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)

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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 2005 session of the JSC, the twenty-sixth, at the Escuela Superior Politécnica del Litoral (ESPOL), Guayaquil, Ecuador from 14-18 March, had been made through JSC Member, Prof. P. Cornejo R. de Grunauer, Faculty of Marine Science and Marine Engineering, ESPOL. The session was called to order by the Chairman of the JSC, Prof. P. Lemke, at 0900 hours on 14 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 compiled for convenience in Appendix B.

The session was formally opened by Dr P. Carrion, Director of Science and Technology, ESPOL, who welcomed all the participants to Guayaquil and, in particular, to ESPOL on behalf of Dr Moises Tacle, Rector of ESPOL. In doing so, he stressed the importance of climate research and the role of the World Climate Research Programme in the context of the changing vagaries of climate. He expressed the need for continuing and increased collaboration between the appropriate scientific community in Ecuador and climate research groups in other parts of the world.

The Chairman of the JSC thanked Dr Carrion for his welcome and his highly appropriate and inspiring remarks. It was a pleasure and privilege for the JSC to meet in Ecuador, in particular Guayaquil, for the first time and to therefore have the first-hand opportunity to acknowledge the outstanding contributions of Ecuadorian scientists to the WCRP. The Chairman also acknowledged with gratitude the presence of Prof. Ing. G. Garcia Davila, Executive Director, Instituto Nacional de Meteorologia e Hidrologia (INAMHI), who was the Permanent Representative of Ecuador with WMO and also the Vice-President of WMO Regional Association III (South America), and also Dr J. Luis Santos, Director, Centro Internacional de Investigacion del Fénomeo El Niño (CIIFEN), Guayaquil. He also thanked Prof. Cornejo and her colleagues for their substantial efforts and support in arranging for this JSC session to be held at ESPOL. In doing so, he acknowledged the encouragement and direct support that had been given to Prof. Cornejo by Dr E. Cervantes, Dean of the Faculty of Marine Science and Engineering, ESPOL.

The Chairman continued by extending his greetings to all the participants in the session. He was pleased to welcome the new members of the Committee attending for the first time, namely Dr D.J. Griggs, Prof. H. Le Treut, Prof. J. Marotzke and Prof. Guoxiong Wu, whilst noting with regret that three JSC members, Prof. J. Shukla, Dr K. Denman and Dr Ilana Wainer could not be present on this occasion.

The Chairman further acknowledged with appreciation the representatives from two of WCRP's sponsors, Dr B. Nyenzi, WMO, and Dr A. Fischer, IOC, and noted with regret that a corresponding representative from ICSU could not be present on this occasion. The Chairman was also pleased to welcome Prof. G. Brasseur, Chairman, International Geosphere-Biosphere Programme and regretted the absence of a representative from IHDP on this occasion.

The Chairman voiced his gratitude for the customary 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; Dr A. Busalacchi, Co-chair of the CLIVAR Scientific Steering Group; Dr B. Goodison, Chair of the CliC Scientific Steering Group; Prof. A. O'Neill, Co-chair of the SPARC Scientific Steering Group; Dr M. Miller, Chair of the CAS/JSC Working Group on Numerical Experimentation (WGNE); Dr J. Mitchell, Chair, Working Group on Coupled Modelling (WGCM); Prof. S. Sorooshian, Chair of the GEWEX Scientific Steering Group and Dr C. Fairall, Chair, Working Group on Surface Fluxes (WGSF). The Chairman noted with regret that Prof. J. Shukla, JSC member and Chair, WCRP Modelling Panel, Dr A.R. Ravishankara, Co-chair of the SPARC Scientific Steering Group and Dr T. Palmer, Co-chair of the CLIVAR Scientific Steering Group could not be present on this occasion. The Chairman expressed his

gratitude to Prof. B.J. Hoskins, Chair, COPES Task Force and Prof. B. Kirtman, Chair, Task Force on Seasonal Prediction, for their participation.

The Chairman was further pleased to note the attendance of Project Office Directors: Dr N. McFarlane, Director, SPARC International Project Office; Dr H. Cattle, International CLIVAR Project Office; R.G. Lawford, Director, International GEWEX Project Office; Dr J. Canadell, Executive Director, Global Carbon Project; and Dr M.B. Endejan, Deputy Executive Officer, Global Water System Project (GWSP). The Chairman was gratified by the participation also of Prof. P.J. Mason, 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) who was also representing the joint WCRP/IGBP/IHDP Global Change System for Analysis, Research and Training (START), Dr M. MacCracken, representing IAMAS, IUGG and Scientific Committee on Oceanic Research (SCOR), Dr J. Marengo, member, GWSP Scientific Steering Committee, and Dr M. Shapiro, representing the WMO Commission for Atmospheric Sciences (CAS). The Chairman noted with regret that Dr C. Dick, Director, CliC International Project Office, and a representative from IPCC could not be present on this occasion.

Finally, the Chairman looked forward with anticipation to the scientific lectures that would be given later in the JSC session; i.e. ''Climatic virtual application system for agricultural management'', by Dr D.E. Matamoros, Associated Researcher, ESPOL and ''CIIFEN and its activities'', by Mr R. Martinez, Deputy Director of CIIFEN.

2. MAIN DEVELOPMENTS AND EVENTS SINCE THE TWENTY-FIFTH 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 has been an important one for the Climate Variability and Predictability (CLIVAR) project, major highlights being the First International CLIVAR Science Conference (Baltimore, USA, 21-25 June 2004) and the associated assessment of progress with CLIVAR since the International CLIVAR Conference (Paris, France, 2-4 December 1998). Over the year, CLIVAR panels have continued to develop their activities though, as a result of the assessment, some have been reflecting on new Terms of Reference and membership. The assessment brought some calls for a radical change to programme structure and organization, but in general the assessors recommended an evolutionary rather than revolutionary path so as not to impede the CLIVAR momentum and the considerable progress to date. The CLIVAR Scientific Steering Group (SSG) acted accordingly and introduced some significant changes. It is interesting to note that the USA implemented a major overhaul of its CLIVAR oversight structure; the new organization, based on the overall headings of “processes”, “phenomena” and “prediction” is more closely linked to the missions of the government agencies supporting various aspects of US CLIVAR research. The SSG Executive will meet in mid-2005 to review what has taken place since the assessment and make recommendations for further changes as necessary.

The overall strategy of the Global Energy and Water Cycle Experiment (GEWEX) was reviewed in mid-year and at the annual SSG session, with emphasis on potential contributions to the new WCRP strategic framework, COPES, and the development of crosscutting activities responding to the general objectives of WCRP. The main contributions expected from GEWEX relate to the high scientific value of its observational component which needs to be better taken into account in the COPES strategy, to its modelling capabilities which need to be fully used in the improvement of climate models, and to its concern for applications already under development in the context of the management of water resources. Following the COPES initiative, Phase II objectives for GEWEX have been revised and some minor revisions to these objectives have been proposed. All panels and most sub-projects held meetings or workshops during the past year. In addition to the annual SSG meeting, the GEWEX Executive held a summer meeting at the University of Maryland, Baltimore County (UMBC) in July. During the coming year, the major scientific meeting will be the 5th International GEWEX Science Conference to be held in Orange County, California, 20-24 June 2005. During the week before, GEWEX and CLIVAR are collaborating in the organization of a pan-WCRP monsoon workshop. Plans for a joint approach for addressing monsoon modelling will be worked out at this meeting.

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. After more than a decade in France, the SPARC International Project Office was relocated in 2004 to the

University of Toronto, Canada, with Dr Norman McFarlane as its Director. Financial and logistical support for the establishment of the new SPARC IPO is being provided by several Canadian sponsors: The Meteorological Service of Canada (MSC), the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), the University of Toronto, and the Canadian Space Agency (CSA). The Third SPARC General Assembly (GA) was held in Victoria, British Columbia, Canada, 1-6 August 2004. The overall goal of this Assembly was to present the science relevant to the new overarching themes of the SPARC programme with emphasis on climate-chemistry interactions. The SPARC SSG met just after the GA at Dunsmuir Lodge, Victoria. Some ideas as to the role of SPARC within COPES were discussed. However, development and implementation of these ideas will require close coordination among the WCRP core projects and clarification of their roles within COPES. In order to address goals enunciated in previous WCRP JSC meetings, the future SPARC programme will be encapsulated within three main themes: (1) detection, attribution, and prediction of stratospheric changes, (2) stratospheric chemistry and climate, and (3) stratosphere-troposphere coupling. A new implementation plan reflecting these themes is under development. It will be important to ensure that the plan reflects the highly crosscutting nature of these themes and how the new SPARC programme fits into COPES and contributes to its objectives.

Since July 2004, the Climate and Cryosphere (CliC) project has been co-sponsored by the Scientific Committee on Antarctic Research (SCAR). SCAR also joined CLIVAR and CliC in their co-sponsorship of the Southern Ocean Implementation Panel and WCRP in its sponsorship of the International Programme for Antarctic Buoys. In 2004, CliC signed a Memorandum of Understanding (MoU) with the International Permafrost Association (IPA) and cooperation with them is broadening. A similar MoU is being considered with the Northern Eurasian Earth Science Partnership Initiative (NEESPI) being promoted by NASA and the Russian Academy of Sciences. CliC has initiated discussion to strengthen cooperation with the newly established Commission on Cryospheric Sciences, which is part of the International Union of Geodesy and Geophysics. The main objective of the first session of the CliC SSG (Hobart, Australia, 25-29 October 2004) was to move the project from its planning to its implementation phase. CliC implementation will be achieved through work within the four established CliC project areas (CPAs). The session determined that a new structure of the project was required that would support crosscutting activities, the CPAs and activities with other WCRP initiatives including COPES. The First CliC Science Conference “Cryosphere - The ‘Frozen’ Frontier of Climate Science: Theory, Observations, and Practical Applications” will take place in Beijing, China from 11-15 April 2005. CliC continues to stimulate and coordinate the preparations for the International Polar Year (IPY) 2007-08 on behalf of the WCRP. The CliC SSG Chair, Dr B. Goodison, is a member of the WMO IPY Intercommission Task Group.

WCRP’s climate modelling activities are centred on two main groups: the CAS/JSC Working Group on Numerical Experimentation (WGNE) and the (WCRP) 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. The review of WGCM (as part of the wider review of CLIVAR) was generally favourable and the thirteenth session of the CLIVAR SSG noted the success of projects such as CMIP. The WGCM Climate Simulation Panel continues to oversee and coordinate collection, archival, and analysis of model data for the IPCC AR4. Nearly 250 people have registered to analyze the multi-model dataset from all over the world and about 125 are presenting results at the Workshop on Analyses of Climate Model Simulations for the IPCC AR4 to be held in Hawaii from 1-4 March 2005. It is expected that about 14 international global coupled models will ultimately be available for analysis, thanks to archiving by the Programme for Climate Model Diagnosis and Intercomparison (PCMDI). Such a large-scale coordinated model experiment and analysis has never been attempted before. The eighth session of the WGCM was held in Yokohama, Japan, 25-27 October 2004 with a half-day joint session with Global Analysis, Integration and Modelling (GAIM) of IGBP on 27 October 2004. In atmospheric modelling activities, the second phase of AMIP (AMIP-II) is coming to a close and much of the data from these runs are available for a wide range of diagnostic sub-projects. The successful international Workshop on High Resolution Regional Climate Models held from 29 March-2 April 2004 in Lund, Sweden, was jointly sponsored by WGNE and WGCM. WGNE will continue to discuss the developments in this area in its future sessions. In reanalysis activities, the ERA-40 reanalysis at ECMWF was complete and experimentation in preparation for the “interim reanalysis” had begun. The Japanese 25-year Reanalysis Project was progressing well. WGNE was also closely involved, jointly with the CAS World Weather Research Programme (WWRP), in the development of THORPEX, a ten-year international global atmospheric research and development programme under the auspices of the WMO CAS, which would have significant implications and benefits for a number of WCRP projects. In its last session, WGNE devoted a session to THORPEX, with presentations on the general background and the Science Plan and its progress and plans. WGNE noted the direct relevance of THORPEX to its activities and interests, and was impressed by the progress of several components of its plans including the Implementation Plan itself.

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

3.1 Fifty-sixth session of the WMO Executive Council

At its fifty-sixth session (Geneva, June 2004) the WMO Executive Council noted with approval the progress being made in the implementation of the WCRP and on its future scientific direction and priorities. The JSC had produced a discussion document, 'The WCRP Strategy 2005-2015: Coordinated Observation and Prediction of the Earth System (COPES)', which had been distributed to a wide range of WCRP's stakeholders, including the Council, for their information and comment. The COPES strategy had arisen from the JSC's recognition that, as WCRP approached its 25th anniversary in 2005, it faced new opportunities and challenges in addressing its two main objectives: to determine the predictability of climate and the effect of human activities on climate. The aim of COPES was 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 intention of COPES was to: provide a framework for ensuring collaboration among nations and synergy across WCRP activities; build new tools to describe and analyze climate variability and change, and their combined effects; assess why those effects were occurring; build improved and more comprehensive climate system models; make climate predictions of greater utility from weeks to centuries and on global to regional scales; and enable improved climate-change assessments for use in widespread applications. Under the framework of COPES, WCRP would set a number of specific objectives, with clear rationale for their importance and relevance and also with associated time-scales for achieving them, and milestones and metrics to map out and measure their progress. The Council noted that the challenges, opportunities, aims and specific scientific and technical problems to be addressed within COPES had much in common with those also being addressed in THORPEX. The Council therefore endorsed fully the need for close cooperation and collaboration between these two initiatives. Following the proposal of the Fourteenth Congress, May 2003, the Council was pleased that the JSC was planning special publications and meetings to celebrate the 25th anniversary of WCRP, with the prospect of a major international conference to announce COPES in 2006.

The Council welcomed specific advances in regional initiatives under the CLIVAR study, with its focus on monsoonal systems worldwide. Those advances included: preparation of an atlas of African climatology; establishment of an Indian Ocean Panel, jointly with IOC, to help drive forward the implementation of ocean observations in the region; and the successful execution of the SALLJEX (South American Low-Level Jet Experiment) field campaign, which was a major contribution to the Variability of the American Monsoon System (VAMOS) project. Major studies of the role of the oceans in climate were also being organized, in particular: variability of the thermohaline circulation in the Atlantic; dynamics and predictability of the Atlantic inter-tropical convergence zone and its regional climate influences; atmospheric forcing and upper-ocean teleconnections and feedbacks on tropical sea surface temperature; the Kuroshio extension; and, Pacific upwelling. Increased emphasis was being placed on ensuring the application of CLIVAR results. To this end, the CLIVAR Working Group on Seasonal to Interannual Prediction was leading a major preliminary initiative under COPES to determine the extent to which seasonal prediction was possible and useful in all regions of the globe with currently available models and data. The First International CLIVAR Science Conference, Baltimore, USA, June 2004, would assess progress to date and identify future challenges for CLIVAR. A major topic of the Conference was how best to deliver the knowledge, products and information brought about by CLIVAR research to end-users, decision and policy makers.

The Council noted that the Coordinated Enhanced Observing Period (CEOP), which had been initiated through GEWEX, had continued its main observation and data collection period, which started in October 2002 and would finish at the end of 2004. CEOP, in conjunction with other components of the WCRP, aimed at assessing the influence of continental heat and moisture sources and sinks on the global climate system. Data from the first CEOP enhanced observation period, July-September 2001, had already been archived at the CEOP Data Centre at the University of Tokyo, and the first composite products were available on the Internet. CEOP had been endorsed by the Integrated Global Observing Strategy Partnership (IGOS-P) as a pilot study contributing to the IGOS Integrated Global Water Cycle Observations Theme, for which WCRP was playing a leading role. It might also prove to be an instructive preliminary campaign for the emerging COPES. Another major activity, sponsored by both GEWEX and CLIVAR, was the African Monsoon Multidisciplinary Analysis (AMMA) being planned as a follow-up to, and extension of, the earlier Coupling of the Tropical Atmosphere and Hydrological Cycle (CATCH) project. The other GEWEX continental scale experiments continued to be pursued with increased coordination.

The Council reaffirmed the importance of the task undertaken by the Global Precipitation Climatology Centre (GPCC) in Offenbach, Germany, to collect rain gauge data worldwide, to develop a global climatology and to continuously monitor global precipitation on a monthly basis in the framework of

GCOS and WCRP. The Council recognized the progress made during the 15 years of operating the Centre and providing near real-time gridded datasets of monthly precipitation, and highly acknowledged the participation of 170 Members by contributing rain gauge data. The Council urged Members to continue to assist the Centre in this work, provide long-term time-series of related climate data and make available current data in a timely fashion. In this context, the Council noted with approval that a further letter from the Secretary-General to Members had recently been prepared requesting continuing support for the GPCC. A corresponding letter requesting support from Members had also been prepared with respect to the Global Runoff Data Centre in Koblenz, Germany.

The Council recognized the achievements of the WCRP Arctic Climate System Study (ACSYS), which had held a successful final science conference, "The ACSYS Decade and Beyond", at the Arctic and Antarctic Research Institute, St Petersburg, Russia, in November 2003. ACSYS had contributed significantly to our understanding of Arctic ocean circulation, the hydrological regime of the ocean basin, and sea-ice and atmospheric conditions over the northern high latitudes. The Arctic had experienced strong warming in concert with the global trend during the last three decades. The new WCRP core project, Climate and Cryosphere (CliC), was a sequel to ACSYS and aimed to systematically enhance monitoring, understanding and modelling of complex processes through which the cryosphere interacted with the global climate system. Studies had already indicated recent significant changes in the Earth's cryosphere including: record low multi-year sea-ice extent in the Arctic Ocean, with lowest levels in September 2002 and 2003; extensive melting of the Greenland ice sheet since satellite observations began in 1980; break-up of the Larsen B ice shelf in the west Antarctic peninsula in 2002; and the accelerated melting of mountainous glaciers on all continents. CliC is expected to cover several important gaps in global climate research and observations including investigation of the possibility of additional releases to the atmosphere of greenhouse gases from frozen soils. The Council noted that the first CliC Science Conference would be held in Beijing, China, 11-15 April 2005. WCRP was also contributing significantly to the planning of the International Polar Year 2007-08 in which climate research and related observations were expected to form a major part.

During the past year, the SPARC project had elaborated new strategic areas of research, namely: the detection, attribution and prediction of stratospheric changes; stratospheric chemistry-climate interactions; and stratosphere-troposphere coupling. Recent SPARC activities had been concerned with stratospheric indicators of climate change, various assessments and development of stratospheric data assimilation. An assessment of stratospheric aerosol was due to be completed in 2004. Jointly with the International Global Atmospheric Chemistry Project of the ICSU-sponsored International Geosphere-Biosphere Programme (IGBP), SPARC was supporting the development of a new system for verification of global climate models that had a comprehensive atmospheric chemistry module. Through the analysis of observations and modelling, evidence had been obtained of a significant impact of stratospheric processes on tropospheric predictability. It had been possible to use the new generation of models to reproduce the appearance of the ozone hole in the polar stratosphere. New techniques for blending data from different sources had generated a basis for new assessments of stratospheric trends including the so far unexplained positive water vapour trend in the lower stratosphere. The Council noted that chemistry-climate interactions would be the central topic of the third General Assembly of SPARC, Victoria, Canada, 1-6 August 2004, and that a further new SPARC initiative would be an assessment of polar stratospheric clouds.

The Council was informed that the closer collaboration established between the WCRP Working Group on Coupled Modelling and the GAIM element of IGBP was working well, especially in respect to the Coupled Carbon Cycle Climate Model Intercomparison Project (C4MIP). Also, the Second Coupled Model Intercomparison Project Workshop had been held in Hamburg, Germany, September 2003.The WCRP was also a strong advocate of multi-year reanalyses of the atmospheric circulation with state-of-the-art assimilation/analysis schemes; reanalyses form an important component of the sessions of the joint CAS/JSC Working Group on Numerical Experimentation (WGNE). The Council was pleased to hear, therefore, that the comprehensive, now 45-year (1957-2002), ECMWF reanalysis (ERA-40) had been completed in April 2003 and that a wide range of ERA-40 products was now available on the Internet. Also, the 25-year reanalysis (JRA-25 for 1979-2004) being conducted by the Japan Meteorological Agency in collaboration with the Central Research Institute of Electric Power Industry (Japan) was progressing well with a view to completion in 2005. WGNE had also continued to be active on a number of issues related to regional climate modelling, including, with other WCRP Working Groups, holding a Workshop on Regional Climate Modelling in Lund, Sweden in March/April 2004.

The Council noted the progress being made under the banner of the Earth System Science Partnership (ESSP), which had been initiated by WCRP, IGBP, the International Human Dimensions Programme on Global Environment Change (IHDP) and DIVERSITAS (an international programme of biodiversity science) for the integrated study of the Earth System, the changes that are occurring to the System, and the implications of those changes for global sustainability. At this early stage of its development,

the ESSP was undertaking three types of activity: joint projects; regional activities; and global change open science conferences. The first four ESSP joint projects focus on: the global carbon cycle; food systems; the global water system; and, global environmental change and human health. In each case, the goal was to identify the challenges caused by global change, understand the implications of human-driven change, and build a research agenda of direct relevance for societies. The Council encouraged WCRP to participate fully in the development and implementation of the innovative initiatives of the ESSP.

The Council welcomed the information that, at its 25th session, held in Moscow, March 2004, the JSC for the WCRP had shared a formal, joint one-day session with the Scientific Committee for the IGBP. The agreements and decisions reached jointly on that day had laid a foundation for continuing and closer future collaborations between WCRP and IGBP, both on a bilateral basis and as key members of the wider ESSP.

The JSC was pleased to note WMO's continuing strong support for WCRP and the strengthening links with other WMO programmes, including other components of the World Climate Programme, and the Atmospheric Research and Environment Programme, in particular, THORPEX.

3.2 Intergovernmental Oceanographic Commission (IOC)

IOC statement at the fifty-sixth session of the WMO Executive Council

The representative of IOC at the fifty-sixth session of the WMO Executive Council (Geneva, June 2004) expressed satisfaction with the management and the work of the WCRP, as it underwent the challenging process of defining an overall framework for future progress through the COPES strategy. The IOC supported the work of the WCRP through its support of the Ocean Observations Panel for Climate (OOPC), and had a particularly close relationship with WCRP's Climate Variability and Predictability (CLIVAR) study, which had recently started providing expertise on individual ocean basins to the OOPC. CLIVAR and the IOC were jointly sponsoring a new Indian Ocean Panel, which had its first meeting in February 2004, and was developing plans for sustained observations in that region in support of climate and monsoon research and predictability. The legacy of past WCRP projects such as the World Ocean Circulation Experiment (WOCE) had been at the base of both the growing GODAE ocean data assimilation effort and the Argo profiling float network, both of which were making important contributions to our understanding and ability to predict the oceans and climate. The IOC reaffirmed its commitment to supporting the Joint Climate Research Fund, and through IOC governing bodies would continue efforts to encourage IOC Member States to support and participate in the marine-related activities of the WCRP.

IOC support for WCRP

Bearing in mind the above IOC statement to the WMO Executive Council in June 2004, and similar statements of continuing commitment to supporting the Joint Climate Research Fund made at previous WMO Executive Councils and, in particular, at the Fourteenth World Meteorological Congress (Geneva, May 2003), it was a surprise to learn later in 2004 that significant funding problems posed a very serious threat to IOC's ability to continue to make future contributions to the Joint Climate Research Fund at the levels achieved in recent years.

The immediate outcome of initial informal discussions between WCRP's three sponsoring agencies, WMO, ICSU and IOC was a formal letter, dated 30 November 2004, from the IOC Chairman to the Presidents of both WMO and ICSU, on the subject of the WMO-ICSU-IOC Agreement on the WCRP. The purpose of this letter was to advise WMO and ICSU on recent developments in the IOC funding and how these might impact on arrangements for IOC's future input to the WCRP. It was emphasised that the IOC and its Member States recognize fully the importance of the WCRP and appreciate the excellent work being undertaken. WCRP work has been highly visible and valued by IOC Member States and IOC believes firmly that its association with WCRP should continue. Nevertheless there are aspects of the funding and future arrangements that require attention. The issue of a continuing involvement in the WCRP has been placed on the Agenda of the twenty-third session of the Assembly of IOC, to be held at UNESCO, Paris, 21-30 June 2005. The outcome is likely to have significant implications for the future funding and operation of the WCRP.

The JSC thanked Dr A. Fischer, the IOC representative, for his statement, referring to the close interaction between WCRP and IOC, especially with respect to CLIVAR activities. He also referred to the financial difficulties IOC is going through and the potential implications for IOC's continuing support of the WCRP. The JSC was pleased to note that IOC has been supportive of WCRP and appealed to its members to contact their national IOC representatives. They should explain to them the value of WCRP research and seek their support nationally and at the forthcoming IOC Assembly in June 2005.

3.3 International Council for Science (ICSU)

ICSU statement at the fifty-sixth session of the WMO Executive Council

The fifty-sixth session of the WMO Executive Council (Geneva, June 2004) was informed that ICSU was currently in the process of developing a strategy that would be presented at the ICSU 28th General Assembly, 17-21 October 2005 in Suzhou, China. One element in this strategic development was the Priority Area Assessment on Environment and its relation to Sustainable Development. In this report the responsible ICSU Assessment Panel 'commends the progress made through the WCRP in establishing the physical basis for understanding and predicting El Niño events, and the improved understanding and predictability of natural variability and human-induced climate change at the regional and global scales'. In addition, the ICSU Panel had recognized that the Earth System Science Partnership (ESSP), comprising the four ICSU-sponsored Global Environmental Change Research (GECR) programmes (i.e. DIVERSITAS, IGBP, IHDP and WCRP) was an important new development and that the joint projects being developed under ESSP were expected to provide significant results of high relevance to the science for sustainable development. However, that report also stressed that it was important to recognize that the science underpinning these joint ESSP programmes would come primarily from research conducted within the individual GECR programmes.

ICSU Strategic Plan 2006-2012

A draft ICSU Strategic Plan 2006-2012 has since been prepared by the ICSU Committee on Scientific Planning and Review (CSPR) at the request of the Executive Board and will be the focus of discussions at the 28th General Assembly in October 2005. Through three Priority Area Assessments and various other review and planning exercises, the CSPR and the Executive Board have collected many suggestions. The background documents are available at www.icsu.org. Two particular recently published background documents of interest to WCRP are:

- A Framework for the International Polar Year 2007-2008, produced by the ICSU IPY 2007-2008 Planning Group
- Scientific Data and Information, A report of the CSPR Assessment Panel

United Nations Commission on Sustainable Development

In 2006 and 2007, the UN Commission on Sustainable Development (CSD) will focus on four areas: energy for sustainable development, industrial development, air pollution/atmosphere, and climate change. At CSD-14 in 2006, governments, in consultation with Major Groups, will review the current situation in these areas in terms of sustainability. In 2007, the CSD-15 session will make policy recommendations on how to improve the situation and accelerate implementation of respective parts of the Johannesburg Plan of Implementation. ICSU has been called upon as a co-leader of the "Scientific and Technological Communities", which is one of the nine Major Groups, to provide official written input into the CSD process. More specifically, the S&T Communities will be invited to prepare a 15-page paper reviewing the state of science and technology on the above theme, as well as the obstacles to a better harnessing of science and technology by policy makers and practitioners. ICSU has asked for input from the Global Change Community to help prepare the ICSU contributions on these topics. In particular, ICSU is hoping that WCRP and IGBP will provide text on air pollution/atmosphere and climate change topics and that perhaps IHDP would do so for industrial development. Participation by DIVERSITAS would also be welcomed. ICSU has therefore asked each Programme interested in contributing to nominate a contact person who would be responsible for the input from his/her Programme.

Workshop Report on Socioeconomic Data in Relation to IGOS-P

At the request of IGOS-P, ICSU organized a meeting of socio-economic data experts in Palisades, New York, USA, in September 2004. Many of the report's recommendations are targeted at IGOS. Within this section there is special mention of the Land, the Water and (at the request of IGOS) the Coastal themes, as the top-priority themes to work with socio-economic experts. The report also recommends that IGOS-P should consider enlarging its membership to include organizations that are knowledgeable about socio-economic data, in particular IHDP. WCRP has a leading role in two of the IGOS themes: Water and the Cryosphere (see section 13.2).

The JSC was pleased to note the very strong support extended by ICSU to WCRP and particularly as expressed in the draft ICSU Strategic Plan for 2006-2012. D/WCRP was requested to liaise with ICSU on UN CSD matters.

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

4.1 Report of the COPES Task Force

Prof. B.J. Hoskins and Dr J. Church, Co-Chairs of the COPES Task Force (TF), made a joint presentation on the TF's activities to date. A revised version of the COPES discussion document taking into account additional inputs from the much wider scientific community engaged in WCRP-related research had been produced. Prof. Hoskins discussed the contents of the COPES document, its implications for WCRP and the roles of the WCRP Modelling Panel (WMP), the WCRP Observations and Assimilation Panel (WOAP), a possible WCRP Partners Board, the Specific Objectives (both existing and possible Specific Objectives for initial and later consideration) and new COPES initiatives. The Co-Chairs sought comments from the JSC and other session participants. COPES implied a re-statement of WCRP goals, called for an active role and responsibility for the JSC, and strengthened the role and responsibility of Projects, Working Groups and Panels to achieve WCRP goals. COPES further implied a commitment to an evolving structure and new panels for the WCRP. The structure and Terms of Reference of the WMP and WOAP were outlined. As for the suggested WCRP Partners Board, its purpose and scope would be to provide a direct link to WCRP user needs, advice on priorities, alignment of WCRP and operational activities, provision of resources (financial and operational – e.g. reanalysis and data centres), and enhance visibility. Its members would include the JSC Chair, representatives from WMO, IOC, ICSU, and invited representatives from key WCRP 'partners' such as, THORPEX, IPCC, Group on Earth Observations (GEO), operational weather and climate centres, satellite agencies, and other users of WCRP's outputs. Among the existing Specific Objectives, a task force on seasonal prediction had already been formed and had submitted its first report to JSC-XXV (see also section 4.2 below). Reports on the other Specific Objectives, namely, chemistry and climate, monsoons, anthropogenic climate change, sea level and data management, would be presented at the current JSC session. Possible Specific Objectives for initial consideration would attempt to: (i) gain an improved understanding of the tropical atmospheric intraseasonal oscillation and determine its predictability (with link to THORPEX), (ii) determine how modes of climate variability change in response to anthropogenic forcing (climate change associated with this is crucial), (iii) increase the accuracy in projections of sea-level rise, (iv) determine the scientific basis for, the best approaches to, and current skill of projections of regional climate change at several time-scales, and (v) focus increased attention on extreme events and their predictability. Several possible Specific Objectives for later consideration were also outlined, namely, (i) improve understanding of arid and desert climates and focus on the skill of climate predictions for them, (ii) address reasons for decadal variability of ENSO (and other modes), (iii) determine if there is a scientific answer as to what is "dangerous" anthropogenic climate change, (iv) diagnose model systematic errors and determine implications for new parameterizations, (v) produce simulations of the Holocene using general circulation models and compare with data (in cooperation with IGBP's Past Global Changes (PAGES) project, (vi) investigate and improve ability of models to simulate the diurnal cycle of tropical convection, (vii) precipitation verification, and (viii) improve understanding of multi-decadal to century time-scale natural variability and its model representation.

The JSC thanked Prof. B. Hoskins and Dr J. Church for presenting the Report of the COPES TF. The JSC suggested that in further revisions of the 'COPES document' synergy with IGBP should be highlighted and ways to facilitate the development of applications should be expressed more clearly. The JSC agreed to consider setting up a board of partners (patrons and sponsoring agencies) to consider WCRP user needs, priorities, and alignment to operational activities and resources. The JSC also accepted with gratitude a French offer to establish a WCRP/COPES 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 (see section 4.3) and WMP (see section 4.4).

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

Recognizing the importance of seasonal prediction as a specific objective under COPES, the JSC-XXIV session recommended that a limited-term Task Force on Seasonal Prediction (TFSP) be established. This task force would draw on expertise in all WCRP core projects (i.e. CLIVAR, GEWEX, CliC and SPARC), WGNE and WGCM. The overarching goal of the TFSP was to determine the extent to which seasonal prediction is possible and useful in all regions of the globe with currently available models and data.

In order to provide direct and immediate support and input to the TFSP, the International CLIVAR Project Office (ICPO) and the CLIVAR SSG asked the Working Group on Seasonal-to-Interannual Prediction (WGSIP) to take the lead in organizing a seasonal prediction workshop drawing on expertise across all the relevant WCRP activities. This took place 3-5 November 2003, University of Hawaii, Honolulu, USA. The goals and expected outcomes of the workshop included: (i) assessing the nature and level of seasonal prediction activities across the whole of WCRP: What is the current state-of-the-art in seasonal predictions? What prediction data sets are currently available? (ii) developing a strategy and working plan for determining the extent to which seasonal prediction is possible and useful in all regions of the globe with currently available models and data.

The overarching objectives of WCRP's strategic framework, COPES, include designing a comprehensive set of WCRP-wide coordinated prediction and predictability experiments with ocean-land-atmosphere models that will ultimately lead to seamless weekly-seasonal-interannual-decadal forecasts. The workshop and the creation of the TFSP were the first steps towards allowing WCRP to meet these objectives.

Assessing the Current State-of-the-Art in Seasonal Prediction

The TFSP strategy for assessing the current state-of-the-art in seasonal prediction is two-pronged and relies heavily on collaboration across many of the WCRP programme elements. First, in collaboration with WGSIP, the TFSP is in the process of cataloguing current seasonal prediction activities at both operational centres and within research groups. This assessment includes a brief description of the prediction methodology and, where available, a documentation of the forecast skill over a range of variables. Second, in collaboration with the regional CLIVAR panels (i.e. VAMOS, VACS, AAMP) and WGSIP, the TFSP is coordinating a "locally driven" skill assessment. For example, scientists participating in VAMOS activities are working with seasonal prediction groups in order to assess the skill in forecasts of interannual variability of the South American Low Level Jet. Similar activities are developing in collaboration with other regional panels.

Seasonal 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 comprehensive coupled general circulation models that include realistic interactions among the component models. The experiment is to perform six-month lead ensemble (10-member) predictions of the total climate system. If possible, longer leads and larger ensembles will be encouraged. The initialization strategy is to use the best available observations of all the components of the climate system. The initialization of the forecasts and the modelling expertise needed to complete this experiment necessarily requires collaboration and interaction across all the element of the WCRP. While the emphasis is 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 PRediction Of climate Variations On Seasonal-interannual Timescales (PROVOST) or Dynamical Seasonal Prediction (DSP) experiments would be excluded because they use observed SST as the simulation evolves, whereas the Seasonal prediction Model Intercomparison Project/ Historical Forecast Project (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 allow for a wider participation, e.g. for groups without sea-ice or vegetation model. The only firm requirement is that no "future" information is used once the prediction is initialized. This requirement means that model tuning and development using observations should be done with data taken from an independent time period (i.e. in a cross-validated way). This is also the case with any statistical model development for the possible prediction of the boundary conditions. The intent here is to mimic real forecast situations and to exclude any artificial skill. Additional numerical experiments are also proposed in order to understand and assess the predictability associated with interactions among the various elements of the climate system. For instance, the GEWEX Global Land-Atmosphere Coupling Experiment (GLACE) project is working to assess how land-atmosphere feedbacks and coupling impact seasonal predictability.

Joint TFSP-WGSIP Workshop

A second joint TFSP-WGSIP workshop was proposed to the JSC. The purpose of this workshop would be:

a. to evaluate the status of cataloguing of seasonal prediction capabilities and current skill assessment including identification of major weaknesses in forecast practices;
b. to review ongoing "regional panel" driven seasonal prediction skill assessment;
c. to develop an implementation strategy for the COPES/TFSP Seasonal Prediction Experiment.

The JSC thanked Prof. B. Kirtman, Chair, TFSP, for his report. There is a need to document available seasonal predictions. The JSC supported the TFSP workshop proposed for August 2005. The limited term of the TFSP should be reviewed at the next JSC session.

4.3 Report of the WCRP Observations and Assimilation Panel (WOAP)

In recognition of the need as expressed in the COPES strategic framework to provide a focus on and coordination of the observational aspect of WCRP's activities, JSC-XXV approved the establishment of an overseeing group, the WCRP Observations and Assimilation Panel (WOAP). The responsibilities and tasks of the WOAP will be fully complementary to, and closely interactive with, those of GCOS and GOOS and also with the corresponding observational and assimilation groups and efforts within existing WCRP projects and other activities. Its members include specified JSC members, one of whom chairs the Panel, representatives of project observational activities, the Chair of the WCRP Modelling Panel, representatives from major reanalysis centres, and possibly other experts as necessary and appropriate. The Terms of Reference (TOR) for the WOAP are:

a. to define 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 WCRP Modelling Panel;

c. to promote and coordinate WCRP information and data management activities, including development of web sites, in liaison with WCRP projects.

JSC-XXV approved that any further activities of the ad hoc WCRP Satellite Working Group should be part of the remit of the WOAP, including the need to maintain and develop further close and strong working relationships with space agencies. WOAP will report to the JSC.

Main issues for WOAP

The aims of the COPES strategic framework require research involving use of many observations of all types, including research on how the observations of important climate variables contribute to the increased information on and predictability of climate at various time and space scales. The observational issues of COPES will require the coordinated collection, analysis and reanalysis of climate observations to describe the structure and variability of the climate system. This will allow the generation of descriptions of states of the coupled climate system that are consistent with both the observations of all variables and the physical framework provided by models, both for the numerical prediction of climate and for documenting the climate record.

Special efforts will be required to obtain, analyse and assimilate data from the new generation of environmental satellites. A task under COPES is to continue to provide a coordinated WCRP input into the international process of defining the in-situ and space observing systems for the next decade required for climate studies and in particular to address the aims and objectives of WCRP, and for the implementation of the COPES strategic framework.

A commitment, in partnership with GCOS, is needed to create the comprehensive, reliable, end-to-end 'Global Climate Observational System', which will produce long-term, high quality, temporally homogeneous data sets and products. WCRP scientists have already participated in the GCOS adequacy report of 2003 and in developing the implementation plan published in 2004. Consideration needs to be given to identifying gaps and deficiencies in existing observing systems, encouraging reprocessing and reanalysis of past data to incorporate lessons from new measurements and research, and addressing other shortcomings which may have resulted in reduced skill of existing prediction schemes. Commitment is also

required for the stewardship, archival and access of data, as well as the support to enable institutions to do these tasks. A balance is needed between new observations and the need to achieve more effective exploitation of current and planned observations (especially from satellites), the latter being achieved through increased international cooperation on developing integrated analyses and products. The transition from research to operational systems is also an important practical issue. It will be a task within WOAP to work closely with GCOS to build on its plan and to specify with more precision the observations needed to improve in practice the predictability of climate at various temporal and spatial scales.

In addition to the longer-term data for climate monitoring and analysis of time-dependent variations, there is a need to collect, analyze and archive high spatial and temporal resolution data of physical variables and chemical constituents using in situ as well as remote-sensing methods. Many such data will likely be obtained for short periods from observational campaigns designed for process studies. Data from these observational components will help formulate, evaluate, and parameterize processes that go into the global models and also help validate satellite data. There may be increasing use of special observational sites and joint experiments that bring the community together in an efficient way, giving maximum opportunity for the cross-WCRP collaboration and synergy that are essential in COPES.

Under COPES, the new observational data, particularly those from the new generation of satellites, will be exploited to the maximum possible extent in pursuit of the aims and objectives of WCRP. A particular aim will be to determine what can be predicted and how it can be done. Hence, WCRP will position itself to help argue for the climate observational system that will be required in future for both assessments of the climate system and for prediction. The CEOP led by GEWEX should be viewed as an example of coordinated global observational activity in the context of COPES.

The ad hoc Group on Earth Observations (GEO) and the related Earth Observation Summits were of value to WCRP in the context of the definition of observational needs and aspirations of COPES. WCRP will continue to provide informed and comprehensive input into the succeeding intergovernmental GEO operations, which will implement the Global Earth Observation System of Systems (GEOSS). In addition, many of the observational issues of COPES will be addressed through the IGOS-Partnership and the Committee on Earth Observation Satellites (CEOS).

The first meeting of WOAP is scheduled to be held at GISS, New York, 1-3 June 2005, at the invitation of Dr W. Rossow. Topics to be covered include the ToR and the domains implied, what is and is not within WOAP purview, how it will be handled, and on what timetable. This will especially include recognition of what individual WCRP projects are already doing in the various areas and ensuring that WOAP does not interfere, but provides an overarching integrating framework for those projects. A preliminary list of areas of interest includes: satellite observations; data management; data policy (with reference to CLIVAR principles); data assimilation (drawing on expertise from CLIVAR GSOP, CliC, GEWEX, WGNE, SPARC); interface with GCOS, GOOS, Global Terrestrial Observing System (GTOS); involvement in GEOSS; reprocessing (recognizing activities in GEWEX, needs of IPCC, and the proposal of the satellite working group); reanalyses (recognizing activities in CLIVAR and WGNE; US, Japan, Europe); web developments; and, funding to support WOAP and the activities identified (workshops, meetings, etc). WOAP will focus initially on:

(i) development of global climate products covering the last 30 years, including coordinated reprocessing of all available satellite data (recommendation of former satellite WG, now taken up by WOAP, following JSC decision, and expanded on current efforts in GEWEX);
(ii) development of a WCRP data management plan, following the various initiatives already taken by some projects (cf. for example GEWEX WGDMA group and CEOP data base, the CLIVAR Data Policy). This includes strategies for web information;
(iii) clearing house for and promotion of reanalysis projects. This would entail the development of a coordinated strategy between the centres involved and the promotion of a sustained reanalysis activity for climate research and monitoring;
(iv) project on assimilation techniques for coupled ice-ocean-atmospheric models. The first step would be to make an inventory of existing initiatives concerning techniques related to sea ice, ocean, land and atmosphere;
(v) the opportunity of specific activities within WOAP around the IPY or in connection with THORPEX.

In acknowledging the report by Dr K. Trenberth, Chair, WOAP, the JSC re-affirmed that WOAP should focus on coordination of project activities and should consider forming a subgroup to deal with Data Management issues given their pan-WCRP importance. The JSC requested a formal plan of activities which would allow WOAP activities to be assessed at the next JSC session.

4.4 Report of the WCRP Modelling Panel (WMP)

The first aim of WCRP is to determine the extent to which climate (at all relevant temporal and spatial scales) can be predicted. The COPES strategy requires that the roles of atmosphere, ocean, land and cryosphere be considered in comprehensive models of the climate system, which are also capable of assimilating weather and climate observations. This will require a sustained research effort in the validation and development of climate models and data assimilation techniques. It will also require the validation of climate models through their ability to simulate past climate variations including abrupt climate changes.

While WCRP has, and will continue to have, a firm foundation in the physical climate system, it will also increasingly consider quantitative modelling of the wider Earth system. This will be done in close collaboration, in particular, with IGBP. Similarly, in order that the science addressed in WCRP should be in support of the sustainable development of societies, WCRP will need to nurture closer collaborations with IHDP and other international projects relevant to the welfare of the global society.

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, detailed models for the atmospheric chemistry and the carbon cycle, including dynamic vegetation modules and interactive marine ecosystems, are now being developed for GCMs. 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.

All WCRP core projects have modelling working groups. The need for liaison between them, and also WGNE and WGCM, is sometimes tackled by cross-attendance or even meeting together. In recognition of the central role of modelling in COPES, and the over-riding need for coordination of this activity, JSC-XXV approved the establishment of a WCRP Modelling Panel (WMP) under the Chairmanship of Prof. J. Shukla. Its prime role will be to coordinate and integrate modelling activities across WCRP with the purpose of meeting the WCRP objectives, especially in the context of COPES. Its members will include specified JSC members, the Chairs of WGNE, WGCM, WOAP and the project modelling groups, and IGBP and IHDP will each be invited to provide a representative. The draft terms of reference for the WMP are:

(i) to coordinate modelling activities across WCRP and facilitate collaborations where appropriate;

(ii) to focus on the prediction and projection aspects of COPES and effective use of coupled models for identification of climate system predictability;

(iii) to act as a focus for the development of new generation models;

(iv) to liaise closely with the WCRP Observations and Assimilation Panel (WOAP) on the requirements for and uses of observations in models (e.g. issues of data analysis, reanalysis, assimilation, model initialization, identifying observational gaps and deficiencies in relation to predictive skill and to understanding and parameterizing processes);

(v) to oversee data management in WCRP modelling activities;

(vi) to coordinate international efforts to move to a common modelling infrastructure;

(vii) to liaise with the modelling activities of IGBP, IHDP and THORPEX.

The business of the WMP should be carried out by electronic means to the greatest extent possible, but it is expected that the Panel will meet, if required, about once per year, often co-located with another WCRP meeting. The WMP will report to the JSC.

The WMP will hold joint meetings with WGNE and WGCM in alternate years. The first such meeting is scheduled to be held in Exeter, UK, in October 2005, jointly with the WGCM-9 session.

The JSC welcomed the brief statement by Dr V. Satyan on the development of the WMP, in particular the proposal to engage WGNE and WGCM by having joint meetings with each of them on alternate years. The JSC requested a formal plan of WMP activities to be assessed at the next JSC session.

5. SPECIAL TOPICS FOR JSC CONSIDERATION

At its twenty-fifth session, the JSC decided that, in the context of COPES, there should be increased focus at future JSC sessions on a few specific topics and issues each year where assessment, advice and decisions are needed from the JSC. Following this decision by JSC-XXV, this year's crosscutting topics which were presented and discussed included: monsoons, atmospheric chemistry and climate; sea-level rise; anthropogenic climate change; THORPEX; and data and information management.

5.1 WCRP Monsoon Research

WCRP monsoon research is addressed through a range of activities within both CLIVAR and GEWEX. In addition, CliC also incorporates monsoon-relevant effort, primarily on the role of the snow and ice cover over Eurasia and the Tibetan Plateau. The following account summarises CLIVAR and GEWEX activities on the monsoons as a background to JSC's discussion on WCRP monsoon research.

5.1.1 CLIVAR Monsoon Activities

Monsoon activities are a key 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 climate variability panels). The CLIVAR monsoon panels comprise:

- The Variability of the American Monsoon System (VAMOS) Panel
- The Variability of the African Climate System (VACS) Panel (covering the West African Monsoon)
- The Asian-Australian Monsoon Panel (AAMP)

The scope and primary activities of these panels in relation to the monsoons of the regions they cover are as follows:

Variability of the American Monsoon System (VAMOS) Panel

VAMOS consists of three major science components: North American Monsoon Experiment (NAME); Monsoon Experiment South America (MESA) and the VAMOS Ocean Cloud Atmosphere Land Study (VOCALS). A unified VAMOS modelling activity is being developed, involving research groups and operational climate prediction centres.

North American Monsoon Experiment (NAME)

NAME is a joint CLIVAR/GEWEX Process Study aimed at determining the sources and limits of predictability of the monsoon region of North America. NAME implementation has included an Enhanced Observing Period during June-September 2004 to provide a comprehensive one-season depiction of precipitation, circulation and surface conditions of the region. NAME also seeks to improve the ability of models to simulate monsoon evolution and variability on diurnal to seasonal timescales, and determine the monsoon response to oceanic and continental boundary conditions.

Monsoon Experiment South America (MESA)

MESA, also a joint activity between CLIVAR and GEWEX, is aimed at providing better understanding, simulation and prediction of the South American monsoon system and its variability. The first MESA target was the South American Low Level Jet (SALLJ). The SALLJ field experiment (SALLJEX), held during the (southern) summer of 2002/3, gathered a unique dataset that is currently being evaluated and analysed. In addition, the data are being used for validation and sensitivity studies with numerical models. 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 is a Continental Scale Experiment again with joint involvement of GEWEX and CLIVAR. VAMOS is also a player in the Global Environment Facility (GEF) Framework Program for the La Platin Basin (LPB). The approved GEF funding is to support the planning and implementation of strategic actions to be taken by the governments of countries in LPB for the environmentally and socially sustainable economic development of the basin. Areas specifically targeted are protection and integrated management of water resources and adaptation to climate change and variability.

VAMOS Ocean Cloud Atmosphere Land Study (VOCALS)

VOCALS provides an oceanic component of VAMOS relevant to the subsiding portion of the monsoon circulation. It is a follow-on of the Eastern Pacific Investigation of Climate (EPIC) 2001. It addresses the feedbacks between stratocumulus clouds, surface winds, upwelling, coastal currents and SST in the eastern Pacific, and the feedbacks of the cloud-topped boundary layer properties on the overall tropical circulation and ENSO. Plans for a VOCALS field campaign are at an advanced stage of development.

Variability of the African Monsoon System (VACS) Panel

The key VACS activity in relation to the monsoons is through the African Monsoon Multidisciplinary Analysis (AMMA) programme, which is jointly sponsored by CLIVAR and GEWEX. AMMA aims to improve our understanding of the West African Monsoon (WAM) and its variability with an emphasis on daily to interannual timescales. Societal need for improved prediction of the WAM is a key motivation for AMMA. AMMA objectives will be 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 will establish enhanced observations over the land, building on the existing surface hydrological measurements available through the GEWEX Coupling of the Tropical Atmosphere and Hydrological Cycle (CATCH) project, and over the ocean (in collaboration with CLIVAR's Atlantic Panel). Scientists from more than 25 institutions in 15 countries in Africa, Europe and USA are working to plan and contribute to AMMA.

Asian-Australian Monsoon Panel (AAMP)

A particular focus of AAMP is on improving capabilities to provide skilful seasonal predictions of monsoon activity and the use of monsoon predictions in applications. The Madden-Julian Oscillation (MJO) and its association with monsoon active/break cycles have been a focal activity and the skill of atmosphere-only and coupled climate models in simulating the mean monsoons and their variability has been examined in intercomparison experiments (the AMIP Monsoon Modelling Intercomparison Project in particular). An Indian Ocean Panel has been established to prepare an implementation plan for sustained observations over the Indian Ocean. The overall focus of AAMP to date has largely been on the Indian monsoon and Indian Ocean region.

5.1.2 GEWEX Monsoon Activities

The GEWEX focus on monsoons arises from its goal of predicting precipitation and hydrological responses over all land areas including monsoon areas. Since monsoons are significant in a number of areas of the world they have been a central focus or a least a priority in a number of GEWEX projects, including four of the GEWEX Continental Scale Experiments. In addition, the GEWEX focus on observing high resolution climate variability and modelling the role of land as part of the fast response of climate have made monsoons an important part of the GEWEX research agenda. 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. Through the GEWEX Radiation Panel, GEWEX has developed long term data sets of cloud and precipitation distributions which are critical for understanding the extent of monsoon processes, especially over the ocean where satellites are a primary source of data.

The overall objective of the CEOP monsoon initiative is 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 for reliable quantitative descriptions of the multi-scale energy and water cycle processes of the monsoon systems, their interactions with conditions at the Earth 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-Australian monsoon, (2) North American monsoon. (3) South American monsoon, and (4) West African monsoon.

Research on monsoons has led to:

- Results showing the importance of the afternoon land heating associated with the North American Monsoon Gulf of California's low-level jet (LLJ) in the pattern of moisture flux changes paralleling the Sierra Madre mountain range and its link to the onset of monsoon rain in the US Southwest.

- Results on the completion of the GEWEX Asian Monsoon Experiment (GAME) have shown the role of the Tibetan Plateau and various feedbacks between land and atmosphere in the monsoon circulation.
- Studies through the GEWEX GLACE (joint with CLIVAR WGSIP) project have shown that the areas where soil moisture has an influence on the predictability of precipitation in areas where the regions are dry part of the time and moist part of the time. The areas where soil moisture effects are most significant include southwestern Africa, the area of the USA north of the Gulf of Mexico and central India.

Other monsoon-related activities included:

- September 2004: GEWEX/CEOP Inter-Monsoon Study (CIMS) Workshop on the Americas Monsoon System Study, in Montevideo.
- Completion of the NAME field experiment (jointly with CLIVAR) in the summer of 2004 and the collection of collaborative GAPP/ Pan American Climate Studies Program (PACS) data sets that are being used in model evaluation and development.
- Completion of CEOP Phase I and the archiving of data sets and the preparation of data sets for use in model studies including monsoon studies.
- Final GAME science conference held in December 2004, Kyoto, Japan. A special journal issue is planned to include presentations made at this meeting.

New GEWEX activities related to monsoons include:

- A diurnal cycle crosscutting activity that will involve WGNE and all components of GEWEX.
- Planning for a GAME follow-on experiment and the second phase of CEOP, which will also have a strong monsoon component.
- The launch of a Landflux effort that will derive land-atmosphere interactions from satellite data. These data sets would be useful in assessing the relative importance of land-atmosphere interactions in different areas.

5.1.3 Coordination activities since JSC-XXV

A number of coordination activities between GEWEX and CLIVAR have taken place since JSC-XXV. In response to the concern that CIMS as yet did not include the full and proper input and participation of CLIVAR's AAMP, JSC-XXV reiterated a request that CLIVAR and GEWEX review their monsoon-related activities with a view to achieving better coordination, reducing the number of monsoon-related panels and developing a pan-WCRP monsoon modelling strategy. The JSC further requested that particular attention be given to the requirements and actions needed in connection with the Asian-Australian monsoon.

In response to these requests, Prof. T. Yasunari convened a meeting of CLIVAR and GEWEX experts involved in WCRP monsoon activities in Baltimore in association with, and just prior to, the CLIVAR Conference. The outcomes of the meeting were discussed a few days later at a follow-up meeting of the CLIVAR and GEWEX Chairs and IPO Directors. The meeting, aimed at examining the crosscutting issues between CLIVAR and GEWEX, reviewed:

(i) past interactions and communication problems;

(ii) the need for an overarching activity for studies of the southeast or east Asian monsoon (as carried out in GAME under GEWEX) and the Indian (or south Asian) monsoon;

(iii) the range of overall scientific issues relating to monsoons, the need for greater coordination and the previously-proposed pan-WCRP Workshop on monsoons as an aid to development of a pan-WCRP monsoon modelling strategy.

Three particular outcomes have emerged in response to these discussions:

Firstly, to aid communication in the future, the need for a monsoon calendar as a means of sharing information was identified. Such a facility has been subsequently developed on the web by the International Pacific Research Center, Hawaii, USA, under the guidance of Prof. Bin Wang (now a CLIVAR AAMP Co-Chair) and at the request of the CLIVAR SSG. It can be found at:
http://iprc.soest.Hawaii.edu/meetings/monsooncal.html.

Secondly, as an outcome of the CLIVAR assessment, the CLIVAR SSG-13 formed a Task Force, led by Prof. Wang, to develop a strategy for collaboration with GEWEX on the Asian-Australian monsoon. The Task Force examined the Indian Monsoon focus of AAMP to date, recognising the considerable success that AAMP has had in this area. It also looked however to the needs for:

- Enhanced East-Asian-Western North Pacific monsoon activity
- Integrated regional modelling activity between GEWEX and CLIVAR
- Coordinated GCM and CGCM studies
- Diagnostic regional analysis of global datasets
- Intra-seasonal Oscillations (ISOs) prediction
- Climate change and the A-A monsoons.
- The linkage between AAMP and the START Monsoon-Asia Integrated Regional Study (MAIRS)

In order to facilitate improved CLIVAR/GEWEX links in work on the Asian-Australian monsoon region, the Task Force recommended implementing an expansion of AAMP activities and a revised membership for the AAMP to allow improved interaction between CLIVAR and GEWEX and a strengthening of the linkage to MAIRS. This has since been implemented.

Thirdly, arrangements for the proposed pan-WCRP "Workshop on the Monsoon Climate Systems – towards better prediction of the monsoons" have been developed through a joint CLIVAR/GEWEX Scientific Organising Committee (SOC), co-chaired by Prof. T. Yasunari and Dr K. Sperber and assisted by the ICPO and the IGPO. There has been wide-ranging debate within the SOC on the structure of the workshop and its participants, reflected in the programme for the workshop. The workshop will be held in Irvine, California, from 15-17 June 2005, just prior to the 5th International GEWEX Science Conference.

It is clear that there is already much ongoing coordination and cooperation between GEWEX and CLIVAR on the American and West African monsoons, that this is working satisfactorily and with good communication between the two projects overall, aided by the mutual attendance of Professors Sorooshian and Busalacchi at the CLIVAR and GEWEX SSGs respectively. Since the JSC last met there have been efforts aimed at improved cooperation on the Asian-Australian monsoon, not least through a revision of the scope and membership of CLIVAR's AAMP. AAMP is expected to have its first meeting in its new configuration in association with the pan-WCRP monsoon workshop in June 2005. One area that remains to be addressed is the relationship with CliC activities on the role of snow and ice cover over Eurasia and the Tibetan Plateau.

In the collaboration between GEWEX and CLIVAR, the GEWEX focus is largely on the representation of processes related to land-atmosphere and cloud interactions, the diurnal cycle and, especially in relation to modelling, development of new parameterizations. Key for GEWEX is also the role of the water and energy budget in monsoon circulations and the predictability arising from the land surface. Regional and global modelling, predictability studies, ocean-atmosphere coupling, the role of Intra-seasonal Oscillations (ISOs) and understanding the fully coupled monsoon system and its context in global climate and climate change all provide key foci for CLIVAR. There is therefore a complementarity in the activities of these two projects in the monsoon area (and with CliC) but there is also a mutual interdependence. Progress will therefore come through the combination of GEWEX and CLIVAR studies and the contributions that both can most effectively make to COPES and to the pan-WCRP monsoon activities arising from GEWEX, CEOP and CLIVAR collaboration. It is important that the planned workshop between the GEWEX, CEOP and CLIVAR monsoon communities in Irvine in June 2005 helps in clarifying how best to move forward with the overall approach to a pan-WCRP modelling effort in this area.

The JSC welcomed the joint CLIVAR/GEWEX document on WCRP monsoon research. As regards CLIVAR monsoon activities, the JSC was pleased with the work done in Africa and America; some progress was also noted concerning the Asian-Australian Monsoon. The JSC requested that the 1st 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. The JSC also noted that the East African monsoon had still to be addressed.

5.2 Atmospheric Chemistry and Climate

Chemically active species contribute significantly to the radiative forcing of the atmosphere, with the combined forcing due to reactive greenhouse gases being equal to that of the industrial CO_2. The contributions of ozone and aerosols are highly significant, with aerosols potentially contributing to the global forcing as much as CO_2, but in opposite direction. However, these forcings do not offset each other everywhere, and regionally the forcing by short-lived species may outweigh those due to longer-lived "globally" important agents such as CO_2. Lastly, it is precisely ozone and aerosols that have direct impact on society through their role in air quality and thus, greatly depend on climate change.

The short-lived species pose a different set of issues than the longer-lived climate forcing agents. The short lifetimes inherently lead to a high degree of spatial and temporal variability- the shorter the lifetime, the more the variability. Therefore, the abundances and, hence, the influence of short-lived agents cannot be extracted from atmospheric observations alone - it demands understanding of the processes that control the rates of production, removal, and transport of the species and their precursors. The emphasis on short-lived agents comes about because they are to a high degree anthropogenically influenced, and will lead to a quick response in the climate if some action is taken; for example, if all the aerosols and their precursors are curtailed, the atmosphere will get rid of these aerosols within a matter of weeks! To a first approximation, the key questions related to climate with regards to chemically reactive species are:

- How long does a radiatively important molecule stay in the atmosphere after it is introduced into the atmosphere?
- How does the presence and reactions of this molecule in the atmosphere alter the composition of the atmosphere and, hence, impact climate?
- How does the chemically active species alter the properties and contributions of other chemicals and aerosols to climate?

The processes that determine the answers to the above questions are highly dependent on two key climate variables - temperature and water vapour abundance. Thus, climate change directly affects the composition.

Atmospheric chemistry is also important because it is one of the venues for feedbacks in the climate system. One of the ways all the forcings, with the possible exception of CO_2, feedback on each other is through chemical transformations. For example, changes in tropospheric ozone will alter the levels of OH in the atmosphere and change the abundance of methane, a greenhouse gas. Alterations in the OH radical abundance can alter the production and properties of aerosols. Production of certain chemicals in the atmosphere through the interactions of aerosols and ozone can alter the cloud nucleating properties of the aerosols and, hence, the aerosol-cloud interactions with large potential influence on the radiative balance.

It is important to recognize that the chemically active agents in the climate issue are also the primary chemically active concerns in air quality. Tropospheric ozone and aerosols are important for human health, visibility, corrosion, and other impacts. Conversely, the "pollution" of aerosols (and its precursors), urban emissions that lead to ozone, and the ozone from a given region are major contributors to the global scale climate forcing by tropospheric ozone and aerosols. Thus, there is a clear link between air pollution and climate change - increased air pollution will lead to larger climate forcing. So, for example, the growth of developing nations will lead to not only more air pollution, but also climate forcing.

Changes in the Earth's climate due to natural and anthropogenic changes will affect the levels of pollution in a region as well as distribution of this pollution to other regions. A classic case is the increased water vapour in some regions due to El Niño, and the associated changes in ozone. This intricate link between air pollution and climate is a key issue for society. In many cases, it can lead to what one would consider the "win-win" strategy where actions taken to influence air pollution will also have climate impact. For example, action taken to enhance local visibility and decrease health impacts by reducing aerosols would reduce the climate forcing by aerosols.

Therefore, what is needed for a fuller evaluation of the role of chemistry in climate science is the understanding and quantification of processes that transform chemicals in the atmosphere, quantification of the emission and removal (deposition) processes, and the transport of the species in the various parts of the atmosphere. To a first order, the major uncertainties in atmospheric chemistry involve the following:

(i) rates of chemical transformations that lead to production and removal of tropospheric ozone and aerosols;

(ii) transport of species from local to regional to global scales and extent of mixing during this transport;
(iii) inventories and distributions of natural and anthropogenic emissions;
(iv) rates of deposition processes;
(v) quantification of sub grid-scale processes (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.

From the above discussion, it is clear that the major shortcoming in the WCRP is the absence of a project dealing with the troposphere. The majority of the climate forcing by gases and aerosols takes place in the troposphere and WCRP does not have a project to address the chemistry in this region. There are, however, some major areas of expertise (and long history) in WCRP that can be developed to make major contributions to the atmospheric chemistry-climate issue:

- SPARC already provides a very strong programme on stratospheric ozone and stratospheric aerosols - both of which force the climate at higher altitudes. Changes in stratospheric ozone and aerosols impact UV levels as well as temperature in the troposphere. The interaction between the stratosphere and the troposphere is an emerging issue in SPARC. Further, because of the influence of the troposphere on the stratosphere (e.g., source gases, water, etc. coming from the troposphere to the stratosphere), SPARC has always paid some attention to tropospheric chemistry. In addition, the new activity of Coupled Climate-Chemistry model intercomparisons will provide valuable information and these modelling efforts can be extended to include more tropospheric chemistry.
- The strength of WCRP in atmospheric dynamics and meteorology is a major asset. This provides a path for addressing chemical data assimilation and transport issues. Stronger ties with WGNE is an obvious pathway here. Further, projects such as chemical weather forecasting will fit into the seamless prediction of chemical information also.
- The microphysics aspects that are so crucial to tropospheric chemistry are a major component of GEWEX and can be expanded to include transport of other reactive, non-reactive, soluble, and insoluble gases through convection.
- The Surface Ocean - Lower Atmosphere Study (SOLAS) and the Working Group on Surface Fluxes (WGSF) can play a critical role defining the air-sea fluxes and deposition processes.

There are some areas that are best addressed through collaboration with programmes such as IGBP. In this respect, the collaboration of SPARC with IGBP's International Global Atmospheric Chemistry (IGAC) is to be encouraged and will provide a good venue for addressing chemical transformation issues. There are some issues such as emission inventories that are best left to programmes that are already addressing them. However, the chemical data assimilation and other such activities could help these projects. Consideration should also be given to the value of collaborations with the Ocean-Atmosphere-Sea Ice-Snowpack (OASIS) and Air-Ice Chemical Interactions (AICI) initiatives.

A suggested way forward would be to form a small group from WCRP, IGBP and IHDP to formulate a good cooperation strategy for the future. This would also help formulate a coordinated effort towards Earth System modelling and coordinated Earth Observations (e.g., in GEOSS).

In thanking Prof. A. O'Neill for his presentation, the JSC reaffirmed the importance of atmospheric chemistry and climate issues to WCRP's objectives and stressed the need for developing a 'roadmap' for chemistry-climate models, observations and process studies. For this purpose, the JSC proposed the establishment of a Joint WCRP-IGBP Task Force (TF) involving WCRP core projects and working groups and IGBP's IGAC as the core-organizers. This TF should establish a 'roadmap' describing the needs for future research in this area, and specifically the ways to better include chemical/aerosol processes into climate models. It was recalled that a first, successful joint SPARC-IGAC Workshop on Climate-Chemistry Interactions had been held in Giens, France, 3-6 April 2003. A second such workshop with broader representation of the scientific community could be envisaged to define the content of the required 'roadmap'. IPCC and IHDP should be kept informed.

5.3 Sea-level Rise

Following discussions at JSC-XXV in Moscow and subsequent discussions as part of the COPES Task Force, it was proposed to hold a sea-level workshop to bring together all relevant WCRP science with a view to identifying uncertainties and research and observational activities for narrowing these uncertainties. The workshop would require contributions from CLIVAR (ocean thermal expansion), CliC (glacier and ice

sheet contributions), GEWEX (terrestrial water storage) and WGCM (coupled climate modelling). IGBP and the ESSP/GWSP might also have useful contributions to make.

Workshop on Sea-level Rise.

Dr J. Church briefed the JSC on the progress towards organization of this workshop. Given the present and projected future rates of global sea-level rise, and the associated variability ranging from long timescales (i.e., decades to centuries, e.g., due to climate change) to short timescales (i.e., hourly to daily, e.g., due to storm surges), the workshop would:

- Identify the factors contributing to the observed sea-level rise and variability, as well as that projected in the future.
- Organize a systematic attack on the error budget:
    - Identify the major sources of uncertainty for each,
    - What can be done to reduce each of these uncertainties?
- In order to reduce the error budget, identify associated requirements for:
    - New and/or augmented research,
    - New and/or augmented technical development, and
    - The collection of sustained, systematic observations.

The major output from the workshop would be a WCRP report summarizing the current state of the science, an outline of future research requirements for improving our understanding of sea-level rise and variability and a description of the observational requirements (both experimental and sustained systematic observations). There would be careful consideration of uncertainties. The report would contain sections on requirements for improving present estimates and future projections of:

- sea-level rise and variability,
- ocean thermal expansion,
- non-polar glacier contributions,
- ice sheet contributions,
- vertical motion due to glacial isostatic adjustments and tectonic motions,
- terrestrial (including anthropogenic) water storage contributions,
- changes in the frequency/intensity of extreme events, and
- changes in surface waves, ocean swell, etc.

The report should also address whether current programmes adequately cover the requirements and what additional efforts may be necessary. The report should consider traditional observational techniques (e.g. tide gauges) as well as recent observational techniques (e.g., radar and laser altimetry, satellite gravimetry). Included as appendices would be the one-page abstracts of the invited overview presentations. The presentations and conference posters would be available at a WWW site.

The full report would be accompanied by a thinner more attractive report, which could be used for justifying research and observational programmes.

The report would be different from the forthcoming IPCC Assessment Report, in that it would not contain projections of future changes. It would contain a greater focus on science and observational requirements, including uncertainties identified during the workshop and by IPCC. The starting point for the workshop would be the current IPCC uncertainties and the report would address how the uncertainties could be addressed for any future IPCC Assessments beyond the AR4.

It is proposed to hold a four-day workshop at UNESCO/IOC in Paris with local organizing by the Global Sea-Level Observing System (GLOSS) Office and with support from the WCRP/COPES Support Unit in Paris. ICSU is also based in Paris and their involvement could be helpful.

The JSC gave strong support to Dr. J. Church for his report and, in particular, his proposal for a sea-level rise workshop as outlined in his document (and above). The JSC was also pleased to note the intention to seek START's support to attract participants from developing countries to the workshop.

5.4 Anthropogenic Climate Change (ACC)

The topic of ACC forms one of the three streams of CLIVAR. Two principal research areas are identified under it:

- Climate change prediction
- 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). The prime focus of work on climate change detection is through the work of the joint WMO Commission for Climatology (CCl)/CLIVAR 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, a role that the ETCCDMI is working towards in respect of the Fourth IPCC Assessment (AR4). In addition, CLIVAR/PAGES has made a contribution through its past workshop with IPCC on drought.

As input to the JSC discussion on ACC, this account briefly summarises the key activities of WGCM, WGOMD and ETCCDMI. It also considers the outcomes of the review of CLIVAR ACC efforts to date carried out as part of the CLIVAR assessment (CLIVAR SSG-13, Baltimore, USA, 27-29 June 2004).

WGCM Activities

Current WGCM activities are summarised in detail in section 10.2. These include:

- The Coupled Model Intercomparison Experiment (CMIP) under which the WGCM has set up a Climate Simulation Panel to oversee and coordinate collection, archival and analysis of model data for IPCC AR4. US CLIVAR sponsored an international Workshop on Analyses of Climate Model Simulations for the IPCC AR4, which was held at the International Pacific Research Center, University of Hawaii, 1-4 March 2005. Other CMIP activities (CMIP2+) are ongoing and CMIP subprojects and publications will contribute significantly to IPCC AR4.
- The international Cloud Feedback Model Intercomparison (CFMIP) Project
- Development and use of climate forcings
- Aspects of decadal variability
- Coordinated experiments on thermohaline circulation response to increasing greenhouse gases
- Interaction with the Palaeoclimate Modelling Intercomparsion Experiment and IGBP GAIM.

WGOMD Activities

These have largely revolved 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 have been 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)“ has emerged.

CLIVAR’s basin panels are seeking to encourage comparison of models forced by interannually varying, as opposed to climatological average, data in collaboration with WGOMD. Additionally, a CLIVAR workshop on Atlantic Thermohaline Variability with emphasis on synthesis was co-sponsored by CLIVAR’s Atlantic Panel and WGOMD (Kiel, Germany, 13-16 September 2004). (See also section 10.2)

ETCCDMI Activities

Over the past year, these have centred on 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
- Brazil, 9-14 August 2004, for South America
- Turkey, 4-9 October 2004, for southwest Asia
- Guatemala, 8-12 November 2004, for Central America
- India, 14-19 February 2005, for southern Asia.

These workshops, which build on earlier such events, 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. Standard software was

developed for use in the workshops. This is being distributed to provide a basis for further development of user applications. Peer reviewed papers resulting from the workshops are intended to provide input to the IPCC AR4.

Other ETCCDMI activities encompass development and publication of indices and indicators of climate variability and change and input on these to IPCC and others (most recently the ET has worked to develop a document on suggested large–scale oceanic and marine climate indices for monitoring and detection). 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/.

An issue for the ET is that the CCl mandate ends in November 2005 when the full CCl (member states) meet in Beijing. The ET recommends that WCRP and CCl consider:

a. giving the ET a long-term mandate in the observational aspects of climate change with a slightly expanded membership;
b. agreeing to the proposal that the ET would share with WGCM the mandate to understand and interpret the observational information; and
c. WCRP and CCl provide resources so that the ET may meet on a biennial basis, sometimes co-located with WGCM.

CLIVAR assessment of its ACC activities and SSG responses

The background to the CLIVAR assessment is provided in section 6.2. The review recognised the key and highly successful work of WGCM in promoting multi-model projections of climate change (through the CMIP project in particular). In this way, as noted above, WGCM is the primary structure by which WCRP supports the IPCC process, though the ETCCDMI is also playing an increasing role. The review also recognised that WGCM has taken the lead on trying to answer fundamental questions concerning, for example, the physical factors which determine the sensitivity of climate to increased anthropogenic forcing, focussing on cloud and other feedback processes.

On the other hand, although CLIVAR scientists were seen to contribute heavily to the IPCC assessment process, CLIVAR itself did not seem to have much visibility in the study of ACC overall. Given that ACC was a major element of CLIVAR, assessors felt strongly that both ACC and the anthropogenic modification of natural variability should receive the same emphasis as the other themes, which was not currently the case. Part of this may be a lack of perception in the outside world that WGCM activities are a part of CLIVAR as well as of WCRP more widely. On the other hand, the links between the CLIVAR SSG and WGCM are not strong. There was considerable discussion as to whether the current arrangement of joint JSC and CLIVAR sponsorship of WGCM was the best. Concern was expressed that as the WGCM increased the complexity of its models, it would be even less likely that time would be devoted to analysis of seasonal, interannual or decadal variability, an area which was of key CLIVAR concern. To help consolidate the interactions on these issues between CLIVAR overall and WGCM, Dr G. Meehl had agreed to act as CLIVAR vice-chair of WGCM.

As also noted in section 6.2.2, the SSG agreed to highlight and focus more clearly on four major themes for the whole of the programme, one of which is ACC. To realise this renewed emphasis, all CLIVAR panels and working groups will be asked to report on their contributions in these four major areas, including ACC, at each SSG meeting, and the SSG will produce an annual report on overall CLIVAR progress organized around these themes. In addition, the SSG will organize annual workshops on one of the four major themes to determine the state of the art and outstanding questions and issues. Two relevant workshops were planned for 2005: one of which, as noted above, was the US CLIVAR-sponsored international IPCC model analysis workshop which took place at IPRC, University of Hawaii, 1-4 March. In addition to the present ACC presence on the CLIVAR SSG (Prof. J. Mitchell already has ex officio membership as Chair of WGCM; Dr T. Tokioka is head of global warming research at the Japanese Frontier Research Institute and Dr T. Palmer was an IPCC lead author on the last assessment and is a member of the scoping panel and reviewer of the current IPCC assessment), efforts are being made to further strengthen the ACC representation. This will be aided in particular by the addition of Dr B. McAvaney to the SSG membership.

In order to contribute more effectively to the effort to monitor both natural variability and anthropogenic climate change, the SSG also requested that all panels consider what indices would be most useful for ongoing monitoring of the climate system. The CLIVAR web site should contain a summary of the state of the climate system that would include these indices. These would be communicated to the

CCl/CLIVAR ETCCDMI, the Ocean Observations Panel for Climate (OOPC) and other relevant groups for implementation.

The SSG further recommended that WGSIP should become involved in analysis of the seasonal to interannual variability aspects of CMIP 3 and IPCC runs. In addition, the SSG asked all CLIVAR panels to organize assessments of global prediction products (seasonal and ACC), promoting, both within the scope of the panels and beyond, diagnostic analysis of these global datasets at the regional level. The analysis could be addressed at quantifying and understanding regional predictability of seasonal climate variability or longer-term climate change, or at the error characteristics of the current generation of climate models to simulate regional climate variations on different timescales. This request has since been followed up by a letter from the SSG Chairs and an article in CLIVAR Exchanges and is forming one of the foci for WGSIP and a number of the CLIVAR regional panels in a seasonal context. This needs to be backed up by a similar activity between the panels and WGCM, possibly through the medium of diagnostic sub-project initiatives.

The JSC noted that the ACC issue overarches all WCRP projects, observation and modelling. The JSC decided to make an inventory of ACC activities, existing and future ones, both from WCRP and IGBP. A 'roadmap' for ACC would be coordinated on WCRP's side by the JSC Officers and should be brought to the next JSC Officers, Chairs and Directors meeting.

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. It was recognised, however, that attention was needed to improve communications between WGCM and the other activities of WCRP. The responsibility for ensuring such communication rested with JSC, WMP, the projects and WGCM.

5.5 Collaboration with THORPEX

Dr M. Shapiro gave a presentation of THORPEX. The World Meteorological Congress in 2003 established THORPEX as a part of the World Weather Research Programme (WWRP) under the auspices of the WMO Commission for Atmospheric Sciences (CAS) (www.wmo.int/thorpex). The CAS International Core Steering Committee (ICSC) leads THORPEX in coordination with the WMO Commission for Basic Systems (CBS), JSC/WCRP, and WGNE and in cooperation with ECMWF, EUMETNET, and the Coordination Group for Meteorological Satellites (CGMS). ICSC comprises senior representatives of 14 nations (Heads of National Meteorological Services and research, organisational and institutional representatives). JSC is represented by Prof. J. Shukla. THORPEX has also established open Regional Committees (for North America, Europe, Asia) aligned with WMO Regional Associations, and a Trust Fund and an International Programme Office in the WMO Secretariat.

The fifty-sixth session (June 2004) of the WMO Executive Council (see section 3.1) noted that the challenges, opportunities, aims and specific scientific and technical problems to be addressed under the WCRP strategic framework, COPES, had much in common with those also being addressed in THORPEX. The Council therefore endorsed fully the need for close cooperation and collaboration between these two initiatives.

THORPEX aims to accelerate improvements in short-, medium- and extended-range (up to two weeks) weather predictions and to demonstrate the social value of advanced forecast products. The THORPEX International Science Plan (www.wmo.int/thorpex/mission.html) defines four main research topics: global-to-regional influences on the evolution and predictability of weather systems; global observing system design and demonstration; multi-model ensemble predictions, targeting and assimilation of observations; and social and economic benefits of improved weather forecasts. Version 3 of the plan is currently under a peer review process.

The THORPEX International Research Implementation Plan (TIP) for 2005-2014 (Version 1) (www.wmo.int/thorpex/implementation.html) was approved by the ICSC in December 2004. TIP had been developed by a group of experts from different disciplines and in close collaboration with the WCRP, WMO Programmes such as WWW, Data Management Practices (DMP), Space Programme, Public Weather Services (PWS), Hydrology and Water Resources Programme (HWR), and other international institutions and initiatives, such as IOC/UNESCO, ECMWF, CGMS, GEO/GEOSS, IPY and AMMA.

WGNE-20 (Exeter, UK, October 2004) appreciated the proposed THORPEX linkages between weather and climate and the opportunities to engage this problem for the benefit of all longer time-scale modelling efforts, including climate. See section 10.1.5 for details.

The CAS Advisory Working Group (AWG) (Geneva, 31 January - 1 February 2005) agreed that THORPEX should play a major role in partnering with the climate forecast community. It is anticipated that within a decade, the current distinction between weather and climate prediction will transition into unified weather-climate prediction, leading to a seamless suite of forecast products applicable on all relevant decision-making time and space scales. Progress in the development of a unified global weather/climate prediction system to improve forecast skill on time ranges from days to centuries would benefit from collaboration between THORPEX and WCRP. The CAS AWG emphasized the importance of close cooperation with WCRP particularly recognising the aspirations embodied in its new strategic framework, COPES.

THORPEX/WCRP collaborative research

Dr Shapiro introduced some specific research topics that could bridge the gap between weather and climate forecasting activities in terms of scientific understanding of the processes involved, and thereby fostering a closer collaboration among scientists working on the oceanic, land, and atmospheric processes. Work on physical parameterization schemes represents one of the areas with strong common interest for weather and climate forecasting. The following are examples of such potential research topics for collaboration:

- The influence of inter-annual and sub-seasonal climate oscillations on high-impact weather and its prediction
- The influence of flow regimes on the climatology of forecast skill
- Organised tropical convection and its influence on global forecast skill
- Improving the skill of climate and global weather prediction systems
- The Global Observing System
- Coordinated field campaigns
- Develop user application methods viable at all lead-times
- Demonstrate joint weather-climate forecast applications

The JSC was invited to consider Dr Shapiro's proposals and to provide guidance and recommendations for collaborative research, including joint activities and exchange of experts to liaise with, and to participate in the JSC and ICSC respective working bodies. In particular, Professors B. Hoskins and J. Shukla were invited to serve in the ICSC Science Advisory Board. ICSC core working groups deal with: Predictability Dynamical Processes, Observing Systems, Data Assimilation and Observing Strategies, Societal and Economic Applications, and also the THORPEX Interactive Grand Global Ensemble and Data Policy and Management. The THORPEX International Implementation Plan is an evolving document and the JSC was invited to contribute to its further development.

The JSC thanked Dr Shapiro for his presentation on THORPEX, which included a list of possible areas for fruitful collaboration between WCRP and THORPEX. In particular, the JSC responded positively to his proposal that the phenomenon of Tropical Convective Organization (TCO) affecting 1-2 week weather prediction (e.g. MJO, diurnal cycle of convection) could be an early target. The JSC recommended that, for this purpose, the TFSP should include a THORPEX representative. The JSC suggested that WGCM closely interact with THORPEX. The interaction of WGNE with THORPEX was ongoing. The JSC also recommended that WGCM should interact closely with THORPEX, and that WGSIP should get involved in the Demonstration System that THORPEX was planning for 2008-09. The interaction of WGNE with THORPEX was ongoing. JSC also encouraged all WCRP projects and activities to consider ways of establishing links with THORPEX. This should be initiated by the Director, WCRP based on the THORPEX document and Dr Shapiro's proposals.

5.6 Data and Information Management

The JSC, recognizing the importance of the Data Management issue across WCRP, suggested that the WOAP should form a subgroup for dealing with Data Management issues. See also section 4.3.

5.7 Special topics for future JSC consideration

The JSC discussed possible specific topics for consideration at its next session. These included:

- Monsoons (workshop report and the 'roadmap' for future course of action);
- Atmospheric Chemistry and Climate (in collaboration with IGBP);
- Anthropogenic Climate Change (including an inventory of WCRP activities related to ACC);
- Water-cycle research (including the relationships between GEWEX and GWSP); and
- Extreme Events and their importance in the climate system.

Such topics would be considered at the next JSC Officers, Chairs and Directors meeting.

6. CLIMATE VARIABILITY AND PREDICTABILITY (CLIVAR)

Dr A. Busalacchi, Co-Chair of the CLIVAR Scientific Steering Group (SSG) made a presentation on the status of CLIVAR. The past year has been an important one for CLIVAR. The highlight was the holding during the year of the First International CLIVAR Science Conference and the associated assessment of progress with CLIVAR since the International CLIVAR Conference (Paris, France, 2-4 December 1998). Over the year, CLIVAR panels have continued to develop their activities, although as a result of the assessment, some have been reflecting on new Terms of Reference and membership. The assessment brought some calls for a radical change to programme structure and organization but, in general, assessors recommended an evolutionary rather than revolutionary path so as not to impede the CLIVAR momentum and the considerable progress made to date. The SSG acted accordingly and introduced some significant changes in the way CLIVAR is doing business, as outlined below. It is interesting to note that the USA implemented a major overhaul of its CLIVAR oversight structure; the new organization, based on the overall headings of "processes", "phenomena" and "prediction" is more closely linked to the missions of the government agencies supporting various aspects of US CLIVAR research. The SSG Executive will meet in mid-year to review the developments since the assessment and make recommendations for further changes as necessary. The following account briefly outlines aspects of the CLIVAR Conference, deals in some depth with the outcomes of the CLIVAR assessment and summarises some of the achievements of CLIVAR's Panels and Working Groups over the year.

6.1 The CLIVAR Conference

The CLIVAR SSG expressed its gratitude to Prof. L. Bengstsson and his scientific organizing committee and Dr D. Legler and his team of local organizers and UCAR staff for their outstanding efforts in organizing the First International CLIVAR Science Conference, which was held in Baltimore, USA, 21-25 June 2004 (www.clivar2004.org). By all accounts it was a great success, attracting over 650 participants from 56 countries, including at least 80 students. A DVD containing all the oral presentations and over 400 of the posters in electronic format, as well as all abstracts, has been produced.

Presentations at the Conference highlighted many CLIVAR accomplishments, but also challenges for the future. It was noted that CLIVAR was being asked to do more for less (in terms of funding), including advancing prediction skill, reducing uncertainties, establishing societal relevance of its work, linking climate change and climate variability, and increasing the dialogue with the applications sector. The cascade from global to regional scales, global synthesis and integration, transition of climate observations from research to operations and support for developing nations to participate in climate studies were all concerns for CLIVAR in the future.

6.2 The CLIVAR Assessment

6.2.1 Organization

Recognizing the opportunity presented by the Conference to review progress and identify areas for future work, the SSG asked the International CLIVAR Project Office (ICPO) and the Joint Planning Staff (JPS) for WCRP to organize an assessment of CLIVAR. The objectives of this exercise would be to measure what progress had been made to date against the CLIVAR objectives and to provide the SSG with the input to

determine what steps might be necessary to ensure future progress, for instance, whether changes to the project structure might be desirable or if certain panel efforts should be redirected.

The review was organised by CLIVAR streams: Global Ocean-Atmosphere-Land System (GOALS), Decadal-to-Centennial global variability and predictability (DecCen), and Anthropogenic Climate Change (ACC) and by the unifying themes of "Data" (Global sustained observations, Improved historical data, Paleoclimate data, Reanalysis and Empirical studies) and "Modelling" (Predictability and prediction, Global modelling, Downscaling). An additional assessment was made of the overall programme structure and the functioning of the International Project Office. This framework allowed for some objectivity (measuring progress against the original science goals as articulated in the Science Plan) and provided for crosscutting analyses (against the "unifying themes").

A team of assessors was selected from past SSG members: Drs D. Anderson, M. Manton, E. Sarachik, F. Schott, N. Smith, and J. Willebrand. The assessors based their analyses on input from the panels (in the form of answers to a questionnaire and personal interviews), their own knowledge of the subject and the invited talks and poster presentations at the Conference. Assessors presented their reports to the SSG at a meeting held immediately following the Conference.

6.2.2 Recommendations and Actions

The assessors remarked on the considerable accomplishments of CLIVAR to date, but also found areas that should be more active. The SSG was addressing the latter through revised panel memberships and terms of reference and a more structured reporting scheme. In addition, several common themes arose from the assessments. In particular, there was a sense that the programme should focus more clearly on a few major topics and that more attention should be given to the integration across the activities of the various panels and to the study of anthropogenic climate change. Data management and links to applications were two areas that were also recommended for increased emphasis. There was general agreement that the programme's visibility could be improved and that the issues of visibility and breadth of the programme were related.

Focus and visibility

The assessors lamented the lack of public visibility of CLIVAR and suggested that a focus on major themes could help in this. It was suggested that the annual SSG meetings should be organized to report on the progress of each Principal Research Area (PRA), not just to the JSC but to the public as well, and that the usefulness of the climate information gathered should be stressed. A lack of visible CLIVAR emphasis on ENSO and particularly on decadal variability of ENSO was noted. Also, although CLIVAR scientists were seen to contribute heavily to the IPCC assessment process, CLIVAR itself did not seem to have much visibility in the study of anthropogenic climate change. Given that ACC was a major element of CLIVAR, assessors felt strongly that both ACC and the anthropogenic modification of natural variability should receive the same emphasis as the other themes, which was not currently the case. There was considerable discussion as to whether the current arrangement of joint JSC and CLIVAR sponsorship of WGCM was the best. Concern was expressed that as WGCM increased the complexity of its models, it would be even less likely that time would be devoted to analysis of seasonal, interannual or decadal variability.

The SSG agreed to highlight and focus more clearly on four major themes for the whole of the programme, those already identified in the very early planning stages of CLIVAR, namely: ENSO, monsoons, decadal modes of variability and thermohaline circulation, and anthropogenic climate change. To realize this renewed emphasis, all CLIVAR panels and working groups will be asked to report on their contributions in these four major areas at each SSG meeting, and the SSG will produce an annual report on overall CLIVAR progress organized around these themes. In addition, the SSG will organize annual workshops on one of the four major themes to determine the state of the art and outstanding questions and issues. Two relevant workshops were planned for 2005: one on natural modes of variability for ACC had been held at IPRC, University of Hawaii, in March and the pan-WCRP monsoon modelling workshop was scheduled to take place in Irvine, California just prior to the GEWEX Science Conference in June.

In order to contribute more effectively to the effort to monitor both natural variability and anthropogenic climate change, the SSG requested that all panels consider what indices would be most useful for ongoing monitoring of the climate system. The CLIVAR web site should contain a summary of the state of the climate system that would include these indices. These would be communicated to the CCl/CLIVAR Expert Team on Climate Change Detection (ETCCD), the Ocean Observations Panel for Climate (OOPC) and other relevant groups for implementation.

Global integration and cross panel links

Assessors felt that CLIVAR implementation and actions should first and foremost be developed with the global domain in mind even if, ultimately, action was regionally based. On many occasions, assessors pointed to insufficient coordination and cooperation amongst the various CLIVAR panels. In response, the SSG reviewed all panel Terms of Reference with a view to emphasising cross-panel coordination. Additionally, at each SSG session each panel would be asked not only to provide a short assessment of how it was contributing to the four major themes, but also on how it was contributing to issues of global concern such as assessment of predictability and variability in global model outputs and data management. A key part of the strategy to accomplish this is through encouragement of regional analysis of global model outputs.

CLIVAR's contributions to the emerging WCRP strategic framework, COPES, were seen as an avenue for global integration. Formation of the Global Synthesis and Observations Panel (GSOP) would also facilitate the integration of the various panel efforts.

Observations and Data Management

The assessment identified the need to develop a framework for the conduct of process studies that would facilitate management of data and preserve the data and knowledge generated by the study. CLIVAR also needed to ensure that its observing systems were well integrated with those of other programmes and that its data policy was clearly articulated. A set of guidelines for process studies was under development and an updated CLIVAR data policy was under review by the SSG.

Concerning data management, the assessment concluded that CLIVAR and the WCRP as a whole had not yet met the challenge. CLIVAR must either give detailed specification of requirements and leave implementation to others, or build a data management scheme that would meet these requirements. It was suggested that CLIVAR identify one or two crosscutting themes within CLIVAR to become the focus of data management activities (e.g., ocean reanalysis and the International Polar Year). As a result, GSOP was developing a preliminary list of data requirements for ocean reanalysis as an outcome of their November 2004 workshop and considering how best these requirements could be met. GSOP and WGSIP together were also asked to develop requirements for initializing seasonal to interannual forecasts and possibly decadal as well. In addition, CLIVAR would ask the International Oceanographic Data and Information Exchange (IODE) of IOC to review the existing Data and Analysis Centres inherited from WOCE.

The SSG identified GSOP as the primary CLIVAR interface with WOAP (see section 4.3) and recommended that it take the lead on ocean reanalysis for WCRP.

Modelling

Working Group on Coupled Modelling (WGCM)

The review recognised the key and highly successful work of WGCM in promoting multi-model projections of climate change (through the CMIP project). In this way, WGCM was the primary structure by which WCRP supported the IPCC process, though the ETCCDMI was also playing an increasing role. The review also recognised that WGCM has taken the lead on trying to answer fundamental questions concerning, for example, the physical factors which determine the sensitivity of climate to increased anthropogenic forcing, focussing on cloud and other feedback processes.

On the other hand, it was felt the impact of anthropogenic forcing on the frequency of occurrence and structure of natural patterns of climate variability (ENSO, Pacific Decadal Oscillation (PDO), Atlantic dipole, North Atlantic Oscillation (NAO) and so on) was an issue that needed more attention in the future. The SSG asked all CLIVAR panels to work with WGCM and WGSIP and vice versa to organize assessments of global prediction products (seasonal and ACC), promoting, both within the scope of the panels and beyond, diagnostic analysis of these global datasets at the regional level.

Working Group on Seasonal to Interannual Prediction (WGSIP)

The review strongly commended WGSIP's work in promoting multi-model seasonal ensemble forecast datasets, e.g., through the Seasonal prediction Model Intercomparison Project (SMIP) and the Development of European Multi-model Ensemble system for seasonal to inTERannual prediction (DEMETER) project. It felt that the availability of these datasets was a major success story for WGSIP and encouraged CLIVAR regional panel activity in the analysis of these, a topic pursued at the October 2004

WGSIP meeting. It was also recognised that WGSIP is playing a key role in the COPES initiative on seasonal forecasting. WGSIP was encouraged to further develop efforts to improve access to, and exchange of model data.

In recognition of the fact that WGCM and WGSIP had many problems in common, the SSG recommended that joint membership on these groups would be appropriate. The SSG asked both groups to address with urgency the critical issue of model error reduction. To facilitate this, common membership of WGSIP and WGNE has also been agreed.

CLIVAR applications activity

Although it was not within the remit of CLIVAR to become involved significantly in full end-to-end climate prediction, the science of climate prediction has advanced to the stage where quantitative application models could be run successfully from downscaled output of ensembles of global climate models. Examples are in seasonal probability forecasts of malaria prediction in Africa, crop prediction in India related to monsoons, and river discharge in Bangladesh. CLIVAR would continue its policy of involvement in this area; representatives from applications modelling groups have been invited to join appropriate CLIVAR panels.

International CLIVAR Project Office (ICPO)

The assessment proposed some reorganization of the duties of the staff at the ICPO that was being implemented. The CLIVAR SSG chairs would like to thank the USA via the US CLIVAR Interagency Group and both the Natural Environment Research Council (NERC) and the National Oceanography Centre, Southampton, in the UK for their continued strong support for the ICPO, and the USA for funding participation of all its nationals in international CLIVAR meetings. In addition, the ICPO was grateful for a donation received from CSIRO, Australia. A proposal to the UK to host the ICPO for a further five years was under review by NERC. In the meantime, provision of carry-over funding has been agreed with NERC.

6.3 Highlights of last year's progress

CLIVAR Ocean Basin Panels

- The Atlantic Panel organised a workshop on "Atlantic Predictability" in Reading, UK, 19-22 April 2004. Two overarching challenges were recognized: a) to realize fully the potential of seasonal predictions for the tropical Atlantic region and b) to take the lead in the development of systems of decadal climate prediction.
- The Atlantic Panel has launched the Tropical Atlantic Climate Experiment to advance understanding of coupled processes and improve climate prediction in the region. In addition, the US-CLIVAR/AMMA (African Monsoon Multidisciplinary Analysis)-led process study on the Atlantic Meridional ITCZ was under consideration for funding by NOAA, NSF and NASA.
- The Atlantic Panel was also addressing a basin-wide synthesis on the Meridional Overturning Circulation (MOC) variability, collaborating with the WGOMD and the WGCM on developing experiments to explore MOC responses and sensitivity. The Panel and WGOMD co-sponsored a Workshop on Atlantic Thermohaline Variability in Kiel, Germany, 13-16 September 2004.
- The CLIVAR SSG has formally endorsed community plans for a Mediterranean component of CLIVAR (MedCLIVAR) and expects that this activity, and perhaps others like it, would provide opportunities to engage a wider scientific community in CLIVAR at the regional level. Funding for MedCLIVAR activities was being sought from the European Science Foundation.
- The Pacific Panel and the WGSIP were initiating an assessment of the ocean component of coupled models from the perspective of seasonal-interannual prediction. Planning for Pacific western boundary current studies continued to be developed. A South Pacific Workshop was being planned, jointly with GOOS and OOPC. The scope and membership of the Pacific Panel were under review.
- In cooperation with the Tropical Buoy Implementation Panel, the Indian Ocean Panel has developed a draft implementation plan for an integrated Indian Ocean observing system. 4 Atlas moorings and 1 Acoustic Doppler Current Profiler have been added to the existing equatorial moorings (deployed by Japan, the US Pacific Marine Environmental Laboratory (PMEL) and India (National Institute of Oceanography (NIO), National Institute of Ocean Technology) in a joint 41-day cruise between PMEL and the NIO.
- Strong input to the planning for the International Polar Year (2007-08) has been made by the Southern Ocean Panel with an integrated and interdisciplinary proposal for research on understanding the role of the Southern Ocean in past, present and future climate.

CLIVAR Monsoon Panels (see also section 5.1.1)

- VAMOS/NAME (the activities of which are joint with GEWEX) implemented a 4-month summer field campaign in the core monsoon region over NW Mexico and the SW USA. Data set development, quality control, evaluation and analysis were in progress. Results would be presented at a NAME workshop in Mexico City in March 2005.
- Under VAMOS/MESA, progress continued to be made with the evaluation and analysis of the SALLJEX data. Coordinated modelling experiments for the SALLJEX period have been performed.
- VOCALS had developed an International Science Plan with coastal and offshore emphases. Plans for a VOCALS campaign in the eastern Pacific were under way.
- The VAMOS/PLATIN group made a successful contribution to the first phase of the GEF Framework Program for the La Plata Basin (LPB), producing surveys of the LPB's hydro-climate including the systems used for its prediction and monitoring. The Intergovernmental Commission of the LPB had recently approved the continuation of PLATIN in phase 2b of the GEF project. At JSC-XXV, a request was made for additional support from WCRP for PLATIN activities in the GEF Framework Program. VAMOS PLATIN and the CLIVAR SSG wished to acknowledge the support that the JPS for WCRP had provided to PLATIN to date.
- Resulting from the CLIVAR assessment, the scope and membership of the Asian-Australian Monsoon Panel had been reviewed. The Indian Ocean Panel and the Asian-Australia Monsoon Panel jointly convened a Workshop on Indian Ocean Modelling at IPRC, Hawaii, 29 November-3 December 2004.
- The VACS Panel's Climate Atlas for Africa was now online at the University of Oxford, UK and continues to be developed. Programmes for research tailored for East Africa and southern Africa were shortly to be disseminated to the wider community for comment. VACS was involved in planning for two major meetings on African Climate.
- Planning for AMMA, jointly sponsored by CLIVAR through VACS and GEWEX, continues. AMMA had attracted 10million Euros from the European Commission, plus strong national support.
- CLIVAR monsoon panel members have been active in developing the agenda for the pan-WCRP Monsoon Workshop to be held in Irvine, California, USA, 15-17 June 2005.

CLIVAR's global Panels and Working Groups

- WGSIP involvement in the COPES TFSP continued. WGSIP was in process of cataloguing current seasonal prediction activities and, in coordination with the CLIVAR monsoon panels, was coordinating a locally driven model skill assessment (see separate report of the TFSP, section 4.2).
- WGCM had organized a wide-ranging opportunity for analysis of the unprecedented set of coordinated 20th and 21st century climate change experiments for AR4. An International Workshop on "Analyses of Climate Model Simulations for the IPCC AR4" was held in Hawaii, 1-4 March 2005, convened by US CLIVAR.
- WGOMD held a major Workshop on "Assessment of a new generation of ocean models" in Princeton, USA, 16-18 June 2004. As a result, WGOMD had developed the concept of "Coordinated Ocean-ice Reference Experiments" (COREs) to facilitate scientifically-based model intercomparisons.
- A major Ocean Reanalysis Workshop was held in Boulder, Colorado, USA from 8-10 November 2004. The first meeting of the CLIVAR Global Synthesis and Observations Panel followed the workshop. GSOP made significant progress in developing CLIVAR data management overall and plans for ocean reanalysis as well as reviewing the current state of the ocean observing system.
- Relevant to the Tropical Buoy Implementation Panel, NOAA's National Data Buoy Center took over management of the TAO array from PMEL in October 2004. It would be important for CLIVAR to monitor the progress of this transition which will set the standard for future such transitions to operations (e.g., of Argo). In the Atlantic, the MoU covering PIRATA between France, the US and Brazil had been extended by 2 years (to 2006). A CLIVAR/OOPC review of PIRATA was planned for October 2005 in Toulouse.
- The joint CCl/CLIVAR ETCCD had organized a series of regional workshops for southern Africa, South America, southwest Asia, Central America and southern Asia aimed at furthering global assessment of climate extremes and changes. Peer-reviewed papers from the workshops were intended to provide input to IPCC AR4. Standard software developed for use in the workshops was being distributed for wider applications.
- The CLIVAR/PAGES Panel has been reconstituted. Following the first meeting of the new panel, a vision document has been produced and is available at www.clivar.org/organisation/pages/doc/VisionTOC_Final.pdf

Issues for the JSC

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

- the key science foci identified for CLIVAR (ENSO, monsoons, decadal/Thermohaline Circulation (THC) and ACC)
- strategy for developing CLIVAR's role in ACC
- continuing to build CLIVAR/GEWEX/CliC activity on monsoons
- developing the visibility of CLIVAR in the context of the visibility of WCRP as a whole
- meeting the data management challenge in CLIVAR and WCRP more widely.

The JSC thanked Dr Busalacchi not only for his comprehensive presentation of the CLIVAR progress report but also for the critical and challenging feedback on several issues relating to WGCM, anthropogenic climate change, and the current draft of the 'COPES document'. The JSC expressed satisfaction at the continuing progress in CLIVAR and endorsed its new four-theme approach, pointing out that the themes also involved interest and effort from other parts of WCRP. The JSC further stressed the need to give more visibility to the role of oceans in climate. All comments on the draft COPES document would be considered fully with a view to further revision of the document by the drafting team.

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

Prof. S. Sorooshian, Chair of the GEWEX Scientific Steering Group (SSG), and R. Lawford, Director, International GEWEX Project Office, 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 in January 2005. In addition to the annual review of GEWEX activities, this SSG session provided an excellent opportunity to establish new links with the Chinese GEWEX community, including in the areas of satellite observations by the China Meteorological Administration, modelling work by the Chinese Academy of Sciences and field projects organised by the National Science Foundation of China. The overall strategy of GEWEX was reviewed in mid-year and at the SSG session, with emphasis on potential contributions to the new strategic framework, COPES, and the development of crosscutting activities responding to the general objectives of WCRP.

7.1 Revision of GEWEX objectives and plans in the context of COPES

GEWEX principals have been reviewing the COPES strategy and have been consulting with Professor E. Wood, the GEWEX representative on the COPES Task Force. Panel Chairs and SSG members have been asked to comment on the COPES proposal and to consider present and potential future contributions of GEWEX this new WCRP strategic framework. This led to constructive discussions at the SSG session. The main contributions expected from GEWEX relate to the high scientific value of its observational component which needs to be better taken into account in the COPES strategy, to its modelling capabilities which need to be fully used in the improvement of climate models, and to its concern for applications already under development in the context of the management of water resources.

A general feeling with respect to the COPES strategy as presently outlined was the bias felt by some of the GEWEX community towards the use of complex integrated climate models as the only means to make progress in climate variability and climate change research. As the global observational records from satellite remote sensing (combined with key surface-based observations) have grown longer and new applications, particularly with respect to the land surface, have gained credibility, other pathways to critical climate products and services become more viable. These pathways are applied climatology and climate monitoring, both of which have been somewhat under appreciated lately, as modelling has eclipsed these more traditional uses of observations in climate applications. Improved climate monitoring is possible using satellite remote sensing, blended with in situ and surface-based remote sensing data, and the value of these data is improving due to the longer records and continued work with the data sets to improve their quality. Applied climatology is defined as the scientific analysis of climatic data records for applications with operational purposes. Operational in this sense does not simply describe the routine production of the data sets, but also entails the routine analysis and application of the data to specific endeavours such as agricultural climatology, industrial climatology, bioclimatology, etc. This pathway is becoming an increasingly important use of remote sensing data. In reformulating the WCRP to address the aims articulated in the COPES strategic framework, all three pathways from observations to applications should be given equal weight. The more direct uses of observations can realize benefits sooner if these data products are prepared with the end-use in mind. These direct uses also provide a baseline against which to measure the progress made by the developing model-based prediction systems.

A second point was the importance of the modelling work within the GEWEX community, including the regional model developments as part of the Continental Scale Experiments (CSEs) and the efforts of the WCRP Modelling Panel to link process studies with the development of climate models. GEWEX regional models are entering a mature phase where their transferability from basin to basin becomes feasible and a large effort is developed to compare the various modelling approaches in standard case studies. One of the main goals is to fill the existing gap between the GEWEX CSE community focusing on the interpretation of field experiments and the regional climate community, which favours a modelling approach largely inspired from Global Climate Model (GCM) techniques. One example of progress in this field is the Max Planck Institute for Meteorology collaborative community modelling effort, Community Earth System Models (COSMOS), which will represent physical, chemical and biological processes in the atmosphere, ocean and on land. The COSMOS programme will include the development of a global Earth system model and a regional component, the Baltic Sea catchment, enabling BALTEX to serve as a regional pilot component to COSMOS. The second main aspect of GEWEX modelling activity is the long term effort dedicated to the development of parameterization schemes for global models, starting from process studies and the direct simulation of those processes, and developing a close cooperation with the whole GCM community. This issue was discussed at length at the SSG meeting. The GEWEX boundary layer and cloud modelling research has reached a mature stage and its results should be considered as a highlight in WCRP's activities. The land surface modelling community has also established a sound basis for land surface parameterizations and displays a range of activities, several of which being directly relevant to COPES objectives. This community should in particular contribute to the assessment of the role of land surface properties and soil moisture in climate variability and change.

The third major point in relation to COPES was the development of applications for society. GEWEX, through the Water Resources Applications Project (WRAP) has initiated this approach several years ago by developing the use of CSEs' data and model results by hydrologists and water resource managers. This is done essentially through dedicated workshops, and the SSG has encouraged the development of more integrated pilot projects in this area. Closer contacts with UNESCO and the Predictability of Ungauged Basins (PUB) project are also recommended. It is suggested that the WRAP community be directly involved in the definition of the COPES approach to the development of application projects.

Following the COPES initiative, Phase II objectives for GEWEX have been revised and GEWEX proposes the following minor revisions to these objectives:

i. Produce consistent research quality data sets complete with error descriptions of the Earth's energy budget and water cycle and their variability and trends on interannual to decadal time scales, and for use in climate system analysis and model development and validation
ii. Enhance the understanding of how energy and water cycle processes function and quantify their contribution to climate feedbacks
iii. Determine the geographical and seasonal characteristics of the predictability of key water and energy cycle variables over land areas and, through collaborations with the wider WCRP community, determine the predictability of energy and water cycles on a global basis.
iv. Develop better seasonal predictions of water and energy cycle variability through improved parameterizations encapsulating hydro-meteorological processes and feedbacks for atmospheric circulation models
v. Undertake joint activities with operational hydro-meteorological services and hydrological research programmes to demonstrate the value of new GEWEX prediction capabilities, data sets and tools for assessing the consequences of global change.

7.2 Main programmatic issues

All panels and most sub-projects held meetings or workshops during the past year. In addition to the annual SSG meeting, the GEWEX Executive held a summer meeting at UMBC in July. This meeting was accompanied by a one-day briefing on GEWEX held at the US National Academy of Sciences.

Through collaboration with and funding from the European Space Agency (ESA), GEWEX has hired a part-time European GEWEX coordinator, Dr P. van Oevelen, whose office is located at the European Space Research and Technology Centre (ESTEC) in Noordwijk, The Netherlands.

Two pre-proposals were submitted to the IPY: one dealing with an enhancement in the number of northern stations in CEOP during IPY and a second GEWEX/CliC pre-proposal dealing with aerosols, clouds and precipitation at high latitudes.

Publications advising the larger science community about GEWEX were produced including a publication in the Bulletin of the American Meteorological Society (BAMS) on “advancing global and continental scale hydrometeorology” and GHP achievements (Lawford et al., 2004) and a general article on GEWEX for the WMO Bulletin (Sorooshian et al., 2005). The brochure summarizing phase I achievements is being finalized for wide distribution.

A number of scientific sessions were held at science conferences. These included GEWEX and Global Soil Wetness Project (GSWP) sessions at the January 2005 AMS meeting and CEOP and Water Cycle sessions at the Spring AGU meeting in Montreal.

GEWEX collaborated with the Integrated Global Water Cycle Observations (IGWCO) and UNESCO in a workshop held in Paris, 3-5 November 2004 to review what is known about trends in the global water cycle variables. The purpose of this workshop was to provide background information for use in the next IPCC/WGI report and to identify observational issues for IGWCO and research needs for GEWEX. There was a consensus on a clear need for the reanalysis of current long-term global data records derived from satellites for climate purposes.

During the coming year, the major scientific meeting will be the 5th International GEWEX Science Conference to be held in Orange County, California, 20-24 June 2005. A total of 309 abstracts have been submitted. Three long-term contributors to GEWEX will be honoured at the conference banquet. A special evening town-hall meeting will be held on COPES. During the week before, GEWEX and CLIVAR are collaborating in the organization of a pan-WCRP monsoon workshop. Plans for a joint approach for addressing monsoon modelling will be worked out at this meeting.

7.3 Coordinated Enhanced Observing Period (CEOP)

The Coordinated Enhanced Observing Period (CEOP), an element of the WCRP initiated by GEWEX, was proposed in 1997 as an initial step for establishing an integrated observation system for the global water cycle. Its guiding goal is:

> "To understand and model the influence of continental hydro-climate processes on the predictability of global atmospheric circulation and changes in water resources, with a particular focus on the heat source and sink regions that drive and modify the climate system and anomalies."

A key achievement of CEOP has been the establishment of an integrated observation system formed by combining different types of observations, in-situ and satellite. In addition, the numerical weather prediction model outputs are merged with the observed data to provide spatially and temporally continuous coverage in a complementary way. The coordinated enhanced observation and model output generation were carried out during the first Enhanced Observing Period (EOP-1) [July-September 2001], the EOP-3 [October 2002-September 2003] and the EOP-4 [October 2003-December 2004] time periods.

CEOP, therefore, has been cited as a unique opportunity to improve the scientific foundation needed to achieve overall water cycle documentation and prediction goals, based on coordination among the GEWEX CSEs, the Committee on Earth Observation Satellites (CEOS) members, including space agencies, and the NWP centres affiliated with the WMO.

Since the last reporting period CEOP has formally constituted two sets of unique functional components:

- components to integrate observations based on coordination among field science groups, space agencies, and numerical weather prediction centres in the local, regional and global scales;
- components required to exchange and disseminate observational data and information including data management that encompasses functions such as Quality Assessment/Quality Control, access to data, and archiving of data, data integration and visualization, and information fusion.

The fourth in a series of annual CEOP International Implementation Planning meetings took place from 28 February to 4 March 2005 at the University of Tokyo. A summary report of the meeting, including the main action items, was presented, including the outline for the CEOP Phase 2 Implementation/Science Plan. This next Phase is intended to proceed in two stages (2005-2007; 2007-2010) that run in series from 1 January 2005 to 31 December 2010. CEOP will continue to move forward with its original timeline while

accommodating the new initiatives that it has undertaken in support of the core projects in WCRP and in the broader international water and energy cycle climate research community.

The GEWEX SSG acknowledged in its January 2005 session the achievements of the CEOP main observational phase and welcomed the first scientific results. SSG acknowledged that the CEOP dataset under completion was a particularly important accomplishment and represented a very useful tool for further improvements in prediction of variations of the global water and energy cycle. The continuation of CEOP in a phase 2 has been endorsed by the CEOP Advisory and Oversight and Science Steering Committees (AOC, SSC). However, SSG thought it was still early to approve a phase 2 with the information available and suggested to have a more extensive discussion on this issue at its next executive meeting during summer.

7.4 GEWEX Radiation Panel (GRP)

One important achievement for the radiation research community has been that the Baseline Surface Radiation Network (BSRN), while remaining a GEWEX project, has been endorsed by GCOS as the baseline surface radiation network for climate monitoring. This follows the endorsement by GCOS of the Global Precipitation Climatology Centre (GPCC) and demonstrates the value of WCRP projects as initiators of long-term climate observing systems.

Another milestone related to the global data sets, which represent a major contribution of GEWEX to climate research, is that the GRP initiated the assessment of its four main long-term global products; i.e. long-term precipitation, clouds, aerosols and radiative fluxes. Working Groups have been established and draft assessment plans have been completed for all four groups. One example of results was the good agreement between three top-of-atmosphere radiative flux products, one based on the continuous ERBE non-scanner instrument record over the past two decades and two different products produced by Surface Radiation Budget (SRB) and the International Satellite Cloud Climatology Project (ISCCP). This assessment was an important step to justify the continuation of those activities, supported by a letter sent by WMO's Secretary-General to all participating countries.

A group on the Continuous Intercomparison of Radiation Codes (CIRC) has been formed to develop a web site (supported by the Atmospheric Radiation Measurement (ARM)) with test case data sets for use in the development of radiative transfer models. This web-based facility would provide a permanent reference for development and improvement of radiative transfer codes used in atmospheric models. GRP also plans to release a common set of cloud, aerosol and atmospheric profile products from eight sites for the same time period. Together with a linked set of web sites, these data would illustrate the value of profile data and prepare users for more extensive data sets expected from CloudSat and Calipso (due to launch in 2005).

GRP was leading one of the GEWEX crosscutting activities with other panels, for a better coordination of research on precipitation observation and modelling. In this domain, one should emphasize the large effort deployed by the GEWEX community to have the space agencies continue TRMM operations (this effort has been at least partly successful and is still on-going). A specific proposal in another aspect of precipitation research was the proposal to jointly use all ground Doppler radar data for mapping precipitation in an international concerted action.

GRP noted the lack of a proper data set for land surface variables and was encouraging either the International Satellite Land-Surface Climatology Project (ISLSCP) to engage in a major effort in this area or a specific action to be initiated by GRP. It also plans to launch the LandFlux project with a focus on two topics: i) organization and systematization of land surface remote sensing products which will be carried out in collaboration with CliC and Global Soil Wetness Project (GSWP); and ii) estimation of land surface sensible and latent heat fluxes to be carried out in collaboration with GSWP.

Finally, through its Working Group on Data Management and Analysis, GRP was making plans to create an integrated set of climate products expanding the information obtained from satellite and other observing systems, in preparation for the coordinated re-processing project proposed under the new WOAP.

7.5 GEWEX Modelling and Prediction Panel (GMPP)

Dr C. Jakob has taken on the leadership of the GEWEX Cloud System Studies (GCSS). Dr Jakob plans to focus on making the work of GCSS more relevant to the GCM community through the development of a systematic model evaluation approach, as a complement to parameterization developments. A pan-GCSS meeting would be held in Athens to address crosscutting cloud studies issues. It was expected that a Pacific cloud cross-section would provide a common basis for the various cloud type teams in GCSS.

The work of the various GCSS groups was progressing well. An example of new activity was the use of data recently collected during the Mixed-Phase Arctic Cloud Experiment (MPACE) by the polar cloud working group chaired by Dr J. Pinto (NCAR). It would focus on understanding and modelling mixed-phase clouds that frequently exist on the top of stable boundary layers in the Arctic. The simulation of such clouds must address both cloud-dynamical and microphysical aspects.

The Global Land-Atmosphere System Study (GLASS), the land surface component of GMPP, was continuing to promote more integration of its activities with other parts of GEWEX and related activities outside GEWEX. An example of interaction with the GEWEX Atmospheric Boundary Layer Study (GABLS) was the new project, Local Coupled Action (LO-CO), which would address the role of land-PBL interaction though local coupled modelling, with a view towards improved simulation of the diurnal cycle of surface fluxes. New interactions outside GEWEX included cooperation with the Snow Model Inter-comparison Project (SnowMIP), closer interaction with operational land data assimilation efforts in Europe and the USA, and the urban modelling community.

More than 16 models have participated in the Second Global Soil Wetness Project (GSWP-2) which is completing its modelling phase and is moving into the analysis phase. Baseline simulations and sensitivity studies have been completed and are being distributed for analysis. The Global Land-Atmosphere Coupling Experiment (GLACE), a multi-model project in large-scale coupled action, resulted in a *Science* paper (Koster et al. 2004) showing the spatial variability of the strength of land-atmosphere coupling. Land surface coupling is greatest where conditions are neither abnormally wet nor abnormally dry and are most pronounced in central North America, central Africa and India. A new project, Isotopes in the Project for Inter-comparison of Land-Surface Parameterization Schemes (IPILPS), has been initiated under the auspices of GLASS to contribute to a comparison of atmospheric, coupled climate, and earth system models that incorporate isotopic representation in their land-surface schemes.

GABLS has achieved its first intercomparison study for stable boundary layers including single column and large-eddy simulation models, in close cooperation with the Global Circulation Model community. This has been followed by a large publication effort and a participation in the next IPCC report. A second case is being prepared using comprehensive observations covering three diurnal cycles over land.

GMPP was leading a GEWEX crosscutting activity on the diurnal cycle, for which a strategy was devised at the WGNE/GMPP meeting in October 2004, and preparatory consultations have taken place on this subject. In order to strengthen the identity and influence of GMPP, closer collaboration between the sub-projects would be encouraged. To this end GMPP sub-projects, GCSS, GLASS and GABLS, would meet biannually (even years) and GMPP would continue to meet with WGNE on odd years. In 2005, it would meet with WGNE in St Petersburg.

7.6 GEWEX Hydrometeorology Panel (GHP)

In the context of GEWEX Phase II, GHP has revised its strategy by updating the criteria for CSEs, supporting the development of CEOP and joint field experiments with CLIVAR, and developing horizontal activities led by thematic working groups.

With respect to CSEs, the GEWEX Asian Monsoon Experiment (GAME) formally ends at the end of 2005 and a possible follow-on project, which would encompass the whole of South East Asia and would include GEWEX and CLIVAR type objectives, is being developed. The Mackenzie GEWEX Study (MAGS) will also formally end at the end of 2005, without yet any follow-up activity. Among the new projects, AMMA was endorsed as a new Continental Scale Experiment at the last SSG meeting.

GHP continued to make major contributions to CEOP. Scientific studies using CEOP data have now been initiated by scientists associated with the CSEs. The GHP Data Management Group sponsored by GAPP was coordinating and archiving in situ CEOP observations made over all of the CSE regions. The CEOP Model Archive at the World Climate Data Centre at the Max Planck Institute for Meteorology, initiated by BALTEX, was archiving global analyses and the Inter-CSE Transferability Study (ICTS) regional simulations, many contributed by modelling centres associated with the CSEs. The satellite data archive at the University of Tokyo, initiated by GAME and the land data assimilation community, were archiving remote sensing observations during CEOP.

As part of the horizontal activities, GHP and the CEOP Water and Energy Simulation and Prediction (WESP) Working Group have established a Transferability Working Group (TWG) to promote the use and application of ensembles of regional climate models for many different climate regimes (e.g., tropical, monsoon, subtropical, arctic). The strategy of the transferability experiments was to identify key processes in

water cycle and energy budget that express themselves to different degrees in different climatic regions. The initial transferability experiment consisted in running regional simulations over all of the CSEs beginning 1 July 1999. The period of analysis would cover the CEOP time period (1 July 2001-31 December 2004) in order to take advantage of the CEOP in situ and satellite data archives as well as to compare these regional simulations with the ensemble of global analyses products being archived during CEOP. The previous GHP working group on predictability had become part of WRAP and would work with WRAP and the Hydrologic Experimental Prediction Ensemble Experiment (HEPEX). A closer link with the UNESCO Prediction in Ungauged Basins (PUB) was also recommended by the SSG.

At first associated with GHP but now with the three GEWEX panels, ISLSCP has completed its Initiative II data collection exercise. It contains 50 global time series spanning the 10-year period 1986 to 1995 (selected data sets span even longer periods) and can be accessed at http://islscp2.sesda.com. A science and evaluation workshop was being planned to present and discuss these results on 4-6 May 2005 in Greenbelt, Maryland, USA. Based on the findings of the workshop the data would be augmented and released as a DVD set.

GHP was developing a crosscutting activity, with the other GEWEX panels, on the global energy and water budget, including surface flux products on sea and over land surfaces. The next GHP meeting is scheduled to be held in Melbourne from 26-30 September 2005.

7.7 Issues for JSC consideration

The attention of the JSC was invited on a few specific points:

(i) GEWEX plans for the coming year and minor changes proposed in the GEWEX objectives were submitted for JSC's approval;
(ii) Comments concerning COPES objectives and GEWEX contributions to those objectives were submitted to the JSC;
(iii) Since CEOP is now a cross-WCRP activity, the GEWEX SSG recommended that CEOP should report directly to the JSC as an independent WCRP project, but it would still appreciate a presentation of CEOP activities at GEWEX SSG.

The report by Prof. Sorooshian was well received and the JSC noted with satisfaction that the project was progressing in the right direction. It approved the revised objectives and took note and welcomed the feedback provided on the draft COPES strategy document. The JSC also acknowledged and looked forward to progress on the new GEWEX crosscutting activities concerning precipitation, the diurnal cycle and the global water and energy budgets, all of which were of central importance to WCRP. 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.

In acknowledging Prof. T. Koike's scientific leadership of CEOP, JSC noted with appreciation the completion of CEOP's main observation period and also its on-going research and data collection activity. The JSC anticipated the increasing importance of a phase 2 of CEOP for global monitoring of the water cycle as a contribution to the GEO/GEOSS and also its direct relevance for the new WCRP strategic framework, COPES. Although CEOP covers various WCRP domains, the JSC recommended that it should continue to report in general to the GEWEX SSG and also that its observational aspects be reviewed by WOAP. Further, the JSC invited Prof. Koike to submit a draft science plan for a CEOP Phase 2 to the next WCRP Officers, Chairs and Directors meeting.

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

The Chairman of the CliC Scientific Steering Group, Dr B. Goodison, reported on the activities of CliC, as well as on the status of the two associated polar buoy programmes in the Arctic and Antarctic, and the planned International Polar Year 2007-08.

8.1 Climate and Cryosphere (CliC) project implementation

The cryosphere continued to receive rapidly increasing interest by the scientific community and the public at large. Research on cryosphere and climate was on the rise. The most recent American Geophysical Union Fall Meeting (San Francisco, December 2004) and forthcoming European Geophysical Union Meeting (Vienna, April 2005) exhibited very impressive arrays of cryospheric studies. Interest in participating in the

First CliC Science Conference (Beijing, April 2005) was very high. The increased attention to the cryosphere, to a significant extent, could be attributed to the awareness created by the activities of the WCRP Arctic Climate System Study (ACSYS) and the CliC project.

Since July 2004, the CliC project has been co-sponsored by the Scientific Committee on Antarctic Research (SCAR). SCAR also joined CLIVAR and CliC in their co-sponsorship of the Southern Ocean Implementation Panel and WCRP in its sponsorship of the International Programme for Antarctic Buoys. Despite the success in generating momentum for cryospheric studies, CliC still has a major challenge in generating adequate support for project implementation. At present only a few countries have established a national committee for CliC. However, national committees for projects such as CliC were not being supported in as many countries as in the past. CliC was actively strengthening cooperation with organizations in the Arctic, such as the International Arctic Science Committee, the Arctic Ocean Sciences Board and the Arctic Council. Active participation of the CliC community in the Second International Conference on Arctic Research Planning (ICARP II, Copenhagen, November 2005) would be an important step in this direction.

In 2004, CliC signed a Memorandum of Understanding (MoU) with the International Permafrost Association (IPA) and cooperation with them was broadening. A similar MoU was being considered with the Northern Eurasian Earth Science Partnership Initiative (NEESPI) being promoted by NASA and the Russian Academy of Sciences.

CliC has initiated discussion to strengthen cooperation with the newly established Commission on Cryospheric Sciences, which was part of the IUGG. Formerly the IAHS International Commission on Snow and Ice (ICSI), this Commission provides CliC with a strong link to the international cryospheric science community, complementing its link with the International Glaciological Society.

The first session of the CliC Scientific Steering Group took place in Hobart, Australia, 25-29 October 2004. The main objective of the session was to move the project from its planning to its implementation phase. CliC implementation would be achieved through work within the four established CliC project areas (CPAs):

CPA 1 The terrestrial cryosphere and hydrometeorology of cold regions
CPA 2 Glaciers, ice caps and ice sheets, and their relation to sea level
CPA 3 The marine cryosphere and its interactions with high latitude oceans and atmosphere
CPA 4 Links between the cryosphere and global climate

The session determined that a new structure of the project was required that would support crosscutting activities, the CPAs and activities with other WCRP initiatives including the new COPES strategy. Now CliC has panels on data and information management, modelling, and observations, an Arctic Climate Panel and Southern Ocean Implementation Panel (joint with CLIVAR and SCAR), which would be able to oversee implementation of CPA3, advisory groups on CPA1 and CPA2, possibly, CPA4, and also several rapporteurs.

Some time would be needed to implement this structure in CliC's activities, and refinements would continue. CliC would strengthen links with WGNE and WGCM and complementary activities of other WCRP projects to help meet its modelling needs.

The Implementation Strategy of CliC has been subject to review by the CliC and wider WCRP communities. Preparations for the First Scientific Conference have limited the Executive and Project Office from publishing the Strategy before this JSC Session.

CliC project area 1(CPA1)

A fundamental task of CPA1 is to improve estimates and quantify the associated uncertainty of the water balance and related energy flux components in cold climate regions. This includes precipitation (both solid and liquid), distribution properties of snow, snow melt, evapotranspiration and sublimation, water movement through frozen and unfrozen ground, water storage in watersheds, river- and lake-ice properties and processes and river runoff, etc. Estimates are required of the amount and form of carbon and ground ice stored in the ground and their release rates to the atmosphere or surface and ground water in a warming climate.

Scientific contributions to CPA1 are anticipated from international or multinational programmes such as the NEESPI, IPA, Global Carbon Project (GCP), various activities of IGBP, Global Land Ice Measurement

from Space (GLIMS), Northern Research Basins (NRB), Arctic Hydrological Cycle Observing System (Arctic HYCOS), and national programmes such as Community-wide Hydrologic Analysis and Monitoring Program (CHAMP) in the US, Cryosphere System (CRYSYS) in Canada, Water Cycle Program at the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) in Japan. CliC would expand existing WCRP activities in cold climate regions and must collaborate with GEWEX on its initiatives for cold regions. Cooperation with GEWEX Panels and CEOP would be a factor determining the success of the CPA and its contribution to WCRP objectives, as reflected in the COPES strategy.

The following CPA associated activities in 2004 were worth noting. A joint CliC/IPA workshop on permafrost modelling and observations was held in Fairbanks in October 2004 with support of the International Arctic Research Centre at University of Alaska, Fairbanks, USA. CliC, GCP, and IPA were developing a joint initiative on assessment of carbon stocks in the upper layer of soil, entitled Permafrost and Carbon Emissions (PEACE). A workshop on the Arctic HYCOS was being organized with help of the Norwegian Water Resources and Energy Directorate (26-27 April 2005, Oslo). CliC plans to contribute actively to the second phase of the WCRP Coordinated Enhanced Observing Period.

CliC project area 2 (CPA2)

The major objectives of CPA2 are to improve direct estimates of the mass balances of the Antarctic and Greenland ice sheets and their contribution to sea level changes; to develop enhanced capability to estimate past and predict future ice sheet change; and to implement a system for monitoring, assessing and predicting glaciers and ice caps globally to determine their contribution to mean sea level changes. The focus here is on the extensive use of the satellite remote sensing, through both existing systems and projects and also the development of new technologies. The activities of this CPA would contribute directly to the deliberations on sea-level rise that had been initiated under the COPES strategy (see section 5.3).

CliC project area 3 (CPA3)

The objectives for CPA3 are to improve understanding through models, process studies and enhanced observations of the polar and sub-polar oceans in full (including dynamics and thermodynamics of sea ice, polynyas, ice shelf-ocean interaction and the impacts of ice on water mass formation and modification); to determine the past and present patterns of variation and change in sea-ice distribution and mass balance in both hemispheres; to improve model simulation of both the mean state and interannual-to-decadal variability of sea ice; to enhance prediction of future variation and change; and to understand the impact of changes in the distribution of sea ice, polynyas and ice shelves on the global thermohaline circulation and any resultant risk of abrupt changes in climate (linked with CPA4).

This CPA will focus on key questions related to:

- Sea ice: its present state, response to change, and feedbacks in the climate system
- Interaction of the ocean with ice shelves and icebergs.

CliC is actively promoting the establishment of the polar ocean observing system as part of the Global Ocean Observing System of ICSU/IOC/UNEP/WMO. A proposal to establish an Arctic Regional Alliance of GOOS was submitted to the GOOS Steering Committee. On this matter, CliC has been in contact with the Ocean Observations Panel for Climate, and the Global Climate Observing System. CliC representatives participated in the NSF-sponsored workshops on ice-tethered observing platforms and Arctic Observing Network. CliC endorsed an AOSB-centred proposal on the development of the Arctic Ocean Observatory System. Massive developments in the area of polar oceanography, taking place mostly through various research projects, have the potential of closing or significantly reducing the polar gap in global oceanographic observations.

Interests of CliC in the Arctic and Southern Oceans may be different and therefore coordination of CPA3 activities could be efficiently organized through the Arctic Climate Panel and the Southern Ocean implementation Panel. Many CPA3 objectives would be achieved in partnership with CLIVAR.

CliC project area 4 (CPA4)

The scope of CPA4 is to deal primarily with broader-scale issues than the other CPAs, i.e. phenomena and mechanisms occurring at spatial scales larger than the regional. The considered timescale was from the beginning of the Pleistocene, through the instrumental period, to the end of the next millennium. The CPA is highly cross-disciplinary and links the variability and change of the cryosphere to atmospheric and oceanic circulations, biogeochemical cycles, and the rest of the Earth's climate system. The three

science themes of CPA4 were global teleconnections, natural and anthropogenic changes in the cryosphere and mechanisms linking the cryosphere and the rest of the Earth's climate system.

The way CPA4 activities would be coordinated needs to be determined. CliC and WCRP interests may be best met by establishing a special advisory group for CPA4.

8.2 CliC regional activities

High Latitude Climate Change

A workshop on 'Recent High Latitude Climate Change' (Fairbanks, Alaska, December 2004), organised by CliC jointly with SCAR and the International Commission on Polar Meteorology, was held to gain insight into the nature of, and mechanisms behind, the major increases that have been observed in near-surface air temperature in some parts of the high latitude areas over the last 50 years. It considered the observed changes, climate change mechanisms and modelling of climate variability and change. The workshop participants prepared and discussed a set of important recommendations concerning data voids and future data requirements, re-analysis data sets, mechanisms of rapid recent regional warming, and improvements required to models. These recommendations would be instrumental for further planning of the project and observations in polar regions. Outcomes of the workshop would contribute directly to the WCRP aims set out in the new COPES strategy.

Arctic

After the completion of the WCRP Arctic Climate System Study (ACSYS) and a successful ACSYS Final Conference (St Petersburg, November 2003), the follow-up activities included a set of two CD-ROMS containing all ACSYS reports and links to Arctic data sets and preparation of a book of selected papers summarising accomplishments during the ACSYS decade. The CD-ROMs were now available and the book was still in preparation. The ACSYS Data and Information System (ADIS) has been incorporated into the CliC Data and Information System.

The scientific community was especially concerned that coordination of Arctic climate studies after ACSYS be maintained and a visible part of the CliC programme. Hence a new CliC Arctic Climate Panel (ACP) was established in 2004 (Dr C. Mauritzen, chair). The Panel would maintain expert knowledge on the coupled land-ocean-atmosphere-cryosphere system in the Arctic, from the point of view of observations and monitoring, process studies, and numerical modelling. Their tasks were to assess the status of research into climate variability and predictability in the Arctic, including identification of gaps requiring process studies, sustained and campaign-based observations, and model experiments, and to serve for the CliC SSG and the wider WCRP as a source of knowledge on these issues. The first meeting of the ACP would occur at the First CliC Conference in Beijing, April 2005. The group plans to have close collaboration with the International Study of Arctic Change (ISAC), a new international initiative, which was an extension of the U.S. Study of Environmental Arctic Change (SEARCH) with which CliC signed an MoU on cooperation in 2003. The ISAC Chairman, Dr L. Anderson, is a member of the ACP. Another new group that was developing under the auspices of IASC was the Pacific Arctic Group, and initial contacts with them have been established and would be furthered at the Arctic Science Summit Week in April 2005.

In November 2003, the report of the Arctic Climate Impact Assessment (ACIA) was released to governments and the public. This report represented a major step forward in creating awareness of the expected change in the region and the multitude of its consequences. The cryosphere features prominently in this report, but WCRP was not mentioned, although most of the simulations in the Assessment were made with the climate models associated with the WCRP modelling development efforts and intercomparisons. A follow-on assessment, more regionally focused, was being considered at the moment. The ACP and WCRP as a whole would need to ensure that the WCRP expertise was appropriately incorporated in follow-on activities and assessments. The ACIA report was a most authoritative document on the Arctic state and its recommendations would certainly be considered in future planning of CliC activities in the Arctic.

A related upcoming activity was the International Conference on Arctic Research Planning II (ICARPII) to be held in Copenhagen, 11-14 November 2005. WCRP was represented on the Scientific Steering Committee. A series of "white papers" was being prepared by circumpolar scientists, many from the WCRP community, as a basis for discussion on Arctic research needs over the next decade. A chapter on future modelling needs, led by Prof L. Bengtsson, should capture both WCRP and WWRP modelling interests. The need for active CliC and WMO participation in this meeting was fully recognized.

WCRP, represented by CliC, continues to participate in the activities of the International Arctic Buoy Programme (IABP). In 2004, the WCRP JPS hosted the annual meeting of IABP, in WMO, Geneva.

8.3 Southern Ocean and Antarctica

With SCAR co-sponsorship, the capabilities of CliC to influence and conduct research in the Antarctic have been enhanced. A new, major initiative in this connection was Antarctica and the Global Climate System (AGCS). The main science questions of AGCS were:

- How does variability in tropical and mid-latitude atmospheric and oceanic conditions modulate the Antarctic climate?
- What were the mechanisms that transfer the tropical signals to the Antarctic?
- What controls the stability of coupled atmosphere-ocean phenomena, such as the Antarctic circumpolar wave and the Southern Hemisphere annular mode?
- What were the quantitative relationships that reflect the non-linear linkages between climate signals in ice cores, Antarctic sea ice and the Antarctic atmospheric circulation, and the varying extra-polar signals?

The first AGCS theme “Decadal Time Scale Variability” focuses on time scale of years to centuries and covers the period over which much of the ocean variability takes place. The second theme “Global and Regional Signals in Ice Cores” would investigate the routes by which global and regional climate signals arrive at the drilling sites and concentrate on quantifying the relationships between signals in the cores and measures of the global climate system. The third theme is “Natural and Anthropogenic Forcing on the Antarctic Climate System”. The fourth AGCS theme, “The Export of Antarctic Climate Signals”, would examine the means by which Antarctic climate variability could affect the conditions at more northerly latitudes (e.g., through the role of Antarctic water masses) and would consider the influence of removal of sea ice on the climate system.

The CLIVAR/CliC Southern Ocean Implementation Panel continued its work advancing the understanding of Southern Ocean climate processes. A pilot Southern Ocean observing system has been established. Progress could be reported in studying the carbon cycle-ocean physics links. Extension of work was needed on the ocean-atmosphere-cryosphere interactions. CliC recognises that one of its important tasks is to contribute more to the activities of the Panel. However, the resource base for that was insufficient. Dr I. Renfrew (UK) was a new CliC-appointed Co-Chair of the Panel. The next Panel meeting would be in Cambridge in June 2005. The Panel was organising a workshop on mid- to high-latitude southern hemisphere climate variability, associated with its meeting, and a workshop on Southern Ocean modelling, including sea ice, which would be a joint activity with the WGOMD.

After a difficult period, there were perspectives for more active work of the WCRP/SCAR International Programme for Antarctic Buoys (IPAB). A new IPAB coordinating office would be hosted by the Alfred Wegener Institute for Polar and Marine Research.

8.4 Cryospheric observations

The main task of the CliC cryospheric observations group is to prepare, in 2004-2006, an Integrated Global Observing Strategy Partnership (IGOS-P) report proposing the way to implement a system of cryospheric observations.

GCOS has shown an increasing interest in cryospheric observations. However, their improved coverage of the cryosphere in the Implementation Plan for the GCOS in support of the UNFCCC (October 2004) was not yet fully satisfactory in the view of several CliC experts. CliC was of the opinion that there needs to be strengthening of “cryospheric” expertise on the GCOS panels, and CliC was preparing a proposal to the GCOS Steering Committee to develop a mechanism through which the Cryospheric Observations Panel would become, in a slightly modified version (and probably with amended composition), a science advisory body providing input on cryospheric observations to GCOS.

Two satellite missions, namely ICESat and CryoSat, are dedicated to measurements of the cryosphere. The ICESat was launched on 13 January 2003 but with the failure of one of its lasers on 29 March 2003, it has operated in a reduced mode. Nevertheless, it has demonstrated the ability of the laser altimeter to produce most accurate elevation maps of Greenland and Antarctic ice sheets and capability to detect ice sheet elevation changes of centimetres/year and map the sea ice thickness (distributions and means). CryoSat is a three-year radar altimetry mission, scheduled for launch in June 2005, to determine variations in the thickness of the Earth’s continental ice sheets and marine ice cover. Its primary objective

was to test the prediction of thinning Arctic ice due to global warming. Outputs of these satellite missions would potentially provide new data and information on changes in key elements of the high latitude cryosphere.

8.5 Modelling and reanalysis

CliC was in the process of adjusting its modelling activities for its new structure and global objectives. Cryospheric modelling has to be an inherent part of the WCRP modelling strategy and should contribute to Earth System modelling. Initial contacts have taken place regarding an extension of the permafrost modelling scheme in the COSMOS Earth System model. Following the initial ice sheet model intercomparison activities, several groups have now started to include quantitative models of ice sheets in climate models oriented towards simulation of long-term changes, such as Ice Ages. More has to be done to contribute cryospheric parts to reanalysis activities, including developing ocean reanalysis. An Arctic regional reanalysis project continues under supervision of the CliC rapporteur on reanalysis, Dr M. Serreze. A possible output of this activity could be best quality gridded data sets of ”essential” cryospheric variables. This work could become part of a wider reanalysis of the global climate system.

8.6 Data and Information Management

The first meeting of the CliC Data and Information Panel (DMIP) is planned for 9-11 June 2005 in Boulder, USA. DMIP would continue the development of the Data Information Service for CliC. CliC was 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 a basis for those proposed in the Framework Document for the International Polar Year 2007-2008.

8.7 First CliC Conference

The First CliC Science Conference “Cryosphere - The "Frozen" Frontier of Climate Science: Theory, Observations, and Practical Applications” would take place at the China Meteorological Administration (CMA) in Beijing, China, 11-15 April 2005. The response to call for abstracts was extremely positive. The programme of the conference would focus on the four CliC project areas; would include parallel sessions, discussion groups, partner programme presentations, and a session on the International Polar Year activities. The conference would attract more than 300 participants from all corners of the world. It should conclude by adopting a statement outlining the role of cryospheric studies for the science of climate variability and change. WCRP and especially CliC were very grateful to CMA for their offer to host the Conference and for the strong ongoing support in the course of its preparation. It was expected that the Conference would be very successful in not only providing a forum for discussion of research on cryosphere and climate, but also in bringing together scientists to address the cryosphere in a global context.

8.8 Operation of the CliC International Project Office (CIPO)

The Norwegian Polar Institute (NPI) continued to support the office and hosting it in Tromsø, Norway. Support for its operations comes form several sources but augmented resources were required, as the scope of the project activities expands from regional to global. Dr C. Dick, the office Director, was resigning from his post on 30 June 2005. A search for a new Director took place and interviews for short-listed applicants were scheduled at NPI on 31 March-1 April 2005. CliC has found that it was possible to have CIPO staff in different countries and still deliver an efficient and effective programme. Today, many countries were more amenable to providing a person resident in their own country to support project offices, such as CIPO.

The JSC thanked Dr B. Goodison for his report on the progress of the CliC project. The JSC was pleased to note strengthening links to regional polar bodies, including the sponsorship of CliC, IPAB and the SO Panel by SCAR and the growing interest in and recognition of CliC by Arctic research communities. The JSC also noted that CPAs 1-3 had excellent focus on important issues. However, CPA4 was considered to be a much broader activity that would require cooperation with other WCRP projects, WGCM, and possibly IGBP’s PAGES. CliC should consider optimal ways of delivering results for this CPA. Water management issues associated with the cryosphere would need to be addressed. Studies of the polar vortex would require cooperation with SPARC. CliC would work with CLIVAR on studies of the thermohaline circulation. A stronger focus was needed on tropical glaciers and the mountain cryosphere. 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.

Whilst agreeing that CliC's specific modelling requirements should be organised within its CPAs, the JSC stated the need also for a mechanism to provide an overview of those activities. SNOWMIP2 would be a joint activity of CliC, GEWEX and WGNE.

The JSC supported the need for consultations between WCRP projects, JSC, IGBP and NEESPI before any formal relations might be established with NEESPI. NEESPI data policy would have to be explored in the course of such consultations.

The JSC invited CliC to report on specialised cryospheric satellites, such as ICESat and CryoSat, at the next JSC session.

8.9 WCRP participation in IPY 2007-08

Background

The first draft of the IPY Outline Science Plan, prepared by the ICSU IPY Planning Group in cooperation with the WMO, was released in April 2004 to the scientific community and national and international organizations for comment and discussion. Comments from the international community and consultation at an open forum in September 2004 resulted in "A Framework for the International Polar Year 2007-2008". Six scientific themes were identified:

- Current state of the polar environment
- Change in the polar regions
- Polar-global linkages and interaction
- Investigating new frontiers
- Polar regions as vantage points
- Circumpolar human societies

To address the six major research themes, interdisciplinary observational strategies have been advanced. A synoptic set of multidisciplinary observations of the polar environments in 2007-2008 was proposed to set up a baseline for identifying future change. Plans to acquire key data sets necessary to understand factors controlling change in the polar environment have been put forward to quantify and understand past present and future change at the poles. Multidisciplinary observational networks would be established to enable better identification of the global linkages between the poles and the rest of the planet. Coordinated, multidisciplinary and multinational investigations would be launched addressing the frontiers of science. Leveraging the unique vantage point of the polar regions would manifest itself through the establishment of polar observatories. Studies of the human dimensions would be supported by the creation of datasets on the changing conditions of circumpolar societies.

Since October 2004 a new WMO/ICSU Joint Committee (JC) has been developing the IPY Programme. This was the leading international committee for IPY.

WCRP participation in the IPY

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 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.

Approximately 900 expressions of intent (EoIs) have been received by the IPY office in Cambridge, UK. The vast majority of the EoIs propose activities in the areas of climate, oceanography, glaciology, meteorology, and remote sensing. They may contribute significantly to achieving the goals of the CliC project, especially in developing the cryospheric observations. The WCRP is well represented on IPY committees and groups. Among other members, the JC included active and past members of the CliC SSG, e.g., Drs I. Allison (a CliC SSG co-vicechair), E. Fahrbach, V. Kotlyakov, Q. Dahe, and the Executive Director of the ICSU Scientific Committee on Antarctic Research, Colin Summerhayes. Drs Allison and M. Beland (THORPEX) are the JC co-chairs. The CliC SSG Chair, Dr B. Goodison was a member of the WMO IPY Intercommission Task Group. Strong representation of the climate science and observation community on IPY bodies is instrumental for the success of the IPY activities because international bodies like WCRP are likely to be asked to lead the analysis and co-ordination of the multiple IPY science initiatives.

The following IPY pre-proposals were submitted to the IPY JC through or in direct contact with the WCRP and its projects:

- The State and Fate of the Polar Cryosphere (CliC)
- The Thermal State of Permafrost: An IPA Contribution to the International Polar Year and the International Year of Planet Earth (IPA)
- PErmafrost And Carbon Emissions (PEACE) (IPA/GCP/CliC)
- Integrated Arctic Ocean Observing System (iAOOS) (CliC)
- The Northern Seas at a time of Global Change: an AOSB-CLIC observing plan for the IPY (joint AOSB-CliC initiative)
- Northern Seas at a time of Global Change: an AOSB-CliC Observing Plan for IPY (CliC)
- Climate in Antarctica and the Southern Ocean (CLIVAR/CliC/SCAR)
- Arctic's Role in Climate Change (CliC)
- Pan-Arctic Climate Variability Activity for the Past 50 to 150 years (CliC related)
- Coordinated Enhanced Observing Period (CEOP) Phase II, Enhanced Polar Observations Project (GEWEX/CliC)
- Arctic HYCOS, an Arctic component of the WMO World Hydrological Cycle Observing System (WHYCOS) (CliC/GEWEX)
- BEARDS (Buoys Encompassing the AntaRctic: an enhanced Deployment Strategy) (WCRP)
- International Arctic Buoy Programme: Expanding Arctic Observations for the International Polar Year (WCRP related)
- The structure and evolution of the stratospheric polar vortices during IPY and its links to the troposphere (SPARC)
- Polar Stratospheric Ozone Depletion and Future Changes (SPARC)
- Impact of Aerosols on the Arctic Hydrological Cycle (GEWEX)
- Ocean-Atmosphere-Sea Ice-Snowpack (SOLAS, CliC)
- IPY Data and Information Service (DWAS) for Distributed Data Management: NSIDC

In addition, there were more than 80 other proposals that refer to WCRP or one or more of its projects in their description or as a linkage. This makes the task of co-ordinating the science especially challenging. The WMO Intercommission Task Group would play an important role, not only for activities within WMO but also with other organizations and scientific groups.

The first session of the JC and the immediately following Third Open Consultative Forum on IPY were held in Paris, over the period 7-11 March 2005, just prior to this JSC session. The JC reviewed all 900 pre-proposals and produced ideas for major projects to form the core of the IPY international activities. The Forum then considered the deliberations of the JC and the outcomes were awaited.

Expected outcome of the JSC-XXVI

The IPY initiative represents a unique opportunity for the CliC project to launch its implementation activities. About 50 of the proposals identify CliC and its activities as linking to their particular project. The CliC SSG and group members should be proactive in reviewing and commenting on the IPY proposals in areas associated with climate change, glaciology, polar meteorology and oceanography. Among the IPY pre-proposals there were some that contain direct contributions to the WCRP COPES goals, both with respect to polar regions and globally addressing, e.g., predictability associated with polar processes and cryosphere, which is of direct interest for seasonal forecasting. The IPY offers an opportunity to initiate deep oceanographic observations in areas with perennial polar ice. Plans to conduct a CEOP-II may go a long way in producing high quality data sets for polar areas. Unfortunately, the interest of WCRP modelling groups in IPY has been weaker than desirable.

There was confidence that most of the WCRP EoIs would be approved by the JC. The WCRP community would then be confronted with a need to find resources and implement what has been proposed. Full proposals for IPY projects involving heavy logistics and international coordination would be due in June 2005. Some of the WCRP EoIs, e.g., proposals by the CLIVAR/CliC Southern Ocean Panel and several activities in the Arctic were of that nature.

JSC was invited to advise the CliC project leadership and other meeting participants involved in IPY activities on the way forward. Comments on the nature of the science proposed would be very helpful. Also, scientific and observational gaps and other areas where WCRP should consider involvement should be identified and discussed. IPY was evolving and there would be ongoing opportunities to engage the community and co-ordinate activities.

The JSC thanked CliC for its efforts in encouraging and coordinating WCRP's input to date to the planning of the IPY observational and research programme. WCRP projects were encouraged to further contribute to IPY planning and to take active part in reviewing the expressions of intent obtained by the IPY office and in formulating IPY lead projects in climate research.

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

Prof. A. O'Neill, Co-Chair of the SPARC Scientific Steering Group (SSG), presented the main developments in SPARC since the last JSC meeting, including the principal items and recommendations from the twelfth session of the SPARC Scientific Steering Group held in Victoria, British Columbia, Canada, 9-12 August 2004.

9.1 Project objectives and approach

The SPARC project continued to strive to facilitate stratospheric research and highlight the importance of stratospheric processes in the climate system. This was achieved by an approach which emphasized three central goals:

- To be responsive to the need for scientific input to international scientific assessments for the benefit of WCRP, WMO/UNEP (UN Environment Programme) Ozone Assessment, Intergovernmental Panel on Climate Change (IPCC), and space agencies.
- To identify manageable projects where co-ordination at the international level can make a difference.
- To have clear deliverables for each project, such as scientific reviews which summarise the state of knowledge, facilitate and stimulate new directions for research.

SPARC brings together the scientific community working on stratospheric science in the broad context of dynamics of the stratosphere, ozone changes in the stratosphere, causes for the changes in stratospheric climate, and the role of stratosphere in the Earth's climate. There is collaboration and cooperation with other WCRP projects with an aim to contribute towards the overall goals of WCRP.

In order to address goals enunciated in previous WCRP JSC meetings, the future SPARC programme would be encapsulated within three main themes: (1) detection, attribution, and prediction of stratospheric changes, (2) stratospheric chemistry and climate, and (3) stratosphere-troposphere coupling. A new implementation plan reflecting these themes was under development. It would be important to ensure that the plan reflects the highly crosscutting nature of these themes and how the new SPARC programme fits into the WCRP COPES strategic framework and contributes to its objectives.

9.2 Recent significant events within the SPARC project

Establishment of the new SPARC International Project Office (IPO)

The SPARC IPO was relocated to the University of Toronto (Canada), after more than a decade in France. The new SPARC IPO is staffed by Dr N. McFarlane (Director), Dr D. Pendlebury (Staff Scientist) and Mrs V. De Luca (Office Manager). Financial and logistical support for the establishment of the new SPARC IPO has been provided by several Canadian Sponsors: The Meteorological Service of Canada (MSC), the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), the University of Toronto, and the Canadian Space Agency (CSA). The transition from Paris to Toronto went smoothly and the new SPARC IPO became fully operational immediately following the SSG meeting in Victoria, BC, Canada in August 2004. At this meeting the SPARC SSG unanimously expressed its gratitude to Dr Marie-Lise Chanin for superb service to the SPARC project, both as one of its founding Co-Chairs and as Director of the SPARC Office since its inception, to Ms C. Michaut for her excellent service as Office Manager in Paris, and to the Centre National d'Etudes Spatiales (CNES), Centre National de la Recherche Scientifique (CNRS) and Météo-France for supporting the SPARC Office while it was located in Paris.

The Third SPARC General Assembly

The Third SPARC General Assembly (GA) was held in Victoria, British Columbia, Canada, 1-6 August 2004. The overall goal of this Assembly was to present the science relevant to the new overarching themes of the SPARC project. The area of climate-chemistry interactions was given particular emphasis. A subsidiary goal of the Assembly was to take into account important current research on processes in the tropical and extratropical tropopause regions. To achieve these goals the programme was organized under themes for each day with the following headings: (Day 1) Chemistry - Climate Coupling,

(Day 2) Extratropical Upper Troposphere/Lower Stratosphere, (Day 3) Stratosphere-Troposphere Dynamical Coupling, (Day 4) Tropical Tropopause Layer, (Day 5) Detection, Attribution, and Prediction. The members of the Scientific Organizing Committee for the Assembly were Drs A. Ravishankara (Co-chair), T. Shepherd (Co-chair), C. Granier, P. Haynes, T. Peter, J. Burrows and W. Randel. The Local Organizing Committee members were Drs N. McFarlane (Chair), M. Berkeley, J. Fyfe, J. Scinocca, D. Tubman, K. von Salzen and V. Arora. The smooth running of the assembly was greatly facilitated with the help of Ms A. Chautard (WCRP), V. De Luca (SPARC IPO), L. Droppleman (NOAA) and C. Michaut (CNRS).

The scientific programme of the Assembly was put together in a format that was somewhat different from most meetings. It was comprised of overview talks by the leaders for each of the daily themes, invited talks, contributed talks, and three special SPARC lectures that provided overarching syntheses. Equally important were the poster sessions which were given ample time and were the main venues for presentation of detailed new science.

Some key developments highlighted in the Assembly were: (1) chemistry - climate models have reached a level of maturity for attribution and prediction of long term changes in the stratosphere; (2) process studies in the upper troposphere/lower stratosphere (UT/LS) region require a multi-disciplinary approach involving both models and measurements; (3) high-resolution cloud modelling will play an increasingly important role in understanding processes in the UT/LS region; (4) connections between different time-scales are important for seasonal and longer term variability; (5) there is an emerging understanding of the coupled nature of long-term changes of temperature, water vapour, ozone, methane, and other chemical species.

The Assembly attracted 345 participants from 33 countries and a total of 378 papers were presented. Many of these are available on request from the SPARC IPO. It was very heartening to see a significant participation from developing countries. Financial assistance from many organizations, including WCRP, allowed for the participation of many deserving scientists, who would not have been able to attend without some help. A comprehensive report on the GA is included in SPARC Newsletter No. 24, published in Toronto in January 2005.

The SSG meeting of SPARC was held just after the GA at Dunsmuir Lodge, Victoria. A report on the deliberations and presentations at the SSG was published in SPARC Newsletter No. 24. The SSG was apprised of the JSC's decisions and wishes, as expressed at the Moscow meeting. In an opening presentation to the SSG, Dr D. Carson outlined the COPES strategic framework and discussed its initial development and status. Some ideas as to the role of SPARC in relation to the COPES strategy were brought forward at the SSG meeting. However, the development and implementation of these will require close coordination between the WCRP core projects and clarification of their roles in support of the COPES aims and objectives. Other principal items and actions recommended by the SSG are discussed in the following sub sections.

9.3 Upcoming SPARC results

(a) Assessment of Stratospheric Aerosol Properties (ASAP). This report is in the final stages of preparation and is expected to be ready for publication by May 2005.

(b) Polar Stratospheric Cloud (PSC) Assessment (SPA). The motivation for initiating this assessment activity is the existence of significant gaps in our 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. Progress has been made in defining the structure of the report and assembling
(c) lead authors. A lead authors kick-off meeting will be held in mid 2005.

9.4 Status of the three main streams of SPARC activities

Detection, Attribution and Prediction of stratospheric changes

The Angell Workshop on Temperature Trends in the Stratosphere (November 2003, co-sponsored by SPARC and reported in Newsletter No. 22) reviewed updated observations, model simulations of stratospheric temperature changes and their interpretation, and the effects of changes in stratospheric variability and circulation. Several of the issues arising from this workshop were addressed in presentations at the SPARC General Assembly.

Key issues for operational data are the availability of long-term, high quality temperature records in the stratosphere and mesosphere, identification of problems and quantification of uncertainties in current satellite data and reanalyses, efforts to bridge datasets across the TOVS-ATOVS satellite boundary and in future satellite datasets, inclusion of SPARC input into future reanalyses and "climate network" designs. Key points for process and experimental data sets are the inclusion of specific UT/LS measurements, multiple sources of data, and ensuring the quality of radiative forcing data sets including ozone, water vapour and aerosols.

Success of modelling requires consistency of simulations and processes, and progress in parameterization. Consistency of simulations requires intercomparison of radiation codes and intercomparison of model responses to specified forcings. Key issues for process studies and parameterization are evaluating the role of interactive chemistry in model variability, improving quantification of parameterization effects, identifying sensitivities and uncertainties, gaining better understanding of dynamical coupling of the troposphere and stratosphere, evaluating model uncertainties in the face of interannual variability (particularly in winter polar regions), improving UT/LS physics (especially aerosol and cloud microphysics), and identifying robust indicators for model sensitivity studies. SPARC will seek to enhance cooperation with AMIP and CMIP, GCOS and GEOSS. The use of PCMDI facilities for SPARC intercomparisons, and making best practices known via the project website would be desirable.

Important issues emerging from the Angell Workshop and the General Assembly for the Detection, Attribution and Prediction Theme included:

- Estimating signal versus noise using ensemble runs and long control simulations, emphasizing the use of a probabilistic approach for attribution and prediction;
- Understanding sensitivity of past and future predictions to uncertainties in forcings;
- Testing consistency across different indicators (e.g. temperature and radiative gases);
- Developing and using fingerprint techniques based on space-time patterns of signal responses and noise;
- Understanding the differences between equilibrium runs and transient response experiments;
- Quantifying the role of tropospheric forcing of the stratosphere including the impact of using observed versus climatological and observed versus simulated SSTs;
- Developing improved diagnostics to distinguish radiative and dynamical responses.

A small SPARC working group has been organized to address uncertainties in quantifying and interpreting the past record, and importance for the SPARC themes and the future WMO Ozone Assessment. A workshop on updating the stratospheric temperature record was being organized and would be held in March 2005. The output of this workshop, in the form of a report or a peer-reviewed paper, would be highly beneficial to the upcoming WMO 2006 Stratospheric Ozone Assessment.

Models are key tools for detection/attribution/prediction of climate change. A challenging issue for this theme is the ratio of signal to noise. In many respects the noise is not well characterized statistically and has time-scales overlapping with those of the forcing. Coupling between the signal and the noise is not negligible. There may be a need to attribute some aspects of the noise. Models likely underestimate the noise and have their own sources of errors in variability. That variability may be crucial in understanding changes in key atmospheric constituents, e.g. H_2O or O_3. Chemistry Climate Models (CCMs) are the main tools for uncovering the coupled chemical-dynamical variability. The dynamical forcing is predominantly wave drag. It is associated with (mainly horizontal) mixing. The planetary wave-drag (PWD) response to climate change may be critically important, but model studies to date are inconclusive on this point.

Various future assessments will require improved diagnostic characterization of model simulations. In order to facilitate this, it is essential that simulations be made using the same forcings and including all relevant chemical processes. This issue is currently being addressed within the process-oriented couple CCM validation (CCMVal) activity, which has emerged as a new SPARC activity following the concepts that were developed following the initial workshop in Grainau, Germany, in November 2003.

Stratospheric chemistry-climate interactions

Knowledge of the coupling and feedbacks between atmospheric, oceanic, land, and biosphere processes and representing the relevant processes adequately in climate prediction models are critical for future assessments of climate changes. Different projects within WCRP as well as some outside, e.g. in IGBP, address ocean, land, and biosphere processes. Collaboration and cooperation with these projects is essential for the success of SPARC in elucidating atmospheric chemistry-climate coupling as well as stratosphere-climate interactions. Clearly, for even the stratosphere-climate interaction studies, an interdisciplinary approach must be adopted involving laboratory measurements, field campaigns and

numerical modelling. Work under this theme will continue to involve strong collaborations between SPARC and the IGBP IGAC project. To have a tangible start, SPARC is collaborating with IGAC in the atmospheric chemistry-climate interactions. It was also decided to have initial emphasis on the UT/LS region. Presentations and discussions at the General Assembly recognized this region as central to the SPARC theme on stratosphere-troposphere dynamical coupling. Clear understanding of the processes that connect emissions (source, precursors) to abundances and the processes that connect the abundances to the climate forcings are essential for an accurate prediction of the future climate and an assessment of the impact of climate change and variations on the Earth system.

The session on Chemistry-Climate Coupling in the General Assembly revealed that within the current decade there have been substantial advances in availability and analyses of global observations within the stratosphere and mesosphere and in the development and use of GCMs, which resolve these regions and include representations of key chemical and physical processes. Validation of these models motivated the SPARC activity on process-oriented validation of CCMs (CCMVal) and this has become an important underpinning activity for this theme. As the CCM Validation Project has been based on the experience gained in the GCM-Reality Intercomparison Project for SPARC (GRIPS) project and is a natural extension of it, amalgamation and renaming of the two projects was proposed and approved by the SPARC SSG. This will take place following the final GRIPS workshop, which will be held in Toronto in March 2005. The next CCMVal workshop will be held in Boulder, Colorado (USA) in October 2005.

Understanding the coupling between clouds, chemistry and dynamics in the UT/LS region is fundamental to improving the representation of microphysical, chemical, and radiative processes in GCMs and reducing the uncertainty in climate change predictions. Recent research suggests that moist convection plays a critical role in the thermal tropical tropopause layer (TTL) as well as in the transport of water vapour and chemical constituents into the tropical upper troposphere. Cloud resolving models (CRM) are increasingly being used as tools to explore and elucidate physical and dynamical processes in this region. In this regard the interest and goals of SPARC overlap to some extent with other WCRP projects, for example the GEWEX Cloud System Study (GCSS). A future SPARC activity which will focus on the TTL is being explored. It is envisaged that such an activity would encourage using combinations of CRMs, observational analyses and other modelling and analytical approaches to study key physical and chemical and radiative processes in this region, as well coupling to the lower troposphere and ultimately the surface of the earth (see section 5.2).

Stratosphere-troposphere dynamical coupling

Stratosphere-troposphere dynamical coupling through the mechanism of planetary wave drag is currently a major research activity, aided by a hierarchy of models. The familiar idea that the troposphere affects the stratosphere through upward propagation of waves (large-scale Rossby and gravity waves) goes back to the simple theory of J.G. Charney and P.G. Drazin. It is supported by numerical experiments with so-called "mechanistic" and troposphere-stratosphere general circulation models (GCMs) and as well by observations of summer-winter differences. However, it has become increasingly clear that such a one-way view of troposphere affecting stratosphere is of limited utility. Extratropical dynamics is non-local in both the horizontal and the vertical. There is evidence from numerical modelling studies that changes in the middle and upper stratosphere affect the troposphere and that communication is dynamical.

Several of the presentations in the SPARC GA dealt with various aspects of this topic. Three paradigms have emerged, supported by results of observational and modelling studies: (a) the troposphere affects the stratosphere (seasonal cycle in stratospheric circulation, interhemispheric differences etc.); (b) the stratosphere affects the troposphere (tropospheric signal of quasi-biennial oscillations, solar cycle, volcanic aerosols, dynamical response to ozone depletion); and (c) there is a two-way coupling (aspects of low frequency variability in NH winter, SH spring, response to changes in long-lived greenhouse gases).

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. This topic, among others, was explored at the Workshop on Stratosphere-Troposphere Dynamical Coupling held in Whistler (BC), Canada, in April 2003 (reported upon in SPARC Newsletter No. 23), at the meeting of the WCRP COPES Task Force on Seasonal Prediction held in November 2003, and again in presentations in the SPARC General Assembly. A second follow-on workshop on this stratosphere-troposphere coupling will be held early in 2006 and will focus on longer time scales (10-100 years) and chemical/dynamical coupling.

The dynamical coupling of the stratosphere and troposphere is also important in understanding the physical processes involved in the transport of chemical species across the TTL, which in turn is important in the prediction and attribution of the climate change. The uptake of chemical species into the stratosphere by

the large-scale Brewer-Dobson circulation is fed from the troposphere by deep convection and is therefore affected by the amount of overshoot of the minimum lapse rate, the location of the cold-point tropopause and the level at which the clear sky radiative cooling is zero. These factors are affected by low frequency variability in the troposphere (e.g. ENSO, seasonal variation), while the Brewer-Dobson circulation is affected by the internal variability of the stratosphere. Research into the TTL is a growing field that will require accurate, high-quality observations together with models that are able to resolve, or accurately parameterize, the physical processes involved.

9.5 Crosscutting and supporting activities

Data Assimilation

The SPARC working group on Data Assimilation has been established under the leadership of Dr Saroja Polavarapu of The Meteorological Service of Canada. This group will establish links to other data assimilation activities within the WCRP. One of the important initiatives to be undertaken within 2005 is the establishment of an annual workshop on data assimilation with the focus on the middle atmosphere and climate. This workshop will be complementary to other data assimilation workshops, which usually focus on operational forecasting issues, with the stratosphere as a side topic. The workshop would also bring together non-data assimilation people from the SPARC community with complementary expertise on dynamics, chemistry, and transport.

The SPARC Gravity Wave Initiative

The VORCORE ("vortex core") experiment proposed by Dr F. Vial received strong support from the SSG at the 10th SPARC SSG meeting in Kyoto in 2002. The VORCORE involves launching an ensemble of super-pressurized balloons (SPB) that would fly for several months at 50 hPa to 70 hPa levels in the vicinity of the Antarctic polar vortex. It was suggested at the SSG meeting that a similar campaign would be valuable in the tropics. The SPARC Equatorial Circulation Experiment (ECE) will be such a tropical campaign. A working group has been formed, co-chaired by Drs K. Hamilton and F. Vial. VORCORE will take place in 2005 as planned. ECE is planned for 2006 near Darwin, and a workshop may be held at the end of the project. Continued SPARC interest is important for its success.

The Gravity Wave Initiative is nearing its completion. A radiosonde climatology paper is in preparation. The Darwin Area Wave Experiment (DAWEX) campaign took place in late 2001, and a workshop was held in Honolulu in 2002. It was reported in SPARC Newsletter No. 20 and a series of papers are part of a forthcoming JGR Special Issue.

SPARC was a co-sponsor of the Chapman Conference, held in Waikoloa, Hawaii in January 2004. This was a very successful conference with 64 participants from 11 countries (see report in SPARC Newsletter No. 23). An additional smaller workshop, on convectively forced gravity waves, may be held in 2006 and will focus on some key remaining theoretical questions of relevance to GW parameterization, analysis of results from, or planning for the 2006 field experiment.

SPARC Data Centre

The Data Centre has been an essential ingredient for much of SPARC's past successes, and we look forward to its evolving to serve SPARC's new agenda in an equally effective manner. Prof. M. Geller, founding Co-Chair of SPARC, agreed to continue as director of the Data Centre at the request of the SSG.

Since December 2004, Dr S. Liess (stefan.liess@stonybrook.edu) from the Stony Brook University has been serving as the SPARC Data Centre Scientist (http://www.sparc.sunysb.edu). Dr Liess will continue the work of his predecessors Drs Petra Udelhofen and Xuelong Zhou in working with the SPARC projects to acquire newly available data as needed, as well as to maintain archives of data that have been used in SPARC projects so that they may be acquired as needed by the world community and also be available for updating should the SPARC projects desire to do so. Subject to funding, plans for the near future include a modernization of hardware facilities in order to accommodate the growing demand for data storage. This demand arises from several sources (e.g. from an ongoing collection of high-resolution radiosonde data from 93 U.S. stations, a planned chemistry-climate model intercomparison project (CCMVal), and a need to provide storage space for SPARC International Polar Year (SPARC-IPY) data). It is also planned to implement online plotting in order to ease data access and decrease data transfer. The SPARC Data Centre has been funded by NASA grants to the Stony Brook University with Prof. M. Geller as Principal Investigator. A new proposal is being prepared for submission to NASA for continued support.

9.6 Linkages with programmes and projects within and outside WCRP

SPARC-IGAC venture in Laboratory Studies of Atmospheric Chemical Processes

This was the first joint venture between IGAC and SPARC and came about because of the vision of the first co-chairs of SPARC and the leader of IGBP. This task has been responsible for two reviews, which are published as peer-reviewed papers, and many workshops. Currently, this task involves collaborating with the Atmospheric Composition Change; the European Network of Excellence (ACCENT) programme and planning on the next steps in evaluating the key data needed for stratospheric and tropospheric chemistry calculations.

Joint SPARC-IGAC UTLS Workshop

This workshop will follow on from the SPARC/IGAC workshop on Chemistry-Climate interactions (Giens, 2003) in Mainz, 18-20 May 2005. It will address the following issues:

- Which dynamical and meteorological processes govern the chemical composition of the midlatitude UT/LS?
- What is the relative importance of chemical versus dynamical processes in governing the chemical composition of the extratropical UT/LS?
- Which chemical/physical processes are important in governing UT/LS composition?
- How do we better quantify the net exchange of ozone, and other trace constituents, between the stratosphere and the troposphere?

The workshop outcomes will include publication of a meeting report in the SPARC Newsletter. In addition, it is expected that a review paper will be produced to summarize current knowledge on extratropical UT/LS chemical composition.

9.7 Participation of SPARC in the International Polar Year 2007-08

An Expression of Interest had been submitted to the International IPY Secretariat on behalf of SPARC under the title “The structure and evolution of the stratospheric polar vortices during IPY and its links to the troposphere” (with the acronym SPARC-IPY). The proposed IPY programme will coordinate the activities of the international SPARC community in relation to IPY. This co-ordination will be directed toward both satellite and ground-based campaigns, as well as specific initiatives promoted by SPARC to increase understanding of the polar atmosphere.

In addition to coordinating and facilitating IPY projects within the SPARC community, SPARC-IPY will promote specific initiatives directed toward the understanding of major features and processes in the polar middle atmosphere during the IPY period. These initiatives will include a range of research activities involving modelling, observations, and analysis and will include workshops and meetings as needed or desirable to facilitate research and dissemination of results. These efforts will be carried out in the context of the SPARC project core thematic programmes.

9.8 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, at its August 2004 meeting the SSG agreed that in the future this initiative should continue as a separate SPARC activity in collaboration with the Scientific Committee On Solar-Terrestrial Physics (SCOSTEP) Climate and Weather of the Sun-Earth System (CAWSES) programme. Dr K. Kodera is the leader on behalf of SPARC. A working group for this activity was being established.

To identify principal problems related to the solar influence on climate, K. Kodera, U. Langematz, and A. Smith organized a successful session on "Solar influence on climate through mesospheric-stratospheric chemical and dynamical processes" at the AGU Fall meeting (San Francisco, December 2004). There were 20 presentations (1 oral and 1 poster session).

To add depth to the discussion, a half-day meeting with participants was held in the hotel in addition to the AGU sessions. The discussion centred on the following subjects, which could be main themes of the SPARC solar influence study:

- Role of energetic particles on minor constituents
- Ozone distribution and the role of the QBO
- Stratosphere - troposphere coupling
- Interaction with the ocean and cryosphere

Concerning a cooperation with the SCOSTEP CAWSES programme, while visiting the University of Reading in September 2004, Dr K. Kodera met with Dr L. Gray, co-chair of the CAWSES theme 1 "Solar Influence on Climate". Dr Gray agreed to co-ordinate activities in CAWSES with those in the SPARC solar influences study group. Further interaction between the SPARC and CAWSES communities will be developed during the International Space Science Institute (ISSI) Workshop on "Solar Variability and Terrestrial Climates" in Bern, June 2005, convened by Dr M.-L. Chanin, among others.

9.9 The role of SPARC in COPES - issues for the JSC

Enunciation of new SPARC themes and exploration of these in the General Assembly have provided a framework for future SPARC activities as well as for the role of SPARC within the COPES strategic framework. There are several areas in which SPARC can and should continue to play a leading role within WCRP in pursuit of the aims and objectives of its new strategic framework, COPES.

The crosscutting issue of Atmospheric Chemistry and Climate overlaps completely with the SPARC theme on Stratospheric Chemistry and Climate.

Large-scale modelling activities have hitherto been one of the main foci of the GRIPS project. With the involvement of GRIPS in the new CCMVal initiative there will be a much greater emphasis on process-based validation within the future SPARC agenda. This is consistent with the goals of the new SPARC thematic programmes and will not reduce the emphasis on large-scale modelling so much as change the perspective of future validation activities. However, the GRIPS project and the complementary ongoing SPARC activities in detection and prediction of stratospheric changes provide a useful starting point for SPARC contributions to the COPES modelling and analysis activities underpinning its emphasis on seamless prediction.

The following are areas in which SPARC can play a significant or leading role in modelling activities for COPES:

Taking the lead on studies of climate model simulations and analyses of the atmosphere from the tropopause region and above

This would include dynamical climatologies for models, water and cloud physics in the TTL and, when necessary, chemical climatologies; validation and links with physical processes would be studied. This could involve "AMIP-like" runs and/or "special" runs (i.e., formulated specifically for the middle atmospheric community). Although virtually all of the major climate modelling groups in the world have participated in AMIP, most of the models used have not included a well-resolved stratosphere and none has included a comprehensive treatment of stratospheric chemistry in its AMIP runs. However, simulations with such models have been studied in the context of the GRIPs project, though with a less structured approach than was used for AMIP. The AMIP activity has largely been subsumed into the broader context of CMIP with the emphasis on coupled climate model simulations. However a carefully defined project, structured similarly to AMIP, which would focus on intercomparison and evaluation of AGCMS with well resolved stratospheres and comprehensive treatments of atmospheric chemistry, would be a valuable contribution to the COPES objectives. There are significant resource issues involved in setting up such a project. The attention and advice of the JSC concerning this would be appreciated.

Model studies of stratospheric impacts on the global circulation

These studies would range from "climate" studies (e.g. how well do models capture statistical connections in AO-like oscillations?), to case studies (e.g., how well are events forecast and what is the impact of the stratosphere on post-medium-range to seasonal forecasts?). Also, depending on the models' ability to capture such coupling, these studies should be applicable to a determination of causal mechanisms.

Leadership of modelling of chemistry-climate coupling (in collaboration with IGAC)

This would include both SPARC and IGAC areas of emphasis (e.g. stratospheric-ozone and climate led by SPARC, GHG-biosphere coupling and climate impacts in collaboration with IGAC). A number of modelling issues in this topic are central to both SPARC and IGAC themes, for example stratosphere-

troposphere exchange, modelling of key processes in the TTL as water moves from "physical" to "chemical" control in this layer. (See section 5.2)

Participation in development of process understanding and parameterization for global models

The basic understanding and quantification of the processes taking place in the atmosphere, physical and chemical, is essential for the accuracy of the models, especially those used for prediction. Representation of processes, especially those that take place in sub-grid scale, in coarser models is also a key issue. Processes such as convection that transport, redistribute, and sometimes bifurcate chemicals (e.g., nitrogen oxides, which are water insoluble are transported up, while soluble gases are removed in convection and precipitation) need to be quantified using acquisition and analysis of field data. Collaborations with GEWEX, IGAC, SOLAS, CliC, etc. will be initiated to further these efforts under the COPES strategic umbrella.

The above-suggested activities will naturally involve collaboration with other WCRP core projects as well as outside of WCRP. The advice of the JSC is sought concerning the above, and more generally for clarification of the role of SPARC.

The JSC thanked Prof O'Neill for his presentation of the SPARC report. The JSC's consideration of SPARC's role in the chemistry-climate initiative was considered under item 5.2.

The JSC considered what needed to be done at a "high level" to ensure that the temperature record derived from satellites is cross-calibrated between satellites. The importance of this issue had been recognised by GCOS and the former satellite working group, leading to the "reprocessing project" now proposed under WOAP.

The JSC was pleased to note the initiation of a joint SPARC/CLIVAR activity on modes of atmospheric variability and their change in a changing climate and that it was on the agenda of a joint CLIVAR/SPARC session at the upcoming AMS meeting. Ideas exchanged there would be used to plan a joint SPARC/CLIVAR Workshop on Stratosphere-Troposphere Coupling and Modes of Variability for early 2006; the scope would also be guided by the discussions at the next SPARC SSG meeting (September 2005).

The JSC supported the proposal that SPARC and GEWEX should together address a new initiative to exploit cloud-resolving models to understand processes in the tropopause transition layer. The GEWEX Cloud System Study workshop, to be held in Athens, would provide an opportunity to develop this initiative. SPARC should also partner GEWEX in a comparison of how aerosols are treated in radiative transfer codes. A merger of WCRP's tropospheric and stratospheric aerosol data sets should be considered. An intercomparison of aerosol radiative transfer codes used in climate models was also needed.

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. 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.

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 Chairman of WGNE, Dr M. Miller, summarized activities being undertaken under WGNE auspices 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, and NWP topics of interest such as verification and comparison of precipitation forecasts and developments in ensemble prediction. Prof J.F.B. Mitchell, Chairman 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.

10.1 Report of Working Group on Numerical Experimentation (WGNE)

The following paragraphs review the main activities of WGNE in support of WCRP objectives, emphasizing items arising at its twentieth session which was held at the Met Office, Exeter, U.K., 11-15 October 2004.

10.1.1 WGNE in the context of COPES

The Chair of the JSC had briefed WGNE on the status of the new WCRP strategic framework, COPES. The Chair of the WMP had also briefed WGNE about the aim and scope of this new WCRP panel. To facilitate the coordination and interaction of WGNE and WGCM with the WMP, the WMP would meet in conjunction with each of WGCM and WGNE in alternative years, starting with WGCM in 2005. It was also agreed that WGNE would in future have an explicit agenda item on the development of next generation atmospheric models.

WGNE had expressed concern that the new WOAP did not appear to have sufficient representation of data assimilation experts and this concern had been conveyed to the Chair of WOAP.

The need for good metrics for climate-type models had been discussed. WGNE welcomed the idea of development of metrics in the spirit of the new 'unified' prediction systems and would consider this at its next meeting. WGNE had also agreed that in future it would have an explicit agenda item on the development of next generation atmospheric models.

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 and reducing or eliminating them.

Atmospheric Model Intercomparison Project (AMIP)

AMIP, conducted by the PCMDI at the Lawrence Livermore National Laboratory, USA, with the support of the US Department of Energy, has been an important and far-reaching WGNE-sponsored intercomparison. The second phase of AMIP (AMIP-II) is coming to a close and much of the data from these runs are available for a wide range of diagnostic sub-projects.

Climatological comparisons are available for nearly every standard AMIP model output field. Overall, there have been progressive general improvements both in terms of the "median" model as well as for many of the individual models. The simulation of interannual variability and performance in specific geographical regions, as measured by global climatological statistics, also appear to be more realistic. Regular updates of the overall status of AMIP, model integrations, diagnostic subprojects are posted on the AMIP home page http://www-pcmdi.llnl.gov/amip.

WGNE expressed its gratitude to PCMDI for undertaking and successfully completing the AMIP projects and for creating a valuable infrastructure for processing model outputs at PCMDI and establishing efficient data formats etc for such exchanges of model simulations. WGNE recommended closure of AMIP2 in a time frame of six months. During this period PCMDI would announce the project's completion and update its status on the AMIP homepage. It will also make available PCMDI diagnostics of all AMIP and CMIP runs. WGNE, WGCM, GMPP and PCMDI would discuss the future of AMIP beyond AMIP2.

"Transpose" AMIP

The goal of the Transpose AMIP is to obtain the benefits for climate model development and evaluation that have been realized in weather prediction by using climate models as weather forecasting tools, but without the huge costs of developing a complete NWP system. Initially the climate models are applied at their relatively low application resolutions and are not expected to make the best weather forecasts, however the approach will also encourage higher resolution studies. The method allows direct comparison of parameterized 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 parameterizations see the erroneous climate model state rather than the true observed state.

Results were presented from the NCAR/PCMDI project, CCPP-ARM Parameterization Testbed (CAPT), the prototype version of "Transpose" AMIP developed for US modelling evaluation. These results demonstrate the viability and utility of this forecast approach for examining climate models and identifying avenues for improvement. It was agreed that WGNE would make a formal proposal to the international climate modelling community (including the AMIP mailing list) for an intercomparison Transpose AMIP.

Aqua-Planet Experiments (APE)

WGNE has endorsed an intercomparison, the 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-pcmdi.llnl.gov/projects/amip/ape/index.html
and http://www.met.reading.ac.uk/~mike/APE/ape_home.html
The experiment is designed to provide a benchmark of current model behaviour and to stimulate research to understand differences arising from: (1) different models, (2) different sub grid-scale parameterization suites, (3) different dynamical cores, and (4) different methods of coupling. Sixteen groups have declared their intentions to participate. Some preliminary results were shown to WGNE, which indicate a substantial spread in results with notably large variations in precipitation amounts. A Workshop will be held to discuss the results, summarize current model behaviour and produce a summary of research questions arising from the experiment.

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) remain high priorities for WGNE. The atmospheric and coupled modelling communities and oceanographers have very strong interest in advancing SURFA, which could provide a good opportunity for progress in estimating and determining surface fluxes. Efforts are continuing through liaison with the newly-formed 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. It was suggested that it was more convenient for NWP centres to provide data in real time. WGNE discussed the problems involved with adhering to data standards and noted that GODAE has been active in this area.

Regional Climate Modelling (RCM)

The Chairman of the WGNE/WGCM RCM panel briefed WGNE about the joint WGNE/WGCM international Workshop, 'High-resolution climate modelling: Assessment, added value and applications' held in Lund, Sweden, 29 March-2 April 2004. The Workshop focused on the application of nested, limited-area models (LAM) for regional-scale climate simulations and climate-change projections. Among the recurring themes at the Workshop were the validation procedure and the identification of the added value beyond the simple increase in resolution. The relative merits and limitations of various approaches used for achieving high-resolution climate simulations (such as time slices of high-resolution GCM, variable-resolution GCM, LAM) and the ensuing climate-change impact analyses were also discussed. The Workshop was the forum for several proposals for collaborative endeavour which included: (i) an inter-comparison project, North American Regional Climate Change Assessment Programme (NARCCAP), (ii) a "Transferability Working Group" (TWG), and (iii) a coordinated project exploiting the protocol of the "Big-Brother Experiment" (BBE). An electronic version of the Workshop proceedings is available from http://www.natgeo.lu.se/Lars.barring/RCMworkshop/RCMhome.htm.

WGNE was pleased with the successful Workshop on High Resolution RCMs held 29 March-2 April 2004, Lund, Sweden. WGNE will continue to discuss the developments in this area in its future sessions. It also discussed results from the Stretched Grid Model Intercomparison Project (SGMIP), noted that this was a very promising approach to higher resolution regional simulations and will continue to monitor the developments in this area in its future sessions.

Stratospheric analyses and forecasts

Following a presentation to WGNE by a SPARC Co-Chair it was agreed to increase interactions between WGNE and SPARC, including the establishment of agreed sets of model diagnostics. WGNE has already undertaken an intercomparison of stratospheric analyses and forecasts from a number of operational (NWP) models and a report is being prepared for publication.

WGNE recognizes that there is a great deal of potential for collaboration and liaison with SPARC and agreed to increase its interaction with SPARC.

Intercomparison of Forest Snow Process Models (SnowMIP2)

A new, project SnowMIP2 is being launched. The Working group commissioned by ICSI has drawn up a schedule of activities for the period 2004-2007. Three SnowMIP2 sites in Canada, Japan and Switzerland will be used, with simulations for forest and clearing at each site, simulations for two complete winters at each site, a pilot study with one model, and comparisons with ground and canopy snow loads. Both WGNE and GMPP endorsed the proposal.

10.1.3 Physical parameterizations in models

The GEWEX "modelling and prediction" thrust, with which WGNE works in close association, is devoting efforts to the refinement of atmospheric model parameterizations, notably those of cloud and radiation, land surface processes and soil moisture, and the atmospheric boundary layer. The discussion at the joint meeting of WGNE and GMPP, encompassing the GEWEX/GCSS, the GEWEX/GLASS, the GEWEX/GABLS, and the progress of CEOP, is described in the report of the GEWEX SSG to the JSC.

Collaboration with WGNE in the related activities of land data assimilation and reanalyses was discussed, and WGNE confirmed the value of the interaction with GMPP for parameterization work, particularly with GCSS. GMPP also considered that close interaction with AMIP is highly desirable. The analysis of the diurnal cycle in AMIP models will reinforce this. A special session on parameterizations was planned for the GEWEX SSG session in 2005.

A new GCSS Panel has been constituted, and a pan-GCSS meeting will be held in May 2005 in Athens. This will address 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 was proposed to evaluate physical parameterizations along the atmospheric cross section following the trade winds.

WGNE responded positively to this proposal and also suggested that there be a follow-up exercise over continents. WGNE also proposed that participants for the study should include the AMIP community and that the proposal provides an excellent opportunity to bring together NWP and climate modellers.

The WGNE community provides comprehensive gridded output from global data assimilation systems for CEOP. Many modelling groups are utilizing CEOP data in research and development activities and this should lead to model intercomparisons during the CEOP period.

Both WGNE and GMPP endorsed the proposal for a new intercomparison project of Forest Snow Process Models.

10.1.4 Re- analysis and data assimilation

Reanalysis projects

The ERA-40 reanalysis at ECMWF is complete and experimentation in preparation for the “interim reanalysis” has begun. This will run at least from 1989 onwards, with production beginning in 2005. The set of medium-range forecasts run twice daily from the ERA-40 reanalyses has been completed, and an “AMIP-style” simulation carried out for the ERA-40 period using the ERA-40 model and distributions of sea-surface temperature and sea ice. The ERA-40 publication series now comprises around 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 (http://www.ecmwf.int/publications/library/do/references/list/192). A comprehensive atlas of the atmospheric general circulation as depicted by ERA-40 is being produced in collaboration with the Meteorology Department of the University of Reading.

The Japanese 25-year Reanalysis Project (JRA-25, 1979-2004) is now well in progress. Performance of JRA-25 is compared with other reanalyses in reference to precipitation data produced by the CPC Merged Analysis of Precipitation (CMAP). The JRA does not show the known problems of excessive tropical ocean precipitation seen in ERA-40. In general, precipitation in JRA-25 has much higher correlation with precipitation in CMAP than ERA-40 and NCEP reanalysis.

WGNE reiterated its strong support for the reanalysis efforts and the desirability of having a dedicated ‘Reanalysis Centre’ at a major NWP operational centre. WGNE recommended that the concept should be part of the COPES strategic framework and that the JSC should try and secure funding for this.

Earth System assimilation

WGNE took note of the new developments in the assimilation of parameters pertinent to the Earth System, but not routinely analysed by current data assimilation systems. These include greenhouse gases, aerosols and reactive gases. Earth System Science such as this will increasingly demand cross-project liaison within WCRP and CAS as discussed in the COPES context.

10.1.5 Numerical weather prediction topics

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. WGNE also took note of recent results from dynamical core experiments indicating that resolutions of 150 km (T85) or better are necessary for accurate simulation of baroclinic wave development. This contrasts with typical climate model resolutions substantially poorer than this. There exists a dichotomy of opinion regarding the use and interpretation of grid-lengths of several kilometres for forecasting. These resolutions will become affordable for GCM use in the coming years, and the prospect of climate simulations with grids of order 1 km is an issue of international activity and debate, and WGNE will continue to monitor such developments.

Unified forecast systems

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 parameterizations and metrics, and bring even closer collaboration between the NWP and climate communities.

THORPEX: A Global Atmospheric Research Programme

WGNE devoted a session to THORPEX, with presentations on the general background and the Science Plan and its progress and plans. WGNE noted the direct relevance of THORPEX to its activities and interests, and was impressed by the progress of several components of its plans, including the Implementation Plan itself. The commitment of the operational NWP community was very clear. WGNE considered, however, that it remained a major challenge to engage the academic community to a similar extent and encouraged the circulation of the draft science plan to suitable members of academia for comment and to stimulate interest. WGNE recognized that the proposed 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. It suggested that the Implementation Plan (TIP) should recognize the fundamental importance of model development (both of the dynamical cores and of the physical parameterizations), and should make clearer its contribution to this in collaboration with existing programmes. WGNE commended the Global Interactive Forecast System (GIFS) concept for its vision, and noted that THORPEX Interactive Grand Global Ensemble (TIGGE) plans are advancing rapidly, with the TIP including many of the research challenges that such an undertaking will entail. WGNE appreciated that the Science Plan stressed the linkages between weather and climate and the opportunities to engage this problem for the benefit of all longer time-scale modelling efforts. WGNE agreed to consider, in consultation with WGSIP, the possibilities of using seasonal forecast systems to study this issue. One possibility is to run seasonal timescale forecasts at several horizontal resolutions, including at as high as practicable, to investigate, inter alia, the resolution dependence of the atmospheric energy transports and their up- and down-scale characteristics. This would require diagnostics including suitable eddy statistics and spectra etc. Results from this should then guide the debate as to what forecast/simulation deficiencies are to be expected from the current use of relatively low resolutions. Ideally these experiments would be performed using several systems. At least one (and hopefully more) groups will be in a position to undertake such experimentation in the next year or so. The Chairs of WGNE and WGSIP will monitor this further.

Model Verification

There are a number of WGNE projects involved with the validation of deterministic forecasts. These include the compilation of the so-called WMO scores, verification of quantitative precipitation forecasts, validation of tropical cyclone tracks and verification of stratospheric analysis and forecasts. There has also been the recognition that with increasingly high-resolution models, there is urgent need to move forward from the basic validation methods that have been used so far.

Verification is of considerable importance for both WGNE and WWRP and, following the formation of the Joint (WWRP/WGNE) Working Group on Verification (JWGV), it has held two meetings during the past year. The JWGV organized and held an International Workshop on Verification Methods, Montreal, 13-17 September, with sponsorship from the WWRP/SSC and WGNE, as well as the Meteorological Service of Canada (MSC). 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. The workshop programme and abstracts can be linked from http://www.bom.gov.au/bmrc/wefor/staff/eee/verif/verif_web_page.html; presentations will be posted there as well.

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 verification web page and verification discussion group continue to be an important focus, with the web page gradually being enhanced as new FAQs and other information pages are prepared. The JWGV is interested in collaborations with other WMO verification projects and groups. A new plan for the coming year is to prepare and make available "canonical" forecast and observation datasets that can be used to evaluate and compare the capabilities of different or new verification methodologies.

10.1.6 Workshops

In collaboration with other Working Groups, the following International Workshops have been held in 2004:

- The WGNE/WGCM Workshop, "High-resolution climate modelling: Assessment, Added value and Applications", Lund, 29 March-2 April
- The WGNE/WGSIP/WGCM Workshop on Ensemble Methods: From weather forecasting to climate change', Exeter, 18-21 October
- The WWRP/WGNE Workshop on Verification, Montreal, 13-17 September

There will also be an Aqua-Planet intercomparison Workshop, Reading, UK on 20-22 April 2005.

The JSC thanked Dr Miller for his presentation of WGNE activities. Responding to the question of the need for a dedicated Reanalysis Centre, the JSC felt that part of the success of reanalysis projects to date had been due to being able to 'leapfrog' from one centre to another; so it was desirable to continue to have multiple centres engaged in reanalysis. The JSC supported the proposal for promotion and coordination of this activity by WOAP and the plan for a further reanalysis conference to be held at a date convenient to the main reanalysis centres. JSC strongly supported the proposal to have a workshop on Model Errors sometime in late 2006 or 2007 organized by WGNE possibly jointly with CLIVAR (WGCM) and GEWEX at least.

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 eighth session of the group held in Yokohama, Japan, 25-27 October 2004 with a half-day joint session with GAIM, IGBP on 27 October 2004.

10.2.1 Relevant Recommendations for the development of WGCM activities

Twenty-fifth session of the JSC

WGCM discussed the new WCRP strategic framework, COPES, with a view to identifying how its activities would serve the COPES aims and objectives. In this context, it was noted that almost all WGCM members are now into Earth System Modelling (ESM). A regional modeller is being brought into the group. WGCM is also moving towards increasing cooperation with IGBP/GAIM, which has expertise in carbon cycle and chemistry and land-surface. It is therefore opportune for WGCM to reorient itself towards Earth System Modelling.

Thirteenth session of the CLIVAR SSG

The review of WGCM (as part of the wider review of CLIVAR) was generally favourable and the CLIVAR SSG noted the success of projects such as CMIP. It was noted that WGCM should give more consideration to decadal to centennial variability, and should strengthen its reporting to CLIVAR. Both these issues have been addressed, the latter by having CLIVAR appoint Dr J. Meehl as the Vice-Chair of WGCM. The CLIVAR SSG recommended that WGCM should report only to CLIVAR and not to JSC. This would strengthen the Anthropogenic Climate Change component of CLIVAR. It was also argued that the establishment of a WCRP Modelling Panel made the link to JSC unnecessary. The chair of WGCM welcomed improved communication between WGCM and CLIVAR. It was noted that most of the guidance to WGCM on issues such as the relationship with IGBP, IPCC etc. had come from JSC and not CLIVAR. WGCM feel strongly that WGCM should continue to report to JSC, but CLIVAR should be kept informed of WGCM activities. The group would welcome suggestions from CLIVAR for WGCM activities.

Overview of CliC project

The plans for CliC presented in the overview of CliC were welcomed by WGCM. The members queried about the incorporation of ice sheet models in coupled GCMs and indicated the need to run such coupled models for long enough times to interact with ice sheets. WGCM wanted to know if there is any organized activity in CliC involving PCMDI, and if CliCnet is listed on the MIPS catalogue.

Overview of WGNE/GMPP session, Exeter, UK, 11-15 October 2004

GCSS would like to be better linked to climate models and cloud parameterizations for climate models. GCSS has initiated limited data collection from existing climate models over the North Pacific. The participation of WGCM-related modelling centres is invited at the pan-GCSS meeting in 2005.

(i) GLASS: GLACE is finding interesting results, such as some regions having 'tighter coupling' between land surface and atmosphere and a corresponding greater contribution to predictability. There needs to be better integration between the carbon modelling within GLASS and activities relating to coupled modelling; and

(ii) there is need for a greater level of participation of GRP in deliberations of WGCM, e.g. methods for computing radiative forcing.

WGCM noted the importance of the land surface in climate simulations. In the light of this, WGCM recommends that a representative from GEWEX/GMPP attend the next WGCM meeting to brief the group on the state-of-the-art of land-surface modelling for the simulation of climate and climate change.

10.2.2 Review of WGCM initiatives

Coupled Model Intercomparison Project (CMIP)

The WGCM Climate Simulation Panel (Dr J. Meehl, Chair) has been set up by WGCM to oversee and coordinate collection, archival, and analysis of model data for the IPCC AR4. PCMDI has agreed to collect, archive and distribute the model data. An invitation for participation was published in CLIVAR Exchanges (June 2004) and EOS (July 2004). To date, 218 scientists have registered to analyze the IPCC model data. An international IPCC model analysis workshop was held 1-4 March 2005 organised by US CLIVAR, hosted by the International Pacific Research Center (IPRC), University of Hawaii, and overseen by the WGCM Climate Simulation Panel. The Coupled Model Evaluation Project (CMEP) has been set up through US CLIVAR and funding has been awarded to 18 PIs to analyze, at minimum, 20th century IPCC runs from US models in IPCC model dataset at PCMDI.

Currently, all CMIP2+ data are available for analysis from PCMDI. Additionally, a catalogue of MIPs, assembled with the cooperation of WGCM and GAIM, is maintained on WCRP web page with link from CMIP web page. A summary of the CMIP Workshop, September 2003, Hamburg, has been published (see G.A. Meehl, C. Covey, B. McAvaney, M. Latif, and R.J. Stouffer, 2005: Overview of the Coupled Model Intercomparison Project. Bull. Amer. Meteorol. Soc. 86, 89-93).

CMIP subprojects have produced 47 peer-reviewed publications, 6 other publications, 4 PCMDI publications, and will produce significant contributions to IPCC AR4. As of October 2004 there are 43 CMIP2+ subprojects currently active, in addition to 10 completed subprojects from CMIP1 and 22 from CMIP2.

CMIP and IPCC

IPCC Workshop on Climate Sensitivity

The aims of the IPCC Working Group I Workshop on Climate Sensitivity, held 26-29 July 2004 in Paris, were to:

(i) evaluate a range of climate model results so as to relate different climate sensitivity estimates to differences in descriptions of physical processes,
(ii) obtain a more comprehensive picture of the relationships between climate sensitivity and other model features such as resolution, numerical approach, radiative transfer parameters, etc.;
(iii) consider how current, historical, and palaeoclimatic data can aid in the determination of the likely range of climate sensitivity;
(iv) improve the understanding of the interpretation; limits of the climate sensitivity concept, including for example possible dependencies upon different forcing agents, predictability questions, and transient and steady-state responses; and
(v) start a process towards objective assessment to critically determine whether the range 1.5 to 4.5°C remains appropriate in the AR4.

Outcomes from the workshop will contribute to climate sensitivity estimates from: palaeoclimate (for Chapter 6 of IPCC AR4); observations (for Chapter 9); and models, radiative forcing from models, probabilistic measures from models, and probability distribution functions from all estimations (for Chapter 10).

IPCC/WGCM Sensitivity Workshop, Exeter, 2004

At this workshop, early results from the International Cloud Feedback Model Intercomparison Project (CFMIP) were presented. Working groups

a. recommended metrics for climate models - a firm proposal of a perfect model methodology to determine objectively a climate model metric that is planned to relate the skill of a model in reproducing the current climate with the climate sensitivity of the model.
b. urged CFMIP to continue but with greater emphasis of slab model experiments; encouragement to pursue CO2 radiative forcing
c. recommended exploration of definitions of climate sensitivity and encouragement to consider regional aspects.

The international multi-model analysis activity for the IPCC.

Nearly 250 people have registered to analyze the multi-model dataset from all over the world and about 125 presented results at the Workshop on Analyses of Climate Model Simulations for the IPCC AR4 held in Hawaii, 1-4 March 2005. It is expected that about 14 international global coupled models will ultimately be available for analysis thanks to archiving by PCMDI. Such a large-scale coordinated model experiment and analysis has never been attempted before. The JSC is asked to note the importance of this WGCM contribution to the international climate modelling, analysis and ACC communities, and its direct relevance to IPCC.

International Cloud Feedback Model Intercomparison Project (CFMIP)

Progress in support now includes: Met Office Web site http://www.cfmip.net/ and Analysis Team; IPSL Data server and PCMDI CMOR MIP table. There are now 11 committed participants. There has been encouraging progress with ISCCP simulator in clustering, dynamic regimes, partial radiation perturbation feedback analysis (PRP), and simplified PRP. The analysis of results from the SLOM subproject will be completed by May 2005. Problems still remain with radiative forcing definition with ad hoc decisions being made by modelling groups.

Historical Forcings

Groups are using many new radiative forcing constituents in the new AR4 runs. The historical solar time series is very uncertain. There is no one group overseeing the collection and vetting of these important time series.

WGCM will ask various WCRP projects to oversee different aspects of historical forcings: e.g., SPARC could oversee radiative, aerosols and volcanic forcings.

Initialization of coupled models

To find pre-industrial initial conditions, Stouffer et al propose a method in which one starts with today's climate, turns radiative forcing back to 1860, runs for a few centuries, and then declares the start to 1860 control (R.J. Stouffer, 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). Most groups are using a variant of their method to find initial conditions for their pre industrial control integrations.

Decadal Variability

One of the dominant themes emerging from key meetings over the past year on decadal variability is decadal variability and continental hydrology. Recent results have shown the ability of atmospheric models to reproduce twentieth century droughts, when forced with global SST patterns. The availability of model results from the IPCC AR4 models at PCMDI provides an excellent opportunity for the decadal variability community to analyze these models.

The Thermohaline Circulation (THC) response to increasing greenhouse gas (GHG) concentrations in the atmosphere: coordinated experiments

The data collection phase is almost over. The early results show that in most models, the THC weakens about 20% due to changes in the surface heat fluxes as the GHGs increase. The THC response to the water fluxes is much more varied. Even in integrations where the water fluxes are specified, there is a wide range in the THC response. A paper will be submitted by the end of the year for inclusion in the AR4 report.

Working Group on Ocean Model Development (WGOMD)

The 5th session of WGOMD was held in GFDL, Princeton, 18-19 June 2004, the week before the CLIVAR Conference. Representatives from the CLIVAR basin panels, Arctic Ocean modelling community, PCMDI, and CMIP "special response experiment" were invited. The future direction of an intercomparison project for global ocean models (IPCC-class models) was intensively discussed.

The CLIVAR Workshop "Evaluating the Ocean Component of IPCC-Class Models", 16-18 June 2004, Princeton (GFDL), was held with the sponsorship of WGOMD. The aims of the workshop were:

- to foster a candid and critical evaluation of the state-of-the-art in ocean models used in the IPCC class of climate models,
- to provide guidance towards the evaluation and documentation of the models, and
- to discuss and debate strategies for improving the physical integrity of the simulations. The workshop was composed of four sessions: i) state-of-the-art in ocean climate models, ii) ocean model intercomparison project, iii) key physical processes, and iv) future directions. The workshop gathered more than 80 people from around the world. An outcome of the workshop was a proposal for Coordinated Ocean Reference Experiments (COREs), whose approach is somewhat different from traditional model intercomparison projects, such as AMIP and CMIP.

Intercomparison project for IPCC-class ocean models

The pilot OMIP (P-OMIP) started in 2001 as a feasibility study with limited (6-7 groups) participation. The P-OMIP protocol specifies ERA-15 based daily climatology of surface atmospheric properties, radiative fluxes, and freshwater fluxes. It also recommends relatively strong sea surface salinity (SSS) restore to avoid model drift. There have been requests from outside (CLIVAR basin panels, for example) to encourage comparison of models forced by interannually varying data, not by climatology. For the purpose of looking at interannual variations, strong SSS restore comes under question, since there is no observed interannual SSS dataset.

COREs framework

- For COREs, both the normal year and interannually varying forcing datasets are provided. And three COREs are proposed: 1) repeating the normal year forcing, 2) interannual forcing with all the other elements (bulk formulae, SSS restore) being the same as the normal year experiments, and 3) enhanced melt water from the Greenland coast. Strength of SSS restore is not specified, different from the P-OMIP case.

- Four ice-ocean models (Community Climate System Model (CCSM), GFDL, Hybrid Coordinate Ocean Model (HYCOM), ORCA) have been run for 100 years as a normal year COREs by now. With relatively weak SSS restore (50m/4yr for CCSM, GFDL, and ORCA; zero for HYCOM), the resulting Atlantic meridional overturning circulation is very different among these models.

- The forcing problem is much larger in the ice-ocean model case than in the atmospheric model case. Surface flux datasets to force ice-ocean models have large error bars compared with SST to force atmospheric models. The ocean modelling community has not reached a consensus on how to force ice-ocean models and, therefore, is not ready for providing model output for unspecified analyses by a broader community. Instead, the COREs framework aims to develop standard practice that facilitates collaborative research and model development. In the COREs framework, scientists are encouraged to modify the experimental design as motivated by relevant scientific questions. Experience accumulated by using the COREs approach will lead to a robust methodology for ice-ocean modelling and more traditional-type OMIP.

- The proposal for COREs will appear in CLIVAR Exchanges or Ocean Modelling before long.

Detection and attribution of climate change

Detection and attribution studies have been extended from global scale temperature changes to include regional scale temperature changes, global scale changes in surface pressure and precipitation and precipitation extremes. The group noted that the limitation of the regional attribution of changes should be clearly stated; in particular, the difficulty of estimating the multi-decadal variability at a regional scale, and the dependence of uniquely identifying the anthropogenic signal at a regional scale.

Although individual extreme events cannot usually be attributed to a particular cause, one can estimate the fraction of the risk attributable to a particular cause. (This is common in the medical world, for example estimating the increase in risk of death due to smoking). Work by Stott et al is looking at the attribution of fractional risk of 2003 European heat wave to greenhouse gases.

Palaeo-climate modelling

In palaeo-climate modelling, and in particular the Palaeoclimate Modelling Intercomparison Project (PMIP) (http://www-pcmdi.llnl.gov/pmip/). New results were highlighted for mid-Holocene, Last Glacial Maximum (LGM) and last glacial inception. In recent years, more coupled AO simulations have been made for all these time periods. The new results concern:

- role of ocean feedback in the tropics
- strength of ocean feedback, vegetation feedback and of their synergy in high latitudes
- evaluation of 6 ka simulations against improved reconstruction of biomes from pollen data in high latitudes
- recent coupled simulations of Last Glacial Maximum and the large spread of changes in the THC for last glacial maximum amongst model results
- new ideas to infer climate sensitivity and evaluate model sensitivity from LGM simulations. A series of results were shown to illustrate these different points.

The following is a subset of these analyses:

- Intercomparison of available coupled simulations for the mid-Holocene was analyzed in order to extract robust features related to the ocean feedback. In particular, a late summer warming in the northwestern part of the Indian Ocean slows down the retreat of the monsoon in this region. Where the ocean warms, a feedback loop was identified between SST warming, convergence of humidity, increased precipitation, stratification of the ocean, due to both warming and fresh water and further amplification of the local warming.

- Analysis of model results in high latitudes against new reconstruction of biome data allows one to estimate the degree of realisms of the model simulations, and attribute the mismatch between model and data. In particular, models have a tendency to produce too much forest in Europe and excessive continental drying in central Asia.

- Thanks to the large effort from the Multiproxy Approach for the Reconstruction of the Glacial Ocean (MARGO) project, compilation and revision of SST estimates from different proxy indicators are now available for LGM. These data will serve as a basis to evaluate LGM coupled simulation.

- Last glacial inception is also part of the new focus of PMIP2. Available simulations highlight the role of local feedback in high latitudes and the equatorial to pole heat transport through latent heat.

10.2.3 Other issues

Intergovernmental Panel on Climate Change (IPCC)

WGCM noted that:

- there are no new scenarios for AR4,
- the Task Group on Scenarios for Climate and Impact Assessment (TGCIA) will be approaching the WGCM/IPCC panel for data from the PCMDI/IPCC database for impact studies.

IPCC Workshop, Maynooth, Ireland, 11-13 May 2004

The IPCC Workshop on ''Describing Scientific Uncertainties in Climate Change to Support Analysis of Risk and of Options" covered the issue of uncertainty in all IPCC Working groups and noted the need to use consistent terminology throughout. A full report of the meeting is available at http://ipcc-wg1.ucar.edu/meeting/URW/product/URW_Report_v2.pdf

The joint WGNE/WGCM international Workshop, 'High-resolution climate modelling: Assessment, added value and applications' Lund, Sweden, March/April 2004
(Covered under section 10.1.2)

WGCM welcomed the report on the RCM Workshop and observed that 'big-brother experiments' indicate that regional climate modelling for climate can add genuine detail in simulations. WGCM proposed to have a regional modeller in WGCM.

Data Management

The lack of a data portal for model data was emphasised. The WGCM recognizes the important of a metadata framework for defining model output and observations. The WGCM requires the use of the Climate and Forecast (CF) convention for its model intercomparison projects and encourages its continued development. In addition, the WGCM recommends that the WCRP support the CF Metadata Convention. It is hoped that the WCRP would also encourage financial support of the CF convention.

10.2.4 WGCM-GAIM Joint Session

A joint session with IGBP's GAIM was held on the afternoon of 27 October 2004. There were presentations on: (i) major issues for coupled Earth System Models (ESMs) covering biosphere, chemistry and atmosphere and on (ii) specific topics such as C4MIP (Coupled Climate-Carbon Cycle Models Intercomparison Project), CMIP/CFMIP, PMIP) and EMICS (Earth System Models of Intermediate Complexity). The last session was on 'possible future activities' including IPCC Fourth Assessment: Chapters of interest to GAIM, and GAIM-WGCM co-operation.

WGCM expressed its keenness in having such joint meetings once every two years and looked forward to developing a suitable meeting format with GAIM. IGBP has introduced a new project to succeed GAIM. It is called Analysis, Integration and Modelling of the Earth System (AIMES). Noting that AIMES has a broad mandate, WGCM felt that there were too many overlaps between AIMES and PAGES. IGBP expressed the need for more interaction with WCRP in bringing together climate and biogeochemistry communities.

The JSC thanked Prof. Mitchell for his report on WGCM activities, especially on 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. The JSC encouraged WGCM to increase its

consideration of natural climate variability in the context of anthropogenic climate change and to move forward towards comprehensive Earth System Modelling. The JSC reiterated that the WGCM should continue to be a pan-WCRP modelling group (see also section 5.4). 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. The Director, WCRP, was requested to send a letter of acknowledgment and thanks to the organisers.

11. WORKING GROUP ON SURFACE FLUXES (WGSF) AND SURFACE OCEAN-LOWER ATMOSPHERE STUDY (SOLAS)

11.1 Working Group on Surface Fluxes (WGSF)

Dr C. Fairall, Chair, WGSF, presented the report of the activities of the WGSF and, in particular, the issues that arose at its first session, 11-12 October 2004.

Background

The WGSF is charged with reviewing and coordinating requirements of the various WCRP programmes for air-sea fluxes (initially) and air-land fluxes (in a few years), promoting research in air-sea fluxes, and facilitating communication of research advances. Specific objectives include: developing flux data sets available from different sources (in-situ, remotely sensed, NWP-based); improving measurement technologies, parameterizations and flux field production algorithms; and assessing the sensitivity of climate models and limits of predictability associated with uncertainties in surface fluxes. The WGSF will also serve as a bridge between WCRP and the IGBP/SOLAS, SCOR, and the Commission on Atmospheric Chemistry and Global Pollution (CACGP).

First session of WGSF

The first meeting of the group (11-12 October 2004) was held prior to the International SOLAS Science Conference (13-16 October 2004) at Halifax, Nova Scotia, Canada. All members and the JSC liaison, Dr S. Gulev, attended the meeting. In addition, the meeting was attended by a number of SOLAS representatives and several other experts. The meeting dealt with organizational issues, specific tasks for the WG, joint activities with SOLAS, and discussion of action plans. Presentations made at the meeting are available at ftp://ftp.etl.noaa.gov/user/cfairall/wcrp_wgsf/meetings/halifax_04/talks/. Various points of action are enumerated below.

SURface Flux Analysis (SURFA)

The original concept for SURFA was deemed too ambitious due to lack of resources. The proposed plan is to archive data at PCMDI in the form of monthly averages (and other statistics) from buoys and participating NWP centres (providing those centres adhere to the data format standards of IPCC AR4). Fluxes and all variables used to derive them will be saved (e.g., air temperature, wind speed, etc). Data from the following four buoys will be archived:

- *North of Oahu (22 N, 158W)* R. Lukas, UH
- *Chilean Stratus (20S, 85W)* R. Weller, WHOI
- *North Atlantic Trade Wind site (15N, 51W)* A. Pluddemann, WHOI
- *Kuroshio Extension (32.3N, 144.5E)* M. Cronin, NOAA PMEL

While the WGSF welcomed the news that SURFA might commence and expressed gratitude to Drs Weller and Gleckler for their commitment, there was concern that the new plans were overly restricted. Drs P. Taylor and E. Kent agreed to consider how data from the Voluntary Observing Ship (VOS) Climate program, VOSClim, might be used within SURFA. For example it may be possible to use the UK Met Office model output, which is being archived within VOSClim as a transfer standard between the two projects. Dr A. Bentamy agreed to provide satellite flux data from the Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER) product. Data from the HOAPS satellite product and other surface radiative flux products (e.g., ISCCP) will also be sought. For the NWP, satellite, and VOS products additional locations N, S, E, and W of the central point will also be archived to provide spatial context for interpreting the buoy results. It has been pointed out that WGSF should closely co-operate with WGNE in supporting SURFA. The possibility of the joint meeting/workshop of the WGSF and WGNE in the future should be considered. Views of the JSC on the proposed resolution of the SURFA project and suggestions on the way forward and sources of support for these activities are sought.

Review of gas and particle transfer parameterizations

After some discussion, it was decided that a formal symposium on this topic that was proposed earlier was unnecessary. The topics will be 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 gas transfer publication will include a short section on comparisons of standard meteorological flux routines (principally taken from the literature) to evaluate their accuracy. The WGSF will also compile a toolbox of computer routines for bulk flux calculations that will reside on the WGSF website for the SOLAS/WCRP community.

Handbook on best practices of ship/buoy flux measurements

Dr F. Bradley has produced a detailed outline for a handbook intended for operators of the data systems on research vessels (outgrowth of the Shipboard Automated Meteorological and Oceanographic System (SAMOS) project). This handbook is intended for data acquired for bulk turbulent flux methods. Drs Bradley and Fairall will work on the document and in June 2005 will distribute chapters to selected members of the WGSF for their input. It was suggested that the chapters be compiled in a similar manner to the IPCC reports, with a lead author and other contributing authors. There was some discussion of the need of a similar handbook for direct covariance measurements but the decision as to whether this be a separate handbook or an addition to the first was deferred for further consideration.

WCRP flux summer school

The WGSF would pursue the idea of a summer school on fluxes and flux methods (similar to the SOLAS summer school) which was proposed.

Radiative fluxes

It was noted that radiative fluxes might offer the most potential for 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., suntrackers 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. Drs R. Phillipona and R. Weller will investigate a BSRN connection. A review of the accuracy of present indirect models needs to be done. Also, a review of the present state-of-the-art in specifying the emissivity and albedo of the ocean is needed. As the SAMOS project comes on line, the database of radiative flux measurements at sea will be greatly increased.

Flux products

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. In other words, this should be a funded project.

Another aspect of this issue is the longstanding problem of the relationship between measured fluxes and implementation of flux parameterizations to data fields and in numerical models. This gets back to the definition of fluxes as time-space averages, flux computation techniques, and accounting for sub grid-scale variability in numerical models. No course of action has been decided. Dr E. Andreas has produced a concise write-up on this topic.

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 Woods Hole Oceanographic Institution (WHOI) Atlantic combined daily 1-degree sensible and latent turbulent fluxes, updated FSU winds and pseudo-stress, new sets of surface flux parameters for forcing ocean general circulation models developed at NCAR and LEGI/IORAS. The P. P. Shirshov Institute of Oceanography of the Russian Academy of Sciences (IORAS) will finish their new climatology of surface turbulent fluxes, based on new averaging approach, in 2005.

WGSF will consider on a case-by-case basis whether or not it can support proposed co-operative applications to different funding agencies for the development of 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, etc., are requested.

Charge to the WG

The various groups and projects of the WCRP sent comments on the charge of the WGSF. The most obvious issue is the desire for the WGSF to begin dealing immediately with the land flux problem (rather than the two-to-three year delay called for in the original decision of the JSC-XXIV in Reading, March 2003). The present WG has a strong expertise distribution towards oceanic fluxes, has forged a close alliance with the ocean component of SOLAS, and has identified a full workload, so it appears to be inappropriate to change the course now. Recommendations of the JSC on this issue are sought.

Another issue is whether WGSF would work to produce DATASETS or whether it is merely a discussion group. If the latter is intended, then the GEWEX GRP will continue the SeaFlux activity - one of the members of WGSF (Dr A. Bentamy) is both a member of GRP and a participant in SeaFlux, so that should serve.

This goes back to discussion of the products. The WGSF recommends that a SeaFlux type activity be continued, but its role in this is not clear. SeaFlux is principally a database of high quality flux measurements from research programmes. The NOAA/SAMOS project (Dr S. Smith, a member of the WGSF) is planning to start archiving data from US research vessels at FSU, and NOAA is funding an effort to evaluate and improve the data quality. This suggests that GRP might consider migrating SeaFlux to the FSU facility and provide the funds for data archiving and analysis. Several WG members could be involved.

WG Member Liaisons/Activities

The following is a list of present liaison assignments for WG members to WCRP activities:

B. Barnier	Task Force on Seasonal Predictability, WGOMD
R. Phillipona	BSRN
R. Weller	CLIVAR, SURFA
F. Bradley	GEWEX precipitation
E. Kent	WGOA (a member of)
E. Andreas	CliC

Liaisons to the WGSF from other groups: WGCM has nominated Dr P. Braconnot; WGNE has nominated Dr P Gleckler.

Other WCRP/SOLAS activities by WGSF members include:

- Drs C. Fairall, F. Bradley, W. McGillis attended the SOLAS IMP2 Implementation Plan workshop in Montreal (13-15 April 2004).
- Drs C. Fairall, R. Weller, S. Smith, S. Gulev, and B. Barnier attended the CLIVAR Workshop on Ocean Reanalysis (8-10 November, Boulder, CO). Dr Fairall gave a presentation on the *Status of surface flux estimates*.
- Dr E. Kent submitted a summary entitled *Regarding Data Sets of Oceanic Surface Fluxes* to WOAP.
- Drs C. Fairall and W. McGillis attended the OASIS Project Implementation Plan Development workshop in Rome (10-13 January 2005). Ocean-Air Ice-Snow Interactions (OASIS) is a SOLAS project with links to CliC.
- Dr E. Kent provided details of observational requirements for the calculation of surface flux datasets to a UK Met Office review of user requirements. The requirements were based on specifications in the final report of the WCRP/SCOR Working Group on Air-Sea Fluxes (WCRP, 2000).
- Dr E. Kent will attend the third meeting of the JCOMM Ship Observations Team (SOT-3) in Brest, 7-12 March 2005.
- Dr R. Weller contacted Dr E. Dutton about the BSRN Workshop and Scientific Review, especially the discussion of a new working group on oceanic observations. He suggested liaising with or participating in that WG as a representative of CLIVAR and the Ocean Observations Panel for Climate (OOPC).

WGSF Website

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 chairman 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.

Issues for JSC

- Continuation of SURFA: suitability of the approach taken, existing opportunities
- Comments of the selected approach to work on the reviews of the gas and particle transfer parameterizations
- Need for a summer school on surface fluxes
- Optimal way of evaluation marine radiative fluxes and having a BSRN-linked seagoing radiative flux standard
- Requirements of the new (possible) WCRP initiatives (seasonal forecasting task force, sea level change initiative, climate system reanalysis, etc.) in the flux data
- Harmony with the SeaFlux activities and the way forward in generating the flux products including sources of support for practical activities is required.

The JSC thanked Dr Fairall for his presentation of the report of WGSF activities. Regarding SURFA, the intention of WGSF to archive monthly-averaged fluxes at PCMDI was considered as useful by the JSC. The OOPC view was that full global flux time series were needed. With the emphasis on the diurnal cycle from GEWEX and CLIVAR, higher time resolution was also needed. WGNE offered to contact NWP centres to arrange for global flux (plus associated data) products to be archived at 4-6 hourly resolution. It was hoped to archive data at one of the GODAE servers, then arrangements would be made to transmit monthly averages to PCMDI. The WGSF would work with WGNE and OOPC to re-examine the NWP parameter list to be archived. NWP centres contributing data, would expect some feedback as to how these were being used. The JSC noted that SURFA and SeaFlux had some overlapping applications. WCRP should consider combining these activities in the future and producing a single gridded ocean surface flux data set (turbulent and radiative fluxes plus precipitation).

The JSC noted the plans for the preparation of the handbook on ocean flux observations, stressing the need for compatibility with procedures for operational networks such as the TAO array.

The JSC noted the need to have supersites over the ocean and for work on the components of the water and energy cycles over the ocean. Opportunities to initiate these activities should be explored by WGSF, CLIVAR, GEWEX and CliC.

11.2 Surface Ocean-Lower Atmosphere Study (SOLAS)

SOLAS activities continue in 23 nations, six of who have a dedicated programme funding SOLAS science or have funded large-scale SOLAS activities. Four nations are preparing, or awaiting the result of, proposals for SOLAS programmes, whilst others already have projects that are affiliated to SOLAS. New funds to coordinate SOLAS-related work are available in Belgium and New Zealand. SOLAS also has national networks in nine countries. There are two EU countries affiliated to SOLAS. The results of several more proposals are awaited. The website http://www.solas-int.org contains up-to-date information on the project including highlights and activities in each nation.

11.2.1 SOLAS Implementation

The three Implementation Groups, each responsible for implementing one of the SOLAS Foci, all met in 2004 to produce their Implementation Plans. These contain the details of what SOLAS intends to do, and lay out the science necessary to achieve its goals. The implementation plans will be published on the web and in hard copy in 2005.

Implementation Group 1 met in October 2004 in Halifax, Canada and the Implementation Plan is currently being drafted. As a result of the meeting, a number of planning workshops will be run in 2005 (see below). Thanks to funding from the Belgian Science Policy Office, Ms V. Schoemann, from Université Libre de Bruxelles (ULB), Brussels will work for two days a week to co-ordinate the group's activities.

Implementation Group 2 met in Montreal in May 2004. Their implementation plan is complete. Daniela Turk (Canadian SOLAS) coordinates the group, with funding from the Canadian Foundation for Climate and Atmospheric Sciences.

SOLAS and IGBP/SCOR Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) have agreed to work together to implement marine carbon research. A joint implementation group will form the backbone of the implementation plan for Focus 3 of SOLAS, but activities on CH_4 and N_2O are also envisaged. The joint group will be formed with the expertise to implement the carbon research in both the SOLAS and IMBER Science Plan and Implementation Strategies. This will follow on from, and replace, the work of the SOLAS Focus 3 Implementation Group.

11.2.2 Other major activities

The SOLAS Science Conference held in Halifax, Nova Scotia, Canada, 13-16 October 2004, was the first international conference to present the results of SOLAS. Approximately 240 participants from 24 countries attended the event and over 30 young scientists were supported to attend.

The IGAC/SOLAS Task Team on Halogens in the Troposphere (HitT) held its first meeting in Heidelberg, May 2004. The group aims to define the scientific questions related to halogen chemistry in the troposphere, particularly the role of halogen species in tropospheric chemistry and their impact on climate, oxidation capacity, and possibly other properties of the atmosphere. They will identify interested research groups and scientists, plan coordinated research activities in the area of halogens in the troposphere, provide links to other projects and provide a forum for exchange of information, knowledge, and expertise on the subject. The HitT white paper is being prepared by Roland von Glasow and Ulrich Platt of the University of Heidelberg.

The OASIS project, an international multi-disciplinary effort to study Ocean-Air-Sea Ice-Snow Interactions in the Arctic and Antarctica, ran a planning workshop in January 2005. An important part of this effort is expected to take place during the upcoming IPY 2007-2008. The specific focus is a study of the impact of air-surface interactions and chemical exchanges between the title reservoirs in polar regions. OASIS will address how these processes affect atmospheric chemical composition, and control the input of toxic chemicals to polar environments, and assess the associated impact on, and by, climate change and the human and ecosystem impacts of air-surface exchanges of chemical species.

SOLAS is also aiming to capitalise on IPY and use it as a platform from which to make measurements of trace gases (CO_2, Dimethyl Sulfide (DMS), organo-halogens etc) in the undersampled Southern Ocean. Dr R. Bellerby of the Bjerknes Centre for Climate Research at the University of Bergen is leading this activity.

An International Ocean Carbon Stakeholders Meeting was held at UNESCO, Paris, 6-7 December 2004. SOLAS, IMBER, International Ocean Carbon Coordination Project (IOCCP) and all the other research projects such as CLIVAR and programmes with an interest in marine carbon research coordination agreed a division of work and responsibility. Together with IOCCP and IMBER, SOLAS develop, evaluate, and evolve strategies for large-scale observations for a sustained ocean carbon observing system, carry out basin and global scale data synthesis and interpretation activities, and develop a data management system for ocean carbon data.

11.2.3 Future Plans

In 2005, the SOLAS International Project Office will expand to two full time equivalents and the newly appointed Executive Officer will take post. The Japan SOLAS will host an Asian SOLAS workshop in June 2005 to plan SOLAS implementation in the region.

The second international SOLAS Summer School will take place at the end of August 2005. Once again, over 70 students and 20 lecturers will participate in the two-week mix of practical work and lectures on the island of Corsica.

The Implementation Group 1 will run a workshop on iron enrichment experiments to synthesise the results from the first generation of experiments and plan the next to more realistically simulate the effects of atmospheric dust deposition. The group will also run a DMS model intercomparison and data synthesis workshop. The Implementation Group 3 is also planning to run a workshop to establish the protocols and procedures needed for mesocosms (experimental tanks that are larger than aquariums but smaller than natural ponds) simulations of global change to be replicated and comparable between different groups.

11.2.4 Issues/questions for consideration by the JSC

The main question is how SOLAS will contribute to WCRP in the context of its new strategic framework, COPES other than to the planned activities of the WGSF. For example, SOLAS could lead on the incorporation of the sulphur cycle into climate models and the role of biogenic aerosols in cloud and radiation. Also, SOLAS could provide crucial chemical and other expertise for the emerging Atmospheric Chemistry and Climate theme.

SOLAS was concerned with the shortage of funding for the WGSF activities, particularly given the extensive agenda of the group, and also with the need to ensure continued marine biogeochemical expertise on the JSC.

The JSC commended the project leadership and support office for the rapid development of SOLAS and the success of the first SOLAS International Conference. It commended the project leadership and support office for the good work. SOLAS proposals to work on incorporation of the sulphur cycle and the role of biogenic aerosols in clouds and radiation in climate models were accepted. The former would have to be worked on with WGCM and the latter with GEWEX/GCSS.

The JSC noted that the coordination of carbon observations in the ocean had been considerably strengthened, involving a new joint SOLAS/IMBER working group. The International Ocean Carbon Coordination Project looked after routine ocean observations and was progressing well. CLIVAR was encouraged to continue its interactions with these groups.

JSC acknowledged the need for better financial support for WGSF, particularly noting its limited term. It also agreed that expertise in biogeochemistry needed to be maintained after both Drs P. Schlosser and K. Denman stepped down from the Committee.

12. CO-OPERATION WITHIN THE EARTH SYSTEM SCIENCE PARTNERSHIP (ESSP)

12.1 Earth System Science Partnership (ESSP)

The collaboration between IGBP, IHDP, WCRP and DIVERSITAS in the field of Earth System Science was 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 work together 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.

12.2 ESSP joint projects

12.2.1 Global Carbon Project (GCP)

Dr J.G. Canadell, Executive Director, GCP, reported on the progress of the ESSP Global Carbon Project (GCP). Activities during the past year included organization of, or participation in, several workshops. These dealt with: intercomparison of optimization techniques for parameter estimation; regional carbon management; discussion with CliC SSG for a possible collaborative effort on the vulnerabilities of the permafrost-carbon-climate system; collaboration with the International Geological Correlation Programme (IGCP) to develop its implementation plan for a globally sustained carbon observing system; methodologies for developing dynamic carbon budgets at the regional level; and exploring potential sponsorship with the NEESPI. Current activities and plans for the future included: a proposal focusing on peatlands as vulnerable carbon pools; a proposal on vulnerabilities of the permafrost-carbon-climate system; a proposal on the vulnerability of the permafrost-carbon-climate system for the IPY 2007-08 in collaboration with CliC and the IPA; collaboration with the Southeast Asia Regional Committee for START (SARCS); proposals for session/panels at the IHDP open meeting (October 2005, Bonn, Germany) to further develop the activities on regional development and carbon management; development of the Terrestrial Carbon Cycle Management Project (TCCM-P); and preparations for participation in the 7th International CO_2 Conference. Highlights of Project developmental activities included: translation of GCP Science Framework (ESSP Report No. 1) in

Chinese-Mandarin and Russian; the Chinese Academy of Science (CAS) and the Institute of Geographical Sciences and Natural Resource Research (IGSNRR) made a formal commitment to establish and fund a regional office for the GCP; and GCP has developed a new website with an extended Carbon Portal more service oriented to the carbon community. Feedback and contributing documents/links are welcome at www.globalcarbonproject.org. The 5th SSC meeting of the GCP will be held 14-17 June 2005, UNESCO, Paris. The meeting will include a one-day mini-conference on vulnerabilities of the carbon-climate-human system.

Dr Canadell invited JSC to consider several issues which included: vulnerabilities of the permafrost-carbon-climate system; contribution and links to coupled carbon-climate modelling (e.g. C4MIP); ocean carbon coordination; carbon emission scenarios; and ESSP governance.

The JSC thanked Dr Canadell for his presentation on the GCP and congratulated him for the excellent work done. The JSC pointed out the need for coordination with observing systems (carbon dioxide and others) including with those of CEOP. The JSC stressed the need for strengthening links between GCP and WGCM. Referring to the issue of scientific leadership and guidance of GCP, the JSC observed that stronger links established between GCP and WCRP projects would contribute significantly to solving this problem.

12.2.2 Global Environmental Change and Food Systems (GECAFS) project

In the absence of a representative from the project, Dr D. Carson briefed the JSC on the status of the GECAFS joint project. Several notable workshops conducted in 2004 included: GECAFS seminars at the Global Change Impact Studies Centre, Islamabad, and at the International Institute for Environment and Development (IIED), London; Scenarios Workshop, Rome; GECAFS Food Systems Workshop, London; GECAFS Southern African Workshop, Gaborone; and, the IGP Site Characterisation Workshop, Dhaka. All such workshop outputs are available at www.gecafs.org.

Highlights of progress during the past year included:

- Science and policy products delivered, e.g.
  - Vulnerability concepts paper to Annals of the Association of American Geographers (AAAG)
  - Series of vulnerability method briefs
  - Paper on GEC research for policy in the Indo-Gangetic Plain published in *ESP*
  - Policy Brief for Caribbean Community and Common Market (CARICOM) Science Plan & Implementation Strategy drafted
- IPO funding secured (UK-NERC: 5 yrs from Sep 2003)
- Vulnerability Research Science Officer funding secured (UK-ESRC: 2 yrs from Sep 04)
- DSS Research Science Officer funding secured (USDA-ARS: 2 yrs from Jan 05)
- Scenarios research funds secured (ICSU: $95k for 2005)
- Two Sessions accepted for Human Dimensions of Global Environmental Change Research Open Meeting, October 2005, Bonn:
  - Institutional dimensions of food systems studies across spatial scales (with Institutional Dimensions of Global Environmental Change (IDGEC))
  - Regional approaches to food systems studies

The JSC thanked Dr Carson for his brief statement on GECAFS. The JSC noted GECAFS' need for scientific guidance and inputs from WCRP, emphasising the benefits that can be expected from WCRP's expertise in global data sets and modelling. As a way forward, it was decided to give GECAFS fuller consideration at the next JSC session.

12.2.3 Global Water System Project (GWSP)

Dr M.B. Endejan, Deputy Executive Officer, briefed the JSC on the status of the GWSP. Activities in the past year included: initiation of the International Project Office hosted at the Centre for Development Research (University of Bonn), Bonn, Germany; nomination and appointment of members for the GWSP Scientific Steering Committee (SSC); first Executive SSC meeting at the University of New Hampshire, Durham, USA; development of the initial GWSP Science & Implementation Plan; development, launch and elaboration of the GWSP website (www.gwsp.org); design and publication of GWSP brochure; establishment of contacts within and outside the ESSP community; promotion of the GWSP at a number of conferences and meetings; preparation and dissemination of three-monthly electronic briefing notes; organisation of a consultation meeting with international collaborators and GEC programme representatives; contribution to an EU proposal about the Vulnerability of the Integrated Earth Water System (VIEWS); holding the first

Scientific Steering Committee meeting; publishing the first issue of the GWSP Newsletter; organising the 'International Conference on Integrated Assessment of Water Resources and Global Change: a North-South Analysis'; and, planning and implementing high priority projects. The past year also saw the Scientific Framework, providing the base on which the GWSP can be implemented, being generally accepted by the Chairs and Directors of the ESSP; and the formation of the Scientific Steering Committee (SSC) with eminent scientists.

The outlook for 2005 included: publishing the GWSP Science Framework and Implementation Plan; developing a communications strategy; planning and running workshops and training courses; holding interdisciplinary public seminars in Bonn about the Global Water System; developing and maintaining a GWSP metadata-database; developing and maintaining the GWSP information system; establishing working groups to implement 'fast-track activities', to provide input to international initiatives (such as NEESPI, GEOSS, UN SCD, GECAFS); producing a Digital Water Atlas and World Water Balance; a Global Study of Environmental Flows; an assessment of Global Water Governance; advanced (educational) Institute on "Global Environmental Change and Water"; and harmonisation of GWS terminology through a GWSP lexicon.

Two remaining major challenges recognised by GWSP are:

- To clarify the concept of the Global Water System and to gain the full support of the scientific community for the project.
- To implement the project with strong links to the projects of the Earth System Science Partnership.

The complexity of the issues facing the GWSP will demand a realistic focus and clear priority setting by the SSC and the engagement of SSC members in project working groups and research activities.

The JSC congratulated Dr Endejan for his presentation of GWSP activities and on the excellent progress that had been achieved in the past year. The JSC felt that WCRP needed to demonstrate more ownership and responsibility for this ESSP joint project. In particular, there was a need to further develop and strengthen its linkages with GEWEX and to identify and develop more applications-oriented projects jointly with water-resources managers. In that same context, the JSC felt that there remained a need to give consideration to how ESSP joint projects, such as GWSP, could focus on a specific problem whilst being expected to depend to a large extent on getting significant inputs from relevant core projects of the ESSP Programmes.

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

Dr D. Carson made a brief statement on the GEC&HH project. In January 2004 a second meeting had been held at ICSU, Paris, to advance the drafting of the Science and Implementation Plans for the project. The meeting involved the participation of 19 collaborators from different countries. The main outputs from the meeting were a revised Science Plan and a draft of the Implementation Plan. Feedback on the draft Science Plan was provided by the ESSP Chairs and Directors at their annual meeting, June 2004. As for the Implementation Plan, a small team (Drs T. McMichael, U. Confalonieri, R. Sauerborn, J. Patz, J. Koella and S. Aggarwal) was set up to review the different parts and produce a revised version. In November 2004, the two project Co-Chairs met to discuss the Science and Implementation Plans and a shorter versions were produced.

As of January 2005, both documents were in their final stage of revision and five major areas had been identified to be addressed by the project, namely:

- Changes in atmospheric composition and water cycling and consequences for human health
- Food producing ecosystems and human health
- Biodiversity changes and health
- Urbanization and human health
- Interdisciplinary methods and data needs

The final versions of the plans were expected to be circulated in early 2005 to key institutional representatives who have been supporting the project (e.g. WHO, DIVERSITAS, IGBP, IHDP, WCRP), for additional comments.

The intentions for 2005 were:

- To produce the final version of a Science and Implementation Plan.

- To discuss the organization of a first open science conference for the project. A preliminary contact had been made with the Chinese Academy of Sciences, which showed interest in hosting such a conference.
- To intensify the efforts to establish an International Project Office (IPO).

The JSC thanked Dr Carson for his brief statement on the GEC&HH project. The project was still being scoped and needed inputs from WCRP, emphasising the benefits that can be expected from WCRP's expertise in global data sets and modelling. The JSC decided to give the project fuller consideration at its next session.

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

Dr M. Manton reported on the progress of START during the year. Currently, START has over 70 ongoing collaborative regional research projects on the following themes: 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. A description of these projects is given in the Annual Reports from START regional centres/secretariats and http://www.start.org.

A major activity of START during 2004 was the continued coordination of 24 regional projects involving 45 countries - in Africa, Asia, South America, the Caribbean and Oceania - on Assessments of Impacts and Adaptations to Climate Change (AIACC) that engages 235 scientists from developing countries, including 60 graduate and undergraduate students. This project is funded by the Global Environment Facility and executed jointly by START and the Academy of Sciences for the Developing World (TWAS) on behalf of the United Nations Environment Programme. The AIACC project is closely linked to the IPCC and the UN Framework Convention on Climate Change. Instigated in 2004, START, at the request of the ESSP, is fostering the Monsoon Asia Integrated Regional Studies (MAIRS) project. The initial effort focuses on sub-regional scoping/rapid assessment studies in East Asia, Southeast Asia and South Asia, undertaken jointly by START and its regional networks, and SCOPE, to systematically review current knowledge regarding regional aspects of global change in monsoon Asia. The MAIRS project will also include intensive field and observational as well as numerical modelling activities. In addition, START has conducted or plans several joint activities with the core and joint projects of the ESSP. Joint activities with WCRP included: START co-sponsored the Regional Climate Modelling Workshop in Lund, March 2004; START, through funding from its small grants programme as endorsed by the Pan-African Committee for START (PACOM), co-sponsored the Climate Trend Detection and Extremes in Africa Workshop (May 2004, Cape Town, South Africa); and START co-sponsored the First International CLIVAR Conference (Baltimore, MD, USA). An international workshop on Climate Prediction and Agriculture (CLIMAG): Advances and Challenges was planned to be held at WMO, Geneva, 11-13 May 2005.

The JSC thanked Dr Manton for his presentation of START activities. Of particular importance was the forthcoming CLIMAG workshop in Geneva. The JSC expressed the need to ensure good representation of WCRP at this workshop.

12.4 Other ESSP issues

The JSC thanked Prof P. Lemke for making a brief statement on IGBP on behalf of the Chair, IGBP. The JSC welcomed the proposal to hold joint WCRP/JSC, IGBP/SC meetings on alternate years; the next such meeting to be in March 2006. The JSC requested that the agenda for such joint meetings should not be too crowded and should include sufficient time for meaningful discussion of joint projects.

The JSC was briefed by Dr D. Carson on the planning for the ESSP Open Science Conference to be held in Beijing, November 2006. This constituted the follow-up to the first such Global Change Open Science Conference, held in Amsterdam in 2001. The JSC was asked to nominate members to the International Organizing Committee of the Conference, Co-chaired by Drs Qin Dahe and G. McBean.

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

13.1 Global Climate Observing System (GCOS)

Prof. P. Mason, Chair of the GCOS Steering Committee (SC), briefed the JSC on current important issues in GCOS.

13.1.1 Implementation Plan for the Global Observing System for Climate and Interactions with the UNFCCC

The Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC was completed under the leadership of GCOS, 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 calls for some 131 actions needed over the next 5 to 10 years to address the critical issues related to global observing systems for climate, namely: improving key satellite and *in situ* networks for atmospheric, oceanic and terrestrial observations; generating integrated global climate analysis products; enhancing the participation of least-developed countries and small island developing states; improving access to high-quality global data for essential climate variables; and strengthening national and international infrastructure. Both the ocean and terrestrial sections of the report stress the need for and encourage the development of national responsibilities for systematic observations.

The space agencies play a substantial role as “agents of implementation” with 22 actions requested of them, many being coordinated actions to produce global data sets and global products from their composite observations (e.g., 19 actions for CEOS). IGOS-P is also mentioned frequently in the plan. WCRP and its various activities appear with equal frequency, and WCRP is explicitly named in 12 actions, covering a wide range of activity. The topics range from those associated with the observing systems to the generation of integrated global climate products and research towards improved observation capability. A greater level of WCRP involvement occurs through its various projects such as GEWEX, CLIVAR and CliC. Some actions are already receiving welcome attention from WCRP.

The Implementation Plan was presented to the tenth session of the UNFCCC Conference of the Parties (COP-10) in Buenos Aires, Argentina, 6-17 December 2004, through its Subsidiary Body for Scientific and Technological Advice (SBSTA-21). SBSTA-21 welcomed the plan and developed a draft decision, which was formally endorsed by COP-10. The combination of the SBSTA conclusions and the COP decision contains encouragement and opportunities to continue to guide the UNFCCC on its needs for systematic observations. In addition, a decision from COP-9 invited GCOS and GOOS to provide information to the SBSTA, at its 23rd session, “on progress made towards implementing the initial ocean climate observing system”.

The WCRP and its component bodies will be the prime players in responding to the actions identified in the Implementation Plan. GCOS looks forward to cooperating closely with WCRP and its associated bodies in the implementation process and in looking for opportunities to help maintain progress through interactions with the UNFCCC.

Prof. Mason invited the JSC to note: (i) the information presented and comment, as appropriate, particularly on ways to encourage progress on the wide range of actions contained in the *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC,* and (ii) the decision from COP-10 requesting action by Parties, their space agencies and international and intergovernmental bodies to facilitate implementation actions in the plan.

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

Dr M. Manton, Chair, AOPC presented the activities of AOPC, which held its tenth session in Geneva, Switzerland, 19-23 April 2004. The main items of discussion focused on (i) the status and latest developments regarding the GCOS atmospheric networks, especially the GSN and GUAN; (ii) consideration of new or enhanced networks for measurement of additional parameters of importance to AOPC (carbon doxide, ozone, aerosols); (iii) review and finalization of statements of guidance for WMO/CBS in three climate applications areas; and (iv) review of activities of the AOPC Working Groups.

AOPC-X established a new Working Group on Reconciliation of Surface and Free Atmosphere Temperature Trends, which is charged, *inter alia*, with exploring the concept of establishing a GCOS reference network for highly accurate measurements of water vapour and stratospheric temperature, possibly as a subset of the GCOS Upper-Air Network (GUAN).

Dr Manton invited JSC's consideration on several issues which included: (i) the development of a limited network of high-quality upper-air reference sites, co-located to the extent possible with existing ones, e.g., GUAN and CEOP sites; (ii) the promotion of regional activities to extend the surface climate record; (iii) the co-operation with BSRN to secure a robust and stable archive; and (iv) the need for international collaboration to optimise investment in global reanalyses.

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

Dr E. Harrison, Chair OOPC, reported on the activities and current concerns of the OOPC. Concerns included: the need for routine, real-time transmission of ocean observations, with unique identifiers, wherever feasible; and, the need to define and develop a set of 'ocean indices', and to know how to interpret them. In the latter context, it was stressed that the WCRP community was playing a crucial role in the WMO-led debate concerning the definition of an internationally-agreed 'El Niño index'. A specific proposal from OOPC was to consider the feasibility of introducing 'ocean reference sites' into the second phase of CEOP. Of particular concern to OOPC was the perceived lack of planned future satellite missions for critical ocean observations.

The JSC thanked Drs Mason, Manton and Harrison for their presentations. GCOS expressed a wish to work with GEWEX on long-term global mean precipitation since precipitation is a key element of the hydrological cycle. Consideration should be given to the definition and development of a set of indices relating to the state and variability of the oceans, and also to the inclusion of ocean reference sites in CEOP Phase 2 (see also section 7.3). The JSC supported OOPC's concern over the potential lack of sufficient planned ocean-observing satellite missions and agreed that WCRP should take every opportunity to raise this concern and make clear its requirements for satellite observations over the oceans.

13.2 The Integrated Global Observing Strategy (IGOS), including the Integrated Global Water Cycle Observations (IGWCO) theme, and the Cryosphere theme

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 its work through the development of themes and establishing teams to oversee their implementation. It has initiated the development of six themes that have been approved: oceans (2000), carbon (2003), geohazards (2003), water (2003), coastal (2004), and atmospheric chemistry (2004). In addition, a proposal for a cryospheric theme is under development. To date, WCRP has been most active in the water cycle theme, providing a Chairman, R. Lawford, for the theme's executive committee. WCRP is also taking the lead in the developing the IGOS Cryosphere 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. It is anticipated that stronger links with the GEO/GEOSS will provide a more stable and adequate funding base for 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. During the spring of 2004, IGWCO, with help from ESA, published the IGWCO report and distributed it to attendees at the GEO-4 and EOS-II meetings. A presentation on the Global Water Cycle theme was also made to the EOS principals in a side event at EOS-II. As a result of these developments, IGWCO was asked to chair the water resources theme for the GEOSS 10-year Implementation Plan. This facilitated the transmittal of some of the central themes of the IGWCO report into the GEOSS documentation.

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 (through its Hydrology and Water Resources Department), CEOS (through the Japan Aerospace Exploration Agency (JAXA)) and WCRP (through GEWEX) that chair the EC. The SAG has 15 members including representatives from space agencies, academia, and international programmes. The Group is supported by a distributed secretariat, which includes support from WCRP, WMO, and CEOS (JAXA). The secretariat provides funding, organizational and administrative support for meetings, workshops and teleconference calls for the EC and the SAG. At present, the meaningful financial secretariat support comes through JAXA.

IGWCO has identified its core projects, which include: a) Data System Development and b) Data Integration. Under the latter project, the CEOP contributes to IGWCO as it develops data products and analysis systems that will serve as core infrastructure for other IGWCO activities as they develop. CEOP was accepted by the CEOS as a precursor to an IGOS-P/IGWCO theme. CEOP Phase I (2002-2004) and its strong links with GEWEX constitute IGWCO's first experience in integration. CEOP has drawn together the observational capabilities of 35 reference sites, mainly from the GEWEX CSEs, 11 NWP Centres and a number of space agencies. The interaction of CEOP Phase II activities (2005-2010) and IGWCO projects will increase as other IGWCO initiatives become fully functional. In particular, 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.

The GWSP of the ESSP addresses questions related to the interaction of the water cycle and human activities, including those involved in global change. IGWCO plans to support 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 ICSU, IGWCO will promote a number of activities directed at meeting the data needs of GWSP, including those related to socio-economic data.

IGWCO has initiated or participated in a number of other activities. Together with GEWEX and UNESCO, IGWCO organized a workshop on trends in Global Water Cycle Variables at UNESCO in Paris, France, 3-5 November 2004. The workshop concluded that few data sets are sufficiently long term and of sufficiently comprehensive and homogeneous coverage to enable the definition of global trends with confidence. Satellite products hold promise but they need to be reprocessed for this purpose.

The JSC was invited to consider the following issues:

(i) Given the emergence of and international support for GEO, it is unclear how the role of IGOS-P and its relationship with GEO will develop in the future. WCRP is encouraged to support the IGOS-P position that it (IGOS-P) is a founding member of GEO and that its activity should be fully considered as a component of GEO. Also WCRP could support the view that IGOS themes (such as IGWCO) can contribute to GEO socio-economic sectors (such as water resources).

(ii) 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 Strategic Implementation Team (SIT). WCRP initiatives such as COPES are encouraged to build stronger connections with IGWCO by recognizing these potential links in the COPES planning documents.

13.2.2 The IGOS-P Cryosphere Theme

The IGOS-P Cryosphere Theme was approved by the Partners on 27 May 2004. It was proposed by two IGOS Partners, namely WCRP, represented by the CliC Project, and the International Council for Science (ICSU), represented by SCAR, which is a co-sponsor of CliC. The unanimous approval of the theme reflected the increased understanding by the Partners of the importance of the cryosphere in the climate system and the fact that it remained strongly under-sampled, despite significant changes. Many of the networks observing cryospheric elements are in significant decline.

Since May 2004, CliC and SCAR have been assembling an initial team of contributors to the theme report, and agreed on its leaders, approach, and outline. Dr J. Key, NOAA NESDIS, has agreed to chair the group with Dr M. Drinkwater, ESA, as the Vice-chair. The former ACSYS/CliC Observational Products Panel is expected to be one of the chief contributors to the task. Dr Key has set up and is maintaining a project website 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. The theme outline, team composition, motivation for the project, supporting information and documentation, and the draft report itself can all be accessed there.

The first workshop on the theme took place in Kananaskis, Alberta, Canada, 2-4 March 2005. 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. Two more workshops for the theme are envisaged, most likely in Europe and Asia. Three main groups of cryospheric observations, namely for the terrestrial, alpine, and marine cryosphere, will be considered in the report. The tables with requirements will make use of available summaries and reviews conducted in the past, wherever possible, to ensure consistency with previous reviews. The real challenge for the team is to

ensure that the updated requirements for cryospheric observations to be prepared through the theme do represent views and needs of the wide community interested in knowing the state of cryosphere. Therefore the report should go through an open and exhaustive review by the cryospheric community and interested projects and programmes. The theme could also review observations, which are either made using sea ice or are hampered by its presence. For example, observations of the International Arctic Buoy Programme and the International Programme for Antarctic Buoys are made on ice, but provide most important meteorological observations in data sparse regions. Under-ice observing systems being developed for use in polar oceans will most likely be included.

Some cryospheric observations are well established; some are made in experimental mode. Optimal use of both types of observations is essential for efficient monitoring of the climate change and for enabling climate predictions through validation of models and their initialisation.

Cryospheric observations belong or are relevant to all existing observing systems: the GCOS, GOOS, and GTOS. The expertise in cryospheric science and observations on committees managing these systems is limited. CliC will propose to the GCOS Stering Committee at its forthcoming session in June 2005 in St Petersburg, Russia, that there be a cryospheric observation group serving all these committees as an advisory body. Through links known to CliC and the team members of the IGOS-P Cryosphere Theme, it should possible to provide to the bodies managing climate observations and science a position that would reflect the requirements of a wide cryospheric community.

The theme will include an assessment of the socio-economic impact of cryospheric observations. The benefit areas will include not only climate change research, but also transportation (marine and land-based), water management, agriculture, energy sector, fishing, indigenous communities, etc. The completion of the theme report is expected in 2006.

The JSC was invited to take an active part in the review of the IGOS-P Cryosphere Theme. The interests of CLIVAR, GEWEX, GWSP, GCOS, GOOS, GTOS, OOPC, AOPC, Terrestrial Observation Panel for Climate (TOPC), GCP, several IGBP projects, monsoon research, sea level rise studies, THORPEX, seasonal forecasting, and probably OASIS and AICI (if the theme will include chemical data) should be represented. Opportunities to conduct future workshops on the theme are sought.

The JSC was pleased with the present status of the development and implementation of the IGOS-P themes. In particular, it acknowledged R. Lawford's significant contributions to achieving the present satisfactory status of the IGWCO theme. The JSC also thanked CliC for organizing the IGOS Cryosphere Theme and stressed the need to highlight tropical glaciers in it.

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

Dr G. Sommeria presented a summary of GEO activities since JSC-XXV, the main issues from the GEO governance meeting in Brussels, 27-28 September 2004, and commented on WCRP's proposed involvement in future GEO activities. The GEO framework document was approved at the second Earth Observation Summit, Tokyo, 24 April 2004. WCRP's input has been significant as part of the subgroups on "user requirements" and "data utilisation", and as a participating international organization. Inputs have been co-ordinated with GCOS. A review of the draft 10-year implementation plan took place during 2004 with significant input from WCRP projects and JSC Officers, again in close co-ordination with GCOS. In addition R. Lawford was nominated "topic co-ordinator" for "water", which allowed him to make full use of the IGOS water theme recommendations. All comments were compiled by an "Implementation Plan Task Team (IPTT)". The task team of four experts included two who are familiar with WCRP activities, Dr D. Williams, EUMETSAT, and Prof. T. Koike of the University of Tokyo. Prof. Koike was specifically charged to compile the two topics "water" and ''climate". WCRP took part in the GEO governance meeting, Brussels, 27-28 September 2004. WCRP's main input was to emphasise the role of research in the GEO process, the need for supporting it and the proposal of the establishment of a scientific advisory body. In GEO-5, Ottawa, 29-30 November 2004, the first version of the 10-year implementation plan for a GEOSS was discussed, as well as the proposal made by WMO to host the future GEO Secretariat in Geneva. Another round of consultations took place afterwards in order to finalize the 10-year plan to be approved in Brussels at EOS-III, 16 February 2005.

WCRP will remain a participating international organization in the new intergovernmental GEO framework, and therefore have a voice in the overall implementation of GEOSS. It is likely that WMO will be part of the executive committee (its exact status is still debated), as well as probably ICSU, and these will be two channels where WCRP's interests can also be represented.

The GEOSS 10-year Implementation Plan is strongly inspired, for the climate "societal benefit area", by both GCOS and WCRP strategies, that is the GCOS objectives for the shorter terms, 2 and 6 years, and the COPES objectives for the 10-year term. This document will now be complemented by a work plan, which should be developed in close coordination with both GCOS and WCRP.

Coordination is also necessary for the water theme with a strong link with CEOP and the IGOS water theme led by WCRP, and is needed for the development of the other "societal benefit areas" for which the climate component is important. It is also in those areas that the benefits of the COPES strategy for society can be developed and highlighted. This coordination should develop through the main GEO mechanism and through regular contacts with the GEO Secretariat once it is established within the WMO building in Geneva.

The funding of research programmes through GEO will not be a direct mechanism but countries that are GEO members (and this has been explicitly mentioned at EOS-III on behalf of the European Commission by the Commissioners) will likely include GEO priorities in their budgets, thus facilitating the development of research or applied projects in relation to GEO. The WCRP community should therefore, in principle, benefit from this.

WCRP has been a strong and consistent advocate within GEO for the need for a scientific and technical advisory mechanism, which will be proposed for discussion at the first session of the new intergovernmental GEO. WCRP has also volunteered to be part of the subgroup dealing with this aspect. The input of JSC on this point would be particularly appropriate, as well as a recommendation on WCRP's participation in a future scientific and technical committee for GEO.

The JSC thanked Dr Sommeria for his report which detailed the establishment of the new intergovernmental GEO and GEOSS. The JSC supported the future involvement of WCRP in the GEO scientific and technical advisory mechanism, and as a key partner of GEO in the climate domain, and in other areas in which society can benefit from climate research.

14. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

The JSC was informed of the progress towards the Fourth Assessment Report (AR4) and was gratified to note that several JSC members were Lead Authors for the AR4. The JSC suggested that IPCC science should be considered in the inventory of ACC activities (see section 5.4) since IPCC assessments are critically dependent on outputs from WCRP and GCOS. Also, WCRP contributions to IPCC should be highlighted in the ESSP Open Science Conference, 2006 (see section 12.4).

15. ADMINISTRATIVE MATTERS

15.1 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 COPES, 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.

To ensure that the JSC maintained an overview of the Programme and that appropriate interactions between WCRP activities take place, in the context of the emerging COPES strategy, specific JSC members were appointed to liaise directly with specific projects and activities. These JSC members should: liaise directly with the Chair/Co-Chairs of the respective Panel, SSG or WG, with discussion/consultation between JSC sessions as necessary and appropriate; serve as focal points, lead discussants and Chairs for items dealing with their respective activities at JSC sessions. The JSC encouraged participation of the JSC liaison person(s) at respective Panel, SSG or WG session(s). The JSC liaison responsibilities are:

CliC: P. Lemke

CLIVAR: J. Marotzke, G.B. Pant

GEWEX: T. Yasunari, G. Wu

SPARC: V. Ramaswamy

WGSF/SOLAS: S. Gulev, M.T. Zamanian, K. Denman

WMP: J. Shukla, V.P. Meleshko

WOAP: K. Trenberth, I. Wainer

ESSP Joint Projects:

Carbon (GCP). J. Church

Water (GWSP): G. Wu, T. Yasunari

Food (GECAFS): P. Cornejo R. de Grunauer

Health (GEC & HH): L.A. Ogallo

IGBP/AIMES: D. Griggs, H. Le Treut

THORPEX: J. Shukla

15.2 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, with effect from 1 January 2006. The compositions of committees effective on 1 January 2005 are listed here.

JSC/CAS Working Group on Numerical Experimentation (WGNE)

Membership of the WGNE was determined by consultation between the Chairman of the JSC and the President of CAS. Prof. P.L. Silva Dias (Univ. of Sao Paulo and CPTEC/INPE, Brazil) was appointed for an initial term of four years beginning 1 January 2005. Thus the composition of the group was:

Membership	Expiry of appointment	
M. Miller (Chair)	31 December	2005
Chen Dehui	"	2005
J. Côté	"	2005
M. Déqué	"	2007
V. Kattsov	"	2005
S. Lord	"	2005
A. Lorenc	"	2005
D. Majewski	"	2005
K. Puri	"	2005
Y. Takeuchi	"	2007
P.L Silva Dias	"	2008
D. Williamson	"	2005

JSC/CLIVAR Working Group on Coupled Modelling (WGCM)

Drs J. Mitchell and G. Meehl were re-appointed as Co-Chairs with immediate effect for terms ending 31 December 2007. The term of Dr T. Delworth, which expired on 31 December 2004, was extended by two years. Drs G. Hegerl, M. Latif and A. Noda, whose terms ended 31 December 2004, had left the group. Drs D. Karoly (Univ. of Oklahoma), M. Giorgetta (Max Planck Institute, Germany), C. Le Quéré (Max Planck Institute fur Biogeochemie, Germany), M. Kimoto (Univ. of Tokyo) and F. Giorgi (International Centre for Theoretical Physics, Italy) have accepted invitations to be members of the group for an initial term of four years effective 1 January 2005. The group was thus now constituted as follows:

Membership	Expiry of appointment	
J. Mitchell (Co-Chair)	31 December	2007
G. Meehl (Co- Chair)	"	2007
C. Boening (ex-officio, Co- Chair, WGOMD)	"	2005
P. Braconnot	"	2005
T. Delworth	"	2006
G. Flato	"	2007
M. Giorgetta	"	2008
F. Giorgi	"	2008
A. Hirst	"	2005
D. Karoly	"	2008
M. Kimoto	"	2008

C. Le Quéré	"	2008
B. McAvaney	"	2005

CLIVAR Scientific Steering Group

Drs K. Trenberth and T. Stocker whose terms ended 31 December 2004 had left the SSG. Drs B. McAvaney (BMRC Australia) and D. Waliser (JPL/NASA, USA) have accepted invitations to be members of the SSG for an initial term of four years effective 1 January 2005. The membership of the CLIVAR Scientific Steering Group was thus:

Membership	Expiry of appointment	
A. Busalacchi (Co-chair)	31 December	2006
T. Palmer (Co-chair)	"	2007
H. Cullen	"	2006
P.L. da Silva Dias	"	2005
J. Marotzke	"	2007
B. McAvaney	"	2008
F. Molteni	"	2007
M. Reinecker	"	2007
T. Tokioka	"	2007
D. Waliser	"	2008
B. Wang	"	2007
R. Weller	"	2006
R. Zhang	"	2006

CliC Scientific Steering Group

Dr I. Allison, Vice-Chair, was stepping down on 30 April 2005 due to his new responsibilities in IPY. Dr A. Worby accepted the invitation to be member of the SSG for an initial term of four years effective 1 January 2005.The composition of the group was thus:

Membership	Expiry of appointment	
B. Goodison (Chair)	31 December	2006
R. Barry (Vice-chair)	"	2005
M. Drinkwater	"	2006
T. Fichefet	"	2005
D. Kane	"	2006
V. Kotlyakov	"	2006
C. Mauritzen	"	2007
T. Ohata	"	2005
Qin Da He	"	2006
J. Turner	"	2006
A. Worby	"	2008
H. Zwally	"	2005

GEWEX Scientific Steering Group

Dr R. Atlas whose term expired on 31 December 2004 stepped down from the SSG. Dr F. Einaudi (NASA, USA) accepted the invitation to be member of the SSG for an initial term of four years effective 1 January 2005. The membership of the group was thus:

Membership	Expiry of appointment	
S. Sorooshian (Chair)	31 December	2007
T. Ackerman	"	2007
A. Beljaars	"	2005
F. Einaudi	"	2008
Y. Kerr	"	2006

Z. Kopaliani	"	2006
K. Nakamura	"	2005
D. Randall	"	2007
U. Schumann	"	2006
K.D. Sharma	"	2007
M.F. Silva Dias	"	2005
K. Takeuchi	"	2007
G. Wu	"	2005

SPARC Scientific Steering Group

Profs T. Shepherd and S. Yoden expressed their wish to step down from the SSG during the year. The meeting of the WCRP Officers, Chairs and Directors (Geneva, September 2004) approved a recommendation by the SPARC SSG Co-Chairs to invite Drs S. Hayashida (Japan), P. Haynes (UK), E. Manzini (Italy), and P. Wennberg (USA), effective 1 January 2005, for an initial appointment of four years which they have since accepted. Dr K. Hamilton, whose term expired on 31 December 2004, stepped down. The membership of the group was thus as follows:

Membership	Expiry of appointment	
A. O'Neill (Co-Chair)	31 December	2006
A.R. Ravishankara (Co-Chair)	"	2006
J.P. Burrows	"	2006
P. Canziani	"	2005
C. Granier	"	2005
D. Hartmann	"	2006
S. Hayashida	"	2008
P. Haynes	"	2008
E. Manzini	"	2008
T. Peter	"	2005
U. Schmidt	"	2005
P. Wennberg	"	2008
V. Yushkov	"	2005

Working Group on Surface Fluxes (WGSF)

Dr A. Beljaars stepped down from the WG at the end of 2004. Drs C. Garbe (University of Heidelberg, Germany), G. Leeuw (TNO Physics and Electronics Laboratory, The Netherlands) recommended by SOLAS, and Dr A. Sterl (Royal Netherlands Meteorological Institute, The Netherlands) had accepted invitations to join the group. 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
F. Bradley	"	2007
W. Drennan	"	2007
C. Garbe	"	2007
E. Kent	"	2007
G. Leeuw	"	2007
W. McGillis	"	2007
R. Philipona	"	2007
S. Smith	"	2007
A. Sterl	"	2007
B. Weller	"	2007

WCRP Modelling Panel

JSC-XXV (March 2004) approved the establishment of a WCRP Modelling Panel. Its members include specified JSC members, one of whom chairs the Panel, the Chairs of WGNE, WGCM, WCRP Observations and Assimilation Panel (WOAP) and the project modelling groups. IGBP and IHDP have been invited to provide a representative. Dr D. Burridge accepted the invitation to join the Panel, in his ex-officio capacity as the Executive Director of THORPEX. The initial membership of the Panel was:

Membership	Expiry of appointment
J. Shukla (Chair)	31 December 2007
C. Boening	" 2007
D. Burridge	" 2007
B. Kirtman	" 2007
V. Meleshko	" 2007
M. Miller	" 2007
J.F. Mitchell	" 2007
S. Pawson	" 2007
J. Polcher	" 2007
K. Trenberth	" 2007

WCRP Observations and Assimilation Panel (WOAP)

JSC-XXV (March 2004) approved the establishment of a WCRP Observations and Assimilation Panel (WOAP). Its members include specified JSC members, one of whom chairs the Panel, representatives of project observational activities, the Chair of the WCRP Modelling Panel, representatives from major reanalysis centres, and possibly other experts as necessary and appropriate. The initial 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

WCRP/GCOS/GOOS Ocean Observations Panel for Climate

The composition of the Ocean Observations Panel for Climate was as follows:

- D.E. Harrison, NOAA Pacific Marine Environmental Laboratory, Seattle, USA (Chair)
- E.J.D. Campos, Instituto Oceanografico, University of Sao Paulo, Brazil
- T.D. Dickey, Ocean Physics Laboratory, University of California, Santa Barbara, USA
- J.A. Johannessen, Nansen Environmental and Remote Sensing Centre, Bergen, Norway
- J.R. Keeley, Ocean Information & Systems Division, Department of Fisheries and Oceans, Ottawa, Canada
- Y. Michida, Ocean Research Institute, University of Tokyo, Japan
- R. Reynolds, NCDC/NESDIS/NOAA, Asheville, USA
- F. Schott, Leibniz-Institut of Marine Sciences, University of Kiel, Germany
- P.K. Taylor, National Oceanography Centre, Southampton, UK
- R.A. Weller, Woods Hole Oceanographic Institution, USA

WCRP/GCOS Atmospheric Observation Panel for Climate

The composition of the Atmospheric Observation Panel for Climate was as follows:

- M.J. Manton, Bureau of Meteorology Research Centre, Melbourne, Australia (Chair)
- P. Arkin, Earth System Science Interdisciplinary Centre (ESSIC), Maryland, USA
- M.D. Goldberg, Climate Research & Applications Division, NOAA/NESDIS, Maryland, USA
- D.E. Harrison, NOAA Pacific Marine and Environment Laboratory, Seattle, WA, USA
- R. Heino, Climate Research, Finnish Meteorological Institute, Helsinki, Finland
- P. Jones, Climatic Research Unit, University of East Anglia, Norwich, UK
- R. Okoola, Department of Meteorology, University of Nairobi, Kenya
- K. Onogi, Climate Prediction Division, Japan Meteorological Agency, Tokyo, Japan
- D. Parker, Met Office, Exeter, UK
- T.C. Peterson, Climate Analysis Branch, NCDC/NOAA, Ashville, NC, USA
- B. Rudolf, Global Precipitation Climatology Centre, Deutscher Wetterdienst, Offenbach-Am-Main, Germany
- J. Schmetz, Meteorological Division, EUMETSAT, Darmstadt, Germany
- M. Suzuki, Atmospheric Chemistry and GOSAT, EORC/JAXA, Tokyo, Japan

15.3 Publications

15.3.1 WCRP 25th Anniversary book

Dr J. Church briefed the JSC on the progress in preparation of the 'WCRP 25th Anniversary book', based on a report submitted by Dr W. J. Gould.

At JSC-XXV, Prof. P. Lemke had presented an outline of a book on WCRP science to mark WCRP's 25th anniversary. Dr W. J. Gould (former Director, WOCE and CLIVAR IPOs and co-editor, with Dr J. Church and Dr G. Siedler of the WOCE book "Ocean Circulation and Climate – Observing and Modelling theGlobal Ocean") was subsequently invited (and accepted) to be lead editor, supported by an advisory team of JSC members. Dr Gould, primarily in consultation with Dr J. Church, had developed a rather different book outline from that proposed by Prof. Lemke. The new approach would be to publish a book aimed, not at a specialist scientific readership, but instead at a much broader lay readership. This approach was considered and endorsed by the advisory panel and by the JSC officers. The rationale for this was that scientists (the target readership using Prof. Lemke's original suggestion) have many means of accessing WCRP science through review articles and the refereed literature. Climate variability and change are becoming the concern of the general public throughout the world and receive much media coverage focused on topics such as the ratification of the Kyoto protocol, the emphasis on climate in the UK's chairmanship of the G8 and press coverage of extreme weather and climate events, droughts, floods and heatwaves. The publication of the Fourth IPCC assessment in 2007 will add to this coverage. The WCRP's role in underpinning these newsworthy issues is largely invisible to the public, to scientists outside the climate arena and to policy makers. The new book outline aimed to change this situation.

The new book outline had been sent to a number of publishers and responses were awaited.

The JSC approved fully the plans being developed by Drs Church and Gould for the preparation and eventual publication of the 'WCRP 25th Anniversary book' that was endorsed at JSC-XXV (March 2004).

15.3.2 WOCE Atlases

Dr J. Church briefed the JSC on the progress in preparation of the World Ocean Circulation Experiment (WOCE) Atlases based on a report submitted by Dr W. J. Gould. A final outcome of the WOCE Hydrographic Programme's global survey of the ocean's physical and chemical properties has been the preparation of a series of four Atlases of trans-ocean sections, horizontal maps and property/property plots. All figures will be included on a DVD so that they may be inserted into Powerpoint presentations.

The preparation of the Atlases has been supported through national funding to the principal investigators (Dr L. Talley (Scripps Institution of Oceanography), Pacific and Indian Oceans, Dr A. Orsi (Texas A and M University), Southern Ocean, both funded by NSF, and Dr P. Koltermann (BSH, Hamburg), Atlantic Ocean, funded by BMBF and BSH). Funding for the printing of the Atlases and for the work of the series editor (Dr M. Sparrow, ICPO) has been provided by British Petroleum.

The work of the PIs in producing Atlas plates had initially been slower than expected, but the Southern Ocean Atlas was now being printed, the Pacific plates were essentially complete, the Indian and Atlantic Ocean sections were all complete. Electronic versions of the Atlases can be inspected at http://www.soc.soton.ac.uk/OTHERS/woceipo/atlas_webpage/links.html. The JSC was invited to consider how the publication of these Atlases might be exploited.

The JSC welcomed the news that the first volume, for the Southern Ocean, of the WOCE Hydrographic Atlas series would be published in April 2005. The second volume, on the Pacific Ocean, was expected to be printed in September 2005, and the Indian Ocean Atlas by the end of the year. It was hoped that the final volume, for the Atlantic Ocean would be completed by early 2006. The JSC acknowledged with gratitude that these publications represented a valuable oceanographic product from WOCE, and therefore from the WCRP. The JSC requested Dr Church to oversee any special distributions of the WOCE Atlases.

15.3.3 In-year publications

The following reports were produced under WCRP auspices in various series since JSC-XXV:

WCRP Report Series

WCRP-117 ACSYS Archives 1994-2003 (WMO/TD-No. 1231)

WCRP-118 Final ACSYS Science Conference (St. Petersburg, Russia, 11-14 November 2004) (WMO/TD-No. 1232)

WCRP-119 Reports from WCRP Satellite Working Group:
1) WCRP Satellite Working Group Report on "Update of Space Mission Requirements for WCRP" (January 2003)
2) Space Mission Requirements for WCRP (January 2004) (WMO/TD-No. 1243)

Informal WCRP reports and documents

2/2004 Report of the second session of the CLIVAR/CliC Southern Ocean Panel, Bremerhaven, Germany, 8-11 September 2003, ICPO No. 76

3/2004 Update of Space Mission Requirements for WCRP: Second report of the WCRP Satellite Working Group, Geneva, Switzerland, 20-22 October 2003

4/2004 Report of the fourteenth session of the GEWEX Radiation Panel (GRP), Victoria, BC, Canada, 10-12 November 2003

5/2004 Report of the sixteenth session of the GEWEX Scientific Steering Group, Marrakech, Morocco, 26-30 January 2004

6/2004 OOPC-VIII report, Ottawa, Canada, 3-6 September 2003

7/2004 Report of the fourth session of the WCRP IPAB Participants, Bremerhaven, Germany, 5-6 September 2003

8/2004 Report of the eighth session of the CLIVAR Working Group on Seasonal to Interannual Prediction, ICPO No. 78

9/2004 Report of the fourth session of the WCRP ACSYS/CliC Scientific Steering Group, St. Petersburg, Russia, 15-18 November 2003

10/2004 Report of the first Indian Ocean Panel and sixth Asian-Australian Monsoon Panel joint meeting, Pune, India, 18-20 February 2004, ICPO No. 80

11/2004 Proceedings of the CLIVAR workshop on Atlantic Climate Predictability, KNMI, De Bilt, The Netherlands, 7-9 June 2004, ICPO No. 81

12/2004 ACSYS/CliC Workshop on Measurements and Modelling of Arctic Ocean Circulation, Palisades, NY, USA, 10-20 June 2000

13/2004 Project Summary report of the joint meeting of the ACSYS/CLIC Numerical Experimentation Group and the ACSYS/CLIC Observation Products Panel, Yokosuka, Japan, 9-12 September 2002

14/2004 Report of the seventh session of the JSC/CLIVAR Working Group on Coupled Modelling (WGCM), Hamburg, Germany, 24-26 September 2003

15/2004 Sea-Ice Thickness Measurements from Moored Ice Profiling Sonars (IPS), Calibration, Data Processing and Application, Tromsø, Norway, 1-3 July 2002

16/2004 Report of the CLIVAR Workshop on Assessment of a New Generation of Ocean Climate Models, ICPO No. 83

17/2004 Report of the ninth session of the Ocean Observation Panel for Climate (OOPC), Southampton, UK, 7-12 June 2004
18/2004 Report of the twelfth session of the SPARC Scientific Steering Group, Sydney, BC, Canada, 9-12 August 2004
19/2004 Report of the first CLIVAR Data Planning meeting, focussing on Ocean Observations, La Jolla, USA, 24-26 March 2004, ICPO No. 84
20/2004 Report of the fifth session of the CLIVAR Working Group on Ocean Model Development, Princeton, USA, 15&18-19 June 2004, ICPO No 85
21/2004 Report of the sixth session of the Atlantic Implementation Panel, Baltimore, USA, 21 June 2004, ICPO. No. 86
1/2005 Report of the seventh session of the CLIVAR VAMOS Panel, Guayaquil, Ecuador, 22-24 March 2004, ICPO No 88
2/2005 Report of the third session of the CLIVAR/PAGES Intersection Working Group, ICPO No 89
3/2005 Report of the GRP Working Group on Data Management and Analysis (WGDMA) and the fifteenth session of the GEWEX Radiation Panel (GRP), Kyoto, Japan, 18-22 October 2004
4/2005 Report of the eighth session of the Baseline Surface Radiation Network (BSRN) Workshop and Scientific Review Meeting, Exeter, UK, 26-30 July 2004
5/2005 Report of the tenth session of the GEWEX Hydrometeorology Panel (GHP), Montevideo, Uruguay, 13-16 September 2004

Special WCRP Reports

- Annual Review of the World Climate Research Programme and Report of the Twenty-fifth Session of the Joint Scientific Committee (Moscow, Russian Federation, 1-6 March 2004) (WMO/TD-No. 1262)

CAS/JSC Working Group on Numerical Experimentation Report Series

- Report of the nineteenth session of the CAS/JSC Working Group on Numerical Experimentation, Salvador, Brazil, 10-14 November 2003, Report No.19 (WMO/TD-No. 1252)

- Research Activities in Atmospheric and Oceanic Modelling (edited by J. Côté) (Report No. 34, WMO/TD-No. 1220, also available on the web: http://www.cmc.ec.gc.ca/rpn/wgne/)

Most of the reports produced by the International CLIVAR Project Office also had a WCRP Informal Report number and have been included in the list of those reports. Other reports/documents available were listed on and accessible through the WCRP Home Page: http://www.wmo.ch/web/wcrp/otherwcrpreports.htm

15.4 WCRP resources

The budget for the WMO/ICSU/IOC Joint Climate Research Fund (JCRF) for the WCRP for the first biennium (2004-05) of the WMO Fourteenth Financial Period 2004-07 was presented to JSC.

The budget for the WMO Fourteenth Financial Period 2004-07 was approved at the WMO Fourteenth Congress held in May 2003. The fifty-fifth session of the WMO Executive Council, May 2003, then approved the budget for the JCRF for the biennium 2004-05. It noted that ICSU was expected to contribute SFR 786,000 (equivalent to USD 600,000, using the UN official exchange rate of May 2003 (SFR 1.31/USD)) and IOC was expected to contribute SFR 655,000 (equivalent USD 500,000) to the fund for 2004-05. It authorized a total WMO contribution of SFR 3,935,400 for 2004-05. A detailed list of specific activities for the first biennium, 2004-05, of the Fourteenth Financial Period, was also approved.

Several decisions have compounded to result in a highly significantly reduced figure (in SFR) budgeted 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 (SFR 1.31/USD). The net effect is a notional loss of about 1.9M SFR in the JCRF budget for WCRP activities in 2004-07, relative to the period 2000-03.

The budget of the JCRF is actually in Swiss Francs (SFR) and the WMO contribution is made in Swiss Francs (1,968k in 2005). The ICSU and IOC contributions are renewed on an annual basis, but they were included in the JCRF budget presented to the WMO Fourteenth Congress as continuing at the same

levels (at least in principle) up to and including 2007. The ICSU payment is made up of contributions received in response to a specific annual request by ICSU to its national members (national scientific academies, etc). In practice, the IOC contributions in recent years have been only 150k USD; i.e. significantly less than budgeted for. This situation is expected to continue and probably worsen for 2005 and into the future and poses a very serious threat to WCRP's capability to support its wide range and number of activities. The budgeted amount of 250k USD from IOC corresponds to about a third of WCRP's annual requirement in support of activities.

The approved budget for the biennium 2004-05 leaves little allowance for activities not foreseen at the time of the budget request and approval. However, climate research is a fast-growing field and new initiatives are required to keep abreast of developments. In this context, the 56th WMO Executive Council (June 2004) approved 'supplementary estimates' of 300k SFR, corresponding to about 229k USD, for the JCRF for the biennium 2004-05. These 'supplementary estimates' required no additional contributions from WMO, ICSU or IOC, and are funded entirely from resources that were already available in the JCRF but not already attributed to activities. Specifically, these funds are: (i) for several activities to help develop further and implement the new WCRP Coordinated Observation and Prediction of the Earth System (COPES) strategy for the period 2005-2015, (ii) to support WCRP's continuing involvement in appropriate GEO-related activities, and (iii) for the preparation of the proposed ESSP Global Change Science Conference 2006, and for the accompanying publications and outreach activities.

The number of positions in the Joint Planning Staff (JPS), Geneva, is 7.6 FTE staff. The current workload on the JPS is high, increasing and widening in scope, consistent with the increasing range and number of activities being undertaken in the WCRP. The WCRP support to its core projects through its four International Project Offices is also generally under-funded and otherwise under-resourced, and therefore under constant and increasing strain.

The JSC noted with continuing and increasing concern the shortfalls in the budget and the anticipated income for the Joint Climate Research Fund for the WCRP over the remainder of the WMO Fourteenth Financial Period 2004-07, compared with the corresponding amounts for the previous period, 2000-2003. As in previous years, all JSC members were urged, as part of their primary duty, to: act as strong advocates for WCRP, especially in their home countries; pursue actively and vigorously all means of finding additional support and funding for the WCRP, the operation of the Joint Planning Staff for the WCRP and the four International Project Offices. Furthermore, JSC members were invited to investigate possibilities for obtaining national and institutional resources to cover the costs of attendance of individual national participants in WCRP meetings, working group sessions and workshops.

16. DATE AND PLACE OF THE TWENTY-SEVENTH SESSION OF THE JSC

The JSC gratefully accepted the kind invitation of Dr G.B. Pant, JSC Member, to host the twenty-seventh session of the Committee in Pune, India, from 6-11 March 2006. Part of the session would be held jointly with the Scientific Committee for the IGBP.

17. CLOSURE OF SESSION

The Chairman 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 further discussions on the new WCRP strategic framework Coordinated Observation and Prediction of the Earth System (COPES) and to its eventual publication and full implementation. The Chairman also acknowledged the excellent scientific presentations that had been given to the Committee by Mr R. Martinez, Deputy Director, CIIFEN, on ''CIIFEN and its activities'', and by Dr D.E. Matamoros, ESPOL Associated Researcher, on ''Climatic virtual application system for agricultural management''.

Finally, the Chairman reiterated his sincere gratitude to Prof. P. Cornejo R. de Grunauer and all who had worked with her 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 1800 hours on 18 March 2005.

APPENDIX A

LIST OF PARTICIPANTS

1. Members of the JSC

Prof. Dr P. Lemke (Chair)
Alfred-Wegener-Institut
P.O. Box 12 0161
27515 BREMERHAVEN
Germany
Tel: 49 471 4831 1751/1750
Fax: 49 471 4831 1797
E-mail: plemke@awi-bremerhaven.de

Dr J. Church (Vice-Chair)
Antarctic CRC and CSIRO Marine Research
GPO Box 1538
Hobart, Tasmania 7001
Australia
Tel: 61 3 6232 5207
Fax: 61 3 6232 5123
E-mail: john.church@csiro.au

Prof. P. Cornejo R. de Grunauer
Marine Science and Engineering
ESPOL-CAMPUS "GUSTAVO GALINDO"
P.O. Box 09-01-5863
Guayaquil
Ecuador
Tel: 593 42 269 478
Fax: 593 42 269 468
E-mail: pcornejo@espol.edu.ec

Dr D.J. Griggs
Met Office
Hadley Centre
FitzRoy Road
Exeter EX1 3PB
United Kingdom
Tel: 44 1392 886615
Fax: 44 1392 885681
E-mail: dave.griggs@metoffice.gov.uk

Dr S. Gulev (Officer)
P.P. Shirshov Institute of Oceanology, RAS
Nakhimovsky Avenue 36
Moscow 117851
Russian Federation
Tel: 7 095 124 7985
Fax: 7 095 124 5983
E-mail: gul@gulev.sio.rssi.ru and gul@sail.msk.ru

Prof. H. Le Treut
Laboratoire de Météorologie Dynamique
IPSL
Université de Paris 6
T25-19, 5E
4 place Jussieu
Case postale 99
75231 Paris Cédex 05
France
Tel: +331 44 27 84 06
Fax: +331 44 27 62 72
E-mail: letreut@lmd.jussieu.fr

Prof. J. Marotzke	Director Max Planck Institute for Meteorology Bundesstrasse 53 D-20146 Hamburg Germany Tel: +4940 41173 440 / 311 Fax: +4949 41173 366 E-mail: marotzke@dkrz.de
Dr V.P. Meleshko	Main Geophysical Observatory Karbyshev Street 7 St Petersburg 194021 Russian Federation Tel: 7 812 257 4390 Fax: 7 812 247 8661 E-mail: meleshko@main.mgo.rssi.ru
Prof. L.A. Ogallo	IGAD Climate Prediction and Applications Centre (ICPAC) P.O. Box 10304 00100 Nairobi Kenya Tel: 25420 578 340 Fax: 25420 578 343 E-mail: logallo@meteo.go.ke / icpac@dmcn.org
Dr G.B. Pant	Indian Institute of Tropical Meteorology Dr Homi Bhabha Road Pashan Pune 411 008 India Tel: 91 20 589 3924 Fax: 91 20 589 3825 E-mail: gbpant@tropmet.res.in
Prof. V. Ramaswamy (Officer)	NOAA Geophysical Fluid Dynamics Laboratory Princeton University Forrestal Campus, US Route 1 Post Office Box 308 Princeton, New Jersey 08542 USA Tel: 1 609 452 6510 Fax: 1 609 987 5063 E-mail: v.ramaswamy@noaa.gov
Dr K. Trenberth (Officer)	National Center for Atmospheric Research P.O. Box 3000 Boulder, CO 80307 USA Tel: 1 303 497 1318 Fax: 1 303 497 1333 E-mail: trenbert@ucar.edu
Prof. Guoxiong Wu	Chinese Academy of Sciences Institute of Atmospheric Physics LASG P.O. Box 9804 Beijing 100029 China Tel: +8610 620 43356/620 43451-214 Fax: +861 6204 3526 E-mail: gxwu@lasg.iap.ac.cn

Prof. T. Yasunari

Hydrospheric Atmospheric Research Center (HyARC)
Nagoya University
Furo-cho, Chikusa-ku
Nagoya Aichi 468-8601
Japan
Tel: 81 52 789 3465 (or 5926)
Fax: 81 52 789 3436
E-mail: yasunari@hyarc.nagoya-u.ac.jp

Dr M.T. Zamanian

IRIMO
P.O. Box 13185-461
Tehran
Islamic Republic of Iran
Tel: 98 216 004 041
Fax: 98 216 469 044
E-mail: zamanian@irimet.net

Unable to attend

Dr K. Denman

Canadian Centre for Climate Modelling and Analysis
University of Victoria
P.O. Box 1700 STN CSC
Victoria, BC V8W 2Y2
Canada
Tel: 1 250 363 8230
Fax: 1 250 363 8247
E-mail: ken.denman@ec.gc.ca

Prof. J. Shukla

George Mason University
Center for Ocean-Land-Atmosphere Studies
4041 Powder Mill Road, Suite 302
Calverton, Maryland 20705-3106
USA
Tel: 1 301 595 7000
Fax: 1 301 595 9793
E-mail: shukla@cola.iges.org

Dr Ilana Wainer

Dept. Oceanografia Fisica
Universidade de Sao Paulo
Praca do Oceanografico 191
05508-120 Sao Paulo
Brazil
Tel: +5511 3091 6581
Fax: +5511 3091 6610
E-mail: wainer@usp.br

2. Invited experts and observers

Prof. G. Brasseur
(Chair, Scientific Committee, IGBP)

Max Planck Institut für Meteorologie
Bundesstr. 55
Hamburg 20146
Germany
Tel: +4940 411 73421
Fax: +4940 411 73430
E-mail: brasseur@dkrz.de

Dr A. Busalacchi
(Co-Chair, CLIVAR Scientific Steering Group)
Earth System Science Interdisciplinary Centre
University of Maryland
244 Computer and Space Science Bldg, Rm 2207
College Park, MD 20742-2425
U.S.A.
Tel: 1-301-405-5599
Fax: 1-301-405-8468
E-mail: tonyb@essic.umd.edu

Dr Josep Canadell
(Executive Director, GCP)
CSIRO Division of Atmospheric Research
Earth Observation Centre
GPO Box 3023
Canberra, ACT 2601
Australia
Tel: 61 26246 5630
Fax: 61 26246 5988
E-mail: pep.canadell@csiro.au

Dr H. Cattle
(Director, International CLIVAR Project Office)
National Oceanography Centre
Empress Dock
Southampton SO14 3ZH
UK
Tel: +4423 8059 6208 / 789
Fax: +4423 8059 6204
E-mail: hyc@noc.soton.ac.uk

Dr Marcel B. Endejan
(Deputy Executive Officer, GWSP)
Global Water System Project
International Project Office
Walter-Flex-Str. 3
Bonn 53113
Germany
Tel: +49 228 736 189
Fax: +49 228 736 0834
E-mail: marcel.endejan@uni-bonn.de

Dr C. Fairall
(Chair, Working Group on Surface Fluxes)
NOAA/OAR/Environmental Technology Laboratory
325 Broadway R/ET6
Boulder, CO 80305
USA
Tel: +1 303 497 3253
Fax: +1 303 497 6181
E-mail: chris.fairall@noaa.gov

Dr Albert Fischer
(IOC observer)
Intergovernmental Oceanographic Commission
UNESCO
1 rue Miollis
75732 Paris Cedex 15
France
Tel: 33(0)1 45 68 40 40
Fax: 33(0)1 45 68 58 12
E-mail: a.fischer@unesco.org

Prof. W.L. Gates
National Institute for Global Environmental Change (NIGEC)
University of California, Davis
1490 Drew Avenue, Suite 140
P.O. Box 808, L-264
Davis, California 95616-8756
USA
Tel: +1 530 757 3350
Fax: +1 530 756 6499
E-mail: wlgates@ucdavis.edu

Dr Barbara Goebel (Executive Director, IHDP)	IHDP Secretariat Walter-Flex-Str. 3 Bonn 53113 Germany Tel: +49 228 739051 Fax: +49 228 739054 E-mail: goebel.ihdp@uni-bonn.de
Dr B. Goodison (Chair, CliC Scientific Steering Group)	Meteorological Service of Canada (MSC) 4905 Dufferin Street Downsview, Ontario M3H 5T4 Canada Tel: 1-416-739-4345 Fax: 1-416-739-5700 E-mail: barry.goodison@ec.gc.ca
Dr D.E. Harrison (Chair, GCOS/GOOS/WCRP Ocean Observations Panel for Climate)	Pacific Marine Environmental Laboratory NOAA/PMEL/OCRD 7600 Sand Point Way NE Seattle, WA 98115 USA Tel: 1 206 5266225 Fax: 1 206 5266744 E-mail: d.e.harrison@noaa.gov
Prof. B.J. Hoskins (Co-Chair, COPES Task Force)	Department of Meteorology University of Reading Earley Gate P.O. Box 243 Reading, Berkshire RG6 6BB United Kingdom Tel: 44 118 931 89 50/53 Fax: 44 118 931 63 93 E-mail: b.j.hoskins@reading.ac.uk
Prof. B. Kirtman (Chair, Task Force on Seasonal Prediction)	Center for Ocean-Land-Atmosphere Studies 4041 Powder Mill Road, Suite 302 Calverton, MD 20705 USA Tel: +1 301 595 7000 Fax: +1 301 595 9793 E-mail: kirtman@cola.iges.org
R.G. Lawford (Director, International GEWEX Project Office)	International GEWEX Project Office 1010 Wayne Avenue, Suite 450 Silver Spring, MD 20910 USA Tel: +1 301 565 8345 Fax: +1 301 565 8279 E-mail: gewex@gewex.org / lawford@umbc.edu
Dr M. MacCracken (Representing IAMAS, IUGG and SCOR)	Chief Scientist for Climate Change Programs Climate Institute 1785 Massachusetts Avenue, NW Washington DC 20036 USA Tel: +1 202 547 0104 Fax: +1 202 547 0111 E-mail: mmaccrac@comcast.net

Dr M. Manton
(Chair, GCOS/WCRP Atmospheric Observation Panel for Climate)

Bureau of Meteorology Research Centre
GPO Box 1289K
Melbourne, Victoria 3001
Australia
Tel: +613 9669 4444
Fax: +613 9669 4660
E-mail: m.manton@bom.gov.au

Dr J. Marengo
(Member, GWSP SSC)

CPTEC/INPE
Rod. Dutra Km 40, Cachoeira Paulista
Sao Paulo 12630-000
Brazil
Tel: +5512 5608 464
Fax: +5512 3101 2835
E-mail: marengo@cptec.inpe.br

Prof. P.J. Mason
(Chair, GCOS Steering Committee)

University of Reading
Department of Meteorology
P.O. Box 243
Earley Gate
Reading RG6 6BB
UK
Tel: 441 344 854 604
Fax: 441 344 856 909
E-mail: p.j.mason@reading.ac.uk

Dr N. McFarlane
(Director, SPARC International Project Office)

Canadian Centre for Climate Modelling and Analysis
Meteorological Service of Canada
University of Victoria
P.O. Box 1700
Victoria, BC V8W 2Y2
Canada
Tel: +1 250 363 8227
Fax: +1 250 363 8247
E-mail: norm.mcfarlane@ec.gc.ca

Dr M. Miller
(Chair. JSC/CAS Working Group on Numerical Experimentation)

European Centre for Medium Range Weather Forecasts (ECMWF)
Shinfield Park, Reading
Berkshire RG2 9AX
UK
Tel: +44 1189 499 070
Fax: +44 1189 869 450
E-mail: mmiller@ecmwf.int

Prof. J.F.B. Mitchell
(Chair, WCRP Working Group on Coupled Modelling)

Chief Scientist
Met Office
FitzRoy Road
Exeter, Devon EX1 3PB
UK
Tel: +44 1392 884 604
Fax: +44 1392 884 400
E-mail: john.f.mitchell@metoffice.gov.uk

Dr B. Nyenzi
(WMO observer)

World Climate Programme Department
World Meteorological Organization
Case Postale No. 2300
1211 Geneva 2
Switzerland
Tel: 41 22 730 8273
Fax: 41 22 730 8042
E-mail: bnyenzi@wmo.int

Prof. A. O'Neill (Co-Chair, SPARC Scientific Steering Group)	University of Reading Dept. of Meteorology Data Assimilation Research Centre P.O. Box 243 Earley Gate, Whiteknights Reading RG6 6BB UK Tel: 44-118-931-8317 Fax: 44-118-931-8316 E-mail: alan@met.reading.ac.uk
Dr Melvyn Shapiro (representing WMO CAS)	NOAA Office of Weather and Air Quality c/o NCAR/MMM P.O. Box 3000 Boulder, CO 80307-3000 USA Tel: +1 303 497 8965 Fax: +1 303 497 8181 E-mail: mshapiro@ucar.edu
Prof. S. Sorooshian (Chair, GEWEX Scientific Steering Group)	Center for Hydrometeorology and Remote Sensing Department of Civil and Environmental Engineering University of California, Irvine E-4130 Engineering Gateway Irvine, CA 92697-2175 USA Tel: 1-949-824-8825 Fax: 1-949-824-8831 E-mail: soroosh@uci.edu

3. WCRP Joint Planning Staff

World Climate Research Programme
c/o World Meteorological Organization
Case Postale No. 2300
1211 Geneva 2
Switzerland

Dr D. J. Carson (Director, WCRP)	Tel: 41 22 730 8246 Fax: 41 22 730 8036 E-mail: dcarson@wmo.int
Dr V. Satyan	Tel: 41 22 730 8418 Fax: 41 22 730 8036 E-mail: vsatyan@wmo.int
Dr V. Ryabinin	Tel: 41 22 730 8486 Fax: 41 22 730 8036 E-mail: vryabinin@wmo.int
Dr G. Sommeria	Tel: 41 22 730 8247 Fax: 41 22 730 8036 E-mail: gsommeria@wmo.int
Ms Ann Salini	Tel: 41 22 730 8494 Fax: 41 22 730 8036 E-mail: asalini@wmo.int