Twenty-seventh Meeting of SCAR Delegates Shanghai, China, 22-26 July 2002

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SCAR co-sponsorship of CliC
Report of a meeting held in London, United Kingdom, 7 March 2002

Agenda Item 5.2

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Present: Professor C G Rapley, Dr H Cattle, and Dr P D Clarkson

Professor Rapley, Director of the British Antarctic Survey (BAS) and a Vice-President of the Scientific Committee on Antarctic Research (SCAR) convened the Meeting at the Medical Research Council, London. Dr Cattle is Head of the Ocean Applications Branch at the Hadley Centre for Climate Prediction and Research of the UK Meteorological Office and Chairman of the World Climate Research Programme (WCRP) Arctic Climate System Study (ACSYS) and Cryosphere and Climate (CliC) Scientific Steering Group (SSG), and Dr Clarkson is Executive Secretary of SCAR.

The Climate and Cryosphere (CliC) Initial Science and Co-ordination Plan outlines research and co-ordination initiatives required to fully integrate studies of the impact and response of the cryosphere, and the use of cryospheric indicators for climate change detection, within the World Climate Research Programme (WCRP). The plan was prepared by the CliC Task Group that was established by the Joint Scientific Committee (JSC) for the WCRP in 1998 at the instigation of the ACSYS SSG.

At the XXVI SCAR Meeting in Tokyo, Japan, during July 2000, Delegates agreed that SCAR should investigate the possibility of co-sponsorship of CliC and Professor Rapley agreed to undertake this. This meeting with Dr Cattle was arranged to explore this possibility.

Dr Cattle explained that the ACSYS/CliC Scientific Steering Committee (SSC) currently has a Chairman, Dr Cattle himself, and two co-Vice-Chairmen, Dr Roger Barry and Dr Ian Allison, plus nine other members. He suggested that if SCAR was a formal co-sponsor of CliC the SSC could move to having two co-Chairmen. CliC currently has four sub-groups:

° Numerical Experimentation Group;

° Panel on Observation Products;

° Panel on Polar Products for Re-analysis;

° Panel on Data Management and Information.

There is also a joint WCRP CLIVAR-ACSYS/CliC Southern Ocean Panel.

Professor Rapley suggested that the SSC for CliC would likely have about 15 members and that these might be drawn in roughly equal numbers from the Arctic community, the Antarctic community, and those who study the cryosphere in the rest of the world. In this case, there would be about five members from the Antarctic community. He suggested further that SCAR might be willing to fund the travel and subsistence costs for those five persons to attend the annual meeting of the SSC. He also stressed that this would likely be the maximum extent to which SCAR could offer any funding for CliC. Dr Cattle agreed to raise these suggestions within WCRP.

After the meeting, Dr Clarkson spoke to Dr D Carson, Joint Planning Staff Director for WCRP, concerning possible SCAR co-sponsorship of CliC. Dr Carson thought that there should be no problem in principle for SCAR to co-sponsor a WCRP project.

The current ACSYS - CliC Project Office is located in Tromsø, Norway, and when the ACSYS Programme finishes later this year the office will be concerned purely with CliC. The office is funded by Norway with Japan and WCRP contributing some additional funds, mainly for travel to meetings. Professor Rapley indicated that BAS may contribute £10k ($14,300) to help support a staff post dedicated to the project. He said that BAS would also be happy to host workshops for the project. Dr Cattle is hoping that the Met Office,UK, will provide a one-off donation of £36k ($51,500) towards such a post (since confirmed).

Dr Cattle said that WCRP is always pleased to receive financial contributions to support its projects. Professor Rapley stressed that it should be understood that any contribution from SCAR would, of necessity, be small. This was understood.

Dr Cattle will be representing ACSYS/CliC at the 23rd session of the WCRP Joint Scientific Committee (JSC) in Hobart, Australia, 18 - 23 March 2002. He will present to the JSC the proposal for SCAR to be a joint sponsor of CliC. After the meeting he will report on the outcome to SCAR for delegates to consider at the XXVII SCAR Meeting in Shanghai during July 2002.

Professor Rapley and Dr Cattle agreed that this would be the most appropriate course of action and the meeting was closed.

P D Clarkson
SCAR Secretariat
12 March 2002

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Acronyms

ACSYS	Arctic Climate System Study
BAS	British Antarctic Survey
CliC	Climate and Cryosphere Project
JSC	Joint Scientific Committee
SCAR	Scientific Committee on Antarctic Research
SSC	Scientific Steering Committee
SSG	Scientific Steering Group
WCRP	World Climate Research Programme

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INTERNATIONAL COUNCIL FOR SCIENCE	**INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION**	**WORLD COUNCIL FOR METEOROLOGICAL ORGANIZATION**

WORLD CLIMATE RESEARCH PROGRAMME
CLIMATE AND CRYOSPHERE (CliC) PROJECT
SCIENCE AND CO-ORDINATION PLAN
VERSION 1

Edited by
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2 May 2000

The full text of this document can be found on the website of the Arctic Climate System Study (ACSYS) programme at the following URL:http://acsys.npolar.no/

It can be viewed on the website and downloaded as a "pdf" file.

The following pages of the document are reproduced here for the benefit of Delegates

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1 EXECUTIVE SUMMARY

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The Climate and Cryosphere (CliC) Initial Science and Co-ordination Plan, outlines research and co-ordination initiatives required to fully integrate studies of the impact and response of the cryosphere, and the use of cryospheric indicators for climate change detection, within the World Climate Research Programme (WCRP). The report has been prepared by the CliC Task Group, which was established by the Joint Scientific Committee (JSC) for the WCRP in 1998, with input from many other climate scientists. It draws on the deliberations of an expert meeting on Cryospheric Processes and Climate in Cambridge, UK (February 1997) and meetings of the CliC Task Group in Utrecht, the Netherlands (July 1998) and in Grenoble, France (August 1999).

The term "cryosphere" collectively describes the portions of the Earth's surface where water is in a solid form and includes sea-, lake-, and river-ice, snow cover, glaciers, ice caps and ice sheets, and frozen ground (including permafrost)[1]. The cryosphere is an integral part of the global climate system with important linkages and feedback generated through its influence on surface energy and moisture fluxes, clouds, precipitation, hydrology, and atmospheric and oceanic circulation. The cryosphere plays a significant role in global climate, in climate model response to global change, and as an indicator of change in the climate system.

However, the impact and response of the entire cryosphere in the global climate system, and the use of cryospheric indicators for climate change detection, have not been fully covered within WCRP. There are notable gaps in present studies of cryospheric elements and in the accurate and appropriate treatment of cryospheric processes in climate models.

In this report the cryosphere and its most important interactions are treated under the following headings:

- Interactions between the atmosphere, snow/ice and land.
- Interactions between land ice and sea level.
- Interactions between sea ice, oceans, and the atmosphere.
- Cryospheric interactions with the atmosphere and the ocean on a global scale.

The cryosphere is also considered as an indicator of climate variability and change.

Atmosphere-snow/ice-land interactions are concerned with the role of the terrestrial cryosphere[2] within the climate system and with improved understanding of the processes, and of observational and predictive capabilities applicable over a range of time and space scales. Better understanding of the interactions and feedback of the land/cryosphere system and their adequate parameterization within climate and hydrological models are still needed. Specific issues include the interactions and feedback of terrestrial snow and ice in the current climate and their variability; in land surface processes; and in the hydrological cycle. Improved knowledge is required of the amount, distribution, and variability of solid precipitation on a regional and global scale, and its response to a changing climate. Seasonally-frozen ground and permafrost modulate water and energy fluxes, and the exchange of carbon, between the land and the atmosphere. How do changes of the seasonal thaw depth alter the land-atmosphere interaction, and what will be the response and feedback of permafrost to changes in the climate system? These issues require improved understanding of the processes and improved observational and modelling capabilities that describe the terrestrial cryosphere in the entire coupled atmosphere-land-ice-ocean climate system.

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[1] The discipline of glaciology encompasses the scientific study of snow, ice and glaciers.
[2] Terrestrial cryosphere is defined as snow, lake- and river-ice, glaciers and frozen ground/permafrost

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The primary issue regarding the role of the cryosphere on sea level is the past, present and future contribution of land ice to sea level change. We need to know how much of the sea level rise over the last 100 years can be explained by changes in land ice volume. In order to understand past sea level change and predict future change, it is essential to measure and explain the current state of balance of glaciers, ice caps and ice sheets, and especially to resolve the large present uncertainties in the mass budgets of the Greenland and Antarctic ice sheets. In spite of the fact that the current state of balance of ice sheets and ice caps is not well known, the sensitivity of the volume of ice stored in glaciers and ice sheets to climate change can and must be studied.

Over a considerable fraction of the high-latitude global ocean, sea ice forms a boundary between the atmosphere and the ocean, and considerably influences their interaction. The details and consequences of the role of sea ice in the global climate system are still poorly known. Improved knowledge is needed of the broad-scale time-varying distributions of the physical characteristics of sea ice, particularly ice thickness and the overlying snow-cover thickness, in both hemispheres, and the dominant processes of ice formation, modification, decay and transport which influence and determine ice thickness, composition and distribution. We do not know how accurate present model predictions of the sea ice responses to climate change are, since the representation of much of the physics is incomplete in many models, and it will be necessary to improve coupled models considerably to provide this predictive capability.

Key issues on the global scale are understanding the direct interactions between the cryosphere and atmosphere, correctly parameterizing the processes involved in models, and providing improved data sets to support these activities. In particular, improved interactive modelling of the atmosphere-cryosphere surface energy budget and surface hydrology, including fresh-water runoff, is required. Better formulations and data sets on surface albedo and its dependence on surface type, vegetative cover, underlying surface albedo, and surface temperature are also required, particularly in regions of ice and snow melt. Other important global issues are the impact of cryospheric anomalies on the atmosphere; and the sensitivity to variability and change of atmospheric moisture transport, which controls snow accumulation and thus the mass balance of ice sheets. Another important aspect of the cryosphere for global change concerns the ice-albedo feedback. A key question, given the impact this has on the high sensitivity of the polar regions to climate change, is how the atmosphere responds to and helps determine systematic changes in the ice and snow cover, and how these will influence the response to global warming. The cryosphere also has the potential for influencing the global ocean through changes in sea level; modulation of the thermohaline circulation, which affects meridional heat and fresh-water transport; and impacts on efficiency of carbon uptake and exchange. The key-underlying interactive processes and feedback between large-scale ocean circulation and the cryosphere must be better understood.

Because of its response to regional and global variations in the climate system, the cryosphere is not only an integrator of climate processes, but also a strong indicator of change. Cryospheric change indicators are particularly valuable in regions where conventional observations are of short duration or completely lacking. Existing time series of the extent of sea ice, snow cover, and permafrost, and of glacier geometry and mass balance, should continue to be monitored for change. Records of past climatic variability at the multi-decadal and longer time-scales are available from historic and geomorphologic records of glacier fluctuations, borehole temperatures and ice cores. These data complement the existing instrumental records of temperature and precipitation and can improve both temporal and spatial coverage. The longer perspective can indicate how significant recent changes are in relation to natural variability.

The scientific strategy for a CliC project is similar in each of the areas of interaction: a combination of measurement, observation, monitoring and analysis, field process studies and modelling at a range of time and space scales. A CliC modelling strategy must address improved parameterization in models of the direct interactions between all components of the cryosphere, the atmosphere, and the ocean. It will need to do this at a variety of scales from the regional to global; and with a hierarchy of models ranging from those of individual processes to fully coupled climate models. It will also be essential to provide the improved data sets needed for validation of models and parameterization schemes.

A broad observational framework for CliC is provided by the World Meteorological Organization (WMO) meteorological and hydrological networks; the International Arctic Buoy Programme (IABP); elements of the Global Climate Observing System (GCOS), the Global Terrestrial Observing System (GTOS) and the Global Ocean Observing System (GOOS) relating to the cryosphere; and continuing WCRP projects for Antarctic buoys (International Programme for Antarctic Buoys (IPAB)) and for sea-ice thickness in the Arctic and in the Antarctic (Arctic Sea Ice Thickness Project (ASITP) and Antarctic Sea Ice Thickness Project (AnSITP)). Satellite remote sensing methods will be particularly important. They provide invaluable and often unique observational data for a range of climate and cryosphere studies, including: process-oriented studies; analyses of large-, regional-, and even global-scale spatio-temporal variability; monitoring and detection of climate change; and validation and/or assimilation data for numerical models. Numerous satellite-derived cryospheric data sets or products have already been developed, and more are under development or planned using data from present and near-future sensor systems. Several future techniques in remote sensing systems, data sets and methodologies for cryospheric studies may be realized within the coming decade. Potentially valuable new systems include the European Space Agency (ESA) CryoSat, a goal of which is to measure fluctuations in sea and land ice masses (thickness) at large space and time scales. Another is the (US) National Aeronautics and Space Administration's (NASA) planned Geoscience Laser Altimeter (GLAS), which will provide valuable data to map sea and land ice elevations, and which may directly address the problem of the mass balance of the large ice sheets. These will complement the current and future systems including Special Sensor Microwave Imager (SSM/I), Advanced Microwave Scanning Radiometer (AMSR) and Synthetic Aperture Radar (SAR), which provide valuable information on snow and ice resources.

The development of a plan for CliC data and their management will build directly on the experience of the Arctic Climate System Study (ACSYS) Data Management and Information Panel and the development of the Arctic Precipitation Data Archive as well as other WCRP projects. CliC data requirements will necessitate the continuation of many ACSYS data collection and archiving activities and their expansion to encompass Antarctic and other cryospheric data needs. Complementary national and international programmes will be particularly important. The cryosphere is of interest to many diverse scientific organisations. CliC will develop an implementation plan that is complementary to other initiatives and draws on expertise of other organisations. There are a variety of gaps in ongoing programmes and a need for co-ordination between the proposed CliC and the other activities to achieve a global perspective of cryosphere research. In particular other WCRP and WMO programme components, International Geosphere-Biosphere Programme (IGBP), Scientific Committee on Antarctic Research (SCAR), Scientific Committee on Oceanic Research (SCOR) and International Arctic Science Committee (IASC) projects need to be considered. Many of the broader global issues in CliC are relevant to wider aspects of the Climate Variability and Predictability (CLIVAR) and the Global Energy and Water Cycle Experiment (GEWEX) projects, and it is critical that there are strong links between the projects and that science initiatives within CliC are co-ordinated with, and complementary to, those initiated or planned in CLIVAR and GEWEX.

The WCRP IPAB and An SITP are at present supervised by the ACSYS Scientific Steering Group. These projects will become part of CliC. Similarly, ACSYS/CliC is well represented in relevant WMO activities; for example, the Global Digital Sea-ice Data Bank (GDSIDB) within the joint WMO/IOC (International Oceanographic Commission) Technical Commission for Oceanography and Marine Meteorology (JCOMM), and the Solid Precipitation Measurement Intercomparison within the Commission for Instruments and Methods of Observation (CIMO). SCAR and SCORo4 have a number of important Antarctic programmes and projects, and there are several relevant scientific unions and commissions within the International Council for Science (ICSU), especially the International Permafrost Association (IPA) and the International Commission on Snow and Ice (ICSI). Options for establishing links with these programmes include joint participation on steering committees and science conferences; establishing links between project offices; co-sponsorship of projects with joint funding support; and full integration of international co-ordinated activities as sub-projects of WCRP/CliC. The particular mode(s) that CliC should adopt has not been determined, but options will be considered by the joint ACSYS/CliC SSG at its first meeting.

2 BACKGROUND

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The main goal of the World Climate Research Programme (WCRP) is to understand and predict -- to the extent possible -- climate variability and change, including human influences. In a stepwise approach, it has first tried to understand seasonal to inter-annual climate variability by mounting projects like the Tropical Ocean/Global Atmosphere (TOGA) project. This project brought the breakthrough to physically based seasonal climate predictions, especially for areas affected by the El Niño phenomenon. Within the Global Energy and Water Cycle Experiment (GEWEX), our understanding of cloud/radiation interaction and land-surface processes was greatly enhanced. These are becoming more and more important for both weather forecasting and climate variability predictions. Progress in understanding decadal timescale climate variability and climate change projections, however, also needs observations of global ocean structure and circulation and tested ocean models. Therefore, WCRP launched the World Ocean Circulation Experiment (WOCE), which has now entered into an analysis, interpretation, modelling and synthesis phase. The importance of the positive snow/ice albedo feedback which amplifies high-latitude sensitivity to external forcing by the sun or an enhanced greenhouse effect, together with the opportunities for internationally co-ordinated Arctic research, stimulated the Arctic Climate System Study (ACSYS). This project is concentrating first on establishing data sets on the Arctic Ocean circulation and sea-ice cover, the Arctic atmosphere and land surface hydrology of the Arctic Basin, and on improved sea-ice models for climate research.

However, the impact and response of the entire cryosphere and the associated interactions and feedback of its components within the global climate system, and the use of the cryosphere as an indicator of climate change, have not been fully covered within WCRP. Fully coupled atmosphere/ocean/land models for decadal timescale simulations and projections of climate change scenarios, as envisaged in the WCRP Climate Variability and Predictability Study (CLIVAR) need this input. Therefore, at the JSC-XVII in Toulouse, France, March 1996 the Joint Scientific Committee (JSC) for WCRP charged ACSYS and CLIVAR with enhancing connections with other cryospheric activities outside WCRP, especially with SCAR-GLOCHANT, IASC-MAGICS and SCOR-iAnZone. In addition, in response to several external requests, the WCRP organized an expert meeting on Cryospheric Processes and Climate in Cambridge, UK, 3-5 February 1997 (WCRP, 1998b). WCRP was also asked by experts representing climate-related activities in other international programmes, groups, and activities to initiate a broader cryospheric project without disrupting successful on-going studies (e.g., ACSYS). Therefore, at JSC-XVIII in March 1997 (Toronto, Canada) the JSC for WCRP invited the Conference on WCRP: Achievements, Benefits and Challenges (Geneva, August 1997) to consider the role of the cryosphere in climate, and to note the weaknesses and gaps in studies of cold climate processes. JSC-XVIII also instructed the 2nd ACSYS Science Conference on Polar Processes and Global Climate (Orcas Island, WA, USA, November 1997) to provide input and suggestions from the broader polar/cryosphere research community. The ACSYS Scientific Steering Group was also asked to prepare a comprehensive statement on the overall status of studies of cold climate processes for review by the JSC in March 1998.

The following were presented to JSC-XIX (Cape Town, South Africa, March 1998):

1) The WCRP 1997 Conference Statement calling for an enlarged WCRP activity with respect to cryosphere and climate.

2) The ACSYS Conference Statement voicing the desire of the broad scientific community for a comprehensive co-ordinated cryosphere and climate activity within WCRP.

3) The proposal from the 6th session of the ACSYS Scientific Steering Group (Seattle, WA, USA, November 1997).

A summary report on the first session of the CliC Task Group was published as WCRP Informal Report No.4/1999 (WCRP, 1999a). The first draft of the CliC Science and Co-ordination Plan (SCP) developed by the Utrecht meeting was reviewed by the seventh session of the ACSYS Scientific Steering Group (Tokyo, Japan, November 1998). The revised draft was presented to JSC-XX (Kiel, Germany, March 1999) and the CliC Task Group was asked to continue its work to map out a full CliC science strategy and define other cryosphere-related scientific and observational programmes. At the JSC-XXI meeting in Tokyo, March 2000, the establishment of the CliC Project within the WCRP and the formation of a combined ACSYS/CliC SSG were approved. Co-ordination of CliC with other relevant projects/programmes is an ongoing part of the project and is essential for success.

The initial science and co-ordination plan for the WCRP Cryosphere and Climate (CliC) Project follows. The plan is seen as a "living document" that will continue to develop as our knowledge of processes and interactions of the cryosphere in the climate system increases. It will evolve as new data from satellite and in situ sources become available, and as our modelling of the hydrological and climate systems over a range of scales improves.