INTERNATIONAL COUNCIL FOR SCIENCE

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

WORLD METEOROLOGICAL ORGANIZATION

WORLD CLIMATE RESEARCH PROGRAMME (WCRP)

Arctic Climate System Study (ACSYS) and Climate and Cryosphere (CliC) Projects

Report of the fourth session of the WCRP ACSYS/CliC Scientific Steering Group (SSG)

(St. Petersburg, Russia, 15-18 November 2003)

June 2004

WCRP Informal Report No. 9/2004

Table of contents

Appendices

1. Introduction

At the kind invitation of Academician V.M. Kotlyakov, Director of the Institute of Geography, Russian Academy of Sciences (RAS), and Dr A.I. Bedritsky, Head of the Russian Federation Federal Service for Hydrometeorology and Monitoring of the Environment (Roshydromet), the fourth session of the WCRP Scientific Steering Group (SSG) for the WCRP Arctic Climate System Study (ACSYS) / Climate and Cryosphere (CliC) projects was held from 15-18 November 2003, at the Arctic and Antarctic Research Institute (AARI) of Roshydromet in St. Petersburg, Russia. The session followed a successful final Conference of the ACSYS Project, which was also held at AARI from 11-14 November 2003. On 15 November 2003, during the first day of the session, a joint meeting was held of the SSG and the National Committee of the Russian Federation for Cryosphere and Climate Research.

Appendix 1 provides a list of participants in the SSG session. Final agenda of the joint meeting on 15 November 2003 and the SSG session on 17,18 November 2003 is available in Appendix 2. Appendix 3 contains a list of follow-up actions agreed at the session. A similar list from the previous SSG session in Beijing (21-25 October 2002) with remarks on the action completion is given in Appendix 4. Appendix 12 with the list of used acronyms concludes this report.

2. A Joint Meeting of the WCRP ACSYS/CliC SSG and the National Committee of the Russian Federation for Cryosphere and Climate Research (15 November 2003)

Academician V.M. Kotlyakov who chaired the joint meeting, called it to order at 09:15 of 15 November 2003. Dr I.E. Frolov, the AARI Director welcomed the members of the SSG, the Russian National Committee (NC), and invited experts to the AARI. After a round of self-introductions, the chair gave the floor to Prof. P. Lemke, the Chair of the WCRP Joint Scientific Committee, who presented an overview of the WCRP, its status and modern developments. This overview set the stage for a summary of the CliC project and its expected contribution to the overall goals and objectives of the WCRP. The ACSSYS/CliC Chair, Dr B. Goodison, gave a presentation covering the scope of the project, its planning and organisation.

In their joint statement, Academician V.M. Kotlyakov and Dr A.I. Bedritsky elaborated the need for Russia to have a National Committee for Cryosphere and Climate Research, which was created under the auspices of the Russian Academy of Sciences and Roshydromet. Academician V.M. Kotlyakov and Dr A.I. Bedritsky are the co-chairs. Academician V. Melnikov, the director of the Institute of Cryosphere, RAS, and Dr I.E. Frolov, the director of AARI are the co-vice chairs. Dr T. Khromova is the Academic Secretary of the NC. In addition to the above executive members of the NC, it also includes 28 members representing various areas of glaciology, meteorology, hydrology and geocryology. Among them there are two members of RAS and four corresponding members of RAS. The SSG members expressed their satisfaction that Russia had decided to establish an NC for Cryosphere and Climate, and by doing this, expressed its interest in the CliC project.

Several presentations by Russian scientists, which continued the meeting, focussed on areas of increased national scientific interest. Dr A. Glazovsky gave a review of glacier studies in Russia. Drs A. Danilov and A. Klepikov spoke on cryospheric research at AARI. Dr V. Smolyanitsky presented a report on studies of the Arctic sea ice conducted both at the AARI as well as under the auspices of the WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM). National presentations at the meeting were concluded with a review of paleocryospheric research by Dr O. Solomina. Then the floor was given to several CliC partner programmes. Dr D. Raynaud presented activities of the Past Global Changes (PAGES) project of IGBP. Dr J. Brown, the President of the International Permafrost Association (IPA), highlighted the main areas of the IPA activities and also, on behalf of Dr V. Rachold, presented to the meeting several results of the Arctic Coastal Dynamics Project. After a discussion, the participants from the ACSYS/CliC SSG, NC, and several guests, adopted a joint statement. It is given in Appendix 5 to this report.

3. Opening of the fourth Session of ACSYS/CliC SSG

The Chairman, Dr B. Goodison, opened the 4th ACSYS/CliC SSG meeting at 08:45 hours on Monday, 17 November 2003, at the AARI, St. Petersburg, Russia. The chair welcomed SSG members and invited experts to the session. He expressed his appreciation to Dr A.I. Bedritsky for his agreement to hold the Final ACSYS Science Conference and the SSG session at AARI, in St. Petersburg, Russia. Academician V.M. Kotlyakov welcomed the session to Russia, also on behalf of Dr A.I. Bedritsky, Head of the Roshydromet. Dr S.M. Priamikov greeted the participants on behalf of the AARI and explained to them the local arrangements. Then the participants were invited to briefly introduce themselves. Dr V. Ryabinin presented working documents of the session. The participants agreed to follow the agenda, which is given in Appendix 2.

4. Relevant recommendations of the JSC-XXIV, status of the WCRP, introduction to COPE, WCRP Task Force on Seasonal Prediction, the outcome of the Earth Observation Summit

The participants of the session were presented with a summary of recent developments in the WCRP prepared by Dr V. Ryabinin. The main points of the summary and its discussion follow below.

Global Energy and Water Cycle Experiment (GEWEX). GEWEX Phase II focuses on: exploitation of both in situ and satellite data, variability and predictability of the global energy budget and water cycle, and applications relating to water resources. A Co-ordinated Enhanced Observing Period (CEOP) is being implemented in which synchronous data sets are being collected from 2001-2004 from sites associated with the GEWEX Continental Scale Experiments. CEOP's success depends also on existing and new streams of satellite data and on the direct involvement of operational numerical weather prediction and climate modelling centres. The project is being strongly supported by the Integrated Global Observing Strategy (IGOS) partnership, as a pilot study for the IGOS Integrated Global Water Cycle Observations theme. CEOP data sets should enable testing of global and regional coupled models in unique ways. A GEWEX Science Conference is planned for 2005 in Irvine, USA.

Stratospheric Processes and their Role in Climate (SPARC). SPARC aims to address specific, important and topical issues and to increase understanding of basic processes, leading in turn to improved models and future projections. Current topics include the dynamical coupling between the stratosphere and troposphere, diagnosing and exploring stratospheric change, and chemistry-climate interactions. SPARC and the International Atmospheric Chemistry Project of the International Geosphere-Biosphere Programme (IGBP) have been exploring the feasibility of a joint WCRP/IGBP project on 'atmospheric chemistry and climate'. A General Assembly of SPARC is taking place in Victoria, BC, Canada, on 1-6 August 2004.

World Ocean Circulation Experiment (WOCE). Almost 20 years have elapsed since the emergence of the concept of a Global Ocean Circulation Experiment (that became WOCE). WOCE has been by far the biggest and most successful ocean programme to date and its achievements were celebrated at the final conference, 'WOCE and beyond', held in San Antonio, USA, in November 2002. WOCE has provided unprecedented insight into the circulation, ventilation and physical structure of the deep oceans - the basic information needed to understand and predict changes in the world ocean circulation, volume and heat storage. Over 1600 peer-reviewed papers attributable directly to WOCE research have been published. WOCE also achieved an unprecedented level of international collaboration, bringing together observationalists (both seagoing and satellite-sensing), modellers and theoreticians.

Climate Variability and Predictability (CLIVAR) study. CLIVAR is the WCRP project now having primary responsibility for ocean issues. There has been a rapid increase in CLIVAR's maturity as it has moved from planning to implementation. CLIVAR is carrying out and planning observations in all the major ocean basins and in many of these there are commitments to virtually all elements identified in CLIVAR's 1998 Initial Implementation Plan.

Monsoonal systems have a huge socio-economic impact and are being studied by CLIVAR in the Indian

Ocean sector, in the Americas and in west Africa. These require CLIVAR to consider not only the coupled atmosphere-ocean system but also the hydrological cycle over land and, in the context of anthropogenic influence, changes in land use. In this context, modelling of the coupled climate system lies at the heart of CLIVAR, from seasonal to interannual prediction to decadal climate variability and the prediction of climate change.

A 1st International CLIVAR Science Conference is taking place in Baltimore, USA, on 21-25 June 2004.

Climate modelling. A major unifying theme is the development of comprehensive global models of the full climate system. Despite a decade of intense research, the greatest uncertainty in future projections of climate probably arises from clouds and their interactions with radiation. In view of its critical nature and complexity, this major problem was given special attention by the JSC at its twenty-third session, in March 2003. In particular, a 'WCRP Feedback Workshop' to address this issue was held in Atlanta, USA, in November 2002.

Earth System Science Partnership. In recognition of the need to address issues of major relevance to society and global sustainability, which require an integrated approach across a wide spectrum of research disciplines, WCRP, IGBP, the International Human Dimensions Programme (IHDP) on Global Environmental Change, and DIVERSITAS (an International Programme of Biodiversity Science), have established the Earth System Science Partnership. Three projects (on the global carbon cycle, food systems and water resources) are being developed and implemented jointly, with a fourth on 'global change and human health' being considered.

Decisions of the Joint Scientific Committee for WCRP of relevance to ACSYS/ CliC. At the invitation of Dr B.J. Hoskins, Department of Meteorology and the University of Reading, the twenty-fourth session of the JSC, took place at the Department of Agriculture, University of Reading from 17-21 March 2003. Among other issues, the session discussed the status and development of ACSYS and CliC. The ACSYS/CliC SSG Chair and the IACPO Director, in their report to the JSC, highlighted the following tasks of the highest importance for ACSYS and CliC:

- To complete ACSYS observational programmes and studies, summarise the results with the goal of improving representation of the Arctic region and corresponding processes in global climate models, to be accomplished, in part, by the final ACSYS Conference.
- To prepare datasets relevant to studies of Arctic climate on CD-ROM and/or the Internet, to be accomplished primarily via the ACSYS Data and Information Service.
- To ensure smooth and full transition of all relevant ACSYS activities to CliC.
- To refine CliC Implementation Strategy document.
- To define and guide CliC initial observational and modelling activities for determining the role of cryosphere in the global climate system and its realistic representation in models.
- To stimulate and coordinate national and regional contributions to CliC.
- To develop strategies for co-ordination of CliC national and regional initiatives, including establishment of partnerships with other scientific organisations, societies, and international committees.
- To strengthen links with other WCRP projects and relevant research and observational programmes outside WCRP.

The following immediate priorities of CliC were named:

- ACSYS Final Science Conference
- CliC Implementation Strategy
- First CliC Science Conference
- WCRP participation in the proposed International Polar Year (IPY).

The JSC accepted the report very positively. It endorsed the new approach to CliC Implementation, which envisaged the development of an overall strategy and more detailed plans for CliC subprojects. The JSC as well:

- agreed to hold an international CliC Conference in 2005;
- supported the involvement of WCRP in any climate-related activities associated with a proposed "International Polar Year" and the promotion of global change and climate research as important foci for this initiative. CliC was requested to organise preparations within WCRP taking into

account the interests of all relevant projects and working groups and represent WCRP in corresponding discussions.
- recommended to pursue activities aimed at strengthening the cryospheric component of GCOS.

Other recommendations of JSC-24 of relevance to ACSYS/CliC were as follows. The JSC recommended continued specific effort on high-latitude precipitation under the GEWEX Hydrometeorological Panel, in co-ordination with CliC, and identification of one person in charge from the CliC community. A task force is to be established to review and report to the next JSC session on WCRP interests and activities dealing with sea-level rise. The projects are asked to identify any contributions being made to the study of sea-level rise. The JSC noted the continuing scarcity of Southern Ocean observations. Efforts are to be continued to develop the observing system in this region. Progress in implementation of the Global Carbon Project was welcomed. JSC noted the ongoing interaction between WG on Coupled Modelling (WGCM) and Global Carbon Project (GCP) and emphasised the need to address the issue of how WCRP activities could feed into GCP not only in modelling area but also in process studies. The JSC welcomed the scoping document 'The Water Challenge' submitted by the Global Water Systems Project scoping team and stressed the need to build on available WCRP expertise and to avoid duplication with existing WCRP projects.

In addition to the specific co-sponsorship of SOLAS, the JSC recommended the formation of a limited-term (three years) WCRP Working Group on Surface Fluxes (WGSF) to address all the requirements of research, observations, analysis and modelling of surface fluxes within WCRP and WCRP's interests in closely-related programmes (e.g. GODAE, GCOS). All relevant WCRP projects and activities, including specifically WGNE and SOLAS, should be represented on the new WGSF. Dr C. Fairall (USA) has accepted WCRP's invitation to chair the group. The SSG was pleased with information that the group was established and resolved to actively co-operate with it.

The JSC welcomed and appreciated the "Second Report on the Adequacy of the Global Observing System for Climate" for the UNFCCC, which was prepared by GCOS. The report assessed how well current and planned observing systems met scientific requirements, observing principles and the needs of the Convention (including the IPCC). The JSC noted the critical finding of the report of the need to improve the availability of, and access to, climate data, particularly to hydrological data, such as precipitation, river discharge and ground water levels.

The JSC noted with encouragement the strengthening direct liaison and interaction between WCRP and IPCC WG-I with respect to specific emerging initiatives and supported WCRP's involvement in the proposed IPCC Climate Sensitivity Workshop in 2004. It decided that expertise from WCRP core projects should be made available in the preparation of Assessment Report 4 and that the WCRP should assist IPCC, where appropriate, with review of draft material through the assessment report process.

The next JSC session will take place in Moscow, 1-6 March 2004, by kind invitation of Dr S. Gulev. A one-day (probably 5 March) meeting will be held jointly with the Scientific Committee for the IGBP, which is expected to meet in Moscow at the same time.

Climate System Observational and Prediction Experiment. The JSC-23 (Hobart, Australia, March 2002) established a task force for a new WCRP-wide "Predictability Assessment of the Climate System". The goal was to plan major steps forward in climate prediction. The report of the task force was presented to JSC-24 and was greatly appreciated and thoroughly debated throughout the session, resulting in the following decisions for the future scientific direction and structure of WCRP:

The major objectives of the WCRP should continue as they have always been, namely, to determine to what extent climate can be predicted and the extent of human influence on climate, together with the research priorities agreed at the WCRP Conference, 1997, namely:
- assessing the nature and predictability of seasonal to interdecadal variations of the climate system at global and regional scales, and providing the scientific basis for operational predictions of these variations for use in climate services in support of sustainable development;
- detecting climate change, attributing causes and projecting the magnitude and rate of human-induced climate change, regional variations, and related sea-level rise (as needed for input to the IPCC, UNFCCC and other conventions).

To recognise the renewed emphasis of WCRP on its prediction aims and the observational activity that is needed to fulfil them, it was decided to develop a major overarching and integrating initiative, tentatively called the "Climate system Observational and Prediction Experiment (COPE)", to be conducted over a decade up to about 2015. It is intended that the proposed focus on the aims of WCRP, setting objectives and viewing them in the context of COPE will provide a new stimulus for the science of WCRP, and widen the recognition of its relevance and importance for a globally-sustainable future.

The JSC will be responsible for guiding and assessing the development and implementation of COPE, in the context of the WCRP's overall objectives and research priorities: JSC members will need to play a more direct and active role in WCRP, with specific members accepting responsibilities for liaison between JSC and WCRP activities; JSC sessions should become more focused on assessment of progress towards the main WCRP objectives.

Two new coordinating bodies, the Modelling Council and the Observational Council, are to be established: their prime role will be to coordinate and integrate modelling and observational activities across WCRP, with the purpose of meeting the WCRP objectives.

WCRP should set itself a number of specific objectives with associated time-scales for completion. At the end of the time-period for each objective, a publication, synthesising the scientific status and understanding of the topic should be produced: such objectives should be widely debated in the WCRP community and stakeholders should be asked for their comments.

The projects and activities will play an essential role in proposing objectives for WCRP: scientific programmes and structures may have to evolve to enable full and proper contributions towards WCRP objectives, and to COPE; at JSC sessions the contributions of projects and activities will focus more on progress towards WCRP objectives, and highlighting topics for future objectives.

All projects should consider and propose their "sunset dates" in the period before 2015 with an outline of what is expected to be achieved by that date (to be reported to the next session of the JSC).

Recognising the importance of seasonal prediction as a specific objective under COPE, it was recommended by the JSC to establish a limited-term Task Force on Seasonal Prediction (TFSP). It should be led by WGSIP, drawing on expertise in all WCRP projects, WGNE and WGCM. A prime aim will be to determine the extent to which seasonal prediction is possible and useful in all regions with currently available models and data.

Dr B. Kirtman (USA) was invited to lead the TSFP and has accepted the invitation. The first meeting of the TFSP took place on 3-7 November 2003 (Honolulu, USA). The TFSP developed a draft plan of actions. Dr J. Christensen (Denmark), a member of the ACSYS/CliC Numerical Experimentation Panel was nominated to TFSP. CliC, as a WCRP project, is expected to actively contribute to COPE and TFSP.

The SSG was very keen to know the details of how COPE aims were understood by the WCRP JSC, what was the expected pace of COPE development including the establishment of its infrastructure. It felt that an overarching activity integrating results obtained within WCRP core projects and transforming the results into useful contribution by science to long-term weather and climate predicting was a positive development. Prof. P. Lemke clarified several positions and also informed the SSG that most of the raised issues and questions were supposed to be actively discussed at the next JSC session in Moscow.

The Earth Observation Summit. On the initiative of the U.S. Government, the Earth Observation Summit was held in Washington, D.C., USA, on 31 July 2003 with 33 countries (plus the European Commission) and 30 international agencies represented. The purpose of the Summit was to promote the development of a comprehensive, coordinated and sustainable Earth observation system (or systems) among governments and the international community to improve the ability to understand and address global environmental and economic challenges and meet international treaty obligations.

The Summit adopted a Declaration which:

- Affirmed the need for timely, high-quality, long-term global information as a basis for sound

decision-making;
- Called for improved co-ordination of systems for observations of the Earth and to fill data gaps;
- Highlighted the need to assist developing countries to sustain their observing systems by addressing capacity building;
- Affirmed the exchange of data from observation systems in a full and open manner with minimum delay and at minimum cost;
- Requested the preparation of a 10-year Implementation Plan.

The Summit also established an ad hoc Group on Earth Observations (GEO), which it entrusted with the preparation of the above Implementation Plan, building on existing systems and initiatives. A framework for this will be prepared by a second such ministerial conference, to be held in Tokyo during the second quarter of 2004, and the Plan itself should be available for a third 'summit', to be hosted by the European Union in Brussels during the fourth quarter of 2004. The GEO held its inaugural meeting, also in Washington, D.C., USA, on 1-2 August 2003. The work will be done through a Secretariat and five complementary Subgroups, namely: Architecture; Capacity Building; Data Utilization; International Cooperation; and, User Requirements and Outreach.

The SSG members enquired on what could be the ways of CliC panels and working groups to contribute to GEO. National channels and preparing proposals for WCRP were indicated as the ways. WCRP is a member of GEO Capacity Building and User Requirements and Outreach subgroups. The SSG considered it important for GEO to fully use findings containing in the 2nd Adequacy Report of Observing Systems for Climate prepared by GCOS and also expressed a view that data assimilation must play an important role in GEO.

WCRR study of Space mission Requirements. The JSC–24 acknowledged and supported the need for closer interaction between WCRP and space agencies with WCRP taking the lead scientific role and exploring appropriate interaction mechanisms. It encouraged WCRP to bring together climate modelling and satellite data communities, especially for the land related issues. The JSC endorsed development of a plan for a coordinated analysis and reanalysis of all global satellite observations for climate research while keeping in mind the need for continued processing as sensors evolve.

In 2002 the WCRP established a working group on satellites, which first met in November 2002 and then prepared a report, which contained a request for increased support of space agencies in the development of climate data sets and a statement of the need for cross-participation of WCRP and space agencies on respective advisory bodies. The group met again on 20-22 October 2003 in Geneva and further elaborated the report and recommendations. Prof. K. Steffen, Chair of the ACSYS/CliC Observation Products Panel, participated in the meeting.

An initial draft plan concerning the global energy and water cycle and the "faster" atmospheric responses to change was presented and discussed by the Group. This plan can serve as a prototype for a WCRP Plan, which would include other key climate processes and the observation of some aspects of the slower climate components. The next specific tasks to be performed as part of consultations within WCRP and with space agencies are:
- To define the scope of the analysis (time-space resolution and/or sampling, time period, state variables and diagnosed exchange quantities)
- To list specific datasets to be included in the processing or to be used for evaluation
- To propose a draft schedule for specific analysis tasks
- To define modelling tasks
- To list expected outcomes ("cleaned-up" input datasets, data products and analysis results, evaluations of quality, identification of problems)
- To describe the types of contributions sought
- To list possible space agency contributions
- To describe the benefits of participation.

The Group concluded that an international collaborative effort is mandatory to re-process the existing data sets into a physically consistent set of high quality climate products. The Group recommended that a proposal for a Coordinated, Integrated Observational Analysis Strategy for the World Climate Research

Programme be elaborated by the WCRP Project Directors/Offices in concert with space agencies on the basis of the above approach.

The Group noted with satisfaction that significant progress has been achieved since the first report of the WCRP study was released in early January 2003, including:

- New important space missions for climate research launched in 2003 (NASA SORCE and ICESat, Canadian SCISAT-1) and several planned in 2004/2005 (Cryosat, Aura, Calipso, Parasol…)
- Final approval given for the development and launch of new missions in the second half of this decade (SMOS, Aquarius…) in line with previous WCRP recommendations
- Numerous missions of high importance for climate research currently under definition for decisions in 2004/2005 (GPM, GOSAT, ESA Earth Explorers including WALES, EarthCare, ACE+, SPECTRA…).

The WCRP Working Group recommendations, in the short-term, include the following priorities:

- Continuation of TRMM operations for as long as possible
- Final decision to proceed with the GPM mission including the EGPM component
- Identification of alternative option(s) for the timely implementation of Megha-Tropiques
- Final decision on GOSAT and HYDROS implementation
- Provision of continuity for high resolution optical imagery mission of the Landsat / SPOT class
- Detailed definition and work plan for a strategy for the development of quality climate products with involvement of CEOS WGISS
- Involvement of CEOS Cal/Val Working Group for an enhanced Cal/Val programme focusing on sensor cross-calibration
- Release of coordinated Calls for Ideas/Mission concept for climate research
- Development of innovative instrumentation for atmospheric chemistry and precipitation measurements from GEO

The Group reiterated the general recommendations expressed last year and strongly recommended that mechanisms be identified by space agencies to ensure data continuity for experimental missions whenever appropriate for climate research. The Group also felt very concerned with the alarming situation concerning frequency allocation and urged space agencies to take the appropriate initiatives with their appropriate authorities to protect frequency bands of high importance for climate measurements.

The SSG reviewed the output of the WCRP Satellite Working Group and paid particular attention to chapter 6, which was entitled "strategy for development of climate products" and contained an initiative to conduct a climate system reanalysis. It noted that the input for this chapter was mostly provided by GEWEX. The initiative has been broadly approved with the understanding that it should be consolidated within WCRP, with a balanced input from all core projects. SSG requested the group to provide a more detailed description of the cryospheric component of the proposal. The SSG felt this could form the basis for a first "observation" contribution to COPE. CliC should support the idea of a WCRP task force on this subject and delegate a representative to this task force.

5. Review of Action Items from ACSYS/CliC SSG III

An update of action items was tabled by the Director of IACPO, Dr C. Dick. A summary is given in Appendix 4.

6. Actions needed to conclude ACSYS

6.1 Preliminary Analysis of the Final ACSYS Science Conference results

Prof. T. Fichefet, an SSG member and a Co-Chair of the conference, presented preliminary results of the Conference, which finished just 3 days before the SSG session. The aim of the conference (**http://acsys.npolar.no/meetings/final/conf.htm**) was to summarize the major improvements in the

knowledge of the Arctic climate system during the ACSYS decade, drawing together advances in the understanding of each of the individual elements of the Arctic climate system and, more particularly, the understanding of the interactions between them. The conference also sought to examine the challenges for future research on the Arctic climate system. To do this, it brought together observational scientists and modellers to provide a common forum for presentation of results.

The conference was divided into four sessions addressing:

- The state of the Arctic climate system. Improvements in our knowledge of it and its variability through historical data, ongoing measurements, and process studies.
- Observing the Arctic climate system. Improvements in our ability to measure and observe aspects of the Arctic climate system and its processes across a range of spatial and temporal scales.
- Process studies and modelling. Improvements in representation of atmospheric, cryospheric, oceanic, and terrestrial processes in models, including assimilation of observations into models.
- Interactions with the global climate system. Improvements in our understanding of the role of the Arctic in the global climate system, its response to large-scale climate variations, and the processes involved.

Each of these sessions included a number of keynote lectures by invited speakers and talks selected from submitted abstracts. In a final session, presentations were made by the chairs of the ACSYS working groups or panels on numerical modelling, observation products, data management and information, and polar products from reanalysis. This was followed by a panel discussion, which examined gaps in our knowledge and considered opportunities and initiatives to fill them.

Most important scientific highlights included:

- The Arctic experienced very strong warming in concert with the global trend during the last three decades. However, variations in Arctic climate over the past century do not track global variations, suggesting a complex relationship to global climate, which should remain the focus of ongoing study and debate.
- Although no convincing evidence of any significant slowdown of the Atlantic meridional overturning circulation (MOC) is yet found, there is some evidence that the recent freshening of the subarctic seas might not be a localized Atlantic event, but the strong local expression of a change in the global water cycle. Freshening has been observed in high latitudes of both the Atlantic and Pacific Oceans, while low latitude oceans seem to become more saline.
- Satellite passive microwave data reveal that the Arctic sea ice extent has decreased by 0.30×10^6 km^2 (i.e., 2.5%) per decade since 1972. All months have negative trends, and the magnitude of the trend is largest in September, the month of minimum ice extent. The lowest levels were reached in September 2002 and 2003.
- The Arctic sea ice has been reported to have thinned substantially over the last 20 to 40 years in most of the deep water areas, especially during summertime. However, sea ice exhibits a pronounced interannual variability in thickness, making it more difficult to interpret the spatially and temporally sparse record. This interannual variability is reasonably well captured by current high resolution sea ice–ocean general circulation models forced by reanalysis atmospheric data, but there is still much work to be done to fully understand the mass balance of Arctic sea ice and its influence on atmospheric and oceanic circulations.
- In 2002, the Greenland ice sheet experienced the most extensive melt since satellite observations began in 1980. A model study suggests that the greenhouse gas-induced increase in freshwater flux from this ice sheet by the end of the 21st century might be sufficient to induce an abrupt weakening of the Atlantic MOC, with a subsequent cooling of eastern Greenland and the northern North Atlantic.
- Analysis of hydrological data shows that the river runoff into the Arctic Ocean has significantly increased during recent decades and that the seasonal freezing of those rivers has diminished in length.
- Proxy data point to a northward movement of the Arctic tree line since the late 1950s. This shift is largest in north-western Canada and eastern and coastal Siberia. Furthermore, satellite-derived vegetation indices suggest a “greening” of Alaska in the past few decades.

Taken individually, each of these changes seems to be indicative of warming in the Arctic region during the last decades of the 20th century. However, high variability over a number of time scales still makes it difficult to draw conclusions about the causes of the changes.

Despite considerable progress in understanding during the ACSYS decade, there are still many gaps. They are summarised below. However, there are also many opportunities that might be taken to address the gaps.

- Arctic climate feedback mechanisms are not known well enough. The associated spatial and temporal scales are connected with the "carriers" of the feedbacks, e.g., sea ice, snow, clouds, etc., giving a complex range of possible climate cycles. An important issue is the extent to which these feedbacks are represented in models, and the fidelity of this representation.
- The difficulties of making measurements in the Arctic are compounded by the fact that the existing observing systems were generally established to help guide short-term weather and water resource management, rather than to look at long-term climate and environmental change. Although the satellite observing system has made remarkable advances, many aspects of the Arctic climate system remain inaccessible to space-borne instruments. There is still a strong need for *in-situ* measurements to provide long-term records of many variables. This must form part of a coordinated and dedicated international effort to improve the Arctic climate observing system, using both *in-situ* and remote sensing techniques. Current positive examples include development of under-ice technology to supplement ARGO ocean observations and the long-term support for the North Pole Environmental Observatory. The Earth Observation Summit and initiatives such as formation of the Group on Earth Observations (GEO) provide an opportunity to influence the development of enhanced observing systems.
- The ACSYS project has provided a valuable legacy of data sets vital to the study of Arctic climate and processes. The challenge is to foster international collaboration in the future. In particular, we must facilitate data sharing through international archives using all available tools, e.g. the World Wide Web.
- Despite improvements in the ability of global climate models to reproduce many features of the observed climate and its historical variability, numerous uncertainties remain. The use of data assimilation in models has been very successful in improving the data sets for atmospheric climate research, and this is something that should be pursued more vigorously in the future for both the ocean and the cryosphere. In addition, models should be used to assist in the development and deployment of observing systems or design of field campaigns.
- The predictability of Arctic climate is still not well characterised, and should be given elevated importance as part of the developing WCRP Climate System Observational and Prediction Experiment (COPE) project.

There were approximately 200 participants in the 4-day meeting. 217 abstracts were submitted. 40 oral presentations were complemented by 161 posters. The conference was supported by the Arctic and Antarctic Research Institute of Roshydromet, the European Science Foundation through its Standing Committee on Life and Environmental Sciences, the International ACSYS/CliC Project Office, the Norwegian Polar Institute, and the WCRP.

6.2 A summary of follow-up actions from the Conference

The findings of the ACSYS project, as reflected by the reports, posters and discussions at the Final Conference, will be summarised in a monograph of the Earth System Science Partnership Series. Profs. P. Lemke and T. Fichefet will edit this first WCRP-based contribution to the series. An extended summary of the conference will be submitted to the Eos newspaper. In addition to that, a WCRP report containing extended abstracts will be prepared and printed. The distribution package will also include a CD-ROM (see section 6.3. of this report). The conference outcomes will be summarised in the CliC and CLIVAR newsletters and in some other publications.

6.3 Publication of ACSYS data sets

Despite the closure of the ACSYS project, several important issues remain. They will be addressed through the CliC project, the successor of ACSYS. The ACSYS website remains available to users. It is located at http://acsys.npolar.no. The Data Management and Information Panel of CliC supported by the CliC International Project Office will prepare datasets relevant to studies of Arctic climate and publish the collection on a CD-ROM and/or the Internet. This will be accomplished primarily via the ACSYS Data and Information Service.

7. ACSYS/CliC Panel Reports

7.1 Results of the joint ACSYS/CliC DMIP, NEG and OPP meeting

A joint ACSYS/\CliC Data Management and Information Panel, Numerical Experimentation Group and Observations Product Panel was held in Victoria, Canada, on 14-17 October 2003.

ACSYS/CliC joint panel project on "observed changes in the global cryosphere during the 20th century". At the meeting a project to review observed changes in the cryosphere was initiated. The purpose of this project is to assemble published information on changes in all cryospheric elements covering as much of the globe as possible, and representing as long a portion of the 20th century as possible. The objective is to provide a synthesis of historical change in the cryosphere that will contribute to the upcoming IPCC Fourth Assessment Report. Participants at the joint panel meeting each presented an overview of some aspect of historical changes, and comparisons/contrast among different cryospheric elements and different geographic locations were discussed. An outline and timeline for a comprehensive review paper were presented and several panel members agreed to contribute. Dr G. Flato (Environment Canada) is leading this effort.

Data Management and Information Panel (DMIP) and developments in CliC data management. The 5th meeting of DMIP had a very full agenda covering topics ranging from the wrap-up of ACSYS and the preparation of an ACSYS final metadata and information CD to development of the new Data and Information Service for CliC (DISC) and refinements to a CliC data management strategy as specified in the CliC Implementation Strategy document and four CliC Project Areas (CPAs).

In April 2003, Mr B. Miville (Environment Canada) joined part-time the CliC International Project Office as the data manager and staff scientist working remotely from Victoria, Canada. He took over the task of improving the management of metadata for CliC. Mr Miville processed all the information in CliC related datasets in order to properly create their metadata. The WMO Core Metadata Profile was used as the basis for structuring the metadata. This standard used the official ISO 19115 standard for geographic metadata. Using an ISO standard will facilitate the exchange of information with other standard compliant data portals. The metadata was then entered into a relational database and a web interface was created for the administration of the metadata and doing queries through a search engine. The web interface has been called Data and Information Service for CliC (DISC). DISC contains not only metadata from CliC related datasets but also CliC/WCRP reports, links of interest to the CliC community and the CliC Newsletter. The maintenance of DISC is an ongoing project and a pro-active method is used to find and publicise CliC related datasets. Mr Miville is constantly searching for Cryosphere data by directly asking the researchers. At the same time a database of specialists working in the Cryosphere Sciences is being developed and will become fully searchable as a web interface in the near future.

According to the above DMIP recommendations, Mr Miville was developing a data exploration mapping system, where the user would be able to view on a world map the location of the CliC related datasets and zoom in and out or click on a location to obtain more information. The same system will be used as an educational tool to give users a general idea of where the cryosphere is located on Earth. CliC is also monitoring the media for news items related to the Cryosphere. Mr Miville created an automated system to monitor on a daily basis several worldwide news agencies for articles of interest to the CliC community. Direct links to the articles are provided and an archive is also maintained.

The Panel noted the strong teamwork over the last 12 months with the project office. The addition of Mr Miville was viewed as timely and beneficial to accomplishing focused data management support for CliC and the completion of ACSYS.

The Panel reviewed and provided comments on the revised web pages for the ACSYS Project. There was discussion and comment on the organization of the Final ACSYS CD that will be distributed in 2004. This CD will summarize the many aspects of the ACSYS project including publications, a searchable metadata archive for more than 1000 datasets and several thousand publications that make up the legacy of ACSYS. A complete archive of reports and summary publications is also provided. The Panel also formulated key points for a presentation made at the Final ACSYS Conference summarising data

management support during ACSYS.

The DMIP discussed the general approach to be taken to address the diversity of data management activities that are possible during CliC. It concluded that the following key activities were important to assuring the long-term success of the project:

- developed and thoroughly maintained Data and Information Service for CliC (DISC);
- coordinated data management related activities with other WCRP projects;
- links with global data centres responsible for cryospheric data and information;
- use of new capabilities in data archive exchange and interoperability including metadata standards, GIS, search tools and World Wide Web capabilities.

Major new DISC capabilities include query and search of references, datasets and publications. All information has been updated where possible to include a complete record of reports, meeting summaries and links to project related web sites. The key next steps for CliC DISC development were summarised. The actions are to:

- establish key contacts in each of the international data centres where cryospheric data is managed and establish WWW links to the DISC;
- develop a list of researchers, organizations etc. that create and/or use cryospheric data;
- provide a forum for CliC data providers, operators/managers and researchers on DISC to exchange ideas and discuss issues;
- facilitate getting CliC relevant data to data centres;
- continue development of the metadata archive for datasets in DISC;
- prepare an inventory of journals focusing on the cryosphere.

These activities will require continuing input from the science and monitoring community as well as staff effort to maintain a complete set of information. An important principle is that DISC development must be user driven.

The Panel was asked to review the CliC Project Areas (CPA) to make sure that data management considerations were adequately expressed in the CPA descriptions. The Panel agreed that data management support is cross-cutting in the first three project areas and includes;

- enhanced data exchange and management system
- data recovery/mining in support of projects
- facilitated dataset generation
- prioritising datasets to match with CPA focus.

Data management efforts, including identification of available data, facilitating composite or integrated dataset generation and documentation procedures (co-ordination of measurements of cryospheric variables) should be added to CPA 4.

The Panel considered, with assistance from international experts, some immediate steps to help develop a better understanding of the diversity of CliC data and information. There are several proposed and ongoing efforts to improve broad community understanding of cryospheric processes and access to related data and information. The list includes:

- development of longer time series datasets and forcing datasets for analysis/re-analysis;
- preparation, archival and distribution of global runoff and precipitation datasets by GRDC and GPCC;
- establishment of a WCRP precipitation working group for *in-situ* measurements with representation of individuals working on specific projects and interested nations.

DMIP also decided to develop a dynamic table and more detailed report of the state of data management for CliC components (e.g. permafrost, glacier, sea ice, etc.). It would include an assessment of a component's importance to CliC, whether the component is observed, modelled or derived, status of the corresponding data archive, information on distribution of and access to data and information about that component. It will be complemented by a world map of cryospheric components with source locations, and impacts on a national scale. It will be possible to use it for looking for information on the cryosphere. As part of this activity, DMIP considers preparation of a global inventory of remote sensing datasets relevant to the cryosphere. Chronology and coverage by various sensors would be a key objective. These plans

will be implemented using a GIS global/regional map interface. Sparse information and data on the Southern Hemisphere was noted as a significant gap for CliC. To resolve this, work with Australian colleagues and others to link better to regional data and inventories is needed.

Numerical Experimentation Group (NEG). The meeting in Victoria, which was the X^{th} meeting of NEG, reviewed progress on the various ongoing projects. It is summarised below:

SIMIP2: The sea-ice model intercomparison project, phase 2, involves simulation of the thermodynamic evolution of multi-year sea ice over an annual cycle. Participating models are forced with observations obtained from the SHEBA field experiment (Beaufort Sea, October 1997-October 1998). Information is available at http://acsys.seos.uvic.ca/acsys/simip2/. A one-day workshop was held on October 20, 2003 in Victoria, Canada. Results obtained so far were presented and discussed, and plans for further model experiments and final evaluation were made. The objective is to prepare a multi-authored paper summarising the project's results within the coming year.

AOMIP: The Arctic Ocean Model Intercomparison Project has been underway for several years. It is comprised of an active group of co-investigators and is funded in part by the International Arctic Research Center in Alaska. The objective is to evaluate and improve models of the Arctic Ocean and its ice cover, and it makes use of historical atmospheric data spanning the period 1948-2002. The AOMIP participants held their 6^{th} meeting May 12-16, 2003 in Woods Hole, USA. More details are available at http://fish.cims.nyu.edu/project_aomip/overview.html.

ArcMIP: The Arctic Regional Climate Model Intercomparison Project is a joint initiative of the NEG and the GEWEX Cloud System Studies Working Group on Polar Clouds. Eight modelling groups are participating and simulations over a smaller Beaufort Sea domain and a larger pan-Arctic domain span the 1997-98 SHEBA year. Most of the groups have completed the required model runs and the output analysis is currently underway. More information is available at http://paos.colorado.edu/~curryja/arcmip/index.html.

ISMINT: A new initiative of the ACSYS/CliC NEG, the Ice Sheet Model Intercomparison Project is aimed at evaluating several aspects of contemporary ice sheet models. It follows on from the successful EISMINT project. A workshop was held in Brussels, Belgium in June, 2003, and participants laid out five topic areas: polar ice sheets and greenhouse warming; benchmark experiments for higher-order models; Heinrich event intercomparison; intercomparison of the Last Glacial Maximum Northern Hemisphere ice sheets; and an update of EISMINT Phase II experiments.

At the meeting, the NEG members also noted the efforts of the International Commission on Snow and Ice (ICSI) Working Group on Snow and its organization of SnowMIP-2, an intercomparison of models representing snow-vegetation interactions. The NEG is also helping to organize a workshop on permafrost modelling to be held at the University of Alaska, Fairbanks (USA) in autumn 2004, and there are now plans to coordinate an intercomparison of ice-shelf models.

The Observations Product Panel (OPP). The joint panels meeting with NEG and DMIP in Victoria was the 5^{th} OPP meeting. Two meetings were held under the patronage of ASCYS, and three meetings under the direction of ACSYS/CliC.

The main activities of the panel in the past year were expanded observational product review relevant for model validation and verification to the global scale, with emphasis on Southern Hemisphere and mid-latitudes. These include the review of observational products from *in-situ* and remote sensing sources for snow surfaces, including terrestrial and oceanic, the review of ice sheet observational products relevant for model validation and verification, including Greenland and Antarctica, and the discussion of strategies for future cryospheric observations in support of model evaluation and process studies.

The panel discussed how to coordinate with space agencies on the requirements of space-borne interferometry for ice sheet and climate studies. The rationale for this effort is that synthetic aperture radar (SAR) does not operate like other satellite sensors – it has a high data rate and a high cost of archiving the associated data volume. Thus, SAR sensors are not operated unless planned – it is an on-demand sensor. Therefore, mapping of the polar regions requires a coordinated programme that includes the commitment of space agencies and directions by scientific working groups. This is the only approach to produce the desired plans that will allow the most effective use of available resources.

Measurements of albedo (reflectivity of solar radiation) are essential for climate change and Earth's energy budget studies. Surface albedo can be estimated using shortwave, broadband or multi-spectral images from satellite sensors such as AVHRR, MODIS, Landsat, and SPOT. The accurate assessment of albedo is a key factor in the ice-ocean-albedo feedback that is expected to cause amplification of climate signals in the polar regions. The panel concluded that overall, satellite data have the potential of providing good and at least acceptable data on large scale albedo and surface temperatures in the Polar Regions. They provide spatial details on a global scale that cannot be obtained by any other means. Combined with surface data, they can be used in conjunction with physical models to gain insights into the changing Arctic climate system.

Key to any assessment of future sea-level change is the mass balance of the Greenland and Antarctic ice sheets: are they increasing or decreasing in volume? Currently, the uncertainty in their mass-balance estimates is approximately equivalent to the observed global sea-level rise. The Programme for Arctic Regional Climate Assessment (PARCA) is a NASA project with the prime goal of addressing this issue for Greenland. The prime result is an order-of-magnitude improvement in our estimates for the mass balance of the entire ice sheet, with quite detailed assessments of the behaviour of smaller regions within the ice sheet. Other significant progress has also been made both in the development of new techniques for glaciological research, and in process studies. Taken as a whole, results from PARCA represent a significant advance in our knowledge and understanding of the mass balance of the Greenland ice sheet, and they form a baseline set of measurements for comparison with precise surface-elevation measurements to be acquired by NASA's Geoscience Laser Altimeter System (GLAS) aboard ICESAT, which was launched in January 2003. Major research emphasis is now on the observation and monitoring of surface melt in the ablation regions, the ice motion of certain out-let glaciers, and the modelling of surface processes to reduce uncertainties in the mass balance. These measurements are crucial given the observational evidence that glaciers have increased their flow speed by as much as 40% within the past 3-years as a dynamic response to increased surface melting caused by warmer summer temperatures.

The OPP panel was actively involved and provided input to activities of the WCRP satellite working group mandated to coordinate and recommend sensor/satellite configurations needed by WCRP for climate monitoring. CliC participants in the group reviewed and gave advice on the overall content of the group report. In particular, for ice sheets, a follow on to the ICESat mission for the determination of decadal variation of ice thickness should be considered in view of the possible reduced lifetime of the ICESat, to allow for overlapping measurements of ice sheets and sea-ice with ESA CryoSat to be launched in 2004/5. Further, the need for a dedicated space mission to measure snow cover water equivalent and snow cover wetness was strongly supported.

The SSG recalled that CliC was mandated to contribute to observation and monitoring of the cryosphere in the three global observing systems (GCOS, GTOS and GOOS). The CLIVAR/CliC Southern Ocean Panel, CliC Arctic Panel and the newly formed Arctic Ocean Observing System initiative form the basis of CliC's contribution to GOOS. It is crucial that CliC observational requirements are reported to these observing systems, and to satellite operators and designers. CliC as a programme must be able to provide a globally coherent approach to specification of future cryospheric observations from space. To achieve this goal, CliC actively participated in the recent review of WCRP satellite data requirements and contributed to the Second Report on the Adequacy of the Global Climate Observing Systems. CliC SSG Co-Vice-chair, Prof. R. Barry, represented cryospheric components at the Terrestrial Observing Panel for Climate (TOPC). Canada, in preparing its GCOS Plan, prepared a separate cryosphere plan, which might serve as a framework for preparing a broader global plan. CliC has to continue to strengthen cooperation and facilitate an increased contribution to the Global Terrestrial Networks (GTNs) for Permafrost (in cooperation with IPA) and Hydrology.

The Global Terrestrial Network for Glaciers (GTN-G) including the World Glacier Monitoring Service (WGMS) and the Global Land Ice Measurements from Space (GLIMS) include studies of glacier mass balance around the world and has facilitated an increased number of glaciers and ice caps being monitored. There is a concern that limited financial resources present a threat to the continuing operation of the WGMS.

An issue still causing concern for CliC is which GTN takes care of snow (beyond snow water equivalent)

and fresh water ice. The question stands whether a specific cryospheric component of GCOS should be developed.

7.2 CLIVAR/CliC Southern Ocean Panel

Dr E. Fahrbach, Co-chair of the CLIVAR/CliC Southern Ocean (SO) Panel, presented the report. The CLIVAR/CliC Southern Ocean Panel was formed in November 2000. According to its terms of reference the panel is supposed to design a strategy to assess climate variability and predictability in the Southern Ocean region, to develop and refine an implementation plan for the Southern Ocean region, to integrate SO observations with those of the neighbouring regions, to enhance cooperation between the different disciplines with an interest in climate variability in the SO region, to serve as forum of discussion and communication, to work with the CLIVAR and CliC data systems to assure the distribution and archiving of SO observations and to advise the CLIVAR and CliC SSGs on progress achieved towards implementation.

The panel had its second meeting in Bremerhaven, Germany from 8 to 11 September 2003. Since the implementation of large parts of the work in the Southern Ocean region occurs through the integration of activities and plans of existing groups and projects, the panel meeting was organised jointly with the meetings of several relevant groups in the framework of a Southern Ocean Science Week. The direct exchange between the groups helped to identify joint objectives and avoid redundancy.

The Southern Ocean Science Week combined the meetings of the CLIVAR/CliC SO-panel with the ones of the following steering groups and projects meetings:

- The WCRP International Programme for Antarctic Buoys (IPAB),
- The GOODHOPE project,
- The International Antarctic Zone (iAnZone) SCOR affiliated programme,
- The Antarctic Sea-Ice Processes and Climate project (ASPeCt) within the SCAR Global Change Programme

The following items were discussed:

Status of implementation plan: The panel agreed that it would not be useful to produce an updated CLIVAR implementation plan, but that it is preferable to address particular topics by producing white papers e.g. the requirements of sustained observations and process studies in the sea-ice zone or adding statements e.g. on carbon issues. To advance the CliC implementation plan, the panel needs the input from the CliC SSG.

Ocean Observation Panel for Climate (OOPC): Dr K. Speer acts as representative of the panel in the OOPC. The sparse observing system in the SO region poses special problems. Enhancements as intensification of ARGO in particular in ice covered areas and surface drifters, subsurface ocean and sea ice observations are needed. The panel will produce a list of climate indices, which can help to work out the requirements.

The Indian Ocean: The panel identified points of special concern for the SO which should be included in the considerations of the newly formed CLIVAR Indian Ocean panel and recommended that a member of the SO panel with interest in those points should be appointed to the Indian Ocean panel.

The South Atlantic: Through the participation on the CLIVAR workshop on the South Atlantic Climate Observing System the panel assured the co-ordination between the South Atlantic and SO observations.

Southern Ocean Carbon studies: Dr C. Sabine keeps contact with the International Ocean Carbon Co-ordination Project (IOCCP). The panel helps to include carbon measurements in SO sections and recommends sections.

Summary of observations: The major contribution of the panel to advance the implementation occurs through its contact with national programmes. Therefore the panel compiles an overview on planned work

in the SO though the communication with the national programmes and displays it on a web site: http://www.clivar.org/organization/southern/CLIVAR_CliC_Obs.html.

Paleo-oceanography: contact is kept with PAGES-IMAGES to support this project and to potentially use the coring cruises for other observations.

GOODHOPE: This international project initiated by Dr S. Speich is working to assure the better coverage of the South-African chokepoint, which, due its large size, is by far less well sampled than the South American and Australian chokepoints. Through the realisation of this project, which includes participation from France, Germany, Russia, South Africa and USA, a wide range of measurements will be made. The panel endorsed this project as a valuable contribution to implement CLIVAR/CliC science.

The International Polar Year: The panel intensively discussed advantages of having an IPY and its potential components. It was agreed that a comprehensive observational programme including atmosphere, sea ice, ocean and shelf ice should be planned, which assures a quasi-simultaneous observation of the Southern Ocean region. This is needed because it becomes obvious that short term variations as the annual cycle and the interannual variability are of such an intensity that non synoptic measurements can lead to large uncertainties in the estimate of large scale properties as heat transports across the SO. The scientific focus should lay on the study of the freshwater cycle. This is timely since it is expected to intensify in the course of global warming. Indications of change are seen in the Antarctic Intermediate and Mode Waters. Because freshwater transports are the links between glacial, sea ice and oceanic processes, changes in the freshwater cycle will affect the interactions between the different components of the SO climate system. Since significant changes in the freshwater cycle are observed in both hemispheres, it provides a natural framework for a bi-hemispheric programme. The panel will produce a white paper to address the envisaged components.

IPAB, ASPeCt and IAnzone: It was agreed that these projects are important contributions to the CLIVAR/CliC implementation.

Data management: The panel appreciated the progress made in the CLIVAR data policy. The need of the DACs was stated. Drs S. Cunningham and S. Aoki are appointed to keep the panel updated on actions needed to implement the CLIVAR data policy.

The panel requests CliC to circulate its draft implementation strategy for further consideration. It strongly supports the efforts towards the International Polar Year. Therefore the panel asks CliC to include the plans developed by the panel in a bi-hemispheric concept.

Since the activities of the panel fall into the scope of CLIVAR and CliC, the panel emphasises at this early state that the CLIVAR and CliC data systems should work in close cooperation to avoid discrepancies in the two domains.

7.3 Development of polar re-analyses

Dr M. Serreze, Chair of the ACSYS/CliC ad hoc group on polar products from reanalysis introduced this issue and the group discussed the role of CliC could play in support of these activities.

It appears increasingly likely that the multi-agency SEARCH programme will include a dedicated Arctic System Reanalysis (ASR). As part of its commitment to the SEARCH programme, NOAA has provided seed funding (to J. Walsh, IARC, M. Serreze, Univ. Colorado, J Tilley, Univ. North Dakota, D. Bromwich, Ohio State University) intended to lay the groundwork for ASR development. This funding is directed at two primary activities. First is evaluation of the new European Centre for Medium-Range Weather Forecasts (ECMWF) ERA-40 reanalysis and the National Centers for Environmental Prediction (NCEP) North American Regional Reanalysis (NARR). The objective is to assess the present "state-of-the-art" of reanalysis depictions in the Arctic region and set performance benchmarks that should be beat by the ASR. The second activity is to develop a prototype ASR, which can be built on with additional funding (likely from several different agencies). ERA-40 and NARR evaluation is proceeding. As a step toward meeting the second goal, a workshop was held in Fairbanks, Alaska, USQA, from November 8-10 2003.

As outlined at the workshop, the planned ASR will be based on the NCEP Weather Research and Forecasting (WRF) system. WRF represents a new direction for NCEP, and will include a family of models. The ASR will be developed for the region north of 45 degrees north at a horizontal resolution of 25-30 km and with high vertical resolution. A 3dVAR assimilation system will be adopted. Ideally, the ASR will be run for the period 1957-present.

The ASR must make optimal use of satellite data. The workshop participants readily acknowledged the need for improved assimilation of TOVS data. Sub-optimal cloud clearing in the Arctic was identified as a key issue. The general view is that assimilation of retrieved properties (temperature and humidity profiles) will be a better approach than the direct assimilation of radiances. MODIS cloud-track winds from TERRA and AQUA were seen a potentially valuable data source for recent years. Results from test cases showed that while assimilation of TERRA winds improved high-latitude forecast skill, assimilation of AQUA winds degraded skill. Resolving this problem was identified as a key research issue. The workshop also identified the requirements for better soil, sea ice concentration and ocean data sets, and the need to explore how the NCAR/NCEP/ECMWF "Big Merge" assimilation data set might be supplemented through data mining efforts (e.g., are there Russian rawinsonde data that are not included in the "Big Merge" data set?).

A meeting was planned at the SEARCH Open Science Conference (November 28-30, 2003) to formulate a coherent strategy for ASR development.

The NOAA seed funding is only sufficient to develop the prototype ASR and is intended as a "proof of concept". Given problems that still need to be addressed in the use of TOVS and MODIS, the prototype will not include assimilation of satellite data. Additional funding will be sought through research proposals to different agencies. NASA is an obvious target for development of satellite data sets. Several projects can also contribute under existing funding. For example, University of Colorado will be conducting experiments with the NOAH land surface model used in WRF. NOAA has an ongoing effort to address the issue of MODIS cloud track winds. Efforts through Rutgers University are examining TOVS retrievals.

International participation will be key to the success of the project. ECMWF will likely play a role as an "interested observer" but more formal collaboration should be pursued. It is envisioned that Russia and China can play roles in data rescue. Japan (JMA, JAMSTEC, NASDA) could contribute through IARC and in the development of satellite data sets. Canada could contribute Radarsat and snow data.

CliC SSG was ready to play a role in advocating and coordinating ASR development. It offered to prepare a letter of support to ASR. It was also felt that other WCRP projects and groups, particularly WGNE and CLIVAR, could be interesting and could contribute to the ASR. CliC SSG expressed a view that a statement on ASR data policy, from which it would become clear that the outcome of the project would be freely available to the science community for non-commercial purpose, would facilitate international cooperation in support of the project and, possibly, would help in data search efforts. It was also suggested that a Southern Ocean or Antarctic System Reanalysis should be considered by CliC in not so distant perspective.

8. Finalisation of Implementation Strategy, CliC Project Areas, national/regional/institutional activities as building blocks of CliC, project structure, roles of SSG members and experts

Dr B. Goodison presented, under this agenda item, an approach to implementation of the project, which was based on developing overall project implementation strategy, defining, in more details, the CliC Project Areas, and subsequent search for suitable expressions of interest by nations, research groups, programmes and projects. Views of the session on the approach were invited.

As reported Dr B. Goodison, the project science goals and objectives were comprehensively summarised in the Science and Co-ordination Plan (Allison et al., 2001). In 2001-2002, the project SSG members were

working on the initial version of the CliC Initial Implementation Plan. Its first draft was made available to the general science community during the first half of 2002. In August 2002, following limited feedback, a meeting of the project leadership proposed a modified approach to implementing the project.

Detailed planning of the project implementation well in advance was recognised to be too prescriptive and in several areas of interest – uncertain in view of rapidly progressing science. Therefore it was decided to develop first a shortened 'Implementation Strategy' for the whole project, which would include the concept of CliC Project Areas (CPAs). Organising CliC into several CPAs will facilitate planning and implementation because each of the CPAs will be more uniform, focussed and self-contained. Each of the areas should be streamlined towards fulfilling CliC goals and answering the main CliC science questions. This would allow for developing more specific implementation plans for each of the CPAs. The Implementation Strategy document would be aimed at funding agencies, programme managers and relevant international programme and project committees, and should contain a thematic science structure with CPAs, a framework for management of the programme and collaboration, recommended methodology, and data management strategy.

This revised approach received support at the joint NEG - OPP meeting in Yokosuka, Japan, September 2002, and at the Second ACSYS/CliC SSG Session in Beijing, China, October 2002. The WCRP JSC-24 (Reading, UK, 17-21 March 2003) also endorsed the modified approach to CliC Implementation. Accordingly, active preparations and discussions of the CliC CPAs were held during 2003. The CPAs were mainly specified before the meeting of ACSYS/CliC DMIP, NEG, and OPP in Victoria, Canada, October 2003.

A version of CPA description was offered to the session. The SSG was asked to read the CPA description and comment on the content, e.g. whether the CPAs were in accordance with what the SSG members and invited experts expected from CliC, ways of implementing the corresponding goals, possible shortcomings, and, importantly, identify useful links and opportunities to obtain support for corresponding activities. Another request by Dr Goodison was for proposals on scientific leader(s) of the CPAs. SSG members were requested to associate themselves with one or more CPAs and to actively work on their development.

The subsequent discussion covered overall ideas of CliC implementation and thoughts on individual CPAs. Dr I. Allison remarked that while ACSYS was to a significant extent a self-contained programme, CliC was not. Activities by other WCRP projects and by some other research programmes and activities should fill an important niche in CliC. Co-ordination was therefore recognised as an essential component of a successful CliC Project. In the discussion, all SSG members agreed in general to the implementation approach proposed by Dr B. Goodison. In addition, several corrections were proposed for the CPAs description. Dr I. Allison was requested and agreed to summarise the comments in a new version of CPAs document. The results of his work are presented in appendix 6.

The SSG considered the links of CliC, as a global project, to national activities. It agreed with a potential need of establishing a council of National CliC Committees. In countries where there are no WCRP contact points, ICSI contact list could be used or address for the National Committee for Global Change. CliC will have to use a variety of methods for reaching out to countries and individuals.

Overall, the session adopted the following overall approach to CliC Implementation. It agreed that the CliC Science and Co-ordination Plan required only minor changes and, together with the draft Implementation Plan and CPA document, might serve as a solid foundation for finalising the Implementation Strategy document. SSG requested Dr C. Dick to finalise the Implementation Strategy document and prepare it for discussion and publication. With these documents, the SSG members would start developing more detailed plans for the individual CPAs taking into account the need to target the CPA activity at answers to CPA science questions. The CPA planning will be done by groups of SSG members and invited experts. Lead experts of CPA will be appointed. The CPA plans should not only plan future activities but should include as fully as possible activities by similar programmes and projects, with whom CliC will have to establish cooperation.

The development of CPAs and activities within them should be supported by CliC working groups and Panels. The overall structure of CliC will therefore consist of:

- a Numerical Experimentation Group (NEG),
- an Observations Product Panel (OPP),
- a Data Management and Information Panel (DMIP),
- a Rapporteur on Polar Products from Reanalysis,
- a joint CLIVAR/CliC Southern Ocean Panel,
- an Arctic Climate Panel,
- a liaison to IPCC.

Dr G. Flato will continue as chair of the NEG but, because of his request to step down, will, in 2004, be substituted by a suitable expert. Prof. K. Steffen will continue to chair the OPP on an interim basis, but, because of his request to step down, will, in 2004, be substituted by a suitable expert. Dr J. Moore will continue to chair the DMIP. The ad hoc CliC group on Polar Products from Reanalysis is disbanded and instead a position of a Rapporteur on Polar Products from Reanalysis is established. Dr. Mark Serreze was nominated as the Rapporteur. Dr G. Flato was nominated a Rapporteur serving as a CliC link to IPCC. Dr E. Fahrbach was requested to continue his activities as co-chair of CLIVAR/CliC Southern Ocean Panel, jointly with Dr S. Rintoul. The nomination of chairperson for the Arctic Climate Panel is covered in section 8.3 of this report.

In the result of the discussion it became apparent that ToRs for CliC panels and groups needed to be reconsidered to reflect the new project implementation structure. Dr C. Dick was requested to provide new draft formulation of the ToRs and to prepare terms of service for panel / working group members.

With this, the SSG turned to appointment of science leaders for individual CPAs and considered, within these CPAs, some individual activities/proposal potentially contributing to them.

8.1 CPA1: The terrestrial cryosphere and hydrometeorology of cold regions

The SSG decided that Dr. D. Kane would take the overall lead in the development of this project area. He will be assisted by Drs T. Ohata, B. Goodison, Qun Dahe, V. Kotlyakov.

Arctic - HYCOS

Taking the advantage of the session venue, the SSG accepted a proposal by Dr V. Vuglinsky, a deputy director of the State Hydrological Institute based in St. Petersburg, to present the current status of the project Arctic-HYCOS, which is an arctic regional component of the World Hydrological Cycle Observing System (WHYCOS). Dr Vuglinsky presented a bit of history of the project and the role of several meetings in setting it up. The Arctic Monitoring and Assessment Programme (AMAP) conducted one of the meetings in 2002. ACSYS/CliC SSG sessions in Halifax (October 2001), Beijing (October 2002), a GEWEX SSG session (Reading, January 2002) approved the idea and revealed a need to strengthen the project proposal document. The general idea of the project is to design and test a system for regional hydrological observations initially at five river in the Arctic basin and then to extend it to all major rivers. A possibility of applying for a support from GEF was mentioned through linking the Arctic – YCOS with a medium-sized GEF project on “climate change sound water management”. The discussion at the SSG confirmed overall support to the project idea. A need to actively involve GRDC, GTN-Hydrology, Hydrology and Water Resources Department of the WMO, partners in Arctic countries was highlighted. Arctic – HYCOS, in co-ordination with other hydrological initiatives, could make a valuable contribution to CPA1.

8.2 CPA2: Glaciers, ice caps and ice sheets, and their relation to sea level

The SSG decided that Prof. K. Steffen would take the overall lead in the development of this project area. He will be assisted by Dr J. Zwally, Prof. R. Barry and Acad. V. Kotlyakov

8.3 CPA3: High latitude oceans and the marine cryosphere

The SSG decided that Drs Ian Allison and E. Fahrbach would take the overall lead in the development of this project area. They will be assisted by Drs C. Mauritzen and M. Drinkwater

Arctic Climate Panel

In the course of the discussions on CPAs 3 and 4 and as well the agenda item on follow up from the ACSYS, a need for a group focussed on the science of climate of the Arctic and its global interactions was felt. Therefore the session established a CliC Panel on the Arctic and invited Dr C. Mauritzen (Norway) to serve as its Chairperson.

Panel membership of approximately six to eight core members was envisaged. Focus should be on science, and on the global interactions of the Arctic rather than on smaller scale processes. The panel should do for the Arctic what the Southern Ocean Panel does for the Southern Ocean, but should try to achieve a balance of interests, which is more specific for the Arctic.

It was resolved that CliC would continue co-ordination of WCRP Arctic research in the former areas of ACSYS interest (Arctic Ocean circulation, sea ice, atmosphere, hydrological cycle, processes through which the Arctic acts as a player in the global climate system) through its existing panels, the new Arctic Climate panel and via cooperation with other active parties. The full scope of the Panel activities has to be developed, but it was felt that the panel should have a marine emphasis, including associated atmosphere-ice-ocean interactions and freshwater runoff from land. The geographic scope would be the Arctic and connecting seas, including the Nordic Seas, Hudson Bay and the Canadian Archipelago, areas not considered by ACSYS. The Panel will intensively collaborate with other important co-ordination mechanisms in the Arctic, e.g. the International Arctic Science Council, Arctic Ocean Science Board, and other groups. It will have strong links to CLIVAR.

One initial task for the Panel will be support to the development of the Arctic Ocean Observing System (AOOS). The SSG considered a working document (see appendix 7), prepared JPS for WCRP and containing a description of the initiative to develop the AOOS, and agreed to follow it, in principle. It requested the newly established Arctic Climate Panel to consider the proposals contained in the document and further develop the proposal for an AOOS.

8.4 CPA4: Linkages between the cryosphere and global climate

The SSG decided that Dr J. Turner would take the overall lead in the development of this project area. He will be assisted by Prof. T. Fichefet, Drs J. Ukita, M. Sereze and C. Mauritzen.

9. CliC expected "sunset" year

Having discussed the requirement of the JSC and taking into consideration that CliC is the youngest among the WCRP core projects, the SSG came to a conclusion that the project should come to its end in approximately 2015.

10. CliC Science Conference

Following the kind invitation of the Permanent Representative of China with the World Meteorological Organisation and a member of the ACSYS/CliC SSG, Prof. Qin Dahe, the session resolved to hold the First CliC Science Conference in 2005 in China. Subsequent consultations between the JPS WCRP and the China Meteorological Administration established 11-15 April 2005 as the Conference dates and Beijing as the venue.

The SSG was pleased to acknowledge several important advantages of the Beijing offer. It was a firm offer. Based on their previous experience, SSG members expected very good local support. The China Meteorological Administration offered a possibility of having inexpensive translation services to the WMO languages. China was the first country to establish a national CliC Committee and therefore the choice of Beijing as the 1st CliC Science Conference venue, would be fair.

The goals of the conference are to:

- Critically review the level of observations and research on cryosphere and climate and to demonstrate their role in climate change detection, understanding and projection.
- Highlight existing findings showing the crucial role of cryosphere for the future of the Earth in a changing environment and to find ways to fill the gaps in observations, research and projections that generate significant uncertainties in decision making support information.
- Contribute to understanding by national and regional governments, local authorities, funding agencies, media, and decision makers of the role of systematic observations of the cryosphere and research on cryosphere and climate.
- Generate contributions by scientists, groups, organisations and nations to activities of cryospheric observations, process studies, and modelling.
- Establish links between groups and institutions active in observations and research on interaction between climate and cryosphere.
- Seek new methods and new collaborative arrangements for carrying out cryosphere/climate research.

The Conference is intended for scientists, managers, representatives of national and local governments, media, funding organisations and will provide an opportunity to discuss co-operation between various groups and initiatives, such as the International Polar Year 2007/08 initiative. All projects active in research on cryosphere and climate will be invited to take part in the conference. Sessions devoted to them can be organised. The format of the Conference will include keynote and invited talks, and posters including a poster session devoted to national CliC activities. The content of the sessions will correspond to the CliC Project Areas. Apart from the WCRP and the CliC International Project Office, current sponsors of the Conference are the China Meteorological Administration, the Chinese Academy of Sciences, Chinese Arctic and Antarctic Administration, Natural Science Foundation of China, Norwegian Polar Institute. Other sponsors are being sought. The work of the Science Organising Committee will be led by three Co-chairs: Dr Ian Allison (Australia), Prof. Peter Lemke (Germany), and Prof. Qin Dahe (China). Prof. Qin Dahe is the chair of the Local Organising Committee.

11. International Polar Year

The year 2007 will mark the 125th anniversary of the First International Polar Year (1882/3), the 75th anniversary of the Second Polar Year (1932/3), and the 50th anniversary of the International Geophysical Year (1957/8). The concept of an International Polar Year in 2007/08 has recently been raised in many forums. The Fourteenth WMO Congress adopted a resolution 33 (Cg-XIV) “Holding a third International Polar Year in 2007-2008”.

The following organisations and bodies were potentially interested in participation in the IPY:

- Scientific Committee on Antarctic Research (SCAR)
- Committee of Managers of National Antarctic Programmes (COMNAP)
- US Polar Research Board (US-PRB)
- European Polar Board (EPB)
- International Arctic Science Council (IASC)
- Forum of Arctic Operators (FARO)
- US National Aeronautics and Space Administration (NASA)
- European Space Agency (ESA)
- Arctic Ocean Science Board (AOSB)
- Arctic and SubArctic Ocean Flux Study (ASOF)
- Arctic Climate Impacts Assessment (ACIA)
- Arctic Science Council

ICSU established an ICSU Planning Group on IPY. Two SSG members (I. Allison and V. Kotlyakov) are its members. The first meeting of the PG took place in Paris in August 2003.

Dr C. Dick presented the item. The Twenty-Fourth Session of the JSC for WCRP approved active participation of WCRP in the IPY. It decided that CliC would coordinate and represent WCRP at meetings

and bodies involved in the preparations for IPY. The SSG decided that the CliC International Project Office and project leadership should contact WCRP projects and working groups and collect their views and proposals on IPY. A discussion paper on WCRP's contribution to IPY should be prepared for the second meeting of the ICSU IPY Planning Group scheduled for 19-21 December 2003.

The WCRP participation in the IPY is welcomed both by the WMO and ICSU. CliC plans to continue the preparations on behalf of the whole WCRP. WCRP projects and working groups are invited to actively express their needs and wishes on how their activities may benefit from WCRP participation in the IPY. The IPY provides an opportunity for raising the profile of polar climate science, and it may be possible to use it to generate resources and support for CliC and other WCRP projects. The CLIVAR/CliC Southern Ocean Panel, the CliC project, and the WCRP International Programme for Antarctic Buoys have presented ideas on possible activities during the IPY. The First CliC Science Conference presents another opportunity to discuss the IPY programme activities. This opportunity should be offered to the IPY planners.

The WMO Secretariat has established a working group, which is responsible for initial preparations for the IPY. The JPS WCRP actively participates in this group's work. The WMO IPY activities are likely to include: strengthening of the WMO World Weather Watch and climate observing systems in the polar regions as well as the Global Atmospheric Watch, operations of the WMO/IOC Joint Technical Commission on Oceanography and Marine Meteorology (JCOMM) mostly focussing on sea ice, monitoring of ozone, studies of specific polar atmospheric circulation dynamics, IPY component of the THORPEX project, hydrological studies with focus on the Arctic-HYCOS, support by the data centres, and some other activities. IPY is likely to provide additional opportunities for the development of COPE.

In the area of CliC interests, the IPY offers an opportunity to unroll several important initiatives.

The IPY presents a unique and challenging opportunity for the collection and integration of a remarkably rich dataset consisting of historical records and focused observations from process studies and regional and global observing networks. A coordinated data management approach and international cooperation will be essential to assure the rich legacy of these activities. The IPY data management scheme should utilise existing regional and global data centres to coordinate the archival of, and access to, data. Improved approaches for data access and retrieval, including use of international metadata standards, advance data search capabilities using the world wide web, and emerging technology for data display and integration should play a crucial role.

12. International ACSYS/CliC Project Office (IACPO)

The report of the IACPO is given in Appendix 8.

13. Co-ordination with WCRP projects and new developments in co-operation with other organizations and activities

13.1 GRDC

The GRDC report to ACSYS/CliC SSG-IV was submitted and presented by its director Dr T. Maurer. A written report is given in appendix 9. The GRDC acquires, stores and disseminates river discharge data and acts as the global discharge inventory with an official UN-mandate. Within the scope of the ACSYS Data and Information Service (ADIS), GRDC assembled and maintained the Arctic Runoff Data Base (ARDB). The ARDB currently contains river discharge time series from a total of 2112 runoff gauging stations in the arctic hydrological region (status Nov 2003), with 263 stations featuring daily data, 2073 stations featuring monthly data. GRDC data products include long-term means of annual freshwater surface water fluxes into the world ocean and monthly discharges and annual characteristics of selected GRDC stations.

The GRDC commitment to CliC is on a long-term basis. It envisages extending the discharge data collection area from the Arctic region to global land-surface, especially glacier regions. It is ready to support CliC projects by data and data products. It is crucial to ensure also the commitment of each group

participating in CliC, to support GRDC's data acquisition. Thus CliC related projects and initiatives are requested to: generally promote GRDC' mission and encourage NHS to release their data to GRDC, make sure that whenever project money is being spend for data collection to NHS or other institutions, a constituent part of any agreement or contract should be the free and unrestricted release of it to international data centres such as the GRDC.

In the forthcoming discussion the SSG members expressed support to and gratitude for GRDC contribution to ACSYS and CliC. They confirmed that CliC indeed needed the proposed contributions by GRDC. Participation of a GRDC representative in the work of the CliC Data Management and Information Panel was considered desirable.

13.2 GPCC

The GPCC report was submitted and presented by its director Dr B. Rudolf. A written submission is available in appendix 10. The general task of the GPCC is collection and evaluation of precipitation and snow data obtained from observations by hydrometeorological networks world-wide. In particular, the GPCC also includes the Arctic Precipitation Data Archive (APDA), which is intended specifically for ACSYS. In serving ACSYS, the GPCC collected daily precipitation and snow depth data for the Arctic hydrological basin, analysed and evaluated precipitation, snow depth and its liquid water equivalent data, in co-operation with the GRDC, participated in the intercomparison of gridded total precipitation, snow depth, and river discharge data for the large Arctic rivers.

The DWD has committed to permanently operate the GPCC as a contribution to GCOS. Solid precipitation in high latitudes and mountainous regions is an important component of the global precipitation, and therefore a link between the GPCC and ACSYS in the past and respectively CliC in future is given. Among current products of GPCC is the development of a gridded Arctic snow climatology.

In 2003-2005 GPCC plans to continue the support for APDA including:

- Adding of data from surface networks.
- Developing a method for correction of raingauge-measured precipitation data with respect of the systematic gauge measurement error.
- Quality assessment based on statistical studies of the APDA data holding.
- Developing of a method to improve the climatological analysis of precipitation at GPCC using snow depth data.
- Verification of precipitation predictions of ERA-40 and the operational DWD model GME on the basis of APDA products.
- Development of an improved large-scale precipitation climatology for the Arctic catchment area on the basis of an overall view of all data.
- Continuation of the archive's service for ACSYS and CliC participants.

As a possible contribution to CliC, GPCC could :

- Extend snow data collection area from the Arctic region to global land-surface.
- Make systematic consistency check between snow depth and precipitation observations.
- Study systematic errors of gauge-observed precipitation totals for new (automatic) instruments and develop methods of its correction
- Analyse percentages of snow in the total precipitation.
- Support CliC project by additional data and data products.

In the forthcoming discussion the SSG members expressed support to and gratitude for GPCC contribution to ACSYS and CliC. The SSG confirmed that CliC indeed needed the proposed contributions by GPCC. The discussion also revealed a need to cooperate with the International Precipitation Working Group (IPWG) established as a permanent Working Group of the Co-ordination Group for Meteorological Satellites (CGMS) and co-sponsored by the WMO.

13.3 Co-sponsorship of CliC by SCAR

Dr C. Dick reported on the progress on the co-sponsorship of CliC by the Scientific Committee on Antarctic Research (SCAR), an inter-disciplinary committee of the International Council for Science (ICSU). SCAR has decided to sponsor two members of the SSG. However, the actual arrangements to make this happen are yet not finalised. Dr J. Turner indicated that contact with the Interdisciplinary Southern Ocean science co-ordination group, which is affiliated with SCAR, might be valuable for CliC as part of its cooperation with SCAR.

13.4 Co-operation with IPA

The IPA document was submitted and presented to the session by its President Dr J. Brown. The IPA Council met during the 8th International Conference on Permafrost in Zurich, Switzerland, July 21-25, 2003, and approved activities of ten working parties and the data committee for the period 2003-2008. These parties are:

- Antarctic Permafrost and Periglacial Environments (proposed joint with SCAR)
- Coastal and Offshore Permafrost (joint with IASC, LOICZ, LOIRA)
- Cryosol (joint with IUSS)
- Glaciers and Permafrost Hazards in High Mountains (joint with ICSI)
- Isotopes and Geochemistry of Permafrost
- Mapping and Modelling of Mountain Permafrost
- Periglacial Processes and Environments (joint with IGU)
- Permafrost and Climate
- Permafrost Astrobiology
- Permafrost Engineering
- Standing Committee on Data, Information and Communications (with NSIDC)

The Council passed two resolutions governing international cooperation and co-ordination of permafrost responses to climate changes. These activities include, but are not limited to IPA participation in:

- GCOS/GTOS Global Terrestrial Network for Permafrost (GTN-P)
- International Polar Year with a proposed borehole measurement campaign in 2007/2008
- International Conference for Arctic Research Planning (ICARP II)
- Arctic Coastal Dynamic programme, and
- development and continuation of joint projects with other international organizations related to carbon and water cycles, ice-permafrost interactions, monitoring of active layer and permafrost thermal state, and preparation of regional and global maps, models and databases.

Results of the above activities will be presented at the 9th International Conference on Permafrost in Fairbanks in summer 2008. Details of IPA and related activities are reported annually in the News Bulletin “Frozen Ground”. Additional information is available at the new IPA website at http://www.geo.uio.no/IPA/.

The discussion reiterated the fact that IPA was a CliC partner of crucial importance for CliC. Among areas of joint interest are the development of GTN-Permafrost and CALM (Circumpolar Active Layer Monitoring) programme, joint proposals for the International Polar Year. Forthcoming meetings included a conference on permafrost in Russia, a seminar in Lanzhou in 2006. In 2004 CliC and IPA are preparing a workshop on permafrost modelling (Fairbanks, USA, September 2004). Dr V. Romanovsky is in charge of the workshop. A coordinated proposal on the role of permafrost in carbon cycle was presented to the Global Carbon Project by the IPA Cryosol group and CliC. The SSG urged CliC groups and involved scientists to actively cooperate with IPA. Direct links need to be established with IPA working parties. A Memorandum of Understanding should be prepared and signed between CliC and IPA, to facilitate their cooperation in the future.

13.5 Global Carbon Project

Dr V. Ryabinin reported on this issue. Jointly with the Cryosol working group of IPA, CliC has established working relations to the GCP. Unfortunately, the comments of the IPA - CliC consortium were not

incorporated in the first published hard copy of the GCP Implementation Plan, which was supposed to be widely distributed. However, they are to be included in the corrected version on the GCP website. Based on CliC input, a proposal for studying vulnerable carbon pools, which was prepared by the GCP, included necessary issues related to permafrost. Other areas of co-operation with GCP include atmosphere – ocean exchange of carbon in presence of sea ice. This should be covered mostly by the Southern Ocean Panel and also probably - by the newly established Arctic Panel.

13.6 CLIVAR

Apart from the activities of the joint CLIVAR/CliC Southern Ocean Panel, enhancement of joint activities in the Atlantic sector is being sought. This should be achieved through the activities of the Arctic Climate Panel. CLIVAR should be approached with a request to co-sponsor the Panel. Some other projects and activities will be invited to cooperate with the Panel. Other areas of joint CliC – CLIVAR interest may include cooperation with ASOF, SEARCH, the Arctic Ocean Observing System, PAGES, links between CliC NEG activities and the JSC/CLIVAR Working Groups on Coupled Modelling and Ocean Model Development. Potential joint interest between CliC and CLIVAR exists in studies of the Asian-Australian Monsoon in relation to the role of the Tibetan Plateau. Both projects have links to GEWEX/CEOP and climate of precipitation is their common concern. As recommended by the SO Panel, both projects should be keen to ensure full co-ordination of their data management approaches, better if at the WCRP level. CliC supported the statement that CLIVAR made at the 24th session of the WCRP JSC of a need of establishing the WCRP Task Force on mean sea level rise. CliC expressed readiness to contribute to this through a special CPA. A contribution of GEWEX was also seen as an important factor of success for this Task Force because uncertainties associated with water storage on continents were among the largest. Through WGSIP and other activities CLIVAR is going to actively contribute to the work of the WCRP Task Force on Seasonal Prediction. CliC has to adequately and fully respond to the requirements of this task force.

13.7 GEWEX

Components of the cryosphere are an integral part of the global water cycle. Co-operation of CliC with GEWEX is essential for WCRP to achieve its goals to determine the predictability of climate and the effect of human activities on climate. Current co-operation with GEWEX includes contribution of CliC to the Co-ordinated Enhanced Observing Period (CEOP) with a CliC SSG member on the CEOP SSC to bring special attention to cold climate modelling, remote sensing and *in-situ* measurement issues. An extension of CEOP, as has been proposed, would be supported by CliC, as it would provide at least one more winter season of data collection. Among GEWEX projects, the GEWEX Asia Monsoon Experiment (GAME), the Mackenzie GEWEX Study (MAGS), and the Baltic Sea Experiment (BALTEX) have cryospheric components. Arctic-HYCOS is a topic of mutual concern that should be discussed further to ensure its effective implementation. The GRDC, GPCC and PILPS are part of GEWEX, but are critical for CliC activities. The CliC theme on terrestrial cryosphere and hydrometeorology of cold regions (CPA1) has many initiatives that link to GEWEX and will require good collaboration if CliC is to meet its objectives.

Following on from the past links that were identified, discussions have been initiated between the GEWEX Radiation Panel and the CliC Observational Products Panel on a joint workshop on clouds and radiation issues. The exact topics to be included are still in discussion. Precipitation remote sensing, another area of common interest with the GRP, still presents significant challenges, and there is a need for activity to compare methods of snow/ice remote sensing to field data. This includes not just snow on the ground, but solid precipitation. With current field and modelling projects (e.g., BALTEX, MAGS, GAME-Siberia, and other “supersites”) and new proposed satellite systems that make up the Global Precipitation Mission (GPM) and the European Global Precipitation Mission (E/GPM), there are areas of mutual interest that could benefit from contributions of both groups. As noted before, CliC can help the GRP with the assembly of good field data for the validation of satellite products, while the GRP can assist with radiative fluxes needed by CliC.

13.8 GAME-Siberia

Dr T. Ohata presented this agenda item. GAME is now in its second year of the concluding synthesis phase. It started in 1996 and in March 2002 finished its first phase. The synthesis phase will continue for at least three years. Main components of the phase are:

- Land surface processes
- Precipitation Process
- Monsoon System Study
- Monsoon System Modelling
- Re-analysis
- Satellite utilization
- GAIN (GAME Information Group)
- Siberia
- WEBS (Water Energy Budget Study)
- WRAP (Water Resource Application Project)

GAME will hold several national and international workshops under these initiatives. A final conference is planned for 2004.

GAME-Siberia activity. The main task of this regional study is to integrate the studies from the five-year observations (1997-2001) including the results of intensive observations in the year 2000. Progress is reported in the following areas:

- better understanding of large sublimation in the Lena Basin Area (Tiksi, Tynda) and snow-melt refreezing process in frozen ground for seasonally and inter-annually varying runoff;
- non-uniform evaporation from deforested area, depending on the hydrological history of such area and initial permafrost conditions;
- improvements in models of tundra and forest surface processes, and sensitivity studies based on these;
- verification, application and improvement of patch-scale physically based heat/water exchange models, land-surface schemes of regional and global climate and hydrological models.

The Frontier Research System for Global Change and Frontier Observational Research Systems for Global Change in JAMSTEC: Northern Eurasia studies have been conducted in cooperation with GAME Project since 1997. It is still continuing and producing large scale analysis studies, modelling studies, observations in eastern Siberia area primarily initiated and developed by GAME-Siberia. JAMSTEC is expected to be reformed and become an independent agency from April 2004.

Core Research of Science and Technology: Forest function studies (mainly structure and physiology) related to water cycle are carried out with participation of ecological scientists, taking data at four study sites in eastern Siberia, Kamchatka, Hokkaido and central Japan. The aim of this study is to develop alternative and more elaborated schemes for treatment of forest and trees.

CliC Project component in Japan will start its activity in 2005 (if funded), and northern Eurasia will be one important component of the study. It will focus on the cryosphere of northern Eurasia. This component will be strongly promoted by Frontier Observational Research System for Global Change in collaboration with universities, and also in cooperation with NIPR (National Institute for Polar Research).

13.9 NEESPI

Prof. R. Barry presented at the SSG session the Northern Eurasia Earth Science Partnership Initiative (NEESPI), which is proposed by the Russian Academy of Sciences (RAS) and US National Aeronautics and Space Administration (NASA). SSG members were requested to familiarise themselves with the initiative and consider at the session the directions of future co-operation.

The NEESPI study region is bounded by 15^{o}E in the west, the Pacific Coast in the east, 40^{o}N in the south and the Arctic Ocean coastline in the north. The initiative is aimed at developing a better understanding of the interactions between the ecosystem, atmosphere, and human dynamics in northern Eurasia. NEESPI

can act in concert with different international science programmes of particular relevance to global climate change research as well as address the concerns that face national and international decision makers of the partnering institutions and countries. NEESPI will identify the critical science questions and establish an international programme of coordinated research on the state and dynamics of terrestrial ecosystems in northern Eurasia and their interactions with the Earth's Climate system to enhance scientific knowledge and develop predictive capabilities to support informed decision-making and practical applications. The NEESPI science plan is focused on understanding the regional dynamics of a particularly significant region of the Earth's terrestrial surface, Northern Eurasia. The single overarching question to be answered is: How do land ecosystems and continental water dynamics in Northern Eurasia interact with and alter the climatic system, biosphere, atmosphere, and hydrosphere of the Earth?

Past observations and model projections of the future indicate that global changes in Northern Eurasia will be among the largest in the world. Furthermore, being the largest land mass in the extratropics, the largest terrestrial reservoir of carbon in the biosphere, one of the regions with the largest climatic variations, and an area of active land use changes during the past century (and possibly in the future), Northern Eurasia has a unique capacity to generate non-linear large-scale sometimes abrupt changes in regional carbon, surface energy and water balances. These changes may feed back to the global climate, biosphere, and society.

Specifically,

- changes in surface physical properties (albedo changes including altered snow/ice cover, shifts in vegetation, land use change) and in atmospheric humidity may change the Earth heat and moisture balances;
- accelerated climatic changes across Northern Eurasia may cause changes in global atmospheric circulation and meridional heat transfer;
- thawing of permafrost may change the soil carbon cycle and, thus, the concentration of greenhouse gases in the atmosphere. It also will produce major changes in land cover and in surface and subsurface hydrology;
- advance/retreat of the forest line, increase/decrease of conditions conducive for forest fires, and logging may lead to global biogeochemical, energy and water cycle changes;
- changes in the hydrological cycle over the continent will affect the fresh water transport to the Arctic Ocean and, thus, may influence the shelf seas and the ocean circulation;
- extensive coastal zone in Northern Eurasia (especially, its Arctic part) is a potential area of extensive changes and interactions that may affect the biological resources of the global oceans;
- ongoing drying of the continental interior may cause a massive aeolian aerosol input into the troposphere that can affect the Earth's heat balance and generate direct biospheric and societal impacts thousands of kilometers away from the origins of these dust storms;
- deglaciation in the mountain systems of Central Asia, increasing water withdrawal, and increasing dryness of steppe and semi- arid zones will affect surface albedo, water resources, and the quality of the interior areas of the continent and, thus, the global climate and society.

The SSG noted that a manuscript presenting the Russian contribution to the NEESPI was expected to be ready by the end of 2003. NEESPI study areas including snow cover, permafrost, glaciers, mountain regions were considered as relevant for CliC and specifically for the CPA1. The SSG felt that remote sensing and validation of its data would play a significant role in the initiative. The SSG took note of these developments and decided to be in contact with the International NEESPI.

13.10 ASOF

Dr E. Fahrbach, a member of the Arctic / Subarctic Ocean Fluxes (ASOF) International Science Steering (ISSG) Group, spoke on programme aims and activities. The ASOF goal is to monitor and understand the oceanic fluxes of heat, salt and freshwater at high northern latitudes and their effect on global ocean circulation and climate. ASOF constructs a coordinated, circum-Arctic ocean flux monitoring system. The system will provide the long-term measurements critical to understanding the factors that control the global thermohaline circulation (THC) and its influence on global climate. ASOF consists of an ASOF-East and ASOF-West component with a joint international SSG. The ASOF-W part includes the Canadian Arctic Archipelago, Labrador Sea and the Deep Western Boundary Current, where all the source water

masses have converged to North Atlantic Deep Water. ASOF-E includes the fluxes through Fram Strait, the Barents Sea opening, the flow through the Nordic Seas and the overflows. ASOF is structured in six regional tasks.

During the recent ASOF-ISSG meeting on 25 –26 November in Seattle, the present status was reviewed. The ASOF-East activities are presently assured on the basis of EC funding until 2005. To adapt the project to the growing interest in the freshwater cycle two EC-proposals are submitted: ASOF-FRAM and ASOF-FAST. Further support comes from the British RAPID and the future Norwegian NORKLIMA programmes. The contributions of ASOF-W come from Canada, the USA and Japan. Canada supports measurements in Barrow Strait, Cardigan Strait, Hell Gate and Jones Sound with funding until 2004. The continuation is not guaranteed. The US NSF Office of Polar Programmes supports work in Nares Strait, Davis Strait and Labrador Sea. Bering Strait and Chukchi Sea are covered by the SBI programme. Further projects include studies of the Arctic halocline between Alert and North Pole, and the use of Barium as tracer of fresh water sources. JAMSTEC contributes jointly with DFO Sidney with repeat-XCTDs. Modelling components are part of both ASOF-E and W.

The first issue of the ASOF Newsletter was issued in September 2003. For more detail see http://asof.npolar.no.

ASOF leadership trusts that it can contribute to the objectives of CliC of establishing an Arctic Ocean observation system and asks for endorsement. The SSG agreed that ASOF indeed represented a very important contribution to the goals of CliC and unanimously agreed to endorse it as such and maintain active contact with the project.

13.11 IABP and IPAB

Dr V. Ryabinin presented to the session the status of the International Arctic Buoy Programme (IABP) and the WCRP International Programme for Antarctic Buoys (IPAB). A written report of IABP, submitted to the session by IABP Executive, is available in this volume as Appendix 11.

A fourth meeting of the IPAB participants was held during the Southern Ocean Science Week (5-7 September 2003, Bremerhaven). The status of the Programme and its co-ordination were reviewed. The co-ordinating office staff, Prof. P. Wadhams and Dr M. Doble, transferred from the Scott Polar Research Institute at the end of 2002, relocating to the Scottish Association for Marine Science's (SAM) Dunstaffnage Marine Laboratory (DML) in Scotland. Their opinion was that this move represented an excellent opportunity to further the work of IPAB, since the co-ordinating office would be co-located with that of the National Focal Point of the Data Buoy Co-operation Panel (DBCP). At the meeting Prof. P. Wadhams expressed his strong wish to continue its duties as IPAB Coordinator and was reappointed as such.

The number of buoys operating in Antarctic waters has fluctuated considerably. From a relatively stable inventory of around ten buoys in 2000 and 2001, numbers dropped off to leave one solitary buoy reporting to the GTS for November and December 2001. The first months of 2002 saw this rapidly redressed, however, with multiple deployments in the Weddell Sea and up to 20 buoys reporting. Numbers then fell again, reaching only six in October 2002. A mass deployment in the waters around the South Sandwich Islands, north of the Antarctic Peninsula, boosted numbers to the low twenties in the first half of 2003. While the very cyclic nature of the number of buoys reporting is itself undesirable, even the relatively well-represented months show a lack of spatial coverage. Large numbers of buoys have been deployed in small areas, leaving the remainder of the Antarctic waters almost un-instrumented. The majority of recent deployments in IPAB area of interest have been performed by the WHOI SO-GLOBEC interests in the Peninsula region and have occurred exclusively in open water regions.

In November 2003, at the time of the ACSYS/CliC Fourth SSG session, the IPAB web site was out of date and was still run from the Australian Antarctic Division. This problem had been already reported to the ACSYS/CliC SSG III (Beijing, 21-25 October 2002). The IPAB Co-ordinator reported at the IPAB-IV meeting in September 2003 that the move to Scotland had caused problems in re-launching the web site, since the new organisation was itself upgrading all major computer and server facilities. The prospects for having a working IPAB web site were nevertheless estimated as positive. The DML laboratory has a large

dedicated information technology department capable of providing the database preparation and maintenance services for the website.

As the coordinator reported at the IPAB-IV session, IPAB data provided by the Australian office had been integrated with the searchable Oracle database maintained at the British Antarctic Survey (BAS). It can be found at http://www.antarctica.ac.uk/met/metlog/cui.html. Scripts will allow the user to select data on the basis of several fields, whether WMO ID, date, position or sensor information. Data is then output directly to screen in either text or graphical format, which can then be directly downloaded. This is seen as a significant extension to the NSIDC interface and will be incorporated in the new co-ordinator's website as time allows. At the beginning of November 2003 Dr Doble reported to an enquiry from the JPS WCRP that the work on the new IPAB web site was on-going.

In the middle of September 2003, after the IPAB-IV meeting, the Director of the WCRP, Dr D. Carson forwarded a letter to Prof. G. Shimmield, Director SAMS, in which he enquired about a possibility to provide Prof. P. Wadhams and the IPAB Coordinating Office with institutional support to effectively run the IPAB Co-ordinating Office. The answer received shortly afterwards was positive.

The status of IPAB was reported to the 2002 Session of the WMO Executive Council Working Group on Antarctic Meteorology. The working group agreed to put forward a draft recommendation in support of IPAB and to request the 55th Session of the WMO Executive Council to adopt it. The recommendation was adopted by the Council in June 2003.

The Fourth IPAB session (Bremerhaven, September 2003) considered a proposal by Dr I. Allison, to undertake a one-off effort to get support for a one-year "optimum" deployment around Antarctica involving

- an early season deployment of 20-30 well distributed buoys, all within the sea ice zone (SIZ)
- a later top-up deployment of an additional 10-15 buoys
- 6 - 10 participant institutions
- all buoys measuring at a minimum temperature and pressure, and all reporting via the GTS
- coordinated and shared logistics for deployments.

In addition the proposal envisages close collaboration with satellite agencies deriving remote sensing sea ice drift fields and collaboration from at least one of the main meteorological analysis agencies to ensure that data from the buoys would be included in the analyses, and the value of the additional observing network would be assessed, as well as potential association with the ARGO project.

The expected outcome of this initiative will likely be the following:

- a one year snap-shot of the ice drift around the whole of Antarctica,
- a valuable data set for validation of the satellite velocity products,
- the possibility of interpolating between buoy data with the satellite products,
- an enhanced network that should improve the SH meteorological analyses,
- with improved SH analyses, a good data set for analysing Antarctic-wide sea ice dynamics,
- possibly data sufficient to model Antarctic-wide sea ice mass budget and thickness distribution,
- if there is a significant improvement in the meteorological products, a demonstration of the value of the buoys that might convince operational agencies to continue deployments.

The IPAB-IV felt that the proposal was very valuable and decided to undertake all necessary actions to implement it as part of the International Polar Year (IPY) activities. It invited IABP to consider the proposal and possibly develop a coordinated plan of actions for IPY.

The SSG session considered the status of IABP and IPAB. The participants were satisfied with the successful development of IABP and expressed their gratitude to the programme management. They recommended considering the potential of closer cooperation of IABP and SEARCH North Pole Observatories project. Also, they supported the idea of preparing a joint IPY-oriented proposal for coordinated buoy deployment as part of an oceanographic campaign. The SSG resolved to keep the development of the IPAB and its co-ordination including the web site under attention of the WCRP and CliC executive and to review the situation in March 2004.

13.12 PAGES

Dr D. Raynaud, an invited expert, presented PAGES to the CliC SGG. This IGBP project seeks to provide a quantitative understanding of the Earth's environment in the geologically recent past (from the pre-industrial time and the last millennium to the glacial-interglacial cycles of the late Quarternary), and to define the envelope of natural environmental variability against which anthropogenic impacts on the Earth System may be assessed.

PAGES includes 5 foci, which cover the paleoenvironments on the continents (PANASH), the marine drilling programme (IMAGES), the past ecosystems (processes and human environment interactions), the decadal to centenial climate variability (PAGES-CLIVAR), and the paleoclimate and environmental variability in polar regions (Polar Programmes). The Polar Programmes focus is bi-polar and of special interest for the CliC community. There are currently four projects identified:

- Circum Arctic Paleoenvironments (CAPE), which aims to facilitate integration of paleoenvironmental research on terrestrial and adjacent margins covering over the last few glacial cycles;
- Quaternary Environment of the Eurasian North project (QUEEN), which concentrates on mapping the extent of the last glaciation in this part of the Arctic; this project is now in the final stage.
- International Trans-Antarctic Scientific Expedition (ITASE), which seeks to map the spatial variability of Antarctic climate over the last millennium;
- Antarctic Ice Margin Evolution (ANTIME), with the aim to establish and investigate the late Quaternary sedimentary record of the Antarctic ice margin evolution.

The international deep ice drilling and long ice core records have been until recently a PAGES project Polar Ice Cores (PICE). The PICE scientific results of the deep ice core research are very important to PAGES. It is also necessary to continue and stimulate the development of a hierarchy of ice sheet models and the model intercomparisons.

PAGES research areas of interest to CliC include ice sheet - sea level - climate interactions, sea ice, abrupt climate changes, studies of cryosphere at high altitudes (glaciers), and permafrost (including CH4 hydrates). The SSG felt that PAGES activities were relevant to CliC because the paleo perspectives provide additional dimension for understanding the cryosphere variability and predictability. Due to the long time scale of cryospheric processes, only knowledge of the past may facilitate study of the mechanisms involved. E.g., multi-proxy records of ice cores, marine sediments, continental and historical archives provide the past variability of the different cryospheric reservoirs and its link with climate, sea level, atmospheric and oceanic circulation, atmospheric composition. Ice sheet and glacier modelling allow reconstructing their past changes and provide information for interpreting the paleo-record. The joint studies of PAGES and CliC could focus on several periods of the past including the last millenium, the Holocene, other interglacials (stages 5 and 11), abrupt changes and rapid changes in sea level. The quantitative records cover time periods ranging from the last 1000 years to the glacial-interglacial cycles, with a resolution as precise as seasonal (e.g., the snow cover record) for the recent past.

PAGES may be interested in several types of cryospheric data including ice core and marine records of "warm" interglacials (stages 5, 11), glacier mass balance and length reconstructions; ice sheet and climate data (ice core record and ice sheet modelling results); appropriate proxies for sea-ice changes, comparisons of ice and oceanic paleorecords and coupling climatic models with ice dynamics models.

The studies of the likelihood of abrupt climate changes resulting from regime changes in the cryosphere, such as the impact of ice shelf-ocean and sea ice-ocean interactions on the thermohaline circulation, could be extended to include iceberg discharges and ice surges. The lessons of the past rapid events such as Dansgaard – Oeschger or Heinrich events are important clues for understanding the response of the climate system to abrupt cryospheric events. Investigation of the magnitudes, patterns and rates of change in terrestrial cryosphere regimes on seasonal to century timescales and the associated changes in the water cycle would ideally complement PAGES studies of tree rings, paleo-permafrost, methane hydrates and CO_2 sources/sinks.

As starting point, Dr D. Raynaud proposed two areas of cooperation:

- developing a joint CliC-PAGES paleo-permafrost programme (with access in the upper layers to the Little Ice Age ice lenses or frozen lakes, studying sources of gases, microbes, if there is melting) and
- looking for reliable sea-ice proxies.

The discussion was very supportive of the idea to work with PAGES. Prof. R. Barry indicated an additional area of interest, which was a study of isotopes and precipitation. He also reminded the SSG that CliC decided to join the Pole – Equator – Pole transects (PEP) activity with a view to monitor changes in cryosphere. Following the productive example of the PAGES/CLIVAR initiative, the SSG agreed to prepare and hold a small joint CliC-PAGES workshop to explore joint interests and overlaps between CliC and PAGES and to promote necessary multidisciplinary approaches between these two research communities.

13.13 Mountain Research Initiative

Dr V. Ryabinin presented the agenda item. The initial contact with the MRI took place at the recent IGBP Congress (Banff, Canada, June 2003). A presentation on CliC was made for the MRI session of the Congress. MRI has four main areas of activity. They are monitoring and analysis of indicators of change in mountain regions, model-based studies, process studies, sustainable land use and natural reserve management.

CliC and MRI have joint interest in the alpine cryosphere. The MRI operates a set of sites, which are potentially useful for the Pole - Equator – Pole sections and may be representative for alpine cryosphere. They have partners in South America. All these perspectives need to be exploited.

The SSG felt that it might be a good idea to invite representatives of the MRI to participate in the planned joint IGS/CliC workshop on cryospheric indicators. A visit to the MRI Headquarters in Bern is desirable, to maintain the contacts, possibly by Dr V. Ryabinin, who is based nearby in Geneva.

13.14 IUGG/ICSU IAHS ICSI

Prof. R. Barry presented to the SSG a proposal that the ICSI attain an association status within the IUGG structure. The Terms of Reference of ICSI state that it shall be the responsible body within IAHS of IUGG for the advancement of the study of naturally occurring snow and ice. The Commission believes that glaciology is a discipline on a par with the disciplines represented by the other Associations in IUGG. The role of the cryosphere in the global processes and feedback mechanisms of our planet is as dynamic and wide-ranging as that of any of the other Earth systems represented by these Associations. By acceding to the status of an association, ICSI will thus play a significant role in IUGG both as a forum for the international glaciological community and as an active partner with the other associations in furthering inter-disciplinary studies of the Earth's dynamic systems.

In the period 1999-2003, ICSI initiated a process of reflection and dialogue that solicited counsel from glaciologists on the problems that the Commission faced in reaching out to their international community. The result of this process led to the production of a proposal that ICSI attain the status of an association within IUGG. The proposal justifies the recognition of glaciology as a discipline and cites the recognition of this fact by the AGU and the recent similar decision by the EGU. It also reviews how ICSI has significantly contributed to fundamental research in the science of snow and ice and to our knowledge of the role of the cryosphere on global geophysical processes for over a century.

The proposal concludes with a request that IUGG reflects on the status that glaciology has now attained within national and international bodies, learned societies and academic institutions, and that the Union endorses the justification that ICSI has submitted to attain the status of an association. It further recommends that IUGG approves and implements association status for a new International Association of Glaciology and the Cryospheric Sciences.

ICSI submitted the proposal to IAHS and IUGG for deliberation at the XXIII General Assembly of IUGG at Sapporo June 30 to July 11, 2003. The CliC SSG took note of these initiatives.

13.15 SEARCH

Dr B. Goodison spoke on CliC collaboration with SEARCH. An MOU between CliC and SEARCH was signed by Barry Goodison and Jamie Morison in October 2003. It is stated in the MOU that the two groups share common goals in trying to understand recent Arctic environmental and climate change and variability. They also both aim to understand the climate links between the Arctic and the rest of the globe and to foster establishment of better long-term observations for monitoring of change.

The MOU aims to promote:

- establishment and maintenance of long-term observations in the Arctic to detect and track environmental and climate change (Arctic Ocean Observing System);
- modelling efforts to synthesise observations, enhance the representation of Arctic climate processes in models, and improve the simulation and prediction of Arctic change;
- appropriate process studies to understand potentially important feedbacks;
- application of knowledge of Arctic climate change to provision of scenarios for appropriate impact studies;
- use of datasets that contribute to the study of Arctic climate variability and change;
- exchange up-to-date information with regards to data management systems being used within SEARCH and ACSYS/CliC and co-ordination of data and information management efforts when possible;
- joint sponsorship of meetings, workshops and conferences where appropriate.

CliC is an international science project that links to other national programmes. CliC will have to develop these linkages with SEARCH as it strives to be not just a US but an international programme.

13.16 Global Water System Project

Dr B. Goodison reported on the GWSP. It is an ESSP activity bringing together WCRP, IGBP, IHDP and Diversitas interests. GWSP seeks to answer two fundamental multi-faceted questions: How are humans changing the global water cycle, the associated biogeochemical cycles, and the biological components of the global water system and what are the social feedbacks arising from these changes?

Research is needed to: assess the magnitude and mechanisms of change in the global water system; determine the main linkages and feedbacks within the earth system arising from changes in the global water system; better understand the resilience and adaptability of the global water system; and identify the best strategies for sustainable water management.

The agenda for the GWSP will incorporate impact studies on water governance, land cover change, major diversions, climate change and nutrient and sediment flows. Linkages at different scales and the legacy of past human impacts will also be included. The Scientific Framework will be finalised by the end of 2004.

CliC has had input to the initial framework development, noting that cold season and high latitudes are considered. The initial focus has been on lower latitude problems, but the cryosphere is global in scope and affects the water system throughout the world. CliC needs to be aware of developments in this ESSP and there may be opportunities for specific activities, which would contribute to CliC's CPA's.

13.17 Northern Research Basins

Dr D. Kane reported on this activity. The NRB community was established in 1975 as part of the International Hydrological Programme (IHP). The Regional Working Group on Northern Research Basins was set up to foster research of river basins in northern latitudes. NRB is intended specifically for Arctic environments, thus full membership is open to countries with territory north of the Arctic Circle. Founder members were Canada, Denmark (Greenland), Finland, Norway, Sweden, the USA and the USSR. Iceland joined in 1992 and Russia has since taken over the role of the USSR. In addition, countries with polar research programmes are eligible for associate membership; current associate members are Germany, Switzerland, the UK and Japan. Most NRB participants are hydrologists or glaciologists, however, participants have also included climatologists, geomorphologists, biologists and ecologists.

The objectives of the Northern Research Basins Working Group are:

- to gain a better understanding of hydrologic processes, particularly those in which snow, ice, and frozen ground have a major influence on the hydrological regime, and to determine the relative importance of each component of the water balance;
- to provide data for the development and testing of transposable models which may be applied to regional, national and international water and land resource programmes;
- to relate hydrologic processes to the chemical and biological evolution of northern basins;
- to assess and predict the effect of Man's activities on the hydrologic regime in northern environments;
- to encourage the exchange of personnel (technicians, scientists, research officers and others) among participating countries;
- to provide information for the improvement and standardization of measurement techniques and network design in northern regions;
- to encourage exchange of information on a regular basis;

and

- to set up task forces to promote research initiatives on topics of special interest to northern research basins.

The CliC SSG agreed that the NRB activities might be of special importance for CliC Project Area 1 and the Arctic-HYCOS. The group requested Dr D. Kane to be CliC contact to the initiative and consider collaboration activities between CliC and NRB.

13.18 IASC and the ICARP II Initiative

Dr B. Goodison in his capacity of the CliC SSG Chair was invited by IASC to serve as a member of the Steering Committee preparing the second International Conference on Arctic Research Planning (ICARP-II). An open meeting on the subject of ICARP II was held on the evening of 27 October 2003. It took advantage of the Study of Environmental Arctic Change (SEARCH) Open Science Meeting in Seattle (27-31 October 2003). It was a good choice for a venue, because the SEARCH meeting was attended by 400 arctic scientists and managers in many disciplines. A similar meeting was held on October 28 for the proposed International Polar Year 2007/2008.

The Steering Group expressed general satisfaction with the vision for ICARP II, namely:

"To bring together Arctic residents, senior and young scholars, policy experts and science and land managers to discuss the research needed to address problems, priorities and concerns of those who live in or near the Arctic. It will also address the linkages between Arctic and global processes. It will formulate physical, biological and social science projects and implementation plans that are necessary to address issues concerning Arctic natural resources and environmental quality and that can guide international cooperation over the next five to ten years."

This first meeting of the Steering Group was to agree on a process for identifying themes. It was recognised that many international plans and events were also taking place and many organizations other than the identified sponsors of the Conference would be interested in participating in the planning process. The IASC and AOSB Secretariats will be writing to as many of these organizations as can be identified to request input into the identification of themes for the Conference. It will be stressed that themes will be identified that promote cross-disciplinary and multi-interest subject matter and not concentrate on specialised research areas *per se*. In this regard a potential candidate was discussed as an example, namely food health, which would bring in the global regional pathways, contaminant research, biological effects and the impact on traditional foods, and therefore on the northern social and cultural situation.

Denmark has offered to host the ICARP II and will be investigating the best time in 2005 and location, within Copenhagen. A website will be established in the year 2004.

The date and place of the next Steering Group meeting was set in 2004 during the week of January 19-23 in Copenhagen. The objective for the next meeting would be to choose about ten themes from the

suggestions put forward. Each of the themes will have an associated Working Group to solicit papers and to develop the theme for the Conference.

14. ACSYS/CliC meetings in the next two to three years

The tentative themes of workshops currently planned by CliC are:

- Permafrost Observations and Modelling (jointly with the IPA)
- Climate warming at high latitudes over the last 50 years
- Towards a global assessment of glacial contribution to sea level rise

A joint workshop with PAGES has been proposed and initial discussions on its scope and aims are underway. CliC also plans to participate in a planned regional workshop on Climate-Glacier interactions in the Himalaya. The feasibility of a joint IGS/CliC workshop on cryospheric climate change indicators has be explored.

15. ACSYS/CliC SSG membership, assignments to SSG members

Dr M. Burgess (Canada) sent Dr B. Goodison a letter, in which she expressed her wish to step down from the SSG due to heavy workload. On 31 December 2003 the terms of service for three SSG members were expiring. On 31 December 2004 five SSG members have their terms of service expiring. In accordance with the request of the WCRP JSC, various extensions were proposed and discussed at the session dealing with all terms ending in 2003 and 2004. Dr Cecilie Mauritzen (Norway) was nominated as a CliC SSG member and the Chair of Arctic Climate Panel. Dr B. Goodison was requested to submit to the JSC-XXV a recommended membership of the SSG after 1 January 2004 and 1 January 2005. The members felt that SCAR had to be approached to seek financial support for two SSG members.

The SSG agreed that more intersessional activities of its members are a necessary condition for developing CliC. Following the discussion on CliC Implementation, they agreed to accept responsibility for the development of certain CPAs. The breakdown of such responsibilities is given in section 8 of this report.

16. Date and place of next meeting

The SSG session considered arrangements for the first session of CliC SSG. Dr I. Allison kindly offered to hold it in Hobart, Australia. This offer was welcomed with enthusiasm and appreciation. At the same time, Dr V. Ryabinin was requested to evaluate the financial implications of such choice.

17. Summary of actions to be taken and concluding remarks

Dr C. Dick presented a table summarising action items following on from the SSG meeting. Target completion dates were agreed by the meeting. The list is given in Appendix 3.

18. Closure of the Session

The Chairman, Dr B. Goodison, closed the session at 18:45 on 18 November 2003. Before doing so, he deeply thanked Dr S. Priamikov and the team of local organisers from AARI for doing their best to offer the SSG session excellent working conditions. A reception co-sponsored by CliC and AARI followed the meeting closure.

APPENDICES

Appendix 1

Meeting participants

ALLISON, Dr, Ian, (**SSG Co-Vice Chair)**
Antarctic CRC and Australian Antarctic Division
P.O. Box 252-80
Hobart
Tasmania 7001
Australia

Tel.: +61-3-6226-7648
Fax: +61-3-6226-7650
E-mail: ian_all@antdiv.gov.au

BARRY, Prof., Roger, **(SSG Co-Vice Chair)**
University of Colorado
NSIDC/CIRES
Campus Box 449
Boulder
Colorado 80309-0449
USA
Tel.: +1-303-492-5488
Fax: +1-303-492-2468
E-mail: rbarry@kryos.colorado.edu

BROWN, Dr, Jerry **(invited expert)**
President
International Permafrost Association

P.O. Box 7
Woods Hole, MA
02345 U.S.A.
Tel/Fax: 1 508 457 4982
jerrybrown@igc.org

CARSON, Dr, David **(WCRP Director)**

World Climate Research Programme
WMO Secretariat
7bis, Avenue de la Paix,
CP2300, Geneva 2, CH-1211
Switzerland

Tel.: + 41 (0) 22 730 8246
Fax: + 41 (0) 22 730 8036
E-mail: vryabinin@wmo.int

DICK, Dr, Chad **(director, IACPO)**
IACPO
The Polar Environmental Centre
N-9296 Troms˝
Norway

Tel.: +47-77-750-145
Fax: +47-77-750-501
E-mail: chad.dick@npolar.no

DRINKWATER, Prof., Mark R.
Oceans/Ice Unit
ESTEC Earth Sciences Division
Keplerlaan 1, Postbus 299
2200 AG Noordwijk ZH
The Netherlands

Tel.: +31-71-565-4514
Fax: +31-71-565-5675
E-mail: mark.drinkwater@esa.int

FAHRBACH, Dr, Eberhard
Alfred-Wegener-Institute for Polar and Marine Research
Columbusstrasse Postfach 12 01 61
Bremerhaven D-27515
Germany

Tel.: +49-471-4831-1820
Fax: +49-471-4831-1797
E-mail: efahrbach@awi-bremerhaven.de

FICHEFET, Prof., Thierry
Université catholique de Louvain
Institut d'astronomie et de géophysique
G. Lemaître
2 chemin de Cyclotron
Louvain-la-Neuve
Belgium

Tel.: +32-10-473-295
Fax: +32-10-474-722
E-mail: fichefet@astr.ucl.ac.be

FLATO, Dr, Gregory **(Chair, NEG)**
Canadian Centre for Climate Modelling and Analysis
University of Victoria P.O. Box 1700
Victoria, BC, V8W 2Y2
Canada

Tel.: +1-250-363-8233
Fax: +1-250-363-8247
E-mail: gflato@ec.gc.ca

GOODISON, Dr, Barry, (**SSG Chair)**
Meteorological Service of Canada (MSC)
Climate Processes and Earth Observation Division
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

KANE, Dr, Douglas
Water and Environmental Research Center
Institute of Northern Engineering
University of Alaska Fairbanks
P.O. Box 755860
Fairbanks, Alaska 99775-55860
USA

Tel.: + 1 (907) 474-7808
Fax: +(907) 474-7979
E-mail: ffdlk@uaf.edu

KOTLYAKOV, Professor Vladimir
Institute of Geography of the Russian Academy of Sciences
Staromonetny Pereulok, 29
Moscow 109017
Russian Federation

Tel.: +7-095-959-00-32
Fax: +7-095-959-0033
E-mail: igras@igras.geonet.ru

KHROMOVA, Dr (Mrs), Tatiana **(invited expert)**
Institute of Geography of the Russian Academy of Sciences
Staromonetny Pereulok, 29
Moscow 109017
Russian Federation

Tel.: +7-095-959-00-32
Fax: +7-095-959-0033
E-mail: igras@igras.geonet.ru, tkhromova@hotmail.com

Lemke, Prof. Dr. Peter **(Chair, JSC WCRP)**
Alfred-Wegener-Institut, Germany
P.O. Box 120161
Bremerhaven
D-27515

Tel.: +49 471 4831 1750
Fax: +49 471 4831 1797
E-mail: plemke@awi-bremerhaven.de

Maurer, Dr, Thomas **(invited expert)**
Head
Global Runoff Data Centre (GRDC)
Federal Institute of Hydrology
Am Mainzer Tor 1
56068 Koblenz, Germany
Tel.: +49 261 1306-5224
Fax: +49 261 1306 5671
Email: grdc@bafg.de, Thomas.Maurer@bafg.de
Homepage: http://grdc.bafg.de

MIVILLE, Mr, Bernard **(IACPO staff)**
Canadian Centre for Climate Modelling and Analysis (CCCMA)
Canadian Ice Service (CIS)
Post: P.O. Box 1700, Victoria, B.C. V8W 2Y2, Canada

Tel.: +1 250-363-8202

Fax: +1 250-363-8247

e-mail: bernard.miville@ec.gc.ca

MOORE, Dr, James A. **(Chair, DMIP)**
UCAR Joint Office for Science Support
University Corporation for Atmospheric Research
P.O. Box 3000
Boulder, CO 80307-3000
USA

Tel.: +1-303-497-8987
Fax: +1-303-497-8158
E-mail: jmoore@ucar.edu

OHATA, Dr Tetsuo
Cryosphere Science Research Section
Institute of Low Temperature Science
Hokkaido University
Kita-19, Nishi-8, Kita-ku
Sapporo 060-0819
Japan

Tel.: +81-11-706-5488
Fax: +81-11-706-7142
E-mail: ohata@pop.lowtem.hokudai.ac.jp

QIN, Prof., Dahe **(unable to attend)**
China Meteorological Administration
46 Zhongguancan Nandajie
100081 Beijing
Peoples Republic of China

Tel.: +86-10-6840-6662
Fax: +86-10-6217-4797
E-mail: qdh@cma.gov.cn

Priamikov, Dr, Sergey **(invited expert, host)**
Arctic and Antarctic Research institute
38 Bering str., St.Petersburg, Russia, 199397

Tel.: +7 (812) 352 0096
Fax : + 7(812) 3522688

e-mail: priamiks@aari.nw.ru
aaricoop@aari.nw.ru

RAYNAUD, Dr, Dominique **(invited expert)**
Laboratorie de Glaciologie et Geophysique de l'Environnement (CNRS)
Box Postale 96
38402 SaintMartin d'Heres Cedex
France

Tel. : + 33 4 76 82 42 52
Fax : + 33 4 76 82 42 01
E-mail : domraynaud@lgge.obs.uif-grenoble.fr

RUDOLF, Dr, Bruno **(invited expert)**
Global Precipitation Climatology Centre
Deutscher Wetterdienst
P.O. Box 10 04 65
63004 Offenbach am Main
Germany

Tel.: +49 (0) 69 8062 2765
Fax: +49 (0) 69 8062 3759
Email: bruno.rudolf@dwd.de

RYABININ, Dr, Vladimir **(JPS for WCRP)**
Joint Planning Staff
for World Climate Research Programme
WMO Secretariat
7bis, Avenue de la Paix,
CP2300, Geneva 2, CH-1211
Switzerland

Tel.: + 41 (0) 22 730 8486
Fax: + 41 (0) 22 730 8036
E-mail: vryabinin@wmo.int

SERREZE, Dr, Mark **(Chair, PPPR)**
National Snow and
Ice Data Center
449 UCB,
University of Colorado
Boulder, CO 80309-0449
USA

Tel. : + 1 303-492-2963
Fax: +1-303-492-2468
E-mail : serreze@kryos.colorado.edu

STEFFEN, Prof., Konrad **(Chair, OPP)**
University of Colorado
CIRES, Campus Box 216
Boulder, CO 80309-0449
USA

Tel.: +-303-492-4524
Fax: +-303-492-1149
E-mail: koni@seaice.colorado.edu

TURNER, Dr, John
Physical Sciences Division
British Antarctic Survey
High Cross
Madingley Road
Cambridge CB3 0ET
United Kingdom

Tel. +44 1223 221485
Fax +44 1223 221279
E-mail: J.Turner@bas.ac.uk

VILLINGER, Mrs, Tordis **(IACPO staff)**
IACPO
The Polar Environmental Centre
N-9296 Troms
Norway

Tel.: +47-77-750-146
Fax: +47-77-750-501
E-mail: tordis.villinger@npolar.no

ZWALLY, Dr, H. Jay
NASA Goddard Space Flight Center
Oceans and Ice Branch
Code 971
Greenbelt, MD 20771
USA

Tel.: +1-301-286-8239
Fax: +1-301-614-5644
E-mail: jay.zwally@gsfc.nasa.gov

Appendix 2

Agenda of a Joint Meeting
of the WCRP ACSYS/CliC Scientific Steering Group (SSG)
and the National Committee of the Russian Federation for Cryosphere and Climate Research (NC)
held on 15 November 2003.

OPENING

Ac. V. Kotlyakov	**Call to order, opening statement by chair**
All	**Round of participant introductions**
Dr I. Frolov	**Welcome on behalf of AARI**

WCRP/CliC ACTIVITIES

Dr D. Carson & Prof. P. Lemke	**WCRP: status and developments**
Dr B. Goodison	**CliC: an introduction and a review of activities**
Dr A. Bedritsky, Ac. V. Kotlyakov	**National Research related to CliC and the goals of the Russian Federation National Committee for Research on Climate and Cryosphere**
Dr A. Glazovsky	**Glacier studies in Russia**
Dr A. Danilov	**Cryosphere research at AARI**
Dr V. Smoliyanitsky	**A report on Arctic sea ice**
Dr O. Solomina	**Paleocryospheric Research**

REPORTS OF REPRESENTATIVES OF PARTNER/RELATED PROGRAMMES

Dr D. Raynaud	**PAGES and its co-operation with CliC**
Dr J. Brown	**IPA**
Dr V. Rachold	**Arctic Coastal Dynamics**
All	**Discussion: comments, proposals**
Dr V. Ryabinin, Ac. V. Kotlyakov	**Final statement by the meeting**

Agenda of the Fourth Session of the WCRP ACSYS/CliC Scientific Steering Group (SSG) held on 17-18 November 2003

1. ***Organization of the session***

   Opening, welcome, round of introductions
2. ***Relevant recommendations of the JSC-XXIV, status of the WCRP, introduction to COPE, WCRP Task Force on Seasonal Prediction, the outcome of the Earth Observation Summit***
3. ***Review of Action Items from ACSYS/CliC SSG III***
4. ***Actions needed to conclude ACSYS***

   Preliminary Analysis of the Final ACSYS Science Conference results
   Publication of the conference results
   Publication of ACSYS data sets
   A summary of follow-up actions from the Conference
5. ***ACSYS/CliC Panel Reports***

   Results of the joint ACSYS/CliC DMIP, NEG and OPP meeting
   CLIVAR/CliC Southern Ocean Panel
   Development of polar re-analyses
6. ***Finalisation of Implementation Strategy:***
7. ***CliC Project Areas***
8. ***National/regional/institutional activities as building blocks of CliC***
9. ***CliC Structure***

   Discussion on overall CliC structure (BG, CD, all), directions and recommendations to CliC panels and groups, changes in their ToR
10. ***Implementation document, schedule of finalisation, roles of SSG members and experts***
11. ***CliC expected "sunset" year***
12. ***CliC Science Conference***
13. ***International Polar Year***

    Co-ordination between WMO and ICSU, possible role of the Intergovernmental Oceanographic Commission (IOC) of UNESCO
    IPY Themes and how CliC could contribute
    Potential contribution of other WCRP projects
14. ***International ACSYS/CliC Project Office (IACPO) and developments in CliC data management***
15. ***Co-ordination with WCRP projects and new developments in co-operation with other organizations and activities***

    GRDC
    GPCC
    Co-sponsorship of CliC by SCAR
    Co-operation with IPA
    Global Carbon Project
    CLIVAR
    GEWEX
    GAME-Siberia
    NEESPI
    IABP and IPAB
    PAGES
    Mountain Initiative
    IUGG/ICSU International Association of Hydrological Sciences International Commission on Snow and Ice
    SEARCH
    Global Water System Project
    IASC and their ICARP II Initiative
16. ***ACSYS/CliC meetings in the next two to three years***
17. ***ACSYS/CliC SSG membership, assignments to SSG members***
18. ***Date and place of next meeting***
19. ***Summary of actions to be taken and concluding remarks***
20. ***Closure of the Session***

Appendix 3

ACSYS/CliC SSG IV Action Items, 15-18 November 2003, St. Petersburg, Russia

Agenda Item/Topic	Decision/Recommendation/Action	Responsible	Due date and comments
2 Recommendations from JSC 24, etc.			
	Documents from the 'Group on Earth Observations' (GEO) to be distributed to SSG members for information and comment. Jim Moore and Barry Goodison nominated as CliC contacts for the GEO.	David Carson	15/12/03
	CliC contact for the WCRP Working Group on Surface Fluxes to be identified.	Vladimir Ryabinin	15/12/03
	Request Bill Rossow to provide a copy of his presentation regarding his proposed data-assimilation/re-analysis effort. The focus of this is to be on clouds and it may be a CliC task to assist with validation. CliC should evaluate and comment.	Koni Steffen, Greg Flato, Jay Zwally, Mark Serreze (plus CliC panels)	15/12/03 and ongoing
3 Review of Action items from ACSYS/CliC SSG 3			
	CliC talks and presentations from the SSG, CliC panel meetings and Final ACSYS conference to be placed on a password protected website.	Bernard Miville (plus all who presented material)	31/12/03
4 Actions needed to conclude ACSYS			
4.1 Conference organization and results	Notes on conference organization to be written up for future reference.	Tordis Villinger, Chad Dick	31/3/04
4.2 Publications	Final ACSYS Science Conference summary to be sent to EOS and other locations for publication. Check commitment of IGBP to Springer and possibility of using other publishers for a book on ACSYS Science. Investigate possibility of a paperback version. Check how publication numbers are allocated and provide information to IACPO. Desire is to have both WCRP and the Project identified in the numbering system.	Thierry Fichefet, Chad Dick Peter Lemke Vladimir Ryabinin	14/1/04 and ongoing 7/12/03 14/12/03
4.3 Data sets	Send out email again requesting submission of datasets, papers, etc.for inclusion in the ACSYS database. Deadline for submissions will be 31 December.	Bernard Miville	1/12/03
4.4 Further actions	A project on monthly air temperature data at Arctic stations is to be investigated	John Turner	31/1/04
5 ACSYS Panel reports			
5.1 Joint panels meeting	A report is being developed on data adequacy by DMIP, and this could benefit from reference to the GCOS adequacy report (on observations). The GCOS webpage should be checked for parameters and other useful background. Outline of review paper from the Joint Panels meeting (on cryospheric indicators of climate change in the 20th century) to be produced and circulated to the SSG. Possible CliC contact in Morocco to be	Tony Worby, Chad Dick, Ian Allison and Jim Moore/Bernard Miville Greg Flato (via IACPO) Roger Barry	Ongoing 14/12/03 14/12/03

	identified and the name sent to IACPO		
5.2 CLIVAR/CliC Southern Ocean Panel	Links of SO Panel to CliC data system to be explored.	Bernard Miville	31/3/04
	New 'CliC' members for SO Panel to be suggested	Ian Allison, Eberhard Fahrbach	31/1/04
	SCAR document on their desired interdisciplinary SO Panel to be supplied to IACPO and distributed.	John Turner and IACPO	31/1/04
	Distribute CliC Implementation Strategy to SO Panel members	CIPO	When available
5.3 Polar re-analysis efforts	Arctic System Re-analysis document to be passed to the SSG for comment.	Mark Serreze	31/1/04
	Document also to be distributed to Rick Lawford (GEWEX), Howard Cattle (HC) and WGNE for comment.	Chad Dick	31/1/04
6 Finalization of implementation strategy document			
	Implementation strategy document to be made ready for addition of CPAs when they are complete. This should be circulated to SSG etc. and comments incorporated before further distribution to other projects etc.	Chad Dick, Ian Allison	31/12/03
7 CliC project areas (CPAs)			
	Comments on the draft CPAs to be sent to Ian Allison.	All	30/11/03
	Jinro Ukita's comments on CPA 4 to be sent in to Ian Allison and IACPO.	Koni Steffen	25/12/03
	CPAs to be re-written in a consistent style/level of detail etc. and sent to the SSG Chair, IACPO and JPS, then SSG for comment before finalization.	Ian Allison	31/1/04
	Draft a list of duties for CPA leaders for comment by SSG and prospective CPA leaders.	Chad Dick	31/1/04
	Identify main CPA interests of all SSG members and attendees.	Chad Dick to coordinate	31/1/04
8 National/regional/institutional activities as building blocks for CliC			
	National points of contact to be identified in as many countries as possible, using European Polar Board, Polar Research Board in USA, ICSI, IPA, IGS etc. to help identify these points of contact.	IAPCO	28/2/04
	Formally establish a body/forum for national representatives/committees.	IACPO, JPS, Barry Goodison	30/6/04
	Circulate a list of countries with a comment on whether we know how to proceed in communicating with them, what we know of them. Work will then be needed to fill out this list.	CIPO	31/12/03
	Obtain ICSI contact list	Koni Steffen	31 January

9 CliC structure			
9.1	Terms of Reference for SSG, IACPO (CIPO) and all panels to be modified on 1 January 2004 to reflect the completion of ACSYS. Draft to be completed and checked first.	Chad Dick	14/12/03
9.3	Sunset date of 2015 to be suggested to JSC.	Barry Goodison	March 2004
10 CliC science conference			
	Inform Qin Dahe of acceptance of Beijing as conference venue, suggesting April 2005 as appropriate time.	Vladimir Ryabinin	30/11/03
	Propose structure for the conference and send to SSG and Science Organizing Committee (SOC) for comment. (SOC to include Doug Kane and/or Tetsuo Ohata, Koni Steffen, John Turner, Eberhard Fahrbach, Qin Dahe and others.)	Peter Lemke and Ian Allison	31/01/04
	Conference flyer to be prepared for distribution, including CPAs as main topics	Ian Allison, CIPO	31/01/04
11 International Polar Year			
11	White paper to be written for ICSU Planning Group. Draft to be circulated first to IPY contact group, then SSG and other WCRP projects. This must offer WCRP as a review body to draw together climate issues from other proposals.	Chad Dick	28/11/03
	GEWEX, CLIVAR, SPARC, WGNE and WGCM contacts to be identified for addition to contact group.	IACPO, JPS	14/12/03
12 IACPO and developments in CliC data management			
12.2	Look for creative ways of finding funds for continued support of Bernard Miville to work on CliC data and information management.	Barry Goodison and all SSG	ASAP and by 31/10/04 at the latest
	Ensure a counter is set up to collect statistics on webpage use, for display at next year's SSG.	Bernard Miville (plus NP IT people)	31/12/03
	Information to be supplied to IACPO on SCAR/COMNAP data system, and ways of establishing further links to be examined.	John Turner	31/12/03
13 Co-ordination with WCRP projects and cooperation with other organizations and activities			
13.1	Action to be taken to clarify issues of data access for the 'New Hampshire' archive of river run-off. The aim is to make the data widely available as soon as possible, with a report on the New Hampshire position the first step.	Mark Serreze	31/12/03
13.2	Establish a link to the existing international group on precipitation.	Bruno Rudolf and Barry Goodison	31/12/03
	Letters to be sent endorsing the continuation of APDA and ARDB and their expansion to serve CliC needs.	Bruno Rudolf, Thomas Maurer to identify the recipients. Barry Goodison, IACPO to write.	31/1/04
	Workshop on precipitation to be planned.	Barry Goodison	31/1/04

		to identify the lead	
13.3	Seek progress with SCAR on co-sponsorship of CliC, through Chris Rapley	Ian Allison	31/12/03
13.4	Provide IPA President with a copy of the CliC/SEARCH MoU, for consideration of a CliC/IPA MoU. Consider having a data management representative from IPA on the DMIP. Seek IPA co-sponsorship of CliC Permafrost Workshop (Vladimir Romanovsky at IARC)	Barry Goodison Jim Moore, Chad Dick, Barry Goodison IACPO	31/12/03 31/1/04 31/1/04
13.8	Ask NEESPI to keep us informed of their developing programme. Consider how NEESPI activities might contribute to CPA1.	Vladimir Ryabinin Doug Kane, Tetsuo Ohata, Vladimir Ryabinin	31/1/04 31/12/03
13.9	IPAB and IABP to consider coordinated submissions for IPY. IPAB should follow this up with IABP coordinator, Ignatius Rigor.	Ian Allison	30/11/03
13.10	Explore possibility of a CliC/PAGES workshop with Keith Alverson. Define the scope of the meeting, and establish clear goals that contribute to CliC goals and objectives.	Chad Dick	31/1/04
13.11	Contact Mountain Initiative group located in Bern, especially with a view to establishing South American contacts. A link to their webpage should also be considered.	Vladimir Ryabinin, Bernard Miville	29/02/04
13.12	Suggestions for cryospheric sessions at the next IAMAS meeting should be made to John Turner.	All	18/12/03
13.13	Copy of CliC/SEARCH MoU to be sent to IACPO and JPS	Barry Goodison	30/11/03
13.14	Status of the Global Water System Project science plan to be checked and followed up.	Barry Goodison	
13.15	Possible topics for ICARP 2 conference to be given to Barry Goodison Consideration to having an assessment process after the conference to see if ideas and priorities are indeed developed following the conference. This should be discussed in appropriate ICARP 2 planning meetings.	All Barry Goodison	31/12/03
14 ACSYS/CliC meetings in the next two/three years			
	Workshop on fast climate change in Alaska, Siberia and Antarctic Peninsula to be planned, starting with discussion of venue options. Workshop on Glaciers and Sea level to be planned, ensuring appropriate representation to cover all glacial regions. To start planning the Cryospheric indicators of climate change conference, with IGS and possibly ICSI as co-sponsors. Venue options to be discussed, SOC to be formed.	John Turner, Chad Dick, Panel chairs Chad Dick, David Vaughan Chad Dick	15/12/03 15/12/03 15/5/04

Appendix 4

ACSYS/CliC SSG III Action Items, 21-25 October 2002,Beijing, China

Agenda Item No.	Action	Responsible	Due date	Status (5 Nov. 2003)
4.2	Information on all Russian data sets from the Barents Workshop to go to DMIP chair. Russians to be contacted regarding completion of ACSYS/CliC metadata forms. Metadata to be obtained for AVHRR and Pathfinder albedo data sets. Any ACSYS or ACSYS related data sets to be reported to DMIP Chair and IACPO. This means that if you hear of a project that has produced data of relevance to ACSYS/CliC, then we would like to know about it. Where appropriate we would provide links to make metadata and data available to the general community.	Chad Dick Chad Dick and Jeff Key All	31/1/03	All in hand and will be covered in item 12.2
4.3	Request GPCC to host a small workshop on precipitation – to discuss CliC needs, minimum station density, GPCC role, data policy (plus other issues – the full scope has yet to be developed). Names of prospective invitees to be suggested to Barry Goodison Write to WCRP and GEWEX outlining the recommendation for this workshop, and initiating consideration of a joint CliC/GEWEX/CLIVAR panel on precipitation. Identify the Chinese person whose name should be suggested for this panel.	Barry Goodison All Barry Goodison Barry Goodison and Jim Moore	15/11/02	There has been relevant discussion at the JSC and elsewhere, and some progress. This should remain as an Action Item.
4.4	CliC to provide letter of support to CLIVAR on the formation of data centers to take over from WOCE DAACs Background information to be provided to Eberhard Fahrbach	Eberhard Fahrbach (assisted by Jim Moore) Howard Cattle	31/12/02 15/11/02	WOCE DAACs will continue, so no action needed.

4.5	ACSYS/CliC to assist in organization of planning meeting for moored IPS intercomparison. Meeting tentatively scheduled for 2004	IACPO	End of 2003	Awaiting report of first IPS workshop, which is in hand
7	8.2 MoU with SEARCH to be located, checked and copies exchanged with Jamie Morison to finalise this 13.2 CliC interest in mountain initiative and other relevant research to be drawn to attention of IGBP through IGBP office or Chair.	SSG Chair (with draft agreement to be provided by Howard Cattle) Roger Barry	15/11/02 31/12/02	With SEARCH – but they want some resolution of CliC/CLIVAR Arctic set-up first. Item 7.2.1 of agenda for 2003. Some discussion with PAGES of Pole-Equator-Pole transects. Mountain initiative leader needs to be identified.
8	IACPO annual report to be ready 3 weeks in advance in future SSG to be informed separately of all ACSYS/CliC workshops and meetings, as well as through normal channels Ensure information on WCRP web pages re ACSYS and CliC is up to date Website committee to be formed and to provide advice to IACPO on what needs to go on CliC web site and how the information will be kept up to date One article to be produced for each Ice and Climate News issue by one panel (in rotation) CliC leaflet to be updated in time for distribution at EGS-AGU-EGU in April 2003 Secure clic.org, clic.com and clic.net web addresses	IACPO Director IACPO Vladimir Ryabinin, Chad Dick Tordis Villinger, Jim Moore, Barry Goodison, Vladimir Ryabinin, Greg Flato, Roger Barry Panel chairs, starting with Koni Steffen (Arctic sea-ice thickness Vladimir Ryabinin and IACPO Tordis Villinger	20/10/03 Ongoing 31/12/02 By the end of the week and on going 30/11/2002 28/2/2003 ASAP	Report sent to SSG Chair, 30 Oct. Joint panels was only mtg. WCRP web page updated, and ACSYS/CliC and IACPO sites overhauled Articles from Seymour Laxon and Koni Steffen in I+C News. NEG next Leaflet awaiting CPAs URLs not available
9.1.1	Hold small ice sheet MIP workshop and notify PAGES project office that this will occur. IGS meeting in Milan may provide a forum. (Short article to be prepared for Ice	Philippe Huybrechts and Chad Dick Philippe Huybrechts and	Early 2003? 30/11/2002	Done Possible NEG contribution to I+C News or maybe

	and Climate News) SIMIP 2 workshop to be planned in conjunction with next NEG meeting Organise a permafrost workshop (for approx. 20 people) within approximately 1 year, bringing together process researchers, large scale modellers and remote sensers. If possible this should be a collaborative effort with the International Permafrost Association (A Chinese researcher to be invited to participate in the planning and the meeting itself.) NEG to discuss frozen ground in the context of permafrost modelling Link to be maintained to WGCM	Chad Dick Greg Flato Vladimir Romanovsky, Greg Flato Zhang Qibing to help identify this person? Greg Flato Greg Flato	 Sep. 2003 30/9/2003 Ongoing Ongoing	separate Successful SIMIP 2 w/s held in Oct. Paper within 1 year. Planning for permafrost W/S underway for late 2004 at IARC. Others done or being done
9.1.2	Christian Mätzler to be invited to next OPP meeting OPP to discuss satellite retrieval of snow accumulation on ice sheets at next meeting	Koni Steffen, Vladimir Ryabinin Koni Steffen	Sept. 2003	Done Done
9.2	Prepare paragraph to define what is ACSYS data and what is an ACSYS-related data set	Jim Moore	May 2003	Not done yet, but many data sets have been classified
9.3	Letter to be prepared for David Carson to send to NSF and NASA on need for more Antarctic buoys, and in particular a buoy on Peter 1. Island Possibility of Chinese participation in buoy programme to be investigated informally	Mark Drinkwater and John Turner to prepare first draft for passing to Vladimir Ryabinin Ian Allison	10/11/2002 Ongoing	Completed. A resolution on IPAB and buoys was adopted by the WMO Congress. An initiative on buoys will be a part of the CliC IPY campaign.
10	Ad hoc group to discuss possible ways forward to promote an International Polar Decade and suitable projects Document with dot points justifying the initiation of an International Polar Decade to be distributed to ad hoc	Chad Dick, Ian Allison, Vladimir Kotlyakov, Jay Zwally, Koni Steffen Jay Zwally	By the end of the week 10/11/2002	For discussion under item 11

	group for comment			
11.2	Each SSG attendee to look at one area of ACSYS Implementation and Achievements document and suggest updates Updates to be coordinated at IACPO	All Tordis Villinger, Chad Dick	30/11/2002 28/2/2003	Still not all complete – alternatives will be discussed
11.3.1	Problems with ECMWF/ERA 40 data to be raised with David Carson	Mark Serreze	31/12/2002	2.5 degree data available via web. Full resolution data to be ported to NCAR.
12	Contact Russian Hydrometeorological Service to get formal OK to hold final ACSYS conference at AARI Draft letter formally asking Russian Hydromet for AARI to host the final ACSYS conference for Peter Lemke to sign Informally investigate IARC as a possible venue for ACSYS final conference Informally investigate Norsk Polarinstitutt as a possible venue for ACSYS final conference Approach John Walsh to chair organizing committee and Valerie Vuglinsky to serve on the organizing committee Organizing committee to set up publications sub-committee, who should investigate options for a special issue Set up web submission for abstracts for ACSYS final conference Flyer to be composed and mailed with I+C news and NSIDC notes Suggest invited speakers for sessions – names to be sent to IACPO and the conference chair	Vladimirs Ryabinin and Kotlyakov Vladimir Ryabinin Barry Goodison Tordis Villinger and Chad Dick Barry Goodison Conference organizing committee Tordis Villinger with help from Koni Steffen's oppo Roger Barry, committee to check All Chad Dick and Vladimir Ryabinin (with the organizing committee)	12/11/2002 5/11/2002 14/11/2002 14/11/2002 7/11/2002 15/12/2002 31/12/2002 20/11/2002 28/2/2003 30/4/2003	Conference will be finished for better or for worse by time of SSG!!

	Develop guidelines and priorities for support of participants			
13	Strategy document to be separated from rest of IP and tidied up Conceptual project areas to be developed Other chapters to be tidied up for web production Terrestrial Sea level Sea ice Indicators of change Global circulation And returned initially to IACPO	Chad Dick to do first draft – then to Barry Goodison Ian Allison, Vladimir Ryabinin Barry Goodison, Margot Burgess Koni Steffen, Mark Drinkwater, Jay Zwally Ian Allison, Eberhard Fahrbach, Mark Drinkwater Vladimir Kotlyakov, ? John Turner	14/11/2002 31/12/2002 31/12/2002	Awaiting CPAs – see items 6 and 7
13.1	CliC conference 2 pager to be written and distributed appropriately	Barry Goodison	31/12/2002	Awaiting CPAs and Imp Strat. Doc. – see items 6 and 7
15.1	Strengthen links to CLIVAR Atlantic Panel, possibly through formation of a CliC/CLIVAR Atlantic panel New ideas to be presented in Nice	Howard Cattle, Valery Detemmerman, Chad Dick, Vladimir Ryabinin	28/2/2003	Atlantic meeting attended, CLIVAR SSG declined a CLIVAR/CliC group proposal, CliC is taking the lead on this. Item 7.2.1 on agenda 2003.
15.2	Southern Ocean Panel report to be distributed to SSG.	Chad Dick or Howard Cattle	ASAP	Report available at http://www.clivar.org/publications/wg_reports/southern/so_rep_1.pdf
15.3	Establish sub-group to review proposal for cold climate component of CEOP	Barry Goodison, Tetsuo Ohata, Vladimir Romanovsky, panel	15/11/2002	Not done. CliC are on CEOP committee. Action on identifying CliC

		chairs		initiatives still needed
15.4	Suggest workshop on polar clouds to GRP	John Turner	31/1/2003	Organization is underway
15.5	GAME-Siberia CD ROM details to be supplied to Jim Moore and IACPO	Tetsuo Ohata	15/11/2002	To be dealt with under item 12.2
15.6	SSG contact to work on developing proposal and links for Arctic HYCOS with GHP, Arctic CHAMP and others	Tetsuo Ohata, Vladimir Ryabinin, Chad Dick	31/1/2003	Will be discussed at ACSYS conference
15.11	Letter of endorsement to be sent to ASOF	Chad Dick, Vladimir Ryabinin and Eberhard Fahrbach to prepare for Barry Goodison to sign	31/1/2003	Completed
15.13	Letter to Paul Mason and Alan Thomas of GCOS to raise issue of cryospheric measurements and especially sea-ice thickness being essential parameters for observation. Email to be circulated to SSG regarding input needed for GCOS/GTOS/GOOS adequacy report	Barry Goodison in consultation with Roger Barry and Koni Steffen Roger Barry	15/12/02 10/11/2002	We did have a consolidated input to GCOS adequacy report – now published at http://www.wmo.ch/web/gcos/gcoshome.html.
15.13.3	Report back on links for CliC from GTN-H meeting	Barry Goodison and Jim Moore	15/12/2002	Successful interaction but integrated theme on on cryosphere ultimately not accepted in GCOS adequacy report. There will be a GTN-H Coordn. Panel and Thomas Maurer and an NSIDC person will represent CliC opportunities for collaboration. Next mtg. – early 2004.
15.15	SSG to be informed on developments with ICSI Permission to use ICSI formal national representatives mechanism for information distribution to be sought	Roger Barry Barry Goodison, Gerry Jones Roger Barry	31/1/2003 Jan 2003 31/1/2003	ICSI status report was distributed. Permission to use ICSI reps. was obtained.

	ICSI report to be circulated			
15.18	Note on how to get ESA data to be prepared for Ice and Climate News ESA data supply call (Announcement of Opportunity) to be publicized in Ice and Climate News if timing is OK (and on web)	Mark Drinkwater Mark Drinkwater and IACPO	15/1/2003 January or May	Done and will be repeated with an update next year.
15.19	Letter of support for ESA-GMES ICEMON proposal to be drafted and circulated Circulate information on ICEMON proposal	Chad Dick for Barry Goodison to sign Chad Dick	8/11/2002 31/10/2002	Done. Two proposals (ICEMON and Northern View were given letters of support and both were supported by ESA.)
15.20	Information on the WCRP 'satellite' Working Group to be distributed to SSG members for response by 7 November 2002	Koni Steffen	1/11/2002	Done A further meeting took place 20 – 22 Oct. '03. Recommendations will be distributed.
16.1 and 16.3	List of Asia CliC and Japan CliC attendees to be supplied to IACPO	Tetsuo Ohata, Vladimir Ryabinin	14/11/2002	Underway
16.4	Official letter to be sent to RAS with copy to Vladimir Kotlyakov encouraging Russian CliC	Barry Goodison	31/12/2002	Russian CliC established
16.5	US CliC proposal to be sent to IACPO and JPS	Roger Barry	20/11/2002	US CliC committee will meet 5/6 Jan 2004, with NASA funding
16.10	Australian CliC committee to be formed	Ian Allison	28/2/2003	Not accepted by Australian PTB.
17.1	Give Greg Flato input on Predictability initiative before the panic	All who have ideas on this	ASAP	Jens Christensen attended first Task Force on Seasonal Prediction w/s,

				Hawaii, Oct. 2003
17.2	Reports from meetings to be sent to office in timely fashion and put on the web All who are invited to talk on CliC to inform IACPO and JPS Leaflets to be distributed at EGS-AGU-EGU and IUGG IUGG talk to be in Climate and Cryosphere session – Barry Goodison to be suggested as speaker to Siobhan O'Farrell Ideas for IAMAS sessions in 2005 to be passed to John Turner	All who represent ACSYS/CliC All IACPO, Vladimir Ryabinin Ian Allison All	Ongoing Ongoing April 2003 5/11/2002 ASAP	Ongoing Leaflet awaiting CPAs IUGG talk given IAMAS sessions include Mountain snow cover, Modelling forest snow processes, Glacier mass balance etc.
17.3	Need to organize input for Draft Global Carbon Project Science Framework Small team to put input through WCRP contact/rep More info on Joint Water Project to be obtained and distributed	Margot Burgess to be our main contact person for this Barry Goodison	Ongoing ASAP	Input given through the IACPO and WCRP Open Science mtg. Oct. 2003. Current status available on website.
General	Subpanels may need to spin-off from main panels and work independently on particular topics. This would involve identification of topics, sub-panel members and rapporteurs (to the main panels).	Panel chairs	Ongoing	Ongoing
General	Set up SSG password protected link on the website	Tordis Villinger	ASAP	Bernard – does this now exist? We need to advertise when it is complete.
General	Need to report on meetings attended with issues, suggested actions, and also to solicit input before meeting – for all connections e.g., CLIVAR, GTN-H	ALL	Ongoing	Ongoing
General	Develop CliC mechanism for endorsing projects	Chad Dick, Vladimir Ryabinin, with input from Howard Cattle	31/1/2003	Input on CLIVAR process still needed.

Appendix 5

Statement of a meeting between the World Climate Research Programme (WCRP) Arctic Climate System Study (ACSYS)/Climate and Cryosphere (CliC) Scientific Steering Group (SSG) and the Russian National Committee (NC) for research on cryosphere and climate

A joint meeting of the SSG and NC took place on 15 November 2003 at the Arctic and Antarctic Research Institute in St. Petersburg, Russia.

The ACSYS/CliC SSG is very pleased to acknowledge a recent establishment of the NC by the Russian Federation, co-chaired by the Head of Roshydromet, Dr A. Bedritsky and Director of the Institute of Geography of the Russian Academy of Sciences, Academician V. Kotlyakov. The Committee is comprised of representatives of the Roshydromet, Academy of Sciences and other leading agencies in Russia who are active in the research on cryosphere and climate. CliC expects a very valuable contribution by Russian scientists into all areas of CliC research.

At the meeting the representatives of WCRP and CliC gave a review of their programmes, the Russian scientists gave a series of talks on the related national research and the goals of the NC, several partner programmes and groups such as PAGES of IGBP, the International Permafrost Association presented themselves, and all participants in the meeting exchanged views on future activities in favour of CliC.

The participants noted with great satisfaction a successful Final Conference of the WCRP Project “Arctic Climate System Study” (ACSYS), which was held prior to the joint SSG/NC meeting at the Arctic and Antarctic Research Institute. The conference was attended by approximately 250 scientists from 19 countries. It highlighted significant advances in several areas of scientific research in the Arctic including studies of the Arctic Ocean circulation, hydrological regime of the ocean basin, sea ice and atmospheric conditions over the northern high latitudes. It was felt at the conference that successful ACSYS studies needed to continue on the global basis and with significantly extended scope.

The participants expressed an opinion that the International Polar Year (IPY) 2007/08 represents a rare and excellent opportunity to support the launch of several CliC studies. WCRP, CliC, Russian participants will co-operate in preparing a coherent programme for IPY activities.

The meeting came to a common understanding that the major CliC goals, namely the development of modern observing systems for all elements of cryosphere, the enhancement of cryosphere modelling capabilities and related process studies are high priority issues for the modern climate research. The Cryosphere holds the keys to several important problems of climate science including possible significant alterations in the global carbon/water/energy cycle and in thermohaline circulation, the rise of mean sea level. Monitoring of cryospheric parameters provide informative indicators of climate change. The cryosphere is involved in several important feedbacks in the climate system. Extended time scale of cryospheric processes contributes to climate predictability. All potential scenarios of abrupt climate change are linked to changes in cryosphere.

The Russian scientists expressed their interest in contributing to research in the four main areas of CliC, comprising

- CPA1: Terrestrial cryosphere, hydrometeorology of cold regions and interactions with the climate system
- CPA2: Glaciers, ice caps and ice sheets, and their relation to sea level rise
- CPA3: High latitude oceans and the marine cryosphere
- CPA4: Integrated interactions between the cryosphere and global climate.

The studies of cryosphere should be recognised as an important component of climate research in Russia and worldwide. Observations, modelling and diagnostic studies of cryosphere should receive more attention and support.

Appendix 6

CliC Project Areas

The WCRP Climate and Cryosphere (CliC) Project addresses WCRP objectives as they relate to the cryosphere as an integral part of the climate system. The principal goal of CliC is to
Assess and quantify the impacts of climatic variability and change on components of the cryosphere and their consequences for the climate system, and to determine the stability of the global cryosphere.

CliC is organised into four Project Areas (CPAs) to facilitate planning and implementation. These individual modules are each more uniform, focussed and self-contained than the whole, but the CPAs are not mutually exclusive and there are important overlaps and linkages between them (as there are between CliC and the other major WCRP projects). Planning and implementation of each CPA will be facilitated by co-ordinator or scientific leader appointed from the Scientific Steering Group or from existing CliC Panels.

CliC implementation is targeted to answer key scientific questions, which are given in the CliC Science and Co-ordination Plan (SCP). In doing so, it is understood that CliC has to avoid duplication of effort; activities by other WCRP projects and by some other research programmes may fill an important niche in CliC. Co-ordination is recognized as an essential component for a successful CliC Project.

The CliC Project Areas are:
CPA1. The terrestrial cryosphere and hydrometeorology of cold regions
CPA2. Glaciers, ice caps and ice sheets, and their relation to sea level
CPA3. High latitude oceans and the marine cryosphere
CPA4. Linkages between the cryosphere and global climate.

The three first areas include studies of individual elements of cryosphere and their interactions while the fourth CPA is intended to summarise the knowledge in all aspects going beyond individual project areas. It is also understood that:
- many results of CliC studies will be directly contributing to other WCRP and Earth System Science Partnership studies and projects,
- some studies may contribute to more than one CPA.

A common output to all CPAs will be enhanced observing, data exchange and management systems for cold climate regions. Co-ordination with global reanalyses projects, such as those of NCEP and ECMWF is also, required. Observing procedures and standards for cryospheric variables need to be updated in conjunction with GCOS/GOOS/GTOS, and many cryospheric observing networks will need to be eventually transformed from research based funding to sustained operational elements of the Global Observing System.

CPA1. The terrestrial cryosphere and hydrometeorology of cold regions

The terrestrial cryosphere includes snow cover, lake- and river-ice, glaciers and ice caps, and frozen ground including permafrost. Studies of balance and exchange of water, energy and matter between the land surface, the cryosphere and the atmosphere involve the sciences of meteorology, climatology, hydrology, geocryology, bio-geochemistry and geomorphology. Each of these disciplines is relatively well developed, but understanding their interaction remains a challenge. Many of the processes involving the terrestrial cryosphere are poorly represented in current climate models.

A fundamental requirement of this CPA is accurate estimates of water balance (and related energy flux) components in cold regions, including precipitation (both solid and liquid), distribution of snow depth and water equivalent, snow melt, evapotranspiration and sublimation, filtration of water through frozen and unfrozen ground, water collection in watersheds, river- and lake- ice properties and processes, river run-off, etc. Estimates are required of the amount and form of carbon stored in the ground and the rate of its release rate to atmosphere or surface water bodies in a warming climate. Improved estimation of solid precipitation is a particular challenge.

The global observing networks of cryospheric elements are commonly sparse and biased in polar and alpine regions, and declining in most of these and other regions. Enhanced observations and rescue of historical data are essential to determining the past and present patterns of variation and change in the terrestrial cryosphere in all regions of the globe. The role of the cryosphere in climate variability and change of high elevation regions (glaciers, mountain permafrost, and fresh water resources) provides a significant challenge. The integration of validated in-situ and satellite data to provide temporally and spatially consistent global information on the terrestrial cryosphere is a very important source of much needed data.

It is essential to assess, and ultimately ensure, that the terrestrial cryospheric components and the associated processes affecting the energy, water and carbon cycles are properly incorporated and validated in forecast, re-analysis, climate and hydrological models. Scaling of terrestrial cryospheric processes will be critical. There is a need to develop and validate physically based models with appropriate land-atmosphere-cryosphere complexity to use in coupled models at a range of scales. The proper scaling (scaling down climate parameters; scaling up cryospheric processes) and verification of the scaling procedure is essential in the development of land surface process models and their link to hydrological models and incorporation into climate models. Establishment of CliC Super Study Sites, spanning a range of terrain settings (prairie, permafrost, tundra, boreal forest, alpine landscapes, glacierised basins, or watersheds dominated by lakes and wetlands) would provide field study areas for improved understanding of the terrestrial processes, testing parameterizations suitable for larger-scale models and development and validation of remotely sensed cryospheric information.

Outputs of this CPA will include:

- Daily/monthly precipitation products, adjusted for known errors, for cold regions in co-operation with GEWEX and the Arctic Precipitation Data Archive (APDA).
- Establishment of CliC Super Study sites in different environments for scaling, process parameterization, model and remote sensing validation.
- Advanced and validated remote sensing algorithms and enhanced products for snow, frozen ground, glaciers, freshwater ice conditions and related indicators for climate change detection and monitoring.
- Improved knowledge of and ability to simulate interactive processes involving cryosphere in climate and numerical weather prediction models at several time scales. Enhanced knowledge of interactions in the system due to increased scope of interdisciplinary research.
- Improved forward-predicting radiative transfer and surface process models to be used in forecasting cryospheric components in operational models.
- Enhanced information for water resource management, including better basis for deriving recommendations for assessment of fresh water resources from glaciers, melting snow-pack, and rain on snow.
- Contribution to improved estimation of carbon emissions from regions with permafrost and frozen ground.
- Evaluation of the magnitudes, patterns and rates of change in terrestrial cryosphere regimes from seasonal to century timescales, and of the associated changes in the water cycle.
- Improved estimation of river runoff in regions affected by snow and ice, particularly the many ungauged rivers in the Arctic.
- Impact of changes in cryological variables of significance to socio-economic activities, including glacier recession, outburst floods affecting water resources, and permafrost degradation with decreases of bearing capacity.

Interactions with several GEWEX and IGBP initiatives including CEOP, PILPS, and ILEAPS will be essential for this CPA. APDA, ARDB, Arctic-HYCOS and other hydrological activities will be parts of this CPA.

CPA2. Glaciers, ice caps and ice sheets, and their relation to sea level

Of the cryospheric contributions to sea-level change, the largest uncertainty pertains to the Antarctic and Greenland ice sheets. However, glaciers in most mountain regions are known to be retreating, and they too make a significant contribution to sea level. To understand past and present sea-level variations and

predict future change, it is essential to measure and explain the current state of balance of glaciers, ice caps and ice sheets and the underlying changes, which have accelerated in many areas of the world since the 1970's. Ice shelves may also play an indirect role through their influence on the flow of land based ice sheets and glaciers.

The major objectives of this CPA are to improve direct estimates of the mass balances of the Antarctic and Greenland ice sheet and their contribution to sea level changes; to develop enhanced capability to estimate past and predict future change ice sheet change; and to implement a system for monitoring glaciers and ice caps globally to better determine their contribution to mean sea level changes.

New technologies, particularly satellite remote sensing technologies, will be essential to better understand the effect of land ice on sea level, and to assess the mass balance and their uncertainties of the major ice bodies. Mass loss from ice sheets is a major area of uncertainty, and the behaviour of ice streams, and the role of ice shelves in restraining them are poorly understood. Glaciological models of the dynamics of ice sheets, ice stream, and ice shelves, and the assessment of the effects of ice shelves on ice sheet stability, need to be improved.

Outputs of this CPA should include:

- Improved ice sheet, ice caps and glacier monitoring system, inventory and related database.
- Mass balance records for a selection of large glaciers (> 25 km^2) and ice caps representative for different climatic regions and altitudinal zones.
- Ice cores for climatic reconstruction from high elevation glaciers and ice caps.
- Improved knowledge of and ability to observe and model ice sheets, ice caps, and glaciers. Ice sheet models should be represented in global climate models.
- Better treatment of basal sliding and/or deforming basal till, and appropriate stress configurations, in ice stream models, and of ice sheet/ice stream/ice shelf interaction and coupling
- Better prescription of the snowfall accumulation and melting/runoff on the large ice sheets and their sensitivity to climate change.
- Substantiated error bars on estimates of the past and future contributions of the cryosphere to the mean sea level change. Reduced uncertainties of such estimates.
- Improved assessment of the West Antarctic Ice Sheet stability and vulnerability to climate change.
- Support to deep and shallow ice coring, which is important for detection of past climates including past records of accumulation variability and change.

Additional contributions to this CPA will come from the IGBP programmes such as PAGES, from the Mountain Research Initiative and other related activities.

CPA3. High latitude oceans and the marine cryosphere

The marine cryosphere includes sea ice, its snow cover, icebergs and floating ice shelves. Sea ice has a significant influence on the mean state and variability of polar and global climates. The extent to which a cover of sea ice modifies ocean-atmosphere interaction is determined primarily by the thickness and concentration of the ice and by the thickness and density of its snow cover. Both of these are determined by ocean-atmosphere interactions. The ice shelves, on the other hand, provide an additional source of freshwater for the ocean, both at their underside and front as well as along the trajectory of calved icebergs.

The objectives for this CPA are to improve understanding, through models and process studies, of the polar oceans in full (including dynamics and thermodynamics of sea ice, polynyas, ice shelf-ocean interaction and polar ocean circulation and water mass formation); to improve model simulation of both the mean state and interannual-to-decadal variability of sea ice and enhanced prediction of future variation and change; to determine the past and present patterns of variation and change in sea-ice distribution and mass balance in both polar regions; and to better understand the impact of changes in sea ice, polynya, and ice shelf distribution on the global thermohaline circulation (linked with CPA4) and risk of abrupt changes in climate resulting from such forcing.

Enhanced observations are required (especially of ice thickness) to obtain spatially adequate estimates of the important variables over climate-relevant time scales. The historical database must be expanded through data rescue efforts, quantification and reduction of uncertainties in these estimates. Combined observational and process studies are needed in both polar regions to develop adequate models for data assimilation and (re-) analyses.

The geographical separation and different boundary conditions between the marine cryosphere in the northern and southern hemispheres allows, in principle, this CPA to be managed as two linked project sub-areas in the Northern and Southern Hemispheres.

For the Arctic, through systematic observations, collection of past observations data, improvement in atmospheric forcing data, and advances in modelling of the ocean circulation and sea-ice dynamics and thermodynamics it should be possible to apply data assimilation methods to combine models and observations to better determine the past, current and future state of the marine cryosphere. Advances in estimation of river run-off (based on CPA1) will help to reduce uncertainties in the oceanic fresh water cycle of the Arctic Ocean, and enable better simulation of the ocean thermohaline circulation. One of the expected outputs of this sub-area will be more reliable estimates of future changes in the Arctic Ocean sea-ice cover and the related oceanic properties such as circulation and vertical stability.

Similar observational and modelling studies are required for the Southern Ocean, and a re-analysis project for Antarctica would be highly desirable. Deep and bottom water formation south of the Antarctic Circumpolar Current occurs mostly through dense water formation by cooling and brine release in coast polynyas over the Antarctic continental shelves. Sea ice formation counteracts freshwater gain by the melting of ice shelves and icebergs and precipitation minus evaporation. Hence in the Southern Ocean an additional focus is required on ice shelf and water mass modification processes, including feedbacks involving the atmosphere and ocean. Measurement programmes should also address the role of the Southern Ocean in the marine component of the global carbon cycle, including the inorganic carbon components.

Outputs of this CPA will include:

- Observational data sets and re-analyses of oceanographic and sea-ice quantities, with estimates of corresponding uncertainty, perhaps as part of a more comprehensive coupled system re-analysis.
- Improved knowledge of and ability to model marine cryospheric processes and contribute to studies of predictability of global and regional climate.
- Reduced uncertainties regarding past variability and trends in sea–ice coverage and associated mass and energy balance, and better ability to predict future changes to sea-ice cover in both hemispheres.
- Better knowledge of the role of ice-ocean interaction in the thermohaline circulation, and of any potential for abrupt change.
- Indicators of climate change related to marine cryosphere.
- Potentially, substantiated scenarios of atmospheric CO2 concentration growth rates with due account of processes in the Southern Ocean.

To achieve the goals of this CPA it will be necessary to maintain strong links to CLIVAR and to other programmes, including IABP, IPAB, SCOR and SCAR (ASPeCt).

CPA4. Linkages between the cryosphere and global climate

The cryosphere is an essential component of the global climate system as evidenced by paleoclimate records. The global climate system is inherently complex and understanding of interactive roles of the cryosphere within the global climate system remains a challenge. Through the large-scale atmospheric and oceanic circulation the cryosphere affects the water cycle, energy, carbon budgets, atmospheric chemical composition, other budgets, and is affected by them. However the water cycle, the energy budget, and budgets of other key variables such as carbon, over a range of spatial and temporal scales (regional to global and seasonal to centennial) provide integrated concepts needed for a synthesis. Large-scale atmospheric and oceanic circulation further provides vital information on transport processes that are essential to understand the water cycle and the energy and other budgets.

The cryosphere influences atmospheric circulation in many ways, including the connections between the snow and ice-covered surface, the atmospheric boundary layer, and the atmospheric cloud and radiation fields. Changes in snow or ice extent alter albedo and hence surface heating, providing a positive feedback on the initial change. However, more complex changes in cloud and radiation fields and atmospheric circulation also occur. We recognize the importance of modes of atmospheric variability, defined as recursive spatial patterns of anomalies, in linking the cryosphere and other climate components, as exemplified by recent studies exploring co-variability between the annular modes and other polar variables. A grand challenge is to gain improved knowledge of underlying mechanisms for these links and co-variability, thus enhancing our ability to predict future variations and changes. The integrated role of the cryosphere in the global climate system, and the impact of cryospheric changes on both atmospheric and oceanic circulation, can only truly be understood by the appropriate treatment of many different cryospheric processes in coupled climate models.

This CPA will also address the likelihood that changes in the cryosphere could lead to abrupt changes in global climate. Sea ice, glacial ice and the polar hydrological cycle crucially affect the surface buoyancy flux in the ocean, and hence control the vertical overturning that regulates the meridional overturning circulation (MOC). The MOC has been implicated in both abrupt and long-term climate change.

An integrated understanding of global climate – cryosphere interactions is required for the Intergovernmental Panel on Climate Change process and activities similar to the Arctic Climate Impact Assessment. Polar re-analysis, design of cryospheric observing systems, and studies of cryosphere - climate interactions involving several different cryospheric components need to be also addressed

Outputs of this CPA will include:

- Improved knowledge of and ability to model high latitude climate and the cryosphere both regionally and as part of the global climate system.
- Improved knowledge of the cryosphere-related feedbacks in climate variability and change at a variety of temporal and spatial scales, better understanding of interactions between anomalies in the extent of cryosphere and the major components of climate variability.
- Understanding of the cryospheric processes that underlie global tele-connectivity in high latitude climate
- Determination of the pathways of moisture transport that control the mass balance of ice sheets
- Better knowledge of and basis for projection of short time-scale (abrupt) climate changes associated with impact of cryosphere on the rest of the global climate system, quantified estimates of the impact of cryospheric variables on climate predictability at relevant time scales.
- Clearer view on the role of cryosphere in water, energy and carbon cycle, with further insights into multidisciplinary connections involving biogeochemical cycles.

Coordinated efforts with other WCRP projects and other programmes, including IGBP and Arctic Climate Impact Assessment, are essential for this CPA.

Appendix 7

The Arctic Ocean Observing System (AOOS)
(a proposal by JPS WCRP and D/IACPO)

Arctic component of GOOS
The AOOS is to be a regional component of the Global Ocean Observing System (GOOS), a programme of the World Meteorological Organisation (WMO), Intergovernmental Oceanographic Commission (IOC) of UNESCO, United Nations Environment Programme (UNEP), and the International Council for Science (ICSU). There are several regional components of the Global Ocean Observing System (GOOS). The Arctic Ocean GOOS activities have not yet been launched.

Why it is needed
The needs are twofold: for the Arctic region and beyond it.

The global climate warming as projected by the IPCC Third Assessment Report is more pronounced over the Arctic Ocean. Rapid changes are expected in the ocean. Many researchers have already reported very significant and fast changes in the sea-ice cover in the Arctic Ocean, since the 1970-s. There is certain controversy in views on the reported changes, on their magnitude and causes. Also, there is a wide range of projections of future changes in sea-ice of the Arctic, particularly the ones for multi-year ice. Only a comprehensive observing system can monitor the changes as they occur, superimposed on the natural variability, and facilitate the understanding their causes and developing the projection capabilities.

The Arctic Ocean is the focal point where rapid global climate changes may be generated through the alterations of the thermohaline circulation. The effect on the climate of northern Europe may be significant.

Expanding navigation through the Arctic, increased tourism and a variety of other activities in the Arctic, such as environmental preservation activities or oil and gas production, also require support.

AOOS components
This note discusses the “physical” domain of the AOOS only. The living resources, health of the Arctic Ocean, coastal problems, marine meteorological and oceanographic services should also be parts of AOOS. There are programmes and international bodies that could take the lead in these areas. The structure of AOOS should be discussed after/if the idea to establish it is approved.

Grounds for building AOOS

National activities
As Dr R. Dixon pointed out at the Arctic Ocean Science Board meeting 2003 (Kiruna, Sweden, April 2003), it was getting more and more difficult to report national oceanographic activities because international co-operation had become an intrinsic part of most of them. Nevertheless, national activities and funding sources remain the main building blocks of research, and therefore it is relevant to note that the following countries actively conduct research and observations in the Arctic Ocean: Canada, China, Denmark, Finland, France, Germany, Japan, Korea, Norway, Poland, Russia, Sweden, UK, USA.

Most of the research activities are of limited duration. The goal of AOOS would be to monitor the Arctic Ocean in sustained mode. To launch such a programme may be possible but not easy. It will be more difficult to ensure its sustainability.

International oceanographic projects in the Arctic
There are several active international programmes working in the Arctic Ocean. Most of them are research-based. The co-operation between them is relatively well developed.

WCRP

With WOCE finished in 2002, ACSYS ending in 2003, the WCRP has to re-organise its marine activities in polar oceans.

For ACSYS the Arctic Ocean was the major topic. The ACSYS web-site (http://acsys.npolar.no) contains information on the studies and their organisation. ACSYS had four subsections focused on Arctic Ocean circulation, Sea Ice, Atmosphere, and Hydrological Cycle. The agenda of the Final ACSYS Conference (1-14 November 2003, Arctic and Antarctic Research Institute, St. Petersburg, Russia) contains a theme "Observing the Arctic Climate System", which should provide a further forum for discussing the initiative of AOOS. The website of the conference is located at the following URL: http://acsys.npolar.no/meetings/final/conf.htm.

CliC (see http://clic.npolar.no) is expected to build on ACSYS. CliC is global and also includes land-based interests. One of the recent contributions of CliC to the development of observations in the Arctic Ocean was a workshop on Ice Profiling Sonars. A workshop on Arctic Modelling and Observations was organised by ACSYS in Palisades, NY, in June 2002. There are more examples of ACSYS/CliC contribution to a system like AOOS. ACSYS/CliC actively supports IABP and is a participant in it.

CLIVAR (http://www.clivar.org) has regional implementation panels for the Atlantic and Pacific Oceans. There is a joint CLIVAR/CliC Panel for the Southern Ocean. Establishment of an Indian Ocean is apparently being discussed with GOOS. There is no CLIVAR Panel for the Arctic Ocean and the CLIVAR SSG meeting in 2003 (May 2003, Victoria, BC, Canada) has declined a proposal by CliC to establish a joint CLIVAR/CliC Panel for the Arctic.

After ACSYS has finished, there will be no panel of the WCRP to look after the Arctic Ocean studies. Therefore WCRP requires a new solution for continuation of the oceanographic research in the Arctic. CliC activities need further development. So far, CliC has not achieved a stage, at which there are significant resources for implementation of oceanographic research. Thus it may be desirable to request CLIVAR to re-consider their position on the Arctic Ocean. It may be relevant to ask the JSC of the WCRP to express their views on the subject. Because of existence of strong research programmes outside of the WCRP and to avoid duplication of efforts, it may be also appropriate to initiate a joint activity with them having CLIVAR involved. A proposal to establish AOOS therefore may serve as a vehicle for continuing WCRP research activities in the Arctic Ocean. Modern research on environmental changes cannot be conducted without a proper observational system. AOOS will provide the general basis. Specific scientific issues of interest to CliC may be resolved through smaller scale projects.

After 2003, the collection, archiving and dissemination of Arctic hydrological and precipitation data will be continued under a renewed agreement with GRDC (http://www.bafg.de/grdc.htm) and GPCC (http://www.dwd.de/en/FundE/Klima/KLIS/int/GPCC/GPCC.htm). The APDA and ARDB archives will be transformed into CPDA and CRDB and will retain and further develop their Arctic collections. By this, these data archives will also contribute to AOOS.

Arctic-HYCOS, a component of the WHYCOS (http://www.wmo.ch/web/homs/projects/whycos.html) in the Arctic, was supported by ACSYS. It has not yet achieved strong development, and needs for a viable hydrological components for AOOS should be considered.

ACSYS/CliC Panel ad hoc Panel on Polar Products from Re-analysis will continue its studies.

The recent initiative of the WCRP Satellite Working Group session (Geneva, 20-22 October 2003) to start a project on satellite data re-analysis may generate positive input to AOOS.

The first effort of the recently established WCRP Working Group on Surface Fluxes on CliC's behalf is likely going to be the creation of a 'handbook' on best practices for flux measurements (turbulent, radiative, precipitation) in polar conditions. This may include direct measurements and typical parameterizations applied to near surface data with much of the experience to be drawn from the SHEBA flux group activities.

SEARCH

A Study of Environmental Arctic Change (http://psc.apl.washington.edu/search) is planning and already conducts observations and research of interest both for CliC and AOOS. A Memorandum of Understanding between CliC and SEACH is about to be signed. SEARCH is planning an extensive set of observations in the Arctic Ocean including fixed and drifting stations, transsections, acoustic tomography.

They will be complemented by comprehensive terrestrial and hydrological observations including studies of pollution. SEARCH will be a suitable partner in the development of the AOOS.

ACIA

The Arctic Climate Impact Assessment (http://www.acia.uaf.edu) is a valuable resource base for studies of the Arctic climate. It will be highly desirable to enquire ACIA's opinion on the benefits of establishing an AOOS.

ASOF

The Arctic – Subarctic Flux Study (http://asof.npolar.no) measures and models "the variability of fluxes between the Arctic Ocean and the Atlantic Ocean with a view to implementing a longer term system of critical measurements needed to understand the high-latitude ocean's steering role in decadal climate variability" (ASOF Implementation Plan, 2002). It is one of the most active and financially well established research programmes in modern oceanography. Its contribution to AOOS will be essential.

GOOS

The Global Ocean Observing System (http://ioc.unesco.org/goos/) of IOC/WMO/UNEP/ICSU has high recognition, considerable experience and developed policy guidelines for regional components. There are two regional components of GOOS with potential interest in the Arctic. They are the North-West Shelf GOOS (NOOS) and Baltic GOOS (BOOS, http://www.boos.org). The European GOOS (EuroGOOS, http://www.eurogoos.org, currently a consortium of 30 oceanographic operators in Europe) has a regional task team, which is charged to develop a regional Arctic Component of EuroGOOS. Stein Sandven of the Nansen Environmental and Remote Sensing Centre is (apparently) the leader of the Arctic Regional Task Team of EuroGOOS.

If the proposal to launch the development of the AOOS is approved, this has to be done under the auspices of GOOS, in close contact with national representatives of GOOS with interest in the Arctic, and jointly with the EuroGOOS task team on the Arctic.

Other international bodies/programmes with Arctic Ocean interests

The following bodies could be contacted with the idea of establishing AOOS:

- The Arctic Council
- The Arctic Ocean Science Board (several projects of AOSB can contribute to AOOS)
- The International Arctic Science Council
- Forum of Arctic Research Operators
- European Polar Board
- Arctic Monitoring and Assessment Programme of the Arctic Council
- Etc.

The European Commission is funding several research projects of potential value for AOOS.

Satellite operators such as ESA, NASA, NASDA, Canadian and Russian Space Agencies, Norwegian Space Council may have significant interest in AOOS. Specialised missions such as ICESat and CryoSat, Radarsat and some others can be involved, as well.

AOOS must be very closely cooperating with the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) of the WMO and IOC. Several Programme Areas of JCOMM have overlapping interests with AOOS. AOOS observations will be an input to the operation of the World Weather Watch of the WMO.

AOOS can attract attention of offshore operators in the Nordic Seas and Arctic Ocean.

AOOS may represent interest for ICES (The International Council for the Exploration of the Sea, http://www.ices.dk), particularly if it has a significant biological component.

Global programmes requiring AOOS

It needs to be stressed that several recently finished and still on-going global oceanographic programmes achieved significant progress in observing the world oceans. However, the advances in the polar ocean activities within these programmes have been, as a rule, more modest. E.g.:

- The WCRP WOCE observation coverage in the polar regions was minimal.
- GODAE, which is based on ship marine meteorological observations, ARGO, satellite altimetry and in-situ observations, must be facing difficulties in polar areas due to shortage of in-situ observations and reduced capacity of dealing with sea-ice data assimilation. It is possible that the quality of oceanographic data assimilation in areas close to polar oceans suffers from increasing errors propagating inwards from polar areas.
- Air-sea fluxes/forcing for ocean models also suffer from increased errors in polar areas. Judging from the results of the recent WCRP/SCOR WG on Air-Sea Fluxes and from presentations s and posters at the most recent IUGG session on fluxes in Sapporo, existing *global* flux products exhibit increased uncertainties in the Arctic Ocean.
- ARGO is non-existent in the Arctic Ocean, due to obvious reasons but there are some proposal for development of ARGO buoys capable of avoiding contact with sea ice.

Polar (Arctic, sea-ice) dimension needs to be reinforced in global operational oceanography.

AOOS, if successful, will strengthen observing capabilities of JCOMM.

Specific problems, possible approaches

The biggest difficulty of the Arctic oceanography is related to the need of observing the water properties under the sea-ice cover. There may be several approaches and solutions including (not in any order of priority) fixed and drifting stations, Voluntary Observing Ships, ships of opportunity, AutoSUBs, “sea-ice smart” profiling floats, acoustic thermography, sonars (sea ice and current), ice buoys, satellite observations, air reconnaissance, tidal gauges.

The AOOS will probably require a special design. More often then elsewhere, assumptions about the vertical profile of temperature and salinity may be successful, particularly in the areas of deep convection. The approach proposed by Dr A. Nagurny and co-authors (estimate of se-ice thickness on the basis of surface gravity wave measurements) may be of value. There will be surely more opportunities to put forward ideas.

Without a multi-variate assimilation of sea-ice, ocean temperature and salinity, and atmospheric parameters it will be difficult to develop an AOOS. Joint assimilation of atmospheric, oceanic and sea-ice observations is still underdeveloped. The majority of existing efforts in data assimilation try to avoid complications associated with polar seas but this is no panacea.

So far, the Arctic Ocean Model intercomparison Project (MIP) and the Sea Ice MIP are far from considering data assimilation. There are significant problems even with coupled modelling of the Arctic Ocean. CliC has to foster advances in this direction, potentially as a CliC Initiative within the CPA 2.

Known results on sea-ice cover and thickness variations and controversies of existing explanation of what (has) happened to the Arcic sea-ice in 1970-s and since then, can only be reconciled if we develop a re-analysis of the total Arctic Climate System with inclusion of sea-ice cover and put error bars on sea-ice fields as part of the re-analysis output.

Existing recommendations on AOOS

The Rovaniemi Declaration on the Protection of the Arctic Environment established the Arctic Environmental Protection Strategy (AEPS) and subsequently five programmes: AMAP, CAFF, EPPR, PAME and Sustainable Development. Provisions of the Declaration are supportive for an AOOS. Similar provisions may be potentially found in the Declaration on the Establishment of the Arctic Council of 1996 and in some other Declarations (Iqaluit, 1998; Alta, 1997; Inuvik, 1996; Nuuk, 1993).

Recommendations in favour of an AOOS are likely to appear in the report of the Ocean Observation Panels for Climate Eighth Session (Ottawa, early September 2003).

The Second report on the Adequacy of Global Observing Systems for Climate in Support of the UNFCCC noted significant difficulties in observing high-latitude oceans particularly in relation to sea-ice. Several statements of the Report are supportive to an AOOS.

Opportunities to look for support

With

- relatively high level of development and healthy state of national economies of most of these countries,
- existence of the Arctic Council, an important international body ensuring governance in the region,
- developed science and existence of several elements of the observing system,
- the very special situation of the Arctic Ocean in the light of enhanced climate warming in the northern polar regions,
- understanding of the importance of the processes in the region for future of the global deep ocean circulation,
- the obvious benefit of the development of a truly international Arctic Ocean Observing System;

it should, in general, be possible to generate interest and find resources for the system development.

Two large-scale international initiatives may be beneficial for the establishment of the AOOS.

The first is the International Polar Year initiative. It is led by ICSU and WMO. The involvement of the IOC is highly probable. The IPY will take place in 2007/08. AOOS can become one of the IPY deliverables.

The second initiative is the Second International Conference on Arctic Research Planning, which is being organised by the IASC. It will be held in 2005.

The AOOS can and should be discussed at the International Science Conference for CliC (first half of the 2005).

If approved by the SSG session, the proposal to develop AOOS can be presented to the AOSB session at the Arctic Science Summit Week (Reykjavik, April 2004).

Actions to undertake

1. The SSG Session can call for an establishment by GOOS, through the existing governing body of GOOS - the Intergovernmental Committee on GOOS (I-GOOS), of an international working group on AOOS (e.g., WG-AOOS).
2. To present the proposal to GOOS, in co-operation with OOPC.
3. The SSG Session may recognise AOOS as a useful activity for fulfilling the goals of CliC CPA 2.
4. If the GOOS accepts the recommendation on the need of an AOOS and the WG-AOOS is established, to propose that the group is co-sponsored by the WCRP.
5. To invite CLIVAR to participate in the WG-AOOS, jointly with CliC.
6. To invite other potentially interested partners, e.g. ASOF, IABP, SEARCH, EuroGOOS, AOSB, IASC, etc, to co-sponsor the group.
7. To organise a workshop on AOOS.
8. To start developing science and co-ordination plan for AOOS.
9. To start preparing an application for funding to NSF, CFCAS, EC, other potential sponsors.

Appendix 8

International ACSYS/CliC Project Office (IACPO)

ANNUAL REPORT

November 2002 – October 2003

Dr Chad Dick
Director IACPO

The mission of the International ACSYS/CliC Project Office (IACPO) is to support the ACSYS/CliC Scientific Steering Group (SSG) and the World Climate Research Programme (WCRP) in implementing the Arctic Climate System Study (ACSYS) and the Climate and Cryosphere (CliC) project. This support includes service to the ACSYS and CliC research communities and to ACSYS/CliC observation (OPP), modelling (NEG) and data management (DMIP) panels, and the CLIVAR/CliC Southern Ocean Panel.

This report summarizes activities of the IACPO from November 2002 to October 2003.

Staff

The staff of two, located at the office in Tromsø (Chad Dick, Director; Tordis Villinger, Office Coordinator), has been supplemented since 1 April 2003 with a 'Staff Scientist/Data Manager', Bernard Miville, located at the Canadian Centre for Climate Modelling and Analysis (CCCMA), Victoria, Canada. Bernard has a two year contract, funded by the Canadian 'Climate Change Action Fund' (CCAF), working 66% of his time for IACPO, with the remainder divided between the CCCMA and the Canadian Ice Service. In addition, funding was found at the Norwegian Polar Institute to employ a 'Conference Assistant', Kaye Robinson, for a total of 95 hours, to assist with preparations for the Final ACSYS Science Conference at AARI, St Petersburg (11 to 14 November, 2003).

There is still a need for more long-term staff to be employed, preferably at the main office in the Norwegian Polar Institute in Tromsø, Norway.

Reports

Summary report of a joint meeting of the International Workshop on 'Sea-ice Extent and the Global Climate System' and the mini-conference on 'Long-term Variability of the Barents Sea Region' – WCRP Informal Report No. 9/2003. This report followed on from the workshop and mini-conference held in Toulouse, France, from 15 to 19 April 2002. The report was printed at WCRP and was published in June 2003.

ACSYS Historical Ice Chart Archive (1553 – 2002), Løyning et al. - IACPO Informal report No. 8. This report completed a 15-year effort to draw together historical records of ice-edge position, and to create an electronic archive of charts suitable for scientific analysis. The project was initiated and for many years led by Torgny Vinje at the Norwegian Polar Institute (NP), and became an ACSYS project when ACSYS began. Following NP's move from Oslo to Tromsø, there were problems completing the work, until funding was obtained by IACPO from the World Wide Fund for Nature (WWF). WWF supported digitization of the last charts, quality control of the archive, writing of the report and publication of the report and of the data on CD. The report and CD were released in February 2003, and are freely available from IACPO or can be downloaded from the webpage at http://acsys.npolar.no/ahica/intro.htm.

Reports to the Research Council of Norway (NFR). A report on office activities was required by the NFR, as one of the office co-sponsors. This report was sent in September 2003.

Meetings and Travel

During the year, the Director attended the following meetings and conferences:-

International Association of Hydraulic Engineering and Research – 16th International Symposium on Ice, Dunedin, New Zealand; 2 to 6 December 2003.

WCRP Joint Scientific Committee, Reading, U.K.; 17 to 21 March 2003.

Arctic Science Summit Week, Kiruna, Sweden; 29 March to 4 April 2003.

International Permafrost Association – 8th International Conference on Permafrost, Zurich, Switzerland; 21 to 25 July 2003.

Southern Ocean Science Week, Bremerhaven, Germany; 5 to 12 September 2003.

ACSYS/CliC Joint Panels Meeting, Victoria, Canada; 14 to 17 October 2003.

Sea Ice Model Intercomparison Project 2 (SIMIP 2) Workshop, Victoria, Canada; 20 October 2003.

The office coordinator also attended the ACSYS/CliC Joint Panels Meeting.

The Data Manager attended the International Geosphere-Biosphere Programme Meeting in Banff, Canada; 20 to 23 June 2003.

Other travel

The Director and Office Coordinator visited the Arctic and Antarctic Research Institute of Roshydromet (AARI), St Petersburg on 26 September 2003, to discuss arrangements for the Final ACSYS Conference. The Office Coordinator returned to AARI for further planning on 31 October.

The Data Manager visited the main IACPO office in Tromsø from 23 April to 9 May, 2003, for work planning and other orientation. Jim Moore, the Chair of the Data Management and Information Panel, also visited the office from 28 April to 2 May, 2003 to assist with discussions and planning.

Other meetings

In collaboration with Terje Brinck Løyning of the Norwegian Polar Institute, the IACPO jointly hosted the 13th meeting of the International Arctic Buoy Programme from 4 to 7 June, 2003.

Support for the Final ACSYS Conference

One major task during the year has been working on the organization of the Final ACSYS Conference, which is to take place at AARI, St Petersburg, from 11 to 14 November, 2003. The office has coordinated all aspects of conference planning, and has supported the website for the conference. The support of the Science Organizing Committee, and in particular its Co-Chair, Thierry Fichefet has been invaluable in making arrangements for the conference.

Publicity Material

Web sites. With the addition of a Staff Scientist/Data Manager to the staff, it has finally been possible to carry out the necessary website development for the ACSYS and CliC projects and the IACPO. The sites have been completely overhauled, along with the ACSYS Data and Information Service (ADIS). All pages now have a consistent 'look', and menus remain the same on moving from one part of the website to another. Databases for ACSYS data sets, links, papers, reports, etc. have been upgraded, and now contain far more information and are fully searchable. Similar development is now being carried out with the new Data and Information Service for CliC (DISC), under the guidance of the Data Management and Information Panel. The new sites were activated on 7 October 2003, and after a few minor problems seem to be operating well. The sites can be found at:-

http://acsys.npolar.no; http://clic.npolar.no; and http://ipo.npolar.no.

Newsletters. With the continuing shortage of staff, something had to give, and this year it was the newsletter. Only one issue of Ice and Climate News was published (September, 2003). As always, this issue has brought several more requests to be added to the mailing list. The next issue is planned to be mainly on the topic of permafrost, after several articles were solicited at the 8th International Permafrost Conference.

Budget

The main support for the operation of the IACPO continues to be provided by the Norsk Polarinstitutt. This year's contribution was approximately NOK750,000, (down approximately NOK50,000) with the Norwegian Research Council (NFR) contributing NOK300,000. These Norwegian funds are used to support salaries, training, general expenses and a small amount of domestic travel. The Japan Marine Science and Technology Center (JAMSTEC) also continued to make a very valuable contribution to the running of the office by providing support, amounting to about NOK120,000, for travel and general activities. It should be noted, however, that the contribution in June 2003 is the last scheduled payment from JAMSTEC. The WCRP also supported some travel for office staff. The UK Meteorological Office made a one-off contribution of NOK450,000 to the office in 2002. This money is being used in small amounts as seed money for specific initiatives, including the initiation of the search for funding and a Staff Scientist in Canada, and a similar effort to obtain assistance in Australia.

(Note that the current exchange rate is approximately NOK8.20 to the Euro.)

All of this support is gratefully acknowledged.

Appendix 9

Global Runoff Data Centre (GRDC) status, products and perspectives and relation to CliC

(GRDC report to ACSYS/CliC SSG-IV)

[Dr Thomas Maurer, Global Runoff Data Centre, Koblenz, Germany]

1 GRDC's mission and services

The Global Runoff Data Centre (GRDC) was established on request of WMO at the Federal Institute of Hydrology in Koblenz, Germany in 1988, in order to support Global Change Research and Water Resources Assessment by collecting and storing river discharge data obtained from observations by National Hydrological Services (NHS) world-wide and disseminating it to the research community.

GRDC provides a mechanism for international exchange of data pertaining to river flows on a continuous, long-term basis, in the spirit of WMO Resolutions which call for free and unrestricted exchange of hydrological data (WMO Resolution 25 (Cg-XIII), 1999) and support of GRDC's mission (WMO Resolution 21 (Cg-XII), 1995).

The scope of data collection is global, regional and river basin scale. So far, approx. 150 countries have contributed to the development of the database which currently comprises monthly discharge data from over 6400 stations and daily discharge data from around 3400 stations. The average time series length is about 30 years.

Scientific objectives of GRDC comprise the analysis of spatio-temporal distribution of river discharge on global scale, with emphasis on two goals, (a) the quantification of the global water cycle, and (b) the determination of climate variability (inclusive trends and extremes). Due to GRDC's limited staff resources analysis is often carried out in collaboration with universities (currently 6 projects that will be reported in the GRDC Report Series) and in the framework of international programmes and projects (GEWEX/GHP, ACSYS, GTN-H, FRIEND, etc.)

2 GRDC's contribution to the Arctic Climate System Study (ACSYS)

Within the scope of the ACSYS Data and Information Service (ADIS) GRDC assembled and maintains the Arctic Runoff Data Base (ARDB) as an ACSYS data set in support of research conducted in the framework of the ACSYS programme.

The ARDB currently keeps river discharge time series data from a total of 2112 runoff gauging stations in the arctic hydrological region (status Nov 2003), 263 stations featuring daily data, 2073 stations featuring monthly data, capturing 71% of the Arctic Ocean basin.

3 GRDC data products

Product 1: Long Term Mean Annual Freshwater Surface Water Fluxes into the World Oceans

Freshwater discharge from continents into the oceans is of major interest in research concerned with global monitoring of freshwater resources, the flux of matter into coastal areas and the open oceans, and the influence of freshwater fluxes on circulation patterns in the ocean and the atmosphere on regional and global scales.

Following two previous publications of estimated Mean Annual Freshwater Surface Water Fluxes into the World Oceans based on 161 and 181 discharge stations, respectively (GRDC, 1996 and GRDC, 1998)

the GRDC has reworked this exercise for a third time, now based on 251 discharge stations close to the estuary, featuring basin areas greater than 25.000 sqkm. A report will be published in a few months.

Discharge from land areas not integrally captured by GRDC stations has been determined via estimating mean annual runoff coefficients (RC) by means of regionalisation from nearby monitored areas taking into account data from another 1378 GRDC stations and applying precipitation data from the Global Precipitation Climatology Centre (GPCC).

Application of GIS analysis on a 0.5 degree elevation grid optimised for flow path detection (Doell and Lehner, 2002) allowed to determine the catchments of all the individual grid cells that form the fringe of the continents (11.853), i.e. all continental grid cells were co-registered with their respective fringe grid cell through which they drain to the oceans. Furthermore, each grid cell was assigned either a calculated or estimated RC. Thus, it is possible to calculate for each fringe grid cell the integral flux from its adjacent catchment as the spatially weighted product of RC and precipitation over all co-registered grid cells. Summarising the fluxes of subsets of continental fringe cells allows to estimate fluxes for arbitrary coastline sections.

Fluxes have thus been determined e.g. for global 5 and 10 degree latitude zones intersected with continents and oceans as well as for the sub-regions defined by the Global International Waters Assessment initiative (GIWA). The results are compared to estimates by other authors and methods among them the global water balance of Baumgartner and Reichel (1975).

Product 2: Long Term Mean Monthly Discharges and Annual Characteristics of Selected GRDC Stations

This GRDC data product offers statistics of 2784 discharge gauging stations in the GRDC database, selected according to the following criteria:

- station catchments have drainage area of more than 2.500 km^2
- station discharge data is available for a minimum of 10 years

Calculated quantities are:

- mean, minimum, maximum monthly discharge and its standard deviation
- time series of mean, minimum, maximum annual discharge
- These statistical quantities may be useful for e.g. studies in low flow analysis, flood estimations, general atmospheric modelling as well as analysis of watershed management issues.

4 GRDC data policy

Data of the GRDC (including the ARDB) is easily accessible. However, due to GRDC's data policy of free and unrestricted but identified access, limited to non-commercial applications, ARDB data is not available online. According to the "GRDC Data Policy Guidelines for the Dissemination of Data and Costing of Services" established by the GRDC Steering Committee, a user has to send to GRDC a request for data, a short project description and a signed "GRDC User Declaration". The data itself is free, only a nominal processing fee may be charged. However, no costs arise for researchers participating in UN-programmes and projects including those identified as ACSYS members by the International ACSYS Project Office (IAPO).

5 Data acquisition issues and required long term vision

Data is fundamental to all scientific programmes, including CliC. The larger the spatial scale of interest (local -> regional -> global) and the more complex the modelling approaches, the more important is a reliable and well organized data acquisition and integration strategy, in order to prevent stagnation due to the dilemma of either redundantly spending too much of valuable resources (time, money...) retrieving basic data or, alternatively, omitting relevant information.

An illustration of the current situation in the field of hydrology (however, transferable to many other disciplines, especially in the terrestrial domain):

- Multifold problems on availability and access to hydrological data remain in spite of WMO Resolutions which call for free and unrestricted exchange of hydrological data (WMO Resolution 25 (Cg-XIII), 1999) and support of GRDC's mission (WMO Resolution 21 (Cg-XII), 1995). (In parenthesis the underlying main problem is indicated, however, almost all problem types are interconnected.):
  - Inadequate exchange of available data (political problem)
  - Fragmented data holdings (technological problem)
  - Lag time in data processing and provision (organisational problem)
  - Declining networks (financial problem)
  - Quality of data (scientific problem)

- Statistics on GRDC discharge data acquisition activities that were started in 2001 revealed that GRDC has around 240 contacts per year to 40 countries (in average 6 contacts per country). Out of this, around one third result in a successful data acquisition (i.e. 13 countries/year and in average 18 contacts per successful data acquisition). This success rate results in a database time lag that does not allow to come up with up-to-date and purely measurement based global monitoring products. Given GRDC's number of staff (2 academics and 2 technicians, 0.5 administrational assistance) of which two persons are spending around 33% of their time for data acquisition in the traditional (and tedious) way, this is not likely to improve significantly.

- With respect to their discharge data provision discipline to GRDC the world's countries can be classified in four groups: Countries that
  1. send data without request (basically: USA, Canada, Norway, Iceland, Australia)
  2. send data on single or few requests (~10-20%)
  3. send data after long lasting negotiations (~50-70%)
  4. do not send data for various reasons (~20-30%)

To sustainably overcome these data related nuisances and its associated problems it is essential to tackle two issues (which are beyond immediate GRDC scope):

1. Investment of a higher percentage of the total resources at disposal of all the international organizations, programmes and projects in the field of Global Change research (on climate, environment, demographic development...) in reaching for the fundamental long term goal "Ensuring the Knowledge Base", what is Challenge #10 of the World Water Development Report (WWDR, 2003). Meeting this goal is a basic prerequisite for coping with most of the other challenges! It requires a statesman's VISION with a perspective of 10-30 years rather than a politician's VIEW, tied to (re-) election-cycles or the next project report deadline in 3-5 years.

   Activities to ensure the knowledge base generates almost necessarily additional overhead, just like libraries do in the world of books. However, as a fundamental prerequisite for further integration we need to come up with comfortable, unified, easy-to-access "libraries" for valuable data costly gained from monitoring geophysical processes. This in turn inevitably requires **international standardization** as already achieved in library science (cf. next section). (All major global businesses, including telecommunication, finance, military, in the long term only succeed because of standardization, in fact the "success story" of mankind's development can be viewed as a history of standardization of networks, technical equipment etc., removing "friction losses" in interaction...).

2. Proactive contribution to sensitively **convincing the political level** (the world's governments) of the need to anticipatory invest more and/or more systematic in data integration. This includes enforcement of data integration by setting up **reporting obligations** in the framework of **conventions** or the like, i.e. controlling feedback-loops at the international-national and the national-sub-national interfaces, in order to enforce a feedback mechanism and thus to ensure at least approaching the vision.

It is encouraging in this context to read the conclusions of "The Second Report on the Adequacy of the Global Climate Observing Systems" which has been developed by GCOS (2003) on request of the United Nations Framework Convention for Climatic Change/ Subsidiary Body for Scientific and Technological Advice (UNFCCC/SBSTA) which is available from the GCOS-homepage at http://www.wmo.ch/web/gcos/gcoshome.html.)

Other encouraging developments are the recent Earth Observation Summit (EOS, http://www.earthobservationsummit.gov) in Washington and the Integrated Global Observing Strategy Partnership (IGOS-P, http://www.igospartners.org).

Also the just now constituting UN-WATER co-ordination body under the High Level Committee on Programmes (HLCP, http://ceb.unsystem.org/hlcp/default.htm) of the UN Chief Executives Board (CEB, http://ceb.unsystem.org) has a potential to tackle these fundamental problems.

6 Perspectives for GRDC operation

There are three principal options/measures to improve GRDC's performance:

1. Increase of **internal capacity**
   - e.g. fund raising allowing to employ additional staff for a multiplication of the current data acquisition practice ("brute force" approach)
   - e.g. fund raising allowing to employ additional staff for increased communication efforts necessary for the advancement of innovative projects as e.g. near real time discharge data integration in the framework of the Global Terrestrial Network for Hydrology (GTN-H).

2. Increase of **external capacity**
   Outsourcing of tasks (however some managerial capacity cannot be outsourced):
- *Data acquisition*: **proactive involvement of all kinds of international organisations, programmes and projects, as e.g. CliC**
- *Data analysis*: proactive involvement of all kinds of international organisations, programmes and projects and proactive cooperation with research institutions analysing GRDC data (currently 6 under way)
- *Data products*: proactive cooperation with research institutions using GRDC data

3. Foster **automation**
   - Automation of *internal* and *external* processes
   - Inevitably linked to *standardisation* of data formats and transfer and storage schemes, needs to be coordinated internationally
   - Experiences gained in the field of *Geomatics*, which came up with a suite of ISO standards on geographic information objects (e.g. ISO 19115 on metadata) may serve as a basis and template (regarding the standards as well as the organisational processes leading to the standards)

7 Possible collaboration of GRDC in CliC

The GRDC acquires, stores and disseminates discharge data and acts as the global discharge inventory with an official UN-mandate (see first section). The GRDC is committed to this task on a long term basis rather than project oriented. Thus, the GRDC is ideally suited for compiling and maintaining a runoff database also for CliC.

- Extending the discharge data collection area from the Arctic region to global land-surface, especially glacier regions
- Support of CliC projects by data and data products
- Participation in a CliC Data Management Panel

However, given the considerations of the previous sections 5 and 6, it is crucial to ensure the commitment of each group participating in CliC, to support GRDC in data acquisition, i.e. in project-related contact with National Hydrological Services (NHS) and other national institutions it would be essential to:

- generally promote GRDC' mission and encourage NHS to release their data to GRDC
- make sure that whenever project money is being spend for data collection to NHS or other institutions a constituent part of any agreement or contract should be the free and unrestricted release of it to international data centres such as the GRDC.

8 Related publications

GCOS (2003): *Second Report on the Adequacy of the Global Climate Observing Systems*. Developed on request of the United Nations Framework Convention for Climatic Change/ Subsidiary Body for Scientific and Technological Advice (UNFCCC/SBSTA). Available from the GCOS-homepage at http://www.wmo.ch/web/gcos/gcoshome.html.

Maurer, Th. (2003): *Challenges in transboundary and transdisciplinary environmental data integration in a highly heterogeneous and rapidly changing world - A view from the perspective of the Global Runoff Data Centre.* In: Harmancioglu, Nilgun B., Ozkul, Sevinc D., Fistikoglu, Okan, Geerders, Paul (Editors): *"Integrated Technologies for Environmental Monitoring and Information Production"* , Proc. NATO Advanced Research Workshop, 10 - 14 September 2001, Marmaris, Turkey. Nato Science Series IV Volume 23, Kluwer Academic Publishers (ISBN HB: 1-4020-1398-1, PB: 1-4020-1399-X).

Maurer, Th. (2003): *Intergovernmental arrangements and problems of data sharing.* Monitoring Tailor-Made IV Conference, Information to support sustainable water management: From local to global levels, St. Michielsgestel, The Netherlands 15-18 September 2003

Dr Thomas Maurer
Head, Global Runoff Data Centre (GRDC)
c/o Federal Institute of Hydrology (BfG)
P.O. Box 20 02 53, D-56002 Koblenz
Am Mainzer Tor 1, D-56068 Koblenz
Germany
phone +49 261 1306 5224
fax +49 261 1306 5280
email thomas.maurer@bafg.de
web http://grdc.bafg.de

Appendix 10

Summary of GPCC functions and products and relation to CliC

(GPCC report to ACSYS/CliC SSG-IV)

[Dr Bruno Rudolf, Global Precipitation Climatology Centre, Offenbach, Germany]

1 Introduction

The general task of the Global Precipitation Climatology Centre (GPCC) is collection and evaluation of precipitation and snow data obtained from observations by hydrometeorological networks world-wide. The GPCC is operated by the Deutscher Wetterdienst (NMS of Germany, Offenbach) following a formal invitation by WMO. In particular, the GPCC also includes the Arctic Precipitation Data Archive (APDA) for ACSYS.

Scientific objectives of GPCC comprise the analysis of spatio-temporal distribution of land-surface precipitation on global scale, with emphasis on two goals, (a) the quantification of the global water cycle, and (b) the determination of climate variability (inclusive trends and extremes). Activity fields being inalienable are data quality control and quantification of observation and analysis errors.

The functions of the GPCC comprise in particular:

- Collection of conventionally measured precipitation data from surface-based networks.
- Quality-control of the data and correction of errors.
- Calculation of monthly gridded area-mean precipitation for the Earth's land surface.
- Error assessment for each individual gridbox and month with special regard to
  - systematic gauge measuring errors
  - sampling and analysis errors
- Climatological studies based on results of the above analysis.
- Development of advanced analysis techniques.
- Dissemination of the gridded products via internet.

Special functions within the Arctic Climate System Study (ACSYS) are:

- Establishment and operation of the Arctic Precipitation Data Archive (APDA).
- Collection of daily precipitation and snow depth data for the Arctic hydrological basin.
- Analysis and evaluation of precipitation, snow depth and its liquid water equivalent.
- Intercomparison of gridded total precipitation, snow depth, and river discharge for the large Arctic rivers (in co-operation with the Global Runoff Data Centre (GRDC).

The primary products of the GPCC are monthly gridded data sets of global land-surface precipitation, which are used as the ground truth within the complete global satellite-gauge combined data sets of the GEWEX Global Precipitation Climatology Project (GPCP) as well as of NCEP CMAP (Adler et al. 2003, Xie & Arkin 1997).

Besides the contributions to GEWEX and ACSYS, the GPCC supports CLIVAR (by collection and statistical analysis of long time-series of observed precipitation data), and GCOS (by operational near real-time global precipitation climate monitoring).

The DWD has committed to permanently operate the GPCC with regard to GCOS. Solid precipitation in high latitudes and mountainous regions is an important component of global precipitation, and therefore an original subject of the GPCC, even if the capacity of the GPCC (eight staff members) is limited to operational analysis of global precipitation. With regard to this, a link between the GPCC and ACSYS in the past respectively CliC in future is given.

Complementary research activities are supported by the Federal Ministry of Education and Research, by the European Union, and by EUMETSAT. Current projects include the development of a climatologic-observational database (precipitation, air temperature and snow depth) for CLIVAR, the development of a

gridded Arctic snow climatology (ACSYS-related), and the development of an advanced multi-sensor precipitation estimate for Meteosat Second Generation.

2 GPCC Product Overview

The GPCC provides gridded data sets separately for two different databases, i.e. near real-time data and data being available with a larger delay only. The variables on the grid are:

- Monthly precipitation amount (mm/month);
- Mean monthly precipitation for the normal period 1961-90 (mm/month);
- Monthly precipitation anomaly as deviation from normal (mm/month);
- Monthly precipitation anomaly as percentage of normal (%);
- Number of raingauges per gridcell for estimation of the sampling error;
- Mean correction factors for the systematic gauge-measuring error.

GPCC Monitoring Product
The near real-time 'Monitoring Product' for the land surface is based on GTS data from about 6,000 to 7,000 stations located over the continents and ocean islands. This product is the in-situ basis of the GPCP Combined Products. All data used are fully quality-controlled. Re-analyses were made back to 1986 using the GTS data base. The product is available on a routine basis within a delay of about two months after observation. It is freely accessible via internet (http://gpcc.dwd.de/).

GPCC Full Data Product
The non real-time 'Full Data Product' for the land surface is based on observations from (up to) 38,000 stations including the additional data from national collections provided by 173 countries so far. The sampling error of this product is lower than it is for the Monitoring Product. A first version (1987-1988) has been published with ISLSCP Initiative I CDROM, a second one has been produced for the period from 1986 to 1995 and delivered to GEWEX for ISLSCP Initiative II. Updated versions will be available on individual user request (mail to: gpcc@dwd.de).

New: The First Guess Product for Precipitation Anomalies
The First Guess Precipitation Anomaly Product is based on automatically processed synoptic data received from the GTS at DWD. The total number of gauges is about 6,000, the data density and quality is sufficient for large-scale anomaly maps, which are published on internet near real-time. Gridded monthly precipitation totals will be supplied by the GPCC to individual users (e.g. for global drought monitoring) based on a joint agreement. This product is not a substitute for the Monitoring Product or the Full Data Product.

In preparation: Gridded Historical Precipitation Dataset
The GPCC is going to pool the large global historical climate data collections of CRU, FAO and GHCN with GPCC's collection of recent data. The major work to be done is control and harmonization of the stations' meta data and a suitable statistical quality-control of all precipitation data (no removal of true extremes!).
(So far, FAO, CRU and GPCC data are pooled in one data bank. A gridded product is planned with special regard to a homogeneous data density for longer time-series. A first version of such a gridded historical product covering the period 1951-2000 is expected to be available in the beginning of 2004.)

GPCC River Basin Area-Mean Precipitation
In addition to the gridded data sets the GPCC provides time-series of river basin area-mean annual and monthly precipitation for the major rivers of the world. The area-means are derived from 0.5°x0.5°interpolation of raingauge data. The precipitation time-series are complemented by river run-off data compiled by the Global Runoff Data Centre (GRDC). The time-series usefull for water cycle studies as well as for validation of numerical models.

3 GPCC Data Policy

All GPCC products (gridded data sets) are freely available. Station-related precipitation data are not available via the GPCC because the use of most of these data is restricted by the data owner (originator).

Those data being generally available can be taken from NCDC/GHCN. Data from APDA are available for ACSYS participants.

4 GPCC Milestones for 2003 - 2006

2003/12	Compilation of the gridded precipitation data set based on the historical collections of CRU and FAO complemented by GPCC data for the period 1961-2000.
2004/12	Compilation of the gridded precipitation data set based on the historical collections of CRU, FAO and GHCN complemented by GPCC data for the period 1951-2000 or longer.
2004/12	Establishment of a new method for assessment of the systematic gauge measuring error based on daily observations and meta data.
2004/12	Termination and publication of the results from the GPCP – BALTEX precipitation comparison study.
2005/12	Compilation of gridded data sets for precipitation, air temperature and snow depth, and statistical analyses for climate variability, trends and frequency of extremes.
2006/06	Final report on the project ”Development of an observational data basis (Europe and global) for DEKLIM and related statistical analysis with regard to climate variability on a decadal to centennial time scale”.

Within this project, all station meta data will be checked and harmonized, all hydrometeorological data will be quality-controlled. The data used within the gridded products will be selected with regard to product homogeneity.

5 Activities of the APDA project 2003 - 2005

- Complementation of the Archive by additional data from surface networks.
- Further development of an applicable method for correction of raingauge-measured precipitation data regarding the systematic gauge measurement error.
- Quality assessment based on statistical studies for the data being hold in the Archive.
- Development of a method using snow depth data to improve the climatological analysis of precipitation at GPCC.
- Verification of precipitation predictions of ERA-40 and the operational DWD model GME on the basis of APDA products.
- Development of an improved large-scale precipitation climatology for the Arctic catchment area on the basis of an overall view of all data.
- Continuation of the archive’s service for ACSYS and CliC participants.

6 Possible Contribution of GPCC to CliC

- Extending snow data collection area from the Arctic region to global land-surface.
- Systematic comparison of snow depth and precipitation observations (check for consistency).
- Further investigation of systematic measuring errors of gauge-observed precipitation totals with respect of new (automatic) instruments and development of applicable methods.
- Analysis of the percentages of snow in the total precipitation.
- Support of CliC projects by data and data products.

Related publications (2000-2003):

Adler, B.F., G. J. Huffman, A.T.C. Chang, R. Ferraro, P. Xie, J. Janowiak, B. Rudolf, U. Schneider, S. Curtis, D. Bolvin, A. Gruber, J. Susskind, and P.A. Arkin, 2003: The Version 2 Global Precipitation Climatology Project (GPCP) Monthly Precipitation Analysis (1979-Present). Journal of Hydrometeorolgy, in print.

Fuchs, T., J. Rapp, F. Rubel and B. Rudolf (2001): Correction of synoptic precipitation observations due to systematic measuring errors with special regard to precipitation phases. Phys. Chem. Earth. (B), 26, Nr. 9, 689-693.

Rubel, F. and B. Rudolf (2001): Global daily precipitation estimates proved over the European Alps, Meteorol. Z., N.F. 10, 403 - 414.

Rubel, F., P. Skomorowski and B. Rudolf (2002): Verification scores for the operational GPCP-1DD product over the European Alps. Meteorol. Z., 11/5, 367-370.

Rudolf B., and J. Rapp (2003): The Century Flood of the River Elbe in August 2002: Synoptic Weather Development and Climatological Aspects. Quarterly Report of the German NWP-System, No. 2, 1 December 2002 until 29 February 2003, Part 1, Deutscher Wetterdienst, Business Area Research and Development, 8-23. (to be printed in WMO RA-VI Annual Bulletin on the Climate of 2002, and on internet via http://gpcc.dwd.de/)

Rudolf, B. and F. Rubel (2000): Regional Validation of Satellite-Based Global Precipitation Estimates. Proceedings of EUMETSAT Meteorological Satellite Data Users' Conference (Bologna, Italy, 29 May – 2 June 2000), EUM P 29, ISSN 1011-3932, 601 - 608.

Ungersboeck, M., F. Rubel, T. Fuchs, and B. Rudolf, 2000: Bias correction of global daily rain gauge measurements. Physics Chem. Earth (B), 26, 411-414.

Wagner, W., K. Scipal, C. Pathe, D. Gerten, W. Lucht, B. Rudolf (2003): Evaluation of the agreement between the first global remotely sensed soil moisture data with model and precipitation data . J. Geophys. Res., Vol. 108, No. D19, 4611.

Xie, P. and P.A. Arkin (1997): Global Precipitation: a 17-year monthly analysis based on gauge observations, satellite estimates, and numerical model outputs. Bull. Amer. Meteorol. Soc. 78, 2539 - 2558.

Dr Bruno Rudolf
Global Precipitation Climatology Centre
Deutscher Wetterdienst
P.O. Box 10 04 65
63004 Offenbach/Main, Germany

Tel.: + 49 - 69 - 8062 - 2765
Fax: + 49 - 69 - 8062 - 3759
email: bruno.rudolf@dwd.de
ULR: http://gpcc.dwd.de/

ACSYS-APDA Homepage (2003):
http://www.dwd.de/en/FundE/Klima/KLIS/int/GPCC/Projects/APDA/index.htm

Appendix 11

INTERNATIONAL ARCTIC BUOY PROGRAMME (IABP)
http://iabp.apl.washington.edu
CHAIRMAN'S AND COORDINATOR'S REPORT
for the 4th Session of the ACSYS/CliC SSG

Participants of the IABP work together to maintain a network of drifting buoys on the ice of the Arctic Basin to provide meteorological and oceanographic data for real-time operational requirements and research purposes including support to the World Climate Research Programme (WCRP) and the World Weather Watch (WWW) Programme.

The Arctic has undergone dramatic changes in weather, climate and environment. It should be noted that many of these changes were first observed and studied using data from the IABP. For example, IABP data were fundamental to Walsh et al. (1996) showing that atmospheric pressure has decreased, Rigor et al. (2000) showing that air temperatures have increased, and to Proshutinsky and Johnson (1997); Steele and Boyd, (1998); Kwok, (2000); and Rigor et al. (2002) showing that the clockwise circulation of sea ice and the ocean has weakened. All these results relied heavily on IABP data. In addition to supporting these studies of climate change, the IABP observations are also used to validate satellite retrievals of environmental variables, to force, validate and initialize numerical models, and to forecast weather and ice conditions. Over 400 papers have been written using data from the IABP (http://iabp.apl.washington.edu/Citations/). The observations and datasets of the IABP data are one of the cornerstones for environmental forecasting and research in the Arctic.

IABP 13th ANNUAL MEETING - Members of the International Arctic Buoy Programme met 4-6 June 2003 in Tromso, Norway. The meeting was hosted by the Norwegian Polar Institute (NPI) and the Arctic Climate System Study / Climate and Cryosphere (ACSYS / CliC).

Annual IABP meetings continue to be an opportunity for the host agency and other agencies in the area to share their work. At IABP-13, Chad Dick gave a presentation on ACSYS CliC activities. IABP-13 also facilitated a tour of the Norwegian Meteorological Service Forecast Office. IABP meeting participant Roger Colony made lunch time presentations to interested NPI staff on hydrographic chemistry data set, and another on ice concentration in the Barents. At IABP-13, the following technical presentations were given:

- Climate Research at the Norwegian Polar Institute – J-G Winther
- Evolution of the IABP and the Study of Environmental Arctic Change (SEARCH) – I. Rigor
- Sea Ice Thickness Observation System – A. Hageberg
- Failure of Sea Ice in the Beaufort Gyre to Converge – R. Colony
- Position of Extreme Atmospheric Pressure and their Link to the Arctic Climate During the Period 1898 to 1998 – T. Løyning
- Activities of the International Ice Charting Working Group – H. Tangen

IABP PARTICIPANT ACTIVITY - The annual reports of IABP Participants are available on the IABP web site: http://iabp.apl.washington.edu as part of the IABP-13 meeting report.

IABP EXECUTIVE AND COORDINATOR

Chairman: Timothy Goos, Environment Canada, Canada	tim.goos@ec.gc.ca
Vice Chairman: Christian Haas, Alfred Wegener Institut, Germany	chaas@awi-bremerhaven.de
Member: Ivan Frolov, Arctic and Antarctic Research Institute, Russia	aaricoop@aari.nw.ru
Member: Elizabeth Horton, Naval Oceanographic Office, U.S.A	hortone@navo.navy.mil
Coordinator: Ignatius Rigor, Polar Science Centre, U.S.A	ignatius@apl.washington.edu.

BUOY ARRAY - IABP Participants strive to maintain an array of at least 25 buoys evenly distributed across the Arctic Ocean providing surface air pressure and surface air temperature to GTS. Monthly buoy mappings and status sheets can be accessed on the IABP web site: http://iabp.apl.washington.edu The mappings show all buoys on the Arctic Basin known to the IABP Coordinator. This includes some buoys the data from which does not get onto the GTS and other buoys that were deployed by non IABP participants. New for 2003, the suite of monthly maps was expanded. It now includes separate maps with:

- buoys with Etopos5 bathymetry;
- buoys with NCEP ice concentration (2 September map accompanies this report);
- buoy instrumentation;
- buoys by deployment year; and
- buoys by experiment number.

Some of the buoys are oceanographic buoys while others are position-only buoys. Most are buoys that provide the basic meteorological parameters of surface air temperature and/or surface air pressure to GTS. The table shows statistics for April 2003 and September 2003. These dates represent when the arrays are typically at their minimum and maximum respectively as most of the annual deployments occur in the period April to August. The annual summer "White Trident" exercise where a total of 7 ICEX buoys provided by IABP participants are air dropped onto the ice of the Arctic Basin courtesy of the US Naval Oceanographic Command remains key to the IABP having an appropriate array of buoys on ice from the perspective of both number and placement. For the 2003 deployment, the Alfred Wegener Institute (1), Norwegian Meteorological Institute (1), Meteorological Service of Canada (1) and U.S. IABP Participants (4) provided ICEX buoys.

2003	Buoys on map and status sheet[1]	Buoys on GTS	Reporting surface air pressure and temperature	Reporting only surface air pressure	Reporting only surface air temperature
1 April	35	21	17	2	Nil
2 September	40	30	28	2	Nil

[1] Plus one land station

The data from a few IABP buoys are not routinely made available on GTS but may be available from other sources. For example, data from JCAD buoys of the Japanese Marine Science and Technology Centre, are available on their web site http://www.jamstec.go.jp/arctic/J-CAD_e/jcadindex_e.htm.

DATA AND PUBLICATIONS - IABP data have been updated through December 2002 and are available on the web. Hardcopy of the draft 2002 IABP buoy report is available from the IABP coordinator. A PDF of the 2002 data report and reports dating back to 1995 are available from the IABP web pages. Work is underway to reproduce all the buoy reports back to 1979 in PDF format and to make these available on the web.

WORK IN PROGRESS OR COMPLETED BY PARTICIPANTS

Coordinator Ignatius Rigor - In the capacity of IABP Coordinator and as the IABP representative to the Metadata working group of the DBCP, Ignatius continues to work to ensure Metadata from the various buoys going on ice is collated. Ignatius also continues working to acquire information on buoy deployments on ice the Arctic Basin that are at present beyond the realm of the IABP. This is being done so that these buoys can be included on the monthly buoy mappings and, as appropriate, made available on GTS. Both Ignatius and IABP Chairman Timothy Goos encourage those doing such buoy deployments to join the IABP.

Meteorological Service of Canada - MSC implemented processes to quality control spurious position calculations coming from the Edmonton LUT.

FUTURE WORK BY PARTICIPANTS - IABP Participants are working on:

- roles of the IABP and IABP Participants in the International Polar Year (IPY) 2007 and how the IABP can make best use of this opportunity;
- increasing organizational commitment versus personal commitment to the IABP;
- increasing the demonstrated value of the IABP data to the operational forecast services and hence getting more support from operational agencies to replace dwindling support, in some cases from scientific agencies; and
- participation in QC of IABP data.

Appendix 12

List of used Acronyms

AAD	Australian Antarctic Division
AARI	Arctic and Antarctic Research Institute, St. Petersburg, Russia
ACE	Antarctic Climate and Ecosystems
ACIA	Arctic Climate Impact Assessment
ACRC	Antarctic Co-operative Research Centre
ACSYS	Arctic Climate System
ADACIT	ACSYS Data Centre for Sea-Ice Thickness Measurements
ADCP	Acoustic Doppler Current Profiler
ADIS	ACSYS Data and Information Service
AGCM	Atmospheric GCM
AIRS	Atmospheric Infrared Sounder
AMISOR	Amery Ice Shelf Ocean Research
AMSR	Advanced Microwave Scanning Radiometer
ANSITP	Antarctic Sea Ice Thickness Project
ANSLOPE	Antarctic Slope Front
AnTIME	Antarctic Ice Margin Evaluation
AO	Arctic Oscillation
AOMIP	Arctic Ocean Model Intercomparison Project
APDA	Arctic Precipitation Data Archive
Arctic-HYCOS	Arctic Hydrological Cycle Observing System
ARCSS	Arctic System Science
ARDB	Arctic Run-off Database
ARM	Atmospheric Radiation Measurement Programme
ASITP	Arctic Sea-Ice Thickness Research Project
ARGO	Project ARGO on ocean subsurface floats
ASOF	Arctic/Sub-Arctic Ocean Fluxes
ASPeCt	Antarctic Sea-ice Processes and Climate
ASR	Arctic System Reanalysis
ATM	Division of Atmospheric Sciences, the Geosciences Directorate, NSF
AVHRR	Advanced Very High Resolution Radiometer
AUV	Autonomous underwater vehicle
AWI	Alfred-Wegener-Institut
AWS	automatic weather stations
BARKODE	Barents and Kara Seas Oceanographic Database
BAS	British Antarctic Survey
BASC	Board on Atmospheric Sciences and Climate
BALTEX	Baltic Sea Experiment
BIO	Bedford Institute of Oceanography
BRIOS	Bremerhaven Regional Ice Ocean Simulations
CALM	Circumpolar Active Layer Monitoring
CAMP	CEOP Asian Monsoon Project *(see below as well)*
CAMP	Community Arctic Modelling Project
CAPS	Circumpolar Active Layer-Permafrost System
CAREERI	Cold and Arid Regions Engineering and Research Institute, China
CASES	Canadian Arctic Shelf Exchange Study
CBS	Commission for Basic Systems (WMO)
CCIN	Canadian Cryospheric Information Network

CCPP	Climate Change Prediction Programme
CCREL	Cold Regions Research and Engineering Laboratory
CD-ROM	CD-read-only-memory
CEOP	Co-ordinated Enhanced Observing Period
CHAMP	Community-wide Hydrological Analysis and Monitoring Programme
CIRC	Climate Impact Research Centre
CliC	Climate and Cryosphere
CLIVAR	Climate Variability and Predictability
CMA	China Meteorological Administration
COP	Conference of the Parties
CPA	CliC Project Area
CRC	Climate Research Committee *(see below as well)*
CRC	Antarctic Co-operative Research Centre
CREST	Centre for Renewable Energy and Sustainable Technology
CRYSYS	Variability and Change in the Cryospheric System Project in Canada
CTD	Conductivity-temperature-depth instrument
DAAC	Distributed Active Archive Centre
DCP	Detecting Change Panel
DFAIT	Department of Foreign Affairs and International Trade (Canada)
DIME	Data Integration for Model Evaluation
DMIP	Data Management and Information Panel
DoD	Department of Defence
DoE	Department of Energy
DOVETAIL	Deep Ocean VEntilation Through Antarctic Intermediate Layers
DWD	Deutsche Wetter Dienst, Germany
EC	European Council
ECHAM	European Centre - Hamburg AGCM
ECMWF	European Centre for Medium range Weather Forecasting
EISMINT	European Ice Sheet Model Intercomparison
EORC	Earth Observation Research Centre (NASDA)
EPA	Environmental Protection Agency (USA)
ERA	ECMWF Re-Analysis
ERL	Environmental Research Laboratory
ESA	European Space Angency
ESE	Earth Science Enterprise (NASA)
EU	European Union
EuroGOOS	European Consortium on the Global Ocean Observing System
FAGS	Federation of Astronomical and Geophysical Services
FRSGC	Frontier Research System for Global Change
FORSGC	Frontier Observational Research System for Global Change
FRIEND	Flow Regimes from International Experimental and Network Data Programme of IHP of UNESCO
FTP	File Transfer Protocol
GAME	GEWEX Asian Monsoon Experiment
GCM	Global Circulation Model
GCMD	Global Change Master Directory
GCOS	Global Climate Observing System
GCP	Global Carbon Project
GCSS	GEWEX Cloud System Study
GDD	Global Geocryological Data
GEC	Global Environmental Change

GEWEX	Global Energy and Water Cycle Experiment
GHOST	Global Hierarchical Observing Strategy
GHP	GEWEX Hydrology Panel
GIS	Geographic Information System
GISP	GAME International Science Panel
GLI	Global Imager
GLIMS	Global Land Ice Measurement from Space
GLOBEC	Global Ocean Ecosystem Dynamics
GLOCHANT	Global Change and the Antarctic
GoS/GLOCHANT	Group of Specialists/ Global Change and the Antarctic
GPM	Global Precipitation Mission
GPS	Global Positioning System
GRDC	Global Runoff Data Centre
GRP	GEWEX Radiation Panel
GSC	Geological Survey of Canada
GTN	Global Terrestrial Network
GTN-G	Global Terrestrial Network for Glaciers
GTN-H	Global Terrestrial Network for Hydrology
GTN-P	Global Terrestrial Network for Permafrost
GTS	Global Telecommunication System (of WMO)
HYCOS	Hydrological Cycle Observing System
IABP	International Arctic Buoy Programme
IACPO	International ACSYS/CliC Project Office
IAHS	International Association of Hydrological Sciences
iAnZone	International Antarctic Zone
IAEA	International Atomic Enery Agency
IAMAS	International Association of Meteorology and Atmospheric Sciences
IAPSO	International Association for the Physical Sciences of the Oceans
IARC	International Arctic Research Center
IASC	International Arctic Science Committee
IAST	International Argo Science Team
ICAPP	Ice core Circum-Arctic Paleoclimate Programme
ICEMASS	Response of Arctic Ice Masses to Climate Change
ICPO	International CLIVAR Project Office
ICRS	International Commission on Remote Sensing of IAHS
ICSI	International Commission on Snow and Ice
ICSU	International Council for Science
IGBP	International Geosphere-Biosphere Programme
IGC	International Glaciological Community
IHACYs	International High Asia Cryosphere Years
IHDP	International Human Dimensions Programme
IHP	International Hydrological Programme (of UNESCO)
IIP	Initial Implementation Plan
ILTS	Institute for Low Temperature Studies
IOC	Intergovernmental Oceanographic Commission (at UNESCO)
IPA	International Permafrost Association
IPAB	International Programme for Antarctic Buoys
IPCC	Intergovernmental Panel on Climate Change
IPF	International Polar Foundation
IPS	Ice-profiling sonar
IPY	International Polar Year

ISMASS	Ice Sheet Mass Balance and Sea Level
ITASE	International Trans Antarctic Scientific Expedition
IUGG	International Union of Geodesy and Geophysics
IUGS	International Union of Geological Sciences
IWG	Interagency Working Group
JARE	Japanese Antarctic Research Expedition
JAMSTEC	Japan Marine Science and Technology Center
JCOMM	Joint (WMO and IOC of UNESCO) Technical Commission for Oceanography and Marine Meteorology
JPS	Joint Planning Staff (for WCRP)
JSC	Joint Scientific Committee
MAGICS	Mass Balance of Arctic Ice Sheets and Glaciers in Relation to the Climate and Sea Level Changes
MAGS	Mackenzie GEWEX Study
MEXT	Ministry for Education, Culture, Sports, Science and Technology (of Japan)
MODIS	Moderate Resolution Spectral Radiometer
MRI	Mountain Research Initiative
NAO	North Atlantic Oscillation
NABOS	Nansen and Amundsen Basins Observational System
NARR	North American Regional Reanalysis
NASA	National Aeronautics and Space Administration (USA)
NASDA	National Space Development Agency (of Japan)
NDFP	Northern Dimension of Foreign Policy (Canada)
NEG	Numerical Experimentation Group
NESDIS	NOAA Satellite and Information Services
NHS	National Hydrological Service
NIC	National Ice Center
NIED	National Research Institute for Earth Science and Disaster Prevention (Japan)
NIES	National Institute of Environmental Science (Japan)
NIPR	National Institute for Polar Research (Japan)
NPI	Norwegian Polar Institute
NRB	Northern Research Basins
NRCS	National Resources Conservation Service (USA)
NSF	National Science Foundation (USA)
NSIDC	National Snow and Ice Date Center
NWS	National Weather Service (USA)
OGCM	Ocean GCM
OGP	Office of Global Programmes (NOAA)
OLS	Operational Linescan System
OMIP	Ocean Model Intercomparison Project
ONR	Office of Naval Research
OPP	Office of Polar Programmes (NSF) *(see below as well)*
OPP	Observation Products Panel
PAGES	Past Global Changes
PARCA	Programme for Arctic Regional Climate Assessment
PILPS	Project for the Intercomparison of Land-surface Parameterisations Schemes
PM	Phase Modulation
PMEL	Pacific Marine Environmental Laboratory

POGO	Partnership for Observations of the Global Oceans
POGSI	Partnership for Observations of Global Snow and Ice
PRB	Polar Research Board
RCP	Responding to Change Panel
READER	Reference Antarctic Data for Environmental Research
RIHN	Research Institute of Humanity and Nature
RGPS	RADARSAT Geophysical Processor System
RV	Research Vessel
SAR	Synthetic Aperture Radar
SBSTA	Subsidiary Body for Scientific and Technical Advice (UNFCCC) SBSTA
SCAR	Scientific Committee on Antarctic Research
SCC	Science and Co-ordination Committee
SCDIC	Standing Committee on Data, Information and Communication
SCICEX	Scientific Ice Expeditions
SEARCH	Study of Environmental Arctic Change
SHEBA	Surface Heat Budget of the Arctic
SLP	sea level pressure
SMMR	Scanning Multichannel Microwave Radiometer
SO	Southern Ocean
SP	CliC Science and Co-ordination Plan
SPPG	Scientific Programme Planning Group
SSC	Scientific Steering Committee
SSG	Scientific Steering Group
SSM/I	Special Sensor Microwave/Imager
THC	Thermohaline Circulation
TOGA	Tropical Ocean – Global Atmosphere Programme
ToR	Terms of Reference
TRMM	Tropical Rainfall Measuring Mission
UCP	Understanding Change Panel
UKMO	United Kingdom Meteorological Office
ULS	Upward Looking Sonar – also IPS
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNEP	United Nations Environment Programme
UNFCCC	Un Framework Convention on Climate Change
URL	Uniform Resource Locator
USDA	US Department of Agriculture
USGS	US Geological Survey
VELMAP	Antarctic Ice Velocity Data Archive
WCRP	World Climate Research Programme
WECCON	Weddell Sea Convection Control
WG	Working Group
WGMS	World Glacier Monitoring Service
WGOMD	Working Group on Ocean Model Development
WHOI	Woods Hole Oceanographic Institution
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WWW	World Weather Watch
YuWEX	Water cycle of Yukon River