



WORLD CLIMATE PROGRAMME

WORLD CLIMATE APPLICATIONS AND SERVICES PROGRAMME

WMO WCRP IPY WORKSHOP ON CLIPS IN POLAR REGIONS: CLIMATE PRODUCT GENERATION, USER LIAISON AND TRAINING

(St. Petersburg, Russian Federation, 8 – 11 September 2008)

WCASP - No. 78

WMO-TD No. 1509

**WORLD METEOROLOGICAL ORGANIZATION
December 2008**

The **World Climate Programme (WCP)** implemented by WMO in conjunction with other international organizations consists of the following major components:

- World Climate Data and Monitoring Programme (WCDMP)
- World Climate Applications and Services Programme (WCASP)
- World Climate Impact Assessment and Response Strategies Programme (WCIRP)
- Coordination activities within the Climate Agenda (CCA)
- World Climate Research Programme (WCRP)
- Intergovernmental Panel on Climate Change (IPCC)
- Global Climate Observing System (GCOS)

World Meteorological Organization
7bis, av. de la Paix
Case postale 2300
CH 1211 Geneva
Switzerland

Telephone : +41 (0) 22 730 81 11
Telefax : +41 (0) 22 730 81 81
Email: wmo@wmo.int

NOTE

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Editorial Note: This report has for the greater part been produced without editorial revision by the WMO Secretariat. It is not an official publication and its distribution in this form does not imply endorsement by the Organization of the ideas expressed.

TABLE OF CONTENTS

| | | |
|----|---|----|
| | Executive Summary | 1 |
| 1. | Opening of the Workshop | 4 |
| 2. | Organization of the Workshop | 5 |
| 3. | Overview of the Main Themes of the Workshop | 5 |
| 4. | Outcomes, Recommendations and Decisions | 5 |
| | 4.1 Data and Research Requirements | 5 |
| | 4.2 Operational Development, Distribution and Communication on Products and Services | 9 |
| | 4.3 User Interface, Identification of User Requirements and Partnerships | 11 |
| | 4.4 Feasibility of Establishment of a Polar Climate Outlook Forum | 12 |
| 5. | Closure of the Workshop | 15 |

ANNEXES:

- ANNEX I - PROGRAMME
- ANNEX II - LIST OF PARTICIPANTS



EXECUTIVE SUMMARY

The people who live and work at high latitudes do so in a very cold climate, and increasingly are challenged by a wide range of weather and climate adversities. This might be most acute at high northern latitudes, where average Arctic temperatures over the last 100 years have been assessed to have increased at almost twice the rate of the rest of the world. People in all walks of life in both Polar Regions have a great need for climate information in order to make effective decisions related to the challenging environment and to the socio-economic opportunities and risks that ensue from observed and potential future climate-related changes that are occurring in these regions.

People, communities, businesses and governments also would benefit from learning how to make optimal use of the available information in developing and implementing their strategies for adaptation to climate variability and change, and in conducting their lives in a changing environment. As part of its efforts to extend the implementation of its Climate Information and Prediction Services (CLIPS) project to address the special needs of the Polar Regions, the World Meteorological Organization (WMO) recognizes a unique opportunity for the National Meteorological and Hydrological Services (NMHSs) of its Members to contribute to the legacy of the ongoing International Polar Year 2007-2008 (IPY), to build collaborative mechanisms for generating sustained, practical, operational products and services, to meet user needs for climate risk management in Polar Regions. In pursuit of this, a Workshop on "CLIPS in Polar Regions: Climate Product Generation, User Liaison and Training" was held in St. Petersburg, Russian Federation, from 8 to 11 September 2008. The workshop was organized jointly by the WMO World Climate Applications and Services Programme (WCASP); the WMO Education and Training Office (ETR); the World Climate Research Programme (WCRP), co-sponsored by WMO, ICSU and the IOC of UNESCO; and the WMO International Polar Year (IPY) Secretariat. This workshop brought together specialists from both circumpolar regions from climate modelling, the Intergovernmental Panel on Climate Change (IPCC), the Arctic Climate Impact Assessment (ACIA), the observations community (land, satellite and marine), climate services, climate risk management, and representatives of user communities (e.g. the Arctic Monitoring and Assessment programme (AMAP)).

In tropical and sub-tropical regions, mechanisms such as Regional Climate Outlook Forums (RCOFs) have become a highly valued and regular activity of WMO Members and the associated regional institutions. RCOFs owe their increasing success to a number of factors including more reliable prediction of climate at seasonal to longer time frames, increasing user awareness of the advances in climate science, and to the direct participation of user communities in RCOFs. Recognizing the scientific challenges of climate prediction in high latitude regions, and also the acute vulnerability of Polar Regions to climate variability and change, consideration has been given at the workshop to extending the benefits of the RCOF process to high latitudes to facilitate sharing of national experiences and networking among the stakeholders for a collaborative handling of the climate issues common to most of the countries in this area.

The workshop sessions represented a valuable collaboration, information sharing and learning opportunity, which covered:

- an overview of international climate science programmes for polar climate;
- an assessment of climate variability and change in Polar Regions;
- the status of products and services relevant to polar communities;
- discussion on potential stakeholders, their vulnerability to climate and on how to identify their requirements for climate information;
- development and communication of information, products and services; and
- outstanding challenges.

The workshop participants strongly supported:

- exploitation of new IPY datasets, data rescue efforts, more intensive measurement and use of the Essential Climate Variables (ECVs), use of precipitation datasets that have been corrected for biases, improving remote sensing of rainfall and snowfall, free and open access to data and establishment of polar 'supersites' where the essential variables would all be measured;
- research into regional downscaling of climate predictions and climate system factors leading to improved prediction on monthly to seasonal or longer time frames;
- identification of improvements needed in global and regional models for high-latitude areas;
- development and implementation of statistical tools e.g. for studies of climate extremes;
- development of new information and operational products from NMHS archives (incorporating new data from the IPY data legacy) including products for adaptation assessments;
- provision of climate monitoring products, including climate indices, to users, along with information on their interpretation and use;
- identification of the climate information needs of people and groups living and working at high latitudes through one or more surveys, developed and conducted with the participation of, for example, the Arctic Council's Arctic Monitoring and Assessment Programme (AMAP);
- improved interdisciplinary networks and collaboration and user liaison;
- the concept of a Polar Climate Outlook Forum (PCOF), as a viable operational mechanism to facilitate effective interactions between climate service providers and users/stakeholders;
- publication of a peer-reviewed article on the concept of a PCOF and other outreach products;
- capacity building, including technical training for climate scientists and product developers, and also for combined provider and user groups.

The concept of a PCOF is taking shape – an RCOF for Polar Regions will be similar to those in the tropics, but will not, at the outset, have the benefit of reliable predictive skill at seasonal scales. A decision has been taken to continue to look into the feasibility of a PCOF, however, because rapid changes in climate and in the socio-economic fabric of the regions increase vulnerability for humans and ecosystems, and hence elevate the need for information. People make decisions everyday in this environment and face considerable risk – better decisions will come about, risks will be reduced, through effective use of the best available information. The workshop recognized that the Members in the region were engaged in a number of activities at the national levels to support the climate information needs of their communities. Considering that the Members having interest in the Polar Regions share common climate information needs and requirements, the participants agreed that a networking approach would be effective in consolidating mutual strengths and optimizing societal applications of climate information. This

will likely include a mix of state-of-the-art climate monitoring products including sea-ice maps and satellite imagery; analyses and trends based on historical climate data; assessments and interpretations of climate change scenarios for the region, and the available prediction products, with interpretation of their uncertainty. WMO is in the process of developing or expanding the scope of mechanisms that would facilitate coordination and improvement of such information and its flow to users. Success will depend on many interested parties working collaboratively, and WMO will proceed to contact all relevant agencies and programmes with a view to further elaborating PCOF feasibility and to taking the first steps to initiating the required collaboration.

Ideally, a PCOF will be a regular international collaboration between climate and user representatives with interests in Polar Regions, to share currently available information, to respond to user requirements for climate information, products and services, and to engage in awareness and technical training of both climate providers and users. The PCOF is recognized as a WMO legacy of IPY 2007-2008, and as a contribution to the future WMO Global Cryosphere Watch (GCW).

1. OPENING OF THE WORKSHOP

1.1 A workshop on CLIPS¹ in Polar Regions: Climate product generation, user liaison and training, was held in St Petersburg, Russian Federation, from 8 to 11 September 2008. This workshop (PolarCLIPS) was jointly organized by the World Meteorological Organization (WMO), the World Climate Research Programme, and the WMO International Polar Year (IPY) office, and involved the direct participation of the WMO World Climate Applications and Services Programme (WCASP), the WMO Education and Training Office, and the WCRP Climate and Cryosphere (CliC) Project. The event was hosted by the Voeikov Main Geophysical Observatory (MGO). Local arrangements, logistics and computer support for the session were facilitated, respectively, by Dr Alexander Zaitsev, Dr Tatyana Pavlova and Dr Igor Shkolnik of the MGO.

1.2 On behalf of the MGO, Dr Vladimir Kattsov welcomed participants to St. Petersburg and to the session. Dr Kattsov noted that climate prediction has proven very challenging for high latitudes, but that the upcoming 2009 World Climate Conference-3 (WCC-3) will be a significant event in terms of development of the overall capacity for prediction. This PolarCLIPS workshop, he added, was also very important - not only to high latitudes, but to prediction and services everywhere.

1.3 Dr Rupa Kumar Kolli noted that the concept for PolarCLIPS had arisen from the kind offer by the Russian Federation, during the Fourteenth session of the Commission for Climatology (CCI-XIV, Beijing, China, 3-10 November 2005) to hold a CLIPS event in Russia. In addition, there were growing needs to reassert and reinforce the long-standing relationship between WCASP and WCRP, to work more closely with WMO's Education and Training office on CLIPS training, and in particular, to make a substantive contribution from WMO's CCI and the World Climate Programme (WCP) as part of the legacy of the IPY 2007-2008. Dr Kolli noted the unique nature of the group assembled – all senior experts with skill sets and experiences ranging from research, climate modelling, the Intergovernmental Panel on Climate Change (IPCC), the Arctic Climate Impact Assessment (ACIA), observations (land, satellite and marine), climate services, climate risk management, and representatives of user communities (e.g. the Arctic Monitoring and Assessment programme (AMAP)). It was highly beneficial that there was research and operational representation from both circumpolar regions, since it is intended to extend PolarCLIPS to both South and North Polar Regions.

1.4 Dr Kolli reviewed the goals of the workshop, namely, to bring together climate and user representatives with interests in Polar Regions, to share information and identify requirements for climate information, products and services, and to engage in awareness and technical training. The programme for the workshop was designed to provide an overview of international climate science programmes for polar climate; an assessment of climate variability and change in Polar Regions in both hemispheres; the status of products and services relevant to polar communities that have been developed or are planned; discussion on potential stakeholders, their vulnerability to climate and on how to identify their requirements for climate information; development and communication of information, products and services; and the inherent challenges that needed to be overcome. The ultimate goal would be to assess the potential for extension of the concept of Regional Climate Outlook Forums (RCOFs) to high latitudes, knowing that long-range forecasting has little skill, at present, in these areas. He urged all participants to consider the benefits of provision, through a Polar Climate Outlook Forum (PCOF), of improved and internationally coordinated products and services, to better meet the needs of the highly vulnerable populations in Polar Regions.

¹ CLIPS is the **C**limate **I**nformation and **P**rediction **S**ervices project of the WCASP.

1.5 Dr Kolli thanked the participants for their enthusiasm for the PolarCLIPs and PCOF concepts and that each had taken time to participate in the workshop. He further noted the deep appreciation of all the organizers of the session, for the excellent support of the Roshydromet and of the MGO and its staff in arranging the event.

2. ORGANIZATION OF THE WORKSHOP

2.1 The programme (**ANNEX I**) for the workshop was adopted with minor amendments, in order to accommodate last-minute changes in individual travel schedules.

2.2 Participants briefly introduced themselves and identified their interests and background relevant to the themes of the session. The final List of Participants is attached as **ANNEX II**.

2.3 Dr Zaitsev provided the required logistic details during the period of the workshop.

3. OVERVIEW OF THE MAIN THEMES OF THE WORKSHOP

3.1 The first three days of the workshop consisted of excellent exchanges of information on a number of topics, through presentations and discussion. The main themes were WMO-related international climate science programmes, climate variability and change in Polar Regions, climate products and services for polar users, climate-related needs of people in Polar Regions, development and communication of information, products and services and training. This background provided a solid basis for discussion of the feasibility of establishment of a Polar Climate Outlook Forum, focused on meeting the information needs of climate-sensitive decision-makers at high latitudes. All presentations and submitted abstracts have been made available on the PolarCLIPS web site: <http://www.wmo.int/pages/rog/wcp/wcasp/polarclips.html>.

3.2 Training was a specific focus of this workshop, and was incorporated in three ways throughout the session. The range of backgrounds and interests in this session was across research and operations, both northern and southern hemispheres, and included individuals that function within WMO entities, and also those from outside the WMO communities. The exchange of information between the different participants was a planned and valuable capacity-building exercise. Secondly, Drs Dikinis and Vershovsky informed the workshop participants of the activities and programmes related to climate training, of the Russian State Hydrometeorological University (RSHU) in St. Petersburg. The RSHU is a WMO Regional Training Centre, with an extensive range of programmes (Bachelors through PhD Programmes), with a perspective of a cold-climate region. Interest was expressed in the RSHU establishing summer-school programmes on topics of interest to the PolarCLIPS community. Finally, the Workshop was introduced to the Climate Predictability Tool (CPT), a software developed by the International Research Institute for Climate and Society (IRI) for the development of seasonal predictions, and shown in detail the products and information available from the WMO Global Producing Centres of Long-range Forecasts (GPCs).

4. OUTCOMES, RECOMMENDATIONS AND DECISIONS

4.1 Data and Research Requirements (Session leader: Francis Zwiers)

4.1.1 Data requirements

4.1.1.1 For polar climate services in both hemispheres, the group noted the need to organize data and deal with certain data issues (land/atmospheric, marine/ocean, *in situ* or remotely sensed). It proposed that the PolarCLIPs effort exploit the *in situ* data as much as

possible; exploit new IPY datasets as much as possible in new products and services; extend the *in situ* records spatially and temporally; perform data rescue; make use of proxy data; expand on remote sensing, especially for high-latitude precipitation measurements; perform data rescue and reanalysis on remotely sensed data; create and use homogeneous, long-term, historical data records. In particular, the group appreciated the approach of Norway, for free and open access to data and to products derived from these data.

Recommendations:

- Provide information on Norway's web site and approach (free access to data and to data products) both on the PolarCLIPS web site, and to the WCRP CliC project office (**WCASP**);
- Identify data requirements needed in relation to the provision of climate services to meet user needs in Polar Regions, including a potential PCOF implementation.

4.1.1.2 WMO's extensive background and experience in data rescue, data homogenization, data management, metadata and data transmission were noted, and the Workshop was pleased to be informed that these perspectives would also be reflected at a number of relevant upcoming meetings, including the American Geophysical Union (AGU) (15-19 December 2008, San Francisco, CA, USA) and at the Workshop on Sustaining Arctic Observing Networks (SAON) (15-17 October 2008, Helsinki, Finland).

Recommendations:

- Identify examples of data rescue relevant to PolarCLIPS (**WCASP and WCDMP**);
- Inform WCDMP and PolarCLIPS data specialists of Hungary's offer to share its software for data digitization (**WCASP**);
- Request the International Ice Charting Working Group to make its historical ice charts (back to the 1930's) available for PolarCLIPS, and to digitize these for maximum utility (**WCASP, through MMO (Marine meteorology)**).

4.1.1.3 With respect to the important variables needed by users and decision-makers, the group agreed that the Essential Climate Variables (ECVs)² are a core and fundamental set, although they may not cover all variables that may be required for research and applications, and definitions and criteria are not always fully elaborated.

Recommendation:

- Raise the need to define the standards and criteria for the ECVs clearly, for the benefit of those taking measurements or designing instruments (e.g. for soil moisture), with relevant decision bodies including GCOS and the Polar Panel (**WCASP**).

4.1.1.4 The Workshop participants agreed that it was critical to have high quality, reliable data for both rain and snowfall (not just total precipitation), for both satellite and *in situ* methods. These data are required for model validation, as input to hydrological and numerical models, for initialization of climate models, and for downscaling. The participants agreed that 'corrected'

² The Global Climate Observing System (GCOS) information on ECVs can be found at: <http://www.wmo.ch/pages/prog/gcos/>

precipitation (*in situ*) should be made widely available for studies and applications in Polar Regions.

Recommendations:

- Develop or acquire one or more ‘corrected’ precipitation data sets, and use these to demonstrate the issues and the impact of measurement biases on results, for the benefit of researchers, independent operators of networks, and NMHSs (**WCRP: CliC**);
- Determine the current status of the WMO CIMO assessment of the effect of automation on solid precipitation records, and liaise with WMO WCDMP, WCRP CliC, and the Global Precipitation Climatology Centre (GPCC) on the need for corrected polar precipitation records and on the need for developing a portal for precipitation products (**WCASP + Norway on corrected precipitation records**);
- Inform the space agencies of the urgent need to develop methods to improve remote sensing of rainfall and snowfall in cold climates and at high latitudes, and identify how to work together to develop the appropriate methodologies (**WCRP with SAT and GEOSS**).

4.1.1.5 The Workshop participants agreed that it was important to identify user requirements for data and information derived from data – recognizing that decision-makers need ‘actionable’ information.

4.1.1.6 The Workshop participants agreed on the benefits of establishment of a number of polar ‘flagship sites’ or ‘super sites’, where all essential variables are measured, and welcomed the information that ‘super sites’ and their benefits would be raised in a number of forums (e.g. SAON, the (WMO) Executive Council Panel on Polar Observations, Research and Services (EC PPORS), WCRP CliC) as part of the IPY legacy.

4.1.2 Modelling and research aspects

4.1.2.1 The Workshop participants recognized a clear need to improve our knowledge of predictability for high latitudes. Participants agreed on the need for downscaling, both dynamical and statistical. The Workshop was informed that WCRP CliC plans to start a polar initiative regarding sea-ice and stratospheric processes and feedbacks, and that a meeting was being planned for 2009 or 2010 on the subject. Participants recognized that research was needed to improve our understanding of carbon and methane release, and to incorporate these processes into climate models.

4.1.2.2 With respect to teleconnections, it was agreed that not only was it necessary to better understand how low latitude processes affect polar regions, but also how weather and climate in Polar Regions affect other, or bordering, regions.

4.1.2.3 Noting the benefit to global prediction of the advent of a new network of WMO Global Producing Centers of Long-range Forecasts (GPCs), participants agreed on a need to find out more how GPC models were initialized in Polar Regions. Participants were informed that in some regional model ensembles, certain parameters such as snow and sea ice may be initialized in the models using climatological data; furthermore, at the meeting of the workshop convened by the WCRP Task Force on Seasonal Prediction (Barcelona, Spain, June 2007), the SIP community did not, at that time, feel that there was much to gain from adding a cryosphere focus into the global models. The Workshop participants agreed that an attempt should be made

to change this perspective and felt that the PolarCLIPS community could help in this regard by making more focused use of GPC products at high latitudes. The Workshop also noted the conclusions of IPCC fourth assessment report that considerable uncertainties remain at high latitudes, and that the fifth assessment report could include a stronger focus on Polar Regions, provided there is literature to assess. In that regard, the Workshop noted a need for additional research related to improving prediction for high latitudes through making better use of cryospheric inputs in the models.

4.1.2.4 The Workshop was informed that sea ice concentration based on passive microwave soundings was known to have problems because, at present, the sensors could interpret 'melt pools' as open water. It was recognized that ice chart data were less inconsistent than satellite data and that ice analysis and ice charting working groups were looking at how to assimilate sea ice information into numerical weather prediction models. In addition, the Workshop was informed that 'blended' ice chart information (from multiple countries) had been submitted to the Hadley Center for reanalysis. The period covered was from 1900 to 2004. The participants identified a potential benefit to using reanalysis data and products, for validation of predictions and for removing biases. The group recognized that thickness of sea ice presented a problem, noting that thickness is inferred from an understanding of what is 'old' ice.

Recommendations:

- Entrain GPC help to assess the skill of present-day seasonal forecasts - T, P, and possibly wind, for both Polar Regions, recognizing the limitations of the observational base for skill assessment (**WCASP, DPFS**);
- Entrain GPC help to establish the nature of the representation of high latitude components and processes in seasonal prediction models, plus initialization procedures – specifically assess potential to incorporate initial fields of snow and sea ice in GPC model runs (**WCASP, DPFS**);
- Encourage the WMO CBS ET on LRF to participate actively in PolarCLIPS work (**WCASP, DPFS**);
- Develop improved dynamical and statistical downscaling techniques, and ensure their operational use in development of climate products and services at high latitudes (**WCRP CliC and CLIVAR, WCASP**);
- Conduct research into the teleconnections that will improve understanding of polar climate, and will thus lead to improved prediction at high latitudes (**WCRP CLIVAR**);
- Identify ways to incorporate the sea-ice reanalysis products into PolarCLIPS activities (**WCASP, MMO**);
- Encourage WCRP Climate-system Historical Forecast Project (CHFP) diagnostic sub-projects to define current prediction skill in high latitudes and ways in which it might be improved (**WCRP CLIVAR/CliC**);
- Request diagnostics on polar-centric projections (ask GPCs to produce polar projections of their forecast products, if possible);
- Develop a WMO/WCRP statement on current status and prospects of high latitude seasonal prediction (**WCASP, WCRP**);

- Assess the nature of current and potential for development of empirical techniques and skill for high latitude seasonal predictions (possibly through a workshop or in combination with an objective assessment of model predictions) (**WCRP, WCASP**);
- Scope the potential for longer term climate model high-latitude scenario data delivery (with AMAP and others);
- Review and improve data assimilation techniques.

4.2 Operational Development, Distribution and Communication on Products and Services (Session leader: Holger Meinke)

4.2.1 It was noted that adaptation science is problem oriented and characterized by: new, integrative and transdisciplinary science; scenario developments and modeling; evaluation and quantification; risk management; and capacity building. Further, adaptation science needs to: clearly define the problem domains with stakeholders (ensure the right questions before answers are provided); acknowledge that science will only ever provide partial answers to certain issues (climate is usually only one of many simultaneous factors a decision-maker must consider); and explicitly quantify the uncertainties (say what we know, and what we don't know). A particular challenge in climate science is to help decision-makers deal with uncertainty (what appear to be 'fuzzy' answers).

4.2.2 Recognizing the current limitations to seasonal scale prediction at high latitudes, the Workshop nevertheless agreed that it was especially important that operational community was equipped to help users better prepare for the future, given the acute vulnerability in these areas. Participants agreed on the following actions, in order of priority:

Decisions:

- Establish and further maintain the 'Community of Practice (COP)' we had begun, noting that a COP has three unique elements: 1) a domain of knowledge, which defines a set of issues; 2) a community of people who care about this domain; and 3) the shared practice that they are developing to be effective in their domain;
- Recommend, if feasible (see item 4.4 below) the establishment of a decision-maker driven Polar Climate Outlook Forum (PCOF), and describe its structure, practices, constituents and users, and its goals and benefits;
- As a group, write a paper or a series of papers for a high-impact journal outlining the PolarCLIPS user-endorsed intentions and capabilities (to explain how PCOF, for example, would satisfy existing demand; and create new demand by engaging with users or stakeholders who do not yet know exactly what is possible and what is not). Possible title of a paper would be '**Adaptation Science: Beyond Impact Assessments – Creating Adaptive Capacity in Polar Regions**'. The structure of the paper could include:
 - **Needs analysis** (sectors, classes of decision makers, applications, outcomes)
 - Proof of concept: case studies (eg. construction, shipping in Finland; cropping in Iceland; safety of indigenous communities; infrastructure planning and protection; fisheries; studies on the value of ecosystems services in the region, etc.);

- **Capacity analysis** (sciences, products, organizational arrangements, partnerships, people)
 - document state-of-the-art and current research plans and priorities;
 - outline what is predictable and what is not, including limits to predictability;
 - **Gap analysis**
 - institutional requirements, educational needs, scientific priorities;
 - how can we:
 - recognize and satisfy existing demand (issue: people live at specific locations and not in a grid cell, what can we do about this?);
 - tailor solutions to the problems, e.g. consider a variety of methods, including statistical approaches to forecasting and downscaling for local relevance;
 - match the problems to the existing scientific capabilities.
 - **Creating adaptive capacity**
 - sector-based recommendations and actions that are stakeholder driven and include all the disciplines that can usefully contribute to creating new solutions (including social and political scientists; local experts).
- Develop, seek funding for and implement a small number of ‘proof-of-concept’ studies.

4.2.3 A significant number of participants immediately agreed to co-author the proposed paper, including the Workshop organizers, and it was agreed that Dr Holger Meinke would serve as coordinating/lead author. All participants would have the opportunity to contribute should they so desire. It was recognized that the work would lend itself to development of the white paper for WCC-3, which would be coordinated by the WCASP Secretariat. It was further suggested to make sure to request participation of China (Prof Qin), due to his long background in polar matters at global and regional scales.

4.2.4 With respect to training, it was agreed that there was certainly a need for training for both the service providers, and also the interest (or user) groups in the region. The group also recognized the need for education and outreach materials to generate interest among young people in polar climate sciences.

Recommendations:

- Establish or coordinate existing courses and training programs throughout the Region, targeting the service providers, and also the interest (or user) groups in the region – consider coordination, for example, of a summer school within a collaborative university project;
- Identify and contact existing training institutions with programmes relevant to Polar Regions (e.g. the WMO Regional Training Centre based at the Russian State Hydrometeorological University (RSHU) in St. Petersburg and the University of the Arctic), and create a list of their curricula and programmes.

Decision:

- Seek opportunities within the development and application of the CLIPS curriculum to focus on the NMHSs and user groups functioning in polar climates (**WCASP and ETR**).

4.3 User Interface, Identification of User Requirements and Partnerships (Session leader: Jaakko Helminen)

4.3.1 Participants were informed of the programme and objectives of the World Climate Conference-3 (WCC-3), (Geneva, Switzerland, August 2009). It was noted that a series of white papers would be developed for the event, to describe aspects of climate and health, climate and tourism, etc, and that there would be one white paper developed for IPY. The opportunity of WCC-3 for embedding the concept of PolarCLIPS and PCOF in the knowledge and plans of decision-makers, including many potential partners, was recognized.

Recommendations:

- Consult with the WCC-3 International Organizing Committee (IOC) and its Programme Committee (Kattsov), and if the IOC believed it feasible, develop and submit to WCC-3 a white paper on the concept of PolarCLIPS and PCOF (**WCASP, et al**);
- At the WCC-3 side session on IPY 2007-2008, reflect the theme of PolarCLIPS and PCOF as IPY legacy initiatives (**IPY/IPO, WCASP**).

4.3.2 The group was informed of a potential funding opportunity through the European Polar Consortium, in association with the European Polar Board of the European Science Foundation. The Polar Climate call for proposals is described at: <http://www.esf.org/polarclimate>. The deadline for pre-proposals was 24 October 2008. Projects approved under this umbrella may run from three to four years. The intent was to support trans-national research at the European level, in both Arctic and Antarctic, and also to maintain the momentum of integrated groups of scientists that was formed during the IPY process. In addition, the group recognized the potential for enhancing likely partnerships for the PolarCLIPS initiative in the international conference 'Arctic Change 2008', (Quebec City, 9-12 December 2008). All participants were urged to consider their involvement in these opportunities, and others including the Arctic Science Summit Week (March 2009), and the IPY Oslo Open Science Conference (Oslo, 6-12 June 2010).

4.3.3 With respect to user requirements, service providers do not often enough speak directly to users or their representatives to identify their needs for climate information products and services. The Climate Outlook Forum process provides a useful platform for this direct interface with users, allowing dialog and feedback, responses to questions and concerns, development of knowledge and trust. Prior to launching a PCOF, however, the group recognized the benefits of surveying the relevant stakeholders. Participants were informed of the launch of a survey of National Meteorological and Hydrological Services (NMHSs), to identify focal points for PolarCLIPS, and to identify NMHS current status and plans for operational climate services and products useful for decision-making in high latitudes. The group urged the completion of this initiative as soon as possible. In addition, participants approved the development of a user-oriented survey, as a first step in identifying the priority climate-related needs to be taken into account by a PCOF.

Decisions:

- Approach the Arctic Council, AMAP, the Inuit Circumpolar Council and other relevant existing governance groups, to seek their advice and input to a user survey (content, target groups, etc) – it would be best if the survey served the interests of partnering groups as well as those of WMO (**WCASP, Helminen**);
- Seek sponsors for the user survey – major organizations in the energy sector, for example, or the reinsurance sector, may welcome an opportunity to help communities in this manner (**WCASP**);
- Conduct the user survey (**WCASP, partners**);
- Complete the survey of NMHSs, including the database of PolarCLIPS focal points in each of the 46 identified polar countries (**WCASP**).

4.3.4 The group urged the broadest possible outreach effort to promote PolarCLIPS and PCOF, and to seek advice and commitment to the goals.

Recommendations:

- Inform the new EC PPORS, SCAR, IASC and the IPY/IPO of the recommendations from the present Workshop regarding PolarCLIPS and PCOF;
- Approach the Arctic Council, AMAP, the Inuit Circumpolar Council and other relevant existing governance groups, to seek their agreement to collaborate/partner with WMO in the establishment of PCOF.

4.4 Feasibility of Establishment of a Polar Climate Outlook Forum (PCOF) (Session leader: Howard Cattle)

4.4.1 The participants reviewed many of the factors relevant to scoping the feasibility of a PCOF, including the RCOF concept itself. Participants recollected that:

- Climate information including predictions/outlooks could be of substantial benefit to many parts of the world in adapting to and mitigating the impacts of climate variability and change;
- RCOFs across the world have the overarching responsibility to produce and disseminate a regional assessment (using a predominantly consensus-based approach) of the state of the regional climate for the upcoming season;
- Built into the RCOF process is a regional networking of the climate service providers and user-sector representatives (NB – this is critical to RCOFs);
- Participating countries recognize the potential of climate prediction and seasonal forecasting as a powerful development tool to help populations and decision-makers face the challenges posed by climatic variability and change;
- National and Regional capacities are varied but certainly inadequate to face the task alone;

- Ownership now lies largely with national and regional players, but there is a continuing need for support at all levels to ensure that the momentum gained to date is maintained;
- RCOFs bring together national, regional and international climate experts, on an operational basis, to produce regional climate outlooks based on input from NMHSs, regional institutions, Regional Climate Centres (RCCs) and Global Producing Centres of Long Range Forecasts (GPCs) and other climate prediction centres;
- Through interaction with sectoral users, extension agencies and policy makers, RCOFs assess the likely implications of the outlooks on the most pertinent socio-economic sectors in the given region and explore the ways in which these outlooks could be applied;
- RCOFs also review impediments to the use of climate information, experiences and successful lessons regarding applications of the past RCOF products, and enhance sector-specific applications;
- These RCOFs then lead to national forums to develop detailed national-scale climate outlooks and risk information including warnings for communication to decision-makers and the public.

4.4.2 Discussion covered a wide range of considerations:

- There are significant uncertainties for climate information, prediction, and services at high latitudes, but the vulnerability is great, and users are making decisions every day – they need the best information and services we can offer;
- That a PCOF could be similar to RCOFs in other parts of the world, particularly in terms of the user interface, timing, consensus-building, and would take place in annual meetings, with providers and users, including the media and partners present, and would culminate in issuance of consensus statements;
- That the geographical area it could encompass would likely be circumpolar, and *could* cover both the Arctic and Antarctic, depending on commitment and user-interest, but that separate PCOFs may be the more feasible approach given the differences between the two regions (e.g. issues, stakeholders, processes, user groups, etc.);
- That, given the limited predictive skill at seasonal climate scales and the rapid environmental changes taking place in Polar Regions, it may be reasonable to include the Nowcast forecast range to help users better access and interpret NWP and monitoring products; as well as seasonal scale; decadal scale; and/or long-term change scale predictions and projections, and also statistical/empirical products, monitoring products and information on the states of the various major climate oscillations;
- That the primary users of PCOF information might be different for each timescale and may include individual indigenous persons, many and varied socio-economic sectors, even highly sophisticated corporations, each of which may require different levels of training or familiarization;

- That a better 'title' for users would be 'decision-makers';
- That these decision-makers in Polar Regions are known to need information on:
 - Temperature (but likely very limited predictive skill),
 - Precipitation, both liquid and frozen (but likely no predictive skill),
 - Winds (not commonly a parameter for seasonal prediction),
 - Sea ice (extent, thickness) (but uncertain whether seasonal models have dynamic/thermodynamic sea ice),
 - Snow cover (is there any skill in predicting snow cover?)
 - Freeze/Thaw periods and conditions;
- That the observational database for skill assessment (and prediction) is poor for Polar Regions, and that ice and snow make model initialization more problematic than in low latitudes.

4.4.3 Given the factors noted above and the need to engage a wider community, participants gave their endorsement for a step forward in establishment of a PCOF. They reiterated their recommendation to proceed with the surveys (i.e. to identify the relevant current and planned activities of NMHSs and other groups providing climate services for these regions, and potential partners, collaborators), and to consider how to maximize the return on these; to build the community of practice; to publish a concept paper for PCOF; to engage in proof of concept studies; to explore training options for services specialist and for users; and to urge the data, monitoring and research communities forward on the specific recommendations above. In addition to these activities to further scope the potential for a PCOF, the group also recommended a subsequent meeting, with both providers and users present to discuss benefits, issues including status of commitment to the process, understanding of user needs, ability to address these needs, communications and so on. The participants urged that the 'community of practice' take advantage of upcoming events including the Conference on Arctic Change 2008 (Quebec City, Canada, December 2008), for networking and outreach on the concept, and to gauge user interest.

Decisions:

- Participants would engage in an assessment of PCOF viability and would evaluate the results preferably by the fourth quarter of 2009. This would draw on the present experience with RCOF practices, the availability of NWP forecasts and GPC output at monthly, seasonal and longer timescales, the availability of sophisticated monitoring products (e.g. satellite-based), the expectation of research advances for observations, modelling, predictions and projections, and the recognition that users need the best available information for climate-risk management;
- The goals, expected outcomes and participating groups in the evaluation would be clarified based on the results of the survey and outreach activities, and the exercise would be coordinated by WCASP (Kolli, Malone); WCRP (Ryabinin, Cattle, Goodison); IPY (Sarukhanian) with the help of Zwiers, Meinke, Helminen, and other volunteers;
- Drawing upon the products and services of WMO GPCs and RCCs serving the region, invite the lead of CBS Expert Team on LRF to actively participate in this exercise.

5. CLOSURE OF THE WORKSHOP

On behalf of the organizers of the workshop, Dr Kolli thanked the participants for their contributions to the discussions and recommendations, and noted that together, the group had achieved a thoughtful and reasonable conclusion that would eventually benefit the entire community associated with PolarCLIPS, including climate service providers, the research community, partnering agencies and the user communities. On behalf of all participants, he reiterated thanks to the hosts and local organizers at the MGO, including Dr Kattsov, Dr Zaitsev, Dr Pavlova and Dr Shkolnik for their efforts in facilitating the session, visas and local transportation and, in particular, for the exceptional evening hosted by the MGO including the tour and dinner, at the Palace of the Great Duke Vladimir Aleksandrovich. Dr Kattsov was asked to relay WMO's appreciation to Dr Bedritzky, the Permanent Representative of the Russian Federation with WMO, and WMO President, for his support for the workshop. Dr Kattsov added his appreciation to participants and to the Secretariat, noting that he felt the workshop had been successful and greatly interesting.

The Workshop closed at 13:00 PM, 11 September 2008.



WMO WCRP IPY WORKSHOP ON CLIPS IN POLAR REGIONS: CLIMATE PRODUCT GENERATION, USER LIAISON AND TRAINING

St. Petersburg, Russian Federation
8-11 September 2008

PROGRAMME

DAY 1: Monday, 8 September 2008

| Item | Topic | Speaker | Time |
|----------|---|---------------------------------------|--------------------|
| 1 | Opening of the Session | | |
| 1.1 | Opening address and welcome from host | V. Kattsov | 09:00-09:10 |
| 1.2 | Welcome; goals, format; Identification of Session Chairman; rapporteurs | R. Kolli | 09:10-09:20 |
| 1.3 | Introductions (Name, Country, Agency) | All | 09:20-09:35 |
| 1.4 | Logistical arrangements, announcements | A. Zaitsev | 09:35-09:40 |
| | | | |
| 2 | WMO-related International Climate Science Programmes | | |
| 2.1 | Climate Change and Variability: Role of WMO | R. Kolli | 09:40-10:05 |
| 2.2 | WCRP including CLIVAR, CliC, and ESSP | V. Ryabinin | 10:05-10:30 |
| 2.3 | International Polar Year 2007-2008 and IPY Observing System Legacy | E. Sarukhanian | 10:30-11:00 |
| | | Break | 11:00-11:30 |
| 3 | Climate Variability and Change in Polar Regions | | |
| 3.1 | Antarctic Climate: Current Status and Projections | A. Klepikov (presenting) and V. Lagun | 11:30-12:15 |
| 3.2 | Climate variability and change in polar regions: Key findings and uncertainties, Arctic region (ACIA, IPCC AR4, ...) | V. Kattsov | 12:15-13:00 |
| | | Lunch break | 13:00-14:30 |
| 3.3 | Regional (polar) modeling, downscaling, model evaluation/reliability | J. Christensen | 14:30-15:15 |
| 3.4 | Cryosphere observation, monitoring, research: An IPY Legacy – Global Cryosphere Watch (GCW) | B. Goodison | 15:15-16:00 |
| | | Break | 16:00-16:30 |
| 3.5 | Open discussion on 'Predictability at seasonal, interannual and decadal time scales' including factors that influence seasonal to decadal scale prediction at high latitudes | Chair: V. Ryabinin | 16:30-17:30 |

DAY 2: Tuesday, 9 September 2008

| Item | Topic | Speaker | Time |
|-----------|--|---|--------------------|
| 4 | Climate Products and Services for Polar Users: Case Studies, Examples | | |
| 4.1 | Background/overview | R. Kolli | 09:00-09:10 |
| 4.2 | Examples of Using Climate Information and Predictions for Decisions in Alaska, USA | A. Holman | 09:10-09:30 |
| 4.3 | Satellite Application Facility on Climate Monitoring: CM-SAF Overview, Germany | M. Werscheck | 09:30-09:50 |
| 4.4 | Climate products and services for polar users: case studies and examples, Norway | E. Forland (presenting) and I. Hanssen-Bauer | 09:50-10:10 |
| 4.5 | 20th century climate, hydrology and glacier variations and 21st century scenarios and impacts, Iceland | T. Thorsteinsson | 10:10-10:30 |
| | | Break | 10:30-11:00 |
| 4.6 | Seasonal forecast in Hungary | S. Szalai | 11:00-11:20 |
| 4.7 | Climate products and services for polar users: Indian Antarctic Research Programme | N. Niyas | 11:20-11:40 |
| 4.8 | Issues related to the polar southern region: perspectives from Chile | J. Carrasco | 11:40-12:00 |
| 4.9 | Climate products and services provided by the Brazilian Antarctic Meteorology Project | A. Setzer | 12:00-12:20 |
| 4.10 | Climate products and services in the Eurasian Arctic | V. Smolyanitsky (presenting), V. Karklin, Y. Mironov, and V. Ivanov | 12:20-12:40 |
| | | Lunch break | 12:40-14:15 |
| 5. | Climate-related Needs of People in Polar Regions | | |
| 5.1 | More than just the pieces – climate-risk management under uncertainty | H. Meinke | 14:15-14:45 |
| 5.2 | Survey on user requirements for climate data, information, products and services | J. Helminen | 14:45-15:15 |
| 5.3 | New approaches to learning and serving polar peoples | H. Huntington | 15:15-15:45 |
| | | Break | 15:45-16:00 |
| 5.4 | Bridging the gaps between climate-related needs of people and output from climate models (GCMs and RCMs) | I. Hanssen-Bauer | 16:00-16:45 |
| 5.5 | AMAP contributions to polar climate outlook process: International polar cooperation and effective end-user relationship | L-O. Reiersen | 16:45-17:30 |
| 5.6 | IASC Overview | V. Ryabinin | 17:30-17:45 |

19:00 *Tour and dinner at the Palace of the Great Duke Vladimir Aleksandrovich, Dvortsovaya, Embankment of the Neva River.*

DAY 3: Wednesday, 10 September 2008

| Item | Topic | Speaker | Time |
|----------|---|--|--------------------|
| 6 | Development and Communication of Information, Products and Services, including Demonstrations | | |
| 6.1 | World-wide NMS sea ice services (WMO/IOC JCOMM ETSI; IICWG, BSIM; WMO GDSIDB project) | V. Smolyanitsky | 09:00-09:30 |
| 6.2 | Advancing Seasonal Prediction: recent achievements | V. Ryabinin | 09:30-10:00 |
| 6.3 | Satellite providers – current and planned products and services | E-A. Herland | 10:00-10:30 |
| | | Break | 10:30-11:00 |
| 6.4 | Global seasonal prediction: products from WMO GPCs and Lead Centres | V. Kryjov (presenting) and R. Graham | 11:00-11:30 |
| 6.5 | Regional Climate Centres – a new approach to strengthening climate services | V. Kryjov | 11:30-12:00 |
| 6.6 | Statistical tools | F. Zwiers | 12:00-12:30 |
| | | Lunch break | 12:30-14:30 |
| 6.7 | RSHU training on climate change and prediction: perspectives of a WMO Regional Training Centre | A. Dikinis and M. Verhovsky (presenting) | 14:30-15:00 |
| 6.8 | Climate Predictability Tool (CPT) | R. Kolli | 15:00-16:00 |
| | | Break | 16:00-16:30 |
| 6.9 | Demonstrations and practical applications, to include discussion of current GPC products, available forecasts and outlooks for the upcoming season (from NMHSs and other agencies or consortia); areas of agreement and disagreement between such outputs, etc. | Chair: R. Kolli Discussion: All | 16:30-17:30 |

DAY 4: Thursday, 11 September 2008

| Item | Topic | Speaker | Time |
|----------|---|--------------------|--------------------|
| 7 | Addressing the Needs | | |
| 7.1 | Group Discussion to scope recommendations for research | Chair: F. Zwiers | 09:00-10:00 |
| 7.2 | Group discussion on recommendations for operational and outreach products and services, their development, dissemination and communication | Chair: H. Meinke | 10:00-11:00 |
| | | Break | 11:00-11:30 |
| 7.3 | Group discussion on recommendations for user interface, identification of user requirements and on partnerships | Chair: J. Helminen | 11:30-12:00 |
| 7.4* | Round table discussion on feasibility of establishment of a sustainable PCOF* - Recommendations to WMO WCP, WCRP, Polar Panel and to other appropriate agencies (e.g. Arctic Council) | Chair: H. Cattle | 12:00-12:55 |
| 8 | Closing | | 12:55-13:00 |

LIST OF PARTICIPANTS

Brazil

Dr Alberto SETZER
 Instituto Nacional de Pesquisas Espaciais
 (INPE)
 Centro de previsto de Tempo e Estudos
 Climaticos (CPTEC)
 Caixa postal 515
 12227-010 SAO JOSÉ DOS CAMPOS, SP
 Tel: +55(12) 3945-6464
 Fax: +55(12) 3945 6652
 Email: asetzer@cptec.inpe.br

Canada

Dr Barry GOODISON
 Visiting Expert (Environment Canada)
 World Climate Research Programme
 c/o World Meteorological Organization
 7 bis, Avenue de la Paix,
 Case Postale 2300
 1211, GENEVA 2
 Switzerland
 Tel: +41 22 730 8055
 Fax: +41 22 730 8036
 Email: BGoodison@wmo.int;
barrygo@rogers.com

Dr Francis ZWIERS
 Climate Research Division
 Environment Canada
 4905 Dufferin Street
 TORONTO, ONTARIO M3H 5T4
 Tel: +1 416 739 4767
 Fax: +1 416 732 3850
 Email: francis.zwiers@ec.gc.ca

Chile

Dr Jorge CARRASCO
 Dirección Meteorológica de Chile
 Av. Diego Portales 3450
 Estación Central
 Casilla 140, Sucursal Matucana
 SANTIAGO
 Tel: +56 2 436 4502
 Fax: +56 2 681 4902
 Email: jorge.carrasco@meteochile.cl

Denmark

Dr Jens Hesselbjerg CHRISTENSEN
 Danish Climate Centre
 Danish Meteorological Institute
 Lyngbyvej 100
 DK-2100 COPENHAGEN Ø
 Tel: +45 3915 7428
 Fax: +45 3915 7460
 Email: jhc@dmi.dk

Finland

Mr Jaakko HELMINEN
 Climate Impact Consulting Limited
 Kruununtie 10 B 4
 FI-02180 ESPOO
 Tel: +358 50 563 5143
 Fax:
 Email: jaakko.helminen@elisanet.fi

Germany

Mr Martin WERSCHECK
 Satellite Application Facility on Climate
 Monitoring (CM-SAF)
 Deutscher Wetterdienst
 Frankfurter Strasse 135
 63067 OFFENBACH
 Tel: +49 69 8062 4919
 Fax: +49 69 8062 3759
 Email: martin.werscheck@dwd.de

Hungary

Dr Sandor SZALAI
 Hungarian Meteorological Service
 P.O. Box 38
 H-1525 BUDAPEST
 Tel: +36-1-346-4624
 Fax: +36-1-346-4665
 Email: szalai.s@met.hu

Iceland

Dr Thorsteinn THORSTEINSSON
 Hydrological Service Division
 National Energy Authority
 Grensasvegi 9
 IS-108 REYKJAVIK
 Tel: +354 569 6000/+354 696 2189
 (GSM)
 Fax: +354 568 8896
 Email: thor@os.is

India

Mr N. T. NIYAS
 National Climate Centre
 Office of Addl. Director General of
 Meteorology (Research)
 India Meteorological Department
 Shivajinagar
 PUNE-411005 Maharashtra
 Tel: +20 25535877 or 9120 25535211
 Ext 277(522)
 Fax: +91 20 25535435
 Mobile: +91 93 70165843
 Email: niyasiota@gmail.com

The Netherlands

Prof Holger MEINKE
 Centre for Crop Systems Analysis
 Department of Plant Sciences
 Wageningen University
 P.O. Box 430
 WAGENINGEN, NL 6700 AK
 Tel: +31317484772
 Mobile: +31 6131 76077
 Fax:
 Email: holger.meinke@wur.nl

Norway

Dr Inger HANSEN-BAUER
 Climate Research
 Climatology Department
 Norwegian Meteorological Institute
 P.O. Box 43
 Blindern, 0313 OSLO
 Tel: +(47) 22 96 33 82
 Fax:
 Email: i.hanssen-bauer@met.no

Dr Eirik FORLAND
 Climate Department
 Norwegian Meteorological Institute
 P.O. Box 43
 Blindern
 0313 OSLO
 Tel: +47 22 96 31 86
 Fax: +47 22 96 30 50
 Email: eirikjf@met.no

Russian Federation

Dr Elena AKENTYEVA
 Voeikov Main Geophysical Observatory
 7 Karbyshev Street
 194021 ST. PETERSBURG
 Tel: +(7 812) 297 2102
 Fax: +(7 812) 297 2102
 Email: eakentyev@hotmail.ru
kobyshnv@main.mgo.rssi.ru

Prof. Genrikh ALEKSEEV
 Arctic and Antarctic Research Institute (AARI)
 38 Bering Street
 199397 ST. PETERSBURG
 Tel: +7 812 352 1520
 Fax: +7 812 352 2688

Dr Alexander DIKINIS
 Russian State Hydrometeorological University
 WMO RTC in St. Petersburg
 Climatology and Applied Ecology
 Malookhtinsky ave., 98
 195196 ST. PETERSBURG
 Tel: +7 812 444 56 36
 Fax: +7 812 444 60 90
 Email: ums@rshu.ru

Dr Vladimir KATTSOV
 Voeikov Main Geophysical Observatory
 7 Karbyshev Street
 194021 ST. PETERSBURG
 Tel: +7 812 297 4390
 Fax: +7 812 297 8661
 Email: kattsov@main.mgo.rssi.ru

Dr. Elena KHLEBNIKOVA
 Voeikov Main Geophysical Observatory
 7 Karbyshev Street
 194021 ST.PETERSBURG
 Tel: +7 812 297 21 02
 Fax: +7 812 297 86 61
 Email: sun@main.mgo.rssi.ru

Dr Alexander KLEPIKOV
 Arctic and Antarctic Research Institute
 (AARI)
 38 Bering Street
 199397 ST. PETERSBURG
 Tel: +7 812 352 0226
 Fax: +7 812 352 2688
 Email: klep@aari.nw.ru

Dr Vladimir KRYZHOV
 Research and Development of MMELRF
 Hydromet Centre of Russia
 11-13, Bol. Predtechensky Pereulok
 123242 MOSCOW
 Tel: +7 499 795 2326
 Fax: +7 499 795 1582
 Email: kryjov@mecom.ru;
kryjov@yahoo.co.uk

Dr Victor LAGUN
 Arctic and Antarctic Research Institute (AARI)
 38 Bering Street
 199397 ST. PETERSBURG
 Tel: +7 812 352 1520
 Fax: +7 812 352 2688

Dr. Valentin MELESHKO
 Voeikov Main Geophysical Observatory
 7 Karbyshev Street
 194021 ST.PETERSBURG
 Tel: +7 812 297 43 90
 Fax: +7 812 297 86 61
 Email: meleshko@main.mgo.rssi.ru

Dr Victoria MIRVIS
 Voeikov Main Geophysical Observatory
 7 Karbyshev Street
 194021 ST.PETERSBURG
 Tel: +7 812 297 86 68
 Fax: +7 812 297 86 61
 Email: mirvis@main.mgo.rssi.ru

Dr Tatyana PAVLOVA
 Voeikov Main Geophysical Observatory
 7 Karbyshev Street
 ST. PETERSBURG 194021
 Tel: + 812 297 43 90
 Email: pavlova@main.mgo.rssi.ru;
t-v-pavlova@mail.ru

Dr Igor SHKOLNIK
 Voeikov Main Geophysical Observatory
 7 Karbyshev Street
 194021 ST.PETERSBURG
 Tel: +812 297 86 68
 Fax: +812 297 86 61
 Email: igor@main.mgo.rssi.ru

Dr Vasily SMOLYANITSKY
 Arctic and Antarctic Research Institute (AARI)
 38 Bering Street
 199397 ST. PETERSBURG
 Tel: +7 812 352 2152
 Fax: +7 812 352 2688
 Email: vms@aari.aq

Dr Michail VERSHOVSKY
 Russian State Hydrometeorological University
 WMO RTC in St. Petersburg
 Climate Change
 Malookhtinsky ave., 98
 195196 ST. PETERSBURG
 Tel: +7 812 444 56 36
 Fax: +7 812 444 60 90
 Email: ums@rshu.ru

Dr Alexandr ZAITSEV
 Voeikov Main Geophysical Observatory
 7 Karbyshev Street
 194021 ST. PETERSBURG
 Tel: + 812 297 43 90
 Email: a.zaitsev@main.mgo.rssi.ru

United Kingdom

Dr Howard CATTLE
 International CLIVAR Project Office
 National Oceanography Centre
 Southampton Empress Dock,
 SOUTHAMPTON, SO14 3ZH
 Tel: +44 23 80596208 (Direct Dial)
 Tel: +44 23 80596777 (Secretary)
 Fax: +44 23 80596204
 Email: hyc@noc.soton.ac.uk

United States of America

Ms Amy E. HOLMAN
 NOAA Alaska Regional
 Collaboration Team
 c/o NOAA National Weather Service
 222 West 7th Avenue #23
 ANCHORAGE, ALASKA 99513-7575
 Tel: +1-907-271-5334
 Fax: +1-907-271-3711
 Email: Amy.Holman@noaa.gov

Dr Henry P. HUNTINGTON
 23834 The Clearing Dr.
 EAGLE RIVER, ALASKA 99577
 Tel: +1-907-696-3564
 Fax: +1-907-696-3565
 Email: hph@alaska.net

INTERNATIONAL ORGANIZATIONS**Arctic Monitoring and Assessment Programme (AMAP)**

Mr Lars-Otto REIERSEN
 Arctic Monitoring and Assessment
 Programme (AMAP) Secretariat
 P.O. Box 8100 Dep.
 N-0032 OSLO
 Norway
 Tel: +47 23 24 16 32
 Fax: +47 22 67 67 06
 Email: lars-otto.reiersen@amap.no

European Space Agency

Dr Einar-Arne HERLAND
 Science Strategy, Coordination and
 Planning Office (EOP-SA)
 ESA/ESRIN
 Via Galileo Galilei
 00044 FRASCATI, Italy
 Tel: +39 06 941 80600
 Fax: +39 06 941 80602
 Email: Einar-Arne.Herland@esa.int

WMO SECRETARIAT

7bis, Avenue de la Paix
 CP 2300
 CH-1211 GENEVA 2
 Switzerland

Dr Rupa Kumar KOLLI
 Chief
 World Climate Applications and Services
 Division
 Climate Prediction and Adaptation Branch
 Climate and Water Department
 Tel: +41 22 730 8377
 Fax: +41 22 730 8042
 Email: RKolli@wmo.int

Ms Leslie MALONE
 Scientific Officer
 Climate Prediction and Adaptation Branch
 Climate and Water Department
 Tel: +41 22 730 8220
 Fax: +41 22 730 8042
 Email: LMalone@wmo.int

Dr Vladimir RYABININ
 Senior Scientific Officer
 World Climate Research Programme
 Tel: +41 22 730 8486
 Fax: +41 22 730 8036
 Email: VRyabinin@wmo.int

Dr Eduard SARUKHANIAN
 Special Advisor to
 the WMO Secretary-General on IPY
 Tel: +41 22 730 8420
 Fax: +41 22 730 8049
 Email: ESarukhanian@wmo.int