMO/UNEP 2010 scientific assessment of ozone depletion. Most major climate modelling groups are shooting for approximately January 2009 as the date at which they must have defined the components and evaluated their climate system model prior to the onset of the requisite long IPCC scenario runs. It is hoped that this project will contribute to the definition of the components of those models through their participation in this project during their development phase. During phase 1, the TF will hold three workshops. The general theme of the workshops will be "improving the representation of chemistry-climate interactions in climate and Earth System models". The time schedule will be:

- Around May 2006 – start planning workshop 1, select the Organizing committee. Revisit the results of the Giens workshop, identify gaps and uncertainties in chemistry-climate modelling and in knowledge of relevant processes, and then propose, for a wide discussion with the research and applications community, a "roadmap" for progress. Refine set of issues or topics that provide the focus for the project over the next three years.
- First Workshop in the third quarter of 2006. Small meeting with representative modelling centre participants and interested WCRP/IGBP projects. Get agreement on issues and the strategy for making progress. Define tasks for producing a manuscript outlining project.

- First quarter of 2007: produce a manuscript for publication (EOS, ACPD, BAMS?) describing the issues and soliciting participation from all modelling groups. The report would outline the most important areas for development and propose a way forward on a selected set of topics.
- Second Workshop in the third quarter of 2007. Real work begins: larger meeting, involving all interested modelling groups. Modelling projects and verification strategies will be defined. Important participants would be modelling groups defining the simulations, agreeing on metrics for evaluation, forming subgroups to perform evaluations etc.
- Third workshop in the second quarter of 2008. Display of first results: determine whether course corrections are necessary. Reports from subgroups. Agree on writing assignments and remaining simulations and analysis tasks.
- Fourth quarter of 2009. Papers submitted describing results of workshop.

At the second phase the TF-AC&C shall
- Review the state and propose efficient ways of development of chemical data assimilation in atmospheric models;
- Review observations necessary to serve the model initialization;
- Review activities necessary for the development of a spectrum of applications ranging from chemical weather to climate prediction;
- Propose ways to implement efficient international programmatic support for the broad climate–chemistry theme including, if necessary, changes in the WCRP and IGBP structure; and
- Organize a meeting on the way forward.

The second phase should start before the full completion of the first phase. Deliverables of the programme in terms of improved model predictions, recommendations on observations, assimilation and possible chemical atmospheric reanalysis should be available for use in the WMO/UNEP IPCC assessment, 2014.

Oversight and reporting:

Progress in this endeavour should be monitored by the WCRP JSC and IGBP SC liaisons on a frequent basis and reviewed by both IGAC and SPARC at their annual meetings and reported to joint sessions of WCRP JSC and IGBP SC.

TF-AC&C composition

The joint IGBP-WCRP TF should include the inner core of 6-8 leading experts in AC&C modelling. They will cooperate with a wider circle of scientists involved in relevant IGBP and WCRP projects, IHDP, IPCC and other activities as required. The TF should be led by two co-chairs nominated by IGBP and WCRP.

Requested action from the joint IGBP SC and WCRP JSC session

The JSC and IGBP SC were invited to consider and discuss the proposal to establish the TF-AC&C, its proposed tasks, which will represent the main Terms of Reference for the TF, as well as the timeline; advise on the suitability of comprehensive atmospheric modelling as the initial thrust of TF-AC&C; suggest members for the TF-AC&C and experts that could contribute to its work; and provide any other advice and guidance as required.

Links to useful references

Links to reports on the Giens workshop in IGAC Newsletter 30and SPARC Newsletter 21: http://www.igac.noaa.gov/newsletter/igac30/Aug_2004_IGAC_30.pdf, http://www.atmosp.physics.utoronto.ca/SPARC/News21/21_Ravishankara.html

The JSC and the SC thanked Drs A.R. Ravishankara and P. Rasch for their presentations on Atmospheric chemistry and climate (AC&C) including SPARC, IGAC and the Joint WCRP-IGBP Task Force (TF). The JSC strongly supported this initiative. The JSC noted that no new observations are required; there is a natural linkage to ACC. The IPCC AR4 is not considering uncertainties in radiative forcing but these are likely to be in AR5. The JSC noted that the timing is good in view of the global Earth Science monitoring project in Europe, which is now one year into its project. The JSC noted that a range of chemistry models is now available and linkage with WGCM/CFMIP should be made.

The JSC agreed to set up in consultation with SC-IGBP, a Task Force led by SPARC and IGAC as the core-organizers, determine its membership and TOR on "Chemistry and Climate" in a two phased manner:

Phase 1: An initial modelling strategy to identify key tractable experiments designed to highlight the important processes concerning short-lived species.

Phase 2: long term vision (involving climate models and observations)

The time frame would be 3 years initially.

JSC supported the new dynamic modelling initiative and expressed the view that there should be increased coordination of SPARC modelling with WMP.

JSC encouraged linkage of this initiative with the new IOC effort on marine chemistry and climate.

12.6.2 WCRP-IGBP Modelling Strategy

Professors P. Lemke, J. Shukla, J. Mitchell, M. Martin and D. Schimel made presentations.

ESSP Modelling Strategy: Requirements to Understand and Predict the Earth System

The current status of modelling the Earth System is characterized by sophisticated high-resolution general circulation models (GCMs) for the physical climate system, with these complex models being expanded to encompass chemical and biological aspects of the Earth System. In particular, GCMs are now developing detailed models for the atmospheric chemistry, the carbon cycle and dynamic vegetation. Earth System Models of Intermediate Complexity (EMICs) offer a complementary approach for long-term simulations, and more holistic, exploratory models are being developed for the investigation of the interaction of human societies with the other components of the Earth System. Improvement of the present modelling capability thus requires a co-ordinated hierarchical approach with a suite of different models. In particular we need:

1. Experimentation with current GCMs to
    a. provide the material for IPCC and other international assessments through sensitivity studies, climate hindcasts and projections of future change,
    b. assimilate and predict the coupled system on seasonal to inter-annual (and eventually longer) time-scales.
2. Continued experimentation and process studies with current GCMs and comparison with observations to improve and validate the models used in the experiment described in 1.
3. Development of the ability to perform more detailed global modelling of the carbon cycle, dynamic vegetation, tropospheric chemistry, ocean biology, lateral transport of elements and a range of other biogeochemical processes (requiring observations, process studies and modelling of the individual systems).
4. Work on extending GCMs to include each of these additional components of the Earth System in turn, as a basis for 1, in particular for COPES.
5. Development of and work with more holistic models (including EMICs) to
    a. study the interactive aspects of the natural system,
    b. simulate longer time-scales, e.g. Ice Age Cycle,
    c. compare and validate with GCMs where possible.
6. Development of models of the interaction between the human and natural systems based on the more holistic models.
7. Use of simpler models to help in the design of the diagnosis of the more complex coupled models.

The development of this modelling programme requires separate collaborative activities. A combination into one overarching ESSP activity is not appropriate, but instead a coordination is achieved through presentation and discussion of the modelling activities as a permanent agenda item of the ESSP Annual Meeting. Based on its qualifications, WCRP continues its lead in 1 and 2 through WGCM and its projects, drawing on the expertise of IGBP projects as appropriate. IGBP continues its lead in 3 through its programme-level modelling activity GAIM, which builds on the work of the IGBP projects and draws, as appropriate, on the expertise of WCRP projects. Item 4 is implemented through the existing WGCM-GAIM partnership, with WCRP taking the lead, and the partnership providing a common platform for a broad range

of communities to collaborate as complex models of physical climate evolve towards more integrated Earth System models. IGBP leads in 5, which must feed into 2 and 3, linking with WGCM and CLIVAR/PAGES. Item 6 will be implemented through a full and equal partnership between IGBP and IHDP, with WCRP kept informed at present. Item 7 is relevant for each of the ESS Partners.

Joint IGBP/WCRP modelling workshop

There are several potential ways of approaching this topic. One would be to have a meeting on the general topic of Earth System modelling. An important aspect to keep in mind if this approach is taken is the fact that there are sensitivities in the ESSP community on this topic, which need to be kept in mind. We all know from the experience in developing the IGBP AIMES project that we need to be very careful how we go have a joint IGBP/WCRP workshop on this topic. We will need to be careful to frame such that the IHDP or DIVERSITAS communities can also be entrained. Perhaps framing the workshop as Earth System (Natural) Science modelling could work. Another approach would be to have a scoping workshop between IGBP/AIMES and WCRP, allowing representatives from these two projects to present their respective scientific strategies and to identify commonalities. An output could be a plan for collaborative activities. This could be a rather small workshop (ca. 10 people).

The JSC and the SC thanked the Chairs of WMP, WGCM, WGNE and AIMES for their presentations. The speakers noted the current challenges in the area including the process of initializing climate models, the role of initialization vs process of feedbacks, the role of chemistry and biology in enhancing the predictability and the real challenge posed by the introduction of human element. There was a great need to improve climate models; computing need is also a big limitation. The objective is to deliver more accurate predictions from days to decades and longer. Another issue for modelling was whether issues for biogeochemistry were fundamentally different from geophysical fluid dynamics. The JSC expressed that uncertainties may increase as we go to more complex models. There was consensus that a common WCRP-IGBP strategy was needed.

The SC and JSC encouraged the AIMES – WMP joint meetings. Both WCRP and IGBP supported the joint IGBP/WCRP modelling workshop on Earth System models in assessment.

12.6.3 GEWEX-iLEAPS

Professors S. Sorooshian and P. Kabat made presentations on the topic. There are a number of important scientific issues here: e.g., transport of water from the troposphere into the stratosphere and ozone in the other direction; the climatic effect of cirrus (subvisible and otherwise); heterogeneous chemistry on clouds in the upper troposphere-lower stratosphere (UTLS) region; the role of convection in determining UTLS conditions. While most of these issues could be said to fit into the chemistry-climate category, the category itself is much broader. GEWEX and iLEAPS are both interested in how processes at the land/atmosphere interface affect the hydrological cycle. In particular, iLEAPS has activities looking at how the emissions from vegetation can influence cloud formation, precipitation and the dynamics of convection. The latter issues are also central to GEWEX, and they also fall into the category of chemistry-climate interactions. GEWEX and iLEAPS could design a programme to look at the role of tropical convection. One can use the idea of a "template" here. This would be a sort of experimental design for the minimum combination of observations and models that would be needed to ensure the comparability of projects, yet not so comprehensive that it would be prohibitive to add observations/models to address questions specific to a particular experiment. To illustrate this concept, consider the following example. Megacities and biomass burning are significant sources of particulate matter. Particles have been correlated with human health effects, but the causes of these correlations remain unknown. Biomass burning has been shown to affect tropical convection – via radiative effects, dynamics and microphysics. Presumably, megacities in the tropics could have effects similar to biomass burning, though one is not aware of any focused studies on this issue. The chemical and physical principles behind the interactions in tropical areas are the same as those in the mid-latitudes, but the manifestations may be quite different. The kind of information required to investigate aerosol/cloud interactions will also be appropriate to investigating aerosol/health effects.

The JSC and the SC thanked the Chairs of GEWEX and iLEAPS for their presentations.

12.6.4 CLIVAR-PAGES Intersection

Dr T. Kiefer made presentation on the topic. Collaboration between IGBP-PAGES and WCRP-CLIVAR has a history that reaches back to the early 1990s. Initially, several informal joint workshops were organized, leading in 1993 to the establishment of an official joint PAGES/CLIVAR working group.

The PAGES/CLIVAR Intersection linked PAGES with WCRP by combining model and data-based research across recent (CLIVAR) and past (PAGES) timescales to improve the understanding of decadal-to-century-scale climate variability. International workshops were held in the U.S. ("hydrological variability") and Spain ("climate predictability") in 2003. A newly constituted Working Group met in 2004 in Canada to revise the terms of reference and propose topics for future activities. These activities include:

1.) *Climate Variability over the Last Few Millennia:* Despite progress in recent years, critical uncertainties and caveats exist with regard to both empirical reconstructions and model estimates. PAGES/CLIVAR advocates a paleoclimate reconstruction methodology and data intercomparison project (PRMDIP). A related workshop will be held in Wengen, Switzerland in June 2006, organized by the PAGES office and co-sponsored by the Electric Power Research Institute (EPRI).

2.) *Abrupt Climate Change:* Topics considered include ocean dynamics, ice-sheet stability and related modelling studies. PAGES/CLIVAR especially seeks to support and initiate modelling studies of past abrupt climate change events. A joint "UK-Rapid" - PAGES/CLIVAR meeting will take place in October 2006 in Birmingham (UK):www.noc.soton.ac.uk/rapid/rapid2006.

3.) *Hydrologic, Biospheric, Land-Surface Interactions:* PAGES/CLIVAR acknowledges the recent progress made by the PMIP 1 and PMIP 2 communities. Comparison of modelling data and related proxy evidence for mid-Holocene paleoenvironments in, e.g., Africa, needs to be extended to other regions and time slices. Related activities, such as small workshops, will be initiated in the coming months.

4.) *Tropical-Extratropical Links Including Ocean and Atmospheric Teleconnections:* Close interaction is expected between the CLIVAR Southern Ocean Panel and the PAGESIMAGES Southern Ocean Program, as well as relevant groups that developed from PAGES Pole-Equator-Pole (PEP) and other activities.

5.) *Overarching and Cross-Cutting Implementation Issues:* PAGES/CLIVAR will promote and coordinate the forward modelling of proxy data as a link between the paleo-data and modelling communities. Furthermore, PAGES/CLIVAR will produce joint publications.The recently published joint special issue of PAGES News and CLIVAR Exchanges (Vol13, No. 3) is available for download at: www.pages-igbp.org/cgi-bin/WebObjects/products

Other developments associated with the CLIVAR/PAGES Intersection:
- *MedCLIVAR*: PAGES has become a partner within the ESF-funded MedCLIVAR programme (http://clima.casaccia.enea.it/medclivar). A workshop on past regional variability in the Mediterranean region, to be held in the third quarter of 2006, is expected to lead to the formation of a PAGES/MedCLIVAR Regional Variability Group.
- LOTRED-SA: Long-Term climate REconstruction and Dynamics of (southern) South America – A collaborative, high-resolution multi-proxy approach. This group has formed under the umbrella of PAGES and will hold a workshop in October 2006 alongside the PAGES SSC meeting: www.pages-igbp.org/science/initiatives/lotred-sa

PAGES/CLIC Intersection (under development):
Contact between the PAGES-Polar community and the WCRP-CliC group in 2004 and 2005 will be developed into a joint scientific agenda and working group. A joint meeting centred on sea-ice topics is planned for 2007.

The JSC and the SC thanked the Chairs of CLIVAR and iLEAPS for their presentations. It was noted that there is also potential for interaction between CliC and PAGES.

12.7 Brainstorming: Roadmap for joint IGBP/WCRP activities

The session was led by Chairs of JSC and IGBP SC. The session essentially centred around discussion on how to practically plan and implement a major international activity jointly between IGBP and WCRP using the example of a programme focused on aerosols, clouds, climate and health. Some suggestions emerged for moving forward: for example, one could consider a "program template"; an experimental design for optimum combination of observation and models to a) enhance process understanding; b) improve model predictive skill. It was suggested that WCRP have an Integrated Centre for Monsoons, in collaboration with IGBP. It was felt that Africa is left out in capacity building efforts and this issue should be taken up. The JSC expressed the view that identifying the interfaces and collaborate there, rather than inventing new areas, is a better future plan.

12.7.1 ESSP Issues

Dr M. Rice, Project Coordinator, ESSP, briefed the session on the ESSP issues, in particular, the upcoming ESSP Open Science conference in Beijing, November 2006.

The JSC and the SC thanked Dr M. Rice for his presentation. Both JSC and SC expressed satisfaction at the progress being made in the preparations for the ESSP Open Science Conference, 2006. Both JSC and SC were pleased to note the possibility of some funding from US National Science Foundation.

12.7.2 WCRP-IGBP Collaborations

There was general feeling that there is a danger of a proliferation of projects. A sense of balance was required, which could be brought about by looking into ongoing projects to remould them to take into account crosscutting/overlapping issues. One such overlapping area is water. Among the issues and challenges remains delivery of benefits of environmental research to end-users. It was felt that WCRP-IGBP collaboration can work only on regional issues, with regional authorities. It is therefore important to find out how these regional issues are related to global issues. Regional scale phenomena are related to global scale phenomena. Therefore 'Act regionally and think globally' could be good guiding principle for the collaboration.

The joint session ended on a positive note. Both WCRP and IGBP needed to rediscover a unifying principle. The IGAC-SPARC collaboration is a very good example for the way forward. Modelling is an area where we have much more commonality and there the dialogue between AIMES and WMP should continue and be encouraged. Both JSC and SC felt it was a highly beneficial meeting and looked forward to moving to a brighter future together.

13. CLIMATE MONITORING AND CO-OPERATION/LIAISON WITH GLOBAL CLIMATE OBSERVING INITIATIVES

13.1 Global Climate Observing System (GCOS)

Dr J. Zillman, Chair of the GCOS Steering Committee (SC), briefed the JSC on the current important issues in GCOS.

13.1.1 Implementation Plan for the Global Observing System for Climate

The *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* was completed under the leadership of the GCOS Steering Committee and Secretariat, with broad input from the climate and related scientific communities. GOOS colleagues and many WCRP scientists were substantially involved in the authoring and reviewing stages of preparing this plan as well as commenting in the open review of the Plan. The actions in the plan fall, as appropriate, to the Nations (i.e., Parties to the UNFCCC) and to the various involved Intergovernmental bodies and programmes and associated bodies either singly or in partnership with GCOS WCRP and IGBP. The Plan addresses the requirements identified in the *Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC* and, in particular, the Essential Climate Variables and their associated products defined therein. It takes into consideration existing global, regional and national plans, programmes and initiatives, including the plans of the recently-established Group on Earth Observations (GEO), and includes implementation priorities and resource requirements as well as indicators for measuring progress. The full Plan and its Executive Summary are available through the GCOS Web site (www.wmo.int/web/gcos).

The Implementation Plan was endorsed by the Conference of the Parties (COP) to the UNFCCC through its Decision 5/CP.10 in December 2004. That decision had also requested GCOS to report regularly to its Subsidiary Body on Scientific and Technological Advice (SBSTA) on progress in implementing the Plan, and had also requested Parties with earth observation space agencies to provide a coordinated response to SBSTA on the needs expressed in the Plan. Reports on both issues were presented to SBSTA-23 in December 2005 and led to the SBSTA conclusions presented in the Appendix to this document. Particularly noteworthy for JSC is the acceptance by SBSTA of the CEOS proposal to provide a detailed report on satellite issues to SBSTA-25 in November 2006 (Para. 6). GCOS and WCRP representatives are working closely with CEOS in developing this response through defining more clearly the detailed needs for climate products from satellite observations. In this regard, a workshop on satellite needs for climate observations was held in January 2006 and work will continue throughout the year, leading to the eventual submission to SBSTA-25.

13.1.2 GCOS Steering Committee

The GCOS Steering Committee (SC) held its thirteenth session in St Petersburg, Russian Federation from 5 - 8 October 2005. Conclusions and actions particularly relevant to WCRP included the following, for which appropriate action is currently under way:

- The SC noted the role of WCRP/CEOP (Coordinated Enhanced Observing Period) as a prototype network in the Global Earth Observation System of Systems (GEOSS). It encouraged the Secretariat and Panels to liaise with both WCRP and CEOP to explore the potential for it to provide a basis for the land and ocean reference sites described in the *Implementation Plan.*

- The SC noted the discussion between the GCOS Panels and the CCl-CLIVAR Working Group on Climate Change Detection on the establishment of a web site on climate indices. It requested the Panels and the Secretariat to ensure that such an initiative, if implemented, would be scientifically sound and well-documented and would be properly coordinated with the World Climate Programme.

- The SC noted with appreciation the invitation of WCRP for the three Panel chairs to serve on the WCRP Observation & Assimilation Panel (WOAP). It noted also the encouraging response of space agencies to the request from WCRP (developed by WOAP) to ensure that satellite observations required for sustained homogeneous global climate products are available.

- The SC encouraged the Panel Chairs to work with WOAP to promote an efficient and effective international regime for reanalysis.

- The SC noted that the direct involvement of the research community in GCOS is vital to the design and evolution of the global observing networks required to satisfy all climate needs, especially those associated with sustained, low-bias measurements. Moreover, the implementation and maintenance of these global climate networks are dependent upon effective engagement of observing system managers in the overall process. The Committee therefore endorsed the proposal that a GCOS international symposium should be held as soon as practicable to promote the actions of the *Implementation Plan* and to foster involvement of the research and operational communities in GCOS activities. This could possibly be in association with a third World Climate Conference (WCC-3).

- The SC noted the activities being carried out and planned under the WCRP/CliC (Climate and Cryosphere) project and the IGOS Cryosphere Theme in the area of cryospheric observation. It recognized the support that these could provide to enable implementation of the cryospheric needs of the *Implementation Plan* and requested the Panels to maintain strong liaison with these groups.

13.1.3 GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC)

The eleventh session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) was held in Geneva from 11 – 15 April 2005. Professor M. Manton, AOPC Chair, reported on this session and other relevant activities of AOPC. The complete list of AOPC-XI Conclusions, Recommendations and Action Items (GCOS-102) can be found on the GCOS Web site at http://www.wmo.int/web/gcos/publications.htm.

The GCOS Surface Network (GSN) includes:

- Baseline data to calibrate regional networks and to monitor global climate change monitoring centres by DWD, JMA and NCDC;
- CBS Lead Centres for GCOS Data provide direct contact with operators across specific regions;
- Lead Centres in Japan, Iran, Morocco, Australia & USA; and
- global coverage by Lead Centres

Although the real-time reception rate has increased in recent years, many gaps remain. Archived GSN data held at WDC (NCDC) form the basis for historical analyses of global climate change. 2006 was a good year for GSN archive as 16 countries contributed and a Gold star was given to Belarus (daily rainfall data back to 1881). Many more data could be available in the GSN archive; many data are held in GHCN but not yet allowed in GSN. Countries should be urged to make historical daily GSN data available to support analysis of global climate change, especially of extreme events.

GCOS Upper Air Network (GUAN) consists of baseline upper air data to support monitoring of climate change in the free atmosphere and accounts for 25% of the total network. The Hadley Centre holds an archive of CLIMAT TEMP for quality control on real-time messages.

The AOPC Working Group on Vertical Temperature Trends held its first meeting in Boulder, 8-11 February 2005 with the main objective of defining climate requirements. The second meeting will be held in Seattle, in May 2006. The USA Climate Change Science Program report on vertical temperature trends concluded that there was no longer robust evidence for a fundamental difference between observations and models.

13.1.4 WCRP/GCOS/GOOS Ocean Observations Panel for Climate (OOPC)

Dr E. Harrison, Chair OOPC, reported on the activities and current concerns of the OOPC. Progress toward implementation of the *in situ* elements of the initial global ocean system was modest but non-trivial in 2003 (45% of designed system), 2004 (48%) and 2005 (55%). Its rate of increase is projected to slow; implementation at the end of 2006 is estimated to be only 57%. At the present level of progress it will be more than 20 years before the initial system can be completed.

Overall metrics of system completion obscure the progress that was made by the Argo community and the surface drifting buoy community. Argo has now nearly 2400 reporting floats, against its initial goal of 3000, and the surface drifting buoy program has about 1380 drifters reporting, against its goal of 1250 (although improved global distribution remains to be accomplished for both Argo and surface drifters).

On the other hand particular challenges are easily identified. The Volunteer Observing Ship fleet faces reduced support from national weather services and the VOSClim element of the observing system is not progressing as had been planned. The underway high-resolution air-sea observation programme also has not progressed as desired. And the rapidly evolving patterns of surface marine commerce continue to challenge the goal of global repeat XBT coverage. Support for the global repeat carbon inventory survey also remains incomplete. Scheduling of ocean satellite missions also suggests that increased advocacy is needed promptly to assure mission continuity and compatibility with the historical record of surface height variability, microwave SST, sea ice and rainfall, ocean colour and surface vector winds. Other examples of concern are that the decade-long German observing efforts in key ocean transport sites are scheduled for termination as research efforts, and the US sustained ocean observing budget has been reduced and faces uncertain prospects.

The JCOMM Observations Coordination Group is fostering an increasing systems approach to deployment and observing system element cross-communication. Progress in development of a unified ship cruise database is welcomed. The Argo and the ocean data community are steadily improving real time metadata transmission and near-real-time quality control. A renewed GCOS-WCRP SST-Sea Ice working group will elucidate sea ice analysis uncertainties. GODAE efforts continue to progress in a number of nations, bringing awareness of the societal utility of enhanced real time ocean observations. Interaction with the SCOR, IGBP and IHDP communities is increasing steadily as awareness of opportunities for mutual benefit has grown (sponsorship by the Sloan Foundation for coordination has been very helpful) and these groups increasingly explicitly support the sustained observing system plan. Enthusiasm to sustain and enhance existing efforts by PIs within the research community remains strong and awareness of the advantages of real-time data transmission is growing. OOPC links with the CLIVAR basin panels and its Global Synthesis and Observations Panel (GSOP), focused on ocean reanalyses, are strong.

2006 is a year of great opportunity for the sustained global ocean observing system. Relationships between the research and sustained observations community are good and are strengthening; national implementation of the agreed plan has been called for by the UNFCCC, GEO and the G8. This degree of high-level endorsement of our community plans is unprecedented. CEOS are working with GCOS to prepare a CEOS implementation plan to respond to the GCOS IP. The IGOS-P Ocean Theme report also is under review and will be revised in 2006.

The JCOMM Observations Coordination Group is functioning well in its coordination role. CLIVAR ocean basin panel planning, implementation and product development are progressing. The coming International Polar Year provides opportunities for enhanced collaboration and observation of the Arctic Ocean. The GCOS SST and Sea Ice working group has new leadership and a developing sea ice subgroup. The Global Ocean Data Assimilation Experiment pilot project continues to make progress and will meet next in China in October.

Resources are the primary constraint on implementation of the agreed initial global system. Under existing national institutional and budgetary frameworks, progress will depend in most nations very heavily upon successful advocacy by the research community for sustained (and enhanced) support in order to address science issues. It appears timely to consider how best this support can be organized.

Another opportunity is posed by the 2006 GEO work plan request to GEO partner nations to identify lead international entities and national focal points for ocean observation efforts that can articulate national goals for their ocean observing sector and coordinate national activities with other designated national entities in order to evolve toward a truly global system of ocean observations.

The JSC thanked Drs J. Zillman, M. Manton and E. Harrison, Chairs, GCOS SC, AOPC and OOPC respectively, for their presentations. In response to request by GCOS to comment on the extent to which GCOS and its component systems meet the needs of climate research, the JSC responded that availability and accessibility of routine data is currently seriously inadequate. There is a major unmet need for better data on extremes (e.g. in hourly precipitation). The JSC affirmed the importance of WCRP-GCOS co-ordination and mutual support in responding to the UNFCCC-COP's needs for information and support in respect of research (WCRP) and systematic observation (GCOS).

The JSC agreed to review/reaffirm the roles, membership and work plans of jointly sponsored panels AOPC and OOPC. The JSC also agreed that WCRP's WOAP should have formal links with GCOS SC because of large overlap of interests and responsibilities.

The JSC recognizes that global atmospheric data recovery, reprocessing and reanalysis require substantial investments, and that these activities rely also on the huge investments made in the global observing system and data assimilation for numerical weather prediction. Relevant programmes and agencies are thus encouraged to collaborate to optimize the global returns from these investments.

The JSC urged countries to make historical GSN data openly available to support analysis of climate extremes and impacts at global and regional levels.

The JSC encouraged AOPC to work with relevant programmes, agencies and organisations to plan and implement a high-altitude high-quality upper-air reference network that helps consolidate the overall investment in and returns from global reference networks for ESS.

The JSC noted with satisfaction the progress of the ocean research community and its national sponsors in advancing the implementation of the *in situ* component of the initial global ocean observing system defined in the GCOS Implementation Plan (GCOS-92), as developed by leading GOOS, GCOS and WCRP climate research scientists. It also noted the extent to which high level international acceptance has been obtained (e.g., UNFCCC, GEO, G-8 Gleneagles).

The JSC congratulated the international Argo community for its accomplishment in obtaining near-global coverage of temperature and salinity profiles over the ice-free ocean and noted that the upper 1-2 km of the world ocean will be monitored systematically for the first time thanks to these efforts.

The JSC congratulated the surface drifting buoy program for attaining its design deployment target of 1250 floats reporting SST and noted the importance of these data in producing climate quality global SST analyses. Recognizing the importance of SLP observations it encouraged an increase in the percentage of drifters measuring SLP in future years.

The JSC noted the limited progress of nations to make commitments to sustain the agreed *in situ*, satellite and ocean analysis activities, and, recognizing that the ocean research community is the primary implementation agent for the global ocean observing system, recommended that CLIVAR and CliC make efforts to continue to sustain the recommended global ocean observing system via research efforts. The JSC expressed the hope that national commitments to sustain the observing system would increase, via long-term non-research funding as national contributions to the global ocean module of GOOS and GCOS.

The JSC noted the difficulty of determining ocean subsurface temperature trends (particularly the difficulty of obtaining statistically significant trends over most of the southern hemisphere), indicating the extent to which there is large spatial and temporal variability in oceanic temperatures. It notes that these results support a greater focus on decadal variability research and observations in coming years.

The JSC agreed to the suggestion by GCOS to emphasize the need for close WCRP-GCOS co-operation in input to satellite operators (especially with CEOS) and GEOSS bodies in respect of climate

observations for research and suggested that WCRP should use GCOS and WMO Space Programme as prime communication routes to CEOS and GEO.

13.2 The Integrated Global Observing Strategy (IGOS), including the Integrated Global Water Cycle Observations (IGWCO) theme, and the Cryosphere theme

Dr R. Lawford reported on the developments in the IGOS Partnership (IGOS-P), the Integrated Global Water Cycle Observations (IGWCO) theme and the emerging IGOS Cryosphere Theme.

IGOS-P undertakes a major component of its work through the development of themes and teams to oversee their implementation. It has initiated the development of six theme reports that have been approved: oceans (2000), carbon (2003), geohazards (2003), water (2003), coastal (2004) and atmospheric chemistry (2004). In addition, reports for a cryospheric and land themes are under development and themes related to energy and health are under consideration. To date, WCRP has its most active involvement in the cryosphere theme (see section 13.2.2) and the Integrated Global Water Cycle Observations (IGWCO) theme. IGOS themes and their projects are "best effort" activities, meaning that space agencies and international partners support them to the best of their ability and to the level that it requires for them to benefit from it. In many cases the work of Integrated Global Water Cycle Observations (IGWCO) theme has been captured in the targets contained in the Group on Earth Observations (GEO) Ten-year Implementation work plan and the annual work packages. It is anticipated that stronger links with the Global Earth Observations System of Systems (GEOSS) will provide a more stable support for the relevant theme activities.

13.2.1 Status of IGOS-P Integrated Global Water Cycle Observations (IGWCO) Theme Implementation

WCRP has provided leadership for the development of the IGOS-P IGWCO theme from its inception. Initially, WCRP asked CEOS to support the Coordinated Enhanced Observing Period (CEOP) as "a precursor to the IGOS water cycle theme." Subsequently a global water cycle theme was proposed and accepted, and a theme report was prepared and approved. During the spring of 2004, IGWCO, with help from the European Space Agency (ESA), published and distributed the IGWCO report.

IGWCO has established a management structure that consists of a Science Advisory Group (SAG) and an Executive Committee (EC). Partners represented on the EC include WMO (HWR), CEOS (JAXA) and WCRP (GEWEX), which currently chairs the EC. It has been agreed that WMO will begin to chair the EC on 1 April 2006, although more planning is needed to ensure a smooth transition. The IGWCO SAG has 15 members including representatives from space agencies, academia and international programmes. The SAG is supported by a Japan-based secretariat with most of its support from CEOS through the Japan Aerospace Exploration Agency (JAXA). The secretariat provides funding and administrative support for meetings, workshops and teleconference calls for the EC and the SAG. The IGWCO SAG has been holding regular teleconference calls and the IGWCO Executive generally participates in these calls. IGWCO also holds an annual workshop, which develops its suite of implementation activities. The first full IGWCO Workshop was held in Tokyo on 28 Feb-4 March 2005. Details on the priorities for capacity building workshops were clarified at that event. A second workshop held in Paris on 1-4 March 2006 was equally successful in providing focus and commitment for IGWCO activities.

IGWCO reports regularly to the IGOS-P meetings and to the CEOS Strategic Implementation Team (SIT) on satellite issues. IGWCO has been promoting the reanalysis of satellite data products, the extension of TRMM and the launch of GPM in this context. As a first step in undertaking its leadership role in the IGWCO Executive, WMO represented IGWCO at the IGOSbis meeting in London in November 2005.

IGWCO has established a good working relationship with GEO in the area of water and is responsible for leading a number of Work Plan Tasks in the 2006 Work Plan. In addition it will provide input on a number of GEO targets for 2007.

IGWCO Projects

IGWCO has identified a number of core projects in its preliminary implementation plan. They are described briefly in the following paragraphs.

a) Data System Development:

Integrated Precipitation Products:

In view of the wide diversity of types of precipitation measurements and global and regional precipitation data products, IGWCO is directing its effort towards the development of an Integrated Precipitation Product. The quality of this product will depend critically on improvements in our ability to make observations and to develop and improve methods for integrating these observations into a final product. Gauge measurements that are not uniformly distributed over the globe can be supplemented by estimates derived from either microwave observations from polar orbiting satellites or by infrared observations from geostationary satellites. As a first step IGWCO is working closely with GEWEX to evaluate the quality of the existing high-resolution global precipitation products. A workshop to begin the planning process for this study was held in Costa Mesa, California in June 2005. At that workshop it was agreed to focus on four major themes in precipitation validation: (1) Regional comparisons (coordinator: Dr J. Turk, NRL); (2) High time resolution comparisons (coordinators: Drs Kuo-Lin Hsu, UC Irvine; P. Arkin, U. Maryland ESSIC); (3) Very high quality field programmes (coordinator: Dr P. Arkin, ESSIC); and (4) "Big picture" comparisons.

Soil Moisture:

Based on expectations that Soil Moisture and Ocean Salinity (SMOS) and Hydrosphere State mission (HYDROS) would be providing useful data, the Global Climate Observing System (GCOS) adopted soil moisture as an emerging "essential climate variable" and committed to developing a prototype integrated near-real time soil moisture product in the next decade. In order to contribute to this goal IGWCO has made improved global observations and model estimates of soil moisture a high priority. IGWCO plans to bring the best available *in situ* observations together with satellite data and modelling and data assimilation capabilities of numerical weather and climate forecast programmes to produce a near-real time experimental product. IGWCO is addressing this issue through its International Soil Moisture Working Group (ISMWG). This group is proceeding with plans for a workshop on establishing a global network of *in situ* soil moisture measurements. Recently, this activity has received a setback with the cancellation of the HYDROS mission. At the moment it is unclear what the consequences of this decision will be for future soil moisture research.

Water Quality and Bio-indicators of Aquatic Ecosystem Stress:

In lieu of the expensive monitoring of the ambient concentrations of anthropogenic chemicals such as pesticides and fertilizers and their stress on environmental systems, monitoring approaches using bio-indicators are being developed. IGWCO plans to evaluate the potential of remote sensing data to assess areas where environmental stress is high, so that a focused, surface-based monitoring programme could be implemented in a region. The initial focus of these discussions has been on imagery in the optical wavelengths. With satellite data, it may be possible to take the results of intensive bio-monitoring studies in selected basins and to generalize them to a regional scale. A proposal for an indicators' workshop, where more detailed plans for specific indicators' projects are developed, is under way and financial support is being sought.

New Initiatives:

In the area of specific water cycle variables, IGWCO is launching two new activities. The first, which will (probably) be led by WMO, involves the development of a quasi-operational near real-time runoff product that would draw from satellite observations and from *in situ* measurements. The second initiative will deal with ground water and will be coordinated through a newly formed working group on ground water. Membership on this working group includes GARS (a geological group on the applications of remote sensing that has focused primarily on groundwater), the UNESCO groundwater programme and IGWCO. It is expected that both of these initiatives will be defined in more detail at the Second IGWCO workshop.

b) Data Integration

CEOP II

CEOP has been a central component of IGWCO from the inception of IGWCO. CEOP Phase I (2002-2004) and its support from GEWEX and CEOS constituted IGWCO's first experience in data integration. During Phase I, CEOP has drawn together the observational capabilities of 35 reference sites, mainly from the GEWEX Continental Scale Experiments (CSEs), 11 Numerical Weather Prediction Centers, and a number of space agencies. Many of these interpretation activities will increase as IGWCO matures. The interaction of CEOP Phase II activities (2005-2010) and IGWCO projects will increase as other IGWCO initiatives become fully functional. For example, IGWCO will test some of the data systems being put in place

by CEOP and will promote the use of these systems in its capacity building efforts. In addition, IGWCO plans to support CEOP as it plays a central role as a GEO prototype for a new GEOSS data system.

IGWCO/GWSP Collaboration:

The Global Water System Project (GWSP) of the Earth System Science Partnership (ESSP) addresses questions related to the interaction of the water cycle and human activities including those involved in global change. IGWCO supports GWSP activities by promoting the development and provision of data for the development of the GWSP Information Base and for an analysis of the current baseline state of the global water cycle. Together with GWSP and the International Council for Science (ICSU), IGWCO will support several "fast track" activities directed at meeting the data needs of GWSP, including at least one related to socio-economic data.

Capacity Building:

International Earth Observation programmes are seeking to expand expertise and infrastructure in developing countries to better utilize integrated Earth information services. IGWCO supports capacity building efforts that increase a region's human, technological, organizational resources and infrastructure through the more effective use of water cycle data and products. IGWCO is building on existing initiatives such as TIGER and is organizing three regional capacity building workshops. The first workshop, which was held in Buenos Aires, Argentina from 26-28 October 2005, was hosted by the Comision Nacional de Actividades Espaciales (CONAE), the Argentina Space Agency. Approximately 100 people from more than 12 countries participated in the workshop, which featured a number of presentations and breakout groups to discuss issues related to water availability, water quality and floods. The workshop was the source of a work item in the GEO 2006 Work Plan related to the development of a TIGER-type programme for South America. The next capacity building workshop is being planned for the third quarter of 2006 in Eastern Asia.

Earth Observations for Sustainable Development

As a result of the World Summit on Sustainable Development (WSSD), many developing countries and governments are formulating national sustainable development plans and programme that encompass the United Nations Millennium Development Goals (MDGs). IGWCO supported these sustainable development efforts by participating in the Commission of Sustainable Development (CSD-13) meeting in New York in April 2005 and hosting two information tables for the delegates. Together with IAHS, IGWCO is also planning a session on space observations and water management for the March 2006 World Water Forum IV. In addition, IGWCO and GEO also are planning a Side Event at the Forum.

Future Activities:

At its recent Paris workshop, IGWCO gave some preliminary consideration to the ways in which it could support drought and flood response research and planning.

Other IGWCO Activities

In addition to the individual projects outlined above, together with GEWEX and UNESCO, IGWCO organized a workshop on trends in Global Water Cycle Variables at UNESCO in Paris, France during 3-5 November 2004. The workshop recommendations have been reported in GEWEX News.

ISSUES

1. IGWCO has the potential to supplement WCRP outreach in a number of ways but primarily through its capacity building discussions and its regular reports to IGOS-P and CEOS SIT. WCRP activities such as Coordinated Observation and Prediction of the Earth System (COPES) are encouraged to build stronger connections with IGWCO by recognizing these potential links in the COPES planning documents.
2. JSC is invited to support the IGWCO implementation and to provide inputs on it through its working groups and panels to the IGWCO implementation.
3. JSC is invited to identify issues that it would like IGWCO to consider and take forward to CEOS and GEO.

13.2.2 The IGOS-P Cryosphere Theme

The IGOS-P Cryosphere Theme was approved by the Partners on 27 May 2004. Since that time, CliC and SCAR have assembled an initial team of contributors to the Theme report, agreed on its leaders, its

approach, and the Theme report outline, and begun drafting the Theme report. A project website has been established at http://stratus.ssec.wisc.edu/igos-cryo. This is not an official website of the Theme but a working instrument for the contributors and interested parties. A more formal web page is a part of the IGOS website at http://www.igospartners.org/cryosphere.htm.

Dr J. Key of the NOAA NESDIS is the chair of the Theme group, and Dr M. Drinkwater of ESA is the vice-chair. The core team includes Drs Key, Drinkwater, V. Ryabinin (WCRP), B. Goodison (CliC), M. Kaczmarska (liaison to SCAR), V. Lytle (CliC International Project Office) and D. Hinsman (WMO) as a liaison to IGOS. The CliC Observational Products Panel is expected to be one of the chief contributors to the task. The initial writing team consists of scientists from twelve countries on four continents.

The first workshop on the Theme took place on 2-4 March 2005 in Kananaskis, Alberta, Canada. It was sponsored by the Canadian Space Agency. The workshop involved scientists and observationalists, mostly from North America. It reviewed the outline and scope of the document and agreed on the approach. A wide group of contributors to the Theme has been identified for most of the report chapters. The workshop reviewed several major applications of cryospheric data and produced initial sets of requirements.

Two more workshops for the Theme are envisaged. The second workshop, co-sponsored by JAXA in cooperation with JAMSTEC, will take place in Tokyo/Yokohama, Japan, on 24-25 April 2006. The core group of the Theme will meet there with participants from Asia. A first draft of the Theme report expects to be compiled at the workshop. It should be presented to the IGOS Partners meeting in Geneva at the end of May 2006.

A possibility to hold the final Theme workshop in Cambridge, UK, in association with the CliC / International Glaciological Society / IUGG Commission for Cryospheric Sciences International Symposium on Cryospheric Indicators of Global Climate Change (21-25 August 2006) is being considered. The CliC SSG-II (Copenhagen, Denmark, 6-9 November 2005) recommended that additional information on accuracy in cryospheric datasets, such as estimates of error covariances, be included in the Theme report to enable their future use in data assimilation and reanalysis activities.

The challenge for the team is to ensure that the updated requirements for cryospheric observations represent the views and needs of the broad community interested in the state of the cryosphere. Therefore, the report will go through an open and exhaustive review by the cryospheric community and interested projects and programmes. The text of the report will be available online and a procedure will be implemented to ensure that views of the community are sought, and that all comments and contributions are received, analysed and considered for incorporation in the final document. Views of the observing system operators will be also sought at that stage to ensure that what is proposed is feasible and can be implemented. By reviewing and updating the report, the team will try to reach a wide consensus on requirements for observations between various user groups and take into account the existing and future possibilities by observing agencies. Involvement of JSC members in the Theme report review is highly desirable.

Climate-related cryospheric observations will be the core part of the Theme report. The team of the IGOS Theme on Cryosphere is working with the GCOS Secretariat and its science panels to produce a consolidated set of recommendations on cryospheric products, which the agencies forming the Committee on Earth Observation Satellites (CEOS) will be asked produce to meet the needs of parties to the United Nations Framework Convention on Climate Change. These recommendations will be compiled by GCOS in February 2006. The recommendations in the final report of the Theme will be consistent with the GCOS set of recommendations to CEOS.

The Theme will include an assessment of the socio-economic impact of cryospheric observations. The links between the Cryosphere Theme and the GEOSS societal benefit areas have been evaluated recently. Information on the cryosphere is most relevant to disasters, climate, water and the ecosystem, and GEOSS areas, but also contributes in the areas of energy and agriculture. For example, avalanches, glacier lake outburst floods, sea-ice storms, sea-ice bottom gouging, snowstorms and icing are disasters that relate directly to the cryosphere. Some catastrophic events may be triggered or related to the cryosphere, including landslides and subsidence due to thawing of permafrost. The cryosphere significantly and usually adversely affects all kinds of transportation, including search and rescue operations. Research has confirmed the pivotal role of the polar regions and the cryosphere in climate including mechanisms responsible for potential abrupt climate change. Glacier run-off is a major source of hydropower and in many areas the only source of water for sustaining life and agriculture. Additionally, many indigenous communities are strongly influenced by changes in the cryosphere.

The core group of the Theme is working with its main partners. Presentations on the Theme were made to the GCOS Steering Committee. The leadership of the GEOSS Secretariat was informed of the Theme. Links are being established with the Global Terrestrial Observing System. Dr Key is a member of the WCRP WOAP. It is essential that the IGOS Cryosphere Theme draft recommendations are reviewed by the WCRP and its various bodies with a view to ensure satisfaction of their requirements, are amended after such review, form an inherent part of the WCRP data requirements and are given adequate attention both within and outside the WCRP.

These recommendations and their subsequent implementation are the only way for CliC to fulfil one of its core objectives – to improve cryospheric observations.

The JSC is invited to note information in this report and seek ways of supporting the successful completion of the Theme report and subsequent implementation of its recommendations.

13.3 Satellite matters including CEOS (Committee on Earth Observation Satellites) and GEO (Group on Earth Observation) issues

Dr G. Sommeria introduced this topic. Satellite matters for WCRP are already partly covered by the reports on GCOS and IGOS-P activities, as well as by WOAP. However, JSC may wish to address general issues not covered previously, with respect to WCRP's relationship with space agencies, particularly through its involvement with CEOS, and some of the points addressed in the joint IGBP/WCRP session on GEO but specific to WCRP. Although GEO is not a "space project", a number of GEO tasks require the support of space agencies, for which CEOS is the natural vehicle.

13.3.1 Involvement of WCRP in CEOS

In addition to the specific relationships developed at the project level with space agencies, WCRP has maintained a strong interaction with them through various channels. WCRP is reporting to space agencies via the WMO channel in the "Consultative Meetings on High Level Policy on Satellite Matters" in support of the WMO Space Programme and in the Coordination Group for Meteorological Satellites. It also reports annually within the UN system to the "Committee on the Peaceful Uses of Outer Space" (COPUOS). However, CEOS, to which WCRP belongs as an "associated member", has remained a privileged channel for direct interaction with space agencies, especially on research related matters, which are not the prime priority of the other bodies.

GCOS and WCRP representatives are working closely with CEOS in developing a response by space agencies to the GCOS IP through defining more clearly the detailed needs for climate products from satellite observations (cf. GCOS report). This work led to a workshop organised by GCOS with WCRP participation in January 2006 and should lead by November 2006 to a CEOS presentation to SBSTA-25, and hopefully to more precise commitments by space agencies. The second issue, concerning benefits expected from improvements of the climate observing system, requires a longer-term reflection, in line with the WCRP strategic plan 2005-2015.

In the wider perspective of GEO and since the exchange of letters mentioned above, the positioning of CEOS with respect to GEO has been clarified, and it is now agreed that CEOS should be considered as the principal point of contact for satellite-based observations needed by the GEOSS 10-Year Implementation Plan. Therefore any cooperation on GEO tasks including space agencies should normally be channeled by CEOS.

13.3.2 Involvement of WCRP in GEO

WCRP's input to the 10 year implementation plan has been significant, to both the climate and water chapters, and to some of the general principles and guidelines on scientific matters and user requirements. Whereas short-term climate observation issues respond mostly to GCOS requirements, longer-term objectives are in phase with the WCRP/COPES strategic framework. Objectives in the water chapter entitled "Improving water resource management through better understanding of the water cycle" are in line with GEWEX objectives and the observation targets closely match priorities expressed by the IGOS-P water cycle observation IGWCO) theme under WCRP leadership.

WCRP's input to the 2005 GEO tasks and 2006 workplan has also been significant, again mostly in the two societal benefit areas related to climate and water. This was done through consultation within WCRP and direct participation of WCRP delegates at GEO meetings. The consultation on climate matters was closely coordinated with GCOS, with major contributions from WCRP's Observation and Assimilation

Panel. The input on water aspects comes in greater part from IGWCO. WCRP views have also been expressed for transverse issues and some of the other domains, which can indeed benefit from the experience gained in the climate domain.

As WCRP participates in GEO along with its three sponsors WMO, ICSU and IOC, its major inputs are as far as possible prepared in consultation with them in order to ensure the required coordination. WCRP being also an IGOS partner and an associate member of CEOS, it endeavours as well to consult within those bodies for key issues. This has helped them better define their role with respect to GEO and to have GEO directly benefit from their multi-year expertise.

Consultation within WCRP on GEO matters is done presently through the JSC Chair and vice Chair, project Chairs and Directors, and the Chairs of WMP and WOAP. Dr G. Sommeria and Dr M. Manton are members of the "Scientific and Technical Committee". Professor T. Koike was one of four scientific coordinators in the preparation of the 10-year Plan. He has been nominated by Japan as vice-Chair of the "Architecture and data committee", and is co-nominated by WCRP in this capacity. Dr R. Lawford, as Chair of IGWCO, has coordinated the input to the water theme in the 10-year Plan and the present workplan. He has been nominated by WCRP as member of the "Users interface committee". Dr H. Virji, representing START, has been jointly nominated by IGBP and WCRP as member of the "Capacity building and outreach committee".

A new task on "the development and use of advanced assimilation methods in high-resolution climate models" has been proposed by WCRP but not retained this year. It should be proposed again next year.

13.3.3 Specific issues to the attention of JSC

- Involvement of WCRP in CEOS: the preparation of a CEOS position paper for SBSTA on climate observations and the role expected from CEOS in carrying out the GEOSS IP are two specific reasons to maintain a regular dialogue between WCRP and space agencies through CEOS. In addition to WCRP's participation in the main CEOS meeting (CEOS Plenary and CEOS Strategic Implementation Team, SIT), the CEOS Chair is regularly invited to the JSC, but this does not seem to be practical. It is therefore proposed to seek to have one WCRP contact person in CEOS, possibly the same person already dealing with GCOS matters. He (she) would be invited to attend JSC and WOAP meetings.

- Involvement of WCRP in GEO: Any conclusion arising from the joint IGBP/WCRP meeting on this subject could be endorsed by JSC, with respect to the internal consultation mechanism, to the representation in GEO committees and to the participation in GEO tasks. The JSC may also wish to comment on the degree of involvement of WCRP in GEO (particularly for the 2006 and the preparation of the 2007 workplan), and how to best benefit from GEO.

The JSC considered how to manage WCRP's interaction with GEOSS. The outcomes of GCOS presentations (and recommendations about linking better to WMO departments) suggest that this activity should be through WCRP/GCOS joint panels for observations and through the WMO Space Programme for research not otherwise covered.

14. RELATIONSHIPS WITH IPCC AND UNFCCC

14.1 Intergovernmental Panel on Climate Change (IPCC)

The JSC was informed of the progress towards the Fourth Assessment Report (AR4) and was pleased to note that several JSC members were Lead Authors for the AR4 and that very many WCRP scientists have contributed. Several issues related to AR4 were discussed. These included: the need to involve aerosols in cloud processes, our inability to describe changes below the ocean surface, etc. The main metric for models is cloud simualtions and these are getting better. It was felt that the JSC should discuss its strategy for IPCC, the opportunity for WCRP in it to increase our visibility.

14.2 Subsidiary Body on Scientific and Technological Advice (SBSTA) of the Conferences of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC)

Professor A. Henderson-Sellers introduced the document on SBSTA. The document referred to the call for input on the 'research needs' for the UN FCCC/SBSTA Synthesis Report and a draft text of WCRP's response. Considering the importance of this for WCRP, the text of the document was crafted into it a series of key messages – expressed as research priority gaps. WCRP was asked for: "a description of how these needs are addressed by ongoing research activities at the national, regional and international level as well

as the identification of any gaps; and a brief summary of the climate change related research that has been ongoing and/or is planned in your organization, together with any important gaps that you have identified." JSC's focus was directed to: (i) emphasizing WCRP's role in international prioritization and integration of research; (ii) gaining SBSTA's 'approval' for planned research (a real strength of GCOS); and (iii) recognition as the leader (at least in the mandated area) not simply one of very many contributors. The areas of research needs and priorities relating to the UNFCCC where WCRP could contribute would include scientific basis of climate change and the cross-cutting issues.

The JSC discussed how to deliver WCRP's capability to the UNFCCC. The JSC recommended that a Task Team should come from WGCM and other activities and be established to develop and deliver WCRP's capability to the UNFCCC. It should have in its Terms of Reference:

- To make input to the IPCC emissions scenarios issue (now and for future mutual benefits)
- To initiate thoughtful interactions in ESSP on people/physics/bio-geochemical scenarios (ultimately perhaps the Task Team becomes an ESSP task team)
- To propose and organize world climate research for the AR5 so that results can be collected, accessed, analyzed and distributed (e.g. for impacts) (the follow-on to the "Hawaii" meeting)
- To prepare WCRP's strategy for the final publication of AR4 in 2007 so that WCRP plans are ready and can be publicized as soon as the AR4 is officially released
- To work on the SBSTA submission (now), assist in preparations for the SBSTA-24 meeting, attend and offer a side event at Bonn and then to follow-up regularly so that each SBSTA and COP sees WCRP fully up-to-date and, if possible, endorsed by COP
- To have and continue a clear dialogue with IPCC on (i) evolving research needs (COP/UNFCCC), (ii) scenario constancy/improvement (IPCC WGs/WCRP), (iii) radiative forcing (historical improvement and analysis and modelling) (WCRP/GCOS) etc.

15. BRAINSTORMING SESSION ON WCRP PARTNERSHIPS, SPONSORSHIPS AND VISIBILITY

Imperative of the New Strategic Framework

The session was initiated by Professor A. Henderson-Sellers. The essential idea behind the session was to search for possible answers to the question "How do we implement the new WCRP Strategic Plan 2005-15 and look to the future with confidence?" This large question involves several sub questions, among the most important being, "What are the societal challenges for WCRP?" and "How do we address them?"

All the Projects and Working groups were asked to focus on 5 issues in their presentations to the JSC at its session in Pune. During the JSC brainstorming, discussion centred on these 5 implementation areas:

- Using the new strategic framework for project orientation and outcomes
- Contributing to cross-cutting task teams: Monsoons, Atmospheric chemistry & climate, Sea level, Anthropogenic climate change, Extreme events
- Raising issues for the JSC arising from activities
- Choosing performance metric(s) to describe success
- Increasing visibility for WCRP outputs and outcomes

The Sponsor Review and Partnering

The brainstorming also addressed the upcoming Sponsor Review. ICSU will review DIVERSITAS, IGBP, WCRP and ESSP over the next two years. The WCRP review will be in collaboration with the other co-sponsors and, ICSU has suggested, the International Group of Funding Agencies for Global Change Research (IGFA). All reviews will focus on both internal and external interactions. The overriding objective of these reviews will be to evaluate the extent to which the character of the international programmes adds value to their area of research and the national programmes that contribute to them. The primary question that each review should answer is: "What do scientists, sponsors and the end-users get out of participating in and supporting these international programmes that they would have missed if the international programmes did not exist?"

Another important question for all WCRP's sponsors is its level of engagement with the Least Developed Countries (LDCs). These 49 LDCs are:

- characterized by low income, poverty of their peoples, severe weakness of their economies, institutional & human resources
- vulnerable to natural disasters
- home to over 600 million people
- necessarily fall below UN thresholds on all three criteria: low income, economic vulnerability & poor quality of life.

The JSC discussed how WCRP delivers and links to: agencies, institutions, programmes (especially the ESSP) and to countries (developed & developing). The JSC also discussed WCRP needs including stronger web presence and outreach. This would improve projects, tasks, IPCC, ESSP, meetings, reports and could promote and improve datasets, such as those to be shared with GEO and GCOS. The JSC recognized that all activities need firm sunset and replacement processes.

WCRP visibility

The JSC discussed WCRP's perceived, and perhaps actual, lack of visibility and noted benefits of improving our "image", which could include:

- Attracting new scientists;
- Motivating sponsors; and
- Retaining and enthusing current participants.

By being more visible and having a greater presence on the web, WCRP could publish:

- updates on observations (for climate) and re-analyses (WOAP)
- updates on climate prediction confidence/uncertainty (WMP)
- updates on seasonal prediction skill (TFSP/CLIVAR)
- and, possibly, others.

On the issue of improving WCRP visibility, the following proposals are made. The JSC notes that some might imply a restructuring of WCRP and that some have higher priority than others:

- Stronger links to operational agencies
- More dialogue with sponsors
- Closer links with climate application communities
- Evidence of socio-economic benefits of WCRP
- Ensuring activities such as the International Polar Year highlight the role of WCRP
- Increased visibility of current and better coordinated future role of WCRP in/to IPCC (esp. AR4 & AR5)
- Closer connection with media, promoting regular features in influential media
- Production of a regular Newsletter

Organizational Challenges

The JSC noted that central funding for the WCRP had fallen short of budgetted plans for the past 4 years and that future resource constraints were likely to seriously impair activities. Thus, despite support for the recent re-orientation associated with the WCRP Strategic Framework, a further review of organization and resources was essential.

The organizational challenges for WCRP include:

- Need for better focus and metrics for WCRP for the next 10-25 years
- Suggestion of Board/Partners/Ambassadors to increase visibility and funds
- Resources: both human and financial are too small
- Urgent need for more sponsors (or do less)
- Perception that there are too many climate programmes
- The need to revitalize structure and turn views outwards
- Tension between e.g. SBSTA's request for research priority setting and existing Core Projects' goals
- Tension between ESSP and current sponsors' needs
- The need to grow and develop.

The JSC also discussed how to promote partnerships and a direct and greater involvement with sponsors. It noted that separate WCRP groups for weather and climate is inconsistent with the 'seamless prediction' goal. The JSC expressed the need to re-structure on all time-scales and considered other

structures, e.g. one group on assimilation and prediction and one group on model development and experiments.

The JSC recognized the view that WCRP structure does not deliver to users and hence discussed whether an alternative structure might be desirable e.g.:

- One stream to focus on ACC (CC sensitivity etc.)
- One stream delivering on disasters, seasonality (TFSP)

The JSC spent a significant amount of time debating how to improve WCRP's input on extremes for IPCC AR4 & AR5 and how to assemble research needs and WCRP outputs for SBSTA-24. The JSC determined to assess predictive skill of climate both for extremes and level of 'safe' climate change:

(i) On seasonal to inter-annual timescales (with THORPEX) and
(ii) On palaeo evidence and biochemistry (with IGBP).

The JSC noted that WCRP had invested greatly in developing its new strategy blending: (i) a desire to go in exciting new directions with (ii) building on the communities and the expertise we have. The JSC further noted that the Strategic Framework plan was not intended to detail who/how to go forward i.e. an implementation path was urgently required.

The JSC concluded that climate research must be better funded given the current importance of and urgency of climate-related decisions. It was agreed to aim to capture Professor Shukla's enthusiasm & drive, not choosing models or observations or processes but carrying a crisp and compelling message to policy makers on the essential aspects of climate research.

Implementation of the WCRP Strategic Plan 2005-2015

The JSC noted the need to take care with claims on research and 'deliverables' and, particularly, that individual pieces of science are *not* WCRP's but rather will be credited to scientists and their home organizations.

The JSC discussed at length during the beginning of its session and throughout the week the important issue of demonstrated benefit delivery and, hence, increased visibility of WCRP. The JSC expressed concern that, despite WCRP's enormous contribution to climate science, its visibility has remained low. The JSC endorsed and encouraged proactive co-operation with GEO, GCOS, the WMO Space Programme and Departments such as WCP, AREP and WWW.

The JSC urged that WCRP take steps to attract young scientists and to reach out to and build bridges to the wider audience of stakeholders, programme managers and sponsors.

The JSC recommended that a roadmap, building on the COPES WCRP Strategic Framework, should be developed both by JSC and by WCRP projects, groups, task teams etc. and then blended. The goals are:

- To identify existing activities that contribute to WCRP achieving its two objectives;
- To identify new activities that should be initiated or enhanced to allow WCRP to achieve these objectives and strategic goals;
- To identify how these existing and new activities contribute to seamless prediction, Earth System Science and deliver benefit to users and stakeholders.

The following steps were agreed:

(i) that a 'road-map' be created for the WCRP as a precursor to the development of an Implementation Plan by means of which WCRP will deliver the directions described in its "Strategic Plan 2005-2015";
(ii) that the JSC (acting as the WCRP "Board of Directors") be asked to input to an initially separate 'route map'; and
(iii) that the Activities (Core Projects, Panels, Working Groups, Task Forces etc.) all be asked to input to another initially separate 'route map'.

These were later to be brought together. The independent development was to allow for an anticipated difference in views i.e. 'global' from the JSC cf. specific from individual Activities.

Draft reports prepared by the JSC and WCRP groups are to be made available in advance of the next OCD meeting.

The JSC concluded that while the Strategic Framework 2005-2015 is an excellent statement of WCRP's aspirations, there is an urgent need for the development of a clear implementation path.

16. ADMINISTRATIVE MATTERS

16.1 Liaison between JSC and WCRP activities

The JSC discussed in executive session various matters bearing on the overall management, organization and structure of the WCRP. These included issues relating to the Strategic Plan, crosscutting themes (including sea level rise, monsoons, chemistry-climate interactions etc.), data management, the ESSP Open Science Conference in 2006 and the JSC liaison persons for WCRP projects and working groups.

The next Officers, Chairs and Directors (OCD) meeting will be held in Beijing, China, 7- 8 November 2006, alongside the START Young Scientists' Meeting and just prior to the Second ESSP Open Science Conference.

16.2 Organization and membership of WCRP scientific and working groups

The JSC approved nominations of new members or renewals of terms of appointment of current members as appropriate. Dr J. Church was elected the new Chair, Professor V. Ramaswamy, the new Vice-Chair, and Drs S. Gulev, Dr K. Trenberth, Professor. G. Wu, the new Officers of the JSC.

The JSC expressed some disquiet about the expanding number of groups. The JSC encouraged back-to-back meetings and groups where synergies could be achieved. The JSC also encouraged careful planning to allow back-to-back meetings whenever useful.

The JSC approved nominations of new members or renewals of terms of appointment of current members as appropriate, with effect from 1 January 2007. The compositions of committees effective on 1 January 2006 (including the changes approved by JSC XXVI) are listed below.

JSC/CAS Working Group on Numerical Experimentation (WGNE)

Membership of the WGNE was determined by consultation between the Chair of the JSC and the President of CAS. The terms of Drs M. Miller (Chair), Chen Dehui, S. Lord, A. Lorenc, D. Majewski and K. Puri, which expired on 31 December 2005, were each extended by two years. Drs D. Williamson, J. Coté and V. Kattssov whose terms expired on 31 December 2005, stepped down. Drs J. Hack (NCAR, USA), G. Brunet (Meteorological Service of Canada) and M. Tolstykh (Russian Hydrometeorological Research Centre) accepted the invitation to be members of group for an initial term of four years effective 1 January 2006. The composition of the group was:

Membership	Expiry of appointment
M. Miller (Chair)	31 December 2007
G. Brunet	" 2009
Chen Dehui	" 2007
M. Déqué	" 2007
J. Hack	" 2009
S. Lord	" 2007
A. Lorenc	" 2007
D. Majewski	" 2007
K. Puri	" 2007
P.L. Silva Dias	" 2008
Y. Takeuchi	" 2007
M. Tolstykh	" 2009

JSC/CLIVAR Working Group on Coupled Modelling (WGCM)

The terms of Drs P. Braconnot and A. Hirst, which expired on 31 December 2005, were each extended by two years. Dr S. Griffies (GFDL, USA), Ex-officio, Chair of WGOMD replaced Dr C. Boening who stepped down as Co-Chair, WGOMD. Dr B. McAvaney stepped down at the end of his term on 31 December 2005. Dr N. Nakicenovics, IIASA and Vienna University of Technology, Austria, was being

invited to be a member of the group for an initial term of four years, effective 1 January 2006. The group was thus now constituted as follows:

Membership	Expiry of appointment
J. Mitchell (Co-Chair)	31 December 2007
G. Meehl (Co- Chair)	" 2007
S. Griffies (ex-officio, Chair, WGOMD)	" 2008
S. Bony	" 2009
P. Braconnot	" 2007
T. Delworth	" 2006
G. Flato	" 2007
M. Giorgetta	" 2008
F. Giorgi	" 2008
A. Hirst	" 2007
D. Karoly	" 2008
M. Kimoto	" 2008
C. Le Quéré	" 2008
N. Nakicenovic	" 2009

CLIVAR Scientific Steering Group

Drs A. Busalacchi (Co-Chair), H. Cullen, P.L. da Silva Dias, R. Weller and R. Zhang would be stepping down at the end of their terms in 31 December 2006. Drs J. Hurrel (NCAR, USA)(Co-Chair), R. Mechoso (USA/Uruguay), M. Visbeck (Germany) were being invited in to be members of the group for an initial term of four years effective 1 January 2007.The current membership of the CLIVAR Scientific Steering Group was:

Membership	Expiry of appointment
A. Busalacchi (Co-Chair)	31 December 2006
T. Palmer (Co-Chair)	" 2007
H. Cullen	" 2006
P.L. da Silva Dias	" 2006
J. Marotzke	" 2007
L. Goddard	" 2009
B. McAvaney	" 2008
F. Molteni	" 2007
M. Reinecker	" 2007
T. Tokioka	" 2007
D. Waliser	" 2008
B. Wang	" 2007
R. Weller	" 2006
R. Zhang	" 2006

Chairs of CLIVAR/WGSIP, GEWEX and Co-Chairs of WGCM are members ex officio of CLIVAR SSG.

CliC Scientific Steering Group

The terms of Drs B. Goodison (Chair), M. Drinkwater, Qin Da He and J. Turner, which would expire on 31 December 2006, were extended each by two years. The terms of Dr T. Fichefet which expired on 31 December 2005 was extended by two years. Drs R. Barry (Vice-Chair) and H. Zwally stepped down at the end of their terms on 31 December 2005. Dr A. Worby was appointed as a new Vice-Chair. Dr K. Steffen (Cooperative Institute for Research in Environmental Sciences, University of Colorado, USA) who accepted to be member of SSG for four years, was appointed as another new Vice-Chair. Dr T. Ohata, whose term ended on 31 December 2005, had his term extended by two years. Dr G. Casassa (Centro de Estudios Cientificos, Valdivia, Chile) accepted to become member of SSG for four years from 1 January 2006. The term of Dr V. Kotlyakov, which would expire on 31 December 2006, was extended by one year. Dr D. Kane stepped down at the end of his term in 31 December 2006. Dr T. Prowse (University of Victoria and National Water Research Institute, Victoria, Canada) was invited to be member for an initial period of four years from 1 January 2007. The composition of the group was thus:

Membership	Expiry of appointment
B. Goodison (Chair)	31 December 2008
A. Worby (Vice-Chair)	" 2008
K. Steffen(Vice-Chair)	" 2009
G. Casassa	" 2009
M. Drinkwater	" 2008
T. Fichefet	" 2007
V. Kotlyakov	" 2007
C. Mauritzen	" 2007
T. Ohata	" 2007
Qin Da He	" 2008
J. Turner	" 2008

GEWEX Scientific Steering Group

The term of Dr U. Schumann (Vice-chair) which would expire on 31 December 2006, was extended by one year. Dr J. Polcher, Chair GMPP, would replace Dr Y. Kerr (CNES/CESBIO, France), as ex-officio member from 1 January 2006. Dr R. Yu was invited to be member of SSG for an initial term of four years from 1 January 2006 as replacement for Dr Wu whose term ended on 31 December 2005. Dr A. Beljaars, whose term expired on 31 December 2005, had his term extended by two years. Drs M.F. Silva Dias and Z. Kopaliani would be stepping down at the end of their terms on 31 December 2006. Dr J. Matsumoto (Univ. of Tokyo, Japan) had accepted to become a member of SSG for four years beginning 1 January 2006 in place of Dr K. Nakamura who stepped down on 31 December 2005. The membership of the group was thus:

Membership	Expiry of appointment
S. Sorooshian (Chair)	31 December 2007
U. Schumann(Vice-Chair)	" 2007
T. Ackerman	" 2007
A. Beljaars	" 2007
F. Einaudi	" 2008
Y. Kerr	" 2006
Z. Kopaliani	" 2006
J. Matsumoto	" 2009
D. Randall	" 2007
K.D. Sharma	" 2007
M.F. Silva Dias	" 2006
K. Takeuchi	" 2007
R. Yu	" 2009

SPARC Scientific Steering Group

The terms of Co-chairs Drs A. O'Neill and A.R. Ravishankara, which would expire on 31 December 2006, were extended by two years and one year respectively. The terms of Drs J.P. Burrows and D. Hartmann, due to expire on 31 December 2006, were extended by three and two years respectively. Drs C. Granier and U. Schmidt stepped down at the end of their terms on 31 December 2005. The terms of Drs P. Canziani, T. Peter and V. Yushkov were extended by three years at the end of their terms on 31 December 2005. The membership of the group was thus as follows:

Membership	Expiry of appointment
A. O'Neill (Co-Chair)	31 December 2008
A.R. Ravishankara (Co-Chair)	" 2007
J.P. Burrows	" 2009
P. Canziani	" 2008
D. Hartmann	" 2008
S. Hayashida	" 2008
P. Haynes	" 2008
E. Manzini	" 2008
T. Peter	" 2008
P. Wennberg	" 2008
V. Yushkov	" 2008

Working Group on Surface Fluxes (WGSF)

There was no membership issue to be considered by the JSC. The present membership of the group was as follows:

Membership	Expiry of appointment
C. Fairall (Chair)	31 December 2007
E. Andreas	" 2007
B. Barnier	" 2007
A. Bentamy	" 2007
P. Braconnot	" 2007
F. Bradley	" 2007
W. Drennan	" 2007
C. Garbe	" 2007
P. Gleckler	" 2007
E. Kent	" 2007
G. Leeuw	" 2007
W. McGillis	" 2007
R. Philipona	" 2007
S. Smith	" 2007
A. Sterl	" 2007
R.A. Weller	" 2007

WCRP Modelling Panel

Dr D. Schimel, Co-Chair, IGBP/AIMES was being invited to become a member of the Panel as a representative of IGBP. Dr R. Koster was being invited as a representative of GEWEX/GLACE2 on the Panel. Dr S. Griffies (GFDL, USA), Ex-officio, Chair of WGOMD replaced Dr C. Boening who stepped down as Co-chair, WGOMD. The membership of the Panel was:

Membership	Expiry of appointment
J. Shukla (Chair)	31 December 2007
D. Burridge	" 2007
T. Arbetter	" 2007
S. Griffies	" 2008
B. Kirtman	" 2007
V. Meleshko	" 2007
M. Miller	" 2007
J.F. Mitchell	" 2007
S. Pawson	" 2007
J. Polcher	" 2007
D. Schimel	" 2007
K. Trenberth	" 2007

WCRP Observations and Assimilation Panel (WOAP)

IGBP was being invited to nominate a representative on the Panel. The membership of the Panel was:

Membership	Expiry of appointment
K. Trenberth (Chair)	31 December 2007
A. Belward	" 2007
G. Duchossois	" 2007
G. Flato	" 2007
D.E. Harrison	" 2007
E. Kent	" 2007
J. Key	" 2007
T. Koike	" 2007
A. Lorenc	" 2007
M.J. Manton	" 2007

B. Randel	"	2007
W. Rossow	"	2007
J. Shukla	"	2007
A. Simmons	"	2007
D. Stammer	"	2007

GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC)

The composition of the Atmospheric Observations Panel for Climate, jointly sponsored by the JSC and the Scientific Committee for GCOS was as follows:

A. Simmons (Chair)	ECMWF
P. Arkin	NOAA/OGP, USA
M.D. Goldberg	NOAA/NESDIS, USA
E. Harrison	OOPC NOAA/PMEL,USA
R. Heino	Met. Institute, Finland
P. Jones	University of Norwich, UK
R. Okoola	Kenya
K. Onogi	JMA, Japan
D. Parker	Met Office, UK
T. Peterson	NCDC, USA
B. Rudolf	GPCC DWD, Germany
J. Schmetz	Eumetsat
M. Suzuki	JAXA, Japan

GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC)

The composition of the Ocean Observations Panel for Climate, jointly sponsored by the JSC and the Joint Scientific and Technical Committees for GCOS and GOOS, was as follows:

Ed Harrison (Chair)	NOAA/PMEL, USA
T. Dickey	University of California, Santa Barbara, CA, USA
J. Johannessen	Nansen Environmental and Remote Sensing Center, Norway
R. Keeley	MEDS, Canada
Y. Michida	University of Tokyo, Japan
R. Reynolds	NOAA/NESDIS/NCDC, USA
F. Schott	IFM-GEOMAR, University of Kiel, Germany
P. Taylor	Southampton Oceanography Center, UK
R. Weller	Woods Hole Oceanographic Institution, USA

A representative from each CLIVAR basin panel, and now GSOP, are also members ex officio of the OOPC.

16.3 Publications

The following reports were produced under WCRP auspices in various series since the twenty-sixth session of the JSC:

WCRP Report Series

WCRP-120	ACSYS Conference Proceeding Report (WMO/TD-No. 1249)
WCRP-121	Baseline Surface Radiation Network (BSRN) Operations Manual version 2.1 (WMO/TD-No. 1274)
WCRP-122	GCSS-ARM Workshop on the Representation of Cloud Systems in Large-Scale Models (Kananaskis, Alberta, Canada, 20-24 May 2002) (WMO/TD-No. 1290)

WCRP-123	The World Climate Research Programme Strategic Framework 2005-2015: Coordinated Observation and Prediction of the Earth System (COPES) (Text-only version) (WMO/TD-No. 1291)
WCRP-124	Assessment of Stratospheric Aerosol Properties (ASAP) SPARC Report No. 4 (WMO/TD-No. 1295)
WCRP-125	First CliC International Conference Cryosphere – The "Frozen" Frontier of Climate Science: Theory, Observations, and Practical Applications (Beijing, China, 11-15 April 2005) (WMO/TD-No. 1300)
WCRP-126	WCRP and Scientific Committee on Antarctic Research: CliC Implementation Strategy Document (October 2005) (WMO/TD 1301)

Informal WCRP reports and documents

WCRP Informal Reports

Report No Title

6/2005 Report of the First Session of the CLIVAR Global Synthesis and Observations Panel (GSOP), (ICPO publication series No. 90)

7/2005 "Report of the TACE Workshop", Rosenstiel School of Marine and Atmospheric Science (Miami, USA, 3 February 2005),(ICPO publication series No. 91)

8/2005 Report of the first session of the WCRP CliC Scientific Steering Group (Hobart, Tasmania, Australia, 25-29 October 2004)

9/2005 Report of the Second CLIVAR/GOOS Indian Ocean Panel meeting (Hobart, Australia, 30 March-2 April 2005), (ICPO publication series No. 92)

10/2005 Report of the Modes of Southern Hemisphere Climate Variability Workshop (Cambridge, UK, 27-30 June 2005), (ICPO publication series No. 93)

11/2005 Report of the 4th Meeting of the CLIVAR Southern Ocean Panel, (Cambridge, UK, 30 June 2005), (ICPO publication series No. 94)

12/2005 Report of the 17th session of the GEWEX Scientific Steering Group (Kunming, China, 31 January-4 February 2005)

13/2005 Report of the 8th session of the JSC/CLIVAR Working Group on Coupled Modelling (Yokohama, Japan, 25-27 October 2004)

14/2005 Report of the 8th Meeting of the CLIVAR Vamos Panel (Mexico City, Mexico, 7-9 March 2005), (ICPO publication series No. 97)

15/2005 Reports of the Modes of Southern Hemisphere Climate Variability workshop (27-28th June 2005) and the third session of the CLIVAR/CLIC/SCAR Southern Ocean Region Panel meeting (29-30 June 2005), Cambridge, UK (ICPO publication series No. 98)

16/2005 Report of the 16th session of the GEWEX Radiation Panel (Paris, France, 3-6 October 2005)

1/2006 Report of the 7th Session of the CLIVAR Atlantic Implementation Panel (Venice, Italy, 20-21 October 2005) (ICPO publication series No. 99)

Special WCRP Reports

- Annual Review of the World Climate Research Programme and Report of the Twenty-sixth Session of the Joint Scientific Committee (Guayaquil, Ecuador, 14-18 March 2005) (WMO/TD-No. 1286)

CAS/JSC Working Group on Numerical Experimentation Report Series

No. 20 Report of the twentieth session of the CAS/JSC Working Group on Numerical Experimentation, Exeter, UK, 11-15 October 2004
(WMO/TD-No. 1297)

16.4 WCRP Resources

The budget for the WMO/ICSU/IOC Joint Climate Research Fund (JCRF) for the WCRP for the second biennium (2006-07) of the WMO Fourteenth Financial Period 2004-07 was presented to JSC.

a. Commitments to the WCRP are governed by an official Agreement between WMO, ICSU and IOC (UNESCO), which came into force on 1 January 1993. This Agreement replaced an earlier WMO/ICSU Agreement on the WCRP, which entered into force on 1 January 1980.

b. The Agreement deals with the 'Financial Arrangements' for the WCRP. In particular, it states that: a special account, to be known as the Joint Climate Research Fund (JCRF), will be established by the Secretary-General of WMO; the administration of the Fund shall be the responsibility of the Secretary-General of WMO; and the WMO Financial Regulations shall apply, including the arrangements for external audit. Contributions are made to the JCRF by WMO, ICSU and IOC, by agreement. The general pooled Fund is then used to provide support for a very wide range of WCRP-sponsored activities, ranging from expert group meetings to meetings of the Scientific Steering Groups of its core activities, to full and open scientific conferences, to the annual meeting of its governing Joint Scientific Committee (JSC). The JCRF also supports a small central secretariat of 7.6 full-time equivalent staff (the Joint Planning Staff for the WCRP), located at the Headquarters of WMO in Geneva, Switzerland.

c. WMO operates four-yearly 'Financial Periods'. The budget for the WMO Fourteenth Financial Period, 2004-07, was approved at the WMO Fourteenth Congress held in May 2003. Several decisions have compounded to result in a highly significantly reduced figure (in CHF) budgetted for JCRF-supported WCRP activities for the WMO Fourteenth Financial Period (2004-07) compared with the corresponding budget for the Thirteenth Financial Period (2000-03). These include: the decision of the WMO Congress (May 2003) to adopt effectively a zero nominal growth budget; new WMO directives about staffing and staff costs; and the imposed (May 2003) UN official exchange rate (CHF 1.31/USD). The net effect is a notional loss of about 1.9M CHF in the JCRF budget for WCRP activities in 2004-07, relative to the period 2000-03.

d. As can be seen from Figure 1, total income to the JCRF has remained fairly steady over the last decade. The cost of JPS salaries has increased steadily and hence the balance available for activities would normally have decreased significantly. However, in the recent past, the decrease in funds available for activities has not been as great as would be expected due mostly to carry-over savings from previous years. In 2004/05 there was a significant drop in income and savings had been exhausted, and therefore spending on activities dropped by about 15 percent. At the close of 2005 WMO allocated the JCRF an extra 150K USD of "end-of-year" money to be spent in 2006 on new COPES-related activities. This should allow us to spend at the level of previous years if indeed IOC and ICSU pay at the expected rates (IOC at 125K USD per annum and ICSU at 250-300K USD per annum) and the dollar value remains at 1.3 or higher. When granting WCRP the additional funds for 2006, the WMO Secretary General noted that this was an exceptional measure and that for future years more effort would be required to secure additional support from the other cosponsors as well as from other extra budgetary sources. This will be particularly necessary for the next four-year financial period beginning in 2008 when it is anticipated that the gap between income and desired expenditures will widen, due largely to the continuing rise in salary costs and a more ambitious spending plan.

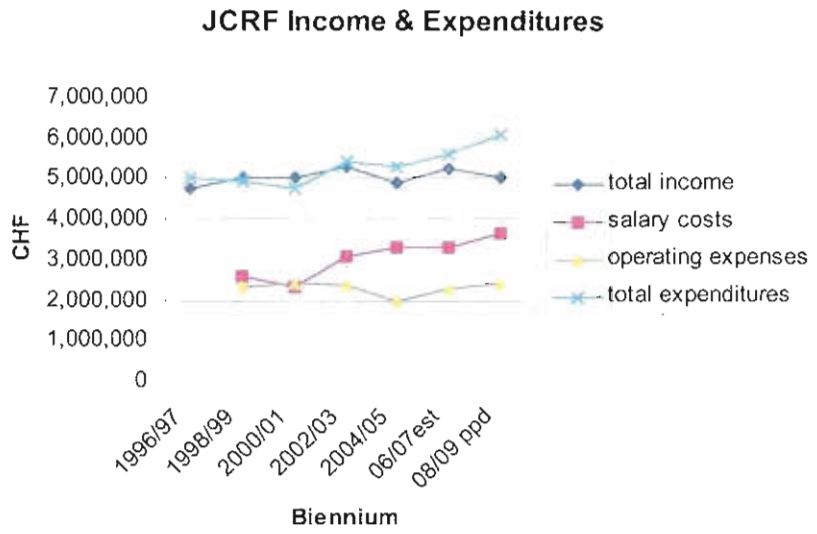

Figure 1. ("total income" here does not include project office, ppd=proposed level)

The overall income for WCRP, including support to the project offices, is distributed as seen in Figure 2, below:

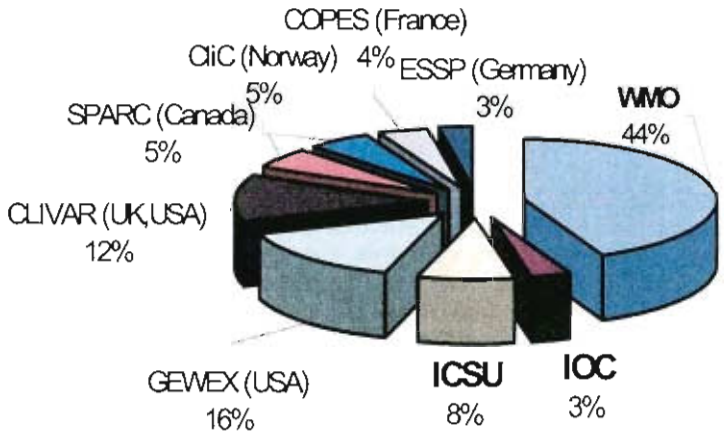

Figure 2. Funding for 2006-2007 for JCRF and IPOs

In future years the situation looks bleak. Without real efforts to increase support from existing and new sponsors, the WCRP faces a significant resource challenge. However, the new WCRP Strategic Framework and the WCRP/THORPEX "White Paper" offers the opportunity, which is timely, to argue for and achieve significantly greater funding for climate research around the world.

17. DATE AND PLACE OF THE TWENTY-EIGHTH SESSION OF THE JSC

The JSC gratefully accepted the kind invitation of Dr L.A.Ogallo, JSC Member, to host the twenty-eighth session of the Committee in Zanzibar, Tanzania, from 26-30 March 2007.

18. CLOSURE OF SESSION

The Chair thanked all participants for their contributions to the session, the high level of scientific discussions and the steps that had been taken in the further development of the WCRP. He looked forward especially to the effective implementation of the new WCRP strategic framework. The Chair also acknowledged the excellent scientific presentations that had been given to the Committee by Dr R. Rajeevan, Director, India Meteorological Department, Pune, on "South Asian Monsoon: Variability and Prediction"and by Dr R. Kolli, Head, Climatology & Hydrometeorology Division, Indian Institute of Tropical Meteorology, Pune on"Recent climate research initiatives in India".

Finally, the Chair reiterated his sincere gratitude to Dr G.B. Pant and all who had worked with him for the memorable arrangements that had been made for this JSC session, the excellent facilities and generous hospitality. He asked that the appreciation of the JSC be relayed to all involved.

The twenty-sixth session of the WMO/ICSU/IOC Joint Scientific Committee for the WCRP was closed at 1300 hours on 11 March 2006.

APPENDIX A

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WCRP Joint Scientific Committee
Twenty-seventh Session, Pune, India, 6-11 March 2006,
With Joint session with SC-IGBP, 6-7 March 2006

SUMMARY OF THE MAIN DECISIONS, RECOMMENDATIONS AND ACTIONS

Agenda item(s)	Subject	Decision, recommendation or action	Responsibility
3	**Matters relating to the WCRP sponsoring agencies, WMO, IOC and ICSU**	JSC welcomed the representatives of two of its sponsors (WMO and ICSU) and thanked them for their statements. JSC noted with interest that ICSU was currently considering co-sponsoring THORPEX in consultation with WMO. JSC welcomed this and pointed out that WGNE was already deeply involved with THORPEX and that WCRP's new Strategic Framework proposes close collaboration with THORPEX	D/WCRP
		JSC was informed of planning for World Climate Conference-3 in 2008(or 2009). JSC should define at an early opportunity what it might wish to see as an outcome of the World Climate Conference–3. JSC was informed of the UN Declaration of 2008 as the International Year of Planet Earth. WCRP agreed to pursue both of these opportunities.	D/WCRP
		JSC was pleased to note the strong supportive statement from IOC, and also its request to WCRP to engage with it more closely. JSC needs to be more active in consideration of climate of the ocean and its impacts. As a first step CLIVAR to liaise with IOC in planning the PICES / ICES / IOC symposium "Effects of Climate Change on the World's Oceans", to be held in Gijon Spain, in May 2008.	CLIVAR Co-Chairs
		JSC was briefed of the upcoming ICSU review of all of the global change programs including WCRP and ESSP. It was suggested that the ESSP should be reviewed first. JSC needs to form a small team to prepare for the review of WCRP in particular and ESSP more generally (including nomination of reviewers).	JSC Officers, D/WCRP
4	**WCRP Strategic Framework 2005-2015: Coordinated Observation and Prediction of the Earth System**	In general, for all WCRP Task Forces, JSC recommended that all TFs should be charged before beginning to define plans towards a 2-year sunset or how a transition to mainstream WCRP activities will be effected. WMP should have oversight of modelling part of all TFs' activities and WOAP oversight of observational and analysis activities and both be empowered to recommend changes to JSC.	Chair, WOAP Chair, WMP
		WCRP should have a more visible web presence (including activities, meetings, reports, newsletters, access to data sets etc). WCRP should also engage in periodic announcements/ highlights about its activities and plans in prominent and high-visibility journals. JSC recognized the need for a more effective connection of WCRP activities to ESSP partners.	D/WCRP and Project Directors

4.1	**Sea-level Rise Task Force**	JSC was briefed about preparations for the upcoming Workshop on Sea-level Rise in Paris, 6-9 June 2006. JSC was informed that the possibility of getting the Workshop report published as a book was being considered.	TF Leader
4.2	**Report of the WCRP Panel on observations and Assimilation (WOAP)**	JSC noted with appreciation the initial steps taken by WOAP for the coordination of global reanalyses and of the preparatory activities for the reprocessing of global data sets. JSC was informed about the upcoming Workshop on Reanalysis at ECMWF in June 2006 and approved the plans to organize a major International Reanalysis Conference hosted by the Japanese Meteorological Agency in the fall of 2007. JSC endorsed the recommendations of WOAP to improve the presence of WCRP projects on internet, including easy access to and adequate information on available datasets. It supported WOAP's effort to define a research strategy for data assimilation in climate models. In order to ensure the efficiency of WOAP's coordination role, JSC reaffirmed the importance of the relay of WOAP's recommendations to projects and of a good follow up of actions in preparation for next meeting scheduled at JRC-Ispra, Italy, 28-30 August 2006. The JSC also commended the WOAP for taking the lead on recommending a way forward on CEOP with regard to the WCRP, and also for the letter stating the WCRP position on satellite observations to CEOS. The JSC noted that a response to the CEOS reply is being coordinated through GCOS. Projects to encourage the sharing of high frequency data for the analysis of extreme events and how they are changing.	Chair, WOAP Chairs, Co-Chairs of all WCRP Projects and Working Groups Chairs, WCRP Projects
4.3	**Report of the WCRP Modelling Panel (WMP)**	JSC was informed of the joint efforts of WMP and THORPEX to prepare a joint white paper on the grand challenge of establishing a multi-national coordinated research initiative to develop next-generation unified models for prediction of weather and climate. JSC encouraged the THORPEX and WMP leaders to develop an appropriate strategy to go forward including possible institutional arrangements for such an endeavour, the need for computing power and data management strategies. The JSC debated intensely on the central issue of seamless prediction. JSC encouraged working groups and projects to interact with WMP in order to unify our stand and move forward.	Chairs, Co-Chairs of all WCRP Projects and Working Groups Chair, WMP
4.4	**Report of the WCRP Task Force on Seasonal Prediction (TFSP)**	JSC was briefed by TFSP chairman about the ongoing efforts on the design and implementation of the seasonal prediction experiment and plans for a climate community wide seasonal prediction workshop for the middle of 2007. JSC Commended the Task force on progress to date and recommended the transition of the TFSP to CLIVAR's charge after the workshop. As requested by TFSP chairman, JSC agreed to send letters to: (i) all relevant panel chairs and operational centres regarding project announcement including numerical experiment, assessment process, and proposed workshop schedule and (ii) all JSC members to explore with their national funding agencies support to small seasonal assessment grants.	Chair, TFSP Co-Chairs, CLIVAR Chair, WMP D/WCRP

		The need for a consistent definition of ENSO was emphasised. The WCP has a group looking at this issue and WCRP (CLIVAR) needs to be more actively included in this activity.	(D/WCP)
4.5	**Proposals receved in response to invitation to particpicate in the WCRP.**	Two proposals received in response to call for proposals in the WCRP Strategic Plan (see Appendix F) were tabled for JSC's consideration: 1.A Moroccan proposal on " Project Study on climate change impacts and adaptation in North Africa" by Abdelkader Allali 2.An Indian proposal on "Monsoon Stability and Global Change", by G.B. Pant, G. Beig, M. Rajeevan, and C.Sharma	D/WCRP
		The JSC was pleased to consider both proposals. To set a strategy in place to deal with such proposals, the JSC recommended that such proposals be delegated to relevant core and joint projects/programmes of the ESSP family for review. In the case of proposal # 1 it should be forwarded to CLIVAR-MED and START for a joint review.	Co-Chairs, CLIVAR, START Secretariat D/WCRP
		For proposal # 2, JSC expressed the view that it should be considered in the Monsoon cross-cutting activity and the ESSP MAIRS Project (see item 5.1).	
		The JSC reiterated that WCRP should be proactive in soliciting proposals under the new strategic initiative.	D/WCRP
		The JSC acknowledged with gratitude the contributiors from the WCRP support unit in Paris with the prime functions to promote and help implement WCRP's new strategy, and to provide assistance to the new WCRP panels, WOAP and WMP.	
5	**Cross-cutting topics for JSC consideration**		
5.1	**Monsoons: including consideration of the report and recom-mendations of the Monsoon Workshop, June 2005**	The JSC expressed the view that the CLIVAR and GEWEX monsoon panels should work more closely together. CLIVAR and GEWEX (with SPARC and CLIC) should establish focal points (with a JSC Rep) to define how to bring the monsoon studies into a more coordinated program for discussion at next JSC. WMP should coordinate the modelling parts of the two projects together with SPARC and CEOP. JSC strongly supported WGNE and THORPEX participation in these activities, particularly in the focus on the diurnal cycle.	Chair, GEWEX Co-Chairs, CLIVAR, Chair, WMP Co-Chairs, SPARC Chair, WGNE T. Koike

5.2	**Anthropogenic Climate Change**	JSC noted that a great deal of effort is going on in various ACC activities of WCRP but that WCRP needs to raise its ACC visibility to a higher profile. An initial roadmap for ACC Activity to be developed by a JSC task team recognizing the existing work of the WGCM (with contributions by the projects, groups, task teams etc) which proposes how WCRP can deliver on its objective to determine the effect of human activities on climate. (JSC Task Team Members: V. Ramaswamy (Lead), J. Mitchell, H. Le Treut, J. Marotzke; Timeline- first draft available for the next OCD meeting). Terms of Reference (TOR) for this Task Team are: - With the aid of the Projects and Working Groups -To document current major activities being undertaken by WCRP that relate directly to ACC -To identify major gaps in WCRP activities that are required to narrow uncertainties regarding ACC -To propose new activities that could fill these gaps and thus reduce existing uncertainties (see also item 13). JSC also encouraged holding workshops with other WCRP groups on ACC e.g. with IPCC (ETCCDMI). JSC suggested that WCRP co sponsorship of ETCCDMI should be ensured.	D/WCRP Co-Chairs, WGCM ACC Task Team
5.3	**Extreme Events**	JSC observed that WCRP needs to address this nascent and increasingly important area. It recommended that WCRP set up a framework for studying the extreme events to address data, modelling, simulation and predictability needs of extremes. An initial step is a session on extremes at the seasonal prediction workshop in 2007. JSC will continue to address the crosscut between Extremes and ACC in its future sessions. Through GCOS, WCRP must continue to stress the need for access to high frequency data for analysis of extreme events. As in Item 4.2, Projects to encourage the sharing of high frequency data for the analysis of extreme events and how they are changing. WCRP activities on extreme events should be brought together on a single WCRP web page.	D/WCRP, Chair, TFSP Chairs, WCRP Projects D/WCRP
6	**CLIVAR**	JSC expressed appreciation of CLIVAR's visibility profile and its list of success measures. JSC was pleased with CLIVAR's engagement with African activity and that VACS is planning a workshop in Tanzania jointly with WMO and START, to address prediction and predictability of the climate of east and southern Africa. JSC requested inputs from this	Co-Chairs, CLIVAR, D/WCRP

		workshop be brought to the JSC prior to the next JSC meeting in east Africa next year. JSC thanked WGCM for the successful international Workshop on Analyses of Climate Model Simulations for the IPCC AR4 convened by US CLIVAR, hosted by IPRC (Univ. of Hawaii) March 1-4, 2005 and overseen by the WGCM Climate Simulation Panel. JSC was pleased to note that this was the largest, most comprehensive, highest profile and the most successful project ever organized by WGCM. JSC also expressed its grateful thanks to Program for Climate Model Diagnosis and Intercomparison (PCMDI) for their invaluable contribution to the collection, archival and distribution effort for the IPCC multi-model analysis activity.	START Secretariat Co-Chairs, WGCM
7	**GEWEX - including CEOP**	JSC would like GEWEX to accelerate progress on role of the land surface processes in predictability of intraseasonal, seasonal and longer time scales. JSC urged GEWEX to contribute to predictability and prediction studies. JSC recommended that a representative from the Global Land Atmospheric Coupling Experiment (GLACE2) (global coupled) be included on the WCRP Modelling Panel.	D/WCRP JSC group Chair, GEWEX Chair, WMP Chair, GLASS
7.1	**GEWEX**	JSC noted with appreciation the roadmap presented by GEWEX in response to WCRP's strategic framework and established a group for review of objectives, implementation, milestones, and timeline. This group includes Drs T. Yasunari (Lead), G. Wu, D.J. Griggs, J. Shukla and L. Ogallo. JSC endorsed GEWEX plans for the coming year subject to review group's recommendations. TOR for the review group are: - To review the draft objectives and milestones of the GEWEX Roadmap - To identify major gaps in these objectives and milestones - To identify potential difficulties in achieving these milestones within the lifetime of GEWEX JSC encouraged GEWEX to increase its contribution to predictability and prediction studies.	GEWEX Review Group
		JSC requested GEWEX to consider how to make progress on aerosol and cloud-related feedbacks, including linkages to climate models and sensitivity to human-induced climate change, to improve projections for the IPCC AR5.	Chair, GEWEX
		JSC considered the MAHASRI proposal and recommenced that GEWEX request CLIVAR to review it and that it meet the CSE criteria.	Chair, GEWEX Co-Chairs, CLIVAR
7.2	**CEOP**	JSC approved the plan for CEOP phase II, subject to a technical review of the science plan by experts from each WCRP project, in order to propose ways to maximize synergies and to prevent potential overlaps with existing WCRP activities. JSC reiterated the recommendation that the science issues be reviewed and reported by GEWEX and the data management aspects through WOAP. (See Agenda item 7, JSC26 Actions.) It	Chair, GEWEX Chair, WOAP T. Koike

		recommended that GEWEX propose to next JSC a plan to reorganize its structure in order to better integrate CEOP agenda in its panels.	
8 8.1	**CliC - including WCRP participation in IPY 2007-08** **CliC**	JSC expressed satisfaction at the progress of activities in CliC. JSC urged CliC to take steps to provide inputs to modelling groups with a view to improving collaborations and the transfer of new modules to WGCM, WGNE, WGSIP, WMP and TFSP.	Chair-CliC Co-Chairs, WGCM Chair, WGNE Chair, WGSIP Chair, TFSP
9	**SPARC**	JSC was pleased with the progress by SPARC, particularly progress in moving forward with the Chemistry and Climate initiative. JSC agreed to set up in consultation with SC-IGBP, a Task Force led by SPARC and IGAC as the core-organizers, determine its membership and TOR on "Chemistry and Climate" in a two phased manner: Phase 1: An initial modelling strategy to dentify key tractable experiments designed to highlight the important processes concerning short-lived species. Phase 2: long term vision (involving climate models and observations) The time frame would be 3 years initially. JSC supported the new dynamic modelling initiative and expressed the view that there should be increased coordination of SPARC modelling with WMP. JSC encouraged linkage of this initiative with the new IOC effort on marine chemistry and climate.	Co-Chairs, SPARC Drs A.R. Ravishankara and P. Rasch and IOC to provide inputs on TOR Chair, WMP D/WCRP
10 10.1	**Climate Modelling** **WGNE, including report on THORPEX**	JSC appreciated the continued progress by WGNE and reiterated its support to the Systematic Errors Workshop planned for February 2007 in San Francisco, USA. JSC encouraged WGNE to carry out predictions beyond 10 days up to a season to know its impact on intraseasonal and seasonal timescales. JSC strongly endorsed the WGNE/GCSS proposal on a coordinated effort on convection (and associated physics). JSC observed that convection is central to many problems in current modelling efforts on almost all space and time scales and that it cuts across most WCRP groups. Climate	Chair, WGNE Chair, GCSS Co-Chairs, WGCM T. Palmer D/WCRM

		Process Teams (CPTs) would be interested. As a next step, JSC suggested that a small group consisting of Chair of WGNE, Co Chairs of WGCM and Dr T. Palmer should discuss this proposal. JSC supported WGNE's proposal to strengthen membership in ensemble prediction and /or coupled modelling.	
10.2	**WGCM**	JSC was pleased to note the great success of the WCRP/IPCC multi-model analysis activity.JSC expressed the view that synergy between WGCM and WGSIP will lead to fundamental advances in WCRP science and encouraged close collaboration. JSC would like to see more collaborative research efforts between the other projects and WGCM, particularly in connection with modelling of climate change. (See also item 6) JSC would like WGCM to lead a Pan-WCRP effort on decadal predictability as well as the development of a WCRP Task Team on ACC (See item 13).	Co-Chairs, WGCM Chair, WGSIP Chair, WMP
11	**WG on Surface Fluxes**	JSC supported joint meeting of WGSF with WGNE on SURFA in Boulder (November 2006) and the joint meeting of WGSF representatives with SOLAS in Heidelberg (September 2006). JSC approved that WGSF start to negotiate with IGBP (iLEAPS), and other WCRP activities, regarding potential cooperation on the WGSF transition to the sea/land mode and hoped that this discussion would lead to some synergies in the number of meetings and groups.	Chair, WGSF D/WCRM
12	**Climate monitoring and co-operation/ liaison with global climate observing agencies and programmes**		
12.1	**GCOS, including AOPC and OOPC**	JSC thanked Drs J. Zillman, M. Manton and E. Harrison, Chairs, GCOS SC, AOPC and OOPC respectively, for their presentations. In response to request by GCOS to comment on the extent to which GCOS and its component systems meet the needs of climate research, JSC responded that availability and accessibility of routine data is currently seriously inadequate. There is a major unmet need for better data on extremes (e.g. hourly precipitation). JSC affirmed the importance of WCRP-GCOS co-ordination and mutual support in responding to the UNFCCC-COP's needs for information and support in respect of research (WCRP) and systematic observation (GCOS). JSC agreed to review/reaffirm the roles, membership and work plans of jointly sponsored panels AOPC and OOPC. JSC also agreed that WOAP/WCRP should have formal links with GCOS SC.	D/WCRP Chair, WOAP

		JSC recognizes that global atmospheric data recovery, reprocessing and reanalysis require substantial investments, and that these activities rely also on the huge investments made in the global observing system and data assimilation for numerical weather prediction. Relevant programs and agencies are thus encouraged to collaborate to optimize the global returns from these investments. JSC urged countries to make historical GSN data openly available to support analysis of climate extremes and impacts at global and regional levels. JSC encouraged AOPC to work with relevant programs, agencies and organisations to plan and implement a high-altitude high-quality upper-air reference network that helps consolidate the overall investment in and returns from global reference networks for ESS.	Chair, AOPC
		JSC noted with satisfaction the progress of the ocean research community and its national sponsors in advancing the implementation of the in situ component of the initial global ocean observing system defined in the GCOS Implementation Plan (GCOS-92), as developed by leading GOOS, GCOS and WCRP climate research scientists. It also noted the extent to which high level international acceptance has been obtained (e.g., UNFCCC, GEO, G-8 Gleneagles). JSC congratulated the international Argo community for its accomplishment in obtaining near-global coverage of temperature and salinity profiles over the ice-free ocean and noted that the upper 1-2km of the world ocean will be monitored systematically for the first time thanks to these efforts. JSC congratulated the surface drifting buoy program for attaining its design deployment target of 1250 floats reporting SST and noted the importance of these data in producing climate quality global SST analyses. Recognizing the importance of SLP observations it encouraged an increase in the percentage of drifters measuring SLP in future years.	Chair, OOPC
		JSC noted the limited progress of nations to make commitments to sustain the agreed in situ, satellite and ocean analysis activities, and, recognizing that the ocean research community is the primary implementation agent for the global ocean observing system, recommended that CLIVAR and CliC make efforts to continue to sustain the recommended global ocean observing system via research efforts. JSC expressed the hope that national commitments to sustain the observing system would increase, via long-term non-research funding as national contributions to the global ocean module of GOOS and GCOS. JSC noted the difficulty of determining ocean subsurface temperature trends (particularly the difficulty of obtaining statistically significant trends over most of the southern hemisphere), indicating the extent to which there is large spatial and temporal variability in	Co-Chairs, CLIVAR Chair, CliC

		oceanic temperatures. It notes that these results support a greater focus on decadal variability research and observations in coming years. JSC agreed to the suggestion by GCOS to emphasize the need for close WCRP-GCOS co-operation in input to satellite operators (especially with CEOS) and GEOSS bodies in respect of climate observations for research and suggested that WCRP should use GCOS and WMO Space Programme as prime communication routes to CEOS and GEO.	D/WCRP
12.3	**Satellite Matters Including Group on Earth Observations (GEO) and GEOSS**	JSC considered how to manage WCRP's interaction with GEOSS. The outcomes of GCOS presentations (and recommendations about linking better to WMO departments) suggest that this activity should be through WCRP/GCOS joint panels for observations and through the WMO Space Programme for research not otherwise covered.	D/WCRP
13	**IPCC and UNFCC issues**	JSC discussed on how to deliver WCRP's capability to the UNFCCC. JSC recommended that a Task Team should come from WGCM and other activities and be established to develop and deliver WCRP's capability to the UNFCCC. It should have in its Terms of Reference: o To make input to the IPCC emissions scenarios issue (now and for future mutual benefits) o To initiate thoughtful interactions in ESSP on people/physics/bio-geochemical scenarios (ultimately perhaps the Task Team becomes an ESSP task team) o To propose and organize world climate research for the AR5 so that results can be collected, accessed, analyzed and distributed (e.g. for impacts) (the follow-on to the "Hawaii" meeting) o To prepare WCRP's strategy for the final publication of AR4 in 2007 so that WCRP plans are ready and can be publicized as soon as the AR4 is officially released o To work on the SBSTA submission (now), assist in preparations for the SBSTA-24 meeting, attend and offer a side event at Bonn and then to follow-up regularly so that each SBSTA and COP sees WCRP fully up-to-date and, if possible, endorsed by COP o To have and continue a clear dialogue with IPCC on (i) evolving research needs (COP/UNFCCC), (ii) scenario constancy/improvement (IPCC WGs /WCRP) (iii) radiative forcing (historical improvement and analysis & modelling) (WCRP/GCOS) etc.	D/WCRP Co-Chairs, WGCM

16	**Administrative matters**	The next OCD Meeting will be held in Beijing, China, 7- 8 November 2006, along side the START Young Scientists' Meeting and just prior to the Second ESSP Open Science Conference.	Chair, JSC D/WCRP
16.1	**WCRP Officers, Chairs and Directors (OCD) Meeting**	JSC approved nominations of new members or renewals of terms of appointment of current members as appropriate. Dr J. Church was elected the new Chair, Prof. V. Ramaswamy, the new Vice-Chair, and Drs S. Gulev, Dr K. Trenberth, Prof. G. Wu, the new Officers of the JSC. JSC expressed some disquiet about the expanding number of groups. JSC encouraged reducing meetings and groups where synergies could be achieved. JSC also encouraged careful planning to allow back-to-back meetings whenever useful.	D/WCRM Chairs, Co-chairs of all projects, WGs
16.2	**Organization and membership of WCRP Committees**		
17	**Brainstorming session on WCRP Partnerships, Sponsorships, Visibility**	JSC discussed at length during the beginning of its session and throughout the week the important issue of demonstrated benefit delivery and, hence, increased visibility of WCRP. JSC expressed concern that despite WCRP's enormous contribution to the climate science its visibility has remained low. Throughout the week JSC endorsed and encouraged proactive co-operation with WCP, GCOS, AREP, WWW, the WMO Space Programme and Satellite Dept etc. JSC urged that WCRP take steps to attract young scientists and to reach out to and build bridges to the wider audience of stakeholders, programme managers and sponsors. JSC recommended that a roadmap, building on the COPES WCRP Strategic Framework, should be developed both by JSC and by WCRP projects, groups, task teams etc and then blended. The goals are: - To identify existing activities that contribute to WCRP achieving its two objectives; - To identify new activities that should be initiated or enhanced to allow WCRP to achieve these objectives and strategic goals; - To identify how these existing and new activities contribute to seamless prediction, Earth System Science and deliver benefit to users and stakeholders.	JSC members JPS members Chairs, Co-chairs of all projects, WGs Chair, JSC D/WCRP

		Draft reports prepared by the JSC and WCRP groups to be made available in advance of the next OCD meeting.	
19	**Date and place of the next JSC session**	26-30 March 2007, Zanzibar, Tanzania, Africa, by kind invitation of Dr L.A. Ogallo. The session will include a half-day poster session, half-day dialogue with local scientists and interaction with scientists from east Africa. START is invited to hold a Workshop alongside for young scientists. (See also agenda item 6).	Chair, JSC D/WCRP L.A. Ogallo START Secretariat