



United Nations
Educational, Scientific and
Cultural Organization

Organisation
des Nations Unies
pour l'éducation,
la science et la culture

International Experts Meeting

**Climate Change
and Arctic Sustainable Development :
scientific, social, cultural and educational challenges**

3-6 March 2009, Monaco

ABSTRACT: OCEANS, ICE AND ATMOSPHERE

Barry Goodison

Visiting Expert,
World Meteorological Organization,
SWITZERLAND

Cryosphere and Climate: The Arctic Challenge

The cryosphere collectively describes elements of the Earth System containing water in its frozen state on land and sea and includes: snow cover and solid precipitation, sea-ice, lake-ice and river-ice, glaciers, ice caps, ice sheets, permafrost and seasonally frozen ground. The cryosphere is arguably the most visible and informative indicator of climate change over the Arctic region, as dramatically seen during the last decade. Through its influence on surface energy and moisture fluxes, clouds, precipitation, hydrology, and atmospheric and oceanic circulation, the cryosphere plays a significant role in not only the regional climate of the Arctic, but also in global climate. Yet monitoring and modelling of the elements of the cryosphere and assessing cryospheric change and associated impacts in an integrated manner in high latitude areas are complex and remain a major challenge.

Gaps in our knowledge on cryosphere-climate interactions and the impacts of the changing cryosphere on physical and socio-economic systems have been identified in recent years through national and international initiatives. Science Plans or Assessments of WCRP's CliC Project, the Arctic Climate Impact Assessment (ACIA), International Conference on Arctic Research Planning (ICARPII), UNEP's Global Outlook for Snow and Ice, the IPCC WG1 chapter on Observations: Changes in Snow, Ice and Frozen Ground, and currently, Arctic Council's SWIPA initiative, all articulate scientific gaps in knowledge and identify needed actions. Reports of the IGOS Cryosphere Theme and SAON focus on observational gaps and needs, complementing the reports noted above. The most recent, ambitious collaborative initiative addressing many of the gaps in our knowledge has come through the International Polar Year 2007-2008 (IPY) projects. Yet, challenges remain to improve our understanding and prediction of the past, present and

future of the Arctic and the Earth Systems. Some knowledge gaps in cryospheric studies which must be addressed include:

- Determination of the mass balance of ice sheets and glaciers and their contribution to sea-level change through improved/enhanced observation and modelling
- Accurate determination of sea ice extent and thickness and improved representation of sea ice in climate models to improve future prediction of changes
- Improved understanding and quantification of the role of permafrost and frozen ground in the carbon cycle through a coordinated measurement and modelling framework for the northern high latitudes
- Significantly improved accuracy of observation and model prediction of precipitation, especially snowfall, over the Arctic land and ocean
- Determination of the present and future freshwater balance of the Arctic and assessment of the impact of changes on bio-geophysical and socio-economic systems
- Improved prediction of the cryosphere using regional climate models leading to improved prediction on monthly to seasonal or longer time scales
- identification of climate and cryosphere information needs of people and groups living and working at high latitudes and provision of cryosphere products to users, along with information on their interpretation and use

The challenge now is to sustain the momentum that IPY generated. IPY Legacy initiatives, which would address gaps in cryosphere-climate knowledge and contribute to a comprehensive, integrated system of the Arctic include:

- Sustaining Arctic Observing Networks (SAON), with an Integrated Arctic Ocean Observing System (iAOOS), Arctic-HYCOS, and *Integrated AON*; Global Cryosphere Watch (GCW);
- Polar Satellite Constellation; and,
- Polar Regional Climate Outlook Forum (PCOF).

An integrated observation and data management system is essential, incorporating *in-situ* and satellite observations from operational and research networks and platforms and proposed polar reference stations or “supersites” following established standards and guidelines. WMO’s GCW initiative is being designed to provide reliable, comprehensive observations of the elements of the cryosphere through an integrated observing approach, in collaboration with relevant national and international programmes and agencies and to provide authoritative products and information on the current and projected future state of the cryosphere to support decision making and environmental policy development.

IPY has not only advanced scientific knowledge, provided a snapshot of the current state of the Arctic system, and shown the benefit of comprehensive, integrated Arctic observing systems, but also has engaged young scientists, who are ready to carry the research to an even higher level, and engaged northerners, especially indigenous peoples, in science projects in which they contribute their knowledge to an improved understanding of the Arctic environment. Now the challenge is to engage national and international support for maintaining and expanding a multidisciplinary Arctic research program that will support achieving sustainable development of the Arctic in a rapidly changing environment.

Recommendations:

1. International Polar Decade:

- *Noting that WMO and ICSU were the co-sponsors of International Polar Year 2007-2008 (IPY)*
- *Considering the large investments of nations to IPY 2007-2008, the continuing and growing requirements for information on environmental change in Northern high latitudes by scientists, communities, northern peoples, decision and policy makers;*
- *Recognising the need to build upon the surge of operational and research programmes conducted during IPY and the need to convert these into sustainable long-term research and monitoring capabilities;*
- *Noting the Declaration from the Monaco Conference on “The Arctic: Observing the environmental changes and facing their challenges” on the need to “uphold the impetus launched by International Polar Year 2007-2008 and capitalise on the momentum created by consolidating and sustaining the mobilisation of scientific research and monitoring initiatives”;* and
- *Noting that WMO Executive Council invited other international organisations to consider the launch of an International Polar Decade*

It is recommended that, following WMO’s suggestion, ICSU and other international organizations consider the idea of an International Polar Decade as a long-term process of research and observations in Polar Regions to meet the requirements for climate change studies, assessments and prediction to benefit society.

2. Sustaining Arctic Observing Networks (SAON):

- *Recognising that observing systems are essential for monitoring the current state and changes in the Arctic environment, and for validating and improving climate predictions over the Arctic;*
- *Recognising that data and information for assessing climate variability and change and environmental sustainability are dependent on operational and research networks, on in-situ and satellite systems, and on effective data and information exchange;*
- *Considering that IPY provided an expansion of observations and stimulated international cooperation on data management and access; and*
- *Noting the Arctic Council/AMAP initiative, with other international organizations, on Sustaining Arctic Observing Networks (SAON), a process to further multinational engagement in developing sustained and co-ordinated pan-Arctic observing and data sharing systems and social, economic and cultural change; and, their recommendations for concerted action on sustaining Arctic observing systems;*

It is recommended that a mechanism be established to facilitate international collaboration among operators, funding bodies and users of observational systems and data over the Arctic region.

3. User Focused Climate Services for Adaptation and Sustainable Development:

- *Considering the importance of identifying the climate information needs of people and groups living and working at high latitudes;*
- *Recognising the need to continue to improve the predictive skill of global and regional models for high-latitude areas, on all time scales;*
- *Noting the need to assist the users in interpretation and application of climate information and products in real life decision making;*

- *Given the need for capacity building, including technical training for climate scientists and product developers, and also for combined provider and user groups;*

It is recommended to establish a viable operational mechanism to facilitate effective interactions between climate professionals and users/stakeholders, such as a Polar Climate Outlook Forum (PCOF), recognized by IPY as an WMO legacy project.

4. Integrated Monitoring

- *Considering the ICARPII recommendation that “an integrated observation and data management system, incorporating all relevant disciplines, scales and observing platforms, is paramount and will make use of polar reference stations, so called “supersites”;*
- *Noting the ICARPII recommendation that integrated observing plans require coordination of observations and modelling ensuring the same domains for modelling and observation work, thus leading to production of high-quality data sets representing the variability of essential parameters at dominant temporal and spatial scales;*
- *Noting the success of the approach of integrated observation by the WCRP Co-ordinated Enhanced Observing Period (CEOP) in creating a global reference network of observatories for water cycle studies, by collecting atmospheric and surface data from in-situ and satellite observations and output from atmospheric model over a reference area; and*
- *Noting the development of co-ordinated pan-Arctic observing through programmes such as WMO’s Global Cryosphere Watch, IPY International Arctic Systems for Observing the Atmosphere (IASOA), and the Circumpolar Biodiversity Monitoring Program:*

It is recommended that an integrated polar reference observing network of “supersites” be established, building on existing infrastructure and facilities, where feasible, where in-situ, satellite and model data can provide long-term, multidisciplinary datasets suitable for environmental monitoring and prediction.