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IPY LEGACY

(Submitted by the WMO Secretariat)

Summary and Purpose of Document

This document provides information on IPY Legacy activities as they were presented to the Executive Panel of Expert on Polar Observations, Research and Services (EC-PORS), 13-15 October 2009, Ottawa, Canada). This includes excerpts of the EC-PORS documents on the Global Cryosphere Watch (GCW), Pan-Antarctic Observations System (PAntOS), The Southern Ocean Observing System (SOOS), Integrated Arctic Ocean Observing System (IAOOS), GIIPSY and the IPY Space Task Group, Sustaining Arctic Observing Networks (SAON), IPY Data Management, and Database Updating. Those documents also include recommendations for WMO on IPY Legacy initiatives.

ACTION PROPOSED

The Meeting is invited to take information in this document into account when discussion relevant agenda item. Expert Team is invited to provide guidance on the future activities related to IPY Legacy.

References:

First session of the Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS-1), Agenda item 7.3 (IPY Legacy Programmes)

7.3.1 WMO Global Cryosphere Watch (GCW)

Background

7.3.1.1 The report of an ad hoc expert team on Global Cryosphere Watch (GCW), see EC-PORS-1, INF.4, presents the rationale, concept, consultations, principles and characteristics, initial framework and next steps of the strategy to establish GCW as a WMO IPY Legacy. A draft conceptual model of the elements of a GCW was prepared to focus further discussion of a structure for GCW.

7.3.1.2 IPY 2007-2008 has provided a unique opportunity to help close the gap in global observations by further developing polar observing systems. WCRP's CliC project, in co-operation with SCAR, led the development of the conceptual framework for CryOS, but there remains an urgent need for a sustained, robust end-to-end cryosphere observing and monitoring system, not only for polar regions, but also globally. Widespread consultation confirmed the need for a GCW and provided valuable suggestions for developing its initial concept.

7.3.1.3. The GCW, in its full/comprehensive concept would include observation, monitoring, assessment, product development, prediction, and related research. It should provide authoritative, clear, understandable and useable information on the past, current and future state of the cryosphere for use by the media, public, decision and policy makers.

7.3.1.4 GCW should be an international mechanism for supporting all key cryospheric in-situ and remote-sensing observations and for implementing the recommendations of CryOS. Collaboration, partnership and engagement of various programs would be essential in providing reliable, comprehensive observations of the components of the cryosphere through an integrated observing approach from national to global scale to meet the needs of climate, hydrology, weather and environmental science.

7.3.1.5 GCW should provide the scientific and operational climate community with the means to predict the future state of the cryosphere and provide quality assured global and regional products of the cryosphere. It should organize assessments of the cryosphere and its components on regional to global scale to support climate change science, decision making and formulation of environmental policy.

7.3.1.6 The feasibility study for GCW was prepared by Dr. B. Goodison while on secondment from Environment Canada to WMO/WCRP. The report was submitted to Executive Council by the Observing and Information Services Department. Partial funding for limited consultation and a team meeting was provided from a GCW Trust Fund supported by Canada and administered by WCRP. Additional funding is required to support ongoing consultation and project development. Reporting relationships within WMO need clarity.

Next Steps

7.3.1.7 The ad hoc expert team, in collaboration with interested WMO Members and partners, proposes to consult and work with the community to continue development of GCW to be able to prepare and present a GCW implementation strategy for consideration for approval by WMO Congress in 2011 by: promoting, negotiating and coordinating the conduct of pilot or demonstration projects to demonstrate the viability of the GCW; developing a mechanism to implement the IGOS Cryosphere Theme recommendations within the framework of GCW; identifying cryosphere information sources and systems to be part of GCW (existing or new); documenting data, information and products currently made available which could be included in a GCW; documenting Members' and other users' needs for cryospheric information, particularly for climate, water, weather and environmental applications and prediction; developing resource requirements to support the ongoing operation of a GCW, nationally, regionally and at the Secretariat levels; and, combining these components as the basis for preparing a GCW implementation strategy.

7.3.1.8 The use of pilot projects to demonstrate operation of GCW was strongly endorsed by the community during consultations. They would be implemented to demonstrate: the range of information that could be provided for cryosphere components, globally, regionally and nationally; how GCW could build on existing efforts by the cryospheric community; identify the time and resources required to create a fully functional integrated cryosphere information system; document standards, guidelines and best practices being used in observing and product development; and, identify challenges/gaps/needs that the GCW could address in a logical manner. Initiating GCW Pilot Projects allows us to address major issues on the integration process and provide clear evidence of not only the feasibility of GCW but also its sustainability and benefits to a range of users. Some of the pilot projects that have been suggested and could be considered for implementation are given in Appendix II.

7.3.1.9 There is also a desire for a limited number of demonstration projects that would focus on regional or national contributions as well as focus on specific tasks to demonstrate standardization, integration and interoperability. There is a very strong desire to implement a standardized network of cryospheric observatories (reference sites/supersites) in cold climate regions. Initially, this would involve a few stations, which would build on existing cryosphere observing programs or add standardized cryosphere observing programs to existing observing facilities to minimize operating costs (e.g. CryoNET).

Suggestions for Pilot and Demonstration Projects:

7.3.1.10 ***Pilot Projects*** would focus on the elements of the cryosphere and identify how they: would contribute to implementing CryOS; meet the GCW principles and characteristics, would contribute to demonstrating integration of cryospheric data and information from research to prediction, and, would provide authoritative cryospheric information. Some suggestions, around which a pilot project could be constituted based on discussions to date, are summarized below.

7.3.1.11 The views of the EC-PORS Panel on these suggested pilot studies, on who would be interested in participating and in potentially leading any of these pilot projects are welcomed. Support for workshops and secretariat support is required.

- **Sea ice**: There are many sea ice products currently being produced by operational and research organizations in many countries. There are research products of area, extent and concentration, such as produced by NSIDC and Arctic ROOS. There are operational sea ice products produced by NMHSs, such as the Norwegian Meteorological Institute (met.no) products produced for ECMWF and EUMETSAT. There are operational sea ice products as produced by national ice services with co-ordination through IICWG. A sea ice product, complete with metadata, algorithm description and evaluation procedures, and product verification is desired as a pilot project

- **Snow** (extent, depth, SWE) is a cryospheric element for which a pilot project is essential. An initial pilot project on “snow extent” seems feasible. There are many such products, from in-situ, satellite, and NWP models. Snow extent has been mapped for years, but there are products at different scales, from different sources and it has been found that during melt there can be considerable difference between products. The challenge is then to produce products that are well documented, verified through an independent intercomparison, and will be sustained. A “snow extent pilot” would serve as a test of what it will take to prepare an “authoritative GCW product”. There is also a desire to test a snow water equivalent product, real-time national/regional snow information (e.g. depth), and a test the transfer of snow information from research products to operational products, such as through GlobSnow.

- A **Glacier** element will build on the excellent work already being done by partner organizations, notably the World Glacier Monitoring Service (WGMS) supported by

Switzerland. It will engage WGMS and what is currently being done for GTN-G of GCOS and link to GLIMS if possible. Discussions on a specific pilot are to be held in the near future.

- A pilot project on **permafrost and frozen ground,** including the active layer, will build on collaborative work being done for GTN-P, largely through the International Permafrost Association. The pilot is yet to be defined, but could build on the IPY project on the Thermal State of Permafrost.

- A critical element of the cryosphere is precipitation, and for GCW, **solid precipitation,** or snowfall. There is an ever increasing need for global and regional precipitation products, adjusted for systematic errors of measurement. The GPCC in Germany does produce global, monthly precipitation products, including maps adjusted for systematic errors in measuring solid precipitation. The CliC project has a new initiative to look at improving the ability to define and adjust for systematic errors. CIMO has an initiative to assess the impact of automation on the measurement of precipitation in cold climate regions using automatic gauges. A pilot project is proposed to combine efforts to produce an improved precipitation product globally and regionally, incorporating new knowledge on errors in measurement. This could be further extended to global products that blend in-situ and satellite estimates. Discussions of what is feasible in a pilot project have been initiated.

7.3.1.12 ***Demonstration Projects*** would focus on regional or national contributions as well as focus on specific tasks to demonstrate standardization, integration and interoperability. Some ideas have been discussed and should be developed to demonstrate the broader, integrated aspect of GCW.

- Consultations have confirmed that the community would like GCW to initiate the CryOS recommendation on establishment of a network of reference sites or “supersites”. It would implement a standardized network of cryospheric observatories in cold climate regions, not just polar regions, where as many cryospheric elements would be monitored in a standard manner for the long-term. These sites would augment relevant CEOP reference sites or GTN sites and would also be suitable for validation of satellite and model outputs of cryospheric elements. This is key near-term recommendation in implementing CryOS. A demonstration team would be established to initiate this process.

- Consultations also identified integrated regional cryospheric products as another value-added contribution that GCW could offer. Very limited cryospheric information is currently presented in an integrated manner. For example, in alpine regions, are changes in glaciers, snow and permafrost giving the same information? A demonstration project in the Alps that would look at the snow and ice in an integrated manner would be desirable

- Other possible demonstration projects, include:
  - transfer of cryosphere remote sensing products from research to operations, e.g. GlobSnow
  - Specific regional contributions, such as contributions from Asia-CliC or tropical regions
  - Real-time reporting of cryospheric “hot news” from NMHSs and the scientific community
  - Modelling: making AR4 and AR5 cryospheric outputs more easily available

7.3.1.13 An important region for which consultations are yet to be completed is Antarctica. Discussions on how to present a more integrated picture of cryospheric change on the continent and in surrounding seas and the development of a possible demonstration project is yet to be done. Consultation with SCAR, research agencies (such as BAS, NSF, NASA, ESA, AAD) and with WMO EC-PORS is yet to be done.

Executive Council (EC-LXI) Decision (June 2009)

7.1.3.14 The Council noted with appreciation the report on "Global Cryosphere Watch (GCW): Background, Concept, Status, Next Steps. It endorsed the next steps for developing the GCW, as follows: the conduct of pilot or demonstration projects to demonstrate the viability of the GCW; the initiation of a network of reference sites in cold climate regions operating a sustained, standard, cryosphere observing programme; the development of a mechanism to implement the Integrated Global Observing Strategy (IGOS) Cryosphere Theme recommendations within the GCW framework; identification of cryospheric observing data sources and systems to be part of GCW; establishment of a trial portal to access data and information, and development of resource requirements to support the ongoing operation of a GCW nationally, regionally and at the WMO Secretariat levels. The Council also requested that GCW engage pilot and demonstration projects in different regions of the world, including tropical regions with glaciers.

7.1.3.15 The Council requested the preparation of a GCW implementation strategy for consideration by the WMO Congress in 2011. The Council noted that the EC Panel of Experts on Polar Observations, Research and Services (PORS) would provide guidance and momentum to the implementation of the GCW. Given the high desire and urgency to establish a Global Cryosphere Watch, it strongly urged Members to participate in the establishment of GCW, and requested Members to provide direct and in-kind contributions to support the next steps of GCW development. It urged the Secretary-General to facilitate these and other efforts to raise extrabudgetary funding to support GCW activities.

PORS Considerations

7.1.3.16 Successful implementation of GCW will require the engagement of WMO Members and other research and operational agencies engaged in cryospheric observation, monitoring, assessment, product development and research. The guidance that EC-PORS can provide is most welcome. Issues for PORS' consideration include:

- concurrence on the next steps outlined above
- input on pilot and demonstration projects, including prioritization
- suggestions on implementing GCW for Antarctica
- acquisition of funding to conduct consultation, pilot and demonstration projects
- formation of a GCW task group to oversee continuing development of PORS
- advise on GCW reporting relationships within WMO
- identification of PORS and GCW focal points

7.3.2. Pan-Antarctic Observations System (PAntOS)

7.3.2.1 Having noted the progress in documenting the observing network in the Arctic through the Sustaining Arctic Observing Networks (SAON) initiative, the SCAR SSGPS decided that it would be a useful exercise to do the same for the Antarctic. It therefore set up a Pan-Antarctic Observations System (PAntOS) Action Group and selected a couple of volunteers to lead the Group; however no resources were allocated to cover the costs of any work. With only voluntary time available, progress has been limited, though there is a web page at http://pantos.siena-space.org/.

7.3.2.2 It is not clear if there is a community requirement for paper documentation of the present state of the Antarctic observing networks; certainly there is little community buy in to the PAntOS proposal. Most user communities are fully aware of what is available to them, and who to contact for data. There may be an issue for cross-disciplinary researchers who are not familiar with the relevant community.

7.3.2.4 If progress in documenting the Antarctic observing networks is desired, then funding for a co-ordinator and for community workshops will be needed. An alternative and less costly solution would be to request Antarctic research institutes to provide a simple web page listing data holdings/network co-ordinators with primary contact names and email addresses. As an example this could be something along the lines of:

Klingon Polar Research Institute
Data Holdings

Weather – James.Kirk@startrec.ac.ent
Dilithium – Scotty@startrec.ac.ent
Etc.

7.3.3 The Southern Ocean Observing System (SOOS)

7.3.3.1 The Southern Ocean is an integral and key component of the global climate system. By connecting the ocean basins and the upper and lower limbs of the ocean overturning circulation, the Southern Ocean plays a critical role in the global ocean circulation, biogeochemical cycles and climate. Feedbacks involving ocean circulation, sea ice, ice shelves and the carbon cycle have the potential to significantly affect rate of future climate change and sea-level rise, but remain poorly understood.

7.3.3.2 The short and incomplete nature of existing time series means that the causes and consequences of observed changes are difficult to assess. Sustained, multi-disciplinary observations are required to detect, interpret and respond to change. Advances in technology and understanding mean that it is now feasible to design and implement SOOS to meet this need. SOOS will provide the long-term measurements required to improve understanding of climate change and variability, biogeochemical cycles and the coupling between climate and marine ecosystems.

7.3.3.3 The geographical domain of the SOOS is circumpolar, from the Subtropical Front south to the coast or the ice sheet grounding line, and from the sea surface to the sea floor. The temporal domain relevant to the SOOS extends from days to decades.

7.3.3.4 The need to better understand global climate change requires SOOS to be: sustained, circumpolar, multi-disciplinary (physics, biogeochemistry, sea ice, biology, surface meteorology), feasible, cost-effective, integrated with the global observing system, based initially on proven technology but evolves as technology develops, integrated with existed data management systems, able to deliver products to a wide range of end-users, builds on current and future research programs. Six key science challenges were identified that require sustained observations to be addressed:

1. The role of the Southern Ocean in the global heat and freshwater balance
2. The stability of the Southern Ocean overturning circulation
3. The stability of the Antarctic ice sheet and its contribution to sea-level rise
4. The future of Southern Ocean carbon uptake
5. The future of Antarctic sea ice
6. Impacts of global change on Southern Ocean ecosystems
7. The SOOS Planning Document is available in DOC and PDF formats

7.3.3.5 Although much of the SOOS will be carried out in a research context, in order to create a platform for obtaining resources for a SOOS, the program has to be recognized and supported by relevant international organizations and programmes and by national agencies.

7.3.3.6 SOOS is sponsored by SCAR, SCOR, CAML, GOOS, POGO and WCRP. SOOS is envisioned to operate as a regional component of GOOS. Climate relevant components of the GOOS, and hence SOOS, are implemented through the JCOMM and contribute to GCOS and GEOSS. JCOMM is already aiding in the development of SOOS, and at the appropriate time the SOOS supporters will seek formal endorsement by and involvement of JCOMM. Several of the

elements of the SOOS are already operating under JCOMM oversight in the Southern Ocean and elsewhere (tide network of GLOSS, Argo float program, and the International Program of Antarctic Buoys – IPAB).

7.3.3.7 In the preparations for IPY, WMO, in partnership with the ICSU and IOC, promoted the notion that SOOS should be one of the key outcomes of the investment in the IPY 2007-2008. Consolidating oceanographic research and observations in the Southern Ocean was the main goal of the IPY project CASO ("The Role of Antarctica and the Southern Ocean in Past, Present and Future Climate: A Strategy for the International Polar Year"). SOOS therefore will constitute a legacy of the IPY. If an IPD starts within several years, the SOOS will be able to both contribute to and benefit from being a part of such long-tem programme.

7.3.3.8 In terms of physical climate science, requirements for SOOS observations should be specified by the GCOS/GOOS/WCRP Ocean Observation Panel for Climate (OOPC), which will look after the requirements of GCOS, the CLIVAR/CliC/SCAR Southern Ocean Implementation Panel, and JCOMM. Issues related to the terrestrial and coastal cryosphere (ice sheets and ice shelves) will be outside of SOOS and be covered by other systems, like the WMO Global Cryosphere Watch.

7.3.3.9 The Member States of the IOC, WMO and other relevant bodies will be asked to formally endorse the SOOS and its network design in order to catalyze the intergovernmental support that is required. The 132 Member States of the IOC have already resolved to work towards development of a SOOS.

7.3.3.10 Possible recommendations that PORS should consider

1. To promote formal endorsement of SOOS by WMO.

2. A critical element of the SOOS is a data system that ensures both past and future data sets are accessible and of known quality. The SOOS data system will rely on existing data centers where possible. PORS may give recommendations for coordination of SOOS data system with WMO data sets.

3. To manage the greater integration of physical oceanography, surface meteorology, cryospheric and biological observations.

7.3.4 Integrated Arctic Ocean Observing System (iAOOS)

7.3.4.1 The integrated Arctic Ocean Observing System (iAOOS), conceived and sponsored by Arctic Oceans Sciences Board (AOSB), was a coordination proposal approved by the IPY Joint Committee in 2006. It is designed to optimize the cohesion and coverage of monitoring of the Arctic Ocean and surrounding seas during the IPY.

7.3.4.2 The focus of iAOOS is Arctic change, particularly the fate of perennial arctic sea-ice and the climatic and social effects of its disappearance. iAOOS has viewed the ocean-atmosphere-cryosphere system of high northern latitudes operating as a complete system for the first time with an aim to understanding this system and testing its predictability. Because of key technological advances, we had the means to measure almost any key variable at almost any place and time that we needed to describe the ocean-atmosphere-cryosphere system of high latitudes. The IPY provided the necessary stimulus for piecing together the available PIs, gear, ships and funding on the pan-Arctic scale that seemed necessary to making the attempt.

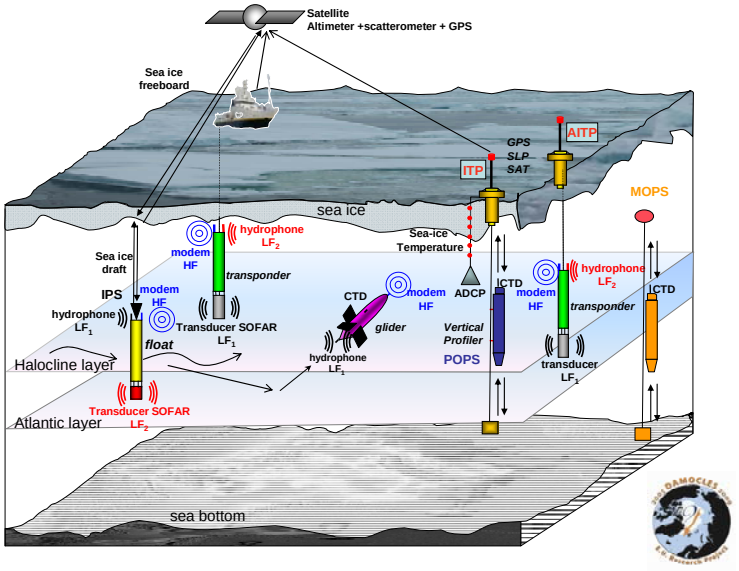


Figure 1. Damocles depiction of measurements taken from space to seabed**.**

7.3.4.3 The many tasks and initial results of iAOOS are outlined in two reports developed for the AOSB by Dr. Robert Dickson of CEFAS in the UK. The reports together, "The integrated Arctic Ocean Observing System (iAOOS) in 2007" and its sister report "The integrated Arctic Ocean Observing System (iAOOS) in 2008," provide a complete account of the main activities of iAOOS during the IPY, including cruises taken, instrumentation deployed, and measurements made. The reports attempt to describe first results of iAOOS.

7.3.4.4 It is important to note that the results from iAOOS could only be achieved through the intense international collaboration taking place during the IPY. The 2008 report concludes with key recommendations of observation tasks and methods which should be sustained into the so-called IPY legacy phase. As Dr. Dickson explains in his Nature Geosciences commentary from the June 2009 issue, "Paradoxically, as the International Polar Year ends, we enter its most important phase. Now we must decide—and quickly—which mix of observations to sustain, based on what we have learnt."

7.3.4.5 In 2009, the Arctic Ocean Sciences Board, as the Scientific Standing Committee on Marine Sciences for IASC, will support the development of a legacy phase report by Dr. Dickson. The report aims to develop, with the help of 12-15 key scientists from various countries and disciplines, a fully-costed proposal for an integrated, sustained and pan-Arctic observing effort focused on the role of the northern seas in climate. The report will be ready in time for the post-IPY conference in Oslo in June 2010.

7.3.5 GIIPSY and the IPY Space Task Group

Background on GIIPSY

7.3.5.1 To realize the benefit of the growing constellation of international satellites to the scientific objectives of the International Polar Year (IPY), the Global Interagency IPY Polar Snapshot Year (GIIPSY) proposal was selected as an IPY flagship project.

7.3.5.2 The goal of GIIPSY is to develop consensus polar science requirements and objectives that can best and perhaps only be met using the international constellation of earth observing satellites. Requirements focus on all aspects of the cryosphere and range from sea ice to permafrost to snow cover and ice sheets. Individual topics include development of high

resolution digital elevation models of outlet glaciers using stereo optical systems, measurements of ice surface velocity using interferometric synthetic aperture radar (SAR/InSAR), and frequently repeated measurements of sea ice motion using medium resolution optical and microwave imaging instruments.

Space Task Group

7.3.5.3 The functional link between the GIIPSY science community and the international space agencies is through the IPY Space Task Group (STG). The STG is convened by the World Meteorological Organization (WMO). STG membership presently includes representatives from the national space agencies of Italy, Germany, France, UK, US, Canada, Russia, China, Japan, and the European Space Agency (ESA), which in itself represents 19 nations. Members of GIIPSY, the WMO, and representatives of IPY data management programs also attend STG meetings.

7.3.5.4 The primary objective of the STG is to determine how best to satisfy GIIPSY science requirements in a fashion that distributes the acquisition burden across the space agencies and recognizes the operational mandates that guide the activities of each agency. The primary objectives of the STG meetings are to review requirements, to provide agency reports on progress in support of IPY, and to identify and solicit new members. GIIPSY science requirements were presented at the first STG meeting (a full description of the details can be found on the GIIPSY web page: http://bprc.osu.edu/rsl/GIIPSY). The STG has met in full session four times. The first meeting was held in January 2007 at the WMO headquarters in Geneva. Since then, the STG has met at EUMETSAT in Darmstadt, Germany in November, 2007, at ESA ESRIN located in Frascati, Italy in May 2008, and most recently again in Geneva in February 2009.

7.3.5.5 The STG also convened a SAR working group chaired by the Canadian Space Agency. The purpose of the SAR-WG is to address on a best effort basis fulfilment of GIIPSY science requirements uniquely related to SAR/INSAR. The SAR-WG first met in March 2008 at the Canadian Space Agency in Montreal, Canada. Subsequent meetings were held in October 2008 at the German Aerospace Center in Oberpfaffenhohen, Germany and in June 2009 at ESA ESRIN in Frascati, Italy.

STG Objectives and Accomplishments

7.3.5.6 The STG adopted 4 primary data acquisition objectives for its contribution to the IPY. These are:

- Pole to coast multi-frequency InSAR measurements of ice-sheet surface velocity.
- Repeat fine-resolution SAR mapping of the entire Southern Ocean sea ice cover for sea ice motion.
- One complete high resolution visible and thermal IR (Vis/IR) snapshot of circumpolar permafrost.
- Pan-Arctic high and moderate resolution Vis/IR snapshots of freshwater (lake and river) freeze-up and break-up.

7.3.5.7 The STG has made exceptional progress towards these objectives including: acquiring L, C and X band SAR imagery over the polar ice sheets and acquiring pole to coast InSAR data for ice sheet surface velocity; optically derived, high resolution digital elevation models of the perimeter regions of ice caps and ice sheets; coordinated campaigns to fill gaps in arctic and Antarctic sea ice cover; extensive acquisitions of optical imagery of permafrost terrain; observations of atmospheric chemistry using the Sciamachy instrument . Most recently, the SAR-WG choose to take a step beyond data acquisition and to investigate coordinated product development. These efforts during the final year of GIIPSY and the IPY-STG will be largely devoted to producing polarization image mosaics of Antarctica, image mosaics of Greenland and X, C and L band interferometrically derived velocity fields for Greenland and Antarctica.

Possible Future Issues for STG

7.3.5.8 Looking towards the proposed Polar Decade, there are a number of issues that could be addressed by the STG, which most basically means expanding the acquisition and product suite beyond the polar regions to all sectors of the cryosphere. More specifically, and along the lines of the SAR-WG, there is consensus that an Optical/IR working group could profitably address an updated list of measurements and derived products. There could be generally better integration of the atmospheric chemistry and polar meteorological communities into the STG activity suite, as well as incorporation of gravity and magnetic geopotential missions into the STG discussion. It is also possible to envision discussion and collaboration on emerging technologies and capabilities such as the Russian Arktika Project and advanced subsurface imaging radars. Finally, there is always the requirement to encourage the addition of new partner agencies such as those from India, Korea and Taiwan.

7.3.5.9 The STG has been a unique mechanism for informing the space agencies about GIIPSY science requirements and in turn for obtaining vast amounts of satellite data whilst distributing the data acquisition load amongst the participating agencies. Continuing a GIIPSY/STG activity, perhaps reconstituted with a new mission statement that addresses some of the additional points mentioned above, can be of future service by providing a direct link from the Panel of Experts and the broader cryospheric science community to those offices of the space agencies responsible for mission planning, data acquisition and product development.

7.3.5.10 Additional information on GIIPSY and the STG in co-ordinating satellite observations during the International Polar Year (IPY 2007-2008) and looking forward to achieving a polar constellation is provided in INF-9.

7.3.6 Sustaining Arctic Observing Networks (SAON)

Introduction:

7.3.6.1 The fragmentary Arctic observing activities and limited access to data led the Arctic Council in 2007 to invite a number of international organizations to

> *"Develop a set of recommendations on how to achieve long-term Arctic-wide observing activities that provide free, open and timely access to high quality data that will realize pan-Arctic and global added-value services and provide societal benefits*."

7.3.6.2 A Sustaining Arctic Observing Networks initiating Group (SAON-IG) was formed and included 13 international bodies representing the Arctic Council, Arctic residents, Arctic research communities, and relevant operational and funding agencies. WCRP's Climate and Cryosphere Project (CliC) was a founding member and also represented WMO perspectives. The group facilitated three international workshops in Sweden, Canada and Finland, and two regional meetings in Russia and the Republic of Korea, that were broadly attended by more than 300 representatives of stakeholders including the science community, operational agencies and indigenous peoples. Based on the discussions at these workshops, the SAON-IG group prepared the report *"Observing the Arctic"* (Report of the Sustaining Arctic Observing Networks (SAON) initiating Group, Edmonton/Stockholm 2009, 12 p.), presenting their recommendations for the follow –up work to sustain future research and monitoring of the Arctic. This report was mailed to EC-PORS members. The report as well as the documents, reports and presentations from the workshops are available at www.arcticobserving.org

SAON next steps:

7.3.6.3 At their Ministerial meeting in Tromso, Norway, 29 April 2009, the Arctic Council agreed to the SAON Recommendations (except for creating an Arctic Observing Forum); see the Tromso Declaration (INF- 6).

7.3.6.4 In the Senior Arctic Official (SAO) Report to Ministers (INF-7), more details on next steps for SAON were provided (see p. 12-14), with specific recommendations to:

- Support continued international coordination to maximize the legacy of IPY within the following areas; observations, data access and management, access to study areas and infrastructure, education, recruitment and funding, outreach, communication and assessment for societal benefits, and benefits to local and indigenous peoples.

- Reiterate the decision of the Arctic Council, expressed in the Salekhard Declaration, to promote the establishment of a circumpolar Arctic observing network as a lasting legacy of the IPY.

- Emphasize that SAON is a long-term undertaking and recognize the valuable contribution of the SAON process as an IPY legacy to coordination of multidisciplinary Arctic data acquisition, management, access and dissemination and encourage the continuation of this work with an emphasis on the improving sustained, long-term observation, and welcome the participation of indigenous organizations in future work.

- Decide to take the lead, as recommended by the SAON-IG (Sustaining Arctic Observing networks – Initiating Group), in cooperation with IASC and other relevant partners, for the continuation of the SAON process, including to consider ways to develop an institutional framework to support circum – Arctic observing, and the preparation and implementation of a workplan for the next two years to initiate work on priority issues including sustained funding and data management.

- Recommend that AMAP (Arctic Monitoring and Assessment Programme - a working group of the Arctic Coucil) together with IASC (International Arctic Science Committee - an international science organization with all countries undertaking Arctic research as members), using existing institutional structures and secretariats and involving all Arctic Council Working Groups, take the lead for a group consisting of representatives from each Arctic country, PPs (Permanent Participants -indigenous peoples' organizations of the Arctic; they are permanently represented in the Arctic Council), **and other relevant partners including the WMO** to draft and implement a detailed workplan for the next two years, drawing on all information gathered by the SAON process to date, and including arranging workshops to make concrete progress on priority issues.

SAON Steering Group (SAON-SG)

7.3.6.5 Following the decision of the Arctic Council in April 2009, all countries and organizations (including WMO) mentioned in the recommendation above have been invited to appoint a representative to the SAON Steering Group. The current list of nominees is given in INF.-8). Mr. David Grimes, co-chair of the EC-PORS has been named as the WMO representative. The SAON-SG held its first teleconference in late June, and agreed to:

- initiate an up-dated survey of Arctic observing networks and data archives (to be undertaken by national representatives)
- plan for a funding agencies' meeting inviting those who have a responsibility for long-term funding of Arctic observations
- maintain a web presence through further development and updating of www.arcticobserving.org
- develop a strategy for community observations

7.3.6.6 The SAON workplan will be further developed through December 2009. SAON-SG will require an active participation of the WMO through its EC PORS Panel.

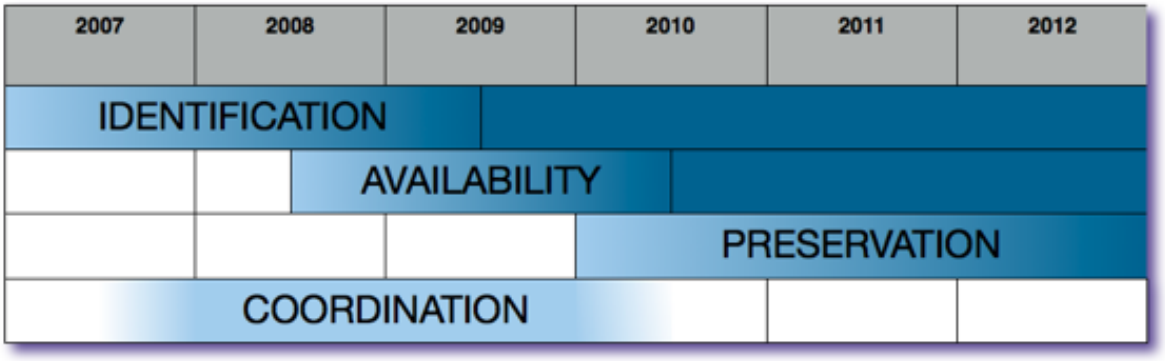
7.3.7 Status and Plans for IPY Data Management

Background

7.3.7.1 IPY data management is based on the ***IPY Data Policy***, which builds from WMO and other related policies. A central provision of the policy is that **data (with a few limited exceptions) are "available fully, freely, openly, and on the *shortest feasible timescale*."** The timely release of data is necessary to understand the rapidly changing polar regions and to facilitate interdisciplinary and international collaboration. The Policy also requires formal data preservation and fair acknowledgment of data use. All IPY projects agreed to adhere to the IPY Data Policy, yet adherence is variable. The timely release clause may be the most controversial. The preservation requirement is the most challenging.

Strategy

7.3.7.2 The IPY Data Policy and Management Subcommittee, a subcommittee of the ICSU/WMO Joint Committee for IPY, developed a basic strategy as outlined in the figure below.



The goal was to identify all the data with complete metadata descriptions by now, for the data to all be available by mid-2010, and to be in secure archives by the end of 2012. Because of a lack of dedicated funding for IPY data management, some delays in IPY project funding, and a delayed realization by national governments of the need for data management, **this schedule is currently delayed by about one year**.

7.3.7.3 The **International Polar Year Data and Information Service (IPYDIS)** is a global partnership of data centers, archives, and networks working to ensure proper stewardship of IPY and related data. The IPYDIS includes discipline-specific data centers and national data coordinators. These national coordinators have been extremely useful in helping identify IPY data and making them available, although some coordinators are more active than others. The following countries have **national IPY data coordinators**.

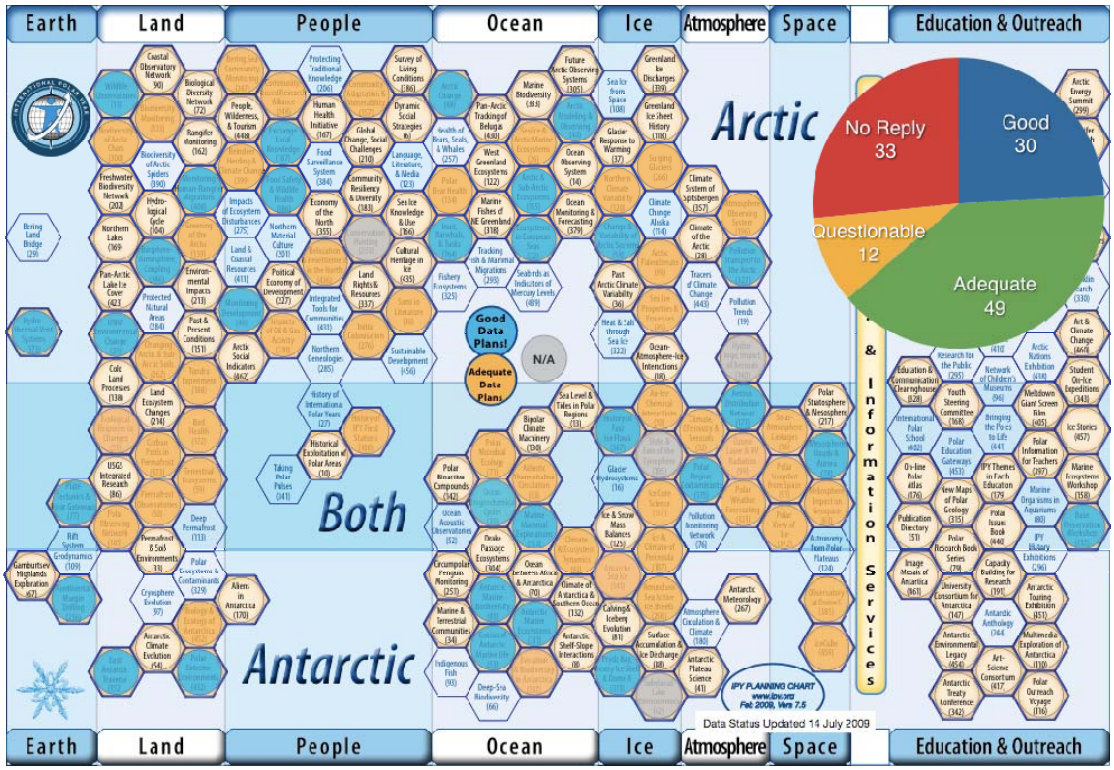
Australia	Germany	New Zealand*	Sweden
Belgium*	Japan*	Norway	Ukraine*
Canada	Malaysia*	Russia	United Kingdom
China	Netherlands	Spain*	United States
France*			

*Ad hoc or self-designated through their role in Antarctic data Management

Not all of these coordinators will continue very long after IPY. This will make completing and sustaining the IPY data collection more difficult. Ideally, all nations that did research in the polar regions should identify data coordinators to facilitate data access across disciplines and to help ensure long-term preservation of the data.

Data Status

7.3.7.4 The Data Committee also conducted several surveys of IPY projects to assess their data management plans. Ongoing assessment continues. The figure below provides an overview of the current status of data management plans for endorsed IPY science projects (hexagons). Note, there are **significant gaps in the land and people domains. This is likely due to a lack of established data systems and data sharing cultures in these disciplines. There are also significant gaps in the ocean, ice, and atmosphere domains. These disciplines do have established data systems, so the gaps are more likely due to a lack of participation in the IPY data structure**.



7.3.7.5 Some IPY data are already available. Partners in the IPYDIS have begun to make metadata and data available through a variety of national and international portals. IPY has also developed a metadata profile and crosswalk that is compliant with a variety of international metadata standards. This profile facilitates international and interdisciplinary data sharing across the portals and IPYDIS is working to create a Union Catalog of metadata using the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). Currently a little over **1,000 metadata records are available. Not all records link directly to available data. This is likely to be a small fraction of the IPY data produced.**

The Way Forward

7.3.7.6 With the formal end of IPY last spring (Some projects continue for a year or two beyond because of funding delays.), we now enter a critical period for data management. The Data Committee published an ***IPY Data Management Strategy, Status, and Roadmap*** **in February 2009.** Two recent initiatives have helped move us forward along that plan.

7.3.7.7 ICSU has developed a pilot project, endorsed by WMO and others, to establish a ***Polar Information Commons*** **(PIC**). The PIC is inspired by the Antarctic Treaty of 1959 that established the Antarctic as a global commons to generate greater scientific understanding, and it asserts that data and information about the polar regions are themselves "public goods" that should be shared ethically and with minimal constraint. The PIC seeks to be a shared virtual resource mirroring the geographic commons. The PIC would serve as an open, virtual repository for scientific data and information, and would provide a shared, community-based cyber-infrastructure. A central tenant of the PIC is for data providers to release their data into the public domain using a legal waiver developed by Science Commons and CODATA called CC0 (CC Zero). Closely associated with this waiver is the development of norms within the scientific community that lay out expected behaviors for data users and providers. This is all within the IPY spirit of open and networked data.

7.3.7.8 The second initiative was an **IPYDIS and Data Committee workshop** sponsored by the Canadian Government. The workshop brought together IPYDIS partners, sponsors, and scientists from ten countries to explicitly define and complete the IPY data collection and to develop a plan for the sustained, preservation of the collection. **A major outcome of the report will be a report on the "State of Polar Data"** with concrete recommendations for IPY sponsors including WMO. The workshop focussed on three major issues: governance of polar data systems, interoperability across systems, and how to sustain the legacy of the IPY data collection and associated systems. The overall theme of open and timely data publication ran throughout all the discussions. The workshop was held September 29-October 1, so formal results are not yet published, but the recommendations below reflect the discussion at this workshop.

Key Issues and Recommendations

7.3.7.9 The IPY Data Committee will be developing formal recommendations for national and international IPY sponsors and data centers as part of the *State of Polar Data* report. In the meantime, however, certain issues and ideas have repeatedly emerged and can inform WMO polar activity over the short term, notably in the development of the WIS and associated governing structures. In general **IPY can be viewed as an example or test case for how future international data activities should be managed, especially interdisciplinary activities**.

7.3.7.10 ***Open and Networked Data:*** The IPY Data Policy has encouraged greater sharing of data across disciplines. The issue now seems to be more of *when* to share rather than *whether* to share. It is notable, however, that many of the oceans and atmosphere projects, areas of particular interest to WMO, have not participated in IPY data activities.

- **WMO should consider formally extending the principles of the IPY Data Policy, including timely data release and formal user acknowledgement.**
- **WMO should encourage members to share their data in the Polar Information Commons as part of the public domain.**
- **WMO data systems and data managers should explicitly label their IPY data and work with IPYDIS partners to share their metadata in the IPY Union Catalog through open protocols, including OAI-PMH. Focusing on the large oceans and atmosphere projects would be especially helpful.**

7.3.7.11 ***Governance:*** The IPY Data Committee dissolves in 2010. The IPYDIS is an ad hoc group with uncertain future funding. There is a form of governance in the Antarctic through the SCAR Standing Committees on Antarctic Data Management and Geospatial Information. The Arctic does not have similar structures, but they are being considered through the Arctic Spatial Data Infrastructure (ASDI) and the Sustained Arctic Observing Network (SAON)—two nascent Arctic Council initiatives. There is debate in the community on how polar data governing structures should be established or continue, for how long, and how they should relate to other existing and

developing data coordination structures. The PORS opinion on these matters would be helpful, especially in light of the proposed Polar Decade. (Note, however, that there does not seem to be a lot of enthusiasm for a Polar Decade in the IPY data community). Whatever governing structures emerge, certain key issues must be addressed:

- **WMO and its members need to recognize the incredible diversity of polar data ranging from astronomical observations to local and traditional knowledge. This diversity challenges existing data systems and governing structures, but interdisciplinary collaboration is essential to a systemic understanding of the polar regions and Earth system.**
- **Nations should maintain (or establish) national polar data coordinators, at least for the next three years. These have proven invaluable in identifying and describing IPY data and helping get the data into secure archives.**
- **WMO should work with ICSU in establishing the World Data System as well as with SCAR, IASC, and others to facilitate coordinated data management in both poles. We need a clear plan to transition IPY data activities into sustained global structures.**

7.3.7.12 ***Interoperability:*** To date, interoperability across different national IPY data centers and portals has focussed on shared metadata. The major challenge here has been in establishing consistent controlled vocabularies and crosswalks across vocabularies. More formal semantic research and applications are necessary to better enable interdisciplinary data discovery and assessment. Within national IPY centers the focus is on interoperability of actual data sets. Data heterogeneity presents the major challenge for ready data comparison and integration, especially across disciplines. There is a lack of consistent data formats within disciplinary communities let alone across disciplines. WMO can help address issues of both metadata and data interoperability.

- **WMO should encourage data providers to label their data with the soon-to-be-developed "PIC badge" which allows providers to formally place their data in the public domain while requesting certain norms of ethical behavior from data users. The XML badge also aids searching and aggregation.**
- **WMO could sponsor disciplinary community workshops bringing together data collectors, users, and managers to begin to agree on common data formats and tools for format conversion. Self describing formats should be encouraged.**
- **WMO should work with IPYDIS partners to enable data in the IPY Union Catalog to be discovered through the WMO Information System (WIS). WIS could provide a portal and authority catalog for IPY data.**
- **As the WIS develops, it needs to actively engage disciplines beyond the traditional atmosphere and ocean domains served by WMO including life and social sciences. Similarly, research data (i.e. those collected by individual researchers and projects) need to be more readily included in the WIS.**

7.3.7.13 ***Preservation and Stewardship—Sustaining the Legacy:*** Preservation and continued data stewardship remains the greatest challenge for IPY. Many disciplines represented in IPY do not have established long-term archives. Existing archives struggle with how to sustain services over decades. We look toward the evolving World Data System as a hopeful solution, but it will require high-level political backing and much broader disciplinary engagement than the historical World Data Centers.

- **WMO should work with ICSU to get the high-level political commitment to maintain long-term data archives in *all* polar disciplines.**
- **WMO should help archives develop new sustainable business models and broaden collaboration with research libraries, archives, and museums, to preserve the IPY legacy.**

- **WMO should help raise the profile of the need for sustained data preservation and should ensure that data stewardship needs are addressed in the initial planning of WMO initiatives.**
- **Rapid data sharing and publication should be encouraged as the first step toward data preservation.**
- **WMO data centers should develop complete documentation for all their data. In accordance with the IPY Data Policy and the ISO standard Reference Model for an Open Archival Information System (OAIS), complete documentation may be defined as all the information necessary for data to be independently understood by users and to ensure proper stewardship of the data. Special attention should be given to describing data quality and uncertainties.**

Additional Information

- International Polar Year Data and Information Service
  http://ipydis.org
- IPY Data Policy
  http://classic.ipy.org/Subcommittees/final_ipy_data_policy.pdf
- Report from an initial IPY Data Management Planning Workshop, 3-4 March 2006
  http://nsidc.org/pubs/gd/Glaciological_Data_33.pdf
- IPY Data Management Strategy, Status, and Roadmap
  http://ipydis.org/documents/jc8report_feb09.pdf
- IPY Metadata Profile
  http://ipydis.org/data/metadata.html
- Observations on World Data Center Involvement in the International Polar Year (attached)
- International IPY Data Management Meeting, 29 Sept.-1 Oct. 2009
  https://ipydis.org:443/wiki/doku.php?id=ottawa
- Polar Information Commons
  http://polarcommons.org

7.3.8 Database updating

7.3.8.1 IPY Data and Information Service (IPYDIS) is a cooperation between data archives and data centres in many countries. Many of the archives and data centres contributing to IPYDIS data handling existed prior to IPY and utilise existing infrastructure end systems to support IPY. The interoperability standards and data management methodologies differ between the various centres contributing to IPYDIS complicating generation of the IPY catalogue.

7.3.8.2 In order to harmonise the IPY Data Management subcommittee formulated data management guidelines through the IPY Data Policy (http://classic.ipy.org/Subcommittees/final_ipy_data_policy.pdf). The IPY Data Policy contains generic requirements on management and access to IPY data. It focus on the obligation of IPY scientists and projects to submit metadata and data in a “timely manner” and emphasise open and free data access within IPY. Interoperability is supported by the IPY Metadata Profile (http://www.ipydis.org/data/metadata.html) which is closely linked to the Global Change Master Directory (GCMD DIF: http://gcmd.gsfc.nasa.gov/User/difguide/difman.html).

7.3.8.3 The above mentioned specifications are insufficient from an interoperability perspective in order to fulfil the intentions outlined in the IPY Data Policy. Experience has also shown that collection of IPY metadata and data is a time consuming process and that the free and unrestricted exchange of metadata and data is far from reality. Collection of metadata gradually

improves, but online access and a unified view of these are yet not as developed as expected at IPY kick off. Online access to datasets is even further away.

7.3.8.4 Part of the explanation relates to poorly funded data management elements of IPY. These parts should have been readily available to scientists before IPY started. As well, a cultural shift in how scientists relate to the datasets that they have collected is required. In the latter context, IPY is an important step and has raised the awareness among scientists on this issue. In order to continue the process initiated through IPY and to support, as stated by the IPY Data Policy - "timely submission of metadata and data" - scientists need to receive proper credit for the work undertaken collecting data. Today this is achieved through publishing in journals, a time consuming process which delays submission of data to secure credit. To circumvent this the International Polar Year Data Management Workshop in Cambridge 3-4 March 2006 (http://nsidc.org/pubs/gd/Glaciological_Data_33.pdf) recommended that "... Data Archives can facilitate proper citation by providing all required elements of a citation including an unambiguous, unchanging reference such as an Digital Object Identifier (DOI)". Some sort of mechanism along these lines is probably required along with other tools to encourage continuous update of the polar regions databases with non real-time data.

7.3.8.5 In order to achieve true interoperability for non real - time polar data further standardisation of file formats and access protocols are required. This is a complex task, especially within IPY which covers sciences ranging from geophysics to biological and human sciences. It is, however, required to reduce implementation and maintenance costs of polar science databases. IPY being an interdisciplinary effort has generated an interdisciplinary legacy for polar science, a legacy that requires cost effective interoperability standards for both data managers and providers to be sustainable. The benefit of sharing data and doing so in a standardised manner has to be highlighted and maintained over time. Besides highlighting the benefit for scientists, the submission process has to be easy. For non real - time data, it is an advantage to support community standards wherever possible. For example, the Climate and Forecast (CF) metadata (http://www.cfconventions.org/) provides self explaining NetCDF files which, with addition of relatively little information, are self explaining within a data discovery setting as well. However, development of tools is needed to support scientists converting datasets to standard formats.

7.3.8.6 Since the start of IPY, international interoperability efforts like WIS, GEOSS, INSPIRE and CEOS WGISS have gained momentum. The interoperability standards (metadata, access protocols, file formats etc) defined within these overlap to a certain degree, but they also differ. Adaptation to new technology and standards is a matter of implementation and maintenance costs. As funding of data management within IPY was limited, the practical approach often focused on cost effective solutions. In the current situation it is important to limit the number of technologies a data centre or archive is required to support, whether this is WIS, GEOSS, INSPIRE or CEOS WGISS requirements. In order to achieve true interoperability and increase the benefit for scientists, interoperability at the metadata level between real time and non real time databases, along with easy access to data, is important.

7.3.8.7 It is important to coordinate the interoperability efforts undertaken in e.g. WIS, INSPIRE, CEOS WGISS and GEOSS, as well as to keep an open mind towards community driven interoperability initiatives like OpeNDAP and NetCDF/CF, which is important for the oceanographic community.

7.3.8.8 The panel is invited to stimulate and encourage:

- development and operation of local and regional databases within the framework of WIS
- harmonisation of interoperability standards in order to facilitate truly interdisciplinary interoperability
- regular updating of scientific datasets to databases through mechanisms for giving credit to the scientists submitting data and metadata.