

PART FIVE

The Legacies of IPY 2007–2008 and Future of Polar Research

*Coordinating Editors: Igor Krupnik and Volker Rachold
Reviewers: Anders Karlqvist and Oran Young*

Introduction

Chapter 5.1 Early Science Outcomes of IPY 2007–2008

Chapter 5.2 Broadening the Cross-Disciplinary Impact of IPY Research

Chapter 5.3 Engaging Asian Nations in IPY: Asian Forum for Polar Sciences (AFoPS)

Chapter 5.4 Connecting to New Stakeholders in Polar Research

Chapter 5.5 IPY and Expanding Partnerships in Coordination of Polar Research

Chapter 5.6 Shaping the Future

EPILOGUE

Introduction

Igor Krupnik

Reviewers:

David Hik and Colin Summerhayes

The five major sections of the JC IPY Summary are structured to provide detailed answers to a set of strategic questions related to the organization and implementation of IPY 2007–2008. Part 1 explains why IPY was launched, and how it was designed and implemented. Part 2 examines what has been learned in IPY by reviewing its key science activities in major fields and disciplines, and Part 3 explores how this was achieved via the multitude of IPY observational and data-management efforts. Part 4 explains how this new knowledge was disseminated to the polar science community, educators and students, and the general public, and how the next generation of polar researchers was involved in IPY.

Part 5, the concluding section, addresses two more strategic questions related to IPY, namely, “**Who learned it**” and “**What is next?**”. It explores the broader scientific and societal legacies of IPY 2007–2008 and the impact it has had or may eventually have upon various stakeholders – scientists and students, polar residents, national research planners, science managers, policy-makers and public at large.

Securing IPY 2007–2008 Legacies – The JC Perspective

Each previous IPY/IGY created a monumental legacy that outlived its planners and participants, often by many decades. The main legacy of the first IPY of 1882–1883 was the realization of Carl Weyprecht’s proposal for concerted, if not fully coordinated observational programs by several nations to address common goals with common methods across the polar regions (Elzinga, 2010a; *Chapter 1.1*). The main legacy of the Second IPY in 1932–1933, besides its many scientific, observational and technological achievements, was to solidify the ‘International Polar Year’ as a multi-disciplinary collaborative program to be successfully replicated every 50 (or 25) years (Elzinga, 2010b). The International Geophysical Year of 1957–1958 was a much larger endeavour and

much more convincingly bipolar. It left several lasting legacies, including the creation of the first permanent research stations in Antarctica (the ‘peopling’ of the last continent); the establishment of the World Data Centers; the beginning of the space research era and the use of satellites, as well as a greater appreciation of the upper atmospheric structure; and the new regime of science partnership that eventually led to the establishment of the Antarctic Treaty (Table 5.0-1, see summaries in Berguño and Elzinga, 2010; Dodds et al., 2010; Elzinga, 2009; Summerhayes, 2008; *Chapter 1.1*). Furthermore, IGY stimulated the development of a whole range of long-term daughter programs – not an obvious legacy from the first two IPYs (Summerhayes, 2008; *Chapter 1.1*)

These and other legacies of the previous IPY initiatives were clearly on the mind of the organizers of IPY 2007–2008 since the very start of the planning process in 2003–2004. It is no accident that the first Science Outline for IPY 2007–2008 produced in 2004 (*Chapter 1.3*) used the term ‘legacy’ more than 20 times (Rapley et al., 2004). At that early stage, IPY 2007–2008 was aimed to pave the way to:

- A new era of scientific progress in knowledge and understanding of the polar regions
- Vital legacy of sustained observing systems
- Increased international research coordination and collaboration
- Stronger links between researchers across different disciplinary fields
- Reference datasets for comparison with the future and the past
- Development of a new generation of enthused polar researchers
- Full engagement and understanding of the public and decision-makers worldwide in the purpose and value of polar research
- Increased participation of Arctic residents, including indigenous peoples, in polar science at all levels to enable future research to make maximum use of indigenous knowledge and for indigenous

communities to benefit from scientific advances (Rapley et al., 2004).

In 2006, upon completing the review of the proposals for prospective IPY projects, the IPY Joint Committee at its third meeting in Cambridge, U.K., identified key anticipated long-lasting ‘successes’ of IPY 2007–2008 as follows (JC-3 Minutes, 20-22 April 2006, p. 18, Table 5.0-1):

- A new regime for access to the Arctic
- Integration of local communities and social sciences
- (New) Observing systems in the Polar Regions
- Changing the data management and data center culture

- A new understanding of the operation of the polar climate.

The Joint Committee continued to discuss the IPY legacies at each of its subsequent meetings, most notably at JC-5 (March 2007, Paris), JC-6 (October 2007, Quebec; Carlson, 2007), JC-8 (February 2009, Geneva – Allison et. al, 2009), JC-9 (June 2010, Oslo), as well as at the IPY Opening Ceremony in Paris (March 2007)¹ and the IPY ‘Celebration’ in Geneva (February 2009). Also, several other groups and bodies involved in IPY, such as the Arctic Council, ATCM, SCAR, IASC, HAIS (Heads of the Arctic/Antarctic IPY Secretariats) and others have addressed the issue of the IPY legacy (or

IGY 1957–1958 achievements (JC-3, 2006; Summerhayes 2008)	JC-3, 2006: expected results (JC-3 Minutes, p.17)	JC-8: planned results (State of Polar Research, p.8-10)	JC-9: Achievements by June 2010
Discovery of Van Allen belts (<i>science</i>)	New understanding of the operation of polar climate (<i>science</i>)		Major science advances in many disciplinary and six integrative IPY themes (<i>science – Chapter 5.1; Part 2</i>)
“Peopling of the Antarctic” (<i>broad science advance</i>)	Integration of local communities and social sciences (<i>broad science advance</i>)	Cross-disciplinary collaboration, synthesis, and integration (<i>broad science advance</i>)	New integrative framework for polar research, global connections, cross-disciplinarity, social issues and biodiversity (<i>broad science advance – Chapter 5.2</i>)
Use of satellites and rockets for polar research (<i>observations, science technology</i>)	Observing systems at the Poles (<i>observations</i>)	Observational systems, facilities and infrastructure (<i>observations</i>)	New long-term observing systems targeted to many stakeholders (<i>observations – Part 3</i>)
The establishment of data centers (<i>data management</i>)	Changing data management and data center culture (<i>data management</i>)	Reference data (<i>data and data management</i>)	New strategic approaches to data and information management, including creation of the Polar Information Commons (<i>Chapter 3.11</i>)
The eventual establishment of the Antarctic Treaty system (<i>political cooperation</i>)	New regimes for access to the Arctic (<i>political cooperation</i>)	Scientific and political cooperation (<i>cooperation</i>)	Development of new ‘bipolar’ vision, partnerships, and institutions (<i>cooperation, science vision – Chapter 5.5</i>)
Establishment of SCAR (<i>science structure</i>)		New generation of polar scientists and engineers (<i>societal implications</i>)	New mechanism (APECS) to advance recruitment in polar research and to ensure the launch of the next IPY in 25 or 50 years (<i>science structure – Chapter 4.2</i>)
		Broad public interest and participation (<i>societal implications</i>)	Education and outreach networks to disseminate IPY results established (<i>societal implications – Chapter 4.1</i>)
		Engaging Arctic residents, including indigenous people (<i>societal implications</i>)	Bringing new stakeholders, i.e., polar residents, indigenous people, non-polar nations to polar research, science planning, and data management (<i>societal implications – Chapter 5.4</i>)

Table 5.0-1. Changing Vision on Major IPY 2007–2008 ‘Achievements’ (Legacies): 2006–2010

'legacies') starting as early as 2006. As a result, scores of articles and discussion papers were produced in assessing various aspects of post-IPY legacy, IPY science synthesis and integration (Arctic Council, 2008; Baeseman, 2008; Dickson, 2009; Goodison, 2008; Hik, 2007; Hik and Church, 2007; Hik and Kraft Sloan, 2007; Kraft Sloan, 2006; Krupnik, 2009; LeDrew et al., 2008; Sarukhanian, 2008; Kraft Sloan and Hik, 2008; Summerhayes, 2007; 2008 Summerhayes and Rachold, 2007). The most recent assessment of the prospective IPY legacies was produced in July 2010 following the joint AC-ATCM workshop conducted during the Oslo IPY Science Conference (Winther and Njåstad 2010). In addition, the 2008 OECD Global Science Forum released an earlier report assessing IPY 2007–2008 in the context of international scientific cooperation and the specific need to consider IPY termination and legacy issues (Stirling, 2007).²

Nonetheless, a special memorandum developed by the HAIS group (Heads of Arctic/Antarctic IPY Secretariats) as early as February 2007 argued that **“the IPY JC should take a leadership role in the efforts to discuss and secure the IPY legacies”** (Rogne; 2007; emphasis ours – IK). That message resonated with the emerging vision that the JC role in IPY should expand to include the evaluation of the key IPY achievements and the stewardship of the IPY legacy. In fulfilling these responsibilities, the JC dedicated substantial effort to formulate its vision on the legacies on IPY 2007–2008 in its two major publications, *Scope of Science for the International Polar Year 2007–2008* (Allison et al., 2007) and *State of Polar Research* (Allison et al., 2009). A large section of the latter document was dedicated to the examination of possible future IPY legacies. It stated that “[the] rapid pace of scientific advance and our increasing awareness of humankind’s impact on the Earth system as a whole suggest that research and data from IPY 2007–2008 will leave a lasting legacy in many fields of science, particularly in providing a clearer picture of what future changes may occur and what effects they may have” (Allison et al., 2009). Other major legacies of IPY 2007–2008 (besides its major science achievements) were identified as follows:

- Observational systems, facilities and infrastructure
- Scientific and political cooperation
- Cross-disciplinary collaboration, synthesis and integration
- Reference data
- A new generation of polar scientists and engineers
- Broad public interest and participation
- Engagement of Arctic residents, including indigenous peoples.

Some of those legacies of IPY 2007–2008 outlined by the JC have already been covered in earlier chapters of the volume, such as IPY observational initiatives and reference data (*Part 3*), new generation of polar scientists (*Chapter 4.3*), and the engagement of the general public (*Chapter 4.1*). This concluding section explores other key IPY legacies in greater detail, starting with *Chapter 5.1*, which overviews major science outcomes of IPY, particularly the development of the new integrative vision on polar processes and their global linkages. *Chapter 5.2* dwells on the role of IPY in broadening the cross-disciplinary and societal scope of the new generation of polar research. *Chapter 5.3* evaluates the growing role of non-polar nations, particularly the members of the Asian Forum for Polar Sciences (AFoPS) in polar studies. *Chapter 5.4* addresses the role of the new stakeholders in polar research, such as polar residents and, especially, Arctic indigenous people, as well as the societal benefits of sharing data and knowledge with local communities and new approaches to polar science education.

Chapter 5.5 examines many new partnerships forged during the IPY 2007–2008 era and, particularly, the new vision for unified ‘bipolar’ (Arctic-Antarctic) science planning and collaboration by major polar bodies, such as IASC, SCAR, Arctic Council, and ATCM, as well as the two IPY sponsors, ICSU and WMO. Lastly, *Chapter 5.6* explores how the momentum created by IPY 2007–2008 may be expanded beyond the timeframe on the fourth IPY, from the Oslo Science Conference in June 2010 toward the planning of the next (and final) major IPY-related Polar Conference in Montreal (April 2012), and into what may eventually become ‘The International Polar Decade.’

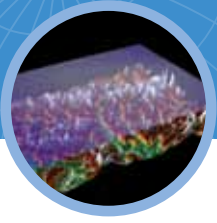
References

- Allison, I., M. Béland, K. Alverson, R. Robin Bell, D. Carlson, K. Danell, C. Ellis-Evans, E. Fahrbach, E. Fanta, Y. Fuji, G. Glaser, L. Goldfarb, G. Hovelsrud, J. Huber, V. Kotlyakov, I. Krupnik, J. López-Martínez, T. Mohr, D. Qin, V. Rachold, C. Rapley, O. Rogne, E. Sarukhanian, C. Summerhayes and C. Xiao, 2007. *The Scope of Science for the International Polar Year 2007–2008*. WMO/TD No. 1364. World Meteorological Organization Geneva.
- Allison, I., M. Béland, K. Alverson, Bell, R. Robin Bell, D. Carlson, P. Cutler, K. Danell, C. Ellis-Evans, E. Fahrbach, G. Hovelsrud, J. Huber, V. Kotlyakov, I. Krupnik, J. López-Martínez, T. Mohr, H. Ödmark, D. Qin, V. Rachold, C. Rapley, O. Rogne, E. Sarukhanian, C. Summerhayes and Yamanouchi T. 2009. The State of Polar Research. A Statement from the International Council for Science/World Meteorological Organization Joint Committee for the International Polar Year 2007–2008. World Meteorological Organization, Geneva.
- Arctic Council. 2008. Maximizing the Legacy of IPY in the Arctic. Proposal for the Arctic Council Submitted by Norway. November 2008. AC-SAO-NOV08-9.1 http://classic.ipy.org/national/HAIS%206_Jan09/HAIS-6.E.5.2.ac-sao-nov08-9.1%5B1%5D.pdf
- Baeseman, Jenny, 2008. Providing a Continuum of Leadership in Polar Science & 150; an IPY Legacy. American Geophysical Union, Fall Meeting 2008, abstract #U23F-08 - <http://adsabs.harvard.edu/abs/2008AGUFM.U23F.08B>
- Berguño, Jorge and Aant Elzinga, 2010. The Achievements of the IGY. In *The History of the International Polar Years (IPYs)*. S. Barr and C. Leudecke, eds. Heidelberg: Springer, pp. 259–278.
- Carlson, David, 2007. IPY Legacies – Assessment and Prospectus in October 2007. Discussion paper submitted to the JC-6 meeting (October 2007). IPY-JC-6
- Dickson, Bob, 2009. Securing the Legacy of the IPY. *Nature Geoscience* 2: 374–376.
- Elfring, Chris, IPY: What Next? The Possible Role of the PRB/USNC in Post-IPY Synthesis and Integration. Unpublished discussion paper (July 24, 2007).
- Elzinga, Aant, 2009. Through the Lens of the Polar years: Changing Characteristics of Polar Research in Historical Perspective. *Polar Record* 45(235):313– 336.
- Elzinga, Aant, 2010a. Evaluation of Achievements of the First International Polar Year. In *The History of the International Polar Years (IPYs)*. S. Barr and C. Leudecke, eds. Heidelberg: Springer, pp. 109–126.
- Elzinga Aant, 2010b. Achievements of the Second International Polar Year. In *The History of the International Polar Years (IPYs)*. S. Barr and C. Leudecke, eds. Heidelberg: Springer, pp. 211–234.
- Goodison, Barry, 2008. Cryosphere Monitoring, Observation Research: An IPY Legacy – Global Cryosphere Watch. Paper presented at the WMO-WCRP-IPY Workshop on CLIPS in Polar Regions. September 8–11, 2008, St. Petersburg, Russia ftp://www.wmo.ch/Documents/PublicWeb/wcasp/PolarCLIPS/3.4_goodison_080908.pdf
- Hik, David, 2007. Some thoughts about the next steps for securing the Legacy of IPY (2007–2008): background for discussion at HAIS-2. Paper submitted to the HAIS-2 meeting, February 2007; http://classic.ipy.org/national/HAIS-2.A2Some%20next%20steps%20for%20IPY%20legacy_DHik%20Jan07.pdf (accessed March 21, 2010)
- Hik, David and Ian Church, 2007. Securing an IPY Legacy. March 1, 2007 - www.innovationcanada.ca/en/articles/securing-an-ipy-legacy
- Hik, David and Karen Kraft Sloan, 2007. Broadening the Legacy of IPY. Paper presented at the Arctic Science Summit Week (ASSW), March 16, 2007, Hanover, NH.
- Kraft Sloan, Karen, 2006. Beyond 2009: Broadening the Legacy of the International Polar Year. Address to Arctic Forum 2006, Washington, D.C., May 26, 2006.
- Kraft Sloan, Karen and David Hik, 2008. International Polar Year as a Catalyst for Sustaining Arctic Research. *Sustainable Development Law and Policy* 8(3): 4–7 www.wcl.american.edu/org/sustainabledevelopment/2008/08summer.pdf?rd=1
- Krupnik, Igor, 2009. IPY 2007–2008: The Legacy of the Social Sciences. Interview to the *SciencePoles*, International Polar Foundation, 27 April 2009 - www.sciencepoles.org/articles/article_detail/igor_krupnik_the_legacy_of_the_social_

- sciences_for_ipy/
- LeDrew, Ellsworth, Mark Parsons and Taco de Bruin, 2008. Securing the Legacy of IPY. *Earthzine*, March 27, 2008 www.earthzine.org/2008/03/27/securing-the-legacy-of-ipy/
- Maximizing the Antarctic IPY Legacy, 2009. Maximizing the Antarctic IPY Legacy. A Working paper submitted by Norway and United Kingdom. *XXXII Antarctic Treaty Consultative Meeting, April 6–17, Baltimore, U.S.A.* www.ats.aq/documents/ATCM32/wp/ATCM32_wp006_e.doc
- Rapley, C., R. Bell, I. Allison, R. Bindschadler, G. Casassa, S. Chown, G. Duhaime, V. Kotlyakov, M. Kuhn, O. Orheim, P.Ch. Pandey, H. Petersen, H. Schalke, W. Janoschek, E. Sarukhanian and Zh. Zhang. *A Framework for the International Polar Year 2007–2008. Produced by the ICSU IPY 2007–2008 Planning Group.* ICSU: Paris, 57 pp. <http://classic.ipy.org/development/framework/framework.pdf>
- Rogne, Odd, 2007. Next Steps and Leadership to Identify and Secure IPY Legacies. Discussion paper submitted to the JC-5 meeting (February 2007). IPY-JC5/Doc. 13.1.
- Sarukhanian, Eduard, 2008. The International Polar Year 2007–2008 (IPY) Legacy. Paper submitted to the WMO/IOC/UNEP/ICSU Global Climate Observing System (GCOS) Steering Committee, 16 Session, 14-17 October 2008, GCOS SC-XVI www.wmo.ch/pages/prog/gcos/scXVI/08.5%20IPY.pdf (accessed March 21, 2010)
- Stirling, George, 2007. International Scientific Collaboration: International Years of Science and the Launch of the International Polar Year 2007–2008 Report prepared for 17th meeting of the OECD Global Science Forum.
- Summerhayes, Colin, 2007. The Science Legacy of IPY – Arctic and Antarctic Research Partnership Opportunities. Paper presented at the Arctic Science Summit Week (ASSW), March 16, 2007, Hanover, NH.
- Summerhayes, Colin, 2008. International collaboration in Antarctica: the International Polar Years, the International Geophysical Year, and the Scientific Committee on Antarctic Research. *Polar Record* 44: 321-334.
- Summerhayes, Colin and Volker Rachold, 2007. The Science Legacy of IPY: Antarctic and Arctic Partnership Research Opportunities. Paper presented at Arctic Science Summit Week (ASSW), Hanover, NH, U.S.A., March 16, 2007 www.scar.org/communications/otherpresentations/SCAR_IASC_3.pdf.
- Winther, J.G. and B. Njåstad, 2010. Chair's Report from the Workshop on the legacy of the International Polar Year (27 July 2010).

Notes

- ¹ Presentation by Ian Allison, JC Co-Chair (1 March 2007) explored *three* major aspects of the IPY legacy – scientific, collaborative, and human (i.e. societal).
- ² The most recent development in assessing the IPY legacies was a special workshop at the Oslo Science Conference in June 2010 and the subsequent scoping report (Winther and Njåstad 2010) produced under a proposal endorsed jointly by the Arctic Council and the Antarctic Treaty Consultative Meeting.



5.1 Early Science Outcomes of IPY 2007–2008

Lead Author:

Robin Bell

Contributing Authors:

Ian Allison, Keith Alverson, Kjell Danell, Eberhard Fahrbach, Igor Krupnik, Jerónimo López-Martínez, Eduard Sarukhanian and Colin Summerhayes

Reviewers:

Robert Bindshadler and Vladimir Ryabinin

Introduction: Reflecting on IPY Planning Themes

During the planning phase of IPY 2007–2008, a number of major themes emerged from the community-based consultation planning. In 2004, the ICSU Planning Group identified six major research themes outlined in the “Framework” document (Rapley et al., 2004; *Chapter 1.3*). These major IPY research themes were:

- (1) To determine the present environmental status of the polar regions by quantifying their spatial and temporal variability.
- (2) To quantify and understand past and present environmental and human change in the polar regions in order to improve predictions.
- (3) To advance our understanding of polar-global teleconnections on all scales and of the processes controlling these interactions.
- (4) To investigate the unknowns at the frontiers of science in the polar regions.
- (5) To use the unique vantage point of the polar regions to develop and enhance observatories studying the Earth’s inner core, the Earth’s magnetic field, geospace, the Sun and beyond.
- (6) To investigate the cultural, historical and social processes, which shape the resilience and sustainability of circumpolar human societies, and to identify their unique contributions to global cultural diversity and citizenship.

This summary reviews the early ideas and findings from each of the themes. Our objective is to take stock of what the IPY scientific community has learned to date, that is, by the official closing of IPY 2007–2008 at the IPY Open Science Conference in Oslo in June

2010 (*Chapter 5.6*). The previous chapters outlined what happened during IPY. Here, we will focus on the general achievements of the IPY science program. This summary is deliberately written to avoid referring to individual IPY projects, program names or specific activities that have been amply covered in other sections of this volume (*Part 2; Part 3; Chapters 5.2, 5.3, and 5.4*). As is known from previous IPY/IGY efforts (*Chapter 1.1*), the major insights will take a substantial time to emerge. Given the initial stage of analysis and interpretation of much of the IPY data, this summary is neither comprehensive nor complete. Also, it uses a limited number of references, since the main literature based on the IPY results has not emerged yet. Many preliminary results (at the time of this writing) were only available from the abstracts of papers presented at the Oslo IPY Science Conference in June 2010 (e.g., Bell et al., 2010a; Ferracioli et al., 2010; Wiens et al., 2010).¹ Nonetheless, this chapter should be viewed as a first glimpse of the advances in our inter-disciplinary (and often, cross-disciplinary) understanding of the processes and linkages in the polar regions. For decades, the data collected during IPY 2007–2008 will support new scientific insights and advances.

Theme 1: Present Environmental Status of the Poles

The aim of the ‘status’ theme was to determine the present environmental status of the polar regions by quantifying their spatial and temporal variability. During the planning process it was envisioned that the main outcome would be a synoptic set

of multidisciplinary observations to establish the status of the polar environments during the 'IPY era' that would become a baseline for measuring future change. The status theme specifically included polar issues related to biodiversity and to polar residents, their health, and social and economic well-being. The examples advanced during the planning process included establishing the status of the high latitude ocean circulation and composition, documenting polar ecosystem structure and function variability through space and identifying the contemporary factors of social cohesion and values for polar societies.

The IPY benchmark measurements produced new baselines of polar environmental conditions, biodiversity and ecosystem processes, status of the polar oceans, uniquely coordinated satellite observations of the polar environments and new measurements of the polar permafrost and the polar atmosphere. Determining spatial and temporal status of the environmental change, understanding the connections between the change and human impacts and understanding polar-global linkages – cannot possibly be addressed with two years of data. Understanding these complex connections will require sustained, global monitoring integrated across a wide range of disciplines.

IPY 2007–2008 built on the wealth of new scientific discoveries that catalyzed the development of sustained observing systems. For example, because of IPY, atmospheric observations are now taken at a consortium of research stations, employing standardized measurement techniques to monitor meteorological parameters, greenhouse gases, atmospheric radiation, clouds, pollutants, chemistry, aerosols and surface energy balances (*Chapters 3.4 and 3.5*). Similarly, the oceanographic community has effectively used IPY projects to address some of the major gaps in global ocean monitoring systems, to develop novel polar technologies as the core of efforts in the Arctic and Southern Oceans, and to link different monitoring systems run by individual agencies or nations into much more extensive and coordinated network (Bates and Alverson, 2010; Figs. 5.1-1 and 5.1-2).

Early insights are emerging from IPY baseline measurements. For example, IPY baseline permafrost observations were based on borehole temperature measurements (*Chapter 2.7*). The analysis of the

permafrost temperature data in the borehole network improved during IPY demonstrated that the evolution of the permafrost temperatures is spatially variable and that the signs of warming of the upper permafrost differ in magnitude regionally. Simultaneously, new observing systems, particularly in biological sciences, have begun. Integrated, systematic observations of key species and habitats as part of long-term circumpolar monitoring programs are beginning to take shape and will be increasingly required to underpin management of ecosystem health and services in the face of the combined future impacts of climatic change and economic development in the polar regions.

IPY 2007–2008 was organized at a critical time. The Arctic and Antarctic Peninsula are known to be warming much faster than the rest of the globe (IPCC, 2007). Many impacts are already affecting biodiversity and ecosystem processes, some of which are likely to have global consequences. The international science community documented changes, deepened understanding of their causes, established baselines against which future changes can be measured, and projected future scenarios including local and global impact (*Chapter 5.2*; Dahl-Jensen et al., 2009; SWIPA, 2009; Turner et al., 2009a). Key to establishing these ecological benchmarks were biodiversity monitoring, data management and reporting through the development of integrated, ecosystem-based monitoring plans, coordinated, web-based data management products and targeted reporting tools (e.g. development of biodiversity indicators and indices). One important result is the intensified discussions on the urgent need for ongoing international, integrated monitoring systems of the Polar systems.

The facilities and instruments were improved at significant number of meteorological polar stations during IPY to provide basic meteorological variables and more reliable aerosol, chemistry, pollutant, greenhouse gases, fluxes, radiation, cosmic rays, ozone and carbon cycle measurements. Fluxes of charged particles observed in the atmosphere are the evidence to unusually profound and long-lasting solar activity minimum (Kotlyakov et al., 2010). To improve the data coverage in Antarctica, the meteorological observing network was extended by deploying new automatic weather stations at the location of the former manned

stations, closed a long time ago, and by establishing new manned stations, such as Princess Elisabeth (Fig 5.1-3). New experiments during IPY enhanced the understanding of the high latitude atmospheric dynamics and demonstrated the importance of Arctic and Antarctic observations for the improvement and validation of local, regional and global numerical weather prediction models and weather forecasting. The large atmospheric measurement campaigns conducted in the Arctic have captured the dynamics, chemistry and microphysical processes within the polar vortices during IPY, providing an excellent reference for detecting future atmospheric changes. It has also been demonstrated that turbidity characteristics of the Arctic atmosphere are due to the emission of anthropogenic pollutants, as well as from agriculture, desert dust plumes and forest fires. The characterization of Antarctic aerosols has documented

the strong differences between the coastal and the High Plateau aerosol particles (Chapter 3.5). IPY data on the polar stratospheric clouds as well as the ozone loss in the Arctic and the Antarctic have provided a coherent and complete picture of the stratospheric ozone depletion at its likely maximal development. These benchmark data sets will improve ozone loss models (Montoux et al., 2009; Chapter 3.5).

The status of the polar oceans was documented during IPY in an unprecedented way, due to intensified coordination and improved technology. A “snapshot” of the physical characteristics of the global ocean was obtained over a considerably shorter period than that made during the World Ocean Circulation Experiment (WOCE) of 1990–1997 (Chapter 2.3). Coordination increased the detection of regional variability by simultaneous cruises to different areas and provided key interdisciplinary contexts by combining

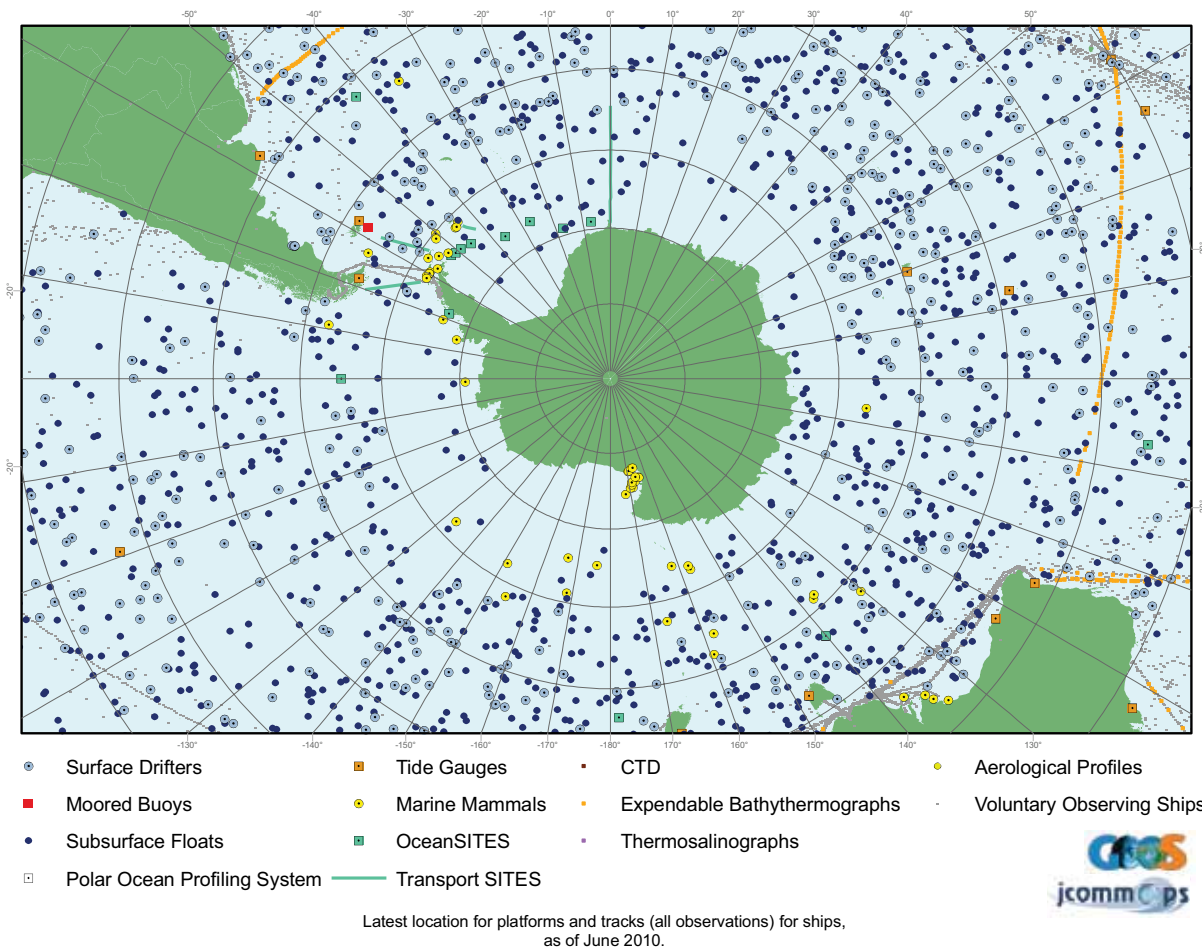


Fig. 5.1-1 *In situ* platforms, including drifting and moored buoys, subsurface floats and profilers, tide gauges, ship based measurements, and sensors on marine mammals, that reported data in June 2010 as part of the existing Global Ocean Observing System in the Southern Ocean.

(Source: IOC-WMO JCOMM-OPS operational support center)

multidisciplinary measurements by different cruises to the same area (*Chapter 3.3*). The operational use of autonomous sampling or observation systems either freely floating in the water column, drifting on the sea ice, being carried by animals or on submersible vehicles opened vast regions to intense observations that previously were inaccessible. The high resolution and high quality measurements in combination with those from pre-IPY activities allow the present status to be seen in the context of variability over a wide range of time scales, from the seasonal to the multidecadal fluctuations, that are part of natural variability.

During IPY, space-borne instruments captured unique benchmark data sets of sea ice, polar oceans, ice sheets, polar atmosphere and seasonal snow. The minimal extent of the Arctic sea ice over the whole period of remote sensing was observed in September 2007 (with two less pronounced Arctic summer ice

minimums also recorded in 2008 and 2009). For ocean studies, future scientists will be able to use IPY measurements of sea ice extent and thickness in the Arctic and Southern Ocean. While for ice sheets, IPY-coordinated efforts produced numerous key benchmark products including ice sheet wide digital elevation models and velocity measurements; multi-frequency, high-resolution imagery; maps of ice shelf extent and change; detailed images and digital elevation models of small ice caps, ice shelves and critical outlet glaciers around the coastlines of Greenland and Antarctica; time-variable series of gravity variability for estimating ice sheet mass balance and mass variability change. Space-borne measurements also provided key benchmarks of polar atmospheric composition and baseline, cloud distribution, cloud properties and upper level wind fields. Terrestrial ice and seasonal snow and terrestrial

Fig. 5.1-2 *In situ* platforms, including drifting and moored buoys, subsurface floats and profilers, tide gauges, ship based measurements, and sensors on marine mammals, that reported data in June 2010 as part of the existing Global Ocean Observing System in the Arctic Ocean.

(Source: "Why Monitor the Arctic Ocean? Services to society from a sustained ocean observing system", IOC/ UNESCO 2010)

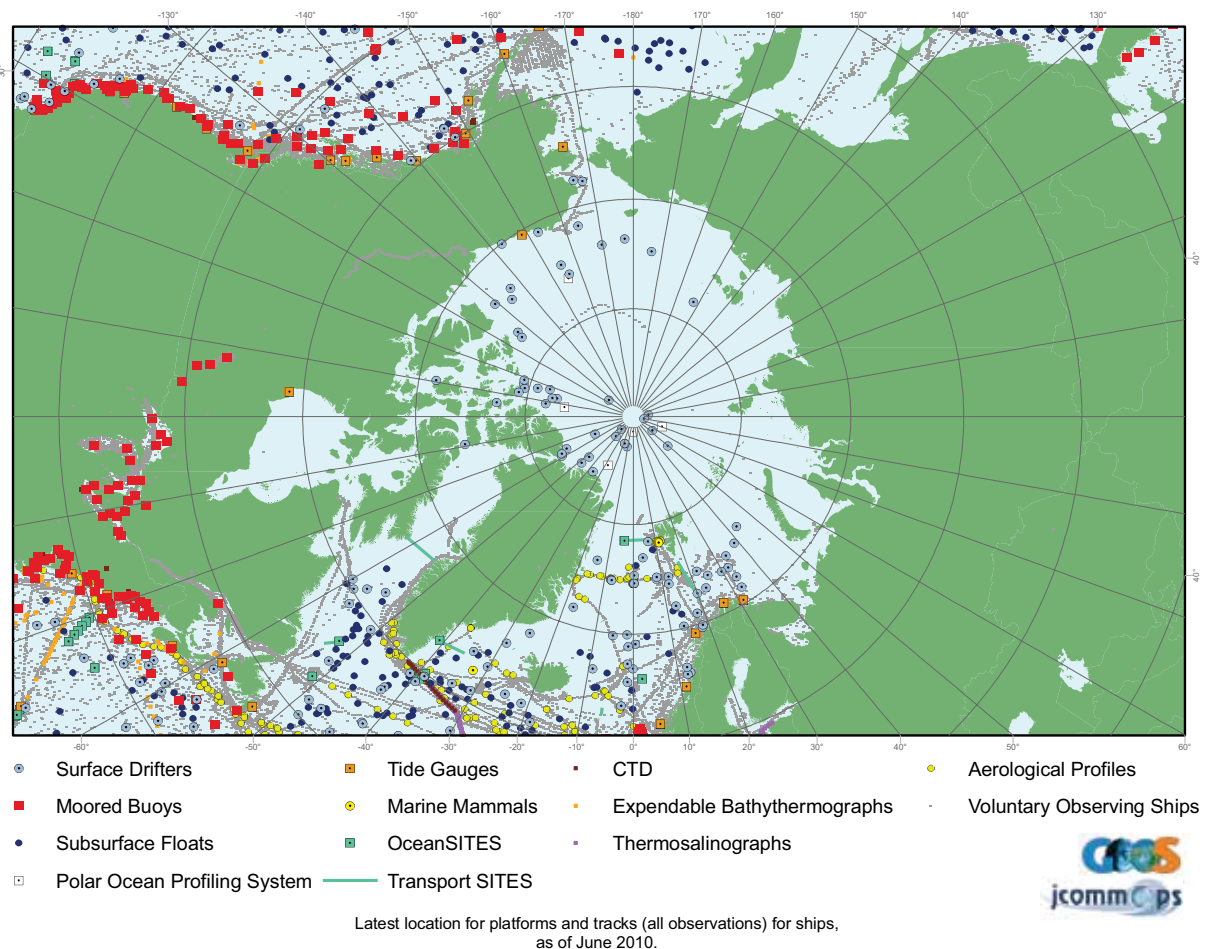




Fig. 5.1-3 Antarctic Station Princess Elisabeth, Belgium, located at 71°57' S 23°20' E.

(Photo: René Robert, courtesy International Polar Foundation)

ice benchmarks included circumpolar optical imagery for mapping thermokarst and permafrost terrain characteristics, circumpolar snow areal extent of snow cover, snow water equivalent, and the timing of formation and break up of lake and river ice. Space-based measurements also produced observations of the distributions of surface albedo and surface temperature. A challenge will be to coordinate all of these results as the basis for developing the next generation of measurements (see several chapters in *Part 2* and *Part 3*).

In the human health field, current status data sets were collected and connected. Some recent accomplishments include an expansion of health monitoring scope to include tuberculosis, an effort to integrate health data collection for northern regions of the Russian Federation and the establishment of circumpolar working groups to focus on research aspects of viral hepatitis, diseases caused by *Helicobacter pylori* and sexually transmitted infections (*Chapter 2.11*). In the social science field, a major circumpolar overview of available 'status' data called the *Arctic Human Development Report* (AHDR, 2004) was just completed before IPY. Following this approach, almost every major IPY project in this field produced data to assess the status of polar societies and social processes. New 'baseline' datasets were

generated on community development; industrial exploitation of polar resources; status of indigenous languages and knowledge systems; cultural heritage; and community use of local resources.

Theme 2: Quantifying and Understanding Change

The second theme focused most explicitly on change. It aimed to quantify and understand, past and present environmental and human change in the polar regions in order to improve predictions. Several approaches were proposed to monitor and predict environmental change, including recovering key paleo-climatic records, documenting the physical factors controlling past climate change, enhancing modeling capability, and developing long-term observation systems. Examples of specific questions to be answered included: how are climate, environment and ecosystems in the polar regions changing, how has polar diversity responded to long-term changes in climate, and how has the planet responded to multiple glacial cycles.

Insights into past climate change can be obtained by analysis of sediment cores and by ice sheet modeling. A frequent question has often been whether the West Antarctic ice sheet collapsed in the past. Sediments in the Ross Sea Antarctica, near McMurdo Sta-

tion documented repeated cycles of ice sheet collapse and growth and some new IPY studies provide direct evidence for orbitally induced oscillations in the West Antarctic Ice Sheet (Naish et al., 2009). This large marine ice sheet appears to have collapsed and reformed during the interval between 3 and 5 million years ago when the planetary temperatures were 3°C warmer than today and the atmospheric CO₂ concentrations reached values as high as 400 ppm. Parallel IPY modeling efforts indicate that during periods with elevated temperatures and atmospheric CO₂, the West Antarctic ice sheet can collapse repeatedly producing ~5m of global sea level rise (Pollard and DeConto, 2009).

The general trend at the landscape level across the Arctic is that the most rapid decadal changes have occurred where there are fine-grained soils, strong natural and anthropogenic disturbance regimes, and relatively ample water and nutrients (Fig. 5.1-4). Nevertheless, not all changes are caused by climate shifts. For example, in Barrow, Alaska, some of the vegetation changes may have been caused by residents changing the hydrological system. Similarly some of the wetlands changes may have been caused by increased goose populations and their effect on eutrophication. Again, shrub and tree abundance shifts in some areas may be related to changes in herbivory. Identification of clear causes of ecosystem changes will require post-IPY investigations. Changes in ecosystems are relatively easy to document, but clear simple attribution to specific causes is often difficult.

Change has to be addressed by projecting IPY observations onto the background of past observations and by considering a wide range of natural variability from interannual to multidecadal time scales. Sea ice extent is a popular indicator of change, although attribution of its change can be globally as well as regionally controversial. The drastic changes in the Arctic Ocean are evidenced by the record minimum summer sea ice extent in 2007, which was followed by a slight recovery later during the IPY period. Over the longer-term a clear trend of decreasing ice extent and thinning has continued. In the Arctic Ocean the mobility of sea ice increased to the extent that the transpolar ice drift accelerated by a factor of two. In contrast, the sea ice cover extent in the Southern Ocean has tended to increase slightly each

year and has shown a slight hemispheric increase of about 1% by decade over 30 years (Turner et al., 2009b). Superimposed on this overall trend there are marked regional differences. There has been a diminishing sea ice cover west of the Antarctic Peninsula (Amundsen and Bellingshausen seas) and an increase in the eastern Weddell Sea and the Ross Sea. There have also been changes to the annual persistence of Antarctic sea ice in some regions (*Chapter 2.3*).

The surface air temperature over the Antarctic continent seems to have increased by around 0.5°C between 1957 and 2006, although there are substantial local differences and the trend is not significantly different from zero at the 95% confidence level (Steig et al., 2009). This result changes the previous accepted vision of the general cooling over the same period (Thompson and Solomon, 2002). The studies carried out during IPY have highlighted the potential of satellite observations together with in situ measurements to contribute to monitoring of weather and climate over the polar areas (*Chapter 3.1*).

During IPY, studies in the snow and firn from Devon Island in the Canadian Arctic allowed tracing human impacts in the Arctic over several millennia. Data back to 4,000 BP show that lead contamination in the High Arctic pre-dated the use of leaded gasoline additives and the Industrial Revolution. Several lead peaks linked to human activity ~3,100 years ago correspond to the Roman period and late 19th-20th centuries. Although the decrease in the use of leaded gasoline diminished the Pb in precipitation in the studied area, Pb isotope data show that at least 90% of the Pb in the High Arctic is still from anthropogenic sources (*Chapter 2.1*).

The Southern Ocean is warming and freshening throughout most of the ocean depth, although significant regional differences exist. Major currents are shifting to the south, causing regional changes in sea-level and supplying additional heat to melt ice around the rim of Antarctica (*Chapter 2.3*). The future of the Southern Ocean carbon sink is under debate. In the north, shifts in exchanges between the Arctic and Atlantic via subarctic seas are impacting the Arctic Ocean. The changing poleward ocean heat flux is central to determining the present and future of the perennial Arctic sea-ice. Changes in atmospheric conditions caused by warming have affected ocean stratification and circulation. Increased heat gain by



5.1-4 IPY studies of exchanges of carbon dioxide, energy and water between the sub-arctic mountain birch forest and the atmosphere required heavy equipment to be taken by helicopter to areas of forest near Abisko, Sweden with different history of insect pest outbreaks.

(Photo: Michal Hellasz)

the ocean introduces the potential for rapid further decrease of the sea ice cover. Indications of the effect of changing physical conditions on biogeochemical cycles and the distribution and development of marine organisms are evident in both the Southern and Arctic Oceans.

Preliminary results indicate mass loss from the Greenland and Antarctic ice sheets has increased in recent years. The satellite observations along with the IPY improved network of polar geophysical observatories are providing accurate measurements of future changes. The advance that occurred during IPY in the deployment of GPS, seismic, magnetic, gravity, tide-gauge and other geodetic stations, especially in Greenland and Antarctica, built an excellent base for such studies. The data will be useful to study geodynamic processes, subglacial environments and bedrock, ice sheets flow and evolution, and atmosphere characteristics, among other issues. Initial results are promising but some of such observations need longer periods to be representative.

Studies of polar atmospheric change focused on ozone depletion and air pollution phenomena. In-

tensified ozone observations carried out during IPY in polar regions together with observations in other parts of the globe have determined that the average total ozone values in 2006–2008 have remained at the same level for the past decade, about 3.5% below the 1964–1980 global averages (WMO/UNEP, 2010; *Chapter 3.5*). The ozone loss in Arctic winter and spring between 2007 and 2010 has been variable, but has remained in a range comparable to the values prevailing since the early 1990s. The Antarctic ozone hole continued to appear each spring from 2006 to 2008. During IPY the amount of ozone depleting substances has been nearly constant indicating that the depth and magnitude of the ozone hole are controlled by variations in temperature and dynamics. The October mean column ozone within the polar vortex has been about 40% below 1980 values. The Antarctic ozone hole appears to be influencing the surface climate in the Southern Hemisphere. Climate models also suggest that the ozone hole is the dominant driver of the observed austral summer changes in surface winds over the Southern Hemisphere mid and high latitudes. These changes have contributed to the observed

warming over the Antarctic Peninsula and the cooling over the high plateau noted by Thompson and Solomon (2002). The changes in the winds have also been linked to regional changes in precipitation, increases in sea ice around Antarctica, warming of the Southern Ocean and a local decrease in the ocean sink of CO₂.

Efforts to study polar air pollution during IPY have yielded two preliminary conclusions. Firstly, the increased level of pollution in the Arctic atmosphere in recent years has an anthropogenic origin and has been generated by both agricultural activities and forest fires in Russia and Kazakhstan. In contrast, there is clear evidence that the atmosphere in the Antarctic remains uncontaminated by any anthropogenic aerosol through IPY 2007–2008.

In the social/human field, the 'change' theme was addressed by many projects, including those that investigated the growing impact of oil and gas development on polar people, their local economies and subsistence activities. Special efforts were made to document the impact of both environmental and social processes on community integration and well-being, as well as the new emerging threats to the continuity of indigenous economies, languages and knowledge systems. Several IPY projects in history and archaeology explored past changes in the polar regions, including former government relocation policies, and the impacts of early forms of commercial exploitation of polar resources, such as whaling, seal-hunting and mining. Arctic social change was documented via longitudinal comparative studies of migrations and the creation of long-term datasets on regional development, population movement, education and community dynamics (*Chapter 2.10*).

Theme 3: Polar Linkages to Global Processes

The third theme focused on how the polar regions are linked to global processes. It sought to advance the basic understanding of polar-global teleconnections on all scales and of the processes controlling these interactions. This theme aimed to address questions such as: the role the polar regions play in the global carbon cycle and the interactions between the polar regions and lower latitudes, including linkages through climatic, social, ecological and hydrological

processes.

IPY efforts have clearly documented some of the key connections between the poles and the global processes. Changes in Arctic Ocean conditions are transmitted through subarctic seas on either side of Greenland, modulating the Atlantic thermohaline conveyor (*Chapter 2.2*). Evidence of fast propagation of anomalous atmospheric conditions to the mid latitudes demonstrated unprecedented large-scale interactions leading to a warm Arctic and colder conditions in mid latitudes. Continuing loss from the West Antarctic and Greenland ice sheets represents a key threat of abrupt increase in the global sea level.

Global paleo-environmental conditions and their changes can only be understood from information about paleogeography and processes that occurred around the poles. The evolution of submarine basins and ridges affected the oceanic bottom currents and produced deviations of the main current branches along the Earth history. During IPY, campaigns in different polar straits improved our understanding of the role of plate tectonics in establishing the main polar corridors for oceanic circulation. This information is also relevant to understanding past glaciation phases at both poles as well as changes in global climate. A new tectonic map of Antarctica is being compiled as a result of IPY research.

In the past, Arctic ecosystems have generally acted as a negative feedback to climate warming, sequestering the greenhouse gas CO₂, storing large quantities of organic carbon in cold soils and reflecting solar thermal radiation away from the snow-covered Arctic land surface. The decrease in the sea ice as well as the decrease in snow and land ice coverage lowers the albedo and introducing a key positive feedback capable of accelerating Arctic water and air temperature increases. The IPY research has contributed to better understanding in soils suffering permafrost degradation of both the microbiological processes and greenhouse gas liberation to the atmosphere. The advances in this field and the improvement of the boreholes network will permit monitoring future changes of these processes that can have global consequences. In both polar regions, biological systems were found to be more closely linked to each other than expected. This is supported by the identification of more than 1000 previously unknown marine animal species of which

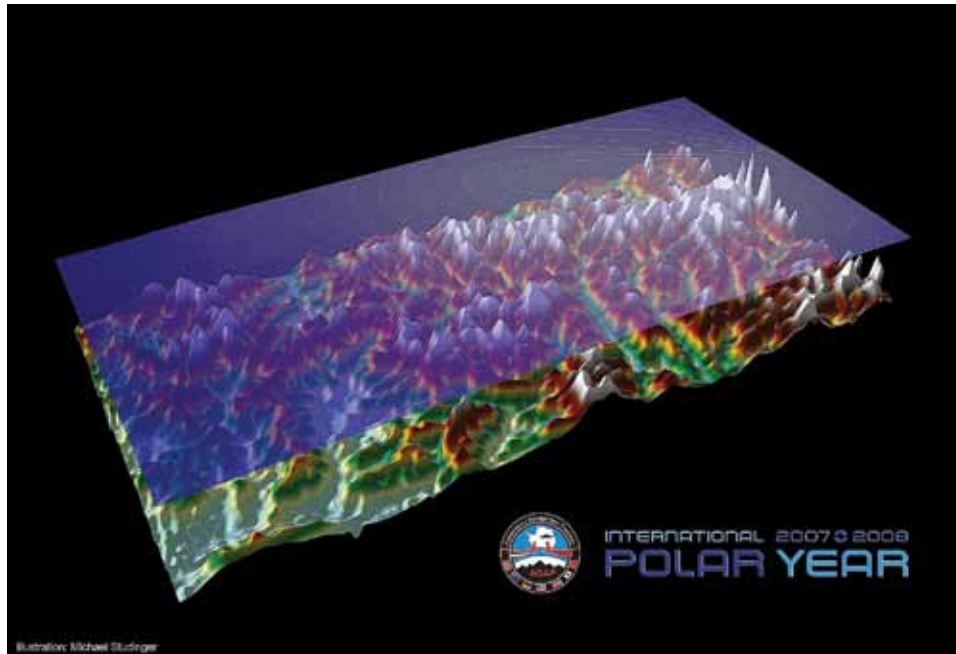


Fig. 5.1-5. 3D view of the subglacial Gamburtsev Mountains relief from inverted airborne gravity data. (Courtesy: M. Studinger)

250 were identified to be common to both poles and the remarkable similarity of the microbial systems between the poles.

Major outcomes from IPY social science and humanities research included the multi-level and adaptive nature of governance of the ‘international spaces,’ such as Antarctica, the Central Arctic Basin, High Seas and Outer Space (Shadian and Tennberg, 2009). This outcome originated in large part from the historical studies of IGY 1957-1958 and previous IPYs (Barr and Lüdecke, 2010; Elzinga, 2009; Launius et al., 2010); the celebration of the 50th anniversary of the Antarctic Treaty and the new role of the United Nations Convention on the Law of the Sea (UNCLOS) in the Arctic Policy debate.

The IPY efforts fostered the recognition of complex relationships among various drivers of change through the inclusion of local communities, their voices and perspectives in the interdisciplinary studies of climate change. Often more immediate challenges stem from the many social agents, such as local system of governance, economic development, break-up in community support networks and culture shifts. In certain areas in the Arctic, the purported ‘threat’ of climate change masks or distorts the impact of more immediate factors, such as the alienation of property

rights, appropriation of land, disempowerment of indigenous communities and more restricted resource management regimes (Konstantinov, 2010). Climate change, environmental change or global warming should be considered an *added* stressor to the already challenging local conditions.

Theme 4: Frontiers of Science in the Polar Regions

The fourth theme sought to investigate the unknowns at the frontiers of science in the polar regions. While few geographic frontiers remain on the earth’s surface, scientific frontiers aimed to be investigated during IPY exist beneath the polar ice sheets and under the ice-covered oceans, as well as at the intersections of science disciplines. Targets proposed during the planning process included: characterizing of the sub-ice and deep ocean polar ecosystems, determining the pattern and structure of polar marine and terrestrial biodiversity, at all trophic levels, and elucidating the nature of earth’s crust beneath the polar ice cover. A number of these frontier questions were addressed during IPY.

During IGY 1957–1958 a large mountain range, the Gamburtsev Mountains, was discovered by

the Russian Antarctic Expedition beneath Dome A, the highest part of the East Antarctic ice sheet. No systematic study of this enigmatic mountain range has been undertaken during the ensuing 50 years. The first results of the major Gamburtsev Mountain range under IPY 2007–2008 program are now emerging (Ferracioli et al., 2010; Wiens et al., 2010) (Fig. 5.1-5). The mountains are carved by a deep fluvial network indicating that they are older than the ice sheet. Both seismic and gravity measurements provide evidence of thickened crust beneath the mountains, indicating that they are old even though the topography may be geologically young (~35Ma). The thickened crust points to a very unusual evolution of this part of the Antarctic continent.

Several new studies just before IPY 2007–2008 revealed that the base of the Antarctic ice sheet contains an active subglacial hydrologic system including lakes that drained over the course of months (Chapter 2.6). Geophysical investigations during IPY showed this also occurred at Dome A and have provided evidences on the important role of subglacial water in ice sheet movement, stability and mass balance. Evidence of water in the deep valleys beneath Dome A indicated an active subglacial hydrologic system including widespread freezing of water from these systems onto the base of the ice sheet (Bell et al., 2010a). Generally the accumulation of snow on the surface of ice sheets is the main mechanism for ice sheet growth, but beneath the Dome, frozen-on ice occurs under almost one quarter of the ice sheet base. In some places up to half the ice thickness is a result of this novel freeze-on process (Chapters 2.5 and 2.6).

The focus of previous IPYs was primarily on geosciences and the physical world. The advent of modern genomic techniques opened the door to a microbial level frontier as one of the targets of IPY 2007–2008. One of the projects discovered polar microorganisms with surprising diversity, essential ecological functions and environmental roles as global warming sentinels. This has resulted in a major leap forward in our understanding of the microbial diversity of polar ecosystems and has contributed fundamental insights into arctic habitats, their communities and climate impacts. Striking microbial communities were found in the perennial cold springs in the Canadian High Arctic. Grey-coloured microbial streamers form there during

winter in snow-covered regions but disappear during the Arctic summer. The streamers are uniquely dominated by sulfur-oxidizing species (Vincent et al., 2009). This finding broadens our knowledge of the physico-chemical limits for life on Earth.

Several High Arctic microbe taxa were >99% similar to Antarctic and alpine sequences, including to the ones previously considered to be endemic to Antarctica. One High Arctic gene sequence was 99.8% similar to *Leptolyngbya antarctica* sequenced from the Larsemann Hills, Antarctica and many of the Arctic taxa were highly dissimilar to those from warmer environments (Chapter 2.9). These results imply a global distribution of low-temperature cyanobacterial ecotypes, or cold-adaptive endemic species, throughout the cold terrestrial biosphere.

Mid-ocean ridges have been the focus of much study since their discovery during IGY. Beneath the Arctic Ocean, the Gakkel Ridge is the slowest spreading mid-ocean ridge on the planet and was targeted for IPY studies. This ultra-slow spreading ridge is often assumed to be relatively inactive. During IPY 2007–2008, evidence for explosive volcanism was discovered on the Gakkel Ridge (Sohn et al., 2008). The first-ever evidence for explosive volcanism on a mid-ocean ridge was documented with images of the ocean floor blanketed in an extensive frozen frothy lava including fragments of a bubble wall. This discovery raises questions about the accumulation of volatiles and gases in the magma chambers beneath slow spreading ridges during the long time between eruptions; little is currently known about the dynamics of magma chambers on these ridges.

Some of the basic discovery during IPY 2007–2008 resulted from collaborative work at both poles looking at the inventory of carbon stored in the permafrost layer. Permafrost is the ground, soil or rock and associated ice and organic material, which remains at or below 0°C for at least two consecutive years. More than 20% of the terrestrial part of the surface of the northern hemisphere consists of permafrost. If permafrost thaws, these large pools of previously frozen organic carbon within it may be remobilized releasing large amounts of greenhouse gases. These can contribute to a positive feedback loop in the climate system as the additional warming resulting from the release of the permafrost greenhouse gases

will trigger more permafrost thawing. The new IPY estimate of total below ground soil carbon stored in permafrost regions (ca. 1672 PgC) is more than twice the previous value. It is more than double the present atmospheric pool (ca. 750 PgC) and three times larger than the total global forest biomass (ca. 450 PgC) (*Chapter 2.7*).

Multiple IPY studies solidified the basis for improved assimilation of satellite data in numerical weather models for regional polar prediction. Particular emphasis was put on improving the representation in models of surface processes, high-latitude clouds, cloud/radiation interactions and other key energy exchanges in the Arctic. These atmospheric models are now being run at increased resolution and are able to reproduce several processes that are essential for high-impact weather prediction. The newly incorporated processes include the role of local and middle latitude flow distortions caused by steep orographic changes, for example that in Greenland, and meso-scale phenomena referred to as “polar bombs”.

In the social/human field, by far the most important frontier theme explored in IPY 2007–2008, was the relationship between indigenous perspectives developed via generations of shared knowledge and observations, and the data and interpretations generated through thematic scholarly research. The field that compares such perspective did not exist prior to the late 1990s. Several IPY projects contributed to our increased understanding of how indigenous knowledge could be matched with instrumental data in monitoring the changes in Arctic ice, snow and vegetation condition, marine mammal and caribou/reindeer migrations, behavioral patterns of polar animals and fishes. Another ‘frontier’ area in IPY social science studies centers on making polar research culturally and socially relevant to local residents by collaborating with new groups of stakeholders on research planning in their home areas (*Chapter 5.4*). As more attention is being paid to local concerns and community observations, the new research goals are set through dialogue with local communities (*Chapters 2.10, 3.10 and 5.4*).

The preservation of the polar environments from possible impacts has been revealed as an important issue connected with the increasing human impacts. The introduction of non-native species in the isolated

Antarctic environment has been studied during IPY and opens a way for future protection actions.

Yet another frontier area pioneered in IPY 2007–2008 is the comparative study of northern-southern hemisphere processes under the concept of ‘fringe environments’ (Hacquebord and Avango 2009); this concept is relevant to both hemispheres. In the social sciences and humanities field, it focuses on the history of polar explorations, commercial use of local resources, polar governance, tourism and heritage preservation (*Chapter 2.10*).

Theme 5: Unique Vantage Point of the Polar Regions

The fifth theme sought to leverage the polar regions as unique sites for investigating distant realms. The vantage point theme aimed to use the unique location and conditions of the polar regions to develop and enhance observatories studying the Earth’s inner core, the Earth’s magnetic field, geospace, the Sun and beyond. The questions advanced ranged from what is the influence of solar processes at the polar regions on earth’s climate to what is the state of the earth’s magnetic dipole.

During IPY, astronomers continued leveraging the unique observing conditions offered by the polar regions to conduct a range of astronomical studies. Polar sites from South Pole, Dome C, Dome A, Dome F and Ridge A on the East Antarctic ice sheet to Arctic sites in Ellesmere Island and Greenland were evaluated as sites for new observatories (<http://mcba11.phys.unsw.edu.au/~plato/>). Places with already existing observatories, such as South Pole (Amundsen Scott Station) and Dome C (Concordia Station), have been broadly recognized as key places with great potential for astronomical observations and have been improved during IPY. Measurements of the atmospheric water vapor above Dome A during IPY showed it to be the driest location on Earth, with a vapor column as low as 25 microns of precipitable water for days at a time. With this dry atmosphere, the Antarctic plateau sites are the only locations on our planet from where routine astronomical observations in the terahertz spectrum (10^{12} Hz) are possible. During IPY, astronomers detected a previously unknown class of galaxy clusters by studies of the Cosmic Microwave

Background with the South Pole Telescope. These galaxy clusters are more numerous and appeared earlier in the evolution of the universe than previously expected (Staniszewski et al., 2009).

Links between the behavior of the sun and earth climate have long been advanced and discussed primarily through variations in the amount of energy put out by the sun, i.e. via solar irradiance changes. During IPY, scientists deployed instruments designed to measure the electrical flux through the polar atmosphere in an effort to examine whether there are additional couplings between the sun and earth's climate. These investigations suggest that small day-to-day atmospheric pressure variations in the Arctic and Antarctic are associated with a proxy for the output of the meteorological generators (thunderstorms and strongly electrified clouds) of the global atmospheric circuit. This proxy is derived from vertical electric field measurements made at the Vostok Station on the Antarctic ice plateau. Proportionate pressure variations on the Antarctic plateau are correlated with atmospheric circuit changes due to solar wind interactions in the polar regions. This result provides experimental evidence that a small portion of the global surface pressure variations is due to the influence of the global atmospheric circuit. The pressure response to the solar wind variations is an example of 'sun-weather' coupling via a different mechanism than solar irradiance changes (Burns et al., 2008).

Measurements in polar regions have potential for improving the seismic and tomographic models of the Earth interior. These regions are also unique vantage points for studying the structure and improving understanding of the evolution of the Earth's inner core and new studies will provide insights into core dynamics with implications for the Earth's magnetic field. Only seismic phases traveling along polar paths can map seismic anisotropy in the core, generally aligned parallel to Earth's rotation axis, which may be due to convection patterns in the core (Leykam et al., 2010).

Lake Vostok is frequently compared to the ice covered moons of Saturn and Jupiter, and the environments in the Antarctic Dry Valleys are viewed as the habitat on Earth most similar to that on Mars. During this IPY scientists used the same technology that was used on the Mars Landers to measure environmental conditions in the Dry Valleys of

Antarctica. IPY scientists identified microbial biota in this extreme environment that may be typical of the types of biota that once inhabited Mars.

The idea that polar regions offer unique insight into global processes also resonates in the social science and humanities research, due to the amplification of many societal phenomena at the local scale. Also, Arctic regions often feature well developed long-term data sets, thanks to the long established tradition of community and human-environmental studies. During IPY, substantial efforts were made to place the circumpolar regions into wider global context, including the development of policies for managing 'common spaces', commercial resource exploitation of the economic 'frontier' zones, population exchange between Arctic and mid-latitudes; and the search for broadly applicable indicators of sustainability and community well-being (Larsen et al., 2010).

An internal 'vantage point' in the Arctic is the stock of knowledge about polar environments accumulated by local residents and, especially, by indigenous people. Many social scientists and indigenous experts believe that both of the vantage points offered by the two ways of knowing, academic knowledge and local/indigenous knowledge, are needed for a comprehensive understanding of the polar regions and processes.

Theme 6: Cultural, Historical and Social Processes (Human Dimension)

While the goal of IPY was to be fully interdisciplinary across all the themes, the ICSU IPY Planning Group added the sixth theme to address various issues related to human activities (e.g. cultural, economic, health, political) in the polar regions (Rapley et al., 2004). This sixth theme ensured that social sciences and the humanities, as well as polar indigenous people were a more visible part of the planning and implementation. The projects developed under this theme sought to investigate the cultural, historical and social processes that shape the resilience and sustainability of circumpolar human societies, and to identify their unique contributions to global cultural diversity.

In the years prior to IPY, the dichotomy between the northern and southern regions went far beyond the basic biological and physical differences exemplified

by the northern polar bear and the southern penguin, or ocean ringed by continents in the north and continent surrounded by ocean in the south. Antarctic social sciences seemed to be an oxymoron; there were 'no people' in Antarctica. During IPY 2007–2008, this perception has changed dramatically and fully-fledged 'Antarctic social sciences' are emerging (*Chapter 2.10*); there is an explosion of interest in social issues that are *common* to both polar regions. These common social issues include the history of science, early economic exploration and commercial exploitation, sustainable economies, governance and political regimes, tourism, heritage preservation and engagement of local constituencies. Some areas are unique to the North including indigenous people, small-community studies and traditional knowledge. On other fronts progress is being made through IPY enhanced contacts and professional interactions between 'northern' and 'southern' social scientists.

Prior to IPY, the prevailing way of modeling complex linkages under the impacts of climate change, was to place "humans" at the margins of the chain-like charts illustrating connections within the ecosystem. The underlying assumption was that people would respond to the projected impacts predicted by computer-based scenarios such as warmer climates, shorter ice season or thawing permafrost. Social scientists were tasked with emphasizing the "human dimension". During IPY, a new approach moved communities to the center of the study of change and impacts. The new approach called *community-based vulnerability assessment* starts with the observations of change within local communities and proceeds bottom-up to identify potential future exposures, specifically new conditions or risks that communities may face or are already facing (Hovelsrud and Smit, 2010). This new approach places people and communities in the center of climate-impact studies. It operates with many more parameters of change, both physical and socio-cultural, and it puts much greater emphasis on what may be seen as *future* risks, sensitivities and adaptive strategies, as the current adaptation mechanisms are researched and understood.

The multiple perspectives approach developed during IPY requires that each process or phenomena should be viewed from many different perspectives (e.g. those of different disciplines or 'stakeholders')

and that putting them together increases our power of understanding. In social sciences this approach is widely associated with the use of knowledge and perspectives of local people, but it is broader than that, since the objects to which the paradigm of 'multiple perspectives' may be applied range across many disciplines. The sea ice, for example, is viewed differently by ice scientists, climate modelers, oceanographers, local subsistence users and anthropologists who study ice-using cultures (Krupnik et al., 2010). Each group can learn from knowing other perspectives and the common resulting knowledge is more than the sum of its individual parts. The goal is to 'broaden the table,' which was one of the purposes of this IPY, and IPY research has successfully changed the dynamics in the relationship and status of data and knowledge used by various groups of polar stakeholders.

Concluding Remarks

IPY 2007–2008 led to a greatly enhanced polar research effort and a general spike in public attention to the Earth's polar regions for almost a full decade. During the formal two-year duration of IPY, the direct funding for polar science, excluding logistics and other support costs, increased by at least 30%. More importantly, the new collaborations formed between research groups, between nations and across disciplines enabling much larger and more integrated polar research challenges to be tackled by IPY projects than would otherwise have been feasible (Bell et al., 2010b). Research cooperation, shared logistics and the support from national space agencies in targeting optimized polar coverage during IPY enabled polar data to be collected systematically over larger geographic areas. IPY 2007–2008 brought in nations and scientists that had not previously worked in the Arctic or Antarctic (*Chapter 5.3*); new techniques, technologies and enhanced data sharing; and improved appreciation from policy makers and the public of the importance to the global community of supporting research in polar regions.

The IPY science outcomes presented in this overview are partial and preliminary. Detailed scientific results and insights can be expected to flow from IPY data and initiatives for the next decade or so. The scope and scale of IPY projects indicate the broad

achievements already made against the planned IPY objectives. Nonetheless, more than fifty years after IGY 1957–1958, there remain hidden science frontiers that are in, or can be observed from the polar regions. Revealing these requires increasingly sophisticated planning and technology, and adequate lead time. In IPY 2007–2008, there was relatively little time between formulation of the program vision and initiation of field activities. A lesson for the next IPY organizers is that the most technologically challenging projects would benefit from greater lead time than was available for IPY 2007–2008. It is expected that some of the more important scientific advances that will emerge from IPY 2007–2008 will only result from synthesis of results and data across disciplines and projects. As was the case after IGY 1957–1958, it will probably take at least several years. More immediate scientific legacies of IPY 2007–2008 will be the ongoing measurements from new polar observational systems initiated during IPY (*Part 3*).

IPY 2007–2008 has also contributed to the improvement in the polar data management by advancing the progress in policy and philosophy beyond technical progress, an important issue that will have major impact in the future of polar research. New polar re-

search directions and initiatives will undoubtedly arise that are guided by data and results from the many projects undertaken between March 2007 and March 2009 (and beyond). Future polar science will also benefit from IPY efforts to establish new links between scientists and between scientific organizations, as well as to develop the next generation of polar researchers.

We confidently expect that polar research institutions like the International Arctic Science Committee (IASC) and the Scientific Committee on Antarctic Research (SCAR) will strive to ensure the success of the IPY legacy especially in terms of the further development of multinational interdisciplinary science programmes on scales larger than individual nations can manage; the nurturing and enhancement of observing systems to underpin science requirements and operational needs; the sharing of polar data to enhance its value (on the principle of “capture once, use many times”); and the nurturing of the pool of talent available to ensure that the best science gets done with the resources available. It is also expected that the Arctic Council and the Antarctic Treaty Parties will continue to support SCAR and IASC in these endeavors (*Chapter 5.5*). Political will and national funding are essential aids to scientific success in support of societal needs.

References

- AHDR, 2004. Arctic Human Development Report. N. Einarsson, J. Nymand Larsen, A. Nilsson, and O.R. Young, eds. Akureyri: Stefansson Arctic Institute.
- Barr, S., and C. Lüdecke, eds., 2010. *The History of the International Polar Years (IPYs)*. Dordrecht: Springer.
- Bates, P. and K. Alverson, 2010. *Why Monitor the Arctic Ocean: Services to society from a sustained ocean observing system*. Paris: IOC/UNESCO, www.ioc-goos.org/index.php?option=com_oe&task=viewDocumentRecord&docID=6262&lang=en
- Bell, R. E., T. Creyts, M. Wolovick, P. Spector, M. Studinger, T. Jordan, N. Frearson, F. Ferraccioli, H. Corr, A. Smith, D. Braaten and D. Damaske, 2010. Melt and Freeze Couplet in Central East Antarctica, International Polar Year (IPY) Oslo Polar Science Conference 2010, June 8-12., 2010 <http://ipy-osc.no/abstract/383046>.
- Bell, R. E., I. Krupnik, D. Hik, K. D. Alverson, and M. R. Drinkwater, 2010. Building on IPY Data, Collaborations and Infrastructure to Understand the Changing Poles, *Eos Trans. AGU*, 91(52), Fall Meet. Suppl., Abstract GC11A-01.
- Burns, G.B., B. A. Tinsley, W. J. R. French, O. A. Troshichev, and A. V. Frank-Kamenetsky, 2008. Atmospheric circuit influences on ground-level pressure in the Antarctic and Arctic. *Journal of Geophysical Research* 113 D15112, 11 pp.,

- doi:10.1029/2007JD009618.
- Dahl-Jensen, D., J. Bamber, C.E. Bøggild, E. Buch, J.H. Christensen, K. Dethloff, M. Fahnestock, S. Marshall, M. Rosing, K. Steffen, R. Thomas, M. Truffer, M. van den Broeke and C.J. van der Veen, 2009. Summary – The Greenland Ice Sheet in a Changing Climate Snow, Water, Ice and Permafrost in the Arctic (SWIPA). AMAP: Oslo, 22 pp.
- Elzinga, A., 2009. Through the lens of the polar years: changing characteristics of polar research in historical perspective. *Polar Record* 45(235):313–336.
- Ferraccioli, F., R. Bell, D. Damaske, M. Studinger, D. Braaten, and C. Finn. Aerogeophysical exploration of the Gamburtsev Province during IPY, International Polar Year (IPY) Oslo Polar Science Conference 2010, June 8–12., 2010 <http://ipy-osc.no/abstract/383046>.
- Hacquebord, L. and D. Avango, 2009. Settlements in an Arctic Resource Frontier Region. *Arctic Anthropology* 46 (1-2): 25-39.
- Hovelsrud, G.K., and B. Smit, eds., 2010. *Community Adaptation and Vulnerability in the Arctic Regions*. Dordrecht: Springer.
- IPCC, 2007. *Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds). Cambridge, U.K. and New York, NY: Cambridge University Press.
- Konstantinov, Yu., 2010. Socioeconomic Life of Climate Change: Extensivity in Reindeer Husbandry in Relation to Synergies between Social and Climate Change (Kola Peninsula). *Acta Borealia* 27(1):44–65.
- Kotlyakov V.M., E.I. Sarukhanian, and I.E. Frolov, 2010. The first results of the International Polar Year 2007–2008. *Priroda*, 9(1141):44-55
- Krupnik, I., C. Aporta, S. Gearheard, G.L. Laidler, and L. Kielsen Holm, eds., 2010. SIKU: *Knowing Our Ice. Documenting Inuit Sea Ice Knowledge and Use*. Dordrecht, Heidelberg, etc.: Springer.
- Larsen, J., P. Schweitzer, and G. Fondahl, 2010. *Arctic Social Indicators*. Arhus: TemaNord 2010:519.
- Launius, R.D., J.R. Fleming, and D. H. DeVorkin, eds. 2010. *Globalizing Polar Science: Reconsidering the International Polar and Geophysical Years*. Palgrave Studies in the History of Science and Technology. New York: Palgrave Macmillan.
- Leykam, D., H. Tkalcic, and A.M. Reading, 2010. Core structure re-examined using new teleseismic data recorded in Antarctica: evidence for, at most, weak cylindrical seismic anisotropy in the inner core. *Geophysical Journal International*, 180(3):1329-1343.
- Montoux N., C. David, A. Klekociuk, M. Pitts, M. Snels, J. Jumelet, P. Keckhut, and S. Bekki. 2009. MATCH-PSC Lidar Campaigns in Antarctica during IPY: Polar Stratospheric Clouds formation and evolution, MOCA-09 *Join Assembly*, Montreal.
- Naish, T., R. Powell, R. Levy, G. Wilson, R. Scherer, F. Talarico, L. Krissek, F. Niessen, M. Pompilio, T. Wilson, L. Carter, R. DeConto, P. Huybers, R. McKay, D. Pollard, J. Ross, D. Winter, P. Barrett, G. Browne, R. Cody, E. Cowan, J. Crampton, G. Dunbar, N. Dunbar, F. Florindo, C. Gebhardt, I. Graham, M. Hannah, D. Hansaraj, D. Harwood, D. Helling, S. Henrys, L. Hinnov, G. Kuhn, P. Kyle, A. Läufer, P. Maffioli, D. Magens, K. Mandernack, W. McIntosh, C. Millan, R. Morin, C. Ohneiser, T. Paulsen, D. Persico, I. Raine, J. Reed, C. Riesselman, L. Sagnotti, D. Schmitt, C. Sjunneskog, P. Strong, M. Taviani, S. Vogel, T. Wilch, and T. Williams, 2009. Obliquity-paced Pliocene West Antarctic ice sheet oscillations. *Nature* 458, 322-328. doi:10.1038/nature07867.
- Pollard D., and R. DeConto, 2009. Modelling West Antarctic ice sheet growth and collapse through the past five million years. *Nature* 458, 329-333. doi:10.1038/nature07809.
- Rapley, C., R. Bell, I. Allison, R. Bindschadler, G. Casassa, S. Chown, G. Duhaime, V. Kotlyakov, M. Kuhn, O. Orheim, P. Ch. Pandey, H. Petersen, H. Schalke, W. Janoschek, E. Sarukhanian, and Zh. Zhang, 2004. *A Framework for the International Polar Year 2007–2008. Produced by the ICSU IPY 2007–2008 Planning Group*. ICSU: Paris, 57 p.
- Shadian, J.M. and M. Tennberg, eds., 2009. *Legacies and Change in Polar Sciences. Historical, Legal, and Political Reflections on the International Polar Year*. Farnham: Ashgate Publishing.
- Sohn, R. A., C. Willis, et al., 2008. Explosive volcanism on the ultraslow-spreading Gakkel ridge, Arctic Ocean. *Nature* 453(7199):1236-1238.
- Staniszewski, Z. et al., 2009. Galaxy Clusters Discovered

- with a Sunyaev-Zel'dovich Effect Survey. *The Astrophysical Journal* 701:32-41.
- Steig, E.J., D.P. Schneider, S.D. Rutherford, M.E. Mann, J.C. Comiso and D.T. Shindell, 2009. Warming of the Antarctic ice sheet surface since 1957 International Geophysical Year. *Nature* 457:459-463.
- SWIPA, 2009. Climate Change and the Cryosphere: Snow, Water, Ice, and Permafrost in the Arctic (SWIPA) An Arctic Council 'Cryosphere Project' in Cooperation with IASC, CliC and IPY. Project summary, 60 pp. www.amap.no/swipa/#Products.
- Thompson, D.W.J. and S. Solomon, 2002. Interpretation of Recent Southern Hemisphere Climate Change. *Science* 296:895-899.
- Turner, J., R.A. Bindshadler, P. Convey, G. Di Prisco, E. Fahrback, J. Gutt, D.A. Hodgson, D.A., P.A. Mayewski, and C.P. Summerhayes, eds., 2009a. *Antarctic Climate Change and the Environment*. SCAR, Cambridge, 560 pp.
- Turner, J., J.C. Comiso, G.J. Marshall, T.A. Lachlan-Cope, T. Bracegirdle, T. Maksym, M.P. Meredith, Z. Wang and A. Orr, 2009b. Non-annular atmospheric circulation change induced by stratospheric ozone depletion and its role in the recent increase of Antarctic sea ice extent. *Geophysical Research Letters*, 36, L08502, doi:10.1029/2009GL037524.
- Vincent et al., 2009. Arctic microbial ecosystems and impacts of extreme warming during the International Polar Year. *Polar Science* 3:171-180, doi:10.1016/j.polar.2009.05.004.
- Wiens, D.A. and A. Nyblade, S. Anandakrishnan, R. Aster, M. Kanao and M. An., 2010. The seismological structure of Antarctica from year-around IPY deployments of autonomous broadband seismography's: the POLENET and GAMSEIS projects, International Polar Year (IPY) Oslo Polar Science Conference 2010, June 8-12, 2010 <http://ipy-osc.no/abstract/382929>.
- WMO/UNEP Scientific Assessments of Ozone Depletion, 2010. Executive Summary prepared by the Scientific Assessment Panel of the Montreal Protocol on substances that deplete the ozone layer, 33 pp. www.esrl.noaa.gov/csd/assessments/ozone.

Notes

- ¹ All paper abstracts from the Oslo IPY Conference (June 2010) are available on the conference website http://ipy-osc.no/osc_programme. They may be searched and accessed by titles, their authors' last names and/or key words in the titles.

5.2 Broadening the Cross-Disciplinary Impact of IPY Research



Lead Authors:

Colin Summerhayes, Volker Rachold and Igor Krupnik

Contributing Authors:

Hajo Eicken, Gary Hufford, Vera Metcalf, Sue Moore, James Overland, Lars-Otto Reiersen, Morten Skovgård Olsen and Helen Wiggins

Cross-disciplinary collaboration, synthesis and integration

The science scope of this IPY was remarkably different from that of its predecessors and other large-scale science programs in polar research. Dedicated efforts were made to include cross-disciplinary studies and projects exploring the human dimension, ecological diversity, and community and ecosystem health. For the first time in an IPY–IGY setting, physical, natural, social and humanistic scientists and local community-based experts worked together under a common multidisciplinary science programme. This new form of cross-disciplinary collaboration is widely perceived as a lasting achievement of IPY 2007–2008. It marks an extraordinary advance in our perception of the complexities of the polar regions and of the importance of synthesis, knowledge integration and data sharing in the understanding of processes that affect our planet.

(The State of Polar Research, 2009, p. 9)

As impressive a venture as IPY 2007–2008 has been, with more than 228 international projects engaging some 50,000 scientists from 60 nations, it was not the *only* major polar science initiative between 2004 and 2010. Nor did IPY introduce the template of a ‘mega-program’ involving experts from many disciplines and funding from several nations. Some of those ‘mega-programs’ started prior to the main thrust for IPY 2007–2008 and were completed and published in parallel with the emerging IPY network. *Arctic Climate Impact Assessment* report (ACIA, 2005), *Arctic Human Development Report* (AHDR, 2004) and *Arctic Research: A Global Responsibility* (ICARP II, 2005) are among the few examples from those years. In other cases, national operators decided to re-label as ‘IPY’ what they would likely have been doing anyway. Although in development independently and prior to IPY, these programs experienced their full advancement during the IPY years and were taken by their originators as contributions to the goals of IPY 2007–2008 and its science program. Arctic Human Health Initiative (AHHI, IPY no. 167 – Chapter 2.11), U.S. *Study of Environmental*

Arctic Change (SEARCH) and its international version, *International Study of Arctic Change* (ISAC, IPY no. 48), *Developing Arctic Modeling and Observing Capabilities* (DAMOCLES, IPY no. 40), *Arctic Social Indicators* (ASI – IPY no. 462), ArcticNet - Network of Centres of Excellence of Canada and several others are good examples of such major multi-disciplinary programs that became the building blocks of IPY.

In yet other instances, new research was indeed started due to the IPY-triggered ‘pulse’ and funded with the new money generated under IPY. For example, the development of the Arctic Ocean and Southern Ocean Observing Systems (*Chapters 3.2 and 3.3*) was a topic of ongoing concern for several years and the preparation for both had already been started. The arrival of IPY added the needed urgency to the process; it enabled many groups and scientists to develop their ideas as IPY proposals, which helped bring the wider community together and get things moving faster. Having the IPY label was a great boost for many science programs that would or might have happened anyway. As IPY illustrated, it makes a difference when you can see that what you are

doing will contribute to a much larger global effort. For example, the five major new science programs approved by SCAR in 2004 all submitted major IPY proposals that, once approved by the JC and awarded their IPY project numbers, constituted special two-year observing periods within their longer-lived programs. These major SCAR programs were: Subglacial Lake Exploration (IPY no. 42); Antarctic Climate Evolution (no. 54); Interhemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research (ICESTAR no. 63); Antarctic in the Global Climate System (no. 180); and the Evolution and Biodiversity in the Antarctic program (EBA no. 137). Other ongoing SCAR programs with special observing periods as IPY programs included, the Census of Antarctic Marine Life (CAML no. 53); the Marine Biodiversity Network (MarBIN no. 83); the SCAR-WCRP Cryosphere Observing System program (no. 105); and the SCAR Antarctic Sea Ice Processes and Climate program (no. 141).

There were also several initiatives that were not formally submitted to the IPY process and thus have not been reviewed and endorsed by the Joint Committee in 2005–2006 based upon the ‘IPY criteria,’ such as inter-disciplinarity, international team, data-management policy, and education and outreach program (*Chapter 1.5*). Nonetheless, their ties to IPY 2007–2008 are indisputable and are proudly acknowledged by the organizers. These programs also influenced the overall IPY development and planning process and its approach to the extent that they may be decisively named ‘IPY-era projects.’

This chapter highlights three of many of the initiatives of the past decade that bear the hallmark of what may be called the ‘IPY science.’ The first is the SCAR’s *Antarctic Climate Change and the Environment* (ACCE) review, which was developed following the model of the Arctic Climate Impact Assessment (ACIA) published in full in 2005. The ACCE review was initiated in 2005 and was designed to produce a balance from the south (Antarctic) to the northern (Arctic) review. Since its work was carried out during the IPY years, the ACCE review was always seen by its originators as a designated contribution to IPY 2007–2008. The work was sped up in comparison to what would have happened without IPY; an element of urgency was added by the advent of IPY.

The second illustration, the *Snow, Water, Ice,*

Permafrost in the Arctic (SWIPA) project, initiated by the Arctic Council, also developed during the IPY years, but would have followed the ACIA Report of 2005 for obvious reasons. Climate change and shifts in many environmental parameters in the polar regions have been advancing with such an alarming speed that periodic updates are urgently needed, as in the IPCC process. Again, the IPY momentum contributed that element of urgency. Another factor of IPY ‘nature,’ was the focus on the impacts those changes are having upon local stakeholders, particularly upon Arctic residents and indigenous people.

The third project featured here as an example of ‘IPY-influenced science,’ *Sea Ice for Walrus Outlook* (SIWO), was launched after the IPY main observational period. It grew ‘on the shoulders’ of several IPY 2007–2008 activities, like *Sea Ice Outlook* (*Chapter 3.6*) and SIKU and SIZONet projects (*Chapter 3.10*), but even more so, it sprung up from the new spirit of collaboration among scientists from different fields and polar residents promoted by IPY. Though SIWO is a pilot initiative with a limited time frame and with a particular regional scope, it perfectly illustrates many of the same influences that IPY science is already having over dozens of new polar initiatives, large and small.

Antarctic Climate Change and the Environment (ACCE) – A SCAR contribution to IPY 2007–2008

Colin Summerhayes

One of the key requirements of IPY 2007–2008 was to assess the state of the polar environments. In the case of the Arctic, this had to a large extent been done immediately before IPY in the “Arctic Climate Impact Assessment” (ACIA), produced by the Arctic Council and the International Arctic Science Committee (IASC), and published by Cambridge University Press in 2005 (www.acia.uaf.edu/pages/scientific.html). In July 2005, the SCAR Executive Committee, meeting in Sofia, Bulgaria agreed that a companion volume on Antarctic climate change should be produced for the guidance of policy makers in the Antarctic Treaty System and to inform the public. The ACCE review was designated by SCAR as a contribution to IPY 2007–2008 (www.scar.org/publications/occasionals/

acce.html).

The plan for the review was fleshed out at the first SCAR Cross-Linkages Workshop in Amsterdam (15-17 November, 2005). Initial results were presented to policy-makers at the Antarctic Treaty Consultative Meeting (ATCM) in New Delhi (30 April to 11 May 2007) (www.scar.org/treaty/atcmxxx/Atcm30_ip005_e.pdf) and published in 2009 (Mayewski et al., 2009). Phase II incorporated biology and chemistry. Preliminary results were presented to the ATCM in Kiev (2-13 June 2008) (www.scar.org/treaty/atcmxxxii/ATCM31_IP62_ACCE.pdf) with final results being delivered to ATCM in Baltimore (6-17 April 2009) (www.scar.org/treaty/atcmxxxii/Atcm32_ip005_e.pdf). The completed ACCE book (Turner et al., 2009 Fig. 5.2-1) was printed in October 2009 and copied to national delegations to the 15th Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC) meeting in Copenhagen in December. Talks on ACCE were given during the UNFCCC meeting and a summary paper was published in *Antarctic Science* in December 2009.

The ACCE review contributes to the goals of the World Climate Research Programme (WCRP) and, in particular, to its Climate and Cryosphere programme (CliC) of which SCAR is a co-sponsor. It will be copied to the Intergovernmental Panel on Climate Change.

The report of 560 pages has 100 authors from 13 countries; it was reviewed by around 200 scientists and was edited by a team of nine led by John Turner of the British Antarctic Survey. It is available on the SCAR web site so as to encourage its widespread use as a research and teaching resource (www.scar.org/publications/occasional/acce.html). The volume is an eventual outcome of the work begun by the SCAR Group of Specialists on Antarctic Climate Research, which was formed in 1980 to plan the Antarctic contribution to the WCRP (then about to be formed) (Allison, 1983) and SCAR Steering Committee for the newly formed International Geosphere-Biosphere Program (IGBP) (SCAR, 1989, 1992).

The ACCE volume provides a comprehensive, up-to-date account of how the physical and biological environment of the Antarctic continent and Southern Ocean has changed over the past 100 million years or so until the present day, and how that environment may change over the next century in a warming world.

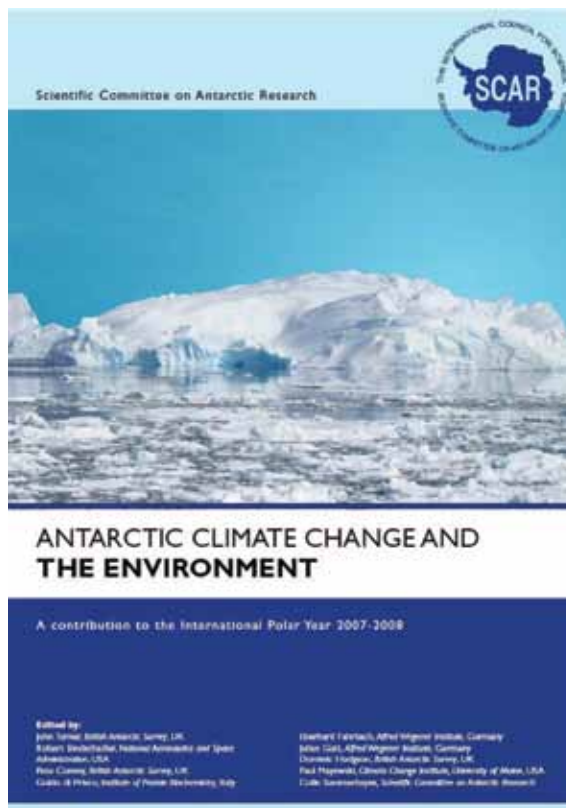


Fig.5.2-1. Antarctic Climate Change and the Environment (2009) – SCAR contribution to IPY 2007–2008 science program.

Climate Change and the Cryosphere: Snow, Water, Ice and Permafrost in the Arctic (SWIPA)

Morten Skovgård Olsen, Lars-Otto Reiersen, and Volker Rachold

“Climate Change and the Cryosphere: Snow, Water, Ice and Permafrost in the Arctic (SWIPA)” is one of the key assessment projects of the Arctic Council that was designed, approved and advanced during the IPY 2007–2008 era.

At their 5th meeting in Salekhard in October 2006, the Arctic Council Ministers urged Arctic Council working groups to continue supporting, analyzing and synthesizing Arctic climate research, particularly in the follow-up to the *Arctic Climate Impact Assessment* (ACIA, 2005) and the ACIA Policy Document. It was suggested that the Arctic Monitoring and Assessment Program (AMAP), in cooperation with other AC working groups and relevant scientific bodies, would continue to review needs and gaps in climate monitoring in the Arctic. The *Salekhard Declaration*, which also endorsed

IPY 2007–2008 (Chapter 5.5), requested that the AC Working Groups continue their collaboration with relevant IPY projects so that data and information from IPY 2007–2008 could be included in the work of the Arctic Council.

A joint statement by Norway, Denmark and Sweden at the Salekhard Meeting concerning their common objectives for the period of their respective chairmanships of the Arctic Council (2006–2012 – see http://arctic-council.org/article/2007/11/common_priorities) expressed strong commitment to “continuing to follow up on the findings of the ACIA report” with an emphasis on the Arctic Council efforts to provide high quality information on climate change, particularly on the consequences and challenges posed by climate change in the Arctic to the member states and the Arctic residents. During its Chairmanship of the Council (2006–2009) Norway proposed a concept for an Arctic ‘Cryosphere Project’ to the Senior Arctic Officials (SAO) meeting in April

2007. The *Climate Change and the Cryosphere: Snow, Water, Ice, and Permafrost in the Arctic (SWIPA)* was formally approved by SAOs at their meeting in Svolvær, Norway in April 2008 and was officially named an “Arctic Council ‘Cryosphere Project’ in Cooperation with IASC, CliC and IPY.”

As stated in the preamble to the preliminary SWIPA Overview Document (SWIPA, 2009)“... The International Polar Year (IPY) represents a considerable basis for accelerated progress in understanding. The proposed SWIPA reports provide an opportunity to synthesize new information from the IPY and provide a bridge between the IPY, Arctic Council and future IPCC activity. Strong coordination between the *Climate Change and Cryosphere Project* and the IPY, and other ongoing relevant national and international activities, is central to the *Climate Change and Cryosphere Project* concept.”

The SWIPA project is being coordinated by the Arctic Monitoring and Assessment Programme



Fig.5.2-2. Cover image of the SWIPA Project (from SWIPA brochure - www.amap.no/swipa/).

(AMAP), a program working group of the Arctic Council in cooperation with the International Arctic Science Committee (IASC), the World Climate Research Programme/Climate and Cryosphere Project (WCRP/CliC), the International Polar Year International Programme Office (IPY IPO) and the International Arctic Social Sciences Association (IASSA) – see Fig. 5.2-2. The project brings together Arctic scientists from a broad range of disciplines in order to compile and evaluate information from Arctic monitoring networks and recent international research activities, such as those carried out during IPY 2007–2008 to better quantify and understand the recent changes to the cryosphere and their impacts since 2005 (i.e. the year when the ACIA report was published).

Overall coordination of the project is conducted by the SWIPA Integration Team (IT), composed of authors and representatives of the sponsoring organizations (i.e. AMAP, IASC, WCRP/CliC, IASSA and IPY IPO). The AMAP Secretariat serves as the secretariat for SWIPA, convening meetings and organizing the overall activities. The SWIPA implementation plan, the draft table of contents and timetable are available at the SWIPA website at www.amap.no/swipa.

SWIPA will produce a number of reports and other products over the course of its lifetime (2008–2011). Its first report, *The Greenland Ice Sheet in a Changing Climate* (Dahl-Jensen et al., 2009, Fig. 5.2-3), together with two short films, was introduced as the Arctic Council's contribution to the 15th Conference of Parties (COP15) under the UN Framework Convention on Climate Change (UNFCCC), in December 2009 in Copenhagen (Chapter 2.4).

The final SWIPA science report will be presented to the Arctic Council in spring 2011 and will serve as an Arctic contribution to the Fifth Assessment Report of the UN Intergovernmental Panel on Climate Change (IPCC), scheduled for completion in 2013–2014. The SWIPA report is subject to a thorough scientific peer review, as well as a national review by Arctic countries prior to publication. The final structure of the main SWIPA Report, which is going to be a document of approximately 500 pages (Fig. 5.2-4) was defined at the SWIPA Cross-Fertilization Workshop held in Potsdam, Germany on 12-15 January 2010.

An approximately 50-page summary report in layman language containing the key findings of the

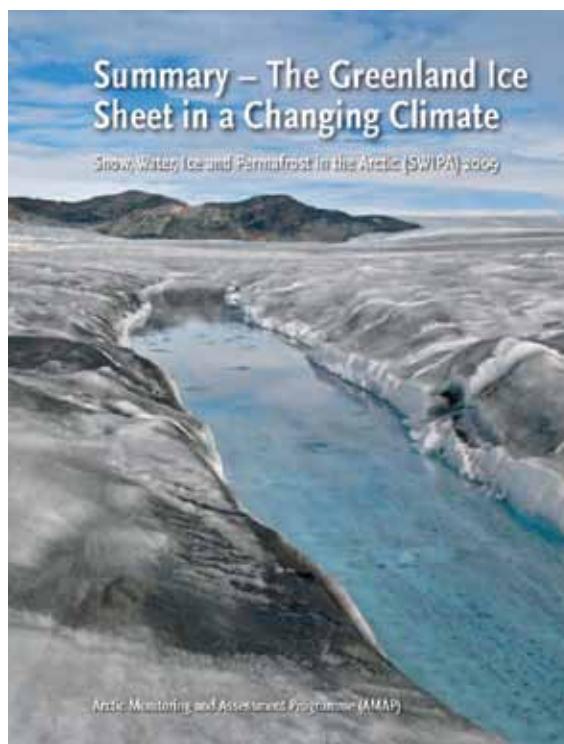


Fig.5.2-3. The Greenland Ice-Sheet in a Changing Climate (GRIS) report, 2009.

SWIPA project and recommendations based on the science report will be written by a science writer in close cooperation with the lead authors of the SWIPA report, the SWIPA IT and the AMAP working group; one or more films conveying the messages of SWIPA are also foreseen. The summary report and the film(s) will also be released at the time of the Arctic Council ministerial meeting .

The SWIPA Project is being conducted according to three main Arctic cryosphere components: sea ice, the Greenland Ice Sheet and the terrestrial cryosphere, composed of snow, permafrost, mountain glaciers and ice caps, and lake and river ice. In addition to assessing the physical and environmental changes occurring in the cryosphere, the project considers the consequences of such changes on the socio-economics, culture and lifestyles of Arctic residents, including indigenous peoples, as well as some global implications. The most critical is the last section of the report called 'Integrated synthesis.' It will be prepared by a special team of several SWIPA scientists, according to their fields of expertise. This is a clear projection of the template developed and advanced during IPY 2007–2008, with increased focus on cross-disciplinary

collaboration, science integration and appeal to local stakeholders, including polar indigenous people. Also, several among these lead authors have been heading individual IPY project teams and during the preparation of the SWIPA, major effort have been devoted to track down and ensure the inclusion of IPY projects relevant to the project.

The preliminary findings of the SWIPA Project, as well as of many IPY 2007–2008 teams, demonstrate that all of the components of the Arctic cryosphere have changed dramatically over the past decade (2000–2010). These changes have multiple (and yet poorly known) feedback and cascading effects. This rapidly changing polar environment affects people in the Arctic and beyond. Understanding the results of these interactions is a major scientific challenge and a key SWIPA activity. Some of the many topics and questions under study in the SWIPA are:

- What will be the effects of cryospheric change on individuals, communities and regions in the Arctic, and how will those effects vary by location and economic sector?
- What will be the effects for global society from

rising sea level and increasing climate change resulting from a changing Arctic cryosphere?

- Given that many changes under way will not easily be halted or reversed, what adaptations are possible in the Arctic and beyond?
- How will the increased flow of freshwater from the melting of the Greenland Ice Sheet, mountain glaciers and small ice caps in the Arctic influence ocean circulation, marine food webs and the people who depend on them?
- What is the total effect of cryosphere changes on climate through changes in reflection of solar energy, release of greenhouse gases and other feedbacks?
- What additional monitoring and observations are needed around the Arctic to better track cryospheric change and its many implications?
- Given that many changes under way will not easily be halted or reversed, what adaptations are possible in the Arctic and beyond?

The findings of the SWIPA project will be disseminated via many scientific and public channels during 2010–2011 and will be available in full by the time of the next major (post) IPY 2007–2008 Conference in Montreal in April 2012. Information on SWIPA and its products may be found on www.AMAP.no/swipa.

Structure of the SWIPA science report
 – as decided January 15 2010 at the Potsdam workshop
 Convening Lead Author (CLA) listed in green

PREFACE [1-2 pages]	
EXECUTIVE SUMMARY [5 pages]	
INTRODUCTION [3 pages] [draft by MS Olsen + L-O Reiersen]	
PAST AND PRESENT CLIMATE [10 pages] [J Walsh]	
MODELLING [10 pages] [J Walsh]	
SNOW [50 pages] [T Callaghan]	ICE CAPS + GLACIERS [50 pages] [M Sharp]
PERMAFROST [50 pages] [T Callaghan]	GREENLAND ICE SHEET [80 pages] [D Dahl-Jensen]
RIVER + LAKE ICE [50 pages] [T Prowse]	SEA ICE [100 pages] [W Meier]
HUMAN DIMENSION [G Hovelsrud] [25 pages]	
SYNTHESIS / INTEGRATION [35 pages]	
<ul style="list-style-type: none"> • Feedbacks [10 pages] [T Callaghan + T Prowse] • Sea level change [5 pages] [D Dahl-Jensen + K Steffen + M Sharp] • Contaminants and UV [5 pages] [L-O Reiersen] <ul style="list-style-type: none"> • Ecological [5 pages] [W Vincent] • Socio-economic [5 pages] [G Hovelsrud] • Major knowledge gaps + obs needs [5 pages] [B Goodison + J Key] 	
CONCLUSIONS + RECOMMENDATIONS [5-10 pages]	
ALL REFERENCES [30 pages in small print]	
ACRONYMS + DEFINITIONS [5 pages]	
ANNEXES	

Figure 1: Structure of the SWIPA Science Report.

Sea Ice for Walrus Outlook (SIWO)

Hajo Eicken, Gary Hufford, Vera Metcalf, Sue Moore, James Overland and Helen Wiggins

Reviewers: Igor Krupnik and G. Carleton Ray

The 'Sea Ice for Walrus Outlook' (SIWO), an activity growing out of the SEARCH IPY *Sea Ice Outlook* project (Chapter 3.6), is a new web-based resource for Alaska Native subsistence hunters, coastal communities and other stakeholders interested in sea ice dynamics and walrus subsistence hunting and management in the Bering and Chukchi Seas. Though chronologically launched after the official completion of the IPY observational period in March 2009, the SIWO descends from two IPY projects, *Sea Ice Knowledge and Use* (SIKU no. 166 – Chapter 3.10) and *Seasonal Ice Zone Network* (SIZONet) sponsored by the U.S. National Science Foundation's IPY program. Most importantly, it builds upon many years of partnership among sea

Fig.5.2-4. Proposed structure of the main SWIPA science report (as of January 2010).

ice and walrus scientists, subsistence users, local indigenous communities, weather forecasting and game protection agencies, anthropologists and heritage documentation specialists (Eicken et al., 2009; Oozeva et al., 2004; Krupnik and Ray, 2007; Metcalf and Krupnik, 2003; Ray and Hufford, 1989).

The SIWO project was formally discussed with representatives from Bering Straits communities for the first time in January 2010 at a meeting supported by the Eskimo Walrus Commission in Nome, Alaska (www.kawerak.org/servicedivisions/nrd/ewc/index.html) and the National Science Foundation. The template and the plan of work were quickly developed and the first weekly sea ice and walrus distribution assessment went online on the newly launched SIWO website on 2 April 2010.

The SIWO is a pilot initiative (2010–2011) aiming to develop consumer-focused ice- and weather-forecasting capabilities that address practical needs

of hunters in Alaskan indigenous communities as well as game managers and marine biologists. For the first time, it created a formal alliance among the U.S. National Oceanic and Atmospheric Administration; the National Weather Service, the University of Alaska Fairbanks; the National Science Foundation and its SEARCH program, which generated the *Sea Ice Outlook* initiative (*Chapter 3.6*); the Arctic Research Consortium of the United States, which administers the SIWO website; and the Eskimo Walrus Commission, an organization of 19 indigenous communities in Western and Northern Alaska.

The SIWO produces improved local weather forecasts and detailed assessments of local sea ice conditions relevant to walrus distribution and migration in the Northern Bering Sea and southern Chukchi Sea region adjacent to northwestern Alaska and northeastern Russia (Chukchi Peninsula). SIWO updates have been released weekly for the period

SEARCH
STUDY OF ENVIRONMENTAL ARCTIC CHANGE

Sea Ice for Walrus Outlook (SIWO)

Printed Friendly Low-Bandwidth Version <http://www.arcus.org/search/ewo/2010/05/07/>

Past SIWO Reports

- Choose -

Latest News: The latest weekly SIWO report (7 May 2010) is now available - see below!

Overview

The Sea Ice for Walrus Outlook (SIWO), an activity of the [SEARCH Sea Ice Outlook](http://www.arcus.org/search/) (www.arcus.org/search/), is a resource for Alaska Native subsistence hunters, coastal communities, and others interested in sea ice and walrus.

The SIWO is updated weekly with information on sea ice conditions relevant to walrus in the Northern Bering Sea and southern Chukchi Sea regions of Alaska. SIWO updates will be released every Friday through late June.

The SIWO webpage includes: (1) An assessment of current ice conditions relevant to distribution and access of walrus, (2) a 10-day outlook of wind conditions, (3) up-to-date satellite imagery for the Bering Strait and St. Lawrence Island, which are two regions of interest to coastal communities engaging in the walrus hunt, (4) written observations of ice development from Alaska Native hunters, sea-ice experts, or NOAA or university researchers, (5) additional data and resources on ice conditions, and (6) additional comments provided by local experts and other contributors.

If you are a local hunter, expert, or a scientist with observations on either the development of sea ice or any other aspect of walrus and sea ice, please send your comments to [Helen Wiggins](mailto:Helen.Wiggins@arcus.org) ([helen.wiggins@arcus.org](mailto:Helen.Wiggins@arcus.org)) at the Sea Ice Outlook Central Office at ARCUS; your comments will be posted to this page.

This collaboration includes weather and ice forecasters, climate scientists and sea-ice researchers at NOAA, the National Weather Service, and the University of Alaska who are teaming up with Alaska Native sea-ice experts and the Eskimo Walrus Commission. Key contacts are:

[Kathryn Cretek](mailto:Kathryn.Cretek@arcus.org) ([kathryn.cretek@arcus.org](mailto:Kathryn.Cretek@arcus.org)), [Bonnie Chapman](mailto:Bonnie.Chapman@arcus.org) ([bonnie.chapman@arcus.org](mailto:Bonnie.Chapman@arcus.org)), [Helen Wiggins](mailto:Helen.Wiggins@arcus.org) ([helen.wiggins@arcus.org](mailto:Helen.Wiggins@arcus.org)) - Sea Ice Outlook Central Office, ARCUS
[Wing Krupnik](mailto:Wing.Krupnik@metcalf.com)/[Metcalf](mailto:Metcalf@arcus.org) ([wing.krupnik@metcalf.com](mailto:Wing.Krupnik@metcalf.com))/[arcus.org](mailto:Metcalf@arcus.org) - Eskimo Walrus Commission
[Alan Falken](mailto:Alan.Falken@uaf.edu) ([alan.falken@uaf.edu](mailto:Alan.Falken@uaf.edu)) - University of Alaska Fairbanks
 Gary Hufford, Don Moore - National Weather Service
 Jim Overland, Nancy Soreide, Tracy Nakamura, Nick Bond - National Oceanic and Atmospheric Administration Pacific Marine Environmental Lab (NOAA/PMEL)
 Sue Moore - NOAA Office of Science & Technology and SEARCH Science Steering Committee (SSC)

Photo by Maggie Phavenes - PolarTREC/ARCUS

Fig.5.2-5. Opening page of SIWO service website www.arcus.org/search/siwo/.

from April 2010 through mid-June 2010. This period was selected to match the interest of local Alaskan stakeholders who hunt walrus primarily during the peak of the spring migration during break-up and northward retreat of ice in the Bering and Chukchi Seas (Metcalf and Robards, 2008).

Each weekly analysis on the SIWO webpage (www.arcus.org/search/siwo - see Fig. 5.2-5) included: (1) an assessment of the current ice conditions relevant to distribution and access to walrus, (2) a 10-day outlook of wind conditions (speed and direction), (3) up-to-date satellite imagery for the Bering Strait and St. Lawrence Island, which are two regions of the most interest to coastal indigenous communities engaging in the walrus hunt (Fig. 5.2-6), (4) written observations of ice development from Alaska Native hunters, sea-ice experts, NOAA/NWS and university researchers, (5) additional data and resources on ice conditions, and (6) additional comments provided by local experts and other contributors, local hunters and academic specialists alike. Indigenous observers from four Alaskan communities, Wales, Shishmaref, Gambell and Nome are contributing to the assessments, together with scientists and observers on ships at sea, at the Alaska NWS headquarters in Anchorage and at the

University of Alaska Fairbanks, who are using satellite imagery, coastal radars and airborne observations.

A key aim of the SIWO activities is to improve research and operational products for assessment and forecasting of weather and ice conditions in Arctic coastal environments. Thus the NWS, in collaboration with the National Center for Environmental Prediction (NCEP), is generating high-resolution long-term weather forecasts (requiring dedicated model runs) for the region. Feedback from local experts on the accuracy and relevance of this product in turn can help improve model performance. Here, input by local partners, like Winton Weyapuk Jr. in Wales, Paul Apangalook and Merle Apassingok in Gambell, who provided updates on ice conditions and deployed supplemental drift sensors proved of critical importance. Similarly, remote sensing products, such as high-resolution visible-range imagery and synthetic aperture radar (SAR) scenes, are interpreted and discussed by both sea-ice geophysicists and local hunters. Both the type of imagery provided and the mode of delivery have been modified from original plans based on comments and input from coastal communities. For example, the Alaska Satellite Facility (ASF) was able to provide short-term access to high-resolution, weather-independent

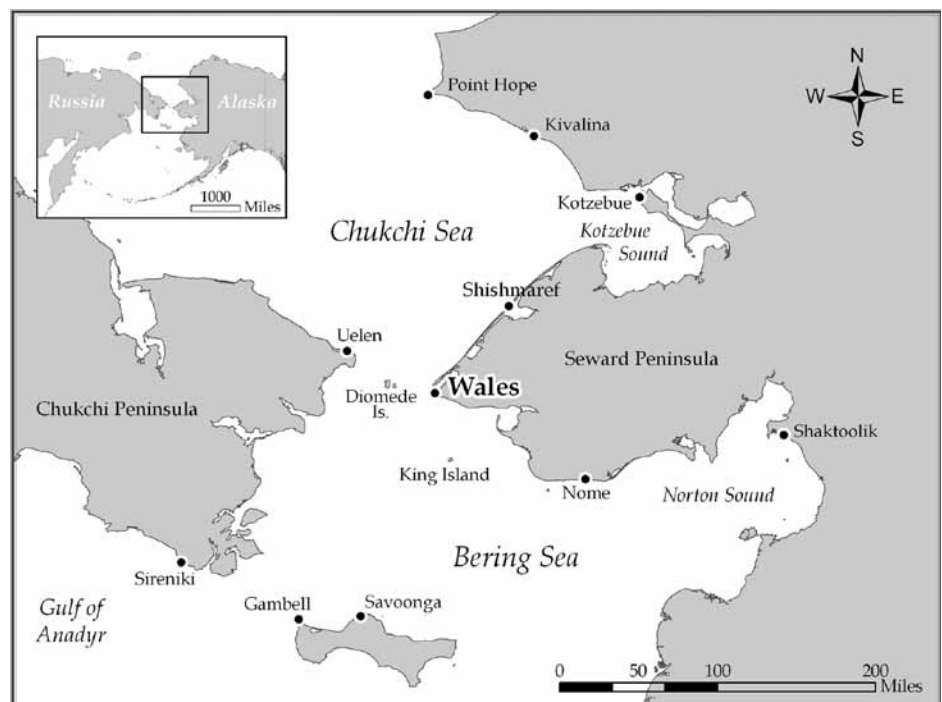


Fig.5.2-6. Area covered by the SIWO pilot initiative in the northern Bering Sea and southern Chukchi Sea (from SIWO website www.arcus.org/search/siwo/).

SAR imagery provided by a Japanese satellite down-linked at ASF in Fairbanks.

A project such as SIWO also requires retrospective analysis to ensure that both scientific findings, e.g. with respect to downscaling of model output and remote sensing data to the local scale and assessment of operational products, lead to significant progress. Such activities benefit greatly from having the SIWO partnership embedded in a larger, U.S. interagency program (SEARCH), which can draw on broader expertise and resources from the scientific community, government agencies and local organizations. Support from outside experts, such as Carleton Ray and Igor Krupnik, who have provided critical input and support to this effort, also help ensure that such local or regional activities can be translated to a larger pan-Arctic scale.

Though designed as a small pilot project, SIWO carries on the legacy of IPY 2007–2008 in terms of making polar research relevant and valuable to the growing number of local stakeholders. It solidifies partnerships across science disciplines (ocean and ice studies, atmospheric science, marine biology, anthropology and subsistence research) and between scientists and indigenous organizations that were forged during the IPY era. SIWO may eventually become a prototype of a much broader observational service network that would incorporate indigenous ice and weather observations into the existing agency-supported weather and ice monitoring and forecasting. Such integration could significantly augment and improve the design and implementation of an Arctic observing system from broad to local spatial and temporal scales (Eicken et al., in press). If such incorporation occurs, what started as pilot efforts by a few IPY 2007–2008 projects may eventually become a permanent fixture of the agency-run polar ‘services’ for years and decades ahead.

Conclusion

The impact of IPY in polar science was several-fold. It encouraged the submission of new research programs from the wider community and the merger of many smaller projects with larger ones, so as to make them more interdisciplinary and increase their potential impact. It triggered new and growing efforts within SCAR and IASC to submit aspects of their work

as IPY projects and the speeding up of programs in the works, like ACCE and SWIPA. It led to the development of programs that had been called for in the IPY planning documents, but not submitted by the research community (e.g. SCAR developed the SOOS proposal outside the formal IPY structure when it was clear that no research proposal had addressed this need). Lastly, it encouraged the re-labeling of some planned work by the national operational agencies as IPY. All of these efforts contributed to the mass of outputs begun or delivered during the IPY years. In that respect, IPY was a great catalyst for action, adding urgency and impetus to activities that might otherwise never have begun or would have been much delayed in execution.

There was also a definite impact of the IPY process, in terms of planning, language and ideology on many other initiatives of the ‘IPY era.’ Firstly, IPY 2007–2008 solidified the transition to more *societal-relevant* science and pushed polar research to be more attuned to the needs and interests of multiple stakeholders, such as polar residents, policy-makers, environmental groups, science educators and the like. Secondly, IPY embedded a new format of polar research with a much broader (‘across-the-range’) spectrum of disciplines than had been common for earlier multidisciplinary studies and infused more input from social sciences and local knowledge of polar residents, at least in the Arctic. That transition is obvious for ISAC, SAON, DAMOCLES and other primarily physical research and observational initiatives in IPY, but it generated similar transitions in many other IPY-era programs. Several teams are known to have altered their work plans to make them adhere more overtly to the IPY goals in order to contribute to the IPY outcomes, or even to be seen to be doing so.

These activities, like ACCE, SWIPA, SIWO (reviewed here) and others of their ilk can all be viewed as IPY-adopted or IPY-inspired. The contribution of such ‘IPY-inspired’ projects to achieving the goals of IPY has been considerable. They all advance the same interdisciplinary approach that addresses status and change in the polar regions and that explores societal and ecosystem impacts of the geophysical processes, so fitted very well with the ethos of IPY.

References

- ACIA, 2005. *Arctic Climate Impact Assessment*. Cambridge: Cambridge University Press, 1042p.
- AHDR (*Arctic Human Development Report*), 2004. Niels Einarsson, Joan Nymand Larsen, Annika Nilsson, and Oran R. Young, general editors. Akureyri: Stefansson Arctic Institute.
- Allison, I., (ed). 1983. *Antarctic Climate Research: Proposals for the Implementation of a Programme of Antarctic Research contributing to the World Climate Research Programme*. Cambridge, SCAR, 65 pp.
- Allison, I., M. Béland, K. Alverson, R. Bell, D. Carlson, P. Cutler, K. Danell, C. Ellis-Evans, E. Fahrback, G. Hovelsrud, J. Huber, V. Kotlyakov, I. Krupnik, J. López-Martínez, T. Mohr, H. Ödmark, D. Qin, V. Rachold, C. Rapley, O. Rogne, E. Sarukhanian, C. Summerhayes and T. Yamanouchi, 2009. *The State of Polar Research: a statement from the International Council for Science/World Meteorological Organization Joint Committee for the International Polar Year 2007–2008*. World Meteorological Organization, Geneva, 16pp.
- Dahl-Jensen, D., J. Bamber, C.E. Bøggild, E. Buch, J.H. Christensen, K. Dethloff, M. Fahnestock, S. Marshall, M. Rosing, K. Steffen, R. Thomas, M. Truffer, M. van den Broeke and C.J. van der Veen, 2009. Summary – The Greenland Ice Sheet in a Changing Climate Snow, Water, Ice and Permafrost in the Arctic (SWIPA). AMAP: Oslo, 22 pp.
- Eicken, H., Lovecraft, A.L. and M. Druckenmiller, 2009. Sea-ice system services: A framework to help identify and meet information needs relevant for Arctic observing networks. *Arctic*, 62:119–136.
- Eicken, H., L.A. Ritchie, and A. Barlau, in press. The potential role of local, indigenous knowledge in Arctic offshore oil and gas development, environmental hazard mitigation, and emergency response. In *North by 2020: Perspectives on a Changing Arctic*, A.L. Lovecraft, and H. Eicken, (eds).
- Krupnik, I. and G.C. Ray, 2007. Pacific walruses, indigenous hunters, and climate change: Bridging scientific and indigenous knowledge. *Deep-Sea Research Part II*, 54:2946–2957.
- Mayewski, P.A., M. P. Meredith, C. P. Summerhayes, J. Turner, A. Worby, P. J. Barrett, G. Casassa, N. A. Bertler, T. Bracegirdle, A. C. Naveira Garabato, D. Bromwich, H. Campbell, G. S. Hamilton, W. B. Lyons, K. A. Maasch, S. Aoki, C. Xiao, Tas van Ommen, 2009. State of the Antarctic and Southern Ocean climate system. *Reviews of Geophysics* 47 RG1003, 38 PP., doi:10.1029/2007RG000231
- Metcalf, V. and I. Krupnik, (eds), 2003. *Pacific walrus. Conserving our culture through traditional management*. Report of the Oral History Project under Cooperative Agreement #701813J506, Section 119. Eskimo Walrus Commission, Kawerak, Inc., Nome, Alaska.
- Metcalf, V. and M. Robards, 2008. Sustaining a healthy human-walrus relationship in a dynamic environment: challenges for comanagement. *Ecological Applications*, 18(2):148-156.
- Oozeva, C., C. Noongwook, G. Noongwook, C. Alowa, and I. Krupnik, 2004. *Watching Ice and Weather Our Way/Sikumengllu Eslamengllu Esghapallegput*. I. Krupnik, H. Huntington and C. Koonooka (eds). Arctic Studies Center, Smithsonian Institution: Washington, DC.
- Ray, C.G. and G.L. Hufford, 1989. Relationships among Beringian marine mammals and sea ice. *Rapports et Procès-Verbaux des Réunion Conseil International pour L'Exploration de la Mer*, 188:22-39.
- SCAR, 1989. *The Role of Antarctica in Global Change*. Prepared by the SCAR Steering Committee for the IGBP:28 p.
- SCAR, 1992. *The Role of the Antarctic in Global Change: An International Plan for a Regional Research Programme*, Prepared by the SCAR Steering Committee for the IGBP: 54 p.
- SWIPA, 2009. *Climate Change and the Cryosphere: Snow, Water, Ice, and Permafrost in the Arctic (SWIPA) An Arctic Council 'Cryosphere Project' in Cooperation with IASC, CliC and IPY*. Project summary, 60p www.amap.no/swipa/#Products.
- Turner, J., Bindschadler, R.A., Convey, P., Di Prisco, G., Fahrback, E., Gutt, J., Hodgson, D.A., Mayewski, P.A., and Summerhayes, C.P., 2009. *Antarctic Climate Change and the Environment*. SCAR, Cambridge, 560pp.



5.3 Engaging Asian Nations in IPY: Asian Forum for Polar Sciences (AFoPS)

Coordinating Editors:

John Calder and Igor Krupnik

Contributing authors:

Jinping Zhao (for China), Alvarinho J. Luis (for India), Natsuo Sato, Hajime Ito, Masaki Kanao, Hiroshi Kanda, Takeshi Naganuma, Tetsuo Ohata, Kentaro Watanabe, Takashi Yamanouchi (for Japan), Dongmin Jin (for Korea), Azizan Abu Samah, Nasaruddin Abdul Rahman and Wong Chiew Yen (for Malaysia)

Reviewer:

Ian Allison

One of the principal aims of IPY 2007–2008 was to engage worldwide resources to create a pulse of activities focused on the polar regions. The IPY early planning document (Rapley et al., 2004) was completed during 2004 by a group of experts drawn from all regions of the world, including Asia,¹ and it underscored the importance of including in IPY “nations not traditionally involved in polar research.” Recognizing the importance of international cooperation, aiming to serve the common interests between Asian countries in polar sciences, and anticipating the coming IPY, the *Asian Forum for Polar Sciences* (AFoPS) was established in September 2004. Its main declared objectives were to provide a foundation for cooperative research activities, to present Asian achievements to the international polar communities and to encourage Asian countries’ involvement in polar research.

Participation of the Asian nations in international polar programs goes back to the early 1900s (for Japan) and to IPY-2, in which China, India, Indonesia, Japan, the Philippines, Syria and Turkey took part (*Chapter 1.1, Box 3*).² Fifteen Asian nations—Burma, Ceylon, Republic of China (Taipei), India, Indonesia, Iran, Israel, Japan, Republic of Korea, Malaya, Mongolia, Philippines, Thailand, and both the Republic of Vietnam (South Vietnam) and Democratic Republic of Vietnam (North Vietnam) participated in IGY 1957–1958 (*Chapter 1.1, Box 4*), though, primarily via conducting geophysical and meteorological observations on their national territories. Japan maintained active research

program in Antarctica since 1957 and was one of the 12 original signatories of the Antarctic Treaty in 1959. Four other Asian nations joined the Antarctic Treaty as Consultative Parties – China (PRC, in 1983), India (1983), Republic of Korea (1986), Democratic People’s Republic of Korea (North Korea, 1987); and Turkey is the Acceding State (since 1996). China, India, Japan, Republic of Korea and Malaysia are also Full Members of SCAR and Pakistan is its Associate Member.

The role of the Asian nations in polar research has increased dramatically over the past decades, due to their economic, political and scientific power. Among 63 nations with scientists involved in IPY 2007–2008, 14 countries (China, India, Indonesia, Israel, Japan, Kazakhstan, Kyrgyzstan, Malaysia, Mongolia, Philippines, Republic of Korea, Turkey, Uzbekistan and Vietnam) are within the Asian region. Five of them—China, India, Japan, Malaysia and Republic of Korea—established their national IPY committees and set national IPY programs (*Appendix 7*). This chapter reviews the contribution by those five nations to the IPY 2007–2008 activities and to international collaboration in polar research.

Demand for practical cooperation among Asian nations in polar science and logistics has been ever increasing. China, Japan and the Republic of Korea, which are the Asian members of the Council of Managers of National Antarctic Programs (COMNAP), had informal communication on this matter for years. At the COMNAP Meeting in Brest in 2003, Korea and Japan agreed to establish a regional ‘East Asian group’

and China agreed to join by on-line communication.

Directors of the national polar research institutes from China, Japan and Korea held their first joint meeting in Shanghai on 25 May, 2004 to build the framework of AFoPS. At the second AFoPS Meeting on 10 September, 2004 in Jeju Island, Korea, the organization was officially inaugurated, with its Secretariat currently located at the National Institute for Polar Research in Tokyo, Japan. At the 3rd AFoPS meeting in Kunming, China (April 2005), India and Malaysia joined the organization (www.AFoPS.org).

The period of IPY, March 2007 to March 2009, was a time of significant scientific accomplishment in polar science by the AFoPS countries. Even more, this period marked new international involvement in science by the Asian nations and scientists. Many Asian countries increased their participation in international polar science or policy organizations, such as SCAR, IASC (in which Japan has membership since 1991, China since 1996 and Korea since 2001); the Pacific Arctic Group that now includes institutions and scientists from China, Japan and Korea (www.pagscience.org/), and the Arctic Council, to which China, Japan, and the Republic of Korea have applied for an observer status.³ Interest by Asian nations in the Arctic Council is particularly noteworthy as this is the only intergovernmental group focused on the Arctic. The involvement in the Council by non-Arctic countries, especially Asian countries with no Arctic tradition, speaks loudly to the perceived role of the Arctic in many global issues such as climate change, maritime transportation, tourism and resource exploitation. Antarctic science also accelerated in Asia during IPY 2007–2008 with new stations and new programs launched by several Asian nations.

China

Antarctic Activities (Summary by John Calder). China has been a major player in polar research for the past 30 years. The Chinese Antarctic Administration (since renamed Arctic and Antarctic Administration) of the State Antarctic Research Committee, a Beijing-based agency of the PRC State Oceanic Administration, was established in 1981. Chinese scientists first participated in Antarctic research with Australian expeditions in the austral summer of 1980–81 and over the following

winter. Over the next several years Chinese scientists continued collaboration in Antarctic research with other nations. China established the first of two year-round research stations in Antarctica (Great Wall Station on King George Island) in February 1985, and the second (Zhongshan in East Antarctica) was opened in February 1989. China also has a research station in Svalbard in the Arctic (Yellow River Station).

In 2006, just one year before the launch of IPY, the Chinese government significantly boosted its commitment to polar science by allocating additional \$70 million in funding to the Polar Research Institute of China and the Chinese Arctic and Antarctic Administration: a spectacular figure by any international measure.

From this investment, some \$4 million was earmarked to directly boost scientific research funding during IPY; \$25 million was spent on the renovation of China's polar research and logistics vessel, the *Xuelong* (Snow Dragon); \$19 million was spent on refurbishing and expanding facilities of the Polar Research Institute of China in Shanghai; and \$22 million was earmarked to modernize the Great Wall and Zhongshan stations in Antarctica. This boost in funding strengthened the platforms from which China has and will launch a series of highly ambitious polar research campaigns and international collaborations. First among these the so-called PANDA project (The Prydz Bay, Amery Ice Shelf and Dome A Observatories, IPY no. 313), the Chinese key international program for IPY. It addresses questions relating to global climate change and, specifically, the role of the Lambert Glacier Basin, the largest glacier system in East Antarctica.

China and other key partners, including Australia, Japan, the U.S.A., Germany, France and the U.K., hope that PANDA will help to better understand how the East Antarctic ice sheet, the largest ice sheet in Antarctica (*Chapter 2.5*) has fluctuated in the past, and how it might respond to ongoing regional and global climatic changes. With the East Antarctic Ice Sheet estimated to contain enough ice to contribute about 50 meters to global sea level rise, it is easy to grasp the importance and relevance of this effort.

As part of the PANDA project a succession of traverses from Zhongshan Station on the coast of East Antarctica, to Dome A (Dome Argus), the highest point on the East Antarctic Ice Sheet, was conducted. Build-

ing on the experience gained during the first Zhongshan to Dome A traverse in 2004-05, these traverses supported diverse observations in glaciology, atmospheric science and physical geography, as well as deploying a series of four automatic weather stations (in collaboration with Australia) along the Zhongshan-Dome A transect. Chinese scientists conducted research on past climate and environmental change in the Grove Mountains protruding out of the East Antarctic Ice Sheet, and the Xuelong icebreaker took part in an integrated marine observation program covering the edge of the Amery ice shelf, the Prydz Bay region and the South Indian Ocean.

In addition, the Dome A region and Gamburtsev mountain range that lies beneath it under the ice sheet were surveyed by both surface and aerial methods in collaboration with the U.S.A., U.K. and Australia (*Chapter 2.5*). One aim of this survey was to find the most scientifically valuable location for future drilling of an ice core that will provide a climate record of more than one million years.

Looking beyond IPY 2007–2008, China's flagship ambition is to build a permanent station at Dome A, one of the remotest, coldest and most physically testing places on Earth. The 2007 and 2008 PANDA traverses lay the groundwork for a multi-year program set to start after 2010 and construction of the new station at Dome A, named Kunlun, commenced during IPY. Kunlun Station, formally opened in January 2009, will push back the boundaries of Antarctic science in a manner reminiscent of the most important and lasting contributions from IGY 1957–1958. The ice at Dome A is up to 3070 meters thick, and precipitation levels are estimated to be the lowest on the continent. When completed, Kunlun Station will be the jewel of China polar research program, and possibly the platform for an international drilling program set on recovering the world's oldest ice record in excess of one million years, perhaps going back to 1.2 million years.

Dome A is also thought to be the world's best location for astronomical research. Thanks to its altitude (4087 meters), the clarity of its skies, the stillness and relative thinness of its atmosphere, the absence of light pollution and the length of its polar night, Dome A will provide astronomers with the possibility to scour space with a greater clarity than anywhere else on Earth - even surpassing Dome C and

the South Pole where a 10-meter telescope has been deployed in 2007. In order to seize and build on this opportunity, an autonomous astronomical site-testing observatory, called PLATO, was deployed at Dome A. The PANDA traverse successfully delivered PLATO to Dome A in January 2008. A large international team has contributed to PLATO and its instruments, with Iridium satellite communication being provided by the U.S. Antarctic Program. The instruments include a 15-centimeter telescope, operated by China, and there are plans to follow with the deployment of a 50-centimeter and even larger telescope in years and decades to come.

Arctic Activities (by Jinping Zhao). During IPY, China planned to conduct two cruises to the Arctic Ocean in 2008 and in 2009, however, the cruise in 2009 was postponed to summer 2010. The scientific focus of the 2008 cruise was Arctic change and its influence on China's climate. The cruise covered the Bering Sea, the Chukchi Sea, the Beaufort Sea and the central area of the Arctic Ocean. It enabled both Chinese and international researchers from France, Korea, Finland and Japan to study ocean-sea ice-atmosphere interactions and variations (Figs. 5.3-1 and 5.3.2). The main fieldwork was focused on the coupling variation of the air-ice-sea system, the response of the ocean to the changing ice and atmospheric condition, changes in the Arctic system, carbon and biogeochemical cycling, micro biological resources, paleoceanography and paleoclimate, influence of Arctic change on the climate of China. The data obtained on this cruise will shed light on the cause and effect relationships between global and regional Arctic changes and processes, and should provide precious insight into how climate change in the Arctic will impact China and the rest of the world.

The second Chinese Arctic cruise during IPY postponed to 2010 (1 July–23 September, 2010) was focused on the ice melting process in the Arctic. A 12-day ice station was set in the Canadian Basin to observe the physical processes related to ice melting. Another topic of the 2010 cruise was the evolution of the Arctic system. The cruise, an extension of Chinese IPY program, was launched to observe the response to rapid changes in the Arctic (see <http://adsabs.harvard.edu/abs/2010AGUFM.C53B.07A>).

The ongoing project at the Yellow River Station on

Fig.5.3-1. Routine CTD profiling during the Chinese Arctic cruise, 2008. The system includes CTD, rosette samplers and lowered ADCP. After CTD deployment, an 120 m profile for water optics were conducted for all daytime stations.

(Photo: Jinping Zhao)

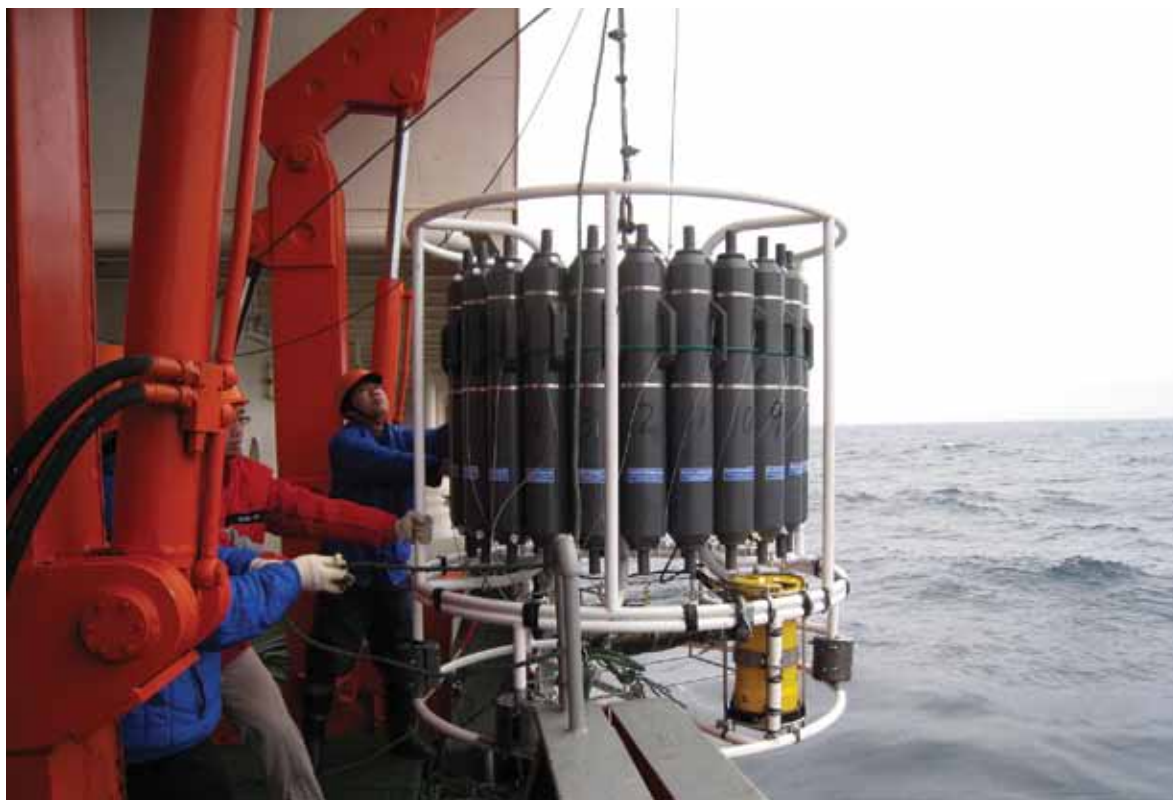


Fig.5.3-2. Optical experiment for sea ice in the summer Arctic. For comparing with winter results, an optical experiment with natural light and artificial light was undertaken during the 2008 summer cruise of Xue Long. A large area must be covered by thick black cloth for the artificial light experiment.

(Photo: Jinping Zhao)





Fig.5.3-3. Water optics observation in northern Bering Sea conducted from the U.S. icebreaker *Healy*.
(Photo: Jinping Zhao)

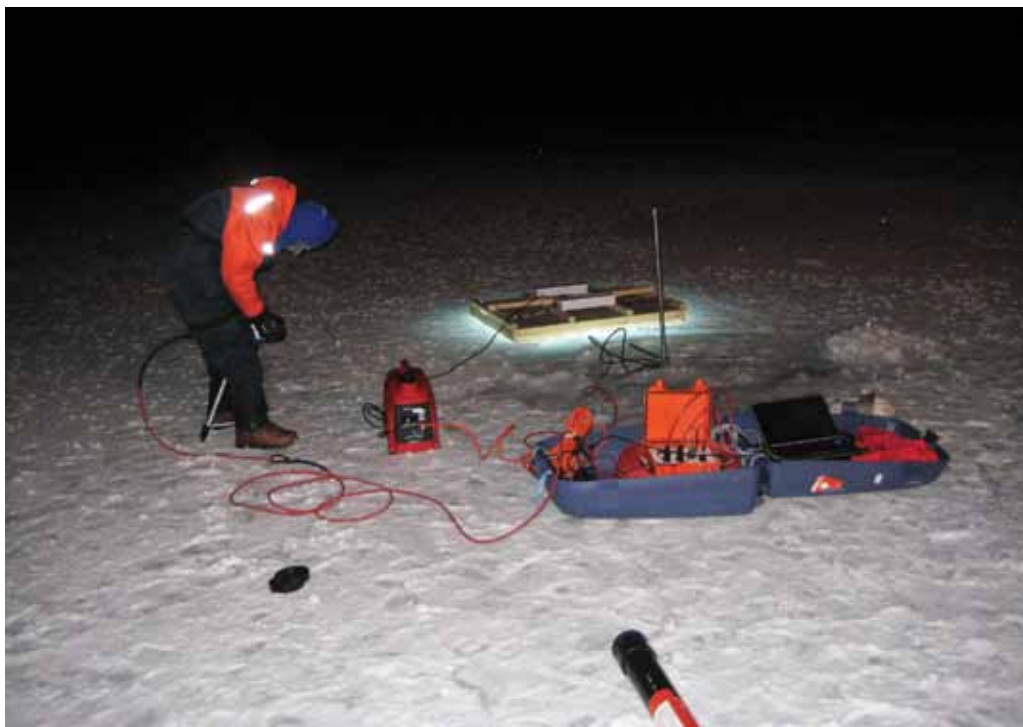


Fig.5.3-4. Artificial light experiment in dark Arctic. This was the first attempt to measure the optical property of first year sea ice with an artificial lamp in winter Arctic. This work was conducted on the Canadian icebreaker *Louis St. S. Laurent*.
(Photo: Jinping Zhao)

Svalbard, Norway was also a part of the Chinese IPY program, and involved long-term observations for space physics and space environment. Also during the summer 2008, a group of scientists conducted observations in biology, glacier, geology and microbiomass.

By participating in other countries' cruises during IPY, Chinese scientists were involved as international collaborators to conduct certain field observations. Chinese scientists took part in three U.S. icebreaker *Healy* cruises in 2007, 2008 and 2009, to explore ice-covered Bering Sea in spring to study optics in both water and sea ice (Fig. 5.3-3). During the winter of 2007–08, a group of Chinese scientists was aboard the Canadian icebreaker *Amundsen* for three months. During the through-winter cruise, they conducted artificial light experiment on sea ice in dark condition (Fig. 5.3-4). Two groups of scientists were aboard the Canadian icebreaker, *Louis S. St. Laurent*, to observe water optics in central Canada Basin in 2006 and 2009. By these international collaborative activities, Chinese scientists involve themselves in Arctic science frontiers and extended their research to a wider area.

Thanks to China emerging data-sharing plan, this data will be also analyzed alongside findings obtained by other large-scale IPY Arctic projects, such as the European DAMOCLES program, thus contributing to a complex and uniquely detailed perspective on Arctic processes. By 2012, China intends to launch a new icebreaker, so that it can conduct both Arctic and Antarctic research more effectively, and mount expeditions to both poles in the same year more frequently.

India

The National Center for Antarctic and Ocean Research (NCAOR) is a nodal Indian agency for Southern Ocean research and for launching Indian scientific expeditions to the Antarctic and the Arctic. Since 1981, 29 expeditions have been launched to Antarctica. India joined the Antarctic Treaty System in 1983 and operates a permanent station Maitri in Antarctica (70°45'57"S, 11°44'09"E), which was established during 1988–1989 at Schirmacher Oasis. During research expeditions, data are being collected in many fields, including glaciology, earth sciences, upper atmosphere and astronomy, meteorology, geomagnetism and bi-

ology. Other studies relate to cold region engineering, communication, human physiology and medicine. In addition, NCAOR houses Antarctic lake studies, Antarctic and global change research, and the National Antarctic Data Centre (NADC).

During IPY, India initiated the process for construction of its second station, Bharati at Larseman Hills at Ingrid Christensen Coast that will be completed by 2012. This state-of-art station will be located at 69°S, 76°E. Upon its completion, India will join the exclusive group of nine nations having multiple stations south of the Antarctic Circle. The new research base is planned to have a life span of 25 years. It shall accommodate 25 people during summer and 15 people during the wintertime. The Bharati Station will advance research in meteorology and atmospheric studies; earth sciences; oceanography; biology and environmental assessment.

During IPY India also expanded its polar interests to include research on Svalbard in the Arctic. In August 2007, a pilot expedition was organized and in early 2008, a second phase of Arctic research was initiated. Research was conducted on snowpack production of carbon monoxide and its diurnal variability; sea ice microbial communities; carbon cycling in the near-shore environments of Kongsfjorden; and understanding the links between the Arctic and tropical Indian Ocean climatic variations. In July 2008, India established a new research station *Himadri* in Ny Ålesund on Svalbard, about 1200 km from the North Pole through a Memorandum of Understanding with the Norwegian Polar Institute. The station is managed by NCAOR and research at *Himadri* will take place year-round with a special emphasis on climate change.

For the IPY science program, India contributed two projects of NCAOR that were endorsed by the IPY Joint Committee:

Monitoring of the upper ocean circulation, transport and water masses between Africa and Antarctica (IPY no. 70, Alvarinho J. Luis, PI – Fig. 5.3-5). Profiling of density structure in the upper 1 km of the Southern Ocean was carried out from January 2007 through summer 2009 by launching expendable CTD probes from a cruising ship between South Africa and Antarctica, chartered under the Indian Antarctic program (Fig. 5.3-6). The hydrographic data so collected have been analyzed for quantifying the changes in the vertical

density structure by comparing with historical data, identification of water masses, changes in the heat content, understanding the circulation, geostrophic currents and Ekman components (Fig. 5.3-7).

Land Based Anthropogenic Impact of Coarse Particles on Antarctic Shelf (IPY no. 129, Anoop Tiwari, PI). Carbon content of air samples was recorded along the ship course starting from Cape Town, South Africa to the India Bay in Antarctica (70°45.94'S and 11°44.13'E) and further en route to the site of India's third station at Larsemann Hills (69°24'S and 76°10'E). Aerosol observations and carbon content of air samples at Larsemann Hills were also analyzed for impact assessment studies, prior to the construction of new station Bharati.

An in-house study of the short-term Holocene climate variability in Antarctica and the Southern latitudes used sediment cores collected from the South Indian Ocean. Researchers also analyzed sediment cores taken from the periglacial lakes and the shallow Antarctic ice-cores. Several articles have

been published to disseminate the information regarding IPY themes and papers were presented at various international conferences.

NCAOR was also actively involved in outreach activities by generating public awareness about the causes and impact of climate change with reference to Polar regions. NCAOR sponsored the visit of two college students to Antarctica during the 25th Indian Antarctic Expedition under the "Students Participation



Fig.5.3-5. The data collection campaign for IPY project no. 70 launched in austral summer 2007. Project PI, Alvarinho J. Luis launches an XCTD probe in the Southern Ocean.

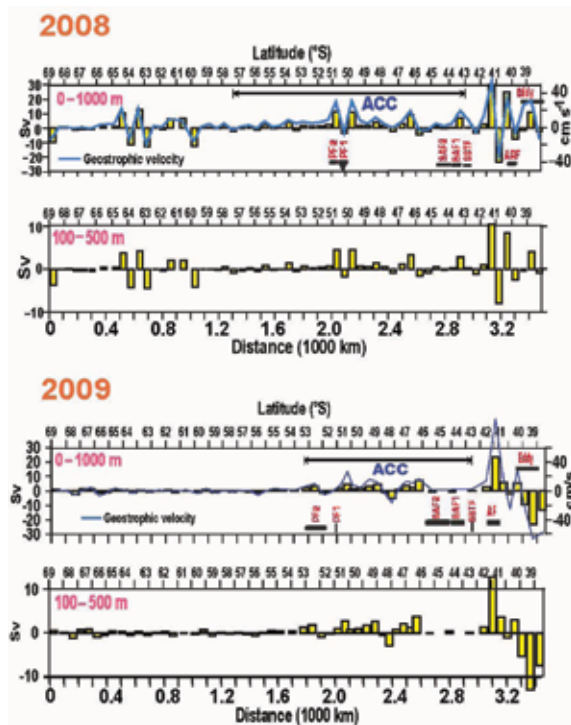
(Photo: Luis Alvarinho)



Fig.5.3-6. Weather parameters were recorded along the ship track by using an Automatic Weather Station installed on onboard MV *Emerald Sea* during the 26th Indian Scientific Expedition to Antarctica (2006–2007) for IPY project no. 70.

(Photo: Luis Alvarinho)

Fig.5.3-7. Comparison of geostrophic transport in 0-1000 m layer and 100-500 m layer during austral summer of 2008 and 2009 for the ship track between Cape Town and India Bay, Antarctica sampled under IPY project no. 70. The abbreviations are as follows: PF1 and PF2: north and south Polar Front; SAF1 and SAF2: north and south Subantarctic Front; SSTF: southern Subtropical Front; ARF: Agulhas Retroflexion Front; ACC: Antarctic Circumpolar Current. (Courtesy: Luis Alvarinho)



Programme". A series of lectures were delivered at more than 20 schools and colleges and students from several schools and colleges and scientists/visitors from Indian institutions and foreign countries visited NCAOR to get first-hand experience of Indian polar research.

Competitions on poster and model making, stamp designing, petition writing, etc., for school students were held during 2007–2009. Prizes were distributed on the *Earth Day* in 2007 and the winner of the model making competition was taken on a trip to Antarctica during the 28th Indian Antarctic Expedition (2008–2009) sponsored by NCAOR. Under the aegis of IPY, a 14-year old Indian student was selected by the Canadian organization, *Students on Ice*, for its annual Arctic expedition, 2–17 August 2007. NCAOR also supplied audio-visual and printed material on Polar Science to Nehru Science Centre (a unit of the National Council of Science Museums, Ministry of Culture) that organized an exhibition, "The Story of Poles" focused on geography, environment, flora, fauna, people and importance of the poles for the issues like ozone hole, global warming, at Mumbai. NCAOR has also participated and financially supported the "4th Science-Expo" organized by the Nehru Science

Centre at Mumbai on 11–15 January 2008 that was attended by 18,000 visitors. Lectures were given by NCAOR Scientists highlighting the efforts of Indian researchers in unraveling the mysteries of the past using ice cores and other anthropogenic problems faced by the Antarctic environment.

Japan

Japanese engagement in polar research goes back to the early 1900s (Shirase's expedition to Antarctica in 1910–1912) and Japan maintained the ongoing presence in Antarctica since 1957. In response to the call from ICSU and WMO, Japanese scientists promptly joined IPY 2007–2008. Japan established its national committee for IPY (<http://polaris.nipr.ac.jp/~ipy/index.htm>; in Japanese) under the Science Council of Japan, SCJ in 2004 (Chair, Natsuo Sato, National Institute of Polar Research, SCJ: www.scj.go.jp/en/index.html). The Committee helped organize, promote and support research plans proposed by polar scientists in universities and institutes across Japan prior to and during the IPY period. A total of 63 projects endorsed by the IPY Joint Committee have been planned with the Japanese participation (Fig. 5.3-8). One project, the Microbiological and Ecological Responses to Global Environmental Changes in Polar Regions (MERGE, IPY no. 58) was organized by a Japanese scientist, collaborating with partners from 16 nations, including non-Antarctic Treaty parties. It will continue to serve as a coordinating platform for post-IPY activities. In the Science Meta-Data Base (SMDB) at the National Institute of Polar Research, Japan (NIPR), a total of 148 metadata sets were accumulated so far with regard to IPY. Brief summaries for several major projects (both endorsed and non-endorsed by the JC) are presented below.

A kick-off event and several symposia and education-outreach activities for younger generations were held in association with IPY "The Polar Open Forum for Junior High and High School Students" was started in 2004 as part of the IPY outreach program by the SCJ and the NIPR to broaden interest in polar sciences among the next generation. This five-year (2004–2009) outreach campaign will be continued as a legacy of IPY to facilitate future recruitment of polar scientists in Japan (Fig 5.3-9).

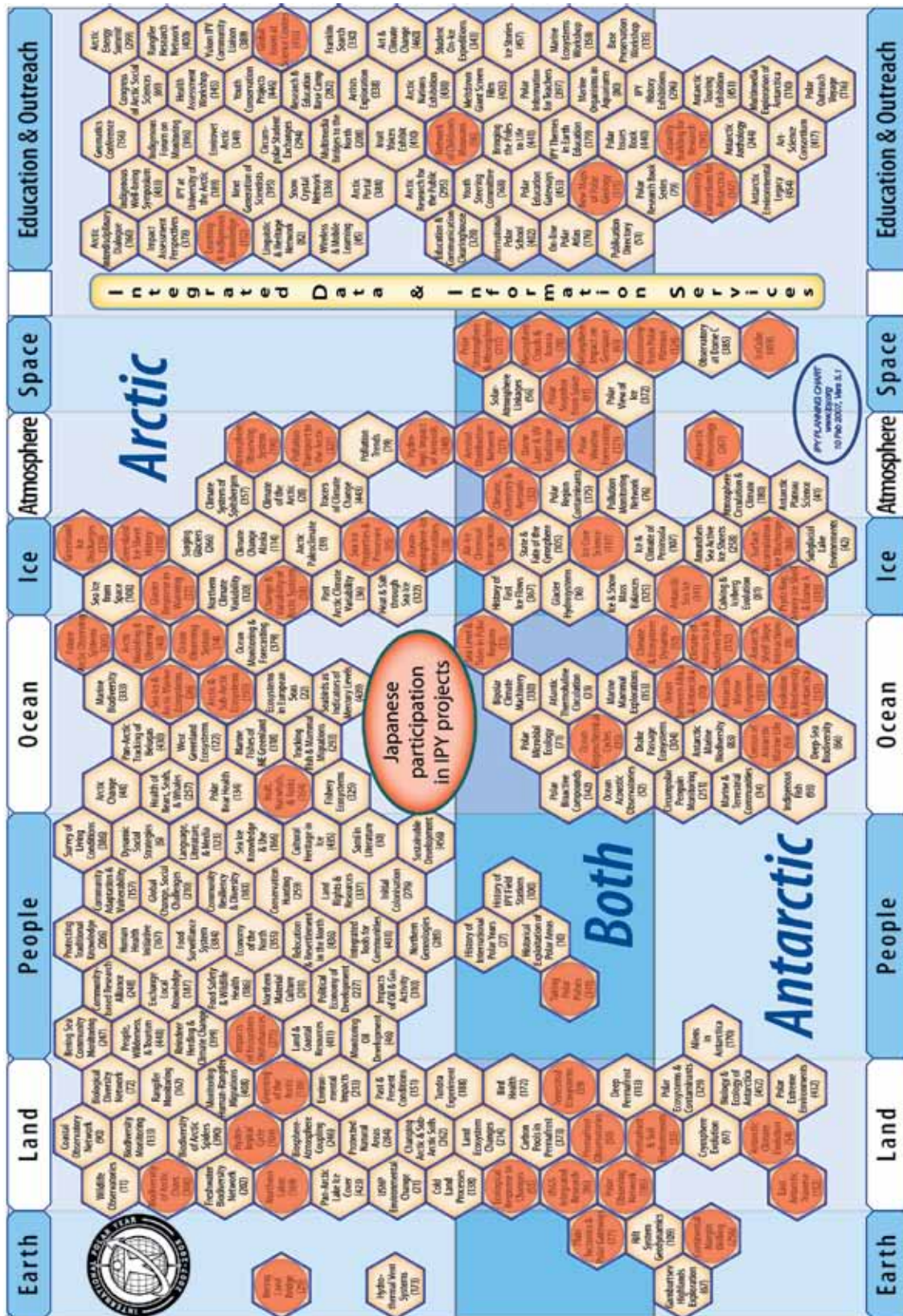


Fig.5.3-8. IPY project chart featuring IPY proposals with Japanese participation.

During IPY period Japan has advanced in the development of coordination structure and information exchange within the Japanese polar research community and internationally. An *ad hoc* group initiated regular Arctic Sessions at the Japan Geophysical Union Meetings since 2007, held in May every year at Makuhari-Messe, Chiba, Japan. The same group initiated the International Symposium on Arctic Research (ISAR) with sub-title "Drastic Change in the Arctic", gathering nearly 200 national and foreign scientists, in November 2008. Second Symposium took place 7–9 December 2010 in Tokyo. Such activities advanced the cooperation among Japanese polar scientists and also international collaboration.

Major Japanese Contributions to IPY Science Program

Comprehensive Ozone Layer Observation at Syowa Station, Antarctica (IPY no. 99). After the opening of the Japanese Syowa Station in 1957 in East Antarctica (69°00'S, 39°35'E), several observations have continued at the station, including upper atmosphere, middle atmosphere, meteorology, glaciology, geology and biology. Among them, the discovery of ozone hole in the Antarctic in 1982 by the 23rd Japanese Antarctic Research Expedition (JARE23) was one of the most remarkable JARE contributions to the earth science.⁴ Since 2007, several comprehensive measurements related to ozone depletion have been conducted. These include high-resolution Fourier Transform Infrared (FTIR) spectroscopy measurements for minor species, low-resolution FTIR measurements for polar stratospheric cloud (PSC) characterization, ozonesonde campaign measurements and aerosolsonde measure-

ments for PSCs. The Japanese activity was a part of the project called "ORACLE-O3: Ozone layer and UV radiation in a changing climate evaluated during IPY" (IPY no. 99) headed by Alfred Wegener Institute in Germany (Fig. 5.3-10).

IPY research cruise in the Indian Sector of the Antarctic Ocean by RV Umitaka Maru. Collaborative oceanographic/marine biological studies in the Indian sector of the Antarctic Ocean were conducted during the southern hemisphere summer of 2008 (January-February 2008) by a research cruise using the RV *Umitaka Maru*. Main survey areas were off Lutzow-Holm Bay and off Terre Adélie and George V Land (www.caml.aq/voyages/umitaka-maru-200708/index.html). The investigation at the former area was conducted as a part of the STAGE (STudies on Antarctic ocean Global Environment) program of the Japanese Antarctic Research Expedition and inter-annual variation of ecosystem in marginal ice zone were studied comparing with the previous results from 2003–2004 and 2004–2005 cruises. The biodiversity studies were conducted at the latter areas as a Japanese-Australian-French collaboration program (Collaborative East Antarctic Marine Census: CEAMARC) which was a part of the Census for Antarctic Marine Life (CAML, IPY no. 53).

Japanese-Swedish Antarctic Expedition, East Antarctica (IPY no. 152). Linking glaciological data spatially between the two deep ice-core drilling sites at EPICA-DML and Dome Fuji was successfully done during the Japanese-Swedish Antarctic Expedition 2007–2008 (JASE – Fig. 5.3-11). JASE was part of the project TASTE-IDEA (IPY no. 152). Data show a geographic variability in boundary conditions of the ice sheet such as surface mass balance, meteorological conditions, physical processes in firn and chemical and biological inclusions in snow. Data also show spatial variations of internal conditions of the ice sheet such as 3D structures and subglacial environment. These data suggest that climate proxies of deep ice cores are linked to the spatial gradients of the environment in the Antarctic plateau. Between November 2007 and February 2008 the area between these sites was surveyed by two groups. The spatial variability in snow layering in shallow



Fig.5.3-9. Participants of the IPY kick-off symposium ("Asian Collaboration in IPY 2007–2008"), 1 March 2007, Tokyo.

(Photo: Japanese IPY Committee)



Fig.5.3-10. Ozonesonde launch at Syowa Station, Antarctica on 5 June 2007. This was the opening flight of ozonesonde match campaign under IPY no. 99, ORACLE-O3, in which nine Antarctic stations from seven countries participated (Photo: Japanese IPY Committee)

depths was observed by subsurface radars, indicating no change in spatial distribution in accumulation during the Holocene. Radar reflections from deeper ice imply no major changes in ice dynamics over time. The basal conditions were mapped in detail at sites where there were indications of existing subglacial lakes or basal melting conditions near the ridge and Dome Fuji. Snow surface conditions showed a variation in snow properties linked to temperature, wind speed and accumulation ratio. Aerosol measurements were carried out along the route and snow samples were collected to link snow and atmospheric conditions.

Linkages between Low Pressure Systems over the Northwestern Pacific and Arctic Regions during Winter T-PARC. For the purpose of improvement of one to 14-day high impact weather forecast, the wintertime THORPEX Pacific-Asia Regional Campaign (Winter T-PARC) was carried out by the U.S. National Oceanic and Atmospheric Administration (NOAA) in January and February 2009. Main observation platform was NOAA G-IV for drop-sonde soundings. The NOAA G-IV was located at Yokota AB near Tokyo during Winter T-PARC. National Institute of Polar Research (NIPR)

supported Winter T-PARC as a part of Japanese IPY activity.

Joint Pacific Arctic Ocean Climate Studies and iAOOS (IPY no. 345 and no. 14). The pattern of the recent sea ice reduction is not spatially uniform and is disproportionately large in the Pacific sector of Arctic Ocean. This regionality implies that the Pacific Ocean inflow has significant impact on the Arctic change. To understand mechanisms of past, recent and future changes in the Arctic Ocean, R/V *Mirai* International Polar Year cruise was conducted in 2008 as the first Japanese cruise that covered the full span of the southern Canada Basin and southeastern Makarov Basin jointly with other IPY cruises. The multidisciplinary research during that cruise consisted of ocean hydrography, mooring observations on major pathways of Pacific inflow into the Canada Basin, water sampling, plankton samplings, bio-optical observations, underway upper ocean and meteorological observations, and piston core samplings for Paleoclimatographic reconstructions. Results of this cruise, such as changes between sea ice reduction and upper ocean structure, were included

Fig.5.3-11. Japanese-Swedish Antarctic Expedition in East Antarctica (IPY no. 152). The meeting of two teams.

(Photo: Japanese IPY Committee)



in the report by the Arctic Ocean Science Board titled "Observing our Northern Seas during IPY" (<http://ipy-osc.no/abstract/376015>).

Terrestrial biology. During IPY years, the integrated program, "Microbiological and ecological responses to global environmental changes in Polar Regions" (MERGE, IPY no. 55) was performed in both polar regions. MERGE is the proposal formed by scientists from 30 nations as a core coordinating proposal led by Takeshi Naganuma (Hiroshima University). MERGE selected three key questions to produce scientific achievements. Prokaryotic and eukaryotic organisms in terrestrial, lacustrine, and supraglacial habitats were targeted according to diversity and biogeography; food webs and ecosystem evolution; and linkages between biological, chemical, and physical processes in the supraglacial biome. Japanese national component of MERGE was focused on the spore-forming halophiles as most stress-resistant microbes exploring sites in Svalbard and Greenland. Research for the project, "Response of Arctic tundra ecosystem and carbon cycle to climate change" (TUNDRACYCLE, EoI no. 794) was focused on plant physiology, microbial ecology, remote sensing and carbon flows and pools on a glacier foreland in Ny-Ålesund, Svalbard and in

Oobloyah Valley, Ellesmere Island, Canadian Arctic.

Satellite application: JAXA's activities during IPY. Japan Aerospace Exploration Agency (JAXA) promotes Arctic research in collaboration with the International Arctic Research Center (IARC) at the University of Alaska Fairbanks through conducting terrestrial and ocean studies (Fig.5.3-12). The terrestrial team evaluated comprehensive impact of wildfires in Alaska in 2004 upon vegetation and permafrost. The ocean research team promoted an integrative approach (Ship Survey-Satellite Remote Sensing-Ice-Ocean-Ecosystem Modeling), to elucidate the linkage of ice/ocean/ecosystem in the Arctic Ocean and Subarctic seas, especially ice melting/formation dynamics and its impacts on primary production. Our main target area is the Bering/Chukchi Sea where we can conduct ship surveys and where rapid changes are ongoing. JAXA-supported research activities such as Japanese R/V *Oshoro-maru* 2008 cruise, R/V *Mirai* 2008 cruise (Fig. 5.3-13) and Chinese Arctic Expedition 2008 by sending sea ice extent information derived from passive microwave satellite (AMSR-E) data of the Arctic Ocean to the researchers on the vessels in near real-time for ship navigation and observation planning. The near real-time AMSR-E data were found to be very effective for research cruises. JAXA

will continue supporting summer research cruises after the IPY period. Also, image datasets of the Arctic and Antarctic regions were made using the data of PALSAR onboard the ALOS satellite. The satellite images of AMSR-E and PALSAR are available at the respective web sites. In particular, the data of the Arctic Sea-Ice monitor by AMSR-E cover the recent drastic changes of the Arctic sea-ice and now capture huge attention of general people and researchers.⁵

Conjugacy of the Ionospheric and Magnetospheric Phenomena as seen from the both Polar Regions (IPY no. 63). Space and Atmospheric Sciences Group of NIPR extended observation network in Antarctica by deploying unmanned magnetometers and promoting collaborations with other Antarctic stations. This effort and direction will continue after IPY. The conjugacy of auroral phenomena using Syowa Station-Iceland conjugate pair stations has been studied. This study will be extended not only in the auroral zone, but also in the cusp and polar-cap region with the aid of the extended observation network.

IPY data management

Metadata related to Japanese IPY projects, together with other Japanese and international projects, have been compiled at the IPY Portal in the GCMD (Global Change Master Directory) (<http://gcmd.gsfc.nasa.gov/KeywordSearch/Home.do?Portal=ipy&MetadataType=0>) in NASA (National Aeronautics and Space Administration). In the Portal

of GCMD, a total number of metadata descriptions (DIFs: Directory Interchange Format) is more than 90.

In the Science Meta-Data Base at the National Institute of Polar Research, Japan (SMDB/NIPR), a total of 148 metadata sets were accumulated so far. The format of metadata is original one, but it includes the items listed in DIFs of AMD (Antarctic Master Directory). There are also links to the corresponding metadata in the AMD for each metadata of the SMDB/NIPR.

Science Outreach and Communication

Scientific symposia. The IPY kick-off symposium, "Asian Collaboration in IPY 2007–2008", was held on 1 March 2007 at the SCJ, Tokyo with 117 participants from 14 countries (<http://polaris.nipr.ac.jp/~ipy/usr/sympo/>). The IPY closing Symposium, "Global Change and Polar Science," to summarize first scientific results and make adequate orientation to the post-IPY generation was held on 1 March 2010 at the SCJ.

Other symposia include:

- 1st International Symposium on the Arctic Research (ISIRA-1: www.jamstec.go.jp/iorgc/sympo/isar1/index.html), organized jointly by the Japanese National Committee for IASC and the SCJ in November 2008 at the National Museum of Emerging Science and Innovation (Miraikan), Tokyo and
- The International Symposium, "Fifty Years after IGY – Modern Information Technologies and Earth and Solar Sciences" (<http://wdc2.kugi.kyoto-u.ac.jp/igy50/>), in November 2008 at the National Institute of

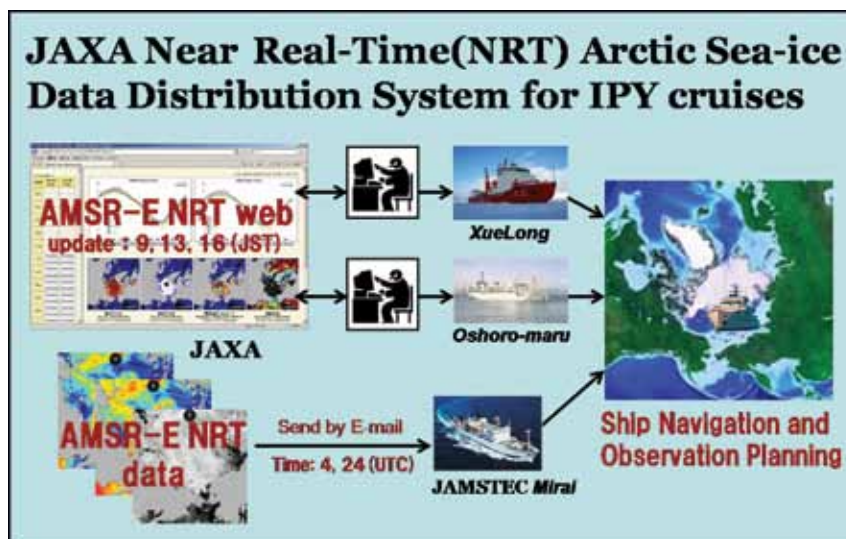


Fig.5.3-12. JAXA's Arctic Sea-ice Data Distribution System for IPY cruises using Near Real-Time AQUA/AMSR-E data. (Photo: Japanese IPY Committee)

Advanced Industrial Science and Technology (AIST), Tsukuba with 160 participants that was sponsored jointly by several National Committees on IPY, eGY (electronic Geophysical Year), IYPE (International Year of Planet Earth) and IHY (International Heliophysical Year).

Education-outreach activities

Polar Open Forum for Junior High and High School Students. The Polar Open Forum for Junior High and High School Students was started in 2004 as an outreach program by the SCJ and the NIPR to broaden interest in polar sciences among the next generation. The catchphrase of the forum was “Arctic and Antarctic

Proposals from School Students.” The forum had been held annually for five years. Implementation of the proposal was carried out by the Japanese Antarctic Research Expeditions (JAREs) overwintering at Syowa Station. The results of the experiments were reported to the students through an Intelsat TV conference system from Syowa, Antarctica, while the expedition members enjoyed conducting the experiment.

After review, it was decided to continue the forum as a legacy of IPY for the recruitment of polar scientists, under the new title, “Contest on Antarctic and Arctic Science for Junior High and High School Students.” A total of 128 proposals were submitted and a research proposal to study dreams of Antarctic expedition personnel won the first prize. The forum was held in November 2009 at the NIPR in Tokyo with 120 participants, including 70 students.

IPY Junior Summit. An outreach event titled the “IPY Junior Summit” was held at the National Science Museum in Tokyo on 1 March 2009. Students who had won prizes in the first to fifth forums described above were invited to give talks on the theme “Polar Research in 2057–2058,” i.e. during the period when the next IPY will be launched. More than 100 participants, many of them quite young, listened to the talks. A retired professor, a member of the Japanese IGY re-

Fig.5.3-13. Memorial photo after the last science station in the Bering Strait. Total of 600+ hydrographic stations were made jointly with CCGS Loius S.St-Laurent (blue: Mirai, red: Loius S.St-Laurent). The area covered the full span of the Canada Basin and eastern Makarov Basin.

(Courtesy: Japanese IPY Committee)



Fig.5.3-14. Korean Antarctic station King Sejong on King George Island, Barton Peninsula.

(Photo: Dongmin Jin)

search team, who overwintered at Syowa in 1957, was invited as a guest panellist. He introduced the early years of JARE, stretching the Summit time focus from 1957 till 2057.

Korea (Republic of Korea)

Formation of KOPRI

Korea began its Antarctic Expeditions in November 1985 with two teams. The mountaineering team became the fifth to reach the summit of the Vinson Massif (4897 meters), the highest mountain in Antarctica on 29 November 1985. The second team set up tents at the coast of the Fildes Peninsula on King George Island in the South Shetland Islands, and researched the island environment. The team also visited foreign stations and collected information on their construction and life at the station.

Korea joined the Antarctic Treaty as the 33rd nation on 28 November 1986. Korea was not a UN member state at that time, and was only able to become a signatory state on the Antarctic Treaty with the endorsement from all Antarctic Treaty Consultative Parties. In 1987 the Korean Ministry of Foreign Affairs made a report on the access to the Antarctic Treaty System as part of its new year's task, which resulted in the construction and opening of the Korean Antarctic station "King Sejong" on 17 February 1988 (Fig. 5.3-14). Since then, Korea has dispatched annually the overwintering parties and summer expedition teams. In 2010, the overwintering party consists of 17 members at the station. Every austral summer season witnesses approximately 100 scientists from research institutes and universities visiting the station. Korea strengthened its polar program in the Arctic by establishing the Dasan Station in Ny-Alesund, Svalbard in 2002 and also by joining International Arctic Science Committee (IASC) in 2002.

To implement its polar science program, a Polar Research Laboratory was established at the Korea Ocean Research and Development Institute (KORDI) in 1987. The Lab was expanded to the Polar Research Center (1990) and enlarged again as the Korea Polar Research Institute (KOPRI) in 2003. KOPRI was developed into an autonomous research institute in 2004 and moved its campus to Incheon in 2006. KOPRI is one of the 13 government supported research

institutes under the auspices of Korea Research Council of Fundamental Science and Technology (www.kopri.re.kr/index_eng.jsp).

The construction of the ARAON

The construction of the first Korean ice-breaking research vessel *ARAON* (Fig. 5.3-15) was implemented by KOPRI as a part of the national polar infrastructure development in accordance with the Korean government 'Polar Science and Technology Development Plan.' *ARAON* is a Korean compound word that combines "ARA," which means "sea," and "ON," which means "all," in the archaic Korean language. As named, *ARAON* embraces a wish to be free to explore all of the oceans in the world.

The *Araon* displaces 7487-tons and is designed for operation in one-meter-thick-annual ice condition (KR PL-10) with 3 knot speed per hour. She can accommodate up to 85 persons (25 crews + 60 researchers), load up to 31 TEU (20 ft container). Her endurance is around 70 days (20,000 nautical miles) without re-supply (Fig. 5.3-16).

The major missions of the *Araon* are to provide logistical support to the Antarctic King Sejong Station and the Arctic Dasan Station, and to conduct scientific research in ice-covered seas. To perform world-class scientific activities, state-of-the-art scientific instruments, like the Multibeam echo sounder, LIDAR, and Dynamic Positioning System were installed on the ship.

Construction began in January 2008 and the ship was launched in June 2009. After delivery to KOPRI in November 2009, *Araon* sailed to the Antarctic Ocean for her maiden voyage and ice-breaking test. KOPRI plans to conduct an Arctic expedition in the summer season of 2010, which will include international collaborative work. KOPRI intends that *Araon* will do a scientific cruise to both the Antarctic and Arctic each year.

Research at the Dasan Station and initiation of a long-term research based on the use of Araon. Since the inauguration of Dasan Station in Ny Ålesund, studies by Korean scientists included atmospheric research, ocean science, biology and geosciences. Especially KOPRI has investigated the relation of Arctic atmosphere variability and climate in East Asia. Energy and CO₂ fluxes have been observed at polar stations using an eddy covariance flux measurement tower. A Cloud Condensation Nuclei (CCN) counter was installed

Fig.5.3-15. New Korean ice breaking research vessel *Araon*.
(Photo: Dongmin Jin)



at the Zeppelin Station, Ny Ålesund to investigate long-short term variation of aerosol activation into cloud droplet size. The collaborative research between KOPRI and the Zeppelin aerosol research team from the University of Stockholm, Sweden has expanded by adding atmospheric particle number concentration monitoring at the Corbel Station in Ny Ålesund in August 2006.

Studies on the biodiversity and adaptation mechanism of the Arctic organisms, investigation on the fauna and flora inhabiting various environments around the Korean Arctic Research Station and sampling of marine plants and sea water have been made. Physiological characteristics and extracellular polymer-degrading enzyme activities will be assessed from the collected samples to understand adaptation in polar environment and nutrient cycle.

In summer 2010, *Araon* made her first voyage to the Bering Sea and the Arctic Ocean to target the rapid melting of the Arctic sea ice and its effect on the ecosystem. Through annual cruises, long term monitoring of the primary production patterns in the Western Arctic will be conducted. *Araon* will contribute to the Antarctic research in areas such as the responses of carbon flow and biological productivity to the

rapid retreat of sea ice in western Antarctic area, and monitoring on the ice-shelves and adaptation of living creatures beneath them.

Expansion of the Antarctic science

In 2006 the Korean government announced a plan to build a new research station in Antarctica to enhance Korean scientific capabilities and promote collaboration for the development of Antarctic sciences. Two key areas were identified according to scientific interest: Cape Burks in Marie Byrd Land and Terra Nova Bay, Northern Victoria Land. An intensive field survey was conducted by 22 scientists, onboard *Araon* from 12 January to 18 February 2010 in both areas. According to the study, the Terra Nova Bay is considered the most suited for the new station. Terra Nova Bay is expected to provide an ideal platform for research on climate change over the Pacific Ocean side of Antarctica. The winter-over research program will contribute to the understanding of rapid climate change in the region. With the new research station, Korea is expected to make significant contribution to the international collaboration and the effective management and conservation of the Antarctic environment.



Fig.5.3-16. Major technical and research parameters of *Araon*.

(Photo: Dongmin Jin)

Malaysia

Development of Malaysian Antarctic Science Program

Malaysia's interest in Antarctica started in 1983. In 1985 the Academy of Sciences of Malaysia encouraged Malaysian scientists to embark on Antarctic research; but funding and interest was then insufficient to launch a national Antarctic program. The breakthrough came in 1997, when New Zealand offered the use of its Scott Base Station in Antarctica to Malaysian scientists to undertake polar studies. The first Malaysian field research in the Antarctic with the focus on climate change and biodiversity was undertaken in October 1999, at the Scott Base Station.

Since 1999, the Malaysia Antarctic Research Program (MARP – www.myantarctica.com.my/aboutMARP.htm#marp) undertook a number of initiatives to develop and sustain Malaysian scientific research in Antarctica. Under the leadership of MARP, the number of research projects grew from the initial four in 2000 to the current 15, covering the fields of atmospheric sciences, remote sensing, upper atmospheric and solar terrestrial connection, and biological sciences. To date, more than 40 scientists and postgraduate students from various universities in Malaysia are involved in Antarctic research. In order to coordinate and archive MARP activities, the National Antarctic Research Centre was established in cooperation with the University of

Malaya in 2002. This is also the physical location of the Malaysian data server under its obligation as a member of Joint Committee on Antarctic Data Management and IPY.

Since the first scientific fieldwork, MARP has established scientific collaboration with a growing list of national polar research centers, such as the British Antarctic Survey, Australian Antarctic Division, Korean Polar Research Institute, Institut Antartico Chile, Institut Antartico Ecuador, Institut Antartico Argentine, Byrd Polar Research Institute, the Japanese National Institute of Polar Research and other Japanese institutions. Malaysian scientists are presently conducting research in Antarctic Peninsula, Ross Ice Shelf, Queen Maud Land and Wilkes Land. They are also working on the sub-Antarctic Marion Island in cooperation with South African partners and recently visited the Korean research station in Ny Ålesund to collect samples for biological research, under the MoU with the Korean Polar Research Institute (KOPRI).

Malaysian IPY initiatives

In 2004–2005, MARP encouraged Malaysian scientists to submit their proposals for future IPY activities, resulting in 14 EoIs by Malaysian researchers; some of them were later merged into endorsed full proposals (IPY nos. 53, 55, 63, 180). The majority of Malaysian biological research was conducted

under the 'Microbiological & Ecological Responses to Global Environmental changes in polar regions' project (MERGE, IPY no. 55). A number of Malaysian biology studies were also integrated with the SCAR *Evolutionary Biology of Antarctica* program. The geophysical group has also been invited to participate in the *Interhemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research* (ICESTAR) program of SCAR contributing their Global Positioning System (GPS) network to study solar terrestrial interaction. An international seminar on Antarctic Research was held at the University of Malaya in Kuala Lumpur in June 2005 in the build-up to IPY.

As a part of the outreach, education and capacity building of the IPY program, under the leadership of University of Tasmania, a multi-institutional International Antarctic Institute (IAI) was established and accepted as an IPY program (www.iai.utas.edu.au/ - Chapter 5.4). In acknowledgement of Malaysian active polar research, the University of Malaya (UM) and the University Science Malaysia (USM) were invited to join the IAI. In addition, the MARP is an active member of the 'Sixth Continent Initiative,' an IPY program proposed by the International Polar Foundation to encourage non-traditional polar countries' research in Antarctica.

During IPY, 45 Malaysian scientists participated in 21 field trips to Antarctica and the Arctic (Fig. 5.3-17). Most of the Malaysian IPY research was conducted in Antarctica: at the Scott Base Station (with New Zealand colleagues), also on Antarctic Peninsula (on collaborative projects with the British Antarctic Survey,

the Ecuador Institute of Antarctic Research and Chile Institute of Antarctic Research), at the Signy and Casey Antarctic stations (in collaboration with British and Australian colleagues). Several trips were made to the islands in the Southern Ocean, such as South Shetland Islands, King George Island and Marion Island. Most Malaysian Antarctic research is in the field of biology, remote sensing, atmospheric studies and geology (Figs. 5.3-17, 5.3-18).

In January-February 2007, one Malaysian biologist took part in the Japanese research cruise in the Bering and Chukchi Seas organized jointly by the National Institute of Polar Research, Japan and Hokkaido University. In July 2008, two Malaysian biologists worked at the German research station in the Arctic managed by the Alfred Wegener Institute (Fig. 5.3-19). Thus, IPY made a breakthrough for Malaysian researchers in their entry to the Arctic.

Science Dissemination and Outreach

Malaysia has placed significant emphasis on communicating the results of its polar science. The *3rd Malaysian International Seminar on Antarctica (MISA3): From the Tropics to the Poles* was held in Kota Kinabalu, Sabah on 20-23 March 2007 in conjunction with the launch of IPY 2007–2008. It was followed by Outreach Program and an ICSU-SCAR Forum. The theme of the seminar, "From the Tropics to the Poles" followed the science program of IPY that argues that the polar regions are integral components of the complex Earth systems. Increasingly, there is also a need to engage scientists from nontraditional polar research countries and from other regions (such as the tropics). The Outreach Program was held to generate interest in Antarctica among the general public and schoolchildren, together with the Forum on "Understanding the Implications of Rapid Warming in the Polar Regions to Earth systems" organized jointly by the ICSU Regional Office for Asia and the Pacific (ROAP) and SCAR.

Following the formal conclusion of IPY, the *4th Malaysian International Seminar on Antarctic - Legacy of IPY to the Tropics (MISA-4)*, with 102 participants was held in Petaling Jaya, Selangor, 1–2 April 2009. In conjunction with MISA-4, two workshops,



Fig.5.3-17. Malaysian biologist Cheah Yoke Queen collects samples at a penguin rockery on the South Shetland Islands (2007).

(Courtesy: Malaysian National Antarctic Research Centre)



Fig.5.3-18. Installing Malaysian Antarctic research program automated weather station (AWS) at McKay, 2007.

(Courtesy: Malaysian National Antarctic Research Centre)

Recent Antarctic Climate Change and Its Implications on the Marine and Terrestrial Biota; and Molecular Markers Techniques for the Identification of the Transport Pathways of Organic Pollutants in Extreme Environment have been organized on 3–4 April 2009 (www.myantarctica.com.my/misa4/misa4.html). The first workshop engaged several leading Malaysian and foreign climate change experts. The second workshop was held at the Faculty of Environmental Sciences, University of Putra Malaysia. The workshop provided a platform for local scientists to get involved in hydrocarbon pollution research, learn the latest developments in research, and to establish an international link with foreign experts in the field.

Students on Ice. In February 2009, one Malaysian postgraduate student and one undergraduate student from the University of Malaya participated in the Canadian-funded trip to Antarctica on the *Students on Ice* project. The two students together with 69 other students and 18 researchers from around the world completed a two-week trip on board the *MV Ushuaia*. During the cruise, they participated in lectures, workshop and hands-on activities related to polar environment and wildlife. This expedition was endorsed as an IPY event (www.studentsonice.com/ipy/).

International Polar Week with the theme “What hap-

pens to the Poles Affects Us All” was organized on 5–9 October 2009 at the University of Malaya, in conjunction with IPY (*Chapter 4.1*). Talks were given by experts and postgraduate students from across the country and poster exhibition was one of the key activities. This event provided the information about Malaysian scientific activities in Antarctica and the Arctic, as well as about the IPY studies across the polar regions.

Conclusion

The five Asian nations, members of the AFoPS, with a combined population of more than 2.7B, used IPY 2007–2008 as an opportunity to increase their polar science capabilities and their role in the global science community. Not only was significant new national funding (the “pulse”) directed to polar research, but also new infrastructure was constructed or committed that will ensure continuing efforts at an enhanced level for decades to come (the “legacy”). Outreach efforts aimed at college and high-school students throughout the Asian nations will add to the lasting legacy of IPY in this region. Of major importance is also the growing presence of China, Japan and Korea in the Arctic Ocean and in the northern polar region, in addition to their earlier involvement in Antarctic research going back to the IGY and post-IGY years.

Fig.5.3-19. Malaysian Arctic sampling program in Ny-Alesund, Svalbard (featuring Wong Chiew Yen), June 2008.

(Courtesy: Malaysian National Antarctic Research Centre)



Another IPY focus was on international cooperation, and the AFoPS member countries increased their participation in international scientific activities during IPY. Many endorsed IPY projects were led or participated in by Asian scientists. Asian-funded field projects were joined by international partners and guests, and several international science organizations held major meetings in Asia, that were crucial in launching IPY 2007–2008, such as the SCAR 26th meeting in Tokyo in July 2000; SCAR 27th Meeting in Shanghai in July 2002, the World Climate Research Programme (WCRP) session in Beijing in October 2002; the Arctic Science Summit Week in April 2005 in Kunming, China; and the official endorsement of IPY 2007–2008 by the 28th ICSU General Assembly in October 2005 in Suzhou, China (*Chapters 1.2, 1.3, 1.5 and 1.6*)⁶. A significant number of scientific papers co-authored by Asian and non-Asian scientists should result from these collaborative efforts. Some of these collaborations can be expected to endure, leading to future insight and the growing role of Asian nations in polar research as the legacy of IPY 2007–2008.

Notes

- ¹ Drs. Prem Chand Pandey from India (National Centre for Antarctic and Ocean Research) and Zhanhai Zhang, from China (Polar Research Institute of China) were members of the ICSU Planning Group in 2003–2004, and two scientists from the Asian nations, Qin Dahe from China and Yoshiyuki Fujii from Japan, were nominated to the ICSU-WMO Joint Committee in 2004.
- ² Most of these countries participated by conducting meteorological observations on their territories, with no special activities in the polar regions.
- ³ Both Korea and Japan had representatives at the AC ‘deputy ministers’ meeting held in May 2010 in Copenhagen. The AC members have stated that they would come to a decision on the observer countries at the next Ministerial meeting, scheduled for May 2011.
- ⁴ Observations of depleted Antarctic ozone were noticed at Halley Station in the late 1970s; but their significance was not recognized until later. The U.S.A., Japan, and the U.K. all obtained ozone data in the early 1980s, and a Japanese scientist, Chubachi Shigeru was first to publish it in 1983. But the British Antarctic Survey announced their “discovery” of the ozone hole in 1985 and received credit in the western press (editor’s note).
- ⁵ See: Arctic Sea-Ice monitor by AMSR-E www.ijis.iarc.uaf.edu/cgi-bin/seaice-monitor.cgi?lang=e; IPY Dataset by ALOS/PALSAR www.eorc.jaxa.jp/ALOS/en/ipy/ipy_index.htm.
- ⁶ Two most recent events underscoring the role of AFoPS nations in international polar year research were the 17th International Symposium on Polar Science, 26–28 May 2010, at the Korea Polar Research Institute, in Incheon, and the International conference on Cryospheric Change and its Influences – Cryospheric Issues in Regional Sustainable Development, organized jointly by CliC and IASC in Lijiang, China, 12–14 August 2010.



5.4 Connecting to New Stakeholders in Polar Research

Lead Author:

Igor Krupnik

Contributing Authors:

Cindy Dickson, Shari Gearheard, Victoria Gofman, Henry Huntington, Lars Kullerud, Chris McNeave, Iouri Oliouline, Mark Parsons, Peter Pulsifer, Outi Snellman and Patti Virtue

Engagement of Arctic residents, including indigenous peoples:

IPY has advanced the participation of Arctic residents, including indigenous peoples, in large-scale interdisciplinary science in their own region. For the first time, Arctic residents and their organizations have acted as full partners and leaders in international projects involving scholars from many nations and disciplines, research planning, data collection, management, analysis and outreach. The contributions, observations and knowledge of Arctic residents have proven key to the success of several IPY studies on the dynamics of sea ice, weather, changes in habitat and wildlife distribution, the sustainability of local economies, public health and community well-being. This legacy of partnership has built a solid foundation for the engagement of Arctic residents and indigenous peoples in future large-scale science projects.

(The State of the Polar Research, 2009, p.10)

Introduction

Igor Krupnik

The inclusion of ‘human dimension’ in IPY 2007–2008 was not merely a symbolic break with the previous model of pure (or primarily) geophysical program of the early IPY/IGY. Nor was it a pragmatic response to the new requirement of ‘societal impacts’ coming from the international science organizations and many national funding agencies. The many reasons for that historic change in the IPY design and for the emergence of the new vision of ‘polar research’ have been addressed in detail in other sections (*Chapters 1.3, 1.5, 2.10, 3.10*). What it meant in practice in 2004–2005, when the IPY science program was being formed via the submission of Expressions of Intent (EoI) and ‘full proposals,’ was the urgent need to reach out to new prospective ‘stakeholders.’ Those new stakeholders—future project participants, proposal writers, research teams and ground-supporters—were coming from the fields that have either marginal institutional memory of the early IPYs and IGY, such as social and human health scientists, or no institutional memory at all, like polar residents and, particularly, polar Indigenous people.

Unlike older scientific organizations and Science

Unions, associations (NGOs) of local polar residents are relatively new phenomenon. All of them appeared long after the completion of IGY 1957–1958 and their activities have always been focused primarily on self-determination, land and resource rights, support for indigenous languages and cultures, and community well-being. Of course, polar residents have a long experience of interaction with polar researchers, and not only with anthropologists, but also with natural and physical scientists from many disciplines. These relationships had their own uneasy history and generally varied from pragmatic partnership to alienation and utmost resistance, as in the case of certain types of archaeological excavations, wildlife and human blood sampling, and genetic research.

To reach out to these new constituencies and to bring them to the IPY ‘big tent’ required new approaches never tested in the previous IPY/IGY. This chapter covers three of those new models (out of many) that were used successfully to bring polar residents to IPY. The first opportunity came from the emergence of vocal and active *indigenous organizations* that now have many fora to increase

their role via major intergovernmental organizations, like the Arctic Council or umbrella NGOs (like the International Work Group on Indigenous Affairs, IWGIA or Survival International), in which they participate. The other model, first explored in IPY 2007–2008, was to engage local and indigenous stakeholders through various *knowledge and data sharing networks*. That latter channel was of crucial importance, since none of the previous IPY/IGY had any policy of *sharing data* with people in whose native areas IPY science teams made their observations, collected samples and drilled holes. Yet another new model was to engage local educational institutions in the polar regions, such as local universities, community colleges, even high schools, in support of IPY research. We were fortunate to rely upon many such partners that did not exist during earlier IPY/IGY, that took the lead in bringing its constituent institutions into IPY 2007–2008 (Box 1).

Of course, the individual stories presented in this chapter are mere snapshots of the diversity of approaches and of new stakeholders that emerged in IPY. Nonetheless, they illustrate how the organizers' dreams of an IPY with a 'human dimension' evolved into practical mechanisms contributing to the success of IPY.

Engaging Arctic Indigenous Organizations in IPY 2007–2008

Victoria Gofman and Cindy Dickson

Reviewers: Jens Dahl, Shari Gearheard and Igor Krupnik

IPY 2007–2008 has received unparalleled support from the scientific community, governments and the public. This support was born, in part, out of sheer necessity to respond to the rapid climate and other environmental changes, most notably in the Arctic. What used to be an exclusive realm of physical science became "the social pole" (Monastersky, 2009). The inclusion of "human dimensions" in IPY 2007–2008 program took it to the next level, but the vision of the IPY organizers eventually expanded the notion of inclusiveness to the range never experienced in the previous 'polar years.' Arctic residents, especially indigenous peoples, were recognized as important stakeholders, collaborators and drivers of new research, and, for the first time, were explicitly called upon to participate in IPY science (Chapters 1.3, 2.10, 3.10).

One of the most symbolical events of IPY 2007–2008 was the launch ceremony for the 'Indigenous Peoples' International Polar Year' in the northern Norwegian town of Kautokeino/Guovdageaidnu on 14 February, 2007 organized jointly by the Nordic Sámi Institute, International Centre for Reindeer Husbandry and other local institutions (<http://arcticportal.org/en/icr/ealat>; www.polarareet.no/artikler/2007/IP_IPY Fig. 5.4-1). By holding such an event two weeks prior to the official launch of the IPY 2007–2008 on 1 March, 2007 these organizations of Arctic indigenous peoples made a concerted effort to raise their profile in IPY and to demonstrate their full support to this multi-national program.¹

The energy culminated in IPY 2007–2008 was a result of many years of an uphill battle for recognizing indigenous, local and traditional knowledge as invaluable components in understanding of physical, natural and social environments in the Arctic. Indigenous and local participation in IPY 2007–2008 was also a result of political changes that occurred in the last few decades. The process of indigenous land settlement claims that began in the 1970s in Alaska and was followed by a similar movement in Canada resulted in the establishment of indigenous government bodies. That led, among other things, to the increase in capacities of local indigenous organizations and to new government regulations requiring consultations and sometimes approval of research planned on indigenous lands. The full list of scientists, indigenous leaders, and various organizations and government agencies that contributed to the inclusion of Arctic residents in IPY 2007–2008 is too long for this short section to cover. Nevertheless, two events leading up to IPY played an especially significant role and deserve to be mentioned: the formation of the Arctic Council and the Arctic Climate Impact Assessment report (ACIA, 2005).

In 1996, eight Arctic states established the Arctic Council (Chapter 1.4), an international body as "...a means for promoting cooperation, coordination and interaction among the Arctic States, with the involvement of the Arctic indigenous communities..."² From the very onset, the Arctic Council laid ground for the inclusion of indigenous peoples in all of its endeavours by "Recognizing the traditional knowledge of the indigenous people of the Arctic ... and taking

note of its importance ... to the collective understanding of the circumpolar Arctic...² The Inuit Circumpolar Council (previously called the Inuit Circumpolar Conference, ICC), the Saami Council and the Russian Association of Indigenous Peoples of the North, Siberia and the Far East (RAIPON) played an important role in the development of the Arctic Council and establishing the category of "Permanent Participants" for indigenous organizations "to provide for active participation and full consultation with the Arctic indigenous representatives within the Arctic Council."²

Currently, six indigenous organizations are admitted as Permanent Participants: the Aleut International Association (www.aleut-international.org), the Arctic Athabaskan Council (www.arcticathabaskancouncil.com), the Gwich'in Council International (www.gwichin.org), the Inuit Circumpolar Council (www.inuit.org), Saami Council (www.saamicouncil.net) and the Russian Association of Indigenous Peoples of the North, Siberia and the Far East (www.raipon.org) (Chapter 1.4) (Gofman, 2008).

The Arctic Council provides one of the few fora where indigenous organizations have a unique role in discussing and shaping policies and research leading to sustainable development, protection of the environment and, in more recent times, also related to Arctic governance. The fact that indigenous organizations share a negotiation table with ambassadors and Foreign Ministers of Arctic States is a remarkable act of recognition. For example, there are no other organizations or fora that would provide a mechanism for the direct participation of indigenous organizations in international scientific assessments of the magnitude of the *Arctic Climate Impact Assessment* report (2005).

The *Arctic Climate Impact Assessment* (ACIA 2005) highlighted the changes expected to occur in the Arctic as a result of climate change over the next decade and throughout the 21st century. It also showed that these changes have already begun and will have significant environmental, economic, social and cultural effects in the Arctic. A key ACIA recommendation for future Arctic research was the improvement of long-term monitoring, extending it to year-round record collection and expanding it spatially.

ACIA was also one of the first major scientific



Fig. 5.4-1. Website for the 'Indigenous People's IPY Opening event in the Norwegian Sámi town of Kautokeino (Guovdageaidnu), February 14, 2007 at www.ip-ipy.org. The site is now owned by the EALÁT project (IPY no. 399) administered by the Sámi University College-Nordic Sámi Institute at <http://arcticportal.org/en/icr/ealat>.

reports that included observations of local indigenous peoples, as case studies, to support and extend scientific findings, and to give a human face to some of the impacts of climate change (Huntington and Fox, 2005). A striking convergence of community-based observations with scientific data helped validate local observations and elevated them from "anecdotal evidence", a term commonly applied to identifying this type of information in scientific research, to an invaluable building block of a holistic understanding of the Arctic environment. Nevertheless, case studies can only convey personal perspectives. They may provide the basis for discussion and scientific inquiry, but they do not provide aggregate statistics or general trends (Huntington and Fox, 2005).

The recognition of the validity of local observations coupled with the need for on-going monitoring created a perfect opportunity for a surge in interest in various forms of community-based monitoring. This was amplified by the opportunity presented by IPY 2007–2008.

The Arctic Council Permanent Participants often cannot fully realize the opportunities afforded by the Arctic Council, such as a meaningful participation in its projects, due to many problems. Some are financial and others are rooted in lack of experience and expertise in permanent participants' organizations. Lack of core funding prevents permanent participants from hiring needed experts. Since most of the obstacles are financial, they act as a *de facto* filter preventing Permanent Participants from full engagement in research projects initiated by the Arctic Council and in the development of research policy and recommendations.

IPY 2007–2008 generated much needed opportunities for funding and those Permanent Participant organizations that had portfolios of research ideas and proposals were in a position to reap the benefits. For example, the Aleut International Association (AIA) saw these opportunities in as early as 2004 and realized that the experience gained while working on ACIA in cooperation with many renowned scientists gave AIA a competitive edge in the development of its research programs. ACIA findings clearly indicated the need for broad-based efforts for monitoring of environmental changes. AIA was also among the first applicants from the social and human studies field that responded to the call for IPY 2007–2008 projects in winter 2004 and had submitted its concept for an IPY activity (“International Network of Arctic Indigenous Community-Based Environmental Monitoring & Information Stations”). That concept was included in the ‘Initial Outline Science Plan’ for IPY in April 2004 (ICSU Planning Group, 2004) and was received with great interest (*Chapter 1.3*). Those early contacts were important in the further development of the full proposal for the Bering Sea Sub-Network: International Community-Based Environmental Observation Alliance (BSSN, IPY no. 247) that became an endorsed IPY project (*Chapter 3.10*).

BSSN was funded by the U.S. National Science Foundation (NSF), first as a pilot under the Arctic Observing Network (AON) funding initiative. The pilot phase started in 2007 and demonstrated that an international network of indigenous communities could be organized to produce usable local observation data sets (*Chapter 3.10*). In 2009, the project received additional funding for five more years and will be operational until 2014 (Fig. 5.4-2).

Another good example of stakeholder involvement was a partnership of indigenous organizations that was formed in Canada for participation in IPY 2007–2008. The Council of Yukon First Nations (CYFN), Canada involvement in IPY 2007–2008 began with the participation in the Canadian National Committee in 2005. The release of the ACIA focused attention on climate change and IPY was viewed as an opportunity to further research and explore the potential effects of global warming in the Arctic and help determine what that would mean for Arctic peoples. The potential challenge was that northern communities did not fully

trust researchers and many of them were expected to come north for IPY research. To mitigate this issue, northern communities decided to get involved in IPY 2007–2008 from the beginning. The Canadian IPY 2007–2008 Program focused on two priority areas for northern science and policy development: 1) Climate change impacts and adaptation; and 2) The health and well-being of northern communities. CYFN’s interest was in the “human dimensions” of the IPY Program (“to investigate the cultural, historical and social processes that shape the sustainability of circumpolar human societies, and to identify their unique contributions to global cultural diversity and citizenship”). CYFN was looking for an opportunity to develop its research agenda that would capture the two priority areas identified as part of the Canadian IPY Program, climate change impacts, and community health and well-being. Similarly, other Canadian northern indigenous organizations were also looking to develop their research agendas and CYFN took the initiative to develop such a partnership. Eventually, CYFN, Gwich’in Council International, Arctic Athabaskan Council, Inuit Circumpolar Council, Inuit Tapiriit Kanatami and Dene Nation formed a committee that enabled them to identify their priorities. They identified community resilience as a priority research focus in their IPY-related efforts, with the aim to build capacity for Arctic community health and sustainability.

This partnership, for example, helped develop a project titled ‘Arctic Peoples, Culture, Resilience and Caribou’ (ACRC). Central to this study was the assumption that change is dynamic, uneven and unpredictable. Long-term socio-ecological health and well-being for Arctic communities means having the ability to adapt to change by accessing a range of strategies to respond to a variety of potential conditions. The project is currently in its final year.

It will be a while before Arctic communities realize the full significance of IPY 2007–2008 research results in the Canadian Arctic. The legacy that will be left behind will be determined through arctic eyes. Yet, they hope that IPY 2007–2008 momentum will continue and that it will adapt for the long-term support of health and well-being of northern communities.

Overall, out of more than 160 IPY research projects that were implemented, 12 projects were led by indigenous researchers or indigenous organizations



Fig. 5.4-2. BSSN workshop participants, Anchorage, 2008. Seated Left to Right: Victoria Gofman (AIA), Lyudmila Kulchitskya (Kanchalan, Russia), Arlene Gundersen (Sand Point, Alaska), Molly Chythlook (Dillingham, Alaska), Helen Chythlook (Dillingham, Alaska) Standing Left to Right: Moses Kritz (Togiak, Alaska), Iver Campbell (Gambell, Alaska), Marty Waters (Anchorage, Alaska), Ivan Vozhikov (Nikolskoye, Russia), Natalya Tatarenkova (Nikolskoye, Russia), Svetlana Petrosyan (Tymlat, Russia), Jim Gamble (AIA). (Photo: Aleut International Association)

while additional 25 projects had indigenous partners (*Chapters 2.10 and 3.10*)³. Many of these projects had a substantial community-based monitoring component (*Chapters 3.10 and below – Fig. 5.4-3*). Community-based monitoring (CBM), a term used mostly in North America, is a complex research field that is becoming an essential and often required component in academic research and natural resource management (Gofman et al., in press). CBM enables researchers to reach beyond “Western” science by using the best available knowledge, be it academic, indigenous, traditional or local. Such holistic approach improves understanding of ecological systems and how they interrelate with human societies. Many IPY projects incorporated elements of CBM or traditional knowledge (*Chapter 3.10*) in a similar way ACIA did. Few, however, attempted to generate statistical data and trends based on information gathered solely from and by local residents. BSSN (IPY no. 247) was one of such projects.

In general, IPY projects that claimed leadership or participation by indigenous and other local organizations and residents can be organized in three groups: 1) Research led by academia focused on indigenous communities (e.g. CAVIAR, no. 157; SIKU no. 166, Narwhal no. 164, ELOKA no. 187, NOMAD no. 408,

MODIL-NAO no. 46); 2) Research led by a partnership of indigenous organizations and academia (EALÁT no. 399 – see Fig. 5.4-4); 3) Research led by an indigenous organization and managing it as a project fiscal agent (e.g. BSSN, no. 247, no. 186). The last two groups represent a measurable increase in the involvement of indigenous and local stakeholders in polar research and management. This growth is a reflection of a growing political influence, financial and human capacities of indigenous and tribal governments, corporations (in North America), legislative bodies, and non-profit organizations in addition to the opportunities presented by IPY 2007–2008.

For the first time, representatives of indigenous organizations were invited to participate in the organizational and management bodies of an IPY. Many national committees included such representation: in Canada – Duane Smith of ICC and Cindy Dickson of the Council of Yukon First Nations, in Russia – Larisa Abryutina and Rodion Sulyandziga of RAIPON, in Sweden – Susanne Spik of Sirkas Same Village, and in the U.S – Richard Glenn of the Arctic Slope Regional Corporation (source: <http://classic.ipy.org/national/committee.htm>). Several representatives of indigenous organizations served on the IPY 2007–2009 subcommittees (Lene Kielsen Holm,

Fig. 5.4-3. Community meeting organized by the EALAT Project team near the town of Khralovo, Yamal-Nents Area, West Siberia for the Nenets, Komi, Khanty and Sami reindeer herders participating in the EALAT project.

(Photo: Svein Mathiesen)



Fig.5.4-4. The IPY EALAT consortium meeting in Kautokeino, Norway, 13 January 2009

(Photo: Philip Burgess, EALAT International Reindeer Center)

Greenland, on the Subcommittee on Observations; Birget Kleist Pedersen from the University of Greenland and Rodion Sulyandziga from RAIPON, Russia on the Education and Outreach Subcommittee). Ole Henrik Magga, the first President of the Norwegian Saami Parliament in 1989–1997 and the PI on the EALÁT project (IPY no. 399 – *Chapter 3.10*) addressed the IPY Open Science Conference in June 2010 as one of its plenary speakers (Fig. 5.4-5). Unfortunately, no member of polar indigenous organizations was invited to serve on the IPY Joint Committee. This will be one more peak to climb in the next International Polar Year.

Success of IPY 2007–2008 cannot be measured solely by the number of involved stakeholders. The main question is whether these initiatives can make significant contributions to the understanding of polar systems. Some projects were designed and funded to be implemented during 2007–2009 (SIKU, no. 166). Other projects used IPY 2007–2008 as a test drive for new ideas and those who demonstrated success have launched full-scale research after IPY, like BSSN (no. 247) and ELOKA (no. 187). The full results of projects will be available in a few years, but the fact of their existence and their longevity is a true IPY 2007–2008 triumph.

The experience gained in IPY 2007–2008 by many indigenous groups and academic institutions can help them better understand the difficulties inherent to integrating non-academic and academic research.

The IPY experience also led to new developments in data management, research methods and funding processes, and to improving future research efforts to actively engage local stakeholders. More importantly, this experience opened doors to the next stage in collaborative polar research. The Arctic is a theatre where indigenous organizations are actors rather than props and it is time for them to play leading roles in polar research. IPY 2007–2008 was a baby step in that direction, but it was a giant baby step.

Exchanging and Sharing Knowledge with Local Stakeholders – ELOKA

Shari Gearheard, Henry Huntington, Mark Parsons, Chris McNeave and Peter Pulsifer

Reviewers: Claudio Aporta and Igor Krupnik

“I believe it is time for the harpoon and the computer to work together”

- Peter Kattuk, Sanikiluaq, Nunavut

Over the last decade, Arctic residents and indigenous peoples have been increasingly involved in polar research. Through Local and Traditional Knowledge (LTK) research and community-based monitoring (CBM), Arctic residents have made, and continue to make, significant contributions to understanding recent environmental change in the polar regions (e.g.



Fig.5.4-5. Ole Henrik Magga, Grete Hovelsrud and Svein Mathiesen at the Opening Ceremony for IPY 2007–2008 in Paris, 1 March 2007.

(Photo: Igor Krupnik)

Krupnik and Jolly, 2002; Huntington and Fox, 2005; Riewe and Oakes, 2006; Krupnik et al., 2010). Arctic residents' participation in IPY 2007–2008 and their critical role in many IPY projects in social and human health fields, marine and terrestrial biology, and environmental monitoring (*Chapters 2.10, 2.11, 3.10*) are commonly viewed as one of the key accomplishments of IPY 2007–2008. Nevertheless, this momentum in Arctic residents' participation in science research created by IPY has to be preserved and extended to become a lasting legacy of IPY. To achieve this goal, IPY scientists, collaborating northern communities and Arctic indigenous peoples' organization are developing new means to strengthen their partnership through a local and indigenous knowledge exchange network beyond the IPY 2007–2008 era.

ELOKA (the "Exchange for Local Observations and Knowledge of the Arctic"), one of IPY 2007–2008 projects (no. 187, <http://eloka-arctic.org>) launched in 2006 with funding from the Arctic Observing Network (AON) (National Science Foundation, U.S.) may become a prime vehicle in such a post-IPY partnership. It received continuation funding for 2009–2012, also from the NSF AON program, and will be processing, sharing and preserving data collected via several collaborative IPY and associated projects during the post-IPY decade. The main goal of ELOKA is to play a role in the creation of a post-IPY *network* to facilitate the collection, preservation, exchange and use of local observations and knowledge of the Arctic by providing assistance in data management and user support services. Such an emerging network will serve a wide range of people, from local citizens in small Arctic communities, to scientists in universities and educators in K-12 schools. In particular, it seeks to connect local and traditional knowledge of Arctic residents with science, and local experts with scientists, to further the collective understanding of the Arctic.

A key challenge of local and traditional knowledge research and community-based monitoring is having an effective and appropriate means of recording, storing and managing data and information. Another challenge is to find an effective means of making such data available to Arctic residents and researchers, as well as to other interested groups such as teachers, students and decision-makers. Without a viable network and operational data management system to

support LTK and community-based research, a number of problems have arisen, such as misplacement or loss of extremely precious data from Elders who have passed away; lack of awareness of previous studies causing repetition of research and wasted resources occurring in the same communities; and a reluctance or inability to initiate or maintain community-based research without an available data management system. Thus there is an urgent need for effective and appropriate means of recording, preserving and sharing the information collected in Arctic communities. The momentum started in the IPY and spearheaded by the ELOKA project aims to fill this gap.

Building a Knowledge Exchange

At the heart of ELOKA is the **development** and **implementation** of the tools and services needed to manage, protect, communicate and share LTK and CBM information. In order to achieve this, ELOKA began its efforts during the IPY years with two case study projects: the *Sanikiluaq Sea Ice Project* (Nunavut, Canada) and *Narwhal Tusk Research* ('Studies of Narwhal Teeth', IPY no. 164). The community of Sanikiluaq has been active for many years in researching and monitoring the local environment from both Inuit and scientific perspectives. ELOKA partnered with Sanikiluaq to provide data management for a small subset of their work: documenting local observations and knowledge of recent sea ice change.

The Sanikiluaq data consists of videotaped interviews with Inuit hunters and map overlays that hunters used to draw their observations of sea ice change. These data are typical of many LTK projects that often use video, audio and mapping techniques. The tools developed to manage this information include a video player and maps created by professional cartographers in collaboration with community members. Together these tools provide a unique and customized means to store and present Sanikiluaq's LTK research (see Fig. 5.4–6).

Narwhal Tusk Research was an IPY 2007–2008 project (no. 164) launched in collaboration with the Inuit hunters and elders from Nunavut, Canada and Northwest Greenland (see www.narwhal.org/; <http://classic.ipy.org/development/eoi/proposal-details.php?id=164>). Hunters and elders from several communities on Baffin Island and Greenland have provided key informa-

tion on changes in hunting strategies for narwhal, observations of narwhal behavior including feeding and migration patterns, and task-related behavior.

ELOKA is developing a website for Narwhal Tusk Research that presents over 30 interviews conducted with Inuit hunters and elders, along with complete, transcribed translations (Fig. 5.4-7). This allows one to view entire, unfiltered interviews in the context in which they were given, or new search tools being developed will allow for more direct access to desired information. Along with the interviews, the sub-site provides information on the science and laboratory work completed in the project and summary information about narwhals.

The Sanikiluaq Sea Ice Project and Narwhal Tusk Research are the first two case studies advanced during the IPY years. Work on sub-sites for other projects is underway as similar and complementary tools are being developed by other projects and organizations that have partnered with ELOKA to develop a network of services for local knowledge and community-based monitoring information. For example, significant research is being carried out in the area of web-based mapping and Geographic Information Systems (GIS) for LTK by research groups such as the Geomatics and Cartographic Research Centre at Carleton University, Ottawa, Canada. Other partners in a growing list working with ELOKA on building a support network include the Sea Ice Knowledge and Use (SIKU, IPY no. 166) project, Department of Fisheries and Oceans Canada, Nasivvik Centre for Inuit Health and Changing Environments, Aleut International Association (AIA), Inuit Tapiriit Kanatami (ITK), Inuit Knowledge Centre (IKC), Sustaining Arctic Observing Networks (SAON), Yukon River Inter-Tribal Watershed Council, Earth Institute (Columbia University), International Polar Year Federal Program Office Canada, SIZONet (Seasonal Ice Zone Observing Network, University of Alaska Fairbanks), Circumpolar Biodiversity Monitoring Program (CBMP), Alaska Native Science Commission and the SnowChange Cooperative, an international group based in northern Finland that is documenting indigenous knowledge about Arctic climate change.



Fig. 5.4-6. Part of the Sanikiluaq Sea Ice Project subsite on ELOKA showing LTK maps and video player featuring an interview with Peter Kattuk, a Sanikiluaq hunter.



Fig. 5.4-7. Presented in an on-line video/translation player, Cornelius Nutarak of Pond Inlet, Nunavut, discusses his life-long experiences observing and hunting narwhal.

Meeting the Challenges of Local Knowledge and Data Management in the post-IPY Era

The unique interdisciplinary approach of IPY 2007–2008 and the experience of exchanging and sharing knowledge generated by Arctic residents (via ELOKA and other IPY projects) have highlighted critical needs to ensure data are well preserved and useful to a broad community. Many of these needs reach across all types of data and information, but LTK and CBM present unique challenges as well. The Arctic Council has determined community-based research to be a priority. For this research to be effective it needs to be supported with robust data management.

All data collection efforts, be they satellite missions or the gathering of oral interviews, require advanced planning to ensure the data collected are well documented, secure and useful. Professional data management should be an explicit requirement of any data collection effort. With LTK collection efforts, additional

training may be necessary to ensure ethical and effective data collection practices that capture the broad context necessary to understand the information.

Data archiving is a critical need. Agencies must support new repositories and resource centres (e.g. Inuit Tapiriit Kanatami in Canada, RAIPON in Russia) for LTK and for CBM data where appropriate archives do not exist. These archives need to collaborate with similar organizations in other countries. ELOKA can facilitate this collaboration, but ultimately there needs to be an internationally supported network of organizations providing LTK and CBM data. SAON, another IPY 2007–2008 initiative (*Chapter 3.8*), provides a logical focal point for this collaboration. There is an acute need for more research and publication on best practices on LTK data organization and presentation that captures necessary context to convey richer knowledge. Funding agencies also need to consider how open data policies can be best applied to LTK through fair but simple intellectual property agreements.

Finally, it is essential to continue and expand community-based research and collaboration. Agencies should support projects and workshops that bring together scientific researchers and community members to identify and explore integrative science questions. ELOKA work with the community of Sanikiluaq revealed several critical science questions and potential hypotheses about the Hudson Bay water cycle and food web is just one example of the potential.

Summary of Prospective Services to Northern Communities in the post-IPY Era

We understand that the development of a circum-polar network and data management services for Arctic local and traditional knowledge and community-based observations will take time, collaboration and input from many sources. Our hope is that the work begun during IPY 2007–2008 has built a strong foundation for the development of such a network and, in particular, that the work will continue. The momentum generated by ELOKA and related IPY projects has the potential to fulfill an existing need in Arctic research and to support northern communities in diverse research and heritage efforts. It has the potential to make a strong contribution to many of the IPY 2007–2008 legacy initiatives, such as SAON and ISAC (International

Study of Arctic Change) as well as to facilitate connections between local and international researchers.

Among the services to be provided to local communities in the post-IPY era, the ELOKA team has identified several activities with potentially the most tangible benefits, such as: (1) data preservation and archiving for local and traditional knowledge and community monitoring; (2) facilitation of data discovery and data distribution; (3) dynamic data presentation that seeks to maintain relevant context around the information; (4) digital mapping and community-contributed mapping and GIS; (5) assistance in developing data management plans, data collection protocols, documentation and data organization; (6) connections between local and community-based information with scientific data, including research and data products that draw on both; and (7) ‘match-making’ between scientists and Arctic communities based on research needs, interests and questions as well as facilitation and support of research collaborations.

The key condition to achieve these and other related goals in managing and sharing data from the local knowledge and community observational projects is to expand the post-IPY network of polar communities, science agencies and individual researchers. Partnerships with Arctic residents and research around knowledge and observation data sharing has made important progress, particularly, thanks to IPY. In order to become a lasting legacy, the network of community-based projects initiated in IPY 2007–2008 needs support with building collaborations across the Arctic, especially by organizations like the Arctic Council, indigenous peoples’ organizations and science funding agencies (NSF, ESF, SSHRC and others).

The University of the Arctic and the International Polar Year

Lars Kullerud and Outi Snellman

Reviewer: Volker Rachold

IPY - an opportunity, a reality and a hope?

The Board of Governors of the University of the Arctic (UArctic) decided as early as 2005 to propose the UArctic as an IPY project. From the perspective of Northern institutions, this was not an obvious choice as many were skeptical about a “southern”



Fig. 5.4-8. EALAT Reindeer Herders Workshop, Kautokeino, Norway, March 24, 2010. (Photo: Svein Mathiesen)

driven (i.e. proposed as IGY+50 – eds.) IPY 2007–2008 that could run over the interest, needs and focus of the people of the North. UArctic was also a young institution, established in 2001, as an outcome of an Arctic Council initiated process (see www.uarctic.org/compactArticles.aspx?m=75). Nonetheless, at its annual meeting in Oulu, May 2005 the Council representative forum of all UArctic member institutions voted in favour of joining the IPY program. This was due to a great extent to a convincing presentation given by Cynan Ellis-Evans on behalf of the IPY team, who explained the work towards including the human dimension into IPY 2007–2008 science program.

Already in January 2005, the UArctic submitted an Expression of Intent (Eol no. 404, *Higher Education in the International Polar Year*) to the IPO aimed to include the University as a whole as a project under the IPY program. In September 2005, a proposal “The University of the Arctic: Providing Higher Education and Outreach Programs for the International Polar Year” was submitted and shortly after it became an endorsed IPY project (no. 189). After completion, it is fair to state that being in the IPY has been a success

in engaging public interest about polar regions and in focusing research investment in polar issues.

In the years leading to the next IPY, we may assume that this IPY will be remembered for the strategic decision to include social sciences, for recognizing indigenous and traditional forms of knowledge, and for enabling the creation of strong networks. While ‘interdisciplinary’ may have been more a buzzword in many projects than a reality, this IPY also shows some outstanding examples (i.e. the EALAT project – *Chapter 3.10*; Fig. 5.4-8), where social and natural sciences as well as indigenous perspectives are fully integrated.

The UArctic has been the lead agent for IPY Higher Education in the Arctic. Even if its effort under the Project no. 189 constituted a minor portfolio among IPY activities, it is a crucial part of the IPY Legacy. Higher education is the tool to foster development of scientists and northern experts and leadership for the future, including future polar years. We therefore are proud that UArctic has grown during the IPY years into a unique and complete network of higher education institutions in the North (Fig. 5.4-9), with more than 100 members, including practically all

of the universities and colleges in the Circumpolar North and several important research institutions and indigenous organizations. Totalling over 650,000 students and some 50,000 academic staff, the UArctic provides a research network built by its members (see Table 5.4-1) and, with support from governments is ready to take on a leadership role in bringing the energy from IPY 2007–2008 into a new level and into a new era (Fig. 5.4-10).

Higher education in the North during International Polar Year

UArctic has grown steadily since its establishment in 2001. Our growth has coincided with many other important processes effecting the North. The IPY, the evolution of the Arctic Council and its working groups, the renewed geopolitical focus on the North, emerging new forms of self-governance, strengthened indigenous organizations, the emerging Arctic implementation of the UN Law of the Sea, as well as the media hype have helped UArctic and other initiatives thrive. It is, however, important to remember that this increased focus on the polar regions is fundamentally driven by many external factors like energy demand,

climate change, globalization of local economies and the like.

UArctic established an IPY Coordination Office in 2007, hosted by the University of Alaska, Fairbanks to ensure that Higher Education proposals generated outside UArctic were supported. This office, in cooperation with the UArctic Field School Office at UNIS on Svalbard, contributed significantly to national and international work of the IPY Education and Outreach Subcommittee. UArctic is particularly happy to observe the establishment of the Association of Polar Early Career Scientists, APECS (*Chapter 4.3*). As an offspring of this work by IPY and UArctic have funded and run specialized IPY field courses for International students as part of this work. UArctic also encourages the development of the International Antarctic Institute, which may over time develop into a strong sister organization of the UArctic (see below).

An important goal for IPY was to ensure increased global awareness and support to polar issues and polar research. UArctic established in 2007 the GoNorth program (www.uarctic.org/SingleArticle.aspx?m=777&amid=8836) which is a collective effort among our members to market northern study



Fig. 5.4-9. The University of the Arctic is a cooperative network of universities, colleges and other organizations committed to higher education and research in the North.

opportunities for students from outside the Arctic.

Partly influenced by our work with IPY, UArctic is now developing more focused strategies for relating to institutions in more southern latitudes. Whereas formerly UArctic's membership was only open to organizations in the Arctic eight countries, the new Associate Member category created in 2010 will enable members from outside the Arctic region to join as long as they have an interest in enhancing collaboration and fully subscribe to UArctic's values and goals. As we grow, it is important to create mechanisms that ensure that we ourselves stay true to our values: circumpolar, diverse and holistic. One of these mechanisms is UArctic's newly created post of Vice-President Indigenous Affairs.

Post-IPY Era: Ways ahead

When it comes to access to education, the North is still "the periphery" in most countries, with a gravity of education opportunities, research, development as well as business and job opportunities located mainly further south. Recent socioeconomic and resource statistics (Glomsrød and Aslaksen, 2008) demonstrates that the North contributes more to the GNP per

capita than other regions of most arctic states. IPY has done a tremendous job in increasing respect for, understanding of and interest in northern issues in the south. It remains a challenge to modify the "images of the North" so that they become something beyond "the frontier".

The UArctic was created before IPY 2007–2008 with the purpose to take the lead to provide stewardship for a sustainable long-term legacy in higher education and research cooperation in the Circumpolar North. We strongly believe that a well-educated northern population and strong northern research networks will foster leadership for the next IPY. Further, UArctic is committed to ensuring that the northern universities and colleges become key players in the development of research and sharing knowledge in and about the North, and that such knowledge is based on indigenous and local traditional approaches as well in modern science.

UArctic would like to do this in close cooperation with the global polar research community, in particular with major polar science organizations like IASSA, IASC and SCAR. This is another legacy of many new partnerships built during the IPY years.



Fig. 5.4-10. UArctic member institutions have been extensively involved in projects of the International Polar Year. This map shows the relative number of projects each member is involved in.

IPY 2007–2008 grassroots approach to define key projects and research issues demonstrated an impressive openness within the science community. Governments and science organizations have also had ample opportunity to influence the priorities of IPY. People living in the Arctic, both indigenous as well as other northerners and their leaders, were rarely informed of the IPY process during its early formative years, 2002–2004, and generally have not been engaged to formulate its research priorities. It remains a challenge for the Arctic science organizations, including IASC and IASSA, as well as UArctic to ensure that the science community will not monopolize the right to define research agenda in the North for the next IPY.

The biggest disappointment of this IPY may be the lack of coordination between various funding agencies. Even if there have been some well meant attempts, the general picture is that funding is nationally prioritized and is only modestly linked to the implementation of projects across the national borders. UArctic view, shared clearly by key actors

such as the Nordic Council of Ministers, IASC and IASSA is that this problem can best be addressed through a concerted collaboration of the Ministries responsible for the funding of science and education in the either Arctic Countries.

Nevertheless, as we wait for the circumpolar funding instruments to be in place for the next IPY, we have also learned other lessons about the funding instrument during this IPY. As funders tend to focus the bulk of the funding on large programs and huge projects it has become harder and harder for smaller partners—and often the Higher Education Institutions in the North are small—to find their place at the table. The necessary step is the wish to be inclusive. If diversity, balance in representation and inclusiveness are seen as important aspects of quality, these adjustments will also become obvious requirements to future polar research as we plan for the post-IPY era and for the future IPY.

Table 5.4-1:
UArctic Members
and Students'
Participation in IPY
Projects, by major
Arctic nation.

	Number of partners to IPY projects	Number of UArctic members among the partners	UArctic members (%)	UArctic members part of national total higher education student mass	UArctic members relative popularity as IPY project partner	Part of UArctic members in each country that do have IPY participation	Part of UArctic members self identify as Indigenous with IPY participation
Canada	513	95	19	18.7 %	1.0	32 %	25 %
Denmark	235	16	7	3.7 %	1.8	75 %	100 %
Finland	101	47	47	34.2 %	1.4	40 %	50 %
Iceland	42	8	19	29.9 %	0.6	80 %	
Norway	365	101	28	8.9 %	3.1	35 %	50 %
Russia	303	16	5	1.3 %	4.1	19 %	17 %
Sweden	191	85	45	22.3 %	2.0	100 %	
U.S.A.	804	141	18	.009 %	194.9	38 %	0 %
International	36	9	25			50 %	100 %

Number of IPY partners by country based on the IPY IPO database of almost 3800 partners in 172 IPY endorsed projects that have Arctic or bipolar focus (Antarctic excluded) and partial or substantial funding. The popularity of UArctic members relative to all universities and colleges in the country is estimated based on total number of university level students in the country (UNESCO, 2007 data) and the number of students as reported by the UArctic members in the UArctic annual survey. The factor indicates that UArctic members are more active in IPY projects than average in most of the Arctic eight countries. In spite of this, in most countries less than half of UArctic members have partnership in any IPY project. UArctic members that self identify as Indigenous (often small organizations) seem to have same popularity as IPY partners as other members. It must be noted that these statistics do not indicate anything about size of the engagement, only whether a researcher from an institution is listed as a partner in the IPY project database.

The International Antarctic Institute and the International Polar Year

Patti Virtue

History of our partnership with IPY

At the very beginning, during our 'dreamtime' in late 2004, it was proposed that IPY would be the platform upon which to launch the International Antarctic Institute (IAI) (Fig. 5.4-11). We were indeed launched upon this wonderful platform and, with the help and guidance of many organizations, we came into being in 2006 with our constitution adopted in 2008. IPY was an opportunity to establish the IAI and to build a legacy for Antarctic education into the future. The IPY Joint Committee endorsed our proposal to establish the IAI (Eol no. 415) and, together with the University of the Arctic, we were identified as potential lead players in Education and Outreach. This gave us great impetus to grow and evolve as we continue to do so in the footsteps of the University of the Arctic. We may not have been a big player in IPY, but IPY was a big part of us, and will continue to be through the collaborations, connections and friends we made throughout 2007–2008.

The need for international training in polar research

By international agreement, the Antarctic continent has been set aside for peace and scientific collaboration. As has been seen over the past half-century, and as evidenced through IPY, international cooperation is the key to the success of large-scale research programs in Antarctica and the Southern Ocean. With climate change now accepted as being a result of human influence, the importance of understanding the role of polar regions on climate mechanisms needs to be part of global education. The delivery of knowledge and information to the next generation of researchers and policy-makers needs to address sustainable resource management, climate impacts and other global environmental and social issues associated with Antarctica and the Southern Ocean. In addition to traditional disciplines, it is important to provide opportunities for students during their formal training to look beyond their home borders. We need to educate our students to be open and receptive to different ways of thinking, of researching and of viewing the world.

The International Antarctic Institute was estab-

lished during IPY as an educational and research platform for all nations, facilitating cooperation and collaboration among member institutes. This platform was built on existing international research and educational programs concerning Antarctica and the Southern Ocean, using recognized skills and expertise within the IAI network. The IAI is governed by a council comprising a person appointed by each participating Institution. The main focus of the IAI is to enhance interdisciplinary studies in relation to Antarctica, the Southern Ocean ecosystem and global climate understanding. Our aim is to cross-credit study programs, develop joint curricula, and share teaching, educational, and other resources and facilities. Together we offer multi-disciplinary and multi-institute courses and units of study. A certain number of places in these courses are allocated for IAI students from partner universities with no associated tuition fees. Students maintain enrolment at their home university and can undertake either course work or research projects at other IAI member universities.

Our Goals

The goals of the IAI, now a consortium of 20 institutes representing 13 countries⁴ are to:

- Develop and provide students with international opportunities in Antarctic education that will enable them to become expertly trained scientists and social scientists with international experience and skills in research and its application.
- Deliver the knowledge and information needed by the next generation of researchers and policy-makers to address sustainable resource management, climate impacts and other global environmental and social issues associated with Antarctica and the Southern Ocean.
- Facilitate the engagement of the international scientific community in Antarctic and Southern Ocean education.
- Extend existing national teaching bases in Antarctic education into the international arena.

IAI activities during IPY 2007–2008

Throughout IPY, we focused on developing new and innovative Antarctic courses, developing effective ways to share teaching resources among partner universities and developing clear articulation of

pathways between degrees to encourage student and staff mobility. We have developed and implemented programs and activities in three key areas: courses and units of study, Masters degree programs, and field opportunities for students. Recently, new Masters programs were developed with a focus on Polar Marine Biology, Chemistry and Glaciology. We have facilitated student exchanges both to undertake courses and research. Some of the exchanges have allowed students to carry out research on the Antarctic continent and participate in Southern Ocean oceanographic research expeditions.

During IPY we developed a UNESCO/Cousteau Chair under the IAI umbrella organization. Through graduate student training programs and global research programs, the Chair hopes to facilitate the bringing together of nations, including countries with strong Antarctic research programs and non-traditional Antarctic research countries. The Chair will serve to bridge scientific and social disciplines to facilitate a better understanding of global issues that affect the Antarctic region.

Post-IPY: Future Development for IAI

Key priorities for the IAI in the coming years include expanding our course offerings to cover physical and geosciences. We are currently developing courses focused on the social sciences, such as Antarctic law and policy, as well as multidisciplinary on-line modules in Antarctic Science offered as a distance option to partner universities. Under the UNESCO/Cousteau Chair we hope to encourage non-traditional Antarctic research countries to join the IAI which will require concerted effort and substantial funding. As we continue to foster the next generation of polar researchers through international collaboration, we hope to work more closely with APECS and UArctic. The goals of our organisations are complementary and this was recognized through the signing of a joint MOU during the Oslo conference. Together the IAI, APECS and UArctic as partners, have enormous synergistic potential, yet to be realised.



Fig. 5.4-11. Inaugural IAI meeting in Hobart, 2004.

(Courtesy: Patti Virtue)

'Dreamtime'

The 'dreamtime' forms a part of Australian aboriginal history, although a complex philosophy, it is a special time when birds got their colours (except the bad tempered crow)⁵, when sacred places were created, when law and custom were developed. It is a period of fashioning, organising and moulding the past to the present and into the future (Dean, 1996). Perhaps IPY 2007–2008 was our 'dreamtime', when the sciences danced with humanities, when the research community embraced education for the future of the Arctic and Antarctica.

Box 1 International Ocean Institute (IOI) promotes objectives of IPY 2007–2008

Iouri Oliouline

Since the announcement of IPY 2007–2008, the International Ocean Institute (IOI – www.ioinst.org/), a non-governmental organization located in Għabra, Malta, demonstrated its interest in supporting the IPY objectives, particularly via information sharing, training and educating new constituencies. The IOI was founded in 1972 by Prof. Elisabeth Mann Borgese, as an international knowledge-based institution, devoted to the sustainable governance and peaceful use of the oceans. In 2004, Yuri Olyunin, former IOI Director, was invited to share with the IPY organizers his experience in coordinating the International Year of the Oceans held in 1998. In March 2005, the IOI representative took part in the first IPY Open Consultative Forum in Paris. IOI expressed its readiness to provide its network, experience and knowledge for contributing to the IPY efforts.

IOI's main contribution to IPY was via hosting the *Pacem in Maribus* Conference (PIM) in 2007 in Malta under the title "Waves of Change: Women, Youth and the Sea, Partnering for the Protection of the Marine Environment and the Sustainable use of its resources." A group of experts on polar issues, including David Carlson, Eduard Sarukhanian, Angelika Renner and Claudia Halsband-Lenk, gave presentation at the special session dedicated to the issues relevant to IPY.

Training programs on ocean governance organized by IOI in Canada and in Malta in 2007–2009 were enriched by the series of lectures dedicated to IPY. IOI annual *Ocean Year Book* volumes 23 (2009) and 22 (2008) featured several chapters on change, biodiversity, fishing and legal aspects of governance in the polar regions. These and other IOI activities relevant to IPY provide a good example of the NGO potential in promoting a multi-faceted global science program.



References

References for Indigenous Stakeholders

- ACIA, 2005. Arctic Climate Impact Assessment. Impact of a Warming Arctic. Cambridge: Cambridge University Press.
- Gofman, V., 2008. "Indigenous Organizations in the Arctic Council". Northern Research Forum, Proceedings from the 5th Open Assembly, Anchorage, U.S. www.nrf.is/images/stories/pdf/anchorage_2008/proceedings/plenary_papers/5th_nrf_anc_2008_gofman_indigenous_organisations_arctic_council.pdf.
- Gofman, V. et al., in prep. Community-based Monitoring in the Arctic: CBM Hand Book. *CAFF CBMP Report* No. 21, CAFF International Secretariat, Akureyri, Iceland.
- Huntington, H. and S. Fox, 2005. The Changing Arctic: Indigenous Perspectives. In *ACIA: Arctic Climate Impact Assessment*. Cambridge: Cambridge University Press: pp. 61–98.
- Monastersky, R., 2009. International Polar Year: the Social Pole? www.nature.com/news/2009/250209/full/4571077a.html Published online 25 February 2009 | *Nature* 457, 1077–1078 (2009) | doi:10.1038/4571077a.

References for the International Antarctic Institute (IAI)

- Dean, C., 1996. *The Australian Aboriginal dreamtime: an account of its history, cosmogenesis, cosmology and ontology*. Gamahucher Press, Geelong, Victoria, Australia.

References for Exchange of Local Knowledge

- Huntington, H.P. and S. Fox, 2005. The Changing Arctic: Indigenous Perspectives. Chapter 3 In *Arctic Climate Impact Assessment* (ACIA). Cambridge University Press: pp. 61–98.
- Krupnik I., C. Aporta, S. Gearheard, G. Laidler and L. Kielsen Holm, (eds), 2010. *SIKU: Knowing Our Ice: Documenting Inuit Sea-Ice Knowledge and Use*. Springer.
- Krupnik, I. and D. Jolly, (eds), 2002. *The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change*. Fairbanks, Alaska: Arctic Research Consortium of the United States. xxvii + 356p.
- Riewe, R. and J. Oakes, (eds), 2006. *Climate Change: Linking Traditional and Scientific Knowledge*. Aboriginal Issues Press, University of Manitoba.

References for the University of the Arctic

- Information about UArctic and its programs is available www.uarctic.org.
- Glomsrød, Solveig and Iulie Aslaksen, eds. 2008. *The Economy of the North* 2008. Oslo: Statistics Norway www.ssb.no/english/subjects/00/00/30/sa_economy_north/.

Notes

- ¹ The town of Kautokeino in the heart of the Sámi territory had a special role in IPY history as the site of one of the first IPY observation stations in 1882–1883 (*Chapter 1.1, 2.10*).
- ² 1996, Ottawa, Declaration on the Establishment of the Arctic Council.
- ³ Based upon recent count from the IPY project chart.
- ⁴ www.iai.utas.edu.au
- ⁵ www.okulture.com/Black%20Opal/index-19.html



5.5 IPY and Expanding Partnerships in Coordination of Polar Research

Lead Authors:

Volker Rachold, Igor Krupnik and Colin Summerhayes

Contributing Authors:

Paul Cutler, Leslie Malone, Helena Ödmark, Manfred Reinke and Eduard Saruchanian

IPY Legacies: Scientific and political cooperation

Owing to the common interest in polar science during IPY, the links between science and the political frameworks provided by the Antarctic Treaty System and the Arctic Council have been strengthened. The heightened level of political attention and financial support has enhanced opportunities for direct international scientific collaboration, facilitated polar access and effective international sharing of polar logistical assets and infrastructure, accelerated the exchange of technological information and improved reporting from nationally supported operational networks. It has also increased connections and collaboration among polar science organizations, such as SCAR and IASC, as well as with non-polar science organizations. As a result, the findings of IPY science have attracted both the interest and the support of the Antarctic Treaty nations and the Arctic Council.

(The State of Polar Research, 2009, p.8-9)

One important outcome of IPY 2007–2008 was the advancement of existing partnerships and the development of new ones. The cornerstone for IPY was the partnership between its two main sponsors, the International Council for Science (ICSU) and the World Meteorological Organization (WMO) that started more than 50 years ago with the implementation of the International Geophysical Year 1957–1958. The collaboration between ICSU and WMO, again, emerged as the main driving factor in the planning and organization for this IPY (*Chapters 1.2, 1.3, 1.5*).

Nonetheless, the new IPY was born and implemented thanks to the collective efforts of many organizations, including the Scientific Committee on Antarctic Research (SCAR), International Arctic Science Committee (IASC), Intergovernmental Oceanographic Commission (IOC), Arctic Ocean Sciences Board (AOSB), World Climate Research Programme (WCRP), European Polar Board (EPB), Arctic Council (AC), Antarctic Treaty Consultative Meeting, International Arctic Social Sciences Association (IASSA) and many more (*Chapter 1.4*). These networks of new relations or of

strengthened established ones will define the future of polar research for decades to come and may serve the model for the future planners of the next IPY.

This Chapter covers only a fraction of these new or advanced partnerships forged during IPY as an important element of the legacy of IPY. The first part deals with linkages between and among the key scientific bodies that were instrumental to IPY and will almost certainly define its legacy in the post-IPY era, i.e. ICSU, WMO, SCAR and IASC. IPY 2007–2008 was clearly a major peak in ICSU-WMO relationship and it ushered in a totally new level of collaboration between the two major polar science organizations, the Scientific Committee on Antarctic Research (SCAR) and the International Arctic Science Committee (IASC). The second part of this chapter deals with the science/policy interface, first and foremost, with the AC and the AT/ATCM collaboration. Due to the heightened level of political attention to the role of polar science in climate research during IPY (and, generally, over the past decade), the awareness of the need for scientific input to underpin political deliberations in the framework of the Antarctic Treaty System (ATCM) and the Arctic

Council (AC) increased significantly. Some prospects of this more active engagement of intergovernmental political bodies in science and science planning, particularly with regard to the next major post-IPY Conference (*From Knowledge to Action*) in 2012, will be covered in more detail in *Chapter 5.6*.

Future ICSU and WMO Engagement in Polar Research

Lead Authors: Paul Cutler and Eduard Sarukhanian

Contributing Author: Leslie Malone

International Council for Science (ICSU)

ICSU is a strategic organization that works on international science cooperation, universality of science and the science-to-policy interface. ICSU acts on behalf of its members¹ through the international, interdisciplinary programmes it plans and (co)sponsors. IPY 2007–2008 was one such program; now that IPY is over, this is how ICSU envisions its continued engagement in polar research.

The starting point is to emphasize that IPY is not the only program with polar dimensions that ICSU sponsors. The Scientific Committee on Antarctic Research (SCAR) is another example, as is the World Climate Research Programme (WCRP) with its Climate and Cryosphere (CliC) project. ICSU has among its members the International Union of Geodesy and Geophysics with its International Association on Cryospheric Sciences. Furthermore, the International Arctic Science Committee (IASC) is a Scientific Associate of ICSU.

These and other ICSU-related entities were boosted by IPY 2007–2008 and all will engage in the future of polar research. The challenge is to do so efficiently and effectively. The planning and implementation of IPY certainly helped with this challenge; IPY fuelled, for example, development of cooperative agreements among the aforementioned groups as well as new joint initiatives like the SCAR-IASC bipolar action group (see below). More fundamentally, IPY illustrated the benefit of international cooperation in polar research and highlighted the value of multidisciplinary approaches, and of inspiring and engaging educators, communicators and early career scientists. These lessons are being captured in ICSU through the ongoing work of polar-related organizations in the ICSU network and by involvement of IPY “veterans” on new, related ICSU initiatives. In the remainder of this section,

we describe two such major initiatives that should add to the momentum IPY 2007–2008 generated for international polar research.

Polar Research as Integral to ICSU Earth System Research Agenda

A theme of IPY 2007–2008 and the 2010 IPY Oslo Science Conference was “Polar Science: Global Impact.” One needs to look no further than the array of IPY science in this volume to appreciate this global impact and to be reminded that polar research is a fundamental component of Earth system research, which has a long history within ICSU. Yet, it is probably fair to say that ICSU-sponsored polar bodies have not been as directly engaged as they could or should have been with the four ICSU-sponsored Global Environmental Change programmes.²

In October 2008, ICSU initiated a “Visioning Process” (www.icsu-visioning.org/) for Earth system research that was motivated by the urgencies of global environmental change and the need for a holistic research strategy among the multitude of international programs, projects and partnerships. By contributing to the Visioning Process and the Earth system research agenda that should follow, the polar research community influences and engages in ICSU’s major thrust in Earth system research over the next decade. The onus is on ICSU to create and highlight opportunities for engagement in this process and its outcome. Taking a lesson from IPY on engagement of early career scientists, ICSU asked the IPY-initiated Association of Polar Early Career Scientists to nominate a participant for the initial “visioning” workshop in September 2009 and ensured that roughly one third of workshop participants were early-career scientists. An equal responsibility lies with the polar research community and its organizations (whether ICSU-affiliated or not) to be proactive in this Visioning Process and subsequently to take ownership of relevant elements of this new initiative that will emphasize the research needed to address the grand challenges of global sustainability.

Polar Research Underpinned by Effective Data Management

IPY 2007–2008 tested the ICSU-sponsored World Data Centers and found them, and many other facets of the data management process, wanting (*Chapter*

3.17). In October 2008, ICSU launched the World Data System (WDS) to begin to improve this situation that also prevails beyond polar data circles. Lessons and ideas from the IPY are influencing the development of WDS; improving polar data archiving is one of the early WDS implementation actions.

ICSU overall strategy toward polar data is further supported by its seed grant to a number of ICSU-affiliated polar organizations investigating the Polar Information Commons (PIC). In parallel, ICSU is examining the role of the “Commons” approach in data management in general; this study will both learn from and highlight PIC’s work.

ICSU Outlook

Strategic development of Earth system research and data management is by no means the only ICSU focus that should benefit polar research in the long term. One could, for example, mention ICSU’s sponsorship of global observing systems or ICSU’s role in promoting the principle of Universality of Science that underpins the conduct of all science (see www.icsu.org/Gestion/img/ICSU_DOC_DOWNLOAD/3245_DD_FILE_Polar_Universality_statement.pdf). One could also note ICSU sponsorship of the 2012 IPY Montreal “From Knowledge to Action” conference (*Chapter 5.6*).

Nevertheless, listing activities distracts from the simple message ICSU wishes to convey in this Summary: ICSU foresees strong ongoing engagement with the polar research community, particularly in the context of Earth system research. This will be built on the shoulders of the polar organizations invigorated by IPY and in collaboration with many partners in its implementation, especially WMO. For its part, ICSU will regularly assess progress and opportunities for enhancement. In addition, ICSU will work on key pillars that support polar science, including international data management, universality, observing systems, international coordination of funding, and public and policymaker awareness of science. For their part, polar researchers and their organizations should test and push ICSU on these many fronts—raising ideas, opportunities and challenges with ICSU’s planning and decision-making organs—so that polar science continues to push the envelope on international, interdisciplinary science cooperation after IPY 2007–2008 is

completed and at this critical juncture in the evolution of the Earth system.

World Meteorological Organization (WMO)

WMO is an intergovernmental organization that initiates and supports international research to enhance the ability of its Members³ and their National Meteorological and Hydrological Services (NMHS) to improve observations of weather, climate, water and environment, and, as a result, improve prediction, service delivery, and scientific assessments of regional and global environmental conditions. In order to ensure the best policies to protect the ozone layer, reduce the effects of the long-range transport of air pollution, and to cope with climate change and variability, the WMO-sponsored research and scientific assessments provide support to relevant international environmental conventions and related protocols concerning, *inter alia*, ozone-reducing substances, climate change, desertification and combating drought. The WMO Commission for Atmospheric Sciences (CAS), the WMO Commission for Climatology (CCI), the Joint WMO/IOC Commission for Oceanography and Marine Meteorology, and the Joint Scientific Committee for the WCRP assist Members’ research through the CAS World Weather Research Programme (WWRP), including The Observing System Research and Predictability Experiment (THORPEX), the Global Atmosphere Watch Programme on atmosphere chemistry (GAW), the CCI Climate Information and Prediction Services (CLIPS) project and through WCRP-affiliated major projects (GEWEX, CLIVAR, CliC and SPARC).

IPY 2007–2008 is a highlight of WMO research leadership and partnership. Indeed, WMO, through the NMHSs and its Commissions, substantially contributed to the IPY research and observations in the areas of polar meteorology, oceanography, glaciology and hydrology. Ultimately, the intensive campaign of internationally coordinated IPY scientific research and observations has significantly contributed to the enhancement of the WMO observational networks in Polar Regions: a better understanding of physical processes; improvements in the use of observations, modelling and prediction in Polar Regions; and better knowledge of the role of environmental changes in sustainability and well-being of Arctic communities. To coordinate WMO activities in Polar Regions in post-IPY era, the Executive Council

established in June 2008 the Panel on Polar Observations, Research and Services (EC-PORS; see www.wmo.int/pages/prog/www/Antarctica/antarctic.html).

Development of polar prediction system

WMO recognizes that the needs of users for weather, climate, hydrological and other environmental services are constantly increasing in changing polar environments, and that services will be in great demand for users including shipping and navigation industries, platforms, search and rescue and other emergency response operations, infrastructure development, overland transportation, hydro-power production and polar science logistics management. To meet these requirements, an important task for WMO in the near future will be to design and develop polar prediction system based on IPY scientific advances. This will require effective collaboration across the NMHSs and relevant WMO Commissions as well as with other partners. The CAS at its fifteenth session (November 2009) recommended the establishment of a THORPEX Polar Research project to improve understanding of the impact of polar processes on polar weather, assimilation of data in Polar Regions and prediction of high-impact weather over Polar Regions (www.wmo.int/pages/prog/arep/cas/index_en.html). At its first session (October 2009) the EC-PORS recommended that efforts be made to advance prediction for polar weather and climate and to extend efforts to snow, ice, carbon and ecosystem modelling and analysis. This would also require the involvement of relevant WMO Commissions and Programs as well as WCRP.

Working towards Climate Outlook Forums for Polar Regions

Despite the interest in and increasing need for long-range forecasts (months to several years) and climate prediction (beyond two years), there is not the same level of predictability in the polar regions as is realized in temperate and tropical latitudes. WMO recognizes the need to determine user requirements for forecasts and prediction, and to develop the requisite prediction capabilities to meet the needs for short and longer term products in the Polar Regions. Considering the extent and rapidity of climate and environmental changes with a profound effect on polar (and indeed global) peoples, WMO, in collaboration with WCRP, is

working to extend the Climate Information and Prediction Services (CLIPS) concept to Polar Regions by establishment of Polar Climate Outlook Forums (PCOF). This idea was proposed by the WMO/WCRP/IPY Workshop on CLIPS in Polar Regions held in St. Petersburg in September 2008 (www.wmo.int/pages/prog/wcp/wcasp/polarclips.html) and supported by EC-PORS-1 and CCI-XV (February 2010). PORS-1 recognized the role of PCOF as a core mechanism for promotion of climate products and services to users within the Global Framework for Climate Services established by countries and agencies at the World Climate Conference-3 (September 2009), and recommended: (i) a survey to assess user requirements and (ii) development of polar climate “statements” by the PCOF. Polar Climate Outlook Forums could be considered to accompany the Trans-Regional Climate Centre evolution currently being developed in WMO, providing a regular international collaboration between climate service providers and user representatives with interests in the 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 climate providers and users. The PCOF concept has been recognized as a WMO legacy of IPY 2007–2008 and as a potential contributing mechanism to the WMO Global Cryosphere Watch (GCW) that represents a third stream of WMO future activities related to polar research (a detailed description of GCW initiative is given in *Chapter 3.7*)

WMO Outlook

The outcomes of IPY 2007–2008 offer benefits to all WMO Programs by generating comprehensive datasets and authoritative scientific knowledge to ensure the further development of environmental monitoring and forecasting systems, including severe weather prediction and the assessment of climate change and its impacts on polar environment and circumpolar communities. Beside the aforementioned WMO scientific initiatives, other WMO projects focused on polar research, such as studies of atmospheric chemistry, ozone depletion, and hydrology and water resources that will continue in the next years. Consequently, the WMO Executive Council at its sixtieth session (June 2008) recognized the unique opportunity for WMO, in consultation with ICSU and other international organizations, to consider the launch of



Fig. 5.5-1. From left, Thomas Rosswall (then ICSU Executive Director), Albert II, Prince of Monaco and Michel Jarraud (WMO Secretary-General) at the IPY Opening Ceremony, March 2007.

(Photo: Palais de la decouverte / C. Rousselin)

an International Polar Decade as a long-term process of research and observation in the Polar Regions to meet requirements for climate change studies and prediction in order to address societal needs (*Chapter 5.6*).

Strengthening ICSU and WMO partnership in polar research in the post-IPY era

The story of ICSU and WMO partnership began more than 50 years ago when both organizations successfully implemented International Geophysical Year 1957–1958 (*Chapter 1.1*). A subsequent collaboration was the successful realization of the First Global Atmosphere Research Program (GARP) Global Experiment in 1979 and, as a consequence, the establishment in 1980 of WCRP (the IOC joined later as the third sponsor of WCRP – *Chapter 1.4*). A new era of active partnership between ICSU and WMO began in the 1980s after the decision of the Second World Climate Conference (1979) to establish the Global Climate Observing Systems (GCOS), Global Ocean Observing System (GOOS) and Global Climate Terrestrial System (GTOS). All of these systems continue today and are co-sponsored by ICSU and WMO as well as, for some of them, IOC, FAO and UNEP.

The foundation of ICSU-WMO cooperation that has accumulated over the last 50 years ensured a strong collaboration on IPY 2007–2008 (see Fig. 5.5-1). In the post-IPY era, and in addition to the many activities de-

scribed above, both organizations will continue their joint efforts towards development of intensive polar research through co-sponsorship of programs like WCRP which, through its projects, contributes to work on polar climate predictability, climate model development and prediction, ozone in the stratosphere, cryospheric and hydrological processes in the terrestrial Arctic, and sea-ice observations and research. Regarding the global observing systems, the analysis of their existing capabilities and of the observational advances made during IPY 2007–2008 suggests a possibility of greatly improving the availability of observational data on the state of the atmosphere, ocean, hydrosphere and cryosphere in Polar Regions in coming years. The development and maintenance of the IPY legacy observing initiatives (*Part 3*) would lead to reinforcement of existing global observing systems to fill gaps in coverage.

Many new and ongoing partnerships will be needed among IPY 2007–2008 legacy observing initiatives and international organizations to: (i) reinforce observations of the polar atmosphere and hydrological cycle by development of SAON and an Antarctic meteorological network; (ii) fill gaps in polar oceans observations through iAOOS and SOOS development; (iii) provide substantial input to further development of GOOS (sea ice observations) and GTOS (hydrologi-

cal cycle, permafrost, ice sheets, glaciers) through the establishment of the GCW; and (iv) provide better services to many new stakeholders invigorated by IPY 2007–2008, including Arctic residents and indigenous communities across the polar regions and beyond.

New Partnership between SCAR and IASC

Volker Rachold and Colin Summerhayes

Background to the Partnership

The SCAR Executive Committee meeting in Brest, France on 11–15 July 2003 (*SCAR Bulletin 152, 2004*) recognized the importance of the Arctic Science Summit Weeks and the interest of having a formal SCAR representation at such meetings. It was decided to approach IASC to request formal representation at their meetings, with a reciprocal invitation to IASC to be represented at SCAR meetings.

At the next SCAR Executive Committee meeting, in Bremerhaven, on 21 January 2004 (*SCAR Bulletin 154, 2004*) it was proposed that an outline document for a program on the cryosphere and the polar regions including potential links with IASC be developed. A first meeting to take these links forward was held between the SCAR Executive Director and IASC Executive Secretary in the margins of the IPY Joint Committee Meeting (JC-1) in Paris in March 2005. A draft agreement between SCAR and IASC was discussed at the SCAR Executive Meeting in Sofia, Bulgaria, 11–13 July 2005. The SCAR Executive Committee approved the idea of creating a partnership with IASC (*SCAR Bulletin 159, 2005*) and encouraged participation of an IASC representative in the SCAR Open Science Conference and Delegates Meeting in Hobart in 2006.

Discussions between SCAR and IASC were developed with a view to improve collaboration in areas of common interest, hold a joint SCAR-IASC forum in association with SCAR's proposed 2008 meeting in St Petersburg and consider the implications of IPY. Given that both bodies have polar interests and both are associated closely with ICSU (SCAR as one of ICSU's Interdisciplinary Bodies and IASC as an International Scientific Associate of ICSU), there were strong grounds for supposing that a closer linkage between the two organizations should bring benefits to both parties, not least in an exchange of views and experience on

important scientific topics. A SCAR and IASC Letter of Agreement was developed and duly signed in July 2006 (www.scar.org/about/partnerships/iasc, *IASC Bulletin 06/07*). Through it, SCAR and IASC agreed to combine their efforts in selected fields and activities (to be decided by mutual agreement) so as to raise the level of impact of both organizations in terms of making scientific advances and of advising policy-makers (e.g. of the likelihood and likely effects of climate change) as well as to avoid duplication. The IPY event was an important driver for the two organizations coming together, though not the only one. The partnership would have developed anyway, but the arrival of IPY provided added impetus and the desire to accomplish something within the IPY time frame. It also 'forced' SCAR and IASC to address what to do about the IPY legacy that they would together inherit as the existing polar science infrastructure organizations.

Under the Letter of Agreement, SCAR and IASC agreed:

- (i) To invite each other to attend the meetings of their major bodies (SCAR Delegates' Meeting and IASC Council).
- (ii) To encourage appropriate linkages between the relevant existing SCAR and IASC scientific projects.
- (iii) To encourage their scientific communities to develop joint bipolar projects and approaches in appropriate fields.
- (iv) To work together in arranging workshops, conferences and reports on topics of mutual scientific interest.
- (v) To exchange ideas on best practices in data and information management.
- (vi) To exchange newsletters and advertise each other's newsletters and web sites on their own web sites.
- (vii) To develop combined approaches to communicating with the wider community on the significance of polar research to find solutions of societal issues, including their respective experience in giving advice to the Arctic Council and Antarctic Treaty Consultative Meeting.

Since then, SCAR has regularly attended IASC Council meetings and Arctic Science Summit Weeks, and IASC has attended SCAR Executive Committee and Delegates meetings as well as meetings of SCAR's Cross-Linkages Group.

Key developments during IPY

In January 2008, SCAR and IASC created a joint Bipolar Action Group (BipAG) charged with advising SCAR and IASC management bodies on further possible linkages, and developing and managing the IPY Legacy (see below). SCAR and IASC began to co-sponsor the biennial High Latitude Climate meetings that take place every two years or so (the first jointly sponsored workshop was held in Seattle, U.S.A. October 2007). SCAR and IASC also co-sponsored an ice-sheet modelling workshop in St Petersburg (July 2008) and, with funding from ICSU and NSF, subsequently co-sponsored its follow up, an ice sheet modelling summer school (Portland, Oregon, August 2009).

From July 2008, SCAR and IASC both co-sponsored with WCRP the Climate and Cryosphere programme (CLiC) and in July 2008 they also co-signed a Letter of Agreement with the new International Association of Cryospheric Sciences (IACS). In March 2009, they co-signed a Letter of Agreement with the International Permafrost Association (IPA). These agreements effectively bind together the five main polar bodies of ICSU (IASC Bulletin 07/08, IASC Bulletin 08/09).

IASC continues to participate in the process towards Sustaining Arctic Observing Networks (SAON) and SCAR is observing this process to develop something along the lines of a "Pan-Antarctic Observing System". If SAON and "PantOS" can be made to develop as in-

tended and attract funds, together they will provide an observing system legacy for the IPY. Both organizations are encouraging the development of the ocean observing systems called for by IPY (an international Arctic Ocean Observing System (iAOOS) and a Southern Ocean Observing System (SOOS) – Chapters 3.2 and 3.3. These will be either stand-alone systems or parts of SAON and "PantOS". The polar ocean observing systems will make complementary contributions in the post-IPY era and are considered essential operational requirements by WMO.

SCAR and IASC worked closely together as members (*ex officio*) of the IPY Joint Committee (2005–2010). The two organizations jointly sponsored the Open Science Conference in St Petersburg, Russia (8-11 July 2008), which was adopted and co-sponsored by ICSU and WMO as the 1st IPY conference (see Figs. 5.5.2-4). The full program and the summary report of the meeting are available (Klepikov 2008; www.scar-iasc-ipy2008.org/; <http://icestories.exploratorium.edu/dispatches/welcome-to-the-scar-iasc-ipy-open-science-conference/>). As a contribution to the development of a data and information management policy for IPY, the Chief Officer of SCAR's Data and Information Management Committee, Taco de Bruin, served as Co-Chair of the IPY Data Subcommittee. Independently, data management had been on the agenda of SCAR and COMNAP (Council of Managers of National Antarctic Programs)



Fig.5.5-2. Joint SCAR-IASC IPY 'Open Science' Conference, St. Petersburg, July 2009. From left to right: Khotso Mokhele (ICSU Vice President), Eduard Sarukhyan (WMO), Kristján Kristjánsson (then IASC President), Chris Rapley (then SCAR President) and Artur Chilingarov (Russian Duma, Co-Chair of the Russian national IPY committee).

(Photo: Alexander Klepikov)

Fig.5.5-3. In the hallways of the SCAR-IASC conference in St. Petersburg, July 2008. Left to right: Kristján Kristjánsson (then IASC President), Chuck Kennicutt (newly elected SCAR President) and Jenny Baeseman (APECS Executive Director).
(Photo: Alexander Klepikov)



and in 2004, SCAR had recognised the need to develop a Data and Information Management Strategy for the Antarctic, seeing this as an essential first step to managing the IPY data legacy in the southern hemisphere. The strategy was approved by SCAR Delegates at their meeting in St Petersburg (2008) and an Implementation Plan is now being developed. SCAR is advising IASC on the development of approaches to data and information management to enable both organisations to contribute to managing the IPY data legacy.

The Joint IASC/SCAR Bipolar Action Group (BipAG)

BipAG was created for two years in January 2008. It met in St Petersburg on 8 July 2008 and in Oslo, on 15-16 October 2009. Members include Heinz Miller (Germany – glaciology, (Chairman), Nick Owens (U.K. – oceanography), Bryan Storey (NZ – geology), Wayne Pollard (Canada – permafrost and geomorphology), Fridtjof Mehlum (Norway – terrestrial biology), Hui-gen Yang (China – upper atmosphere physics), Elena Andreeva (Russia – social sciences), Sue Moore (U.S.A. – marine mammals), Chris Rapley (SCAR EXCOM rep), Volker Rachold (IASC Secretariat), Colin Summerhayes (SCAR Secretariat) and Jenny Baeseman (APECS)

BipAG has two main terms of reference:

- (i) To advise the SCAR and IASC Executive Committees on the development of instruments such as workshops, programs and networks to address bi-

polar issues (i.e. the first priority is to see how and where we could work more closely together).

- (ii) To advise the SCAR and IASC Executive Committees on the development of mechanisms to nurture the IPY 2007–2008 legacy, with a special focus on the roles of IASC and SCAR.

The reports of the BipAG meetings are available on SCAR's IASC partnership website (www.scar.org/about/partnerships/iasc/bipag.html). In 2010, SCAR and IASC will consider whether or not to continue BipAG and, if so, in what form.

IPY Legacy Developments

As the existing polar coordination structures, SCAR and IASC are positioning themselves to take a prominent role in ensuring the IPY legacy. SCAR and IASC have focused on four key aspects: (i) scientific cooperation; (ii) development of observing systems; (iii) data and information management; and (iv) development of early career scientists (the next generation).

SCAR's data and information management system will ensure better management and more effective exchange of data and information. As part of post-IPY data management, ICSU, through a coalition led by CODATA and including SCAR, IASC, IPY IPO and IUGG, is developing a new approach to data and information management: the Polar Information Commons (PIC). In addition, Kim Finney (new Chief Officer of SCAR's Standing Committee on Data and Information Man-

agement or SCADM) is a member of ICSU's Strategic Coordination Committee on Information and Data, which looks strategically at data issues across all ICSU-sponsored activities. Her participation should help ensure that SCAR's data management developments, ICSU's PIC and broader developments with the emerging ICSU World Data System remain connected. There are sensitivities across national boundaries in the Arctic that do not exist within the Antarctic Treaty area. Thus, so far, a similar data management system for the Arctic does not exist. Nevertheless, together with the Arctic Council and WMO, IASC is developing the Sustaining Arctic Observing Networks initiative (SAON, *Chapter 3.8*), which includes pan-Arctic data sharing systems.

IASC and SCAR are already co-sponsoring the development of early-career scientists and hence provide a natural home for the Association of Polar Early Career Scientists (APECS), an offshoot of IPY.

In addition, SCAR and IASC are working together to ensure a higher profile for the polar science in the post-IPY world. Main examples are as follows:

- (i) SCAR and IASC wish to obtain a higher profile at ICSU General Assemblies, where recently, polar matters have only been considered under the heading IPY, which itself will disappear when the ICSU-WMO IPY Joint Committee comes to an end (summer 2010).
- (ii) SCAR and IASC have a common interest in having a higher profile within ICSU's global environmental change programs (Earth System Science Partnership – ESSP and International Geosphere-Biosphere Program – IGBP), which previously have largely ignored the polar realms. This is currently the subject (among others) of an ICSU consultation (see below). It should be noted that SCAR and IASC do have a high profile within the World Climate Research Programme, of which ICSU is a co-sponsor.
- (iii) SCAR and IASC continue to work together as co-sponsors (with others) of the second IPY science conference (Oslo, June 2010) and have begun to work in a similar fashion in relation to the third IPY conference (Montreal, 2012). After these conferences, there will be scope to consider holding another joint SCAR-IASC Open Science Conference in 2014 (or later) provided it is located in the northern hemisphere.
- (iv) To ensure closer linkage to the climate community, SCAR and IASC intend to seek representation as observers at IPCC. As a start, SCAR and IASC have obtained permission from ICSU to attend IPCC meetings as part of the ICSU delegation. SCAR has also gained observer status with the UNFCCC, and attended the recent Copenhagen meeting. This may provide leverage to obtaining observer status with IPCC.



Fig.5.5-4. Volker Rachold, IASC Executive Secretary and Colin Summerhayes, SCAR Executive Director, acting as moderators for the opening session of the SCAR-IASC IPY Conference in St Petersburg, July 2008.

(Photo: Alexander Klepikov)

New Role of the Arctic Council in Polar Research

Helena Ödmark

Reviewers: Volker Rachold and Colin Summerhayes

The fifth Arctic Council Meeting of Foreign Ministers in Salekhard, Russia, in October 2006 (see Figs. 5.5-5 and 5.5-6), adopted a Declaration that welcomed “the expansion of the IPY to include *the human dimension*”, which the AC considered to be an important new feature of IPY 2007–2008. Many IPY projects in the socio-economic and human sciences were closely linked to ongoing AC work aimed at improving living conditions in the Arctic and will continue after IPY.

A prominent example is the coordinating efforts on scientific research on human health performed by the Arctic Human Health Initiative (IPY no. 167) during IPY. That has inspired the AC working group on sustainable development (SDWG) to form a dedicated Arctic Human Health Expert Group to support and promote further integration and collaboration between scientists and health practitioners striving to improve the health of all Arctic residents and, in particular, indigenous peoples.

The Arctic Social Indicators project (IPY no. 462), a collaborative effort between scientists and local communities that attempts to identify indicators to enable comparative monitoring of social and other important welfare conditions in Arctic communities, also built on previous AC work and will continue after IPY within the AC framework.

In Salekhard, the Ministers further emphasized “the importance of *climate change* in the context of the IPY, and to achieve a legacy of *enhanced capacity of Arctic peoples to adapt to environmental, economic and social changes* in their regions, and enabling Arctic peoples to *participate in and benefit from scientific research*”.

They urged “Member States and other entities to strengthen monitoring and research efforts needed to comprehensively address Arctic change and to promote the establishment of a *circumpolar Arctic observing network of monitoring stations with coordinated data handling and information exchange for scientific data, statistics and traditional knowledge* as a lasting legacy of IPY (and as the evolving Arctic component of the Global Earth Observing System of Systems, (GEOSS))”.

As these extracts from the 2006 Declaration show,

the AC had identified two distinct legacies that it anticipated as lasting results of the IPY:

- i) Arctic science would be conducted in a manner that would provide benefits to the people who live in the Arctic.
- ii) Establishment of transparent and coordinated observations, monitoring, data handling and information exchange structures.

The importance of IPY legacies in these two areas was reiterated in the Declaration adopted by the sixth AC Meeting of Foreign Ministers in Tromsø, Norway in April 2009, which expressed support for “continued international coordination to maximize the legacy of [the] 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”.

The Tromsø Declaration also called “for consultations involving national funding and operational agencies to create a basis for internationally coordinated funding and shared infrastructure and enhance the recruitment of young scientists into polar science” and encouraged “the exploration of ways to continue the innovative forms for IPY outreach and the presentation of outcomes of the IPY, including the use of scientific data and traditional knowledge in future assessments”.

During IPY, contacts increased between the AC working groups and scientists, even when the scientists had no previous links to AC work. That active interaction illustrates the role of the AC as a body that is well-placed to articulate the needs for information from the science community to underpin policy-making on Arctic issues. A major task for the AC working groups is to review issues that matter to policy-makers and regularly prepare assessments on, for example, specific contaminants, individual species or certain economic activities, and to present their findings in reports on status and trends.

Another task is to inform policy-makers on new, complex developments that require scientific explanation and analysis. The 2004 *Arctic Climate Impact Assessment* (ACIA) report was based on a comprehensive review of available scientific knowledge on impacts of climate change in the Arctic combined with traditional knowledge from indigenous peoples and other Arctic



Fig. 5.5-5. AC Ministerial Meeting venue in Salekhard, Russia.

(Photo: Helena Ödmark)

residents. That synthesis report proved to be very valuable to policy-makers. IPY provided a major boost to this kind of synthesis work. In 2009, the AC released a follow-up report, the *Arctic Marine Shipping Assessment* (AMSA).

During the IPY era, the AC working groups also identified many new partners in the international Arctic science community. New interdisciplinary networks were created. The AC and its working groups will continue to develop and expand these cooperative formats. Cooperation and collaboration with IASC and the International Arctic Social Sciences Association (IASSA) in particular, has increased and deepened as a result of various creative joint activities during IPY.

Two new major synthesis reports are under preparation in the AC, the “*Snow, Water, Ice and Permafrost Assessment*”, SWIPA, (*Chapter 5.2*) scheduled for completion before the next AC Ministerial Meeting in April 2011 and the “*Arctic Biodiversity Assessment*”, ABA, expected to be presented in 2013.

The *Sustaining Arctic Observing Networks* initiative, SAON (*Chapter 3.8*), was identified by the AC Ministerial Meeting already in Reykjavik in 2004 as a potential major legacy of IPY. In the Tromsø Declaration, the AC decided to “consider ways to develop an institutional framework to support circum-Arctic observing”. Even though the SAON process has turned out to be quite complex, the AC continues to believe that substantial

improvements in monitoring and observations is critical to future scientific research on impacts of climate change and other types of change in the Arctic. New methodology for community-based monitoring developed during IPY should be seen as a useful complement to more advanced technology solutions such as space observations.

Another IPY project, the *Arctic Portal* (IPY no. 388) that was built on an earlier AC project, has been selected as the gateway home for the IPY IPO website to ensure continued easy access to all IPO web-based material after the end of IPY. The Arctic Portal also hosts the websites of the AC and its working groups as well as those of IASC, IASSA and other activities (e.g. the SAON process, www.arcticportal.org). Some of the successful outreach and education work during IPY might be pursued under the auspices of the AC in cooperation with IASC, IASSA and others.

In the Tromsø Declaration the AC decided “to consider the proposal to arrange an international polar decade”. This and other proposals for contributions to the potentially quite substantial legacy of IPY will need continued attention by SAOs during the Danish AC chairmanship 2009-2011 to ensure that the inter-governmental AC cooperation can take full advantage of experiences gained during IPY and contribute to increased support for scientific research.

Fig. 5.5-6. Ice sculptures of national emblems of AC Member States, Russia and United States.
(Photo: Helena Ödmark)



AC and ATCM Collaboration

Helena Ödmark, Manfred Reinke and Colin Summerhayes
Reviewers: David Hik, Igor Krupnik and Jerónimo López-Martínez

There are many similarities between the two polar regions, but there are also some remarkable differences between the Arctic and Antarctic with respect to geographical, legal and political realities, which need to be kept in mind. Antarctica is an uninhabited continent surrounded by the Southern Ocean. The Arctic is a circumpolar range of lands that have been populated for several thousand years and that surround a North Pole deep under the Arctic Ocean.

In the midst of the Cold War, the Antarctic Treaty was negotiated as a *binding security policy instrument* on the basis of the cooperative arrangements that were agreed upon for scientific activities during the International Geophysical Year (1957-58). Since its establishment, the Treaty has accommodated the different existing positions on sovereignty over territory in Antarctica by putting aside any claim or right to claim and by stipulating a set of agreed upon rules on joint governance and management that devote the land and sea areas south of 60°S to peace and science. The Antarctic Treaty Consultative Meeting, ATCM, is currently a yearly two-week long *meeting of the parties* to the Antarctic Treaty and exists only for the duration of

each meeting. A permanent secretariat located in Buenos Aires has existed since 2005 (*Chapter 1.4*).

The Arctic Council, AC, was established through a *Political Declaration* signed by the Foreign Ministers of the eight Arctic States at a meeting in Iqaluit, Canada (*Chapter 1.4*). The Declaration focuses on sustainable development and environmental protection. The AC was set up as a *forum for intergovernmental cooperation* on all issues, except military, and for consultations with Arctic indigenous peoples. The Arctic land territories and the peoples that live there belong to sovereign states. The applicable legal framework is a combination of national and international law. The UN Convention on the Law of the Sea, UNCLOS, constitutes the basis for governance in Arctic marine areas, even though not yet ratified by the U.S.A., as its main provisions form part of international customary law.

Due to the distinct differences in applicable legal framework for the two polar regions, the contexts for international and, in particular, intergovernmental cooperation on Arctic and Antarctic issues, respectively, are consequently very different.

There was no notable collaboration between the AC and the ATCM prior to IPY 2007–2008. Nevertheless, that does not mean that governments believed that there were no lessons to be learned from intergovernmental cooperation on issues related to the other pole.

On the contrary, in many cases the policy objectives that governments pursue in the AC and at the ATCMs are the same (e.g. reducing conflicts of interest, creation of multi-national fora to discuss issues relevant to many nations, mitigation of, and adaptation to climate change, maritime safety and security, integrated ecosystem-based management, environmental protection, access to research sites, conservation and sustainable use of living resources, establishment of protected areas, science-based regulation of fisheries, energy efficiency etc.). A widely held view is that legitimate activities in the Arctic as well as in the Antarctic should meet the highest environmental and safety standards. They should take into account the specific conditions that are unique to the polar regions and be based upon the fundamental scientific knowledge generated through sound and multi-disciplinary research. This is where yet another line of similarities comes to mind between ATCM working with its scientific arm, SCAR, and AC, for which IASC plays similar role (see above).

There are many examples of ATCM deliberations being informed by discussions on similar issues in the AC context, and vice versa, which is quite natural since seven of the eight AC member states and all the AC observer states are Parties to the Antarctic Treaty.

Several issues that are addressed by the intergovernmental community at the global level are also of specific concern in the polar regions. In such cases, deliberations in the AC and/or at the ATCM can inform and facilitate discussions in other forums. One example is international shipping, where regulations need to be adopted by the International Maritime Organization, IMO, in order to be binding on all flag states. The AC has endorsed a set of detailed recommendations in its 2009 "Arctic Marine Shipping Assessment". The ATCM has adopted a number of measures on many of the same issues. Negotiations are now ongoing under the auspices of the IMO on a binding "Polar Code" that seems to enjoy very wide support.

A different approach is required for biological prospecting. Biological material in the Arctic falls under national law and the UN Convention on Biological Diversity. Specific rules are needed for areas outside national jurisdiction and are currently under deliberation in the UN General Assembly. In that situation, it is up to the ATCM to take corresponding action in order to protect Antarctic biodiversity from excessive exploitation.

New Forms of AC-ATCM Collaboration

The first formal cooperative activity involving the member states of the AC together with the Antarctic Treaty Consultative Parties, ATCPs, took place in the margins of the 32nd ATCM in Baltimore 2009, when representatives of the AC and the ATCPs were invited at ministerial level for their first ever Joint Meeting, in Washington DC on 6 April to mark the 50th anniversary of the Antarctic Treaty and the successful conclusion of IPY 2007–2008. The Joint Meeting was Co-Chaired by Hillary Rodham Clinton, U.S. Secretary of State, for the U.S. chairmanship of the ATCM, and Jonas Gahr Støre, Norwegian Minister of Foreign Affairs, then chairman of the AC. The Declaration was adopted at that meeting (Box 1).

The AC Ministerial Meeting in Tromsø in late April 2009 welcomed "the Washington Ministerial Declaration highlighting IPY 2007–2008, an internationally coordinated scientific research and observation campaign in polar regions, which, for the first time, considered the human dimension and concerns of local and indigenous peoples and engaged Arctic residents".

Other Forms of Cooperation

A workshop on "The Legacy of the International Polar Year", coordinated by the Norwegian Polar Institute and supported by the AC and the ATCM, took place in Oslo in June 2010 in conjunction with the IPY Science Conference.

In 2005, stimulated by the attention accorded to the ACIA report, SCAR began developing a southern hemisphere equivalent, which resulted in the report



Fig.5.5-7. Website for the 50th Antarctic Treaty Summit meeting, Washington, DC, 30 November – 3 December, 2009, www.atsummit50.aq.

on “Antarctic Climate Change and the Environment”, ACCE, published in November 2009 (*Chapter 5.2*). The ACCE report forms part of SCAR’s annual provision of scientific advice to the ATCM. At the 29th ATCM in Edinburgh in 2006, the attention of the ATCM was drawn to the activities of the AC, in particular the preparation of the ACIA report, through a presentation by the ACIA team leader Dr Robert Corell.

Ongoing work in the ATCM context on improved observations and monitoring in the Antarctic Treaty Area has been inspired by corresponding work on co-ordination and integration of observations and moni-

toring in the Arctic within the SAON process under the auspices of the AC (*Chapter 3.8*).

Some Academics and other expert commentators argue in favor of more parallel treatment of the Arctic and Antarctic regions. They point to the 50 years of successful implementation of the Antarctic Treaty to reinforce their argument and, at times, also suggest that a similar legal instrument be negotiated for the Arctic region as a legacy of IPY 2007–2008. That message was reiterated at the *Antarctic Treaty Summit: Science-Policy Interactions in International Governance* four-day meeting dedicated to the 50th anniversary of the Antarctic Treaty, which was held at the Smithsonian Institution in Washington, DC from 30 November – 3 December 2009 (see Figs. 5.5-7, 5.5-8 and 5.5-9). The meeting celebrated “the development and resilience of the Antarctic Treaty on the 50th anniversary of its signature day”, but was also focused on the “lessons learned from the first fifty years of international governance of Antarctica” that may be applied to other domains and areas, i.e., the Arctic. The meeting, attended by over 200 participants, was one of the IPY endorsed projects (IPY no. 342) in the ‘Education and Outreach’ field. Its organizers, keynote

Fig.5.5-8. Paul Berkman, Chair of the ATSM 50 Meeting presents Antarctic Treaty Summit Medal to HSH Prince Albert II of Monaco (December 2009, Washington, DC). (Courtesy: Paul Berkman)



Fig.5.5-9. Speakers at the “Building Bridges: Communicating Science with Policy-Makers” luncheon dialogue organized by APECS at the conclusion of the 50th Antarctic Treaty Summit Meeting (Washington, DC, December 2009). Left to right: Olav Orheim (Former Chair - Committee on Environmental Protection), Dr. Marie Jacobsson (Member, United Nations International Law Commission; International Counsel, Swedish Ministry for Foreign Affairs; Member, International Board for the Antarctic Treaty Summit); Prof. Oran Young (University of California Santa Barbara; Member, International Board for the Antarctic Treaty Summit); and Dr. Yeadong Kim (Former Director, Korean Polar Research Institute; Member, International Board for the Antarctic Treaty Summit).

(Photo: Paul Markman)

Box 1 Antarctic Treaty Consultative Meeting, Baltimore, U.S.A., April 6-17, 2009
Antarctic Treaty-Arctic Council Joint Meeting
Washington Declaration on the International Polar Year and Polar Science

On the occasion of the conclusion of the fourth International Polar Year (IPY), the Member States of the Arctic Council and the Consultative Parties to the Antarctic Treaty,

Observing that the IPY occurred against a backdrop of rapid and significant climate and environmental change in the polar regions,

Acknowledging the unique scientific importance of the polar regions, both as actors and barometers of these changes, which are vital to the functioning of the earth's terrestrial, biological, climate, ocean and atmosphere systems,

Recognising the need to improve the modelling and prediction of change on a regional basis,

Recognising the significant work of the Intergovernmental panel on Climate Change in assessing documented and predicted changes in polar regions and in relating them to larger global systems,

Affirming the importance of the IPY's findings to the scientific community, Arctic residents, including indigenous peoples, and to humanity as a whole,

Observing the success of participants in forming IPY collaborations that integrate the human, physical, and biological aspects of their research to achieve system-scale knowledge,

Recognising the vital contributions toward understanding the characteristics and dynamics of polar regions and their roles for the world's ecosystems made by scientists and other participants from over sixty countries,

Noting the extensive efforts of the International Council for Science (ICSU), the World Meteorological Organisation (WMO), the many IPY National Committees, and the scientists and other participants around the globe whose research made IPY a great success,

Recalling the goals for the IPY set forth in the 2006 Edinburgh Antarctic Declaration on the International Polar Year 2007–2008, and the strong support for IPY expressed by the Arctic Council in the 2006 Salekhard Declaration,

Expecting that the legacy of the IPY will continue well beyond its formal conclusion,

Hereby:

1. Urge states, national and international scientific bodies, and other interested parties to cooperate to deliver a lasting legacy from the IPY, and to support appropriate infrastructures to achieve this;

2. Commit themselves to reviewing key issues related to scientific cooperation and recent scientific findings at the biennial Ministerial Meetings of the Arctic Council and annual Antarctic Treaty Consultative Meetings, and further commit to using science to help inform the cooperative development of measures to address the threats to the polar regions;

3. Call upon IPY participants to continue to make data collected under IPY 2007–2008 and its legacy programs available in an open and timely manner, recall the obligations related to exchange of scientific information to this effect in the Antarctic Treaty, and encourage the same spirit of scientific openness among Arctic researchers;

4. Endorse the goal of strengthening international cooperation at all levels in polar regions among States, scientists, Arctic residents, including indigenous peoples, and their institutions in areas such as educational outreach, human and ecosystem health, environmental protection, and scholarships or young scientists;

5. Encourage the development of coordinated research and scientific observations at both poles to compare the current dynamics of polar areas and their contributions to the Earth's processes and changes;

6. Recommend that governments continue their support for efforts initiated during IPY to create and link observational systems in order to improve the modelling and prediction of climate change on both regional and temporal scales;

7. Encourage states and international bodies to use the scientific understandings derived from IPY research to support the development of concrete steps to protect the environment in the polar regions;

8. Support the analysis and use of scientific data and information collected from the polar regions as a result of IPY to contribute to future assessments by the Intergovernmental Panel on Climate Change, as well as other efforts to address climate change, and future Arctic Council assessments;

9. Call upon states, organisations, scientists, and other stakeholders to continue to engage with young people to cultivate the next generation of polar scientists, and to communicate with the general public to develop an awareness of the importance of polar research for life in all regions of the world; and

10. Affirm the value of collaboration and coordination between states and Arctic residents, including indigenous peoples, for the benefit of polar research.

Adopted at Washington, April 6, 2009.

speakers and panellists included many distinguished scholars, science managers, policy specialists and young scientists representing APECS from both the Antarctic and the Arctic fields (see www.atsummit50.aq/about_summit/speakers.php)

Nevertheless, the governments of the eight Arctic States have made it clear that they believe that continued peace and stability in the Arctic can best be achieved by continuing to strengthen and develop the present intergovernmental cooperation structures with full respect for existing legal and political realities. Within that framework, there is scope for more lessons to be learned and more experiences to be shared on how to address similar issues in the two polar regions. Joint action between the AC and the ATCM could be contemplated to highlight matters of common concern such as the need for improved hydrographic charts, adequate satellite coverage and increased funding for polar research.

Conclusions

New or advanced partnerships in support of coordination of polar research – Arctic, Antarctic as well as bipolar – can be considered a main outcome of IPY. The corresponding central achievements of IGY were in the Antarctic domain. The frameworks for scientific and political cooperation in the Arctic, i.e. IASC and AC, were only established in the early 1990s. IPY succeeded in both fully integrating the relatively young Arctic components and strengthening bipolar scientific activities and collaboration. The linkages between the political frameworks provided by the ATCM and the AC as well as the collaboration between and among the key scientific bodies, i.e. ICSU, WMO, SCAR and IASC, have been strengthened and will continue. This emergence of a bipolar cooperative approach to polar research that did not exist prior to IPY will certainly influence how the next IPY will be organized.

References

- IASC Bulletin 06/07* - <http://web.arcticportal.org/iasc/services/publications>.
- IASC Bulletin 07/08* - <http://web.arcticportal.org/iasc/services/publications>.
- IASC Bulletin 08/09* - <http://web.arcticportal.org/iasc/services/publications>.
- Klepikov, A., 2008. SCAR/IASC IPY Open Science Conference "Polar Research - Arctic and Antarctic Perspectives in the International Polar Year." *SCAR Bulletin 169* (December):4–8.
- Report of Senior Arctic Officials to Ministers at the Fifth Arctic Council Ministerial Meeting, Salekhard, October 26, 2006, www.arctic-council.org.
- Salekhard Declaration, On the occasion of the tenth Anniversary of the Arctic Council, the fifth Arctic Council Ministerial Meeting, the 26th of October, 2006, Salekhard, Russia, www.arctic-council.org.
- SCAR Bulletin 152*, January 2004 - www.scar.org/publications/bulletins/.
- SCAR Bulletin 154*, July 2004 - www.scar.org/publications/bulletins/.
- SCAR Bulletin 159*, October 2005 - www.scar.org/publications/bulletins/.
- Senior Arctic Official (SAO) Report to Ministers, Tromsø, Norway, April 2009, www.arctic-council.org.
- Tromsø Declaration, On the occasion of the Sixth Ministerial Meeting of the Arctic Council, the 29th of April, 2009, Tromsø, Norway, www.arctic-council.org.

Notes

- ¹ See www.icsu.org. The members include 121 National Scientific Bodies (mostly national academies of science) covering 141 countries, 30 International Scientific Unions, and 21 International Scientific Associates.
- ² WCRP, International Geosphere-Biosphere Programme, International Human Dimensions Programme, DIVERSITAS, and their Earth System Science Partnership.
- ³ See www.wmo.int WMO has a membership of 189 Member States and Territories (as of 30 April 2010).



5.6 Shaping the Future

Contributing Authors:

Jenny Baeseman, Kathleen Fischer, David Hik, Karen Kraft Sloan, Hugues Lantuit, Olav Orheim, Odd Rogne and Eduard Sarukhanian

Broadening and Sustaining the IPY Momentum

David Hik and Karen Kraft Sloan

Background for Broadening the Legacy of IPY

One important role of science and research is to assist governments, and therefore society, in effectively discharging their responsibilities and mandates. In the polar regions, these mandates are necessarily far reaching, diverse and include a broad range of disciplines, from the natural sciences, the human behavioral, social and historical sciences, medical sciences, engineering and applied sciences, and research in the managerial, economic, and legal fields. Polar research is characterized by an abundance of cross-cutting issues that require interdisciplinary or multidisciplinary approaches, and the knowledge provided by research must address questions on a wide range of scales from local to global, and from immediate to long-term. In the Arctic, it is also recognized that advanced technological knowledge and fundamental or theoretical research must be combined with the holistic observations and knowledge of indigenous northern peoples.

From the very beginning of IPY there was a discussion of its potential legacies, and promotion of the notion that IPY could be a “catalyst” for sustaining future Arctic and Antarctic research efforts (Kraft Sloan and Hik, 2008). For example, the word ‘legacy’ was used 14 times in the IPY Framework publication (Rapley et al., 2004). History would suggest this outcome is possible and even likely, but what continuing efforts are required to secure a legacy of sustained interest and investment in Arctic and Antarctic research? Even at the conclusion of IPY 2007–2008, there is still a need to define and pursue the next steps in securing a broad legacy for IPY, as envisioned by so many of the scientific and governmental participants.

In 2005 we began a dialogue about IPY legacies that we called ‘Broadening the Legacy.’ There were several elements to our approach including:

1. Making the IPY legacy part of the IPY process itself;
2. Identifying partners in order to link with and build upon other initiatives, through Arctic Council and other organizations, including national governments;
3. Learning from other efforts to formalise international polar science cooperation, especially from the implementation of the Antarctic Treaty System and from the first fifteen years of the evolution of the Arctic Council;
4. Being opportunistic and identifying fora to engage governments and other potential partners and supporters;
5. Identifying champions and providing them with resources to promote the global and local value of enhancing polar science, research, and knowledge capacity.

This initiative was presented at the Arctic Science Summit Week and ARCUS in 2006, and at meetings with the Commission on Sustainable Development, the OECD Global Science Forum, the Heads of Arctic and Antarctic IPY Secretariats (*Chapter 1.7*), among others. In retrospect it is likely that our efforts in 2006 were premature. The IPY planning process was still in its early stages, and many countries had not yet allocated funding or resources to support the substantial interest in IPY. A discussion of ‘legacy’ could not find much time on the agenda. However, these ideas still resonate at the conclusion of IPY and are relevant to successfully implementing and sustaining diverse IPY legacies. Indeed, legacy has become a major consideration for Arctic Council, IASC, SCAR, Arctic Parliamentarians, WMO, ICSU and many other sponsors of IPY, including the governments and agencies that funded IPY activities.

Approach for Broadening the Legacy

International scientific assessments and reports involving thousands of scientific and research contributors have detailed the urgent and accelerating global environmental crisis, which create headline news for a few days and then usually seem to go unnoticed by both the public and politicians. Examples include the *Arctic Climate Impact Assessment* (2005); *Millennium Ecosystem Assessment* (2005); *The Stern Review: On the Economics of Climate Change* (2006); *Global Footprint-Living Planet Report* (2010); and so on. New approaches to encourage meaningful follow-up to scientific discovery and assessments need to be explored. To strengthen appropriate policy responses to the scientific outcomes of IPY, the Broadening the Legacy dialogue sought to engage decision-makers in relevant IPY processes early on. Decision-maker participation throughout IPY could assist them to better understand both the substantive outcomes of IPY and the conditions that are required to sustain international support for polar science.

The scientific legacies of International Polar Year would occur, regardless of what action was taken to broaden the legacy of IPY. However, in order to heighten decision-makers' understanding of polar scientific issues and to encourage acceptance of

their responsibility for on-going support of polar science, their engagement at the beginning of the IPY process was important. IPY presented an interesting opportunity to build links amongst the science communities, Arctic residents, the public at large, the private sector and governments to ensure that the impact of IPY would be lasting and substantive.

The opportunity to 'use' IPY as a catalyst for something new did not pass unnoticed by the IPY Joint Committee, IPY participants and other observers. Previous Polar Years in 1882-83 and 1932-33 contributed to the development of international polar science programs, and the International Geophysical Year of 1957-58 also left a political legacy in the form of the Antarctic Treaty System, which set aside an entire continent for the peaceful study of science. However, no such coordinating mechanism or instrument formally exists for the Arctic, as highlighted in an editorial in the journal *Nature* in May 2006:

"In contrast with Antarctica, there is no political framework for collaboration on Arctic research. Despite the stark findings of the 2004 climate assessment, the eight nations with territory north of the Arctic Circle — Russia, Canada, the United States, Denmark (on behalf of Greenland), Iceland, Finland, Norway and Sweden — remain

Fig. 5.6-1. Presidents of SCAR (Chuck Kennicutt) and IASC (David Hik) met at the Oslo IPY Conference in June 2010 to discuss collaborative efforts to promote IPY legacy activities.

(Photo: Jerónimo López-Martínez)



too passive in their approach to coordinating polar research. Their benign neglect has led to the gradual deterioration of parts of the network of meteorological stations in the Arctic. Better baseline support for such monitoring would cost little, but would make a huge difference to Arctic researchers of all disciplines.” (Nature, 11 May 2006, Vol. 441, no. 7090)

The Broadening the Legacy approach attempted to set the stage for political and policy discussions on polar issues after IPY by creating a forum where science and policy could converge in a broad, inclusive dialogue that would operate at all levels of scale (international, national, regional and local). Polar years have set the precedent for international cooperation in science and research; emphasized the need to make sense of disparate data and methods of data management, and ensure access for scientists, communities and others; assisted policy-makers understand the impact of research through mechanisms for translating scientific data and creating science into policy communications; and contributed to the development and evolution of new institutional forms to ensure the on-going investment and interest, the “glue” to sustain international cooperation in polar research.

It is already apparent that IPY 2007–2008 has raised some critical polar and global issues and created momentum for political action and policy responses, but the many outcomes may not be immediate. For example, it was the scientific community in the 1960s and 1970s that first focused international attention on the threats imposed by global climate change. Even though it took many years before international governance and policy mechanisms were created to enable national governments to seriously respond, the mounting scientific evidence and the profile that these scientific conferences provided was a major contribution to raising the issue of climate change internationally.

Evidence for Broadening the Legacy

As IPY 2007-2008 formally comes to a close, it is fair to ask if there is evidence of sustained momentum for the international cooperation, collaboration and institution-building that will be necessary to support IPY legacies in the future? So far, these responsibilities seem to lay with the primary sponsors of IPY

(WMO and ICSU), the scientific organizations at the forefront of polar research (SCAR and IASC), and the political organizations in the Arctic (Arctic Council) and Antarctic (the ATCM). These organizations have recognized the need to provide institutional commitment and solutions for sustaining polar research, and discussions regarding the IPY legacy are now an important agenda item within these bodies, including the two polar science organizations, SCAR and IASC (Fig. 5.6-1; *Chapter 5.5*). Importantly, IPY was a catalyst for these organizations to initiate several new international observing initiatives focused on gathering and sharing information about change in the polar regions (*Part 3*).

The conditions necessary to sustain IPY legacy outcomes will also require engagement with other international processes and partnership with the wider global research and policy community, and with other elements of civil society. Outside of the polar regions there are some good examples of institution-building approaches for furthering the science – policy nexus, including the Intergovernmental Science – Policy Platform on Biodiversity and Ecosystem Service (IPBES - www.ipbes.net). IPBES is not restricted to the Arctic region, but its goal of providing “scientifically sound, uniform and consistent framework for tackling changes to biodiversity and ecosystem services” is highly relevant. Similarly, the Global Earth Observation System of Systems (GEOSS) program was launched as a response to requests from the 2002 World Summit on Sustainable Development and by the G8 (Group of Eight) leading industrialized countries for greater international collaboration to make better use of Earth observations to support decision making (www.earthobservations.org). To maximize the global impact of IPY, these sorts of international programs and approaches will have to be encouraged to participate in the IPY Montreal Conference, “From Knowledge to Action” in April 2012 (see below).

Observations about engaging society, policy makers and governments in polar science may not surprise many of the participants in IPY 2007-2008. Indeed, there is increasing evidence of interest from other groups in participating in the dialogue about approaches for gathering and sharing knowledge about the polar regions, models of openness, interdisciplinarity and collaboration that IPY

promoted since its very early planning stages (*Chapter 1.2, Chapter 1.3*). Some authors (e.g. Brock, 2010) have suggested that the observed gap between research and policy in the Arctic may reflect poorly calibrated expectations about the conditions under which research is relevant to public policy. Others have concluded that the primary challenge is to develop a “holistic and integrating international plan” to steward and govern the Arctic environment in a sustainable manner (Aspen Institute, 2011). There is also a growing interest in reconciling the influence and rights of Arctic residents within the existing governmental and scientific framework (Kraft Sloan and Hik, 2008; Bravo, 2009; Brock, 2010; Aspen Institute, 2011). So while there are still many challenges, we are increasingly confident that efforts to ‘Broaden the Legacy’ of IPY will succeed.

The combined pages of this IPY Summary show that IPY has already succeeded in inspiring a discussion

about the future of polar research. The polar research and polar policy agendas has been dynamic and full over the past several years, with a number of parallel processes occurring that collectively have provided space for exploring the future of these regions. Some barriers to international cooperation require simple technical or scientific solutions. Others are multi-dimensional, systemic and deep rooted. These require institutional and/or political responses, and therefore must involve governments. Still others may need a combination of approaches. For example, utilization of scientific data may reflect a simple management problem, solvable with technical remedies such as standardization (*Chapter 3.11*). However, access to data could be limited by political or systemic barriers, thus requiring different strategies to resolve (e.g. Carlson, 2011). Solutions to these and other issues will only be found by continuing to broaden the discussion of IPY legacy.

References

- Aspen Institute., 2011. *The Shared Future: A Report of the Aspen Institute Commission On Arctic Climate Change*. The Aspen Institute, Washington, D.C., U.S.A. 93 pp.
- Bravo, M.T., 2009. Arctic science, nation building and citizenship. In: Francis Abele, et al., *Northern Exposure: Peoples, Powers, and Prospects in Canada’s North*. Institute for Research in Public Policy, Montreal, Canada. 141–168 pp.
- Brock, D.M., 2010. When is research relevant to policy making? A study of the Arctic Human Development Report. *Pimatisiwin: A Journal of Aboriginal and Indigenous Community Health* 8:125-149.
- Carlson, D., 2011. A lesson in sharing. *Nature* 469:293.
- Kraft Sloan, K. and D. Hik, 2008. International Polar Year as a catalyst for sustaining Arctic research. *Sustainable Development Law and Policy* 8(3):4-8.
- Rapley, C., R. Bell, I. Allison, P. Bindschadler, G. Casassa, S. Chown, G. Duhaime, V. Kotlyakov, M. Kuhn, O. Orheim, P. Ch. Pandey, H. Petersen, H. Schalke, W. Janoschek, E. Sarukhian and Zh. Zhang, 2004. *A Framework for the International Polar Year 2007–2008. Produced by the ICSU IPY 2007–2008 Planning Group*. ICSU: Paris, 57 pp. <http://classic.ipy.org/development/framework/framework.pdf>

The Next Generation of Polar Researchers

Jenny Baeseman and Hugues Lantuit

The International Polar Year 2007–2008 was an immense success on many levels. Born in the mind of a few enlightened researchers, the IPY grew to become more than a science event. It involved thousands of researchers in its multifaceted scientific endeavors and provided global awareness for polar regions to date. But it also did more than just that: It changed the way we do science, emphasizing international and interdisciplinary collaboration, open scientific practices and involving residents of high latitudes. Its legacies are many and will provide a lasting basis upon which polar research will build to drive its next ventures. Young researchers involved in IPY must capitalize on the legacies of IPY and help shape the future of polar research.

The high-quality science stemming from the IPY effort has demonstrated the benefits of an enhanced level of support for polar research into the future. The direct impact of changes at higher latitudes on southern regions has made this greater involvement more acutely needed. Without significant investment in sustaining research activities, but also global data stewardship and recruitment and training of promising young researchers, the basic requirements of polar science to answer pressing scientific questions can not be correctly met. IPY has indeed brought out a series of research challenges that have great societal relevance and urgency beyond IPY, but that can only be comprehended in a long-term scientific observing framework.

The greater level of collaboration during IPY has also emphasized the need and the benefits of working cross-disciplines and cross-borders. Far from being a placeholder concept, international and interdisciplinary partnerships have led to very substantial results that could not have been attained without the added value of the forum that IPY provided. It is, then, necessary to promote and develop programs that go far beyond discipline and national borders and that integrate climate, ecosystem and socio-economic prognoses. National borders and scientific disciplines will certainly remain both in the geopolitical and scientific arena as the pillars of polar research, but polar research should strive to go beyond these very real yet environmentally abstract borders to solve scientific issues in a very targeted manner.

Polar science is very special in that it requires a different approach to space, people and time. IPY has done considerable groundwork in publicizing this message among decision-makers. What it needs to do now, is to work further to secure the full engagement and understanding of decision-makers worldwide in its purpose and value.

With the remarkable accomplishments of this IPY, it is essential now to focus on the IPY legacy, display and explore the richness of IPY data, and to chart future directions for sustainable long-term polar observing systems. Reminding the science community, national funding agencies, data providers and most importantly the new generation of polar researchers should be one of the driving principles of polar science over the years to come. Initiatives, such as the Polar Information Commons should be supported to provide a rewarding mechanism for researchers to release their data, but still needs much more attention (*Chapter 3.11*).

Observing systems for monitoring change are essential for validating and improving predictions, especially of future global warming. A unrewarding job for many, the coordination of observations at the regional level is in itself a challenge, but it holds vast promises in polar regions, for the level of remoteness in these areas requires to coordinate and standardize observations to understand the driving processes behind the evolution of the environment, whether those deal with ice, ocean, atmosphere, coastal or land observations. The coordination of observations is a matter to all polar research stakeholders and should be acknowledged and supported as such, as it matters to both science and society. Parallel to this, polar research will have to strengthen international collaboration at large. That includes international funding mechanisms, transnational field site access and use of internet-based technologies. While such efforts are often regarded as difficult, if not idealistic, they proved necessary to the conduction of science in polar regions.

The Paradox of IPY

The paradox of IPY is that it created a vast range of opportunities, fostered the involvement of national

states in polar regions, but added a thick layer of complexity to the conduct of research in polar regions. Polar researchers are scientists, managers, logisticians, and diplomats at once, and that in an area of the world where access and infrastructure are arranged fundamentally differently from other regions. This results in challenging work conditions for researchers, which can only be addressed by improving the system on the administrative side, making it faster, more efficient, and more consolidated. That applies to the peer-review of applications, but also on licensing, dialogue with local stakeholders and logistics preparation and implementation. With expected improvements to infrastructure and access in the polar regions, an increase of the number of researchers can be expected. This increase needs to be mitigated by strong environmental requirements, coordination and consolidation of logistics, and not by bureaucracy, which would be detrimental to the conduction of science and dialogue with local stakeholders.

IPY 2007–2008 has provided a solid foundation for the engagement of Arctic residents and indigenous peoples in future large-scale science projects. Future scientific endeavors will without a doubt, consider research in the Arctic very differently and elaborate an added number of projects in partnership with northern residents. With its global relevance, though, the Arctic has traditionally be the focus of scientific investigations from countries from all over the globe. The range of cultural approaches in the research landscape is probably just as large as the range of cultural understandings of the environment in arctic communities, and researchers coming to the Arctic will have to proactively seek to apprehend, understand and acknowledge the cultural differences and richness of northern communities. This dialogue is an exciting challenge and is relevant to all: large scale institutions, communities, indigenous peoples organizations, and, above all, individuals.

IPY has created a large influx of new energetic, enthusiastic and talented young researchers interested in helping to better understand the Arctic and Antarctic systems. Through the addition of grassroots initiatives and generous mentoring from senior scientists, these early career scientists have progressively benefited from a comprehensive and coherent training system at the international level, focused on soft skills and inter-

national collaboration. This incredible success needs to be sustained beyond IPY and mechanisms need to be created to retain these young researchers that began Polar Research during IPY and keep them involved.

Naturally this includes more positions at research institutions, but it also needs to include more positions for science communication, logistics coordinators, data managers, programme managers, industry positions, and other positions that are important to the full spectrum of science, outreach, and policy making in polar regions. It is, in 2010, hardly realistic to match the expectations of the general public in terms of research and involvement in polar regions without increasing personnel and finding successors to the baby-boomers.

The polar researcher's job has evolved with time and IPY strongly showed both the interest and the need to offer a comprehensive training framework to young researchers to rapidly train and involve them in international activities and outreach activities. Polar research will have to grab this opportunity and provide better career development training on and international and interdisciplinary level, such as the organization of field schools; participation in international conferences; a dedicated mentorship programme; career development workshops and virtual poster sessions. Finally, international organizations will have to encourage early career people to take on leadership roles in organizations and committees to provide a continuum of leadership in polar science.

Enhancing investment in polar research for the benefit of all can only be achieved through the political will that comes from greater public understanding. The polar researchers of the twenty-first century will be asked to be more than researchers and devote part of their time to outreach efforts. Following up on the extraordinary and multifaceted outreach initiatives of IPY, polar researchers will explicitly embed education and outreach components in their research projects that will feed into high-quality educational, outreach and communication initiatives and networks. These networks, which were created during IPY 2007–2008 will need to be supported to help researchers in producing publications, exhibitions, films, web pages and lectures around science. Only then, will polar research reach out to society and play an important role in involving communities in the continuing analysis and assessment of IPY outcomes and impacts.

The IPY Oslo Science Conference, 8–12 June, 2010

Olav Orheim

The initial process

Following the JC-3 meeting in April 2006, the Joint Committee for IPY issued a call in August 2006, asking for proposals to host a global conference that would present the science results from IPY 2007–2008 (*Chapter 1.5*). Norway had already a Secretariat for IPY established at the Research Council of Norway (RCN) led by Olav Orheim, which quickly took the initiative to develop such a proposal. The elements of the plan to hold the main IPY Science Conference in Oslo were pieced together and presented to the JC at the JC-4 meeting on 27–28 September 2006 in Longyearbyen, Svalbard. In its proposal the RCN took as a given premise that the Conference might be attended by at least 3000 participants, and that it should take place in the summer of 2010. The venue location would be the Norway Trade Fair Centre at Lillestrøm, outside Oslo (Fig.5.6-2). This proposal was enthusiastically approved by the JC.

In September 2007, Olav Orheim met with Michel Béland (Co-Chair of JC) and prepared a detailed outline for the organization of the conference. It was discussed at the JC-6 meeting the following month in Québec. Planning for the conference started in full in January 2008, following the approval by the JC of overarching plans and organising structure for the conference.

An international Steering Committee (SC) was established with representatives from relevant organisations. It was led by Orheim, and had its first meeting on 16 May 2008, and its sixteenth and final meeting on 11 June 2010. SC established the programme, appointed scientific committees, selected plenary speakers, and considered all other matters related to the content of the conference. RCN had the economic and organisational responsibility, but SC was updated on and discussed major decisions related to RCN's responsibility, such as inspection of localities, determination of registration fees, etc

The committee had the following composition:

- Susan Barr, Oslo, nominated by Norwegian National Committee for Polar Research
- David Carlson, Cambridge, head of IPO
- Paul Cutler, Paris, JC Member nominated by ICSU

- Øystein Hov, Oslo, nominated by Norwegian IPY Committee
- Kriss Rokkan Iversen, Tromsø, nominated by APECS
- Jerónimo López-Martínez, Madrid, JC Member
- Olav Orheim, Oslo, representing RCN
- Margarete Pauls, Bremerhaven, representing IPY EOC subcommittee
- Volker Rachold, Potsdam, JC Member, nominated by IASC
- Eduard Sarukhanian, Geneva, JC Member, nominated by WMO
- Colin Summerhayes, Cambridge, JC Member, nominated by SCAR

The SC had unchanged composition through the period, with the exception of APECS' representative, who was later replaced by Hugues Lantuit, Potsdam.

APECS Executive Director Jenny Baeseman attended regularly as an observer. It turned out to be difficult to obtain a nomination of a representative from Arctic indigenous communities, as no single person could represent all these. It was resolved that IPS (Indigenous Peoples' Secretariat) in Copenhagen sent an observer, from SC fifth meeting onward. At that meeting Kathleen Fischer, Executive Director, Government of Canada Program for IPY, also joined the SC, to ensure the link to the next major IPY-related conference to be held in Montreal in 2012. The SC had an executive group which made decisions between meetings on items requiring a more immediate response; it consisted of Carlson, Orheim, Rachold and Summerhayes.

In parallel with the international work, RCN established a project Secretariat, consisting of Olav Orheim as project leader, Asgeir Knudsen, project coordinator, and Kristen Ulstein, responsible for communications. All of these members took part in the SC meetings, as did others from RCN at times. Congress Conference, Oslo, was also hired at an early stage as PCO (Professional Conference Organiser).

Information on the conference was distributed by electronic means, which included three circulars. Nevertheless, the main conference website www.ipy-osc.no was the most important communication channel both before and during the conference. Up to August 2010, the web page has had 42,000 unique visitors.

The first Conference Circular was issued in June 2008. The main message was an invitation to submit proposals for sessions, with a deadline of 24 October 2008. The second Circular came out in November 2009. It presented the complete programme with listed themes and sessions, and established the deadline for abstracts, 20 January 2010. The third Circular was a brochure about the conference which was distributed digitally in February 2010.

The program

The SC decided that the conference should be organised under six separate themes, with international committees established for each theme (Chairs' names are given in parenthesis; the full committee membership is listed on <http://ipy-osc.no/article/2009/1233092078.8>):

- T1: Linkages between Polar Regions and global systems (Harald Loeng, Norway)
- T2: Past, present and future changes in Polar Regions (Valérie Masson-Delmotte, France)
- T3: Polar ecosystems and biodiversity (David Hik, Canada)

- T4: Human dimensions of change: health, society and resources (Sverker Sörlin, Sweden)
- T5: New frontiers, data practices, and directions in polar research (Chuck Kennicutt, U.S.A.)
- T6: Polar science education, outreach and communication (Louise Huffman, New Zealand).

IPY participants were invited to send proposals for sessions under these themes. The secretariat received about 120 different proposals by the end of 2008. It took many months to combine them in such a way that the total number of sessions was manageable, with not too much overlap, so that it would be clear where a submission could find its home, and all IPY-related activities were covered. For each session a team of usually three scientists was selected as conveners. The composition of the session conveners (about 150 altogether) was balanced by geography, gender, and age. It should be noted that SC decided very early in the process that each session team should include a representative for young researchers in the respective field.

There was much engagement in these issues, and as a result the SC and Science Committee added three more sessions to include subjects that were not well enough covered in the original programme. In the end 41 sessions were approved (Box 1).

By the end of January 2010, 2650 abstracts had been submitted from 2200 persons. During the next few weeks all abstracts were evaluated individually by the conveners, and based on total scores the abstracts were designated to oral or poster presentation. The Committee used a system from Elsevier that functioned without problems. Eventually 2200 abstracts were accepted, from persons from 49 different nations.

The Secretariat worked in parallel to produce a programme. Originally it was planned for 15 simultaneous sessions. The large number of abstracts led to the decision to have sessions in 17 lecture halls. Even so it was only possible that about 40% of the submissions could be scheduled as oral presentations, each for 15 min.

Eventually the conference was attended by 2323 persons, from 53 nations (Fig.5.6-3). After Norway, which exceeded 500 including support staff, the countries with the largest number of participants were as follows:

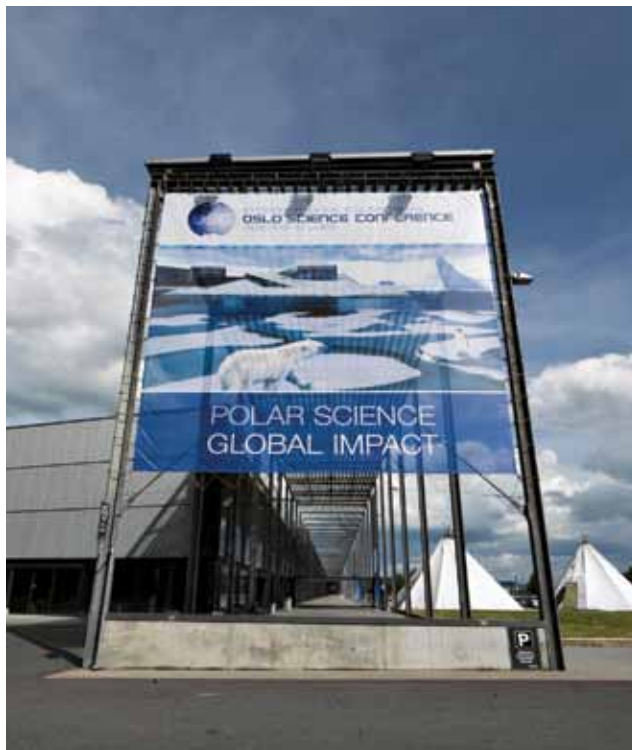


Fig.5.6-2. The IPY Oslo Science Conference 2010 required the largest conference center in the country, Norway Trade Fair in Lillestrøm. Two Saami tents (lavvu) were erected by the Saami participants from Kautokeino in front of the Conference Hall. (Photo: Jostein Fossnes)

Country	# of Participants
United States	331
Canada	270
Russian Federation	130
Germany	120
United Kingdom	110
Poland	71
Sweden	67
France	57
Denmark	46
Spain	43
Italy	41
Japan	36
Finland	34
China	32
Netherlands	28
New Zealand	28
Australia	27
Belgium	27
Brazil	19
Switzerland	13

The conference activities

The main activity at the conference was the presentation of results of individual and collective research during IPY 2007–2008. During the five days there were altogether 1,054 oral talks and about 1000 poster presentations. Much of the presented material is available online. All plenary lectures were web-streamed, and archives can be viewed on the conference website at <http://ipy-osc.no/live>. The conference program and all conference abstracts are also available at http://ipy-osc.no/osc_programme. Most of the results are published in the regular scientific journals. However, there were also book launches connected with sessions, and the journal “Polar Research” is producing a special issue presenting key papers from the conference.

In addition there were a large number of other events. These started prior to the conference, when the University of Oslo offered space for two related activities on 6 and 7 June 2010. An early career professional development workshop was organized by the Association of Polar Early Career Scientists (APECS) for about 120 young researchers. An international Polar Teachers conference collected a similar number



Fig. 5.6-3. Inside the Lillestrøm Centre during the conference days. The main mingling area was named ‘The Polar Street’ for a week. (Photo: Jon-Petter Reinertsen)

of teachers from 20 countries under the theme “How to use polar science in your classroom”. Here the IPY EOC subcommittee also launched its new resource book for polar teaching (*Chapter 4.1*). The day before the opening of the conference the IPY JC held its last meeting (JC-9) in the RCN, just five years and three months after its first meeting (JC-1) (*Chapter 1.5*).

The conference was opened on the morning of 8 June by HRH Crown Prince Haakon of Norway (Fig. 5.6-4). The other speakers at the colourful opening ceremony were Minister of Research Tora Aasland, Executive Director of ICSU Deliang Chen, WMO Secretary-General Michel Jarraud (by video link), Indian Minister of Research Prithviraj Chavan, Special

Box 1 Oslo Science Conference Program

Theme 1: Linkages between Polar Regions and global systems

- T1-1 Polar Oceans and their importance for global ocean circulation
- T1-2 Plate tectonics and polar gateways in earth history
- T1-3 Chemical exchanges between snow, ice, atmosphere and ocean in Polar Regions
- T1-4 Polar climate feedbacks, amplification, and teleconnections, including impacts on mid-latitudes
- T1-5 Polar contribution to sea level rise
- T1-6 Arctic and Antarctic marine chemistry: The role of the polar oceans in global carbon cycling and acidification
- T1-7 Polar/global atmospheric linking processes: Polar aerosols - sources and impacts

Theme 2: Past, present and future changes in Polar Regions

- T2-1 Climate and paleoclimate dynamics and processes
- T2-2 Troposphere and stratosphere dynamics and processes and their links with climate
- T2-3 Snow and ice dynamics and processes
- T2-4 Permafrost on a warming planet
- T2-5 From land to ocean: Hydrological, coastal, near shore and upper shelf processes in Polar Regions

T2-6 Ocean physical and geochemical dynamics and processes

T2-7 Solid earth geophysical and geochemical processes

T2-8 Heliosphere impact on geospace

Theme 3: Polar ecosystems and biodiversity

- T3-1 Chemosynthetic eco-systems in polar waters
- T3-2 Invasive and introduced species in polar environments
- T3-3 Arctic-subArctic connections: Ecosystems and bio-diversity
- T3-4 Processes in polar deep-sea benthic biodiversity
- T3-5 Arctic and Antarctic freshwater ecosystems
- T3-6 Impact of climate change on polar terrestrial ecosystems
- T3-7 Integrated processes in leads and polynyas
- T3-8 Ecosystems of the Southern Ocean

Theme 4: Human dimensions of change: health, society and resources

- T4-1 Human health and well-being in the Polar Regions
- T4-2 Natural resource exploration and utilisation
- T4-3 History of polar exploration, cooperation, research and logistics
- T4-4 Communities and change

T4-5 Polar lessons: Arctic and Antarctic governance and economics

T4-6 Human impacts in the Arctic and Antarctic: Environmental and management implications

Theme 5: New frontiers, data practices, and directions in polar research

- T5-1 New frontiers and directions in biology, ecology and biodiversity
- T5-2 New frontiers and directions in observing and technologies
- T5-3 New frontiers and directions in subglacial exploration
- T5-4 Data and other cross-cutting issues for future polar research

Theme 6: Polar science education, outreach and communication

- T6-1 Learning together: The impacts of integrating education, outreach and research in IPY
- T6-2 Incorporating polar science into formal education
- T6-3 Adventures in the field: Impacts of field programs for students, teachers, artists, writers and others
- T6-4 Global learning: The impact of the media
- T6-5 Informal initiatives and polar inspiration: IPY in museums, art, films, books and drama
- T6-6 PolarCINEMA



Fig.5.6-4. Crown Prince Haakon of Norway greets Mr. Klemet Erland Hætta, the Mayor of Kautokeino Municipality at the Saami cultural 'booth' set during the Oslo Conference among over 25 organizational thematic exhibits (booths) at the main Polar Expo Centre. (Photo: Jon-Petter Reinertsen)



Fig. 5.6-5. Sergey Kharyuchi, the President of the Russian Association of the Indigenous Peoples of the North (RAIPON) speaks at one of the sessions under the Theme 'Communities and Change' that took place inside the Saami lavvu tent. (Photo: Jon-Petter Reinertsen)

Representative of President of Russian Federation Artur Chilingarov, and RCN's Managing Director Arvid Hallén. Other community leaders that spoke during the conference included HSH Prince Albert II of Monaco, Chuck Strahl, Canadian Minister of Indian Affairs and Northern Development, and Sergey Kharyuchi, the President of the Russian Association of Indigenous Peoples of the North (RAIPON – Fig.5.6-5).

Plenary ceremonies during the conference included the award of Martha T. Muse-price of U.S. \$ 100 000 to Prof. Steven Chown (by the Tinker Foundation/ SCAR), and the award of the IASC medal to Prof. Patrick Webber (by IASC).

Various groups with polar interests held side events in conjunction with the conference. A workshop on the IPY legacy was organized by AC and ATCM; it was chaired by Jan-Gunnar Winther, Director of the Norwegian Polar Institute. The workshop was attended by more than 70 representatives of IPY-JC, SCAR, IASC, AMAP and many national polar scientific and indigenous organizations. The workshop participants agreed that it would be critical to maintain the momentum of the IPY legacy process, and that the organizations, such as IASC, SCAR, University of the Arctic, IAI, APECS, ICSU/CODATA that have the capacity and mandate to further advance the IPY legacy would be provided with the necessary means and resources to

do so (Winther, 2010). The workshop also recommended that continued focus on scientific research in the polar regions in the coming decades should be supported and that the initiative of the WMO Executive Council for an International Polar Decade (IPD) should be further explored and supported as appropriate (see below). Considerations should be given to find the mechanisms for working together with the AC and the ATCM to develop a strategy to sustain polar research, including the concept of an IPD. National funding agencies should be encouraged to commit to such long-term efforts.

Education, Outreach and Communication (EOC) activities played large part in the Oslo conference program, just as they had during IPY 2007–2008. A special EOC-committee was established to supervise such activities in Oslo, in part based on the IPY-EOC subcommittee, and chaired by Margarete Pauls, Germany (media), and Sandy Zicus, Australia (education). The committee had several meetings and developed a great variety of public and educational events that were implemented during the week of 7-12 June 2010 (Fig.5.6-6).

A total of 90 films from 17 countries were nominated to be shown at the PolarCINEMA. Selection was by four juries (in Malaysia, Alaska, Netherlands and Norway). A total of 69 productions were shown, with a total of 40



Fig. 5.6-6 The inclusion of early career scientists, teachers, and others involved in outreach was one of the major achievements of IPY-QSC 2010. Here some of them are enjoying themselves on a cruise on The Oslo Fjord.

(Photo: Jon-Petter Reinertsen)

hours of show time.

BBC science journalist Sue Nelson led three afternoon science talk shows termed PolarEXCHANGE, which were all web cast, with the aim of promoting polar science to a wider audience than the conference participants alone.

To meet the public in Oslo the EOC-committee developed the concept PolarFESTIVAL, which took place in front of the Town Hall over two days. Here seven Norwegian institutions participated, together with three research vessels (*G.O. Sars*, the Polish research vessel *Oceania* and *KV Aalesund*).

The Joint Committee was responsible for the plenary which formally closed IPY on 12 June 2010, the final day of the conference. This ceremony was opened by Gerlis Fugmann, President of APECS.

Prof. Jerónimo López-Martínez presented the JC summary perspective on IPY, and pointed to a surge in multidisciplinary polar scientific activities, extensive new circumpolar data baselines and improved observing systems, enhanced international collaboration and stronger links between the Arctic and Antarctic science communities, an enthusiastic new generation of polar scientists, the active engagement of Arctic residents in IPY activities, and the unprecedented involvement of educators and increased public awareness about polar regions.

"IPY was founded on the ideas and energy of thousands of scientists, educators, technicians and many more," said Elena Manaenkova, Assistant Secretary General of WMO. "As co-sponsors of IPY, we would like to express our most sincere thanks to all the participants and the organisers who have made this venture one of the biggest internationally coordinated research programmes ever undertaken." (Fig. 5.6-7).

Dr. Deliang Chen, Executive Director of ICSU, added, "IPY has paved the way for a sound understanding of the polar regions at a critical time for society's relationship with the Earth. The collaboration among many nations and among many scientific disciplines has been critical to the success of IPY, and it is crucial that the energy and partnerships that came together for IPY are sustained in the long-term."



Fig.5.6-7 Dr. Elena Manaenkova, Assistant Secretary General of WMO, speaks at the closing of IPY 2007–2008. (Photo: Jon-Petter Reinertsen)

"I have the honour to officially close the IPY 2007–2008," announced Dr. Manaenkova, before López-Martínez, on behalf of the Joint Committee, handed over the IPY flag to Gerlis Fugmann, as a symbol that the next generation of researchers must take responsibility for continuing the momentum of IPY and polar research. Web casts were made from 21 plenary sessions, and 30 interviews, and edited versions were quickly available for on-demand download. Making all presentations available in this manner was, unfortunately, outside realistic budgets. From the start of the conference to the end of August the web cast and the web-TV-page had 13,000 visitors from 75 countries. With its multitude of presentations and other activities the Oslo Science Conference was a fitting tribute to the many people who invested large portions of their careers in the International Polar Year.

The importance of the IPY Oslo Science Conference is hard to overestimate. At the first IPY Science Conference in St. Petersburg, in June 2008 most of the presentations were based primarily on the results of the previous polar studies, since by the time of that Conference the IPY research and observational phase had been running for only a little more than a year. At the Oslo Conference in 2010, the majority of the presentations introduced scientific advances achieved during the three-year period of IPY 2007–

2008 implementation. Altogether, over 2000 oral talks and posters presented a monumental and multi-faceted snapshot of the natural and social conditions in the polar regions and major ongoing changes. It provided the scientific community with new ideas and knowledge that can be used in the future development of polar science and will serve as a fundamental baseline for prediction of the future state of polar regions and of the planet as whole.

The Oslo Conference was formally closed later on 12 June by Jonas Gahr Støre, Norwegian Minister of Foreign Affairs. At the closing ceremony, Olav Orheim

handed over the baton from IPY-OSC to Dr. Peter Harrison, Chair of the Montreal IPY "From Knowledge to Action" conference to be held in Canada in April 2012.

References

Winther, J.-G., 2010. Chair's Report from the Workshop on the legacy of the International Polar Year (including prioritized follow-up actions). 26 July 2010. Oslo, 24 pp. (PDF file)

Montreal 2012: From Knowledge to Action

Kathleen Fischer

The IPY 2012 Conference *From Knowledge to Action* will be the final major conference for International Polar Year 2007–2008. Building on the results of the IPY St. Petersburg Conference in 2008 and the IPY Oslo Science Conference in 2010, the focus of this conference is to apply the findings and knowledge gained from IPY to policies, programs, and practices and other actions. The idea of the 2012 'post-IPY' conference was first discussed at the JC-6 meeting in Québec, Canada, at which the Joint Committee held several sessions jointly with the

members of the Canadian IPY Committee and National Secretariat (*Chapter 1.5*). The Canadian proposal for hosting the final IPY conference in Montreal in April 2012 was discussed at several subsequent JC meetings and at the closing ceremony of the IPY Oslo Science Conference on 12 June, 2010, the IPY "torch" was symbolically passed from Norway to Canada as the future host of the next major IPY meeting (Fig. 5.6-8).

The objectives of the Montreal 2012 IPY international and interdisciplinary science-to-action conference include (www.ipy2012montreal.ca/050_program_e.



Fig.5.6-8. Olav Orheim, Chair of the IPY-OSC 2010 Steering Committee, handed over a Norwegian traditional "budstikke" (baton) to Peter Harrison, Co-Chair of Montreal 2012 'From Knowledge to Action' IPY Conference. (Photo: Jon-Petter Reinertsen)

shtml):

- Demonstrating and applying the findings and new knowledge gained through IPY research
- Assessing and synthesizing IPY scientific findings about polar regions and global systems
- Defining and addressing the key issues facing polar regions and identifying appropriate responses
- Using a common platform for scientists, policy-makers and Arctic peoples to discuss the implications of changing conditions in their regions and issues important to their health and well-being
- Conveying knowledge from IPY research effectively to key stakeholders
- Seeking opportunities to increase the application of polar research to benefit, not only the Poles, but the planet

This upcoming international forum of some 3000 participants, on 22–27 April 2012 will be a valuable opportunity to demonstrate and apply the latest findings of polar research on a broad range of topics from oceans and sea ice, to permafrost, vegetation and wildlife, to changes in Arctic communities and beyond (Fig. 5.6-9). The *From Knowledge to Action* Conference will present the highlights of IPY 2007–2008 and the recent polar science assessments that are advancing our knowledge of the polar regions. The Conference will draw on examples and best practices of the application of this knowledge to policies, programs and education, as well as to observation systems and networks and other actions. It is to bring together internationally-renowned polar researchers with policymakers, analysts, community members, industry representatives, non-governmental organizations and other interested groups to discuss the results of IPY 2007–2008, the largest-ever coordinated program of multi-disciplinary research in the earth's polar regions. In addition to presenting the current state and key changes in the polar regions and identifying actions that will be important in a global context, the Conference is also tasked with sharing results and providing the opportunity for participants to plan the future directions for polar science.

The 2012 Conference is being organized around four main areas:

1. *Highlight the latest polar science findings:* The Conference will be an opportunity for international researchers to present interdisciplinary research
2. *Synthesize knowledge and results into system-scale understandings:* The Conference will draw on IPY and other polar research along with recent assessments to provide a synthesis of knowledge in areas critical to the polar environments and the well-being of circumpolar and indigenous communities at different scales.
3. *Link knowledge to action:* The Conference will provide an opportunity for scientists, northern communities, policy-makers, industry and other stakeholders to discuss the application of the scientific results to issues facing the polar regions. Global change, community and ecosystem adaptation, resource development and conservation - what actions are required? The Conference will bring together those interested in the application of the latest polar science to address future actions and needs.
4. *Advance public engagement to further action on polar issues:* Engaging various audiences on polar science through communication, outreach,

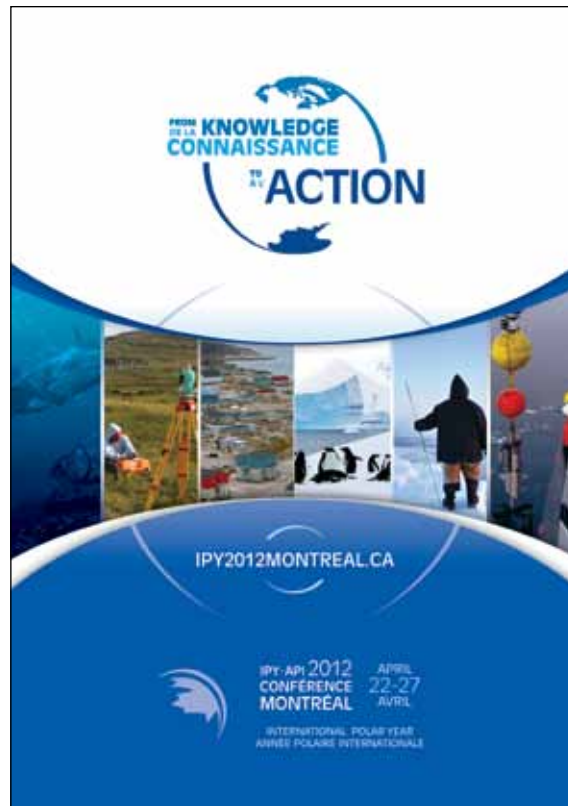


Fig. 5.6-9. Poster for the IPY 2012 'Knowledge to Action' Conference, 2010 (www.ipy2012montreal.ca/docs-pdf/IPY2012-poster.pdf)

capacity building, and education initiatives creates an informed citizenry with a deeper understanding of the importance of the polar regions and their role in global systems. Drawing on the expertise from other fields, sessions will be held on how polar science can enhance the flow of information between researchers and those interested in applying the new knowledge and information. A special emphasis will be placed under this area of the conference on communicating science to support the use and application of research results.

The planning for the Montreal 2012 Conference is being led by the Conference Steering Committee chaired by Dr. Peter Harrison, Stauffer-Dunning Chair and Director of the School of Policy Studies, Queen's University, Kingston, Ontario, Canada and Co-Chaired by Dr. Karl Erb, Director, U. S. National Science Foundation, Office of Polar Programs. The Conference Steering Committee of 12 members includes representatives from the World Meteorological Organization, International Council for Science, International Arctic Science Committee, Scientific Committee on Antarctic Research, International Arctic Social Sciences Association, International Union for Circumpolar Health, U.S. National Science Foundation, Association of Polar Early Career Scientists, Inuit Circumpolar Council, Forum for Arctic Research Operators, and the Council of Managers of National Antarctic Programs. The IPY

2012 Conference Secretariat has been set up within the Northern Affairs Organization, Department of Indian and Northern Affairs, Canada with responsibility for the daily organization, planning and coordination of the IPY 2012 Conference, in partnership with the National Research Council of Canada.

The Conference Steering Committee has held several meetings in 2010 in preparing the draft of the Conference program. Keynote speakers, numerous plenary, concurrent and poster sessions, as well as panel discussions and special events are being planned. In addition, workshops, interactive presentations, and roundtables will provide conference participants with the opportunity to discuss the application of the IPY research findings, the policy implications and how to take the polar science advances during IPY 2007–2008 from knowledge to action (www.ipy2012montreal.ca/001_welcome_e.shtml).

The 2012 Montreal Conference will be the largest concluding event associated with IPY 2007–2008 (Fig.5.6-10). By the time of the conference, major results of IPY and polar science, observational, and other activities will be circulating within the international science community. The conference will then become the major next step in making those IPY writings, data and records relevant to policy-makers, polar communities and indigenous residents, science managers, educators, and public at large.

Fig.5.6-10. The IPY 2012 Conference will be hosted in the vibrant, cosmopolitan city of Montréal at the Palais des Congrès in downtown Montréal. (Courtesy: Palais des Congrès, Montreal)



International Polar Decade¹

Eduard Sarukhanian and Odd Rogne

Reviewer:

Anders Karlqvist

Introduction

The idea to launch an International Polar Decade (IPD), based on scientific advances and lessons learned during IPY 2007–2008, was first discussed at and supported by the 60th session of the WMO Executive Council in June 2008 (WMO, 2008).

The Council recognized the success of IPY's first year; the large investments made by governments to this international campaign and the growing requirements of the scientific and local communities to continue sustained observations and research in the polar regions beyond IPY 2007–2008. Consequently, the Council proposed that WMO, in consultation with ICSU and other international organizations, consider the launch of an International Polar Decade as a long-term program for research and observations in polar regions.

The IPD idea was subsequently discussed at several international fora, including the conference, *The Arctic: Observing the Environmental Changes and Facing their Challenges* organized by the European Union (Monaco, November 2008); the Conference on the IPY Legacy organized by UNESCO (Monaco, March 2009); and the workshop, *Space and the Arctic* sponsored by the European Commission, European Space Agency (ESA) and EUMETSAT (The European Organisation for the Exploitation of Meteorological Satellites, Stockholm, October 2009).

The IPD initiative was also considered by IASC (Bergen, March 2009) and by the Sixth Ministerial Meeting of the Arctic Council (Tromsø, April 2009), where Ministers representing the eight Arctic States “welcomed commitments to deliver a lasting legacy from the IPY and decided to consider the proposal to arrange an International Polar Decade” (Tromsø Declaration, 2009). Two weeks earlier, the Antarctic Treaty Consultative Meeting (April 2009) called on members to “work with SCAR and COMNAP to maintain, extend and develop long-term scientific monitoring and scientific observations in Antarctica and the surrounding Southern Ocean” (Resolution 9-ATCM XXXII).

Noting the general positive response to the

IPD initiative expressed by the international polar community, the 61st session of the WMO Executive Council (June 2009) requested its Panel on Polar Observations, Research and Services (EC-PORS) to consider modalities and plans for the IPD, focusing on decadal needs and issues of long-term character in order to make recommendations to the Council. The first session of EC-PORS, held in Ottawa, Canada in October 2009, was very supportive of launching the IPD. The session participants recognized the need to engage a broad spectrum of partners, including those outside the physical science community (social sciences, human health research, etc.). They also noted the significant contribution that space agencies made to IPY 2007–2008. The next session of EC-PORS, held in Hobart, Australia in October 2010, was charged with considering this broader IPD concept based on communications with interested parties.

IPD scientific requirements

The IPD concept can be developed using the major findings and conclusions of IPY 2007–2008 as outlined in the Joint Committee's Statement (Allison et al., 2009) and expanded in this Summary Report. The starting point is recognizing that the polar regions are an integral and rapidly changing part of the Earth system and have an influence on the rest of the globe. Preliminary IPY findings reveal new evidence of the widespread effects of global warming in the polar regions *inter alia*:

- Greenland and Antarctic ice sheets are losing mass, contributing to the sea level rise.
- The minimum extent of year-round sea ice in the Arctic decreased during summer 2007 to its lowest level since satellite records began 30 years ago; an unprecedented rate of sea-ice drift was observed.
- Large pools of carbon are stored as methane in permafrost. Thawing permafrost threatens to destabilize the stored methane, an active greenhouse gas, and send it into the atmosphere. Substantial

emissions of methane from ocean sediments were observed along the Siberian Arctic coast.

- The types and extent of vegetation in the Arctic have shifted, affecting grazing animals and local economies based on hunting and reindeer-herding.
- The Southern Ocean, particularly the southern flank of the Antarctic Circumpolar Current, has warmed more rapidly than the global ocean average, and a freshening of the bottom water near the Antarctic continent is consistent with the increased ice melt that could affect ocean circulation.

These phenomena were discovered during a relatively short period of time during IPY 2007–2008, which resulted in a valuable snapshot of the polar environment. What environmental changes can we expect in the near future? Will people be prepared to meet those changes and secure a sustainable socio-economic development? To answer these and similar questions, it is necessary to develop proper techniques for climate change prediction. One main problem is the predictability of polar climate. Given that high latitudes are areas where decadal variability prevails, knowledge about polar climate change and its long-term variability could provide opportunities for developing reliable climate predictions for the polar regions that would also help assess global climate change. Polar predictability is one of the main drivers of IPD. IPD results would then help develop environmental prediction techniques that will be extremely important for industrial, social, cultural and other activities in the Arctic, such as life support, protection of the environment, transport, defence, resource exploration and extraction.

During IPY 2007–2008, significant emphasis was given, for the first time, to human and social issues, and to the concerns of local and indigenous peoples, such as requirements for sustainable development, impacts of globalization, human wellbeing, culture and health. Local communities have joined several IPY monitoring networks to collect and document changes in weather and climate, sea ice, biota and the ongoing community adaptation to these changes. The results of these activities during IPY (*Chapters 2.10, 3.10*) would form a basis for an IPD human and societal-oriented component.

IPD objectives

As a starting point for discussion, the main objectives of the International Polar Decade may be formulated as follows:

- To address critical long-term issues for developing and improving international cooperation in polar research and observation.
- To integrate observations through modern data assimilation systems, and use them in weather, climate and environmental prediction systems.
- To assess the ecological state of the polar environments and develop measures for reducing the negative impact of pollution on polar populations and ecosystems.
- To increase the level of science and education in the field of polar research and raise the awareness of the general public.
- To assess the consequences of polar climate change, in order to develop adaptive measures for growing industrial and social infrastructures and protection for resident populations in the polar regions.

IPD observing structure

IPY 2007–2008 has shown the feasibility of addressing key environmental and social issues in the polar regions, but their complex nature requires a systematic and sustained approach. This requirement is consistent with several major initiatives that form the core of the legacy of IPY observing systems. Detailed descriptions of these initiatives are provided in Part 3. It is proposed that these initiatives, in particular SAON (*Chapter 3.8*), IASOA (*Chapter 3.4*), iAOOS (*Chapter 3.2*), SOOS (*Chapter 3.3*), GCW (*Chapter 3.7*), Sea Ice Outlook (*Chapter 3.6*), CBMP (*Chapter 3.9*) and the Human-based observing systems (*Chapter 3.10*) should be considered as building blocks for the framework of observing systems to be developed during the IPD. Some long-term ongoing IPY projects should also be considered as possible candidates for including in this IPD framework.

IPD research criteria

As in IPY 2007–2008, a set of well-defined criteria is needed in order to select the most promising IPD activities that would complement each other. At this

stage, it may be sufficient to list at least three critical features of the prospective IPD initiatives:

- cover decadal phenomena (e.g. climate variability);
- require international cooperation;
- address important societal needs.

Nevertheless, these (and other) criteria should be refined through coordinated findings and by the input from prospective stakeholders.

Organizational steps

To define the scientific concept of IPD and its prospective observing and organizational structure, it is necessary to engage those international organizations that have strong interest in polar research, such as WMO, ICSU, UNESCO and its programs, such as IOC, UNEP, among others. The Arctic Council and the Antarctic Treaty Parties with IASC and SCAR, should play the leading role in the organization and development of long-term strategies for polar research, monitoring and management. APECS, as important component of the IPY legacy, is another key group to take IPD forward.

A critical issue in IPY 2007–2008 was to secure internationally coordinated funding. Today, as many IPY activities are winding down, polar research is still primarily based on national government funding. Various national funding agencies have their own research priorities and procedures. A possible next step is to bring science funders and fund managers together to identify common themes that meet their priorities and to consider mechanisms for coordinated funding (a consortium). Similar to the beginning of IPY 2007–2008, a broad marketing effort would be needed for IPD, as well as for polar research in general. Therefore, it is highly desirable to involve the International Group of Funding Agencies for Global Change Research (IGFA) and the European Science Foundation in the IPD process, in addition to the individual national funding agencies.

To broaden the way the IPD is framed and to engage the broader community, it is proposed that a

series of workshops, focused on the IPD program, be organized. Such workshops should include some key funders, not only from research funding agencies, but also from operational agencies that have the mandate to make sustained observations. These international organizations would also ensure connections with GCOS, GOOS and other global observing systems. As for polar research and prediction, the four global environmental change research programs would need to be engaged as should be various ICSU Scientific Unions and the WMO technical commissions.

The purpose of such planning workshops should be clear, as should be the overall purpose of IPD. It is thus desirable to develop a succinct and broadly supported statement outlining the IPD concept, what IPD aims to achieve and its potential benefits. An important outcome of these workshops would be to identify partners and stakeholders for IPD by forming a joint body that would develop a science and implementation plan for IPD and provide the oversight and guidance for its organization and funding. This is another valuable lesson of the planning and implementation of IPY 2007–2008 that will be carried into the future.

References

- Tromsø Declaration, 2009. Tromsø Declaration on the occasion of the Sixth Ministerial Meeting of The Arctic Council, 29 April, 2009, Tromsø, Norway. <http://arctic-council.org/filearchive/Tromsoe%20Declaration-1..pdf>
- WMO, 2008. WMO Executive Council Sixtieth session. Geneva, 18–27 June 2008. Abridged final report with resolutions. *WMO-No. 1032* pp. 61–62. ftp://ftp.wmo.int/Documents/PublicWeb/mainweb/meetings/cbodies/governance/executive_council_reports/english/pdf/60_session_wmo_1032_part1_en.pdf

Notes

¹ The status of the International Polar Decade proposal is discussed here as of June 2010 – ed.