

# IASC 08/09

BULLETIN

## [IASC] · INTERNATIONAL ARCTIC SCIENCE COMMITTEE

The International Arctic Science Committee (IASC) is a non-governmental, international scientific organization established to encourage, facilitate and promote leading-edge multi-disciplinary research to foster a greater scientific understanding of the arctic region and its role in the Earth system.

### TO ACHIEVE THIS MISSION IASC:

- Initiates, coordinates and promotes scientific activities at a circumarctic or international level;
- Provides mechanisms and instruments to support science development;
- Provides objective and independent scientific advice on issues of science in the Arctic and communicates scientific information to the public;
- Seeks to ensure that scientific data and information from the Arctic are safeguarded, freely exchangeable and accessible;
- Promotes international access to all geographic areas and the sharing of knowledge, logistics and other resources;
- Provides for the freedom and ethical conduct of science;
- Promotes and involves the next generation of scientists working in the Arctic; and
- Promotes bipolar cooperation through interaction with relevant science organizations.

The IASC Secretariat implements decisions of the Executive Committee and Council, manages IASC finances, conducts outreach activities and maintains international communication.



IASC Bulletin 08/09

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## [IASC] · STRUCTURE

Representatives of national scientific organizations from all 19 member countries form the IASC Council. The President of IASC is elected by Council, which also elects 4 Vice-Presidents to serve on the Executive Committee. Council usually meets once a year during the Arctic Science Summit Week, ASSW. IASC Executive Committee operates as a board of directors and manages the activities of IASC between Council meetings. The Chair is the President of IASC.

### IASC MEMBER COUNTRIES

|                   |  |  |
|-------------------|--|--|
| Canada            | Canadian Polar Commission                                      | <a href="http://www.polarcom.gc.ca">www.polarcom.gc.ca</a>                                     |
| China             | Chinese Arctic and Antarctic Administration                    | <a href="http://www.chinare.gov.cn">www.chinare.gov.cn</a>                                     |
| Denmark/Greenland | The Commission for Scientific Research in Greenland            | <a href="http://www.fi.dk">www.fi.dk</a>   |
| Finland           | Delegation of the Finnish Academies of Science and Letters     | <a href="http://www.tsv.fi/international/akatemiati/">www.tsv.fi/international/akatemiati/</a> |
| France            | Institut Polaire Français                                      | <a href="http://www.institut-polaire.fr">www.institut-polaire.fr</a>                           |
| Germany           | Deutsche Forschungsgemeinschaft                                | <a href="http://www.dfg.de">www.dfg.de</a>   |
| Iceland           | RANNÍS, The Icelandic Centre for Research                      | <a href="http://www.rannis.is">www.rannis.is</a>   |
| Italy             | National Research Council of Italy                             | <a href="http://www.cnr.it">www.cnr.it</a>   |
| Japan             | Science Council of Japan, National Institute of Polar Research | <a href="http://www.nipr.ac.jp">www.nipr.ac.jp</a>   |
| The Netherlands   | Netherlands Organisation for Scientific Research               | <a href="http://www.nwo.nl">www.nwo.nl</a>   |
| Norway            | The Research Council of Norway                                 | <a href="http://www.forskingsradet.no">www.forskingsradet.no</a>                               |
| Poland            | Polish Academy of Sciences, Committee on Polar Research        | <a href="http://www.polish.polar.pan.pl">www.polish.polar.pan.pl</a>                           |
| Russia            | The Russian Academy of Sciences                                | <a href="http://www.ras.ru">www.ras.ru</a>   |
| Republic of Korea | Korea Polar Research Institute                                 | <a href="http://www.kopri.re.kr">www.kopri.re.kr</a>   |
| Spain             | Comité Polar Español   | <a href="http://www.micinn.es">www.micinn.es</a>   |
| Sweden            | The Swedish Research Council                                   | <a href="http://www.vr.se">www.vr.se</a>   |
| Switzerland       | Swiss Committee on Polar Research                              | <a href="http://www.polar-research.ch">www.polar-research.ch</a>                               |
| United Kingdom    | Natural Environment Research Council                           | <a href="http://www.nerc.ac.uk">www.nerc.ac.uk</a>   |
| USA               | Polar Research Board   | <a href="http://www.dels.nas.edu/prb/">www.dels.nas.edu/prb/</a>                               |



PHOTO: OLAF JUSCHUS

The drilling platform Russian GLAD 800 on Lake El'gygytgyn, northeastern Russia. Between October 2008 and May 2009, an international team of scientists from Russia, Germany, the USA and Austria staged scientific drilling operations at Lake El'gygytgyn, located in a 3.6 Million year old impact crater. The retrieved cores will provide new insights into the millennial-scale climate evolution of the Arctic, the formation of the impact crater, and the history of the permafrost. The completion of the project marked the end of years of challenging logistical planning and the development of international partnerships to share in the scientific goals.

A wide-angle photograph of an Arctic landscape. In the foreground, there is a flat, icy plain with two yellow shipping containers. In the middle ground, a large, rounded, brownish hill dominates the view. The sky is a clear, pale blue. The text 'IASC 08/09' is overlaid in white, sans-serif font across the middle of the image.

# IASC 08/09

BULLETIN

[IMPRINT]

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COVERPHOTO: MARTIN FORTIER

Scientists are sampling newly formed pancake sea ice in the Beaufort Sea. The scientists are lowered in a cage from the research icebreaker CCGS Amundsen as part of ArcticNet's annual expedition to the coastal Canadian Arctic.

# [CONTENT]

## PREFACE

### 1 IASC Internal Development

|                          |    |
|--------------------------|----|
| Organization .....       | 10 |
| IASC in Transition ..... | 11 |
| Membership News .....    | 12 |
| Secretariat .....        | 16 |

### 2 Relationship to Other Organizations

|  |    |
|--|----|
| Introduction .....   | 20 |
| New Partnership Agreements .....                               | 21 |
| Arctic Ocean Sciences Board (AOSB) .....                       | 24 |
| International Arctic Social Sciences Association (IASSA) ..... | 28 |
| World Climate Research Programme (WCRP) .....                  | 30 |
| International Association of Cryospheric Sciences (IASC) ..... | 31 |
| Scientific Committee on Antarctic Research (SCAR) .....        | 32 |

### 3 Arctic Science Summit Week 2009

|   |    |
|---|----|
| Introduction .....                              | 38 |
| Open Science Symposium .....                    | 39 |
| Keynote Speakers .....                          | 39 |
| Sessions Reports .....                          | 49 |
| Summary of the Business Meetings .....          | 62 |
| Forum of Arctic Research Operators (FARO) ..... | 62 |
| Pacific Arctic Group (PAG) .....                | 63 |
| European Polar Board (EPB) .....                | 65 |
| Arctic Science Summit Week 2010 and 2011 .....  | 67 |

### 4 Major International Science Initiatives

|   |    |
|---|----|
| Sustaining Arctic Observing Networks (SAON) .....   | 70 |
| Climate Change and the Arctic Cryosphere: Snow, Water, Ice and Permafrost in the Arctic (SWIPA) ..... | 73 |
| International Polar Year (IPY) 2007-2008 ....   | 77 |

### 5 IASC Networks

|  |    |
|--|----|
| Network on Arctic Glaciology (NAG) .....           | 84 |
| Polar Archeology Network (PAN) .....               | 88 |
| Arctic Palaeoclimate and its Extremes (APEX) ..... | 90 |
| Arctic Coastal Dynamics (ACD) .....                | 95 |

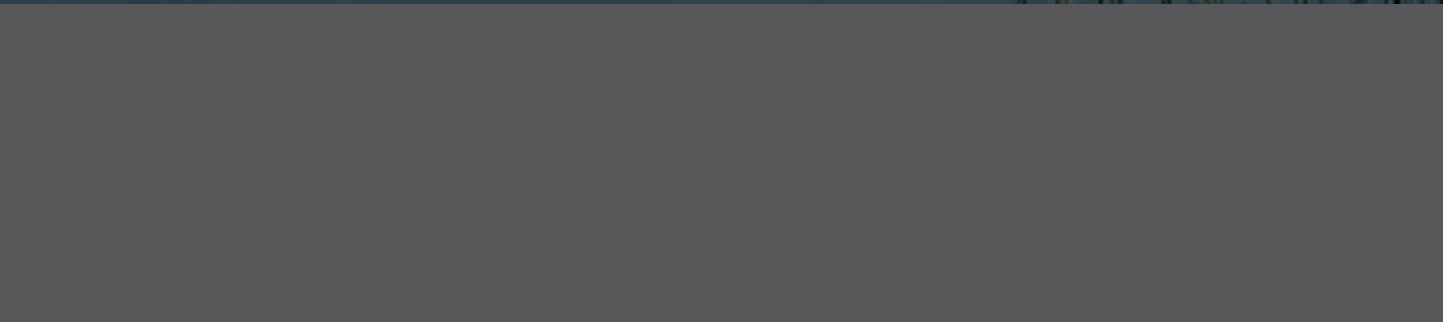
### 6 Early Career Development

|  |     |
|--|-----|
| IASC Stimulates Early Career Scientists .....              | 100 |
| Association of Polar Early Career Scientists (APECS) ..... | 103 |

## ANNEX

|   |     |
|---|-----|
| Annex 1   |     |
| Merger between AOSB and IASC .....  | 104 |
| Annex 2   |     |
| Letter of Agreement (LoA) between the Pacific arctic group (PAG) and IASC .....   | 105 |
| Annex 3   |     |
| Memorandum of Understanding (MoU) between the International Permafrost Association (IPA), Scientific Committee on Antarctic Research, (SCAR) and IASC ..... | 108 |
| Annex 4   |     |
| List of Acronyms and Abbreviations .....  | 111 |

[PREFACE]



The purpose of this yearbook, the IASC Bulletin 08/09, is to distribute IASC information to the arctic research community. The IASC Bulletin generally covers the period between two Arctic Science Summit Weeks (ASSW), ending with a report of the latter.

The reporting period for this third IASC yearbook falls within the International Polar Year (IPY) 2007-2008 and its aftermath, which had a tremendous effect on the arctic science community, including arctic science organizations involved in planning and coordination of international arctic research, such as IASC. A collective volume summarizing the IPY activities is currently being prepared by the IPY Joint Committee. IASC is a major contributor to this IPY summary report, which is envisioned to become the lead reference source on the origin, planning, and implementation of IPY 2007-2008.

After the success of the mid-term IPY Conference that was jointly organized by IASC and its Southern Hemisphere partner organization, the Scientific Committee on Antarctic Research (SCAR), in St. Petersburg (Russia) in July 2008, IASC, with its partners, began planning the next two IPY Conferences: the IPY 2010 Oslo and the IPY 2012 Montreal Conferences.

The IPY officially ended in February 2009, but it left an enormous legacy, which needs to be conserved and nurtured. IASC will play a major role in ensuring the success of the IPY legacy in terms of facilitating scientific cooperation and fostering the next generation of arctic researchers. A major challenge after the end of the IPY will be to ensure the conservation and availability of data and observations. With the Sustaining Arctic Observing Networks (SAON) initiative, IASC, the Arctic Council and the World Meteorological Organization (WMO) have set the course for the way forward.

Since the publication of the Arctic Climate Impact Assessment (ACIA) in 2005, IASC has closely cooperated with the Arctic Council, its working groups. IASC is

involved in the Arctic Council project "Climate Change and the Cryosphere: Snow, Water, Ice and Permafrost in the Arctic (SWIPA)", which is coordinated by the Arctic Monitoring and Assessment Programme (AMAP), the Climate and Cryosphere Project (ClC), the International Polar Year International Programme Office (IPY IPO) and the International Arctic Social Sciences Association (IASSA). The first component of the SWIPA project, the "Greenland Ice Sheet in a Changing Climate" report was recently presented at the UNFCCC COP15 meeting in Copenhagen in December 2009.

To further enhance scientific cooperation in the Arctic, IASC continues to strengthen its cooperation with other arctic science organizations and recently signed formal agreements with the Pacific Arctic Group (PAG) and the International Permafrost Association (IPA). The latter was jointly signed with SCAR.

The ASSW 2009 in Bergen (Norway) was the first annual gathering of the arctic science organizations that included a Science Symposium. This major event attracted over 300 scientists, students, policy makers and other professionals. Following the success of the Bergen meeting, IASC and its partner organizations involved in the ASSW have decided to arrange such a Science Symposium every second year. The next one will be held at the ASSW 2011 in Seoul, Korea.

One important step for IASC to underpin its role as the preeminent international science organization was the merger with the Arctic Ocean Sciences Board (AOSB), which was made official at the ASSW 2009.

We would like to thank everyone who contributed to the successful development of IASC during the past year. The support of the IASC Executive Committee and Council Members is vital to the success of IASC work in general.

**Kristján Kristjánsson** | IASC President

**Volker Rachold** | IASC Executive Secretary

PHOTO: TORSTEN SACHS

The Polar Bear Pass wetland area on Bathurst Island is the second largest wetland in the Canadian High Arctic. The wetland is a mosaic of land types comprising ponds, lakes and zones of dry ground that alternate with wet areas in a range of only a few meters.

PHOTO: JULIA LAROCHE  
Camping in the field





## 1. IASC Internal Development



# » 1 IASC Internal Development

## Organization

The International Arctic Science Committee (IASC) is a non-governmental organization that aims to encourage, facilitate and promote leading-edge multi-disciplinary research to foster a greater scientific understanding of the arctic region and its role in the Earth system.

IASC was established in 1990, began operations in 1991, and today comprises 19 member countries. The IASC member organizations are national science organizations covering all fields of arctic research.

| Country                  | Organization   | Representative                    |
|--------------------------|--|-----------------------------------|
| <b>Canada</b>            | Canadian Polar Commission                                      | David Hik   Vice-President        |
| <b>China</b>             | Chinese Arctic and Antarctic Administration                    | Liqi Chen                         |
| <b>Denmark/Greenland</b> | The Commission for Scientific Research in Greenland            | Naja Mikkelsen                    |
| <b>Finland</b>           | Delegation of the Finnish Academies of Science and Letters     | Kari Laine                        |
| <b>France</b>            | Institut Polaire Français                                      | G rard Jugie                      |
| <b>Germany</b>           | Deutsche Forschungsgemeinschaft                                | Dieter F tterer   Vice-President  |
| <b>Iceland</b>           | RANNIS, The Icelandic Centre for Research                      | Kristj n Kristj nsson   President |
| <b>Italy</b>             | National Research Council of Italy                             | Carlo-Alberto Ricci               |
| <b>Japan</b>             | Science Council of Japan, National Institute of Polar Research | Hiroshi Kanda                     |
| <b>The Netherlands</b>   | Netherlands Organisation for Scientific Research               | Louwrens Hacquebord               |
| <b>Norway</b>            | The Research Council of Norway                                 | Susan Barr                        |
| <b>Poland</b>            | Polish Academy of Sciences, Committee on Polar Research        | Jacek Jania                       |
| <b>Russia</b>            | The Russian Academy of Sciences                                | Vladimir I Pavlenko               |
| <b>Republic of Korea</b> | Korea Polar Research Institute                                 | Byong-Kwon Park   Vice-President  |
| <b>Spain</b>             | Comit  Polar Espa ol   | Manuel Catalan                    |
| <b>Sweden</b>            | The Swedish Research Council                                   | Magnus Friberg                    |
| <b>Switzerland</b>       | Swiss Committee on Polar Research                              | Hubertus Fischer                  |
| <b>United Kingdom</b>    | Natural Environment Research Council                           | Julian Dowdeswell                 |
| <b>USA</b>               | Polar Research Board   | Jackie Grebmeier   Vice-President |



## Council

Representatives of the national scientific organizations from the member countries form the IASC Council. Each national member organization has a mechanism to provide ongoing contact between its IASC Council Member and its arctic science community. The President of IASC is elected by Council, which also elects four Vice-Presidents to serve on the Executive Committee. Council usually meets once a year during the Arctic Science Summit Week (ASSW).

During this reporting period, Naja Mikkelsen (Geological Survey of Denmark and Greenland) replaced Tom Greiffenberg as the IASC Council representative for Denmark/Greenland and Hubertus Fischer (University of Bern) replaced Thomas Stocker for Switzerland.

## Executive Committee

The IASC Executive Committee operates as a board of directors and manages the activities of IASC between Council meetings. The Chair is the President of IASC.

**Kristján Kristjánsson** | President

**Dieter Fütterer** | Vice-President

**Jackie Grebmeier** | Vice-President

**David Hik** | Vice-President

**Byong-Kwon Park** | Vice-President

**Volker Rachold** | IASC Executive Secretary

## IASC in Transition

### FACING NEW CHALLENGES IN ARCTIC SCIENCE

Since the founding of IASC, the scientific, environmental, economic and political realities of the North have changed dramatically. New problems and challenges ask for new or improved scientific knowledge. This increased need for knowledge of the arctic region has made international cooperation even more essential. With the commitment, input and support from all its members and the arctic science community, IASC now has the chance to strengthen its position as the leading international organization of scientific expertise in the Arctic.

The core elements of the proposed IASC structure are the Scientific Standing Committees (SSCs) and Action Groups (AGs). The Standing Committees will identify and formulate science plans, act as scientific advisory boards to the IASC Council and will assist IASC in the implementation of its science mission.

### Role and responsibilities

Top scientist from all IASC member countries and ex-officio representatives from arctic organizations will be appointed to the Scientific Standing Committees.

PHOTO: CHINESE ARCTIC AND ANTARCTIC ADMINISTRATION

IASC Council today comprises of representatives from 19 member countries. All member countries run extensive and long-term research programs in the Arctic.

The structure is designed to facilitate international consultation and cooperation in all aspects of arctic research. In particular, the role and responsibilities of the new committees include:

- » **Identify priority areas for international research;**
- » **Encourage and support international scientific efforts;**
- » **Encourage the initiation, coordination and maintenance of long-term observational systems;**
- » **Address data management issues;**
- » **Ensure interaction with other relevant organizations;**
- » **Develop crosscutting proposals where appropriate;**
- » **Provide scientific advice to the Council and outside organizations;**
- » **Initiate conferences, workshops and educational events;**
- » **Promote future generations of arctic scientists;**
- » **Encourage the exchange and dissemination of information.**

### **Open Science Forum**

The proposed new IASC structure was presented to the public at the Science Forum held during the ASSW 2009. All five Interim Chairs, - Terry Callaghan, Martin Sharp, Harald Loeng, Louwrens Hacquebord and James Overland - presented the scientific foci and cross cutting issues of their SSC and welcomed questions from the audience. Most professionals, early career, and renowned scientists in the audience saw great opportunities of collaboration and more action orientated science initiatives.

At the same time, these experts shared the concern that the potentially large bureaucracy could slow operations. Different experts also highlighted the importance of involving non-scientific organizations and indigenous representatives.

The process of constructing and setting up the new structure will enter the final phase in the summer of 2010 to apply and integrate the responses received at the forum meeting and additional input from IASC member countries. The final goal will be to create a new structure that reflects the more integrative nature of today's polar science.

## Membership News

### **SPAIN BECOMES 19TH IASC MEMBER**

During the ASSW in Bergen, Spain was officially welcomed as the 19th IASC member country. Manuel Catalan represent The Spanish Polar Committee in the IASC Council. Spain began its polar institutional program in 1988 with the first Spanish Antarctic base Juan Carlos I, soon followed by the second base Gabriel de Castilla. In parallel with the Antarctic activities a number of Spanish researchers began participating in international scientific research programs in the Arctic. In 2008 the Spanish research vessel Hesperides sailed off on its first oceanographic expedition in the Arctic Ocean. Overall Spanish initiated polar research has expanded over the last decades with over 150 researchers participating in polar campaigns.

WRITTEN BY: Manuel Catalan | Comité Polar Español

The historical approach of Spain to the polar regions follows the discovery of America. In successive steps along the 16th, 17th, and 18th centuries, Spanish researchers charted the coasts of America and adjacent islands, from the northern Atlantic mid-latitudes, to Cape Horn, and from Cape Horn to the northernmost

tip of America. In these centuries, Spanish cartographers and scientists explored the Southern Pacific, describing in charts and publications, the Southern Ocean and the newly discovered lands.

In the Pacific, the high latitude coast of North America was explored by successive expeditions of Spanish navigators, reaching 60° N, when in 1791, Dionisio Alcalá Galiano and Cayetano Valdés reached the Strait of San Juan de Fuca. The expedition of Malaspina and Bustamante can also be seen as an outstanding example of the Spanish marine research in the high latitudes. The two men and their crew left for their expedition on the 30th of July 1789, they sailed from Cadiz. By the time they reached Mexico in 1791 they received a dispatch from the king to search for the possible existence of a Northwest Passage connecting the Pacific Ocean and the Atlantic Ocean through the Arctic and they headed for Yakutat Bay, Alaska. Between 59°N and 61°N, they searched the islands for a passage but concluded that the sound mentioned by Maldonado, an ancient Spanish navigator, did not exist.

The development of an 'exploration enterprise', at such a grand scale was only possible with the support of



La Casa de la Contratación, founded at Seville in 1503 as a school for navigation with the intention of creating the first Maritime University. The center was also responsible for keeping the Padron Real, a top-secret universal navigation chart, to which observations and discoveries from each voyage were submitted. These ancient research voyages and the Maritime La Casa de la Contratación contributed, beside the geography extension, to the scientific knowledge of the botany, mineralogy and navigation in both hemispheres covering all known latitudes

### **Present scientific structure in the polar regions**

After two centuries of absence from polar research, Spain returned to its historical bipolar interest in high latitude science and became an Observer State in the Antarctic Treaty in 1982, an Antarctic Treaty Consultative Member in 1988, a SCAR member in 1990, a COMNAP member in 1998, an Observer State in the Arctic Council in 2006 and a member of IASC in 2009. At present, the Spanish polar research land infrastructure includes the Juan Carlos I Antarctic Base, located in Livingston Island, and the Gabriel de Castilla Antarctic Base, located in Deception Island. Both bases are in the South Shetland Islands.

For oceanographic research Spain has two oceanographic vessels. The R/V Hesperides, launched in 1990 and commissioned in 1991, and the R/V Sarmiento de Gamboa commissioned in 2007. Both vessels have a displacement close to 3000 Tm, including updated scientific facilities and equipment to allow all kinds of oceanographic research. R/V Hesperides has an ice-strengthened hull and has participated in the Spanish Polar campaigns. The R/V Las Palmas is a 1500-ton ocean tug launched in 1978. In 1988 it was rebuilt as a logistic vessel with limited oceanographic possibilities. It has an ice-strengthened stern that allows for navigation in high latitudes.

Portrait of Alessandro Malaspina, a Spanish naval officer and explorer. In the company of José de Bustamante y Guerra, he explored the possible existence of a Northwest Passage connecting the Pacific Ocean and the Atlantic Ocean through the Arctic.



The polar national authority is the Spanish Polar Committee (CPE), an inter-ministerial committee that coordinates the polar activities with direct support from the Ministry of Science and Innovation (General Directorate of International Cooperation and Institutional Relationships). The National Research Program determines all matters related to the scientific programs in both polar regions, including the evaluation, approval and financing of the research programs. The Technical Marine Unit (UTM/CSIC) manages the Juan Carlos I Antarctic Base and provides logistic support for the polar campaigns of Spain. The Army manages the Antarctic Base Gabriel de Castilla. The R/V Hesperides and the support vessel Las Palmas are Navy owned ships.

## **Polar research programs**

A considerable number of Spanish researchers are presently working in programs and projects related to the Arctic. Many of these research campaigns are developed in cooperation with polar colleagues from centers and laboratories lead by the arctic countries and cover practically all science disciplines.

During the IPY, Spain carried out seventeen projects: four Arctic, nine Antarctic, three bipolar and one subpolar. Four of these projects were performed with the R/V Hesperides (two in the Arctic and two in the Antarctic). Six projects were developed on the Spanish Polar Bases and field camps. In addition, it must be pointed out that Spanish scientists, using other countries' infrastructure, carried out significant research during the IPY at both poles, but mainly in the Arctic.

PHOTO: MAJA KIRKEGAARD  
Sea ice



## A look to the future

Spanish scientists are more and more interested in the necessary bipolar research approach. In this sense most of the researchers are considering it necessary to understand both poles' ecosystem changes, and responses to new pressures arising from climate change. This is especially true considering that the spectacular recent acceleration of ice loss of the Arctic Ocean and glaciers, suggests that climate change could be entering a new phase, identified as one of the key elements in the world climate system.

Besides the national program, Spanish researchers participate in the working groups and steering committees in two of the seven European Framework Programmes (HERMIONE and Arctic Tipping Points). Spanish researchers will also participate in the European Science Foundation Polar Climate Programme, which aims to address wide issues of

scientific importance at the European and global scale and to fully utilize and facilitate access to arctic and antarctic research facilities that are operated by national polar organizations. These challenges include dealing with the threats posed to populations in the context of climate change.

Hundreds of Spanish polar researchers in our scientific institutions and universities have competitive possibilities to work on Spanish oceanographic vessels and antarctic bases and have access to major pieces of advanced instrumentation, as could be required for polar research. Our polar scientific facilities are specifically open to cooperate with colleagues from all countries to face the present challenges of polar research, addressing interhemispheric comparisons to better understand the drivers and impacts of climate variability in the Arctic and Antarctic.

PHOTO: SUSANA AGUSTI

Spanish researchers are sampling sea ice during one of their expedition on the research vessel Hesperides.

# Secretariat

It was quite a move, but as of March the IASC Secretariat in Potsdam, Germany, is fully manned and up and running. For the period of five years, the new secretariat will be hosted by the Alfred Wegener Institute (AWI) for Polar and Marine Research and co-financed by the German Science Foundation. The AWI is Germany's leading institute for polar and marine research and conducts research in the Arctic, Antarctic and at temperate latitudes.

The new secretarial support staff, Heike Midleja and Mare Pit, has set up its workplace at the Telegrafenberg in Potsdam and will be assisting the Executive Secretary Volker Rachold. Sara Bowden, Secretary of the Arctic Ocean Sciences Board (AOSB), joined the IASC Secretariat staff after the IASC and AOSB merger. Her office remains in the United States.

The Secretariat is responsible for the daily operations of IASC including:

**Communicating with Council Members;**

**Communicating with other organizations including the Arctic Council and its subsidiary bodies and ICSU;**

**Publication of the IASC Bulletin and IASC material as required;**

**Maintaining the IASC web site, preparing the IASC newsletter Progress, and in general facilitating outreach;**

**Administration of IASC finances.**

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PHOTO: ANNA SUNDIN

In 2009 the IASC Secretariat moved from Sweden to Germany. The Secretariat is hosted by the Alfred Wegener Institute in Potsdam and is responsible for IASC's daily operations.

PHOTO: MAJA KIRKEGAARD  
A helicopter is hovering above a small landing platform in Mestersvig  
(East Greenland).



## 2. Relationship to Other Organizations

## » 2 Relationship to Other Organizations

IASC has worked towards strengthening its relationship with other polar and global organization through the years. The merger with the Arctic Ocean Sciences Board (AOSB), the Letter of Agreement with the Pacific Arctic Group (PAG) and Memorandum of Understanding signed with the International Permafrost Association and the Scientific Committee on Antarctic Research (SCAR) in the past year are good examples. Different organizations are strong recurring partners in promoting arctic and bipolar science. For the IASC Bulletin some of these organizations were asked to highlight their past, present and current activities. These are all initiatives that IASC believes are of value for the broader arctic research community and very often are supported by the committee.

Although the formal relationship with AOSB has changed after the merger, their science report covers activities decided upon before this step and are therefore included in this chapter. Other organizations highlighted in this chapter are: the International Arctic Social Sciences Association (IASSA), the World Climate Research Program (WCRP), the International Association of Cryospheric Sciences (IACS) and the Scientific Committee on Antarctic Research (SCAR).



PHOTO: COLLIN FAIR

A Zodiac is prepared outside Pangnirtung, Nunavut (Canada) during the Students on Ice expedition of 2009. In marine studies it has also become clear that to try and understand the ocean without understanding the atmosphere above it, the people who live off it, the land that surrounds it and the rivers that discharge into it, is counterintuitive.

# New Partnership Agreements

## Joint future for AOSB and IASC



### MERGER AGREEMENT BETWEEN AOSB AND IASC

WRITTEN BY: Sara Bowden | Secretary Arctic Ocean Sciences Board

The merger of the Arctic Ocean Sciences Board (AOSB) and IASC was made official at the IASC Council meeting in Bergen. The choice for a joint future was made in light of the growing integration of arctic programs as well as the strategic need to address issues affecting both the physical and social sciences. Both organizations believe that the merger will strengthen their ability to develop crosscutting programs that reach out to local residents, indigenous populations and the global community. The combining of resources and scientific expertise creates inherent benefits in impacting politicians and funding officials.

AOSB remains committed to facilitating research in the Arctic Ocean and surrounding seas through the support of multinational and multidisciplinary natural science and engineering program. This mission will be carried out within the broader goal of IASC to encourage, facilitate and promote leading-edge multi-disciplinary research to foster a greater scientific understanding of the arctic region and its role in the Earth system.

### Joint ventures

AOSB has a long history of facilitating collaboration and cooperation among countries interested in multinational and multidisciplinary science. In 1984, a small

group of visionary scientists realized that through regular communication, coordination of activities, and long-term planning, they could accomplish more by working together than through their individual efforts. Their vision became a reality, resulting in many worthwhile joint ventures yielding significant benefits to the arctic science community. Among its many successful programs are the Greenland Sea Project, jointly sponsored with the International Council for the Exploration of the Sea (ICES); the International Polynya Program; the Arctic Subarctic Ocean Fluxes program; and most recently, the integrated Arctic Ocean Observing System program (iAOOS).

The vision articulated in 1984 continues today, but in a very changed environment. As noted in the ICARP II Report: *"The Arctic is a unique and important part of the Earth system, environmentally, socially, economically and politically. It surrounds a northern polar sea strategically positioned between two continents and bridging eastern and western societies. How the Arctic system works, how it is changing, and what it will be like in the future are important questions being asked by policy makers, land use managers, and people who reside in the Arctic."* To separate this polar sea from the other environmental and social activities in the Arctic was counterproductive.

### Combining efforts

To try and understand the ocean without understanding the atmosphere above it, the people who live off it, the land that surrounds it and the rivers that discharge into it, is counterintuitive. Combining our efforts to understand the Arctic Ocean and its biology and history with science programs promoted by IASC would benefit the scientific community, the people who live in the Arctic and the global community who deserve to understand better the changes taking place there. The ICARP II Report went on to say: *"It became clear during the work of the Conference that the Arctic is a system that can no longer be divided into traditional disciplines. The linkages to other disciplines and other knowledge systems and to the global system*

are critical and must be addressed in the post-conference process.” This merger undertakes to implement this recommendation.

As the Scientific Standing Committee (SSC) for Marine Sciences, AOSB will expand its membership to include all the IASC member countries, and will have a natural mechanism to promote interdisciplinary programs with other scientific standing committees. Already, the AOSB has begun discussions with the SSC for Atmosphere to plan interdisciplinary activities related to biological and hydrochemical feedbacks in the Arctic Ocean and how they impact and are impacted by the atmosphere.

The Board looks forward to working with IASC to fulfill its mission. The years ahead promise to be very exciting.

[www.aosb.org](http://www.aosb.org)

## Official recognition of a long history of co-operation



### LETTER OF AGREEMENT BETWEEN PAG AND IASC

WRITTEN BY: John Calder | Chair Pacific Arctic Group

The Pacific Arctic Group (PAG) was created in 1999 to enhance discussions of science issues related to the Pacific Arctic region, in particular from the perspective of Asian countries. Especially in the light of the current IASC merger with AOSB, tightening the relationship with PAG is a natural course. A course that recognizes the large area of common interests including physics of the ocean and sea ice, ecology and biogeochemistry, geology and environmental modeling.



The LoA states the joint support of education and outreach efforts and includes working together to advise policy- and decision-makers who require scientific information as the basis for their actions. By working closely together, IASC and PAG will avoid duplication of efforts and identify common opportunities.

IASC was founded in 1990 with initial an initial membership of the USSR and several European and North American nations. Over time membership grew to including several Asian nations. To provide a focal point for discussion of science of particular interest to these new members, and also to enhance discussion of arctic science issues from a pacific perspective, IASC agreed formally in 2003 to create the PAG as a subset of IASC, with its own leadership and secretariat.

### Basic objectives

Participants in PAG established four basic objectives: **1)** To facilitate and coordinate science operations among PAG member countries; **2)** To promote and facilitate data accessibility and integrated data bases for the region; **3)** To serve as a forum for information exchange on Pacific Arctic Region (PAR) science programs; and **4)** To establish and maintain a direct link between PAG and other relevant science organizations. PAG has adopted eleven science themes that describe its interests and provide motivation for the work of the involved nations and scientists.

From left to right

1. After the signing of the documents for the official merger between AOSB and IASC, the AOSB Chair, Harald Loeng (right), and IASC President Kristján Kristjánsson (left) toast on a successful cooperation.



In 2008, IASC developed a plan for restructuring itself and determined that PAG had developed sufficient strength that it could stand on its own as a separate organization, and PAG members agreed. Yet the scientific interests of PAG and IASC retain much in common, and it is in the interests of both groups to maintain strong coordination and collaboration. PAG agreed to enter into a formal agreement with IASC that would set forth the rationale and objectives for continued strong interaction between the two groups.

### Discovering new science interests

From PAG's perspective, continuing to associate with IASC is deemed important for demonstrating that PAG intends to be a part of the international community of arctic scientists. Additionally, while PAG has a regional focus, its science themes relate to issues found throughout the Arctic and that requires a more comprehensive approach to achieve the desired level of understanding. Associating with IASC and its Scientific Standing Committees is an effective way of engaging with scientists working in other areas of the Arctic. As the diverse SSCs are populated, PAG may discover new science interests and engage new – to PAG – scientists to address these issues. Traditionally PAG and IASC have come together during the ASSW. With the new focus on interacting with the SSCs, PAG participants will have to consider how to engage in the increased number of meeting opportunities that will arise.

<http://pag.arcticportal.org>

## Bipolar science puts the spotlight on permafrost

### MEMORANDUM OF UNDERSTANDING BETWEEN IPA, SCAR AND IASC



WRITTEN BY: Hugues Lantuit | Secretary International Permafrost Association

A Memorandum of Understanding (MoU) was signed between the International Permafrost Association (IPA), SCAR and IASC. The document emphasizes the common goal to increase understanding of permafrost in the polar regions and its connection to the global system. The MoU identifies a joint commitment to excellence in the field of permafrost and polar research, to the pursuit of scientific advances, public awareness and advice to policy makers as well as the professional development of young researchers. SCAR, IASC and IPA intend to combine their efforts in permafrost and/or polar activities to raise the level of impact of all three organizations.

### Promoting cooperation

The tri-partite Memorandum of Understanding is a natural outcome of IPA's continued involvement in

2. The signing of the documents to make the merger between AOSB and IASC official.

3. John Calder (right), Chair of the Pacific Arctic Group (PAG) and Kristján Kristjánsson, President of IASC, sign a Letter of Agreement.

4. Colin Summerhayes (left), Executive Director of SCAR, and Hans-Wolfgang Hubberten (right), President of IPA, are congratulation each other on the freshly signed MoU while IASC President Kristján Kristjánsson places the final signature.

polar research over the past 25 years. The International Permafrost Association, founded in 1983, has as its objectives to foster the dissemination of knowledge concerning permafrost and to promote cooperation among persons and national or international organizations engaged in scientific investigation and engineering work on permafrost. Stemming from the first international conferences on permafrost, which were an initiative to promote communication and understanding between Soviet and North American permafrost scientists and engineers, it rapidly grew to host an increasing number of countries and activities. By 1988 the IPA was serving as a catalyst and organizer of several major international activities.

The IPA developed the Global Geocryological Database (GGD), the basis of which is identification and description of data sets beginning in a metadata format. The IPA also prompted the production of a multi-language glossary of permafrost and related ground ice terms. It released the first circum-arctic map on permafrost and ground ice conditions based on a common classification in 1997 and took the leadership in initiating and coordinating several international, long-term monitoring networks and related data acquisition programs, such as the Global Terrestrial Network for Permafrost, which consists of two components: the borehole measurements or Thermal State of Permafrost (TSP) and the Circumpolar Active Layer Monitoring (CALM) network. Both components of GTNP are bipolar. A second major network exists in the Arctic Coastal Dynamics (ACD) program, which investigates coastal processes on permafrost coasts at thirty key coastal sites located around the Arctic Oceans. Numerous publications have arisen from IPA working parties, projects and related activities, which can be found on the IPA website.

### Meeting growing expectations

Because of the increasingly bipolar involvement of the IPA and the growing expectations for the integration

of permafrost data in other science realms, the three parties acknowledged that there are strong grounds for a closer linkage between them, not least in an exchange of views and experience on important scientific topics. A link between them at this time ensures that all three communities together make an integrated and comprehensive contribution to developing the International Polar Year (IPY 2007-2009) legacy.

<http://ipa-permafrost.org>

## Arctic Ocean Sciences Board (AOSB)



WRITTEN BY:

Sara Bowden | Secretary Arctic Ocean Sciences Board

The mission of the Arctic Ocean Sciences Board (AOSB) is to facilitate multidisciplinary multinational science research in the Arctic Ocean and surrounding seas. AOSB has fulfilled this mission by focusing its activities in three priority areas. These are:

- » The state and fate of Arctic perennial sea ice;
- » Long-term study of the geological record of the Arctic Ocean; and
- » Improving our understanding of the feedbacks between physical drivers, biological production and biogeochemical cycles.

The integrated Arctic Ocean Observing System (iAOOS), conceived and sponsored by AOSB, was a coordination proposal approved by the IPY Joint



Committee in 2006. It is designed to optimize the cohesion and coverage of monitoring of the Arctic Ocean and surrounding seas during the IPY.

The focus of iAOOS is arctic change, particularly the fate of perennial arctic sea-ice and the climatic and social effects of its disappearance. iAOOS has viewed the ocean-atmosphere-cryosphere system of high northern latitudes operating as a complete system for the first time with an aim to understanding this system and testing its predictability. Because of key technological advances, we had the means to measure almost any



key variable at almost any place and time that we needed to describe the ocean-atmosphere-cryosphere system of high latitudes. The IPY provided the necessary stimulus for piecing together the available PIs, gear, ships and funding on the pan-Arctic scale that seemed necessary to making the attempt.

The many tasks and initial results of iAOOS are outlined in two reports developed for AOSB by Dr. Robert Dickson of CEFAS in the UK. The reports together, "The integrated Arctic Ocean Observing System (iAOOS) in 2007" and its sister report "The integrated Arctic Ocean Observing System (iAOOS) in 2008," provide a complete account of the main activities of iAOOS during the IPY, including cruises taken, instrumentation deployed, and measurements made. The reports attempt to describe first results of iAOOS. It is important to note that the results from iAOOS could only be achieved through the intense international collaboration that took place during the IPY. The 2008 report concludes with key recommendations of observation tasks and methods, which should be sustained into the so-called IPY legacy phase. As Dr. Dickson explains in his Nature Geosciences commentary from the June 2009 issue: *"Paradoxically, as the International Polar Year ends, we enter its most important phase. Now we must decide—and quickly—which mix of observations to sustain, based on what we have learnt."*

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

### **Long-term study of the geological record of the Arctic Ocean**

The modern Arctic Ocean appears to be changing faster than any other region. To understand the potential extent of high latitude climate change, it is necessary to sample the history stored in the sediments filling the basins and covering the ridges of the Arctic Ocean. These sediments have been imaged with

PHOTO: JACQUELINE GREBMEIER

The Arctic Ocean Sciences Board is committed to facilitating research in the Arctic Ocean and surrounding seas through the support of multinational and multidisciplinary natural science and engineering programs.

seismic reflection data, but, except for the superficial record, which has been piston cored, they have been sampled only on the Lomonosov Ridge in 2004 during the Arctic Coring Expedition (ACEX; IODP Leg 302) and in 1993 in the ice-free waters over the Yermak Plateau to the North of Svalbard (ODP Leg 151). On November 3rd thru 5th of 2008, a meeting was held at the Alfred Wegener Institute in Bremerhaven, Germany to plan the future of scientific drilling in the Arctic Ocean.

One hundred and forty one applications were received for the ninety five available seats. The Consortium for Ocean Leadership provided support for the workshop through the U.S. Science Support Program associated with the Integrated Ocean Drilling Program and through the Nansen Arctic Drilling Program. In addition to these funds, contributions from European Science Foundation supported European and American participants. The Arctic Ocean Sciences Board (supported three participants) and contributions from six oil companies (BP, ConocoPhillips, ExxonMobil, Statoil, the Norwegian Petroleum Directorate and Shell) made it possible to support Canadian, Russian, Japanese and Korean participants.

In planning this meeting, the conveners attempted to mesh the arctic science and the ocean drilling communities. To develop a common reference frame, the first day of the meeting focused on presentations about what is known about the Arctic Ocean, the limited history of high-latitude drilling and the process of developing proposals for IODP. The next day and a half was spent in break out groups discussing the questions to be addressed by drilling and targets for arctic scientific drilling.

On the final day, the participants committed to submitting new IODP pre-proposals for Arctic Ocean drilling. Based on discussions at this meeting, we believe approximately ten new pre-proposals will be submitted to IODP. These proposals will be submitted at a critical time, both for the future of Arctic Ocean science

and the future of scientific ocean drilling. Only in the last few years, through dedicated efforts of a number of research groups, have there been sufficient data to propose testable hypotheses and to select drill sites on most of the significant bathymetric features.

A community-wide (USA, Europe, Japan, and others), multidisciplinary and international conference – INVEST IODP New Ventures in Exploring Scientific Targets - is planned for September 2009 to discuss future directions of scientific ocean drilling beyond 2013. The INVEST process will define the future of scientific ocean drilling. It will be important to have people there to directly represent the future of Arctic Ocean drilling. The SSC Marine System: AOSB is committed to supporting three to six Arctic scientists to participate in the INVEST meeting.

### **Arctic in Rapid Transition (ART)**

During the winter of 2008-09 the Early Career Scientists sub-group of the Marine Roundtable of the ICARP II produced a project proposal entitled Arctic in Rapid Transition. The ART initiative is a proposed integrative, multi-disciplinary, long-term pan-Arctic program to study changes and feedbacks with respect to physical characteristics and biogeochemical cycles of the Arctic Ocean and its biological productive capacity. ART will focus on integrating data on past and present transitional states of the Arctic Ocean that can be used synergistically with ongoing monitoring, observing and modelling efforts, to better assess future changes. Specific aims are to develop process-oriented perspectives on sea ice variability and biological productivity that merge knowledge on centennial through millennial timescales (acquired from geological records) with decadal through seasonal variations (recorded in instrumental and observational records). An equally important aspect of ART is to help bridge processes and ecosystem responses on shelves, margins and the central Arctic Ocean, all of which are facing rapid transition. This knowledge is necessary to im-

PHOTO: DAVID HIK

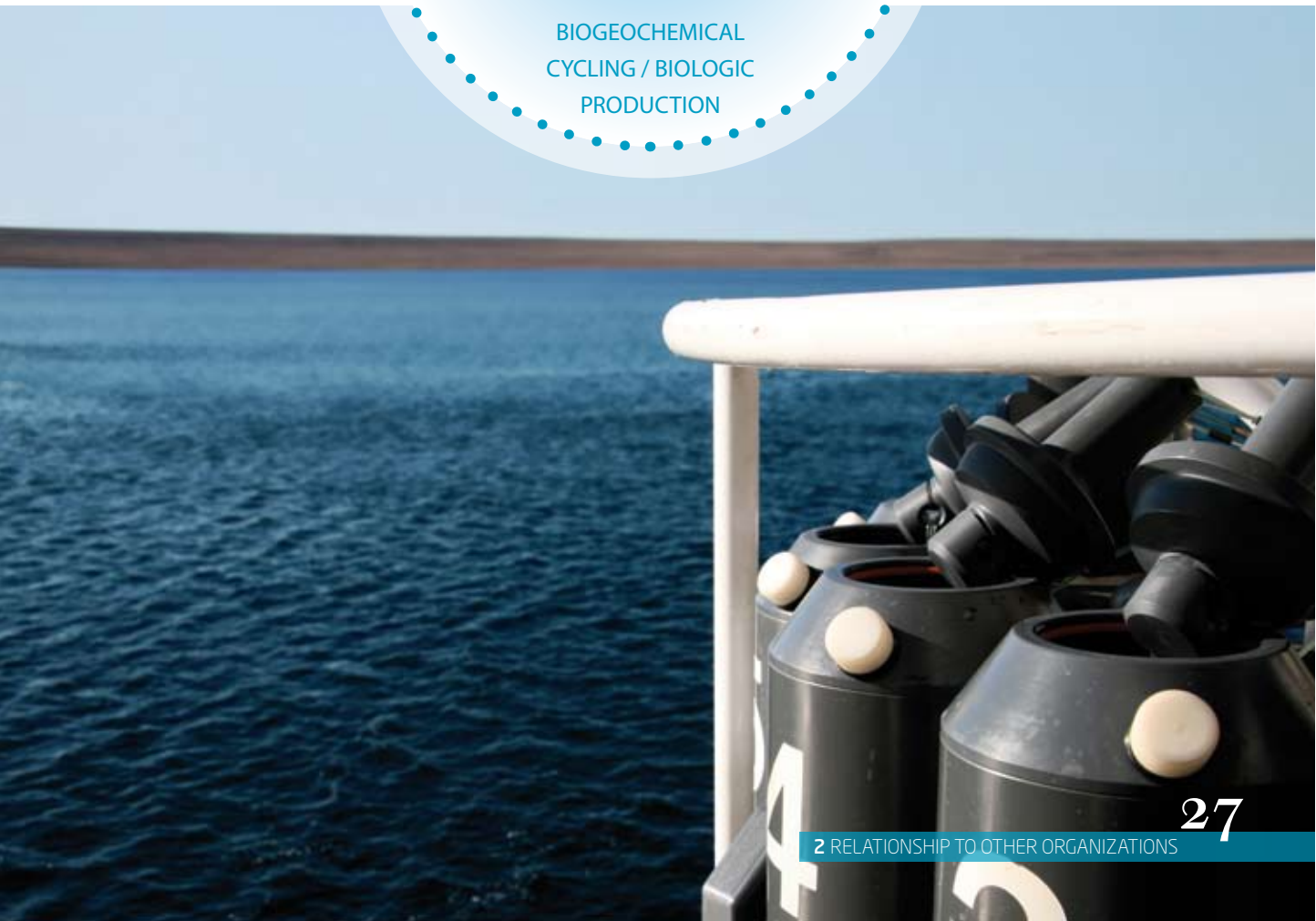
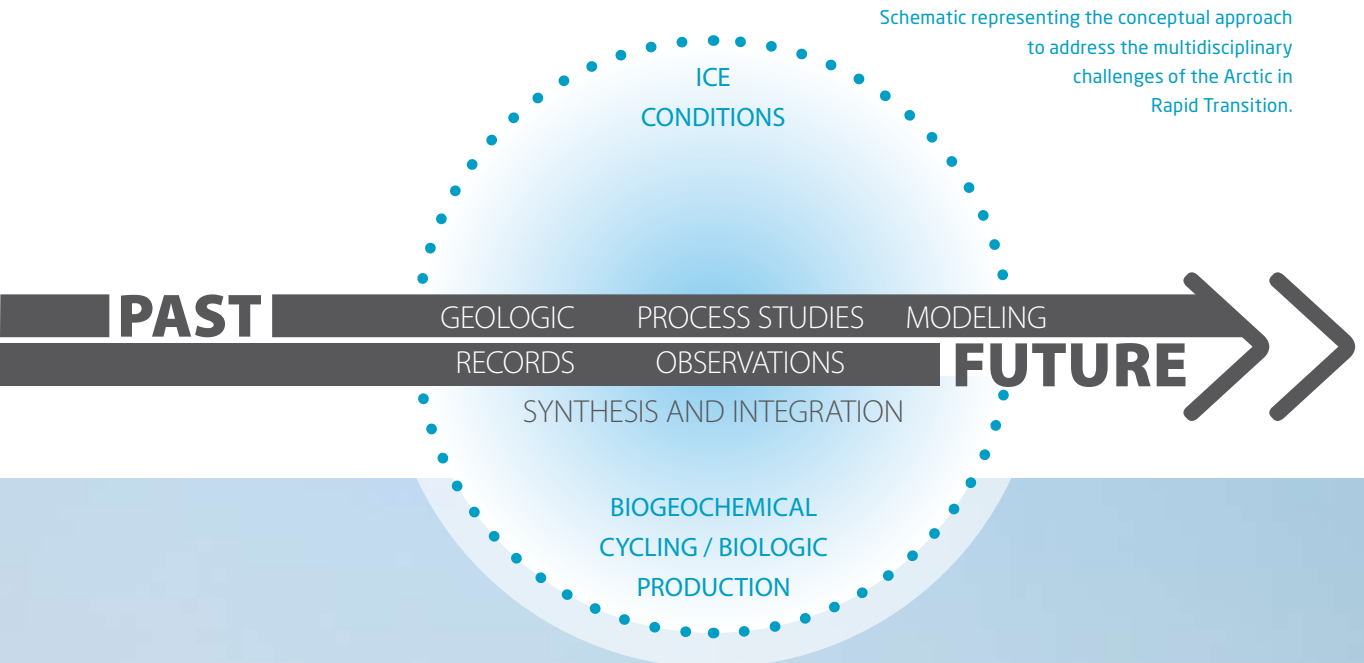
The ART initiative intends to study changes and feedbacks with respect to physical characteristics and biogeochemical cycles of the Arctic Ocean and its biological productive capacity.

prove our ability to understand, predict and adapt to current and future Arctic transitions.

At the 2009 Arctic Science Summit Week in Bergen, the concept of the ART Initiative was formally presented to the Arctic Ocean Sciences Board and received with enthusiasm. AOSB expressed its strong support for the ART Initiative and in turn requested that the ICARP II Marine Group Roundtable and greater community develop a science and implementation plan for ART. AOSB believes that in order to further the overall goals of the ART program, it is critical to develop the ART concept into a science plan with implementation and funding strategies for the plan.

The next step is an ART Initiation Workshop, which will be held November 7-9, 2009 in Fairbanks, Alaska to write a complete science and implementation plan for ART. A written workshop report (including an executive summary and specific recommendations for action) will be made available online and in printed format shortly after the close of the workshop. The results of the workshop will also be presented to the AOSB and IASC representatives during the ASSW 2010 in Nuuk, Greenland. By April 2010, the full science and implementation plan will be made available on the IASC website and through various list servers for comment from the broader community.

Schematic representing the conceptual approach to address the multidisciplinary challenges of the Arctic in Rapid Transition.



# International Arctic Social Sciences Association (IASSA)

WRITTEN BY: Joan Nymand Larsen | President  
International Arctic Social Sciences  
Association



The Arctic is defined as all arctic and sub-arctic regions of the world. The social sciences encompass disciplines relating to behavioral, psychological, cultural, anthropological, archaeological, linguistic, historical, social, legal, economic, environmental, and political subjects, as well as health, education, the arts and humanities, and related subjects.

## The objectives are:

- to promote and stimulate international cooperation
- and to increase the participation of social scientists in national and international arctic research;
- to promote communication and coordination with
- other research organizations;
- to promote the active collection, exchange,
- dissemination, and archiving of scientific information in the arctic social sciences;
- to promote mutual respect, communication, and
- collaboration between social scientists and northern people;
- to facilitate culturally, developmentally, and
- linguistically appropriate education in the North; and;
- to follow the IASSA statement of ethical
- principles for the conduct of research in the Arctic.

## Arctic Social Indicators

One of IASSA's current lead projects is The Arctic Social Indicators (ASI) project: Phase-II on implementation. The AHDR (2004) described the unprecedented

combination of rapid and stressful changes confronting arctic societies today including environmental processes, cultural developments, economic changes, industrial developments and political changes. The report called for the development of indicators to track and monitor these changes, and to help facilitate the evaluation and assessment of the impact of change, including helping facilitate the setting of priorities by policy makers and the Arctic Council (AC).

The ASI project was formulated to fill this critical gap in knowledge identified by the AHDR on the construction of social indicators to help facilitate monitoring of changes in human development. ASI (IPY 462) constitutes critical follow-up to the AHDR. It is endorsed by the Arctic Council and falls under the Sustainable Development Working Group (SDWG) of the AC. The ASI work also follows closely from the ICARP-II process - the majority of ASI partners were participants in the ICARP human dimension scientific working groups – closely aligned with the issues and call for research on indicators and quality of life in the Arctic.

Guided by the AHDR, the first phase of ASI identified a set of Arctic-specific indicators to monitor arctic human development and quality of life in the Arctic. ASI indicators have been developed within six domains: (1) Fate control and or the ability to guide one's own destiny; (2) Cultural Wellbeing and Cultural Integrity or belonging to a viable local culture; (3) Contact with nature or interacting closely with the natural world; (4) Material Well-being; (5) Education; (6) Health and Population.

The final report of ASI Phase-I was launched at the meeting of the SDWG of the Arctic Council in Copenhagen on November 10, 2009. The report, published by the Nordic Council of Ministers, will be available in print and on the web shortly. Complete with photos, maps and graphical illustrations it features about 180 pages on arctic social indicator construction and human development that fall within six domains highlighted as being particularly prominent in the Arctic.



With the first ASI report now launched, the next step - ASI Phase-II - aims to implement the identified indicators, through testing, validating and refining the indicators across the Arctic, and then measuring and performing analyses of select cases, with the ultimate goal of moving toward to adoption by arctic governments and the Arctic Council of the indicators for the purpose of long-term monitoring of human development.

Long-term monitoring of human development in the Arctic is the key goal of ASI. As a human dimensions monitoring system in the making, ASI has been included among the list of potential human dimension building blocks in SAON.

ASI Phase-II involves further developing the results achieved during the IPY with the goal to improve living conditions in the North and quality of life based on long-term monitoring. The focus on indicators and monitoring contributes to furthering our knowledge and understanding of the consequences of global change for human living conditions in the Arctic. ASI-II will include analyses of select cases focused on the application of ASI indicators for tracking and monitoring change and its impacts. The project's focus on the ability to monitor and track changes in human development provides a framework for the development and improvement of quality of life of arctic residents, with special attention to indigenous peoples of the north.

## Identifying data challenges

The first international ASI-II workshop on ASI Implementation was held on November 12-14, 2009, in Roskilde (Denmark). Participants of the workshop began the work of identifying critical data challenges encountered in ASI Phase-I, and started identifying key applications, or regions for specific case studies,

for the purpose of testing the constructed ASI indicators, and analyzing the ability of the indicators to compare and contrast quality of life in the North.

A second and more comprehensive workshop, with financial support by IASC, will take place in June 2010. The purpose of this workshop will be to continue the work to systematically identify and describe data challenges, including data availability and data quality by region for each of the final set of recommended ASI indicators as well as select other and promising arctic social indicators considered in ASI. This will include categorizing indicators according to a tier system based on data availability and ease of measurement. The workshop will also include discussions of the ASI work on testing and validation, and refinement of indicators; further development of ASI applications; and preliminary discussions of an ASI monitoring system.

The ASI-II project period is 2009-2011. A report on ASI implementation - published by the Nordic Council of Ministers, featuring a discussion of data quality and challenges, results of testing and validation, refinement and measurement of ASI indicators, and a series of analyses to illustrate applications - will be presented end of 2011.

The main target group for this report is the science community, policymakers at all levels, inhabitants of the Arctic, northern colleges and universities, and the Arctic Council and its Sustainable Development Working Group. The results will be presented in a book format that makes it accessible to a broad audience, including for educational instruction in northern colleges, universities, and in particular the UArctic.

[www.iassa.gl](http://www.iassa.gl)

PHOTOS: HUGH BEACH | From left to right

1. Ellen-Inga has fallen asleep with her dog on the sled during the 1975 spring migration in northern Norway.
2. Reindeer herders have parked their motorbikes outside of the corral in northern Sweden.
3. A young boy is riding a caribou.

Contact with nature or interacting closely with the natural world is one of Arctic-specific indicators to monitor Arctic human development and quality of life in the Arctic that was identified by the Arctic Human Development Report.

# World Climate Research Programme (WCRP)

WRITTEN BY: Vladimir Ryabinin | Senior Scientific Officer, World Climate Research Programme



In 2008/2009 the World Climate Research Programme (WCRP) kept advancing the understanding of the climate system and its predictability through the combined use and development of observational networks, modeling and analysis. The Programme community published a WCRP Implementation Plan 2010-2015 aimed at completing the tasks formulated in the WCRP Strategy 2005-2015 "Coordinated Observation and Prediction of the Earth System". WCRP is concentrating its work on the following major areas:

- » **Anthropogenic Climate Change;**
- » **Atmospheric Chemistry and Climate;**
- » **Sea-level Rise;**
- » **Climate Extremes;**
- » **Seasonal Prediction;**
- » **Decadal Predictability; and**
- » **Monsoon Prediction.**

WCRP actively contributed to the preparations of the third World Climate Conference (WCC – 3) held in Geneva (Switzerland) in September 2009 under the auspices of the World Meteorological Organization. WCC-3 resolved to establish a Global Framework for Climate Services (GFCS), a long-term cooperative arrangement to "enable better management of the risks of climate variability and change and adaptation to climate change at all levels, through development and incorporation of science-based climate information and prediction into planning, policy and practice". The following GFCS components are envisaged:

- » **Observation and Monitoring;**
- » **Research, Modeling and Prediction;**
- » **Climate Services Information System; and**
- » **User Interface Program.**

Among the many WCRP current activities, one particularly important is the Coupled Model Intercomparison Project Phase 5 (CMIP5), a new set of numerical runs aimed at ensemble climate prediction at the decadal and long-term time scales. The experiment setup is shown in the figure below. Like in the case of the WCRP experiment CMIP3, which had a tremendous impact on the climate change impact analyses for IPCC AR4, the output will be made freely available for the analysis by the scientific community before the completion of IPCC AR5 analysis.

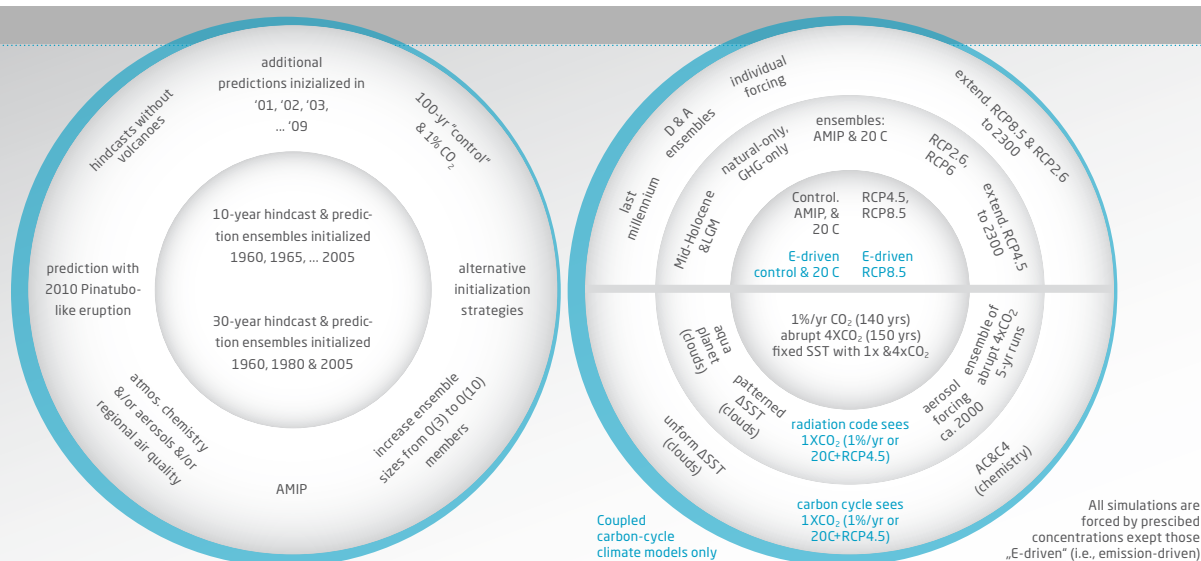


FIGURE: Schematic summary of CMIP5 experiments: left - decadal, right - long-term.

## The Climate and Cryosphere (CliC) Project

WCRP calls on CliC, one of the WCRP core projects, which is co-sponsored by IASC together with SCAR, to address the following major scientific challenges:

- explain and improve predictions of the rapidly changing Arctic sea ice;
- assess uncertainties in climate projections associated with the possibility of increased release of carbon from thawing permafrost in a warming climate;
- organize international research on all aspects of sea-level variability and change and substantiate sea-level assessments and predictions;
- contribute cryospheric knowledge to seasonal, decadal and centennial climate predictions; and
- initiate prediction of the cryosphere at a variety of scales to enable prediction of the future state of cryospheric sources of fresh water.

A major WCRP Science Conference is scheduled for spring 2011.

<http://wcrp.wmo.int>

PHOTO: PHILIP BURGESS

Inger Maria Gaup Eira is sampling snow at traditional reindeer grazing grounds during EALÁT fieldwork.

## International Association of Cryospheric Sciences (IACS)

WRITTEN BY: Ian Allison | President  
International Association of  
Cryospheric Sciences



The International Association of Cryospheric Sciences (IACS) is the newest Association within the International Union of Geodesy and Geophysics (IUGG) of ICSU. IACS was established as a separate Association in July 2007, evolving from the International Commission on Snow and Ice (ICSIH) that can trace its own legacy back to the Commission International des Glaciers, which was founded in 1894. The objectives of IACS are to promote studies of cryosphere (snow and ice systems) on Earth and other planets of our Solar System and to promote discussion, education and collaboration in cryospheric research. The scientific objectives of the Association are managed through five divisions representing research on snow and avalanches, glaciers and Ice sheets, marine and freshwater ice, cryosphere-climate interaction, and extra-terrestrial ice.





## Our warming planet

In July 2009 IACS joined with the International Association of Meteorology and Atmospheric Science (IAMAS) and the International Association for the Physical Sciences of the Oceans (IAPSO) in a joint scientific assembly on the theme “Our warming planet”, held in Montreal (Canada). This event attracted about 1350 delegates from over fifty countries, and was particularly notable for the strong cross-disciplinary nature of many of its symposia. During this period, the foundation President of IACS, Georg Kaser, completed his term and was succeeded by Ian Allison.

A Working Group of the IACS Snow and Avalanche Division, headed by Charles Fierz, has recently completed work on a new standard for snow classification. This work has resulted in an UNESCO-IHP report<sup>1</sup> detailing the snow classification scheme as well as a series of type faces for printing snow classification symbols. A new handbook of glacier mass-balance terminology and methods, being prepared by a Working Group of the Glacier and Ice Sheet Division and headed by Graham Cogley, is nearing completion.

Between 28 June and 7 July 2011, IACS will participate with other Associations in the in the XXV IUGG General Assembly in Melbourne (Australia). This multi-disciplinary conference with the theme “Earth on the Edge: Science for a Sustainable Planet” will include a consi-

derable number of symposia related to polar sciences. Election of the IACS Bureau (executive officers) will take place during this meeting.

Cryospheric scientists interested in contributing to the work of IACS should contact the Secretary-General, Prof. Dr. Manfred Lange, at [m.a.lange@cyi.ac.cy](mailto:m.a.lange@cyi.ac.cy).

[www.cryosphericciences.org](http://www.cryosphericciences.org)

## Scientific Committee on Antarctic Research (SCAR)

WRITTEN BY: Colin Summerhayes  
Executive Director Scientific  
Committee on Antarctic Research



The Scientific Committee on Antarctic Research (SCAR) is charged with initiating, developing and coordinating high quality international scientific research in the antarctic region, and on the role of the antarctic region in the Earth system. The highlight

1. The International Classification for Seasonal Snow on the Ground. To be published in the series of IHP-VII Technical Documents in Hydrology No 83, IACS Contribution No 1. UNESCO, Paris





of SCAR's year in 2009 is completion of the southern hemisphere equivalent of the Arctic Climate Impact Assessment. Entitled „Antarctic Climate Change and the Environment“ (ACCE), this 560-page book is now being distributed. Only 500 hard copies were made, but the entire book will be accessible on the SCAR web site so don't worry too much if you are not on the distribution list. This integration of physical, chemical, glaciological, geological and biological information serves the needs not only of SCAR's science community but also of bodies like the IPCC and policy makers (the Antarctic Treaty Parties). A summary of the physical studies was published early this year in *Reviews of Geophysics* (Mayewski et al), and a summary of all of the book's key findings will appear in the December issue of the *Antarctic Science Journal* (Convey et al).

#### **Among the key findings:**

- for the last 30 years the ozone hole has shielded the bulk of the Antarctic from the effects of „global warming“;
- the Southern Ocean is warming - the marine ecosystem will change - stocks of krill have already declined as have Adelie penguin colonies in the Antarctic Peninsula;
- plant communities have expanded across the Antarctic Peninsula, where melting is greatest;
- parts of Antarctica are losing ice at a rapid rate

(Antarctic Peninsula and Amundsen Sea Embayment of West Antarctica - the latter due to oceanic warming);

- sea ice has increased overall by 10% since the 1980s (a side effect of ozone hole shielding), despite a decrease west of the Antarctic Peninsula;
- the recent loss of ice shelves is unprecedented in the last 10,000 years;
- assuming a doubling of carbon dioxide over the present century, Antarctica is expected to warm by 3 degrees C, which will not do much to cold, high East Antarctica, but should lead to a 33% decline in surrounding sea ice cover;
- loss of ice from the West Antarctic ice sheet is expected to contribute some tens of centimeters to sea level rise by 2100.

The report identifies the need for higher resolution global climate models, regional climate models, and improved models of ice sheet behavior; these would also be of use in the Arctic. As in the Arctic, the climate models need better simulation of polar-specific processes. Also as in the Arctic, greatly improved monitoring of present climate change, and improved observations of past climate change are needed to increase confidence in the detection and attribution of climate change and to more firmly underpin projections of future change in these rapidly changing environments.

PHOTO: SLAWEK TULACZYK  
Camping near an outlet glacier on Greenland.

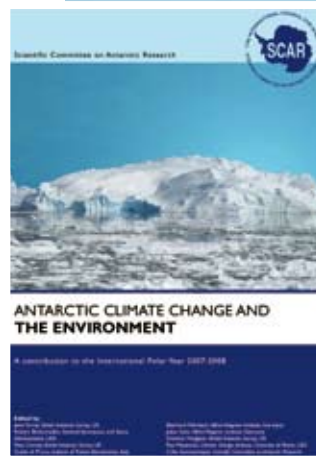
To meet the observational challenge, SCAR worked with the Climate and Cryosphere (CliC) project to develop and publish plans for a Cryosphere observing system (CryOS) (see the Cryosphere Observing Plan at <http://www.scar.org/researchgroups/physicalscience/>). SCAR is also working with the Scientific Committee on Oceanic Research (SCOR) and other organisations to develop plans for a Southern Ocean Observing System (SOOS), which should be published early in 2010.

## Bipolar activities

SCAR continues to partner with IASC in a number of bipolar initiatives, most recently the Summer School on Ice Sheet Models for the 21st Century, held at Portland State University in Oregon (3-14 August). SCAR and IASC share a Bipolar Action Group (BipAG), to advise their respective management bodies on desirable future collaborative ventures and on the most appropriate ways to implement and manage the IPY Legacy. Data management is a key issue for the future, and in that context SCAR has now published a strategy for data and information management, and is contributing to ICSU's development of a Polar Information Commons. Another major contribution has been the Census of Antarctic Marine Life (CAML), which identified 1000 species new to science, one quarter of them common also to the Arctic. CAML, SOOS and CryOS were all contributions to the International Polar Year.

SCAR and IASC continue to work together through the IPY Joint Committee, which steers the IPY process, and are currently co-sponsoring and helping to organize the 2nd IPY Conference (the Oslo Science Conference), which takes place from June 8-12, 2010.

[www.scar.org](http://www.scar.org)



In 2009 SCAR completed the southern hemisphere equivalent of the Arctic Climate Impact Assessment, entitled „Antarctic Climate Change and the Environment“ (ACCE).



PHOTO: CARLOS FURTADO

Brazilian Veterinarian, Angela Pessanha is admiring a Southern Elephant Seal (pup) on the Elephant Island in Antarctica.

PHOTO: HUGH BEACH

Local fishermen of a small Russian Nivkhi settlement have gathered with researchers from the CLUE project on the dynamics of circumpolar land use and ethnicity. The villagers are discussing the difficulties they face because of the regulations that constrain their traditional fishing livelihood.



3. Arctic Science Summit Week (ASSW) 2009



## » 3 Arctic Science Summit Week (ASSW) 2009

The Arctic Science Summit week (ASSW) held in Bergen (Norway), 23-28 March 2009, turned out to be a great success. The major event hosted by the Institute of Marine Research, the Bjerknes Centre for Climate Research and the Research Council of Norway, attracted 300 scientists, students, policy makers and other professionals. An Open Science Symposium was organized for the first time in the ten-year history of the ASSW.

The three-day symposium “Arctic Connections - results of 150 years of arctic research”, made clear that there’s a high demand for such an activity in the arctic science world on a regular base. It was a week that created a platform for exchanging know-

ledge, learning opportunities, cross fertilization and collaboration. The main organizers, Harald Loeng and Louwrens Hacquebord, chose a model that left participators with an impression of the wide specter of research activities that took place in the Arctic throughout history.

The summit provided plenty of opportunity for international coordination, collaboration and cooperation in all areas of arctic science and combined science and management meetings. Summaries of the business meeting held by the Forum of Arctic Research Operators (FARO), the Pacific Arctic Group (PAG) and the European Polar Board (EPB), can be found at the end of this chapter.



PHOTO: GABY BOHLE - INNOVATION NORWAY  
The 2009 ASSW was held in Bergen (Norway). A city with a long tradition in arctic science.

## ARCTIC CONNECTIONS: RESULT OF 150 YEARS OF ARCTIC RESEARCH

WRITTEN BY: Louwrens Hacquebord and  
Harald Loeng

In 1999, the first ASSW was organized in Tromsø, Norway. The ASSW is intended to provide a forum for all Arctic science organizations to meet together at one location in one week thereby stimulating communication and collaboration. Over the past ten years, the ASSW has provided a venue for business meetings to be combined with a science and project day, along with presentations by the host country highlighting significant arctic science work within their community.

After ten ASSWs organized in ten different countries all over the world, the organizations behind this event decided to change the concept of the week by including not only annual meetings of the arctic science organizations, but also the Open Science Symposium. The theme for the first 3-day Open Science symposium was organized around the ambitious theme: "Arctic Connections: Results of 150 years of Arctic research".

The symposium consisted of one plenary day with keynote speakers and two days of parallel session that concentrated on the interaction of the natural, social and human sciences. Two of the eight sessions were exclusively focused on human and social science topics but all sessions aimed to provide interaction between the disciplines the Open Science Symposium provided

a good opportunity for young researchers to discuss their first research results with senior researchers.

Altogether, more than 300 scientists, policymakers, students and stakeholders visited the three day symposium and made clear the need for a regular scientific arctic meeting focused on special aspects of arctic research. The executive committee of IASC called the first symposium a great success and it will become a regular event at ASSWs every second year.

Special contributions from the invited speakers and the session chairs can be found in this chapter highlighting the importance of their scientific themes, the contributions made during the symposium and challenges for the future.

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### Keynote Speakers

## Risks to Human Health from a Changing Arctic

WRITTEN BY: Jay Van Oostdam | Senior  
Epidemiological Advisor Health Canada

A number of populations in the Arctic have health status and longevity that are the best in the world (e.g. Sweden, Norway). Compared to these populations, some indigenous populations of arctic Canada, Greenland and Russia often have less access to health care and subsequently have overall poorer health. The Arctic Monitoring and Assessment Programme (AMAP) has undertaken several assessments of contaminants (e.g. persistent organic pollutants [POPs], metals, radionuclides), human health and climate change over the last eighteen years. The most recent AMAP human health assessment has found that the concentrations of some legacy POPs and metals are declining in some indigenous populations but new contaminants are being found in the Arctic.



The findings presented in this AMAP human health assessment also suggest that there are subtle but significant health impacts on learning ability, the cardiovascular system and the immune system in some arctic populations at the current levels of contaminant exposure. A major dietary shift is also taking place in the Arctic, with increases in intake of sugar and unhealthy fats, which may have significant health implications in the future.

Climate change is a complex phenomenon, which will likely have a significant impact on redistribution of contaminants in the Arctic, resulting in a change in human exposure to contaminants. This may be due to changes in contaminant levels in food chains and traditional foods of arctic peoples and/or changing availability of various arctic species. Oil and gas and other industrial development is also taking place across the Arctic. New employment opportunities and population interactions from these developments, as

well as direct environmental impacts and emissions from these industries, will affect arctic populations.

There are a number of studies that are attempting to assess the impacts of a changing Arctic on contaminants and human health, plus health researchers across the circumpolar Arctic are working together to better assess health status of arctic peoples. This talk will present an overview of some of the important factors affecting human health in a changing Arctic, plus outline some of the challenges that health researchers must address in the near future.

### **Arctic health perspectives and trends**

Health in the Arctic is viewed differently among many of the Aboriginal peoples of the circumpolar world as it is thought to be more holistic, including social, spiritual and cultural dimensions. Egede (1995), from Greenland, expressed this clearly in his response to the issue of environmental contaminants in their traditional foods and health: *"Inuit foods give us health, well being and identity. Inuit foods are our way of life. Total health includes spiritual well being. For us to be healthy, we must have our foods, recognizing the benefits they bring. Contaminants do not effect our souls. Avoiding our foods from fear does."*

Health status varies markedly across the Arctic. Life span in the Scandinavian Arctic is among the longest spans seen around the world. However, lifespan





among a number of indigenous groups of the circumpolar Arctic can be much lower than in the south, such as in arctic Canada where lifespan is ten or more years less than that in southern Canada. Suicides and accidents are a much greater health concern among indigenous peoples in arctic Canada, Greenland and Alaska. Though there are health challenges in the Arctic, it should also be noted that there have been decreases in a number of important causes of morbidity and mortality over the last fifty years.

## Contaminant monitoring and effects research

Human contaminant monitoring being coordinated under AMAP (1997, 2002, 2009) has shown that environmental contaminants are building up in the arctic marine mammal food chain through deposition of contaminants transported by long-range air movements. Contaminants such as polychlorinated biphenyls (PCBs), dichlorodiphenyldichloroethylene (DDE) and mercury were found at higher concentrations in seals, walrus and polar bears, plus in the Inuit peoples of the arctic who consume them. The most recent human contaminant monitoring in the arctic has found good news, as monitoring has shown significant declines in many of these contaminants such as PCB and DDE among a number of arctic indigenous group. This ongoing monitoring has also found that new contaminants such as PBCs (polybrominated compounds) and PFC (perfluorinated compounds) are also being found in arctic peoples, but there is little trend information for these compounds.

Though contaminant concentrations were higher in arctic peoples, they were not at concentrations that would be considered acutely toxic. Epidemiological studies following mothers and their young infants have found associations between contaminant concentrations of PCBs, lead, and mercury in mothers and infants and a number of health parameters in infants such as foetal growth, the immune system (increases



in infections) and neurobehaviour (reflexes, visual memory). Most of the effects are extremely subtle and would not be noted in a clinical medical exam, but they do indicate that effects are being seen at the present concentrations of exposure in the Arctic.

## Food security

There is a major dietary change taking place in the Arctic due to rapid economic, environmental, social and cultural changes. A healthy diet is key to human health, and in the past the traditional foods of indigenous peoples of the Arctic were key sources of proteins, essential fatty acids, vitamins and minerals. However, traditional foods are becoming less available due to the previously noted changes. Traditional foods are often the glue that binds communities together through social sharing networks and traditional knowledge passed on to future generations through the traditional hunt. There is also a parallel increase in the consumption of market foods from southern regions, which are rich in sugar and fats. This dietary change has been linked to the increases in diabetes, cardiovascular disease and obesity in a number of regions of the world. It is becoming a significant challenge for many arctic countries to ensure that all arctic residents have access to healthy, nutritious foods.

## The changing Arctic

Major economic changes are coming to the Arctic with industrial and mining development reaching

« PHOTO: PHILIP BURGESS - EALÁT / INTERNATIONAL CENTRE FOR REINDEER HUSBANDRY

Johan Mathis Turi of the Association of World Reindeer Herders discusses reindeer earmarks with Evenki reindeer herders in Northern China. Traditional foods are often the glue that binds communities together through social sharing networks and traditional knowledge passed on to future generations through the traditional hunt.

PHOTOS: DAVID HIK

Fish and meat is drying in the sun. Climate change can modify the presence of wildlife that are important in the traditional diet and could easily affect the adequacy of many peoples' diets in the arctic.

farther out to attain new sources of energy and minerals. The drilling for oil and gas and mining for diamonds create both negative and positive impacts on local indigenous peoples. Increased financial resources from economic development can increase the availability of medical resources and facilities in the Arctic and increase the availability of nutritious market foods. However, one of the challenges that northerners face is that they may not be equipped to participate in this new economy, potentially standing by as southerners commute in to take on the high paying work and then leave when the job is done.

Climate change due to man-made activities is being felt to the greatest degree in the arctic, with a number of possible direct and indirect impacts on human health. Contaminant cycling and bioaccumulation in the arctic marine environment will change as the Arctic warms. Climate change can also have direct impacts on human health through an increase in extreme precipitation events (mudslides) or unstable ice packs (people becoming stranded or drowning), plus indirect impacts such as an increase in disease prevalence due to new insect vectors being introduced to the Arctic (tick borne encephalitis). Climate change can also modify the presence of wildlife that are important in the traditional diet and could easily affect the adequacy of many peoples' diets in the arctic. The access to clean water, the built environment (houses /roads sliding into the ocean) and access to traditional foods will be significantly impacted by the thawing permafrost and can have significant social, cultural and economic impacts in the Arctic.

## **Circumpolar arctic health research and assessment**

Over the past decade there has come a resurgence of interest in arctic health research. A circumpolar health study of Inuit people has begun in arctic Canada and Greenland and will involve over 12,000 people in an initial cross-sectional survey, with a possible later follow-up. A major study of human health, contaminants and

climate change in Europe and the Arctic (i.e., ArcRisk) has also just been funded by the European Commission. Arctic Council, the Ministers of the eight circumpolar nations and its working groups have been active over the last ten years in assessing the health status and the various challenges to arctic peoples. The AMAP Human Health Assessment Group has completed three assessments of environmental contaminants and human health over the past eighteen years. The Sustainable Development Working group has also recently formed an Arctic Human Health Expert Group, which will coordinate research, monitoring and assessment across a broad range of health outcomes (e.g., infectious respiratory disease, tuberculosis, cancer, etc).

There are definite health challenges in the Arctic but there have been improvements of health status in a number of areas. Arctic monitoring has shown that many arctic peoples have higher exposures to various environmental contaminants. Recent monitoring / research has shown that a number of these historic contaminants are decreasing in the environment and in arctic peoples, but new contaminants are being found. The greater interest in arctic human health is welcome and the coordination of this activity under various Arctic Council working and expert groups will be of great use to arctic peoples.

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## The Role of the Arctic in the Global Change Process

WRITTEN BY: Eddy Carmack | Senior Research Scientists, Department of Fisheries and Oceans, Canada

The Arctic is changing fast, and to understand why requires a view of its two-way inter-connection with Subarctic domains. First, the Arctic and Subarctic oceans surrounding northern North America and Eurasia are fully connected to one another and fulfill an absolutely critical role in global-scale hydrological and thermohaline cycles. Second, while it has long been suspected that the high latitudes will respond fastest and largest to climate forcing, the changes actually observed over the past two to three years have far out-paced the most pessimistic of model predictions used in the 4th IPCC report of 2007.

Third, humans are inextricably linked to the changes we are observing today, both as drivers of change through our greenhouse gas emissions and as the very populations needing to prepare for the uncertainties that lie ahead.

I review the Arctic's place in the global climate system, highlight changes we are seeing in the physical world of ocean currents and sea ice cover, and then explore what such changes - as components of a coupled system - will mean in terms of marine life and ecosystems, invasive species, ocean acidification and challenges to governance. Given that the broad purpose of climate monitoring is to collect sets of relevant, inter-comparable data over sustained periods of time so as to allow quantification of change within a system for decision-making purposes, and given that policy horizons and model predictions look forward to the year 2050, then institutional commitments for observational programs must be made on the same time frame.

PHOTO: NICOLE COUTURE

Undergraduate student Heather Cray samples vegetation on Herschel Island, Yukon Territory in order to characterize vegetation succession patterns related to retrogressive thaw slump activity. Keynote speaker Eddy Carmack underlined the importance to explore the effects of changes in the physical world of ocean currents and sea ice cover on the marine life and ecosystems in the Arctic.

# The Legacies of Arctic Science from Humboldt to the High Arctic

WRITTEN BY: Michael Bravo | Head of History and Public Policy Research Group, Scott Polar Research Institute, University of Cambridge

This paper presentation takes as its point of departure the 150th anniversary of the publication of Darwin's "On the Origin of Species" and Alexander von Humboldt's "Cosmos", two of the nineteenth century works most credited with establishing scientific legacies that survive and have remained important down to the present day. Given that Darwin and Humboldt as travelling naturalists, have become chiefly remembered and commemorated for their voyaging and fieldwork in the species rich tropics, what lessons might historians derive that can help us understand the legacy of International Polar Years and similar high latitude research networks and expeditions?

I here propose five provisional answers. First, the integration of the Arctic into regional and global understanding of the globe has occurred through

a division of scientific labour between scientific disciplines and their practices of observation, and measurement. Second, there is an inherent tension between the stability of scientific paradigms or models of knowledge on which scientific legacies depend, and the changing research problems, practices, instrumentation, and modes of scientific communication around which research networks organize themselves. Third, the wider social and political concerns in relation to which observation networks are justified and sustained (e.g., geopolitics, climate change) are generally fragile and can be suddenly disrupted by changing external political or economic conditions.

Fourthly, practices of observation (e.g., design and deployment of instrumentation, site selection, and experimental technique) which are in general highly skilled, have in some cases created opportunities for making scientific reputations and careers, while in other cases have jeopardized personal and collective legacies. Fifthly, analyzing why the reception of key scientific texts like *Cosmos* has varied considerably across different audiences, is a crucial aspect of evaluating their legacies. In summary, scientific legacies are complex phenomena, expressions of continuity, stability and significance, within diverse and rapidly changing societies.





## Sea Ice Changes and Impacts on Biodiversity and Human Communities

WRITTEN BY: Hajo Eicken | Associate Professor at the Geophysical Institute & International Arctic Research Center, University of Alaska Fairbanks

The arctic sea ice cover has undergone major transformations over the past few decades: a reduction in summer minimum ice extent current with replacement of much multi-year by first-year ice, changes in circulation patterns and ice velocities, and shifts in the seasonality of the annual ice cycle. These changes are due to a combination of factors, including increased greenhouse gas radiative forcing, enhanced absorption of solar radiation due to changes in the ice pack and the overlying snow cover, changes in surface wind and temperature forcing and oceanic change.

Impacts of this change on marine ecosystems include potential increases in the biological productivity of (seasonally) ice-covered seas, changes in the migratory patterns of species such as walrus or whales, altered dispersal patterns of ice-associated organisms, large-scale shifts in the distribution of ice-dependent species, and both positive and negative effects on the health and diversity of biological communities and organisms whose life cycle is tied to the ice.

Direct impacts on arctic coastal communities through changes in the distribution of and access to species that are key to subsistence and the subsistence economy, and through changes in the coastal environment are compounded by large-scale geopolitical and socio-economic change. The latter are at least in part also tied to alterations in the arctic ice cover. One of the challenges for scientists is to provide useful information to arctic communities and other stakeholders at a time of increasing conjoined uses of the ice cover. What exciting results have emerged to date? What do these results mean from the broadest perspective? How have these advances fundamentally changed our view of the Arctic and its role in the Earth system and what will be required to make the next advances?

PHOTO: MAGNUS TANNERFELDT

Scientists from the International Polar Year 2007/2008 were confronted daily with the long history of arctic research by bumping into leftovers at the Kinnvika station built during the International Geographical Year (1957-1958). The Kinnvika initiative kept running after the last IPY and is a multinational initiative to enhance our understanding of the arctic system, to monitor global change and to study effects of human activity on arctic islands.

PHOTO: MARKUS KARASTI

A reduction of the sea ice will start large-scale shifts in the distribution of ice-dependent species such as the polar bear.

# Climate of the Arctic – an Influential Player in the Earth’s Climate System

WRITTEN BY: Dorthé Dahl-Jensen | Head of the Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen

Temperature changes in the Arctic are enhanced compared with the global changes because of the high sensitivity of the high latitudes and the major landmasses in the Northern Hemisphere. The sea ice in the Polar Ocean and the Greenland Ice Sheet in the arctic region, further amplify the impact of changes in the North due to the albedo-temperature feedback mechanism and sea level changes.

New results show that the atmosphere circulation can change abruptly from year to year resulting in major climate changes. The climate system is very complex and the internal forcing of the system causes changes of the same scale as those from external forces such as changing solar irradiance. The recent increase of greenhouse gasses and subsequent global warming will lead the climate into a new state. Will this increase the risk of abrupt changes and can we identify tipping points of our climate system?

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## Indigenous Cultures - Past to Future

WRITTEN BY: Grete K. Hovelsrud | Senior Researcher, Center for International Climate and Environmental Research, Oslo

Indigenous peoples of the Arctic are viewed by many as living under harsh and inhospitable conditions. From

the perspectives of the indigenous peoples themselves this may be a misrepresentation, which lacks an understanding of the basis for these indigenous cultures. The arctic environment and its resources and climate are what people have adapted to and survived in for thousands of years. Through history their cultures and values have to a large extent been shaped by the environment. Currently, we see a varying degree of sensitivity or vulnerability to changes in the environmental, societal and political conditions.

### Challenges and opportunities

The rate and magnitude of climate change is higher in the Arctic than elsewhere which pose significant challenges for many indigenous and also non-indigenous societies. For others the changes may provide new opportunities. For example, the loss of sea ice will have consequences for the peoples hunting ice-dependent species, such as ringed seals, and the opening up of arctic shipping routes will have consequences for coastal communities. A warmer climate may compromise access to berries, fish, caribou and marine mammals, and it may also increase the growing season and result in new fish species. Climate change is, however, but one driver of change and does not occur in isolation from other changes. The combined changes will have different, direct and indirect, consequences for the indigenous peoples living in the Arctic.

Indigenous cultures in the Arctic are considered resilient and highly adaptive, but the current changes may pose greater challenges than before. With climate change as an entry point, and with the knowledge that all cultures are dynamic, I discuss change in arctic indigenous cultures. I explore the cultural aspects that may be most likely to strengthen or reduce the resilience of the indigenous cultures in the context of globalization and global warming. I also explore the parallels between indigenous and non-indigenous societies in the Arctic and how we may transfer our current knowledge to societies and peoples beyond the Arctic.

# Ecosystem Change and Carbon Cycle on a Glacier Foreland in the High Arctic

WRITTEN BY: Hiroshi Kanda | National Institute of Polar Research, Tokyo

In recent decades, glaciers throughout much of the Northern Hemisphere have drastically retreated because of the warming climate. The arctic terrestrial ecosystem at the foreland of glaciers is thought to be extremely sensitive to climate change. However, an overall response of the ecosystem carbon cycle to climate change is still hard to predict. Ecosystems with some succession stages at the high arctic glacier foreland are expected to understand the ecosystem carbon cycle and to predict future ecosystem responses to climate change. Such glacial retreat areas provide new habitat for plant colonization and hence organic carbon accumulation.

In this review, we focused on several recent studies conducted to clarify the pattern of the carbon cycle on the deglaciated areas in Ny-Alesund (79°57'N, 11°21'E), Svalbard in the high Arctic. Cryptogamic data will contribute to the major proportion of phyto-mass in the later stages of succession. However, even in the latter stages, the size of the soil carbon pool was much smaller than those reported from the low arctic tundra, and their net primary production was smaller than that of the vascular plants. The compartment model that incorporated major carbon pools and flows suggested that the ecosystem of the latter stages is likely to be a net sink of carbon at least for the summer season. A comparison between ecological features in Ny-Alesund with maritime climates, and in Ellesmere, Canadian Arctic (Oobloyah valley, 80°51'N, 82°50'W) with those of continental climates is significant for evaluating response to climate change in near future.



PHOTO: ANDREAS PETER AHLSTRØM - GEUS

Although Indigenous cultures in the Arctic are considered resilient and highly adaptive, the changes they face these days may pose greater challenges than before.

# Coastal Environments as a Link between Land and Sea in the Arctic

WRITTEN BY: Søren Rysgaard | Center of  
Marine Ecology and Climate Impact, Greenland  
Institute of Natural Resources, Nuuk

Coastal areas in the Arctic represent a link between land and the sea and, as such, are sensitive to changes in processes both on land and at sea. The annual average temperature in the Arctic has increased at almost twice the rate of that of the rest of the world over the past decades. Widespread melting of glaciers and sea ice and a shortening of the snow season have changed dynamics of coastal areas. Increases in glacial melt and river runoff add more freshwater to the sea. This affects stratification of the water column and water circulation in coastal areas as well as the exchange with shelf waters.

Historically, the Arctic has been regarded as a relatively simple system in which species interactions and environment-organism dynamics are straightforward

and easily described. Recent research has, however, revealed a complex ecological interconnectedness in this sensitive region. Reduced sea ice cover, improved light conditions and more nutrients to coastal areas will stimulate primary production and affect the biological structure and function of the ecosystems. However, increased thawing of permafrost and coastal erosion may also lead to increased runoff of suspended matter to coastal areas reducing light availability for primary producers in some areas.

## Complexity of interactions

While reduction in sea ice will drastically shrink marine habitats for polar bears, ice-inhabiting seals and some birds, it may affect other species differently. Less sea ice will, for example, prolong the period in which walrus can feed on the bivalve-rich coastal communities each summer, whereas it will negatively affect walrus that are dependent on sea ice as a resting platform above offshore feeding grounds. Displacement of species within the Arctic and invasion of new species will increase the complexity of interactions and thus pose a challenge for predictions of the future. Reduced and unstable sea ice conditions already cause problems for traditional

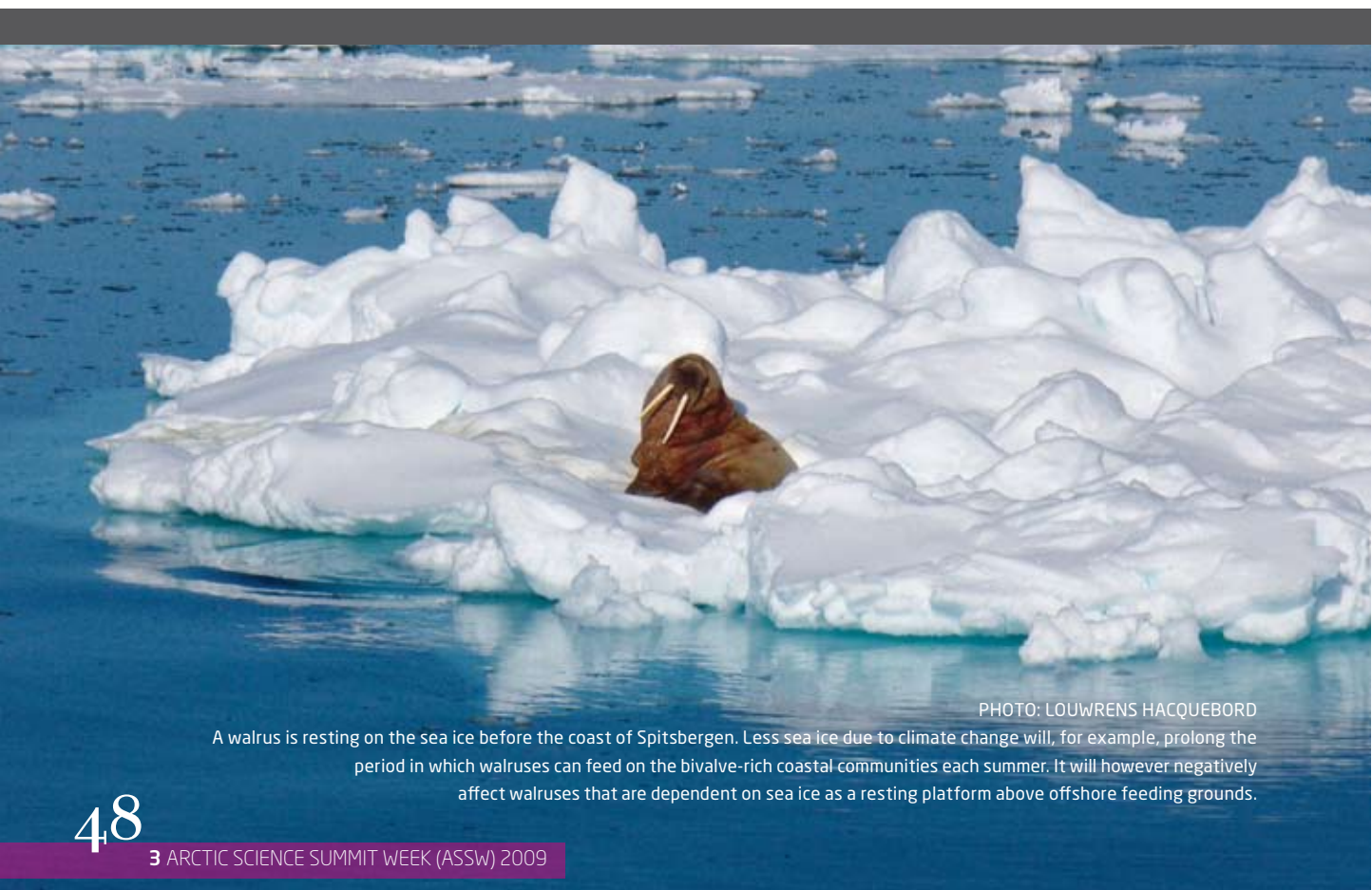


PHOTO: LOUWRENS HACQUEBORD

A walrus is resting on the sea ice before the coast of Spitsbergen. Less sea ice due to climate change will, for example, prolong the period in which walrus can feed on the bivalve-rich coastal communities each summer. It will however negatively affect walrus that are dependent on sea ice as a resting platform above offshore feeding grounds.





hunting and fishing, whereas it will lengthen the navigation season and increase commercial marine access to natural resources in the Arctic as well as increasing possibilities for mining, hydropower, oil and gas exploitation.

Compared with the rest of the world, investigations covering a full annual cycle are scarce in the Arctic. However, a recent study in high arctic Greenland extended methane flux measurements beyond the growing season into early winter and reported an unexpectedly large release of methane into the atmosphere at the onset of soil freezing comparable to methane emission over the entire growth season. In addition, recent studies of biogeochemical processes in sea ice during winter and summer suggest that sea ice may play an important role for CO<sub>2</sub> uptake in the region as well. Thus, an extension of monitoring programs, such as Zackenberg Basis and Nuuk Basis ([www.g-e-m.dk](http://www.g-e-m.dk)), is urgently needed to collect long-term data quantifying seasonal and inter-annual variations and long-term changes in the biological and geophysical properties of the terrestrial, freshwater and marine ecosystem compartments in relation to local, regional and global variability and change.

## Session Reports

# Sea Ice Changes and the Impacts on Biodiversity and Human Communities

Session Conveners: Koji Shimada and Ignatius Rigor

Co-Convenor: Lawson W. Brigham

In the session on "Sea Ice Changes and the impacts on Biodiversity and Human Communities", atmospheric, ocean and ice experts focused on the recent rapid reduction of sea ice cover. During the last decade, ice-albedo feedback and discharge of sea ice from the Arctic Ocean to the Greenland-Iceland-Norwegian (GIN) Seas, through Fram Strait, have been recognized as a key mechanism accelerating the reduction of sea ice cover.

## Changes in climate patterns

A recurring topic in this session was changes in climate patterns. James Overland presented changes in the patterns typically associated with the spatial distribution of sea ice cover. The non-uniform reduction of sea ice cover establishes zonal asymmetric patterns in sea level pressure that enhances the meridional circulation of the atmosphere. In the Pacific sector of the Arctic Ocean, southerly winds have prevailed and huge amounts of heat from the south are delivered to the Arctic. This is one of the key mechanisms that explains why the sea ice retreat is disproportionately more pronounced in the Pacific sector.

In addition to the dramatic retreat of sea ice extent, the thickness of sea ice has also been decreasing rapidly. With less sea ice concentration, wind forcing more easily penetrates the sea ice causing the dissipation of energy and increased internal stress on the sea ice. An accelerated sea ice motion enhances the upper

PHOTO: NAJA MIKKELSEN

Over the last years, the reduction of arctic sea ice has gone faster than predicted. In addition to this dramatic retreat of sea ice extent, the thickness of sea ice has also rapidly decreased.

ocean circulation. Strengthening the upper ocean circulation delivers more heat from the south into the central Arctic Ocean. The increased oceanic heat diminishes further sea ice formation during the winter. Less ice formation results in the thin initial thickness of sea ice at the beginning of the melt season.

## Seasonal ice

The presentations from biogeochemical experts focused mainly on the changes in seasonally ice-covered areas. Jacqueline Grebmeier introduced the changes in ecosystem associated with physical environmental changes. Contrary to the changes in the Arctic Ocean, the changes in the Bering Sea did not show a clear trend. The response of the biogeochemical system in the Bering Sea also showed a deviation from the responses observed in the Arctic Ocean. Grebmeier identified the biologically hot spot in 4-dimensional viewpoint with space and time. Karen Frey presented some of the impacts of climate change on the biological productivity in the northern Bering and Chukchi seas.

Overall, the session helped improve our understanding of active atmosphere-ice-ocean interactions that control the fate of the Arctic climate. The changes in marginal ice area and rim of the arctic multiyear ice area have been and will continue to be one of the hot spots of science.

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## Arctic Climate Variability - Past to Future

Session Convener: Harro Meijer  
Co-Conveners: Peter Lemke and Eystein Jansen

The arctic climate is highly interesting. In a practical sense, arctic countries are unusually dependent on the state of the climate for the livelihood of their societies,



use of lands and seas, and exploitation of marine resources. But from an academic viewpoint, the Arctic is a most interesting region for climate research. This region is the most sensitive to changes in climate. Effects of long- and short-term climate change are often first observable in the Arctic. For example, the Arctic is responsible for providing early contributions to our understanding of the geological effects of continent-wide glaciations during the ice ages.

## Understanding climate change

The complex postglacial history of the Circum-Arctic countries and the varied sediment sequences preserved under lakes with an extraordinary seasonality in their sediment input, as well as the detailed records of temperature, ice texture and impurities and greenhouse gas variations of the last Glacial and of the Holocene preserved in the ice cores from Greenland also contribute to our understanding of climate change. Iceland, with its volcanic sequences and intercalated sediment layers, not only preserved the history of this sub-aerial segment of the mid-Atlantic Ridge, but also provides an easily accessible paleoclimate data records. The fate of the Vikings who settled during the medieval climate optimum in Iceland and later in Greenland and who lost their habitat in Greenland at the beginning of the Little Ice Age, illustrates vividly the climate-dependent subsistence of the indigenous and non-indigenous arctic populations.

PHOTO: ELIZABETH THOMAS

Effects of long- and short-term climate change are often first observable in the Arctic. For example, the arctic region is responsible for providing early contributions to our understanding of the geological effects of continent-wide glaciations during the ice ages. During the 2009 International Polar Year Fieldschool, Hanne Christiansen taught students on the geology of Svalbard.

Modern arctic climate research includes the whole range, from recovery and interpretation of paleoclimate proxies via the assessment of historical and present-day recordings of many different climate-related parameters, to sophisticated modeling and contributions to assessments of future climate scenarios. The Session Arctic Climate Variability, contained examples of all these aspects. A total of eighteen speakers contributed to this session, including Karin Refsnes who gave an update on the plans for the "Svalbard Integrated Arctic Earth Observing System". Contributions dealt with time scales from the pleistocene to the coming centuries; included observations, data assimilation and various types of models; studied different types of materials from all over the Arctic; and focused on several aspects of the climate, such as air and sea temperature, precipitation patterns and sea ice.

### **Extracting information from cores**

For the long-time scale studies of paleoclimate, examples using ocean floor sediments cores were presented by Bjørg Risebrobakken and by Kirstin Werner. Multiproxy analysis of such cores reveals information about the past water temperature, column stratification and salinity, which in turn relate to climate. In both cases presented, the information covered the Holocene. Sediment cores from arctic lakes were presented by William D' Andrea, Reinhard Pienitz and by Larisa Nazarova. These cores are in one way similar to marine ones (in that they use tracers) and in another way quite different. For example, lake sediments relate to the land around the lakes and thus tell a direct paleo-environment story. D'Andrea used water temperature proxies, whereas the other two presented chironomid and other paleo-environmental tracers.

Land sediment cores from permafrost regions were used by Sebastian Wetterich and Alexey Lupachev. Wetterich used a range of fossil bio-indicators to re-

construct the paleo-environment of the Lena Delta in pleistocene times, whereas Lupachev used the present-day soil organic carbon content and its thermal isolating capacity to predict the possibility for massive carbon escape from the thawing permafrost in the near future. Liguang Sun (work presented by Xie) and L. X.Yuan both worked on shell remains from a sediment profile at Ny Ålesund, Spitsbergen. Sun investigated the relation between their isotope content and climate, whereas Yuan reconstructed the arctic seabird population history for the Holocene.

Isotopes of water were used by Michael Fritz for climate as well as ice cap reconstruction based on existing ground ice from pleistocene times on Herschel Island. Harro Meijer demonstrated the use of a new technique, called differential diffusion, to independently calculate paleotemperatures from ice core isotopes.

Sergey Pisareva, reported on measurement campaigns using advanced Ice-tethered profilers for conductivity, temperature and depth (CTD) profiles of arctic waters. Combining her data with existing, older datasets, she investigated trends and variability in salinity and halocline characteristics. As an intermediate step between observations and models, Vladimir Alexeev gave a critical review of the -sparse- arctic air temperature observations (using wind velocity measuring radiosondes, so-called rawinsondes) and their agreement or disagreement with several reanalysis data products.

### **Climate modeling**

Inger Hanssen-Bauer, Yvan Orsolini and John Cassano presented three different model exercises. Hanssen-Bauer used a regional climate model for the Svalbard archipelago region, and compared the outcome to available historical observations. Subsequently she used the model in combination with future scenarios for predictions for the coming century. Orsolini focused on the occurrence probability of cyclones in

the arctic region as a consequence of future climate change (driven by two of the IPCC scenarios). He used the Bergen climate model. Finally, Cassano's study involved the mass balance of the Greenland ice sheet, which is threatened by global warming. This warming brings about, however, increased precipitation as well. Bringing the IPCC model into a weather perspective, he addressed the cause and likelihood of this increased precipitation.

All in all, it has been a very diverse session, showing the rich variety of subjects, tools and even philosophies that contribute to our knowledge of the arctic climate and its future changes. Due to the 'climate change' laboratory character of the Arctic, these studies advance climate research as such in a more than proportional way.

## The Role of the Arctic in the Global Change Process

Session Conveners: Sung Ho Kang, Jingping Zhao and Peter Schlosser

There are large uncertainties in the response of the arctic climate system to global climate change. These uncertainties are partially caused by poorly quantified feedbacks and thresholds associated with the albedo, the thermohaline circulation (THC), and the uptake of greenhouse gases (GHGs) by the ocean. Since climate models differ in their projections of future change in the pressure fields and hence their associated winds, much uncertainty remains in terms of potential changes in stratification, mixing, and ocean circulation. The arctic THC is a critical component of the atlantic THC.

The latest assessment by the Intergovernmental Panel on Climate Change considers a reduction in the atlantic THC likely, while a complete shutdown

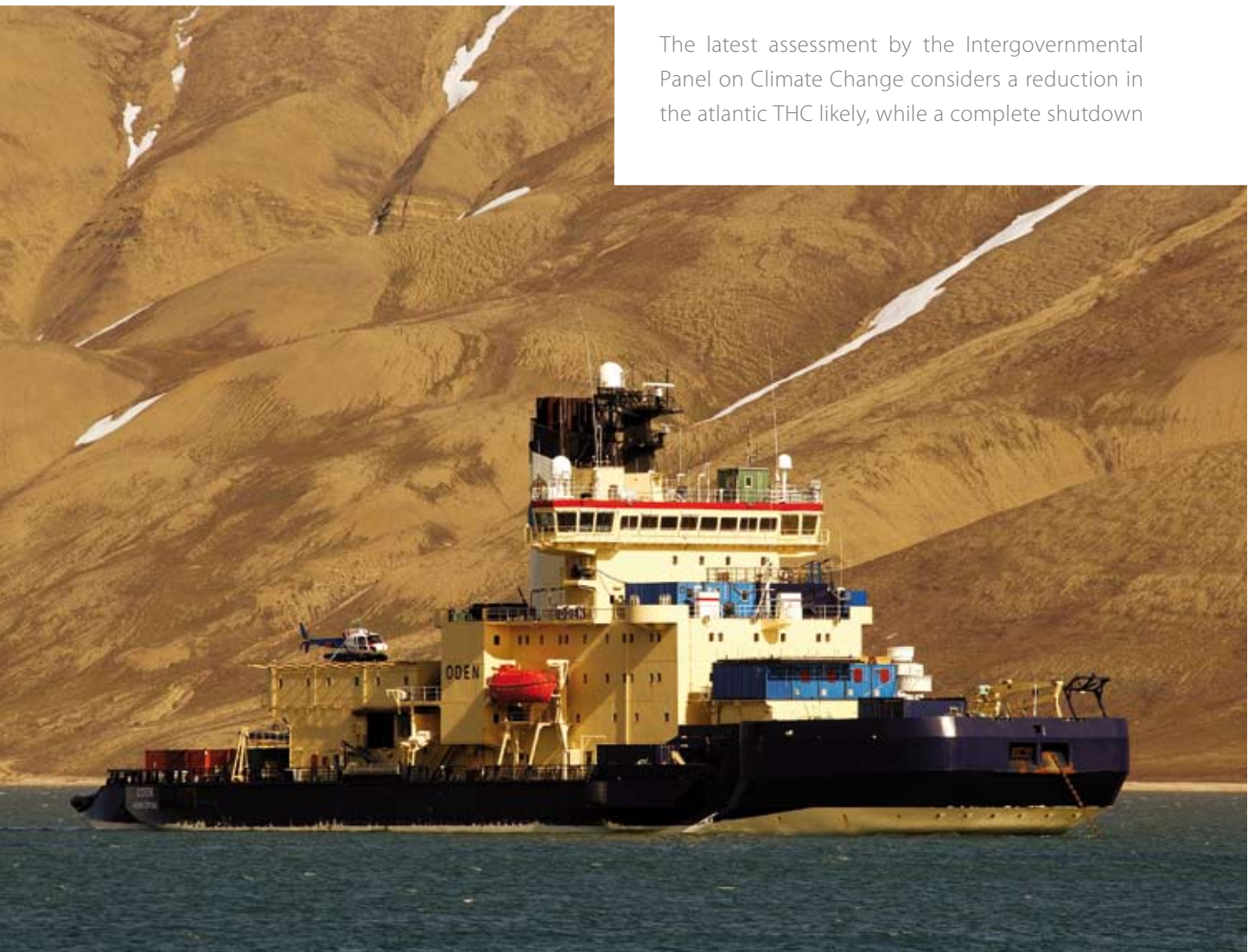


PHOTO: MARKUS KARASTI

A large fraction of the field experiment results presented by speaker Anders Sirevaag consisted of an ice drift, in which the Swedish ice breaker Oden was moored to an ice floe and drifted passively with the ice for twenty days.

is considered unlikely but not impossible. If the arctic THC is reduced, it will affect the global THC and thus the long-term development of the global climate system. Reduction in the global THC may also result in a lower oceanic heat flux to the Arctic. If the THC is reduced, local regions of the Arctic are likely to undergo cooling rather than warming, and the location of ocean fronts may change. This session welcomed papers focusing on all kinds of climate processes in the Arctic that are important for the global climate.

### International partnerships

Robert Dickson described the major advances that were made in our understanding of large-scale change in northern seas through the close international coordination that was achieved during the IPY. Dickson contributed to the debate on which of these efforts should be maintained into a post-IPY legacy phase by prioritizing the observational needs of climate models and ecosystem management against the technical demands and cost of meeting these on a sustained international basis. Another IPY effort was addressed by John Burkhart who gave an update on the international partnership to establish the Polar Study using Aircraft, Remote Sensing, Surface Measurements and Models of Climate, Chemistry, Aerosols and Transport (POLARCAT).

The vertical structure of warming in the Arctic was addressed by Igor Esau. Esau argued that this vertical structure of the warming can be better understood by taking the effect of the vertical turbulent mixing throughout the shallow, stratified arctic planetary boundary layer (PBL) into account. With simulations and observational data, he demonstrated that on average the asymmetry of the PBL response and the PBL summertime decoupling lead to trapping of the cold anomalies near the surface in all seasons with the minimum trapping effect in the spring season of the greatest observed warming.

Svalbard was well represented as climate change research location. Florian Geyer looked more closely at the dense overflow at the Storfjorden Sill, while Malgorzata Cisek examined the role of the west Spitsbergen shelf and slope in the interactions between the atlantic and arctic type water masses in the summers between 2005 and 2008. Winter heat loss from the west Spitsbergen current due to eddy exchange across the shelf edge front was addressed by Vigdis Tverberg. To investigate how the carbon-flow through the microbial community is affected by mineral nutrient limitation, Jorun K. Egge and colleagues carried out mesocosm experiments at Svalbard. Namyi Chae reported on research in the Dasa Station, Ny-Ålesund, where the role of soil carbon to the net ecosystem exchange of CO<sub>2</sub> efflux from soil surface to atmosphere and its controlling factors were evaluated. Kjetil Lygre constructed a simple box model to examine how changes in physical parameters alter carbon storage and the partitioning between downward transport of sinking particles and dissolved organic matter.



PHOTO: VINCENT VAN ZEIJST

A group of school children on their way in Ilulissat (Greenland). Speaker Rasmus Gjedssø Bertelsen presented on the effects of climate change mediated by oil/gas exploration and trans-arctic shipping on security in the Greenland-Iceland-Faroe Islands region under eventual Faroese and Greenlandic independence.

Waldemar Walczowski gave a talk about the changes of the thermohaline circulation of the Nordic seas and climate. In his presentation Walczowski brought together research results from Svalbard and another well represented research location: the Barents Sea region. The sensitivity of the Barents Sea towards variation in oceanic advection of heat and vertical heat fluxes was explored by Lars H. Smedsrud while Bert Rudels took a closer look at the Barents Sea inflow branch and its interactions with the Arctic Ocean water column. Marius Årthun used a 40-year (1958-1997) hindcast simulation from the regional coupled ice-ocean model HAMSON to study interannual to decadal variability in climate relevant processes in the Barents Sea.

## **Barents Sea region**

Ole Henrik Segtnan and colleagues studied the transport of Atlantic water through the Barents Sea, which is regarded as a key region with respect to the thermohaline circulation in the North Atlantic. Segtnan concluded that characteristics of the water exiting the Barents Sea is determined to a large extent by the surface heat loss southwest of the Central Bank. Vidar S. Lien looked into the relation between the Barents Sea and Arctic Ocean as well. Lien argued that current observations show that the most important transport of Cold Bottom Water (CBW) is in the lower layer near the northern tip of Novaja Zemlja. Some recirculation of Atlantic Water from the Arctic into the Barents Sea in the middle of the section was also observed. In total Lien suggested that the Barents Sea may act as a heat sink for the Arctic Ocean. Tor Eldevik presented on the variability and constraints of the Arctic-North Atlantic thermohaline circulation.

Changes in the distribution and properties of the Deep Water Masses in the Fram Strait for the period 1984-2005, where the topic of Helene Reinertsen Langehaug. Langehaug's results revealed several alterations in the deep gap. The deep water masses

from the Nordic Seas have become warmer and more saline, while the most saline intermediate water mass got fresher during the study period. Anders Sirevaag presented the first results of upper ocean turbulence measurements taken during the Arctic Summer Cloud Ocean Study (ASCOS) in 2008. A large fraction of the field experiment consisted of an ice drift, in which the Swedish ice breaker Oden was moored to an ice floe and drifted passively with the ice for twenty days.

Gabriel Wolken presented maps of the distribution of snow and ice facies on these ice masses and analyses of facies changes over the last decade and their relationship to climatic forcings. Enhanced resolution QuikSCAT (QS) scatterometer data were used to map the distribution of snow and ice facies on the major pan-arctic land ice masses during the period 1999-2008. Steingrímur Jónsson used data from the Greenland Sea project from 1987-1991 and the more extensive dataset from the ongoing project "Ecosystem of the Iceland Sea" to study the upstream path of the Denmark Strait overflow water through the Iceland Sea.

## **Analyzing data**

Data from the International Radiosonde Archive (IGRA) was used by Svetlana Sorokina to study the atmospheric energy flux across 70°N. The annual mean flux derived from the IGRA dataset turned out very similar to the results calculated from reanalysis data in previous studies. Vladimir Alexeev as well chose to test the robustness of polar amplification obtained from the reanalysis products against radiosonde data from IGRA. He analyzed an aquaplanet atmospheric General Circulation Model coupled to a mixed layer ocean in terms of its polar amplified response to a 2xCO<sub>2</sub>-like forcing and in terms of phase space trajectory of the relaxation of a free perturbation to equilibrium. Idar Barstad presented a modeling study of the baroclinicity and surface fronts near the ice-edge. Barstad's study included the intrusion of a realistic, upper level potential vorticity anomaly



in to the model atmosphere. The advection of such an anomaly into a region where there is a pre-existing meridional temperature gradient triggers cyclone developments (Polar Lows).

Arctic Oscillation, a spatially varied and non-seesaw-like oscillation, was the title of the presentation given by Jinping Zhao. Zhao argued that Arctic Oscillation (AO) is defined by a space-stationary and time-fluctuating result of Empirical Orthogonal Function (EOF) method and expresses the seesaw-like fluctuation between polar and mid-latitude regions, which is sometimes inconsistent with the real situation. By calculating the running correlation coefficient (RCC) between grid sea level pressure and AO index, an AO-dominant region has been identified to illustrate the spatial variation of AO. In recent years, the spatial structure of the AO-dominant region becomes indistinct because of arctic warming. EOF and RCC are addressed to be mutually complementary methods by viewing the different facets of the AO process.

From a different line of approach, but no less interesting, were the talks on climate change and new security in the North Atlantic and poverty in Nunavik, arctic Canada. Rasmus Gjedssø Bertelsen studies the effects of climate change mediated by oil/gas exploration and trans-arctic shipping on security in the Greenland-Iceland-Faroe Islands region under eventual Faroese and Greenlandic independence. Gerard Duhaime concluded that

very little is known about poverty in the Arctic. Duhaime called for original research in order not only to adequately measure the phenomenon, but also to identify population segments that suffer most from poverty in Nunavik.

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## Evolution of Arctic Ecosystems in a Warming World

Session Conveners: Falk Huettmann, Terry Callaghan and Svein Sundby

The session “Evolution of Arctic Ecosystems in a Warming World”, dealt with long- and short-term evolutionary processes in arctic ecosystems. It consisted of a wide range of evolutionary topics presented during sixteen exciting oral presentations on Wednesday 25th March, and twelve equally impressive oral presentations on Thursday 26th March. Afterwards, a well-attended plenary discussion was held. All sessions enjoyed a nice attendance, with up to fifty participants in the audience. Presenters came from over fourteen countries (e.g. Russia, Norway, Sweden, UK, Japan, China, S. Korea, Canada, Germany, France, US, Denmark, Holland and Greenland). A wide variety of topics were addressed that deal with various aspects of Evolution in the Arctic; some of them dealt with applied aspects.

PHOTO: JANICE LANG - POLAR CONTINENTAL SHELF PROJECT | NATURAL RESOURCES CANADA

Changes in the Arctic are happening at an incredibly strong rate. In many cases the evolutionary consequences cannot even be understood yet. The International Tundra Experiment (ITEX) and IPY science experiment studied the effect of climate variability and change on tundra ecosystems. Here Adrian Leitch and Greg Henry examine the effects of the experimental warming of tundra plants and soil in a greenhouse at Alexandria Fjord on Ellesmere Island, Canada.

## Wide variety of topics

Presented topics of this diverse session were centered around isotopes in soil, permafrost, microbial diversity, arctic methane, halophilic bacteria, aspen in a warming sub-arctic, photosynthesis, ecosystem changes and shrubs during climate change, winter warming, foraging pikas, topoclimate models, cladocera assemblages, arctic national parks, the Amundsen Gulf, sea ice, plankton archaeal distribution, the Beaufort Sea, the Barents Sea, pelagic species, polar bear behavior, data mining, local waterfowl populations, fish stock distribution, wildlife populations in time and space, entropy production, climate change, and various adaptations. Lively discussions were found in virtually all presentations, and more so, at the final discussion panel.

Although it was not the original goal of this session to provide a final statement by the participants, a couple of things became clear. For instance, (evolutionary) changes in the Arctic are happening now at an incredibly strong rate. The evolutionary consequences cannot even be understood yet. Like in the tropics or other places in the world, the Arctic still holds numerous evolutionary riddles to be solved. As a matter of fact, the Arctic is unique in the sense that it combines selection forces such as extreme temperature, short and long day light, combined marine, terrestrial, temperature and physical forces that shape evolutionary processes; thus, the Arctic should provide us with a fascinating test bed for evolution as a whole.

## Embracing uncertainty

Humans, as well as the non-human world of ocean and marine ecosystems, are coping with the recent (fast) change, and many components are modified, others are getting lost, some new ones occur, others are not even recognized so far. A centralized and easily available documentation of these events is basically not available yet, but would be crucial to have. Embracing uncertainty, leading to a meta-analysis and a science-based adaptive management could prove essential.

As session organizers we have some additional personal impressions regarding the relevance of the symposium for the scientific world. 1) climate change is more than just an evolutionary process. It puts the poles into the global spotlight, which 2) makes for a situation for which nobody is truly prepared. 3) Arctic biodiversity is still not well inventoried and international standards hardly exist. 4) This raises governance issues and appropriate leadership to be addressed, beyond the traditional sciences. 5) The amount of research is quite high, international and detailed, and it is starting to be truly interdisciplinary. 6) Notions like what is the best available circumpolar management schema to handle the arctic land and seascapes are not incorporated, nor even thought out, and not applied yet. In a world with nine billion people and climate change, there can hardly be any doubt that science-based adaptive management can be ignored.

To conclude, it was the wider consensus of the session organizers and the audience that a traditional niching in, and purely national and narrow view, well packed into neat but fragmented national borders and traditional science disciplines will fail if we are to fully understand and grasp the evolutionary process of the recent years, and for the years to come. In that regard, the arctic research community still has not achieved fully a truly global, or even a polar view even. The Arctic, and the poles are not stand-alone units without global context. However, on the positive side, it can be said that the international and multi-disciplinary aspect of polar issues was achieved in this meeting. Further, sea ice, and climate (e.g. temperature and precipitation) were at the center of the attention, and are better understood. Finally, the questions of "so what", "what does this all mean", and "where to go from here", came up vividly in the panel discussion, and elsewhere. It is here where we still need to build a better consensus, put the sciences in the cultural center of attention, and offer effective (sustainable management) solutions for the global village to achieve.



# Indigenous Cultures - Past to Future

Session Conveners: Joan Nymand Larsen  
and Deanna Kingston  
Co-Convenor: Grete K. Hovelsrud

The session “Indigenous Cultures – Past to Future”, had two main themes: climate change and indigenous peoples’ observations and adaptations, and globalization, particularly the effect of global and western cultures on indigenous peoples.

## Observing and adapting

In the context of the first theme, the presentation by Lawrence Amos’s on Inuvialuit observations of climate change was very valuable. Amos is Inuit himself and Tuktoyuktak is his home community. He and the people in his community are experiencing the effects of climate change first hand, and were among the first indigenous peoples to communicate their concerns. Changes include a decrease of sea ice, less predictable weather patterns and impacts on navigational abilities, the practice of traditional activities, and housing and infrastructure. The Inuit are learning how to adapt to climate change.

Strong session contributions also came from early career scientists. Elizabeth Marino, an Anthropology Ph.D. student, presented on environmental relocations in Alaska, particularly the community of Shishmaref where she has completed fieldwork several times in the past five years. She discussed how the government processes of planning for relocations fail to empower communities; indigenous communities still have no voice in the matter. Raila Salokangas and Zoe Todd, both MA students also gave interesting presentations on the changing meaning of education (Salokangas) on the Inuvialuit and participation in the wage economy among the Inuvialuit (Todd). Among other data used, Salokangas interviewed diverse multigenerati-



onal families in order to show how the meaning of the term ‘education’ was differently used by different generations, from “learning the Inuvialuit way of life” to “the best of both worlds” to “becoming whatever I want”. Todd’s paper showed how employment and engaging in a wage economy impacted the time spent on the land in hunting, trapping, and fishing. One issue that was apparent in Todd’s research was that food insecurity is emerging in these communities.

Of the other papers, Winifried Dallmann, Vladislav Peskov and Joan Nymand Larsen presented the results of IPY-endorsed projects. Dallmann and Peskov demonstrated the development of a web-based map database, under the International Polar Year, that monitored development in the Nenets Autonomous Okrug in Russia. The sheer amount of information given graphically in this website is impressive and will be a useful tool for indigenous peoples in this region to assess land use and development and how that might affect their livelihood as reindeer herders.

## Social indicators

Nyman Larsen’s paper presented information about the Arctic Social Indicators (ASI) project that was conducted under the International Polar Year. ASI works towards establishing a social indicator monitoring system for the long-term monitoring of human development in the Arctic. The indicators lie within six domains that reflect aspects of human develop-

PHOTO: DEANNA KINGSTON  
Matt Ganley, Vice-President for Land and Resources for the Bering Straits Native Corporation, archaeologist and cartographer, is clarifying the place names on the map of King Island, Alaska. He is assisted by the King Island Inupiat elders Gabriel and Edward

Muktoyuk. The personal experience of residents is particularly urgent with regard to community relocations and the relative power that indigenous peoples have over how and when to relocate.

ment that have been highlighted as being particularly prominent in the Arctic: fate control, cultural integrity, contact with nature, material well-being, education, and health and demography. The presentation focused on the indicator selection and criteria for their assessment. It also included a look at critical data challenges and the scope for implementing a system to enable comparative research across the Arctic in the future.

Deanna Kingston, a descendent of the King Island (Bering Strait, Alaska) Inupiaq community, discussed how relocation of the King Islanders in the 1950s to the mainland Seward Peninsula affected their community. In particular, she discussed the very different experiences King Islanders had in moving to the East End of Nome in the 1950s and 1960s, and their move in Nome-proper after a fall storm surge destroyed their Quonset hut-homes in 1974. This presentation discussed how the loss of physical proximity both between homes and within the homes has resulted in the King Islanders' sense of closeness and unity within their own community after the 1974 relocation, whereas they still felt a sense of cohesion after the move from King Island to East End.

The relevance of this session and symposium for the scientific world was twofold. First, the experiences of arctic indigenous peoples in the wake of climate change were highlighted. While many of the other papers presented at ASSW 2009 spoke of climate change, it was usually from a theoretical or scientific perspective. Often lacking was the personal experience of the residents who live there. This is particularly urgent with regard to community relocations and the relative power that indigenous peoples have over how and when to relocate. The second significance of this session was highlighting how indigenous peoples in the Arctic experience globalization, whether it

be from economic development of their lands, western educational systems, a western wage-economy, relocations, and health.

We recommend that future research on arctic indigenous peoples should include discovering methods to effectively increase indigenous people's political power in governmental decision-making, whether it be on relocation, education, health, or subsistence activities and land-use, as well as how to increase their participation in scientific research endeavors. We feel that this session was an important contribution to ASSW 2009 Science Symposium, especially the participation of indigenous participants. A stronger effort to include and financial support of more indigenous participants should be made a priority for the next Science Symposium.

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## Coastal Environments as a Link between Land and Sea in the Arctic

Session Conveners: Hugues Lantuit,  
Paul Overduin and Karen Frey

The coastal zone features some of the most dramatic changes occurring in the Arctic. Decreasing sea ice cover, destabilisation of permafrost systems and increased exposure of the coast to storms lead to the rapid rearrangement of already dynamic systems at the land-sea interface. Changes include both changing environmental conditions, bearing threats and options for human welfare and biodiversity, as well as new forms of land and sea use such as enhan-



ced access to resource extraction, or increasing ship traffic along the coast. Despite the obvious linkages between terrestrial, atmospheric, marine environments and society occurring around the arctic coastline, connections between these science disciplines are scarce.

This session, held during the science symposium was sponsored by the Land-Ocean-Interactions in the Coastal Zone (LOICZ) program and the Arctic Coastal Dynamics (ACD) project. Its geographical focus was deliberately determined by the overlap between the maritime and the terrestrial environments in the Arctic in an attempt to bring together several research disciplines working directly or indirectly at the interface between the land and sea environments.

## **Integrating disciplines**

The objective was to provide a forum for discussions of recent developments in the study of physical, biological and human dynamics along arctic coasts, on the upper shelf, in the near shore zone and in the backshore area. It purposely included presentations integrating several disciplines over the entire coastal tract: investigation of material and energy exchanges at the land-ocean interface driven by near shore and offshore currents, tides, and surface and internal waves as well as ecological, socio-economic, biogeochemical and zoological studies centred around the coastal environment.

The start of the session was primarily focused on terrestrial science and its connection to the coastal environments. Hydrological (Antonina Cheteverova and Karen Frey) studies often connected to the evolving occurrence of permafrost on land masses (Janet Rethemeyer and Anna Urban) provided some baseline data on the contribution of the terrestrial environment to the near shore and upper shelf realm. Carolyn Wegner and Hans-Wolfgang Hubberten focused on the Laptev Sea shelf, its sediment dynamics

and the current state of sub-sea permafrost put these fluxes of sediment and nutrients into context.

## **Social impacts**

The second part of the session focused on the social impacts from changing coastal environments and initiatives taken to mitigate and adapt to these changes. Kathleen Parewick described the complex phenomena at work in small communities from the Canadian Arctic, while Donald Forbes and Falk Huettmann showcased new initiatives to grasp these challenges at the arctic level.

The third part of the session emphasized the current state of knowledge on coastal erosion along the arctic coastal rim. Hugues Lantuit, Paul Overduin, Mateusz Strzelecki, Irina Streletskaia and Alexander Vasiliev demonstrated that the geographical coverage of current arctic coastal erosion data is not sufficient to correctly determine meaningful erosion trends. They showed some insightful new process data collected at specific sites in Russia, Canada, Alaska and Svalbard but also pleaded for the integration of these efforts into a broader and funded effort.

The last part of the session brought together presentations on the ocean part of the coastal zone, focusing on the optical properties of the wasters (Gisle Nondal and Alexey Pavlov) and illustrating new findings on CO<sub>2</sub> levels and organic matter decay in Russia (Leif Anderson and Kirill Egorov). The session was concluded by the demonstration that the variability in ocean conditions could influence substantially bowhead whale populations (Sue Moore)

## **Ongoing process**

This session was a follow up to a similar session organized during the SCAR/IASC Open Science Conference In July 2008 and should be continued with a session to be held at the International Polar Year Conference

PHOTO: TORSTEN SACHS

The arctic coastal zones feature some of the most dramatic changes due to global warming. Changing environmental conditions bear threats and options for human welfare and biodiversity, as well as new forms of land and sea use.

in Oslo in June 2010. The large attendance and the interest shown by the audience have showed us that the confrontation collection of the research disciplines active in the coastal zone prompts a series of challenges and science questions that engage the research community in ways it hasn't before. This, in return, paves the way for initiatives attempting to combine these approaches and disciplines.

The 'coastal tract', that is the conceptual description of the coastal zone integrating both the terrestrial, land-sea interface and the upper shelf provides a framework in which these new integrated approaches can be combined. The newly established Arctic Research in Transitions (ART) project of the Arctic Ocean Sciences Board (AOSB) proposes to address the interactions between the terrestrial and ocean environments and provide a useful platform to develop these new research questions.

### **Working towards an integrated strategy**

Beyond, single research initiatives, however, it stems from this session that current arctic coastal research is not integrated and sustained enough to provide the necessary baseline data to correctly apprehend the processes at work in the coastal zone. The geographical coverage of current studies, the systematic observing of hydrodynamical forcing, the partnership with local communities to implement an observing strategy are too weak, and have not yet been devised in an integrated strategy.

The message stemming from this session is one of a need for sustained observing efforts integrating science disciplines in the arctic coastal zone. The current Sustaining Arctic Observing Networks (SAON) effort is a pioneering effort that could provide the platform needed to conduct such effort and to consolidate operational observing capabilities across disciplines,

countries and international operational organisations. Its coastal component, the Arctic Circumpolar Coastal Observatory Network (ACCONet) is envisioned as the right instrument to coordinate coastal observing efforts and feed those in higher-level programs such as the coastal module of the Global Ocean Observing System (GOOS) and the Coastal Global Terrestrial Observing System (C-GTOS).

This session showed that coastal studies do not work in isolation and that the strong scientific rationale being coordinated research projects provides an incentive to integrate observing efforts with the existing observing platforms active in the ocean of terrestrial realms, such as the Integrated Arctic Ocean Observing System (iAOOS).

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## Risks to Human Health from a Changing Arctic

Session Conveners: Maarten Loonen, Larisa Abryutina and Nazune Menka

Physical health integrates a wide variety of environmental stresses and is an important component of human well being. In a changing environment like the Arctic, health conditions will change too. In this session, we looked at health issues from an ecological context and opened a new framework of discussing change. The main perspective was on human health, but a lot can be learned by including animal health issues.

The session focused on two different issues. First, changes in the environment can have direct effects on the health of individuals. Examples discussed in the session included polluting chemicals and cosmic rays. Second, changes in the environment can introduce new pathogens and parasites. In the session, we dis-



cussed these effects for ungulates (meaning roughly 'being pawed' or 'hoofed animal') and birds, but also the risk of new pathogens jumping from animals to humans like avian influenza.

## Human health assessment

The session had a plenary lecture by Jay van Oostdam. In the Arctic Monitoring and Assessment Programme (AMAP), there is a human health assessment group that has undertaken several assessments of contaminants, human health and climate change over the last eighteen years. Van Oostdam showed subtle but clear changes in health issues of indigenous people following changes in contaminant exposure or dietary shifts. In the science session Jon Øyvind Odland continued from an AMAP perspective discussing adaptation processes from a sustainable development perspective.

Sergey Chernouss and Nathalia Belisheva combined their presentations and discussed how the close proximity to the magnetic pole might affect human health via cosmic rays and geomagnetic fields. Bjørnar Ytrehus showed that arctic ungulates are prone to new diseases and problems with temperature regulation during recent warm years. Finally, Maarten Loonen discussed birds as a potential vector for diseases like avian influenza and west-nile virus. He showed how birds vary the activity of their immune system and why the Arctic can be regarded as a place with a lower pathogen risk than more temperate areas.

The session was an important step in combining different disciplines and backgrounds into an integrative theme. Due to the small number of presentations and the different background of the participants, the session did not develop a unifying concept for future research. However, it did succeed in presenting an overview of the issues and their relevance, especially for the arctic environment and those living there.



## History of Arctic Science

Session Conveners: Susan Barr, Jörn Thiede and Erki Tammiksaar

History has never been dealt with in a substantial way during the past ASSWs. This time the ASSW 2009 chose a theme with an historic background "Arctic Connections: The Results of 150 Years of Research." In addition, the week was held in Bergen, a place with great traditions in arctic research. With Fridtjof Nansen in his early years and other famous oceanographers who worked from Bergen in their time, the city is a classic place for arctic research and hence it was an excellent venue for the ASSW 2009.

In this setting, the conveners expected to be overwhelmed with offers for exciting contributions. However, to our surprise this was not the case. We can only assume that the scientific community dealing with historic aspects of research in the Arctic will have to get accustomed to the idea that future ASSW science symposia will offer a venue for studying the roots of the development of our science. A similar process has been going on in the Scientific Committee for Antarctic Research (SCAR), which needed almost fifty years to found its first Action Group on the History of Antarctic Science, but which now regularly hosts workshops and symposia devoted to historic topics during its Open Science Conferences.

PHOTO: ALEXEY PAVLOV

Little auks (Alle alle) nearby a small open water area in Isfjorden, Svalbard. Birds are a potential vector for diseases like avian influenza and west-nile virus. The Arctic, however, can be regarded as a place with a lower pathogen risk than more temperate areas.

PHOTO: HANNES GROBE

A sculpture of Roald Amundsen stands in front of the blue house at the French-German AWIPEV research base on Svalbard. The first ASSW Science Symposium chose the historic theme "Arctic Connections: The Results of 150 Years of Research".

## International Polar Year

Erki Tammiksaar discussed in great detail the difficulties of the first IPY, which later developed into a great success. At that time it was well understood that one needed synoptic observations to understand the global weather patterns, but nobody had any experience in organizing an internationally well coordinated effort of expeditions into such extreme regions like the Arctic (and also Antarctic). Karl Weyprecht played a fundamental role when preparing for the first IPY as was illustrated in the talk of James Overland, and finally eleven nations joined to implement Weyprecht's plan. All but one scientist returned safely with a load of scientific data.

The first and second German North Pole expeditions were precursors to the first IPY, and of only limited success, but curiously the ship used for the first one was the Norwegian „jekt“ /Grønland/, bought by Captain Koldewey in 1868 in Bergen, as Jörn Thiede described. The ship still exists as part of the historic fleet of the German Maritime Museum in Bremerhaven and hence preserves the tradition of the early vestiges of German polar research. Sergey Chernouss discussed the auroral studies of a Russian-Swedish expedition to Spitsbergen almost 110 years ago, with fine illustrations of old photography.

## Developing infrastructure

Susan Barr described and discussed the origin and history of the Norwegian research efforts in Svalbard, which resulted in the foundation of the Norwegian Polar Institute, originally in Oslo, however recently relocated to Tromsø. The three following talks were devoted to the development of arctic research infrastructure. Functions and meanings of polar research field stations were described by Urban Wråkberg. Shuo Li from China explained how modern ROV and AUVs could be used in the Arctic Ocean. And Marty Bergmann explained the development of the Canadian field logistics, representing a huge

challenge because of the extent of the Canadian arctic wilderness.

Rupert Wienerroither finally addressed the marine fish diversity in the area of Jan Mayen where fishing has gone on for a long time and where the first oceanographic data was collected as early as 1877. A careful assessment of changes of the fish biodiversity, based on field data and museum collections, illustrated changes and faunal shifts in distribution, with an increase of registered species since the late 1970s.

Despite few contributions we feel that the session on the History of Arctic Science was a success. We achieved a good mix of themes devoted to the first IPY and times before, as well as more modern topics, widely spread over several disciplines. The large number of participants in the audience documented the interest in historic topics of the arctic research history, despite the relatively small number of contributions. Historic topics will in all probability also be dealt with during future ASSWs.

## Summary of the Business Meetings

### Forum of Arctic Research Operators (FARO)



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Contact: Morten Rasch | Executive Secretary,  
mras@dmu.dk

The Forum of Arctic Research Operators (FARO) is a forum for information exchange, establishment of

cooperation and development of new ideas among the national logistics operators in countries with arctic research activities. FARO aims to facilitate and optimize logistics and operational support for scientific research in the Arctic. The forum's annual meeting was held during Arctic Science Summit Week in Bergen with twenty participants representing fourteen different countries and the European Polar Board.

At the beginning of 2009, the FARO secretariat moved from the Danish Polar Center to the National Environmental Research Institute at the Aarhus University, Denmark, after the closing of the Danish Polar Center. Chairman, Simon Stephenson Division Director for Arctic Sciences of the US National Science Foundation (NSF), announced at the 2008 annual meeting that he would step back as chairman of the forum in 2009. At the 2009 meeting, Marty Bergman, Director of Polar Continental Shelf Programme (Canada) was elected as the new chairman.

### Arctic research infrastructure

During an information session, each of the represented countries/organizations presented information on their current and planned research activities within the Arctic. Due to the International Polar Year (IPY), 2008 was a busy year for most of the national logistics providers. Major news concerning the establishment of new research infrastructure in the Arctic included: the construction of a Japanese icebreaker to be ready for operations in 2010, the construction of a Korean icebreaker, also to be ready for operations in 2010, a European Science Foundation / European Polar Board project (under European Strategy Forum on Research Infrastructures, i.e. ESRI) concerning the project design for a European ice breaker, Aurora Borealis, and another ESRI project led by Norway concerning the establishment of Svalbard Integrated Earth Observing System (SIOS).

Danielle Labonte from Indian and Northern Affairs Canada (INAC) informed the forum about Canadian

plans to establish a 'world-class high-arctic research station', which will be at the cutting edge of arctic issues. Marty Bergmann gave a presentation about the program as a provider of logistics support in the Arctic. Danielle Biebow from the Alfred Wegener Institute (AWI) gave a presentation about the European Research Icebreaker Consortium (ERICON) and plans concerning the construction of the icebreaker, drilling platform and multi-purpose research vessel, Aurora Borealis. Morten Rasch from the National Environmental Research Institute (NERI) at Aarhus University, Denmark, presented SCANNET, a circumarctic network of terrestrial field sites.

At the end of the meeting, a possible transition of FARO into a member organization was discussed. Most of the meeting participants were positive about the possibility. The retiring chairman, Simon Stephenson, concluded that the secretariat should initiate a survey among the members concerning their expectations for FARO as a member organization.

<http://faro-arctic.dmu.dk>

### Pacific Arctic Group (PAG)

Contact: John Calder | Chair  
[John.Calder@noaa.gov](mailto:John.Calder@noaa.gov)



The Pacific Arctic Group (PAG) is a group of institutes and individuals having a Pacific perspective on arctic science. Organized under IASC, PAG has as its mission to serve as a Pacific arctic regional partnership to plan, coordinate, and collaborate on science activities of mutual interest. The four PAG principle science themes are: climate, contaminants, human dimensions and the structure and function of arctic ecosystems.

During the PAG business meeting, the group reviewed the status of the PAG Regional Synthesis, held a joint session with AOSB, discussed future interactions with a restructured IASC, discussed the OceanObs09 conference, and discussed the need for new officers and an Executive Secretary by 2010.

## Regional Synthesis

The PAG Regional Synthesis was conceived as a means of bringing together the results from all of the PAG participants in an organized way. The synthesis will be conducted in several parts defined on a science basis. The initial activity was a modeling workshop held in Sanya (China) in February 2008. The primary outcome of this workshop was a special issue of the "Chinese Journal of Polar Science" that contained 13 papers authored by workshop participants. The Journal was published in December 2008. A US-Chinese-Japanese team is working on improving an atmosphere-ice-ocean model of the Pacific sector of the Arctic and the results of this work will be shared with PAG over the coming years.

The PAG synthesis will continue with additional efforts on other areas of arctic science. It was decided during the meeting to convene a group of experts on the marine carbon cycle in Xiamen (China) in late June 2009 to develop a plan for producing a synthesis report on this topic. Suggestions for additional science-themed synthesis efforts were made during the meeting, and plans for implementing these will be developed as soon as possible. The scheduled IPY Science Conference in Oslo in June 2010 is a prime target for presenting initial results of these synthesis activities.

## Letter of Agreement

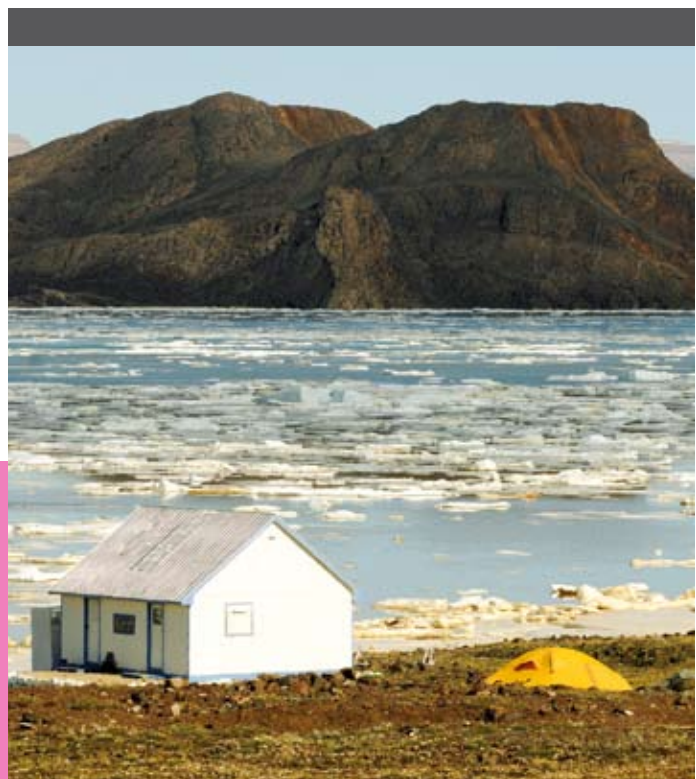
The joint session with AOSB was very useful and focused on discussion of plans for ship-based work in the Arctic in 2009 and 2010. PAG reviewed the draft Letter of Agreement between PAG and IASC and

agreed that it was ready for signing. Basically, PAG and IASC will interact through the Marine Systems Scientific Standing Committee, which incorporates the agenda of the AOSB. PAG and AOSB have many common interests, and there was general agreement that interacting through the Standing Committee would be fruitful.

The OceanObs09 conference was introduced and its relevance to PAG discussed. The conference is intended to cover global ocean observations and to provide scientific guidance to the next update of the Global Climate Observing System implementation plan. It was stressed that the next GCOS plan had to do a better job of describing the need for and nature of observations in the Arctic Ocean. The primary science content of the conference will be provided by a large number of community white papers. Over 150 of these papers will be developed and four will focus on the Arctic. Interested members of PAG are encouraged to attend the conference and comment in advance on the white papers that are available on the OceanObs09 website.

The Chair, Vice-Chair, and Executive Secretary of PAG are expected to step down during 2010. The PAG members were asked to consider how these offices should be filled with a view toward making decisions at the PAG meeting during ASSW 2010.

<http://pag.arcticportal.org>





## European Polar Board (EPB)

Contact: Paul Egerton | Executive Director  
pegerton@esf.org



The European Polar Board (EPB) is Europe's strategic advisory body on science policy in the Arctic and Antarctic. It is a platform for European engagement in international science programs and provides strategic science policy advice to the European Commission and international bodies.

The European Polar Board's spring plenary meeting was held over two days during the Arctic Science Summit Week in Bergen. The ASSW was a successful and cooperative week with the other international polar organizations. On Sunday 22nd March 2009, the EPB delegates met at the Institute of Marine Research to carry out business issues such as conducting elections and determining the budget. Professor Carlo Alberto Ricci was re-elected as the Chair of the European Polar Board and five members were elected to the Executive Committee. New portfolios have been assigned to the vice chairs: Antarctic and global science Nicholas Owens (United Kingdom); research infrastructures Karin Lochte (Germany); capacity building and programmes in new EU member states Christo Pimpirev (Bulgaria); bi-polar marine issues Harald Loeng (Norway); terrestrial arctic research and Scandinavian countries Kari Laine (Finland).

It was decided that the EPB would receive and implement the Memorandum of Understanding on a "European Polar Framework" after being signed by the participating parties at the European Polar Summit of June 24th. On Monday, March 23rd, the EPB delegates and invited guests gathered for a scientific and strategic initiatives session. This session examined the EPB's developing Green Paper on European Polar Research, updated attendees on the PolarCLIMATE Programme,

looked at the ERICON Aurora Borealis project and demonstrated the communications plan. The next plenary meeting will be held in Autumn 2009 in Brussels.

### **An overview of major EPB activities:**

#### **INFRAPOLAR**

European Research Infrastructure Platform for Climate and Environmental Monitoring in the Polar Regions. The European Polar Board is in the process of designing and submitting a large scale 7-8 Million Euro integrating activity to the European Commission in December 2009. This will involve a series of flagship research sites in the Arctic and the Antarctic to promote transnational access and networking of these facilities in the context of joint research programmes and priority scientific topics. A number of countries with large and developing polar programs plus international partners have expressed an interest. The project is likely to be coordinated under the European Science Foundation's EPB unit.

#### **EUROPOLAR ERA-NET**

The EUROPOLAR ERA-NET started in March 2005 and just recently ended in February 2009. This project was financed by the European Commission Framework Programme 6. The project achieved many outputs including the first comprehensive survey of the landscape of polar programs and infrastructures, the launch of a joint multinational research program Polar CLIMATE and a forward look investigation on decision support systems in the Polar Regions. One of the final deliverables of this project is a Memorandum of Understanding. At the European Polar Summit of 24th June, this Memorandum of Understanding for a "European Polar Framework" will be signed by around 27 national funding organizations and Polar operators. This Memorandum of Understanding is an important way forward in creating a European Polar Framework to launch future joint calls, enhancing the coordination of European research Infrastructures and engaging in strategic discussions regarding future

PHOTO: JANICE LANG - POLAR CONTINENTAL SHELF PROJECT | NATURAL RESOURCES CANADA

A former Royal Canadian Mounted Police outpost building beside a field camp at Alexandra Fiord, Nunavut (Canada).



and science priorities. The European Polar Summit will officially close the EUROPOLAR ERA-NET as well as recognize the work achieved and deliverables accomplished throughout the project.

### **PolarCLIMATE Research Programme**

In September 2008, the European Polar Consortium launched the Call for Pre-Proposals: European Partnership in Polar Climate Science (PolarCLIMATE). This call, supported by 20 ministries and funding agencies from eighteen European countries generated a lot of interest and 36 multinational Pre-Proposals. In late November, 19 Pre-Proposals were invited to submit Full Proposals, with a deadline for submission of 6th March 2009. From March to May, the proposals underwent Peer Review, at the end of which the Project Coordinator had the opportunity to respond to the anonymous assessments. The Programme Board recommended six PolarCLIMATE proposals for funding (one which is subject to reevaluation). The proposals are spread across the three research themes and a near balance between the Arctic and the Antarctic.

### **ERICON-AURORA BOREALIS Project**

The ERICON-AB project is completing its first year of activity. However, even before its official start, major scientific and technical activities were performed within a project sponsored by the German Ministry of Education and Research BMBF. The project is financed by the European Commission under Framework Programme 7 and coordinated by the European Polar Board Unit inside the ESF.

The ERICON-AB project will generate the strategic, legal, financial and organisational frameworks for European ministries and funding agencies to decide about the construction and operation of AURORA BOREALIS. The possibility to achieve this target is related to two general conditions: a) a critical number of European Countries which recognize political and strategic interest to have a powerful tool for scientific research in hitherto unexplored areas of the polar oceans, mainly the Arctic Ocean b) a strong international and interdisciplinary scientific interest which looks at AURORA BOREALIS as a unique tool for understanding the past and present environment and climate.

A Financial Advisory Panel was created to establish the financial framework necessary for government commitments. To reach this objective the panel will first define the verifiable estimate of total construction cost and forecast future running costs for the operation of the AURORA BOREALIS. Composed mainly of experts from our European partners but also from Japan and the United States, the panel gathers the expertise from research vessels operators, ship designers and heads of logistics. Later in the project, the Financial Advisory Panel will prepare the business planning foreseen for the funding of the icebreaker and converge with the work of the legal work package to feed in the decision process defining the legal structure and governance to be implemented for the AURORA BOREALIS.

[www.esf.org/research-areas/polar-sciences.html](http://www.esf.org/research-areas/polar-sciences.html)

PHOTO: AWI/SCHIFFKO PRV 200

A visual impression of, and ice model test for the AURORA BOREALIS, an icebreaker, drilling platform and multi-purpose research vessel in one. The ERICON-AB project will generate the strategic, legal, financial and organizational frameworks for European ministries and funding agencies to decide about the construction and operation of AURORA BOREALIS.

# ASSW 2010 & 2011

The Arctic Science Summit Week of 2010 takes place in Nuuk (Greenland) from 15 - 19 April. This ASSW consists of business meetings and a common day and is generously sponsored by the Government of Greenland and the Commission for Scientific Research in Greenland.

## The local organizing committee consists of:

### **Najaaraq Paniula**

Research Coordinator, Government of Greenland,

### **Lone Nukaaraq Møller**

Research Coordinator, Government of Greenland.

### **Carl Christian Olsen**

Head of Department, Language Secretariat.

### **Daniel Thorleifsen**

Director, Greenland National Museum and Archives.

### **Helle Siegstad**

Head of Department, Greenland Institute of Natural Resources.

[www.assw2010.org](http://www.assw2010.org)

## New Frontier for Global Science

The dates for the Arctic Science Summit Week (ASSW) 2011 are set at March 28 to April 1. The ASSW 2011 will take place in the Coex Center in Seoul (Korea) and will have an integrated Science Symposium covering the theme: "The Arctic: The New Frontier for Global Science". The Science Symposium that will be organized for the second time after a successful launch in Bergen 2009 creates a platform for exchanging knowledge, cross fertilization and collaboration in arctic science.

The Scientific Steering Group is chaired by Byong-Kwon Park, Korea Polar Research Institute, and Jacqueline Grebmeier, University of Maryland.

They are supported by: Hanne Christiansen, The University Centre in Svalbard, Alexander King, Anthropology Department University of Aberdeen and Alexey Pavlov, Arctic and Antarctic Research Institute St. Petersburg.

## The local organizing committee consists of:

President

### **Hong Geum Lee**

Director-General of KOPRI

Members

### **Bang Yong Lee**

Vice Director-General of KOPRI

### **Moon Young Choe**

Head, Div. of Polar Earth-System Sciences, KOPRI

### **Hyoung Chul Shin**

Head, Div. of Polar Biology & Ocean Sciences, KOPRI

### **Sungmin Hong**

Head, Center of Climate Sciences, KOPRI

### **Joung Han Yim**

Head, Polar Bio Center, KOPRI

### **Yong Joo Jwa**

Professor of Kyungsang University

### **Tae-jun Han**

Professor of Incheon University

Executive Officer

### **Dongmin Jin**

Executive Officer of KONPOR

PHOTO: JOSEF ELSTER

Czech research group in the Arctic. During the 2009 expedition, research was conducted under the auspices of the "Biological and climate diversity of the central part of the Svalbard Arctic archipelago". The Sustaining Arctic Observing Networks (SAON) aims to support and strengthen the development of multinational engagement for sustained and coordinated pan-Arctic observing and data sharing systems based on research results from expeditions like this.



#### 4. Major International Science Initiatives

## » 4 Major International Science Initiatives

### Sustaining Arctic Observing Networks (SAON)



SAON is a process to support and strengthen the development of multinational engagement for sustained and coordinated pan-Arctic observing and data sharing systems that serve societal needs, particularly related to environmental, social, economic and cultural issues.

The SAON vision is that users should have access to free, open and high quality data that will realize pan-Arctic and global value-added services and provide societal benefits. To attain that vision, SAON's goal is to enhance arctic-wide observing activities by facilitating partnerships and synergies among existing 'building blocks', and promoting sharing and synthesis of data and information. To achieve that goal, SAON will engage a broad community that includes governments and operational agencies,

scientific researchers, indigenous peoples and northern residents, other stakeholders and the general public.

SAON was initiated by the Arctic Council, and a SAON Initiating Group (SAON IG) was established in January 2007. The SAON IG organized a series of workshops and international meetings focusing on five key questions:

- 1: What Arctic observing sites, systems and networks currently exist?
- 2: What spatial, temporal and disciplinary gaps exist?
- 3: How will gaps be filled and the entire effort sustained?
- 4: How are these activities to be coordinated and integrated?
- 5: How is free, open and timely access to data to be achieved?

#### Set of Recommendations

Based on the outcomes of these meetings, the SAON IG proposed a Set of Recommendations to the Arctic Council and partners:

- 1: Arctic Council to take the lead in continuing the SAON process;



**2:** Arctic Council member states should:

- sustain and increase current level of observing activities and data and information services
- create a data dissemination protocol;

**3:** Each Arctic state should create a national inter-agency group. These groups to form the basis for increased inter-governmental cooperation;

**4:** Arctic states should welcome non-Arctic states to take part in this inter-governmental cooperation and adopt, support and implement the recommendations above.

The Arctic Council agreed on these recommendations and decided in their Tromsø Declaration of April 2009 to take the lead in implementing them together with IASC and the World Meteorological Organization (WMO). The SAON Steering Group (SAON SG) defined by the Arctic Council, consists of representatives of each of the eight Arctic Council (AC) member states, AC Permanent Participants, AC Working Groups, IASC and WMO and is co-chaired by John Calder (Arctic Monitoring and Assessment Programme / AMAP) and David Hik (IASC).

PHOTO: A. HORMES - ALFRED WEGENER INSTITUTE

Joann Smidt and student Anne Theuerkauf are preparing the tethered balloon „Miss Piggy“ for launch from the AWIPEV research base. The balloon can rise up to 3km height and brought down again. The conservation and availability of IPY and other data and observations poses an enormous challenge. With the creation of the Sustaining Arctic Observing Networks (SAON) leading international organization have set the course the ensure data preservation and accessibility.



## Priority areas

The SAON approach is to build on existing observing sites, systems and networks (SAON building blocks). SAON is a means for addressing issues that transcend individual networks. The SAON SG agreed in June 2009 on four priority areas:

- \* **Inventory (survey) of existing networks**
- \* **Data access and sharing**
- \* **Community-based monitoring**
- \* **Multinational collaboration**

## How to become a SAON Network?

The SAON SG aims to be a facilitator that serves the needs of existing observing sites, systems and networks, and data and information management activities that wish to be building blocks of SAON. To achieve this, the SAON SG has prepared a short survey with two questions and an inventory form requesting some basic information about your observing activity. Network leaders are asked to complete the survey and help the SAON to best serve the Arctic observing community of operators and users.

Observing sites, systems and networks, and data and information repositories can be recognized by SAON if they are long-term activities, meet a few minimal criteria and submit the SAON Network Inventory form. Such long-term activities include operational observing, scientific research-based observing, community-based observing and traditional knowledge. Short-term, campaign-style activities or process studies are unlikely to qualify, unless they create baseline data sets for future comparative study.

### The minimal criteria for SAON recognition are:

- 1:** It is a functioning activity, not a plan or proposal;
- 2:** There is a defined point of contact and a process

for regular dissemination of information (web site and/or newsletter);

- 3:** There is a public mechanism (preferably a web site) for obtaining information (metadata) about the observing activities and data;
- 4:** Data quality control procedures are in place;
- 5:** The principal of free and open data access is being followed to the maximum extent possible;
- 6:** Plans are in place for both medium and long-term data archival at nationally–and/or internationally-recognized data repositories.

### The benefits to an observing network or site of being recognized by SAON are:

- 1:** SAON will develop a “brand” and reputation for quality that will be readily recognized by potential funding sources, and by governments, scientific researchers, indigenous peoples and northern residents, stakeholders and the general public;
- 2:** SAON will act as a clearinghouse for information about pan-arctic, long-term observing activities;
- 3:** SAON will promote international partnerships and synergies among observing networks and sites, thus reducing duplication and redundancy;
- 4:** SAON will facilitate the use and incorporation of traditional knowledge and promote community based monitoring as complementary to operational observing and scientific research-based observing.

### Contact information

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[www.arcticobserving.org](http://www.arcticobserving.org)

PHOTO: KONSTANZE PIEL - ALFRED WEGENER INSTITUTE

Reticular structures of ice-wedge polygons in the permafrost landscape. Thawing of permafrost can lead to waterlogged soils and slumping of land. These changes in terrain are followed by major changes in the vegetation of the affected areas.





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



Climate Change and the Cryosphere: Snow, Water, Ice and Permafrost in the Arctic (SWIPA) is a project of the Arctic Council which is coordinated by AMAP in cooperation with 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).

The SWIPA Project was approved by the Arctic Council at its Ministerial Meeting in April 2008 as a follow-up to the 2005 Arctic Climate Impact Assessment (ACIA). The project brings together arctic scientists to compile and evaluate information from arctic monitoring networks and recent international research activities, such as those carried out during the IPY, to better quantify and understand the recent changes to the cryosphere and their impacts that have occurred since the ACIA report was published.

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 implications globally.

The final SWIPA report will be delivered to the Arctic Council in the spring of 2011. A preliminary report on "The Greenland Ice Sheet in a Changing Climate", one component of SWIPA, has been delivered to the Fifteenth Conference of Parties (COP 15) of the United Nations Framework Convention on Climate Change (UNFCCC) in December 2009.

The preliminary findings of the SWIPA Project clearly show that the arctic cryosphere has changed dramatically during the past decade:

## Sea ice

The extent of Arctic sea ice has decreased during the past thirty years. The past five years have seen the five lowest ice extents recorded during September, when sea ice is at its annual minimum. The loss of sea ice creates a positive feedback to warming, because the open water absorbs far more sunlight and heat than ice and snow. The ice cover has also become thinner and younger, with a decreasing area of multi-year ice. These changes leave it more vulnerable during coming summers, setting the stage for further rapid retreat.



Sea ice is an essential habitat for animals such as polar bears and walrus. Reduced sea ice threatens both the food web that supports these species and the ice habitat in which they live for most of the year. Altered sea ice characteristics will affect other parts of arctic ecosystems including, e.g., the productivity of organisms living on, in, and associated with the ice. The retreat of arctic sea ice has increased coastal erosion, but also improved access to arctic resources, and increased traffic on major shipping routes through and within the Arctic. The first transit of the Northeast Passage by commercial ships without icebreaker support occurred in the summer of 2009.

### **Greenland Ice Sheet**

The Greenland Ice Sheet is the second largest ice sheet in the world, after the East Antarctic Ice Sheet, and the largest body of ice in the Northern Hemisphere. It contains about 3 million km<sup>3</sup> of ice. If it were to melt completely, a process that climate models suggest would take more than 3000 years, global sea level would rise by almost 7 m. With warmer temperatures over the past few decades, there has been an increased melting of the ice sheet and discharging of icebergs along the coast. In recent years, the Ice Sheet has lost around 160 km<sup>3</sup> of ice each year to the sea; this dramatic loss of ice has surprised scientists who are studying the Ice Sheet.

The melting Greenland Ice Sheet sends massive quantities of freshwater into the sea around Greenland. This will affect marine ecology in the area and global ocean circulation patterns. It is already clear that this melting is contributing to the global rise in sea level. By the end of this century, recent projections indicate that water from the Greenland Ice Sheet and other sources, plus thermal expansion due to ocean warming, may result in a sea level rise of around 1 m. The first results from this part of the SWIPA project are available in the report: "The Greenland Ice Sheet in a Changing Climate".

## Permafrost

Permafrost—ground that remains below freezing for at least two consecutive years—is found throughout the Arctic and in vast areas of Asia as far south as the Tibetan Plateau. Permafrost has warmed in many areas in the last two to three decades. This warming has resulted in the loss of permafrost along the margins of the permafrost zone. Thawing of permafrost can lead to waterlogged soils and slumping of land. In mountain areas, thawing ground can cause landslides. Along coastlines, the loss of permafrost can result in more rapid erosion. Some lakes are held in place by permafrost and can drain if the ground thaws. These changes in terrain are followed by major changes in the vegetation of the affected areas.

Much arctic infrastructure, including buildings, roads, and pipelines, is built on permafrost. Changes in permafrost and associated land subsidence can cause considerable and costly damage to infrastructure, and thus major problems for arctic residents and businesses. At the global scale, thawing permafrost may create an enormous positive feedback to climate warming. Huge quantities of carbon, released largely in the form of methane—a potent greenhouse gas—are locked in the ground within permafrost, and massive amounts of methane are trapped within permafrost below the seabed of the arctic continental shelves. Studies suggest that if even 1% of this methane is released, it could trigger abrupt worldwide climate change.

## Snow cover

Snow cover is a defining characteristic of the arctic environment, covering the landscape for eight to ten months of the year. Although there are regional differences, there has been an overall decrease in arctic snow cover during the past thirty years and the spring melt is coming earlier and earlier. Snow cover reflects the majority of the sunlight back into space, helping keep the planet cool. When snow is absent, much more sunlight is absorbed, leading to further

warming. Small particles of soot absorb sunlight and cause snow to melt much more quickly, especially in spring. Burning of fuels and other materials produces soot, which can be carried in the air from locations far to the south before settling onto snow. Even low concentrations of soot can have a major effect. Snow protects vegetation from harsh winter conditions, but snow quality has been changing.

There has been an increase in rain-on-snow and mid-winter thaw events that can be devastating for plants, which may be coated in ice or exposed to harsh temperatures after a thaw. Animals may lose lairs in the snow or may not be able to break through a layer of ice to reach food. The flow of northern rivers is intimately connected with the amount of snow and the timing of the melt. Changes in these patterns will affect fish, hydroelectric power, and the overall hydrology of the region. Because snow insulates the ground from low air temperatures, reduced snow in mid-winter may actually help keep permafrost intact in some areas. Snow affects arctic residents directly in many ways and also indirectly through its impacts on wildlife, fish, and the landscape. Some changes may be beneficial. For example, a shorter snow season will reduce costs such as highway maintenance during winter. Other changes, such as loss of recreational opportunities and tourism potential, may harm northern communities.

## Ice caps and mountain glaciers

Small ice caps and mountain glaciers in the Arctic cover an area of over 400,000 km<sup>2</sup>, accounting for 55% of the world's total land ice area outside the Greenland and Antarctic ice sheets. The shrinking of mountain glaciers and ice caps worldwide is currently the largest single land ice contributor to global sea level rise. The largest regional contributor is the Arctic, including Alaska. Reductions in glacier-covered areas are widespread across the Arctic and the rates of retreat have increased over the past fifteen to twenty years.

PHOTO: TORSTEN SACHS

There has been an increase in rain-on-snow and mid-winter thaw events that can be devastating for plants, which may be coated in ice or exposed to harsh temperatures after a thaw. Animals, such as the arctic wolf, may lose lairs in the snow or may not be able to break through a layer of ice to reach food.

In Russia, for example, mountain glaciers have lost from 17% to 50% of their surface area during the past five or six decades. Icebergs calved from arctic glaciers can be a serious hazard to marine navigation and to offshore oil and gas activities in areas such as the Barents Sea. The collapse of floating ice shelves in northern Ellesmere Island has destroyed unique ecosystems in melt ponds on top of the shelves. It has also produced large ice islands that could drift into the Beaufort Sea, where oil and gas exploration is active. The loss of glaciers can affect hydroelectric power production, as river flow changes. Glaciers are also a major attraction for many tourists to northern regions, and their loss may reduce the number of visitors to areas with popular glaciers.

## Freshwater ice

Freshwater ice on lakes and rivers is a dominant feature of the Arctic, where lakes are covered by ice for six to twelve months each year. Climate change is resulting in earlier dates of ice break-up. Lakes in the northernmost High Arctic are becoming ice-free in summer for the first time, with wide-ranging influence on their ecological properties. In many areas of the Arctic, lakes or large rivers cover a considerable part of the landscape. A significant shortening of the duration of ice coverage can have profound impacts on local, regional, and even larger scale climate over the Arctic. For example, shorter durations of ice cover will affect the amount of evaporation from lakes and thus rainfall patterns.

Throughout the Arctic, communities and various types of infrastructure are linked in winter by a network of roads built over frozen lakes and rivers. A shorter ice season will greatly reduce the viability of ice roads and thus transportation options in many areas of the Arctic. During spring break-up, river ice can form jams, which block the river, leading to floods. These can affect hydroelectric dams as well as riverbank communities, which can be affected by both flooding and by rapid erosion of riverbanks.

## Scientific challenges

The changes in the cryosphere highlighted here interact in many ways. The interactions affect people in the Arctic and beyond, along with local, regional, and global environments. 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 project are:

- How will the increased flow of freshwater from the melting of the Greenland Ice Sheet, and 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?
- 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?

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# International Polar Year 2007/2008 (IPY)



## Understanding Earth's Polar Challenges

### Summary Report on IPY 2007-2008 by the IPY Joint Committee

WRITTEN BY: David Hik and Igor Krupnik

The IPY Joint Committee (JC) is currently working on a 'summary' report on the International Polar Year 2007–2008 activities to be available by the time of the Oslo Science Conference (OSC) in June 2010. The Report titled "Understanding Earth's Polar Challenges: International Polar Year 2007–2008" will be a major collective volume. It is envisioned to become the lead reference source on the origination, planning, and implementation of IPY 2007–2008 for all participating scientists, students, media people, and future science historians.

The idea to produce an IPY overview report on behalf of the JC was first discussed at the JC-7 meeting in St. Petersburg in July 2008, and three proposed concepts for the report outline were discussed at the next JC-8 meeting in Geneva in February 2009. The JC members

PHOTO: PÅL HERMANSEN - SAMFOTO

East Greenlandic Inuit is smoking a pipe while mushing his dogs. Human dimensions of change: Health, society and resources is one of the six main themes of the IPY Oslo Scientific Program. Celebrating the success of the past International Polar Year, the 2010 conference aims to become the main international event for the polar community.

approved the proposed structure of the future 'IPY synthesis' document and appointed a small editorial team to lead the effort, with a release scheduled early 2011. However, a new concept was subsequently suggested—an 'overview' of IPY 2007–2008 operations rather than a 'science synthesis' document—and that the publication date should be tied to the June 2010 Oslo Science Conference. In July 2009, Igor Krupnik and David Hik were invited by the JC Co-chairs to serve as the Report lead editors, and a new outline was developed comprising five major sections (chapters):

**Chapter 1:** Origination, Planning, and Implementation of IPY (2000–2009) - IPY predecessors; early discussions related to IPY (2000–2002); ICSU-WMO collaboration and early work of the IPY Planning Group (2003–2004); contributions by major other groups and organizations (IASC and SCAR, Arctic Council, AOSB, and other); activities by the JC and International Programme Office in implementing IPY (2005–2009).

**Chapter 2:** The IPY Science Program- to be reviewed by 11 major disciplinary fields (Atmospheric Studies; Arctic Ocean, Southern Ocean; Greenland and Antarctic Ice Sheets; Terrestrial Ecology; Human and Social Studies, etc.).

**Chapter 3:** IPY Observing Systems, their legacy and Data Management – satellite observations, oceanographic and sea ice monitoring systems, terrestrial and marine biodiversity, etc.

**Chapter 4:** IPY Public Programs – Education and Outreach; New Generation of Polar Scientists; Archiving and Publishing IPY

**Chapter 5 ('Epilogue'):** The Legacies of IPY 2007–2008 and the Future of Polar Research – the science impact of IPY; IPY 'legacy initiatives' and major new ventures generated/initiated by IPY; new collaborations in science and polar regions management stimulated by IPY; including partnership between IASC and SCAR;

new role of AC and the Antarctic Treaty Consultative Meeting (ATCM); participation of polar residents and indigenous people.

## Report team

Almost all of the JC members volunteered to serve as section contributors and many additional co-authors have been contacted and agreed to participate. Presently, the Report team includes over 35 'lead authors' for its 60-some individual sections and almost twice the number of 'contributing authors' representing major fields of the IPY science program and associated activities. We expect the number of 'contributing authors' eventually to grow to make the JC Report a genuine community effort.

The writing of the Report sections was started in October 2009 and, as of February 2010, the Report manuscript is 300 pages and counting. Based on our rather conservative estimates, it may eventually evolve into a major collective volume of some 500 pages, with extensive references, numerous illustrations, and several Appendices.

The writing phase will be mostly completed by early-mid March 2010 and the Report sections will then go into extensive peer reviewing, first by the Editorial Board and the JC members, and then by appointed external reviewers. All reviewers will be acknowledged and external reviewers will be listed on the opening pages of each section, next to the lead and contributing authors. We expect to have a reviewed and revised manuscript by mid-late April (which would require a monumental and very dedicated work), so that the Report style editing and layout may be started in May 2010. By 1 June 2010, we hope to have a formatted PDF file with embedded illustrations, so that a few hard copies may be printed by the opening of the Oslo Conference, and many more will be available on CD or as electronic files. We also plan to post the downloadable Report file on the Arctic



Portal, on the Oslo Conference website, and on the IPY website, so that it would be accessible to the full IPY community and all interested readers.

### Presenting the report

The Report will be formally introduced at the Oslo Conference as the main concluding document of the Joint Committee that will complete its service in steering the implementation of IPY 2007-2008. A small editorial group will most certainly be tasked to undertake some revisions and edits from the IPY community at the Conference and beyond. Upon the completion of the Report, the JC will decide how to disseminate it to a wider audience as an electronic or printed book.

We are enthused by the level of commitment by the JC Report team and by the energy of the IPY community, and we see the Summary Report to be presented at the Conference as an excellent contribution to that truly monumental venue, the largest ever in the history of polar science.

There is yet another consideration that helps lift the spirit of the JC Report team. None of the previous IPY/IGY's has ever produced a full report by its steering committee as a single major document. In fact, the first IPY 1882–1883 had none; the second IPY 1932–1933 delivered a short summary and a bibliography seventeen (!) years after its completion; and IGY 1957–1958 produced 48 volumes of its proceedings and over 6000 other publications but no single reference overview by its main oversight team. So, the current effort undertaken by the JC, in less than a year after formal completion of the IPY 2007–2008 observational period (March 2009) stands as a remarkable achievement. But neither did any previous IPY/IGY team face a community forum of the magnitude to be presented at the Oslo Conference. This is once-in-a-lifetime opportunity to mark the official completion of IPY 2007–2008 and for the JC to fulfill its mandate to the IPY community.

## Upcoming IPY Conferences

### IPY OSC 2010: polar science - Global impact

Celebrating the success of the past International Polar Year, the IPY Oslo Science Conference 2010 aims to become the main international event for the polar community. The organizers completed a challenging scientific program that will attract interested parties from all over the world. In Oslo there will be the opportunity to display and explore the richness of IPY data and to chart the future direction of polar science.

The IPY conference will highlight the global impact of polar science, interdisciplinary and multinational research initiatives in the Arctic and Antarctic, and efforts in communicating science to the public. *“The polar regions evoke a sense of discovery as locations of unexplored places and the origin of surprising findings that inspire unconventional thinking”,* says Dr.

PHOTO: JULIA LAROUCHE

A young researcher is sampling epilithon; biofilms attached to rocks in rivers and streams. In the IPY Report “Understanding Earth’s Polar Challenges: International Polar Year 2007–2008”, a special chapter will be dedicated to IPY Public Programs - Education and Outreach; New Generation of Polar Scientists and Archiving and Publishing IPY.

Mahlon Kennicutt, President of the Scientific Committee on Antarctic Research (SCAR) and member of the overarching science committee for the conference. Kennicutt is chairing one of the six conference themes "New frontiers, data practices and directions in polar research", a theme, that according to its Chair, highlights research at the frontiers of science.

### **Science that challenges current thinking**

According to Kennicutt polar research often cross-cuts disciplines catalyzing new scientific directions and challenges current thinking. It is a view of polar science that appropriately fits the celebration of a year that represents an ambitious international collaboration in globally urgent science. IPY 2007-2008 attracted over 50,000 participants from different backgrounds and disciplines, ranging from students to renowned scientists, from artist to politician and from journalist to technician. Through international projects and partnerships, covering nearly every scientific discipline, this IPY set new standards for technical achievement, data access and visualization, recruitment of new polar researchers, and education and outreach.

The IPY Oslo science conference takes place from June 8-12, 2010. The six main themes of the Scientific Program are:

#### **Linkages between Polar Regions and**

- **global systems**  
**Past, present and future changes**
- **in Polar Regions**  
**Polar ecosystems and biodiversity**
- **Human dimensions of change: Health,**
- **society and resources**  
**New frontiers, data practices and directions**
- **in polar research**  
**Polar science education, outreach**
- **and communication**

[www.ipy-osc.no](http://www.ipy-osc.no)

### **IPY 2012 - From knowledge to action**

Canada will be hosting the IPY Global Conference 2012 "From Knowledge to Action". This conference will take from April 22-27 in Montreal and addresses the policy implications resulting from the largest-ever collaborative polar science program undertaken during IPY.





PHOTO: TEUGSU SHIN

Korean researchers are drilling near the Dasan Station at Ny-Ålesund. The station, which supports mainly Earth and life scientists is part of an international research community including stations owned by Norway, France, Germany, Italy, Japan, Korea and UK.



## 5. IASC Networks

## » 5 IASC Networks

### Network on Arctic Glaciology

The Arctic Climate Impact Assessment (ACIA) already concluded in 2004 that the Arctic is warming rapidly in an amplification of the global rise in temperature. Obviously this conclusion leads to an immediate concern for the huge ice masses stored in the Arctic, in the Greenland Ice Sheet and in the circumpolar ice caps and glaciers. The ice caps and glaciers of the Arctic are currently reacting strongly to climate change, causing a significant contribution to sea level rise. The Greenland Ice Sheet has in recent years surprised the research community by exhibiting a large-scale synchronous accelerating mass loss on the time-scale of a few years, rather than centuries as previously assumed. The IASC Network on Arctic Glaciology (NAG), formed out of the Working Group on Arctic Glaciology, aims to address these rapid changes in arctic ice masses by initiating scientific programs and facilitating international cooperation between glaciologists and climate modelers in order to develop the understanding of arctic land ice and its role in global climatic and environmental change.

#### **The NAG strives to achieve this aim by:**

- Providing a forum and platform for information exchange on arctic glaciology
- Initiating symposia and workshops
- Shaping the future glaciological research strategy in the Arctic
- Revision and review of existing and planned research programs
- Advising IASC on glaciological matters

The first project coordinated by NAG was entitled “Mass balance of Arctic Glaciers and Ice sheets in relation to the Climate and Sea level changes (MAGICS)”. The scope of NAG is currently being extended. Apart from compiling and updating mass-balance observations on arctic glaciers, which is regarded as an important task, the NAG is active in a major project on the dynamics of calving glaciers. This project, called “The Dynamic Response of Arctic Glaciers to Global Warming (GLACIODYN)”, is a contribution to the International Polar Year 2007-2008.

#### **Organizational structure**

NAG has a relatively simple organizational structure that was last revised during the last annual workshop in 2009. Each year the network will hold an Open Forum Meeting, with participation of the national representatives as well as registered workshop participants from the glaciological scientific community. This type of meeting is believed to best utilize the combined



expertise of the arctic glaciological community in addressing the aims of the network. Connected to this Open Forum Meeting is a two-day workshop on the mass budget of arctic glaciers, which is likewise open to all interested scientists. Brief presentations and posters provide an overview of recent results and ongoing activities. Extended abstracts are collected and printed as a report that is available for free through the website once compiled.

The annual workshop also serves as a place where more practical plans are made to share costs and logistics for field work. In the past very fruitful international collaboration has been initiated at the annual workshops. Occasionally NAG organizes events on a larger scale, like the Symposium on Arctic Glaciology that was held in Geilo, Norway (August 2004). This sym-

posium was co-sponsored by the International Glaciological Society. NAG has had a small budget made available by IASC on an annual basis. The budget is normally used to cover some administrative costs and to support of a few young scientists that want to participate in the annual workshop.

## Results and achievements

### Author contributions

An important achievement of the Network for Arctic Glaciology has been the significant contributions of members as lead authors, chapter leads and contributors to the IASC effort to assess the climate change impact on the cryosphere (abbreviated SWIPA, for Snow, Water, Ice and Permafrost in the Arctic) in collaboration with the Arctic Council, Climate and Cryos-

PHOTO: ANDREAS PETER AHLSTRØM - GEUS

PROMICE station on the Greenland Ice Sheet near Scoresbysund, East Greenland. In recognition of the importance of the Ice Sheet as the largest arctic ice mass, Danish NAG members now monitor the mass loss through a comprehensive network of automatic weather stations.

phere Project (under WCRP) and the IPY International Programme Office. This effort aims at providing timely, up-to-date and synthesized scientific knowledge on arctic cryospheric changes, a review of key processes, a summary of predictions from models, an analysis of impacts on ecosystems and an analysis of socio-economic impacts. The first SWIPA report termed "The Greenland Ice Sheet in a Changing Climate" was published in time for the COP15 meeting in Copenhagen, Denmark, with contributions from NAG. Other parts of the SWIPA report series also have significant contribution from the network, e.g. as leads on the "Mountain glaciers and ice caps" and "Cryo-interactions: antagonistic/synergistic effects of the various cryosphere components" modules.

In recognition of the importance of the Greenland Ice Sheet as the largest arctic ice mass, Danish NAG members now monitor the mass loss through a comprehensive network of automatic weather stations measuring climate and melt directly and through calculation of the calving mass loss using repeated airborne surveys in conjunction with radar satellite data and in-situ GPS-instruments. Efforts from this Programme for Monitoring of the Greenland Ice Sheet (PROMICE) are presented on the outreach and data website [www.promice.dk](http://www.promice.dk). NAG members from Denmark have likewise begun a complimentary monitoring of the A.P. Olsen Ice Cap at the monitoring station Zackenberg in Northeast Greenland, in an extension to the mainly ecological monitoring already established there.

### **Glaciology summer school**

A successful idea proposed at the 2009 Open Forum Meeting of NAG was the initiation of an International Summer School in Glaciology held in the US, to offer to US students the same opportunities given by the long-standing Karthaus Summer School to European students. This US summer school is now scheduled to be held at the University of Alaska, Fairbanks (UAF) and Wrangell Mountains Center, McCarthy, Alaska

on 7-17 June, 2010, with support from among others IASC. The course is intended to provide glaciology graduate students with a comprehensive overview of the physics of glaciers and current research frontiers in glaciology. A focus will be on quantitative glaciology, modeling, and remote sensing. The scope is broadened by including some related topics relevant to the Arctic, such as glacier-volcano interactions, permafrost, sea ice and isostatic rebound.

A number of projects have been conducted as a result of the Network proposal activities. As part of MAGICS, two significant contributions were made. **1.** A compilation of existing in situ mass-balance observations on Arctic glaciers. **2.** An estimate of the contribution of Arctic glaciers to sea-level change in the next 100 years (a contribution to ACIA). As a direct result of NAG, a number of projects have been funded on national and international basis for different groups, as example, the Response of Arctic Ice Masses to Climate Change (EU-ICEMASS) 1998-2001, Space-borne Measurements of Arctic Glaciers and Implications for Sea Level (EU-SPICE) 2002-2005.

The ongoing IPY-project GLACIODYN 2007-2008 is latest in the series of successful collaborations. The EU-project ice2sea 2009-2013, aiming at determining the contribution to sea-level rise from land ice masses over the next 200 years, also has significant participation from NAG members. NAG members are represented in a host of advisory bodies such as the United Nations Intergovernmental Panel on Climate Change (IPCC), the Climate Expert Group of the Arctic Monitoring and Assessment Programme (AMAP) under the Arctic Council and the Climate and Cryosphere (CliC) Project of the World Climate Research Programme (WCRP) ensuring a cohesive and informed Network. Field activities conducted as part of the national and international projects all over the Arctic are reported at the annual IASC NAG meeting and published in the annual Book of Extended Abstracts.

## List of Publications

### Peer-reviewed publications

Members of the network have published a large number of publications over the years. A few select publications representative to the work of the NAG are:

Dowdeswell, J.A., Benham, T.J., Strozzi, T. and Hagen, J.O., 2008. Iceberg calving flux and mass balance of the Austfonna ice cap on Nordaustlandet, Svalbard. *Journal of Geophysical Research*, v. 113, F03022, doi:10.1029/2007JF000905.

Oerlemans, J., R.P. Bassford, W. Chapman, J.A., Dowdeswell, A.F. Glazovsky, J.-O. Hagen, K. Melvold, M. de Ruyter de Wildt, R.S.W. van de Wal, 2005. Estimating the contribution from Arctic glaciers to sea-level change in the next hundred years. *Annals of Glaciology*, 42, 230-236.

Koerner, R.M. 2005. Mass Balance of glaciers in the Queen Elizabeth Islands, Nunavut Canada. *Annals of Glaciology*, 42, p.417-423.

Navarro, F., A.F. Glazovsky, Yu.Ya. Macheret, E.V. Vasilenko, M.I. Corcuera and M.L. Cuadrado. 2005. Structure, dynamics and ice volume changes of Aldegondabreen (Spitsbergen) during 1936-1990. *Annals of Glaciology*, 42, p.158-162.

Holmlund, P., Jansson, P., Pettersson, R. 2005. A re-analysis of the 58 year mass-balance record of Storglaciären, Sweden. *Annals of Glaciology*, 42, p.389-394.

Hagen, J.O., Melvold, K., Pinglot, F. and Dowdeswell, J.A., 2003. On the net mass balance of the glaciers and ice caps in Svalbard, Norwegian Arctic. *Arctic, Antarctic and Alpine Research*, v. 35, p. 264-270.

Dowdeswell, J.A., Hagen, J.O., Björnsson, H., Glazovsky, A.F., Harrison, W.D., Holmlund, P., Jania, J., Koerner, R.M., Lefauconnier, B., Ommanney, C.S.L. and Thomas, R.H., 1997. The mass balance of circum-Arctic glaciers and recent climate change. *Quaternary Research*, v. 48, p. 1-14.

### Project workshop reports

Every year since the establishment of NAG a two to four days workshop has been arranged in connection with the annual national representatives meeting. The workshops are called: "Workshop on the mass budget of Arctic glaciers." Often a book of extended abstracts has been published from the workshop. The workshop reports can be downloaded from the website, see below. Hard copies of books prior published up to 2008 are available on request by contacting the

secretariat of the Institute for Marine and Atmospheric research Utrecht (IMAU): imau@phys.uu.nl. The book of extended abstracts published in 2009 is available from the Geological Survey of Denmark and Greenland (GEUS)

Workshop on the dynamics and mass budget of Arctic glaciers, Kanaskis, Canada. 16 – 19 February 2008. Book of extended abstracts 2009.

Workshop on the dynamics and mass budget of Arctic glaciers, Obergurgl, Austria. 29 – 31 January 2008. Book of extended abstracts 2008.

Workshop on the dynamics and mass budget of Arctic glaciers, Pontresina, Switzerland. 15 – 18 January 2007. Book of extended abstracts 2007.

Workshop on the mass budget of Arctic glaciers, Obergurgl, Austria. 30 January – 3 February 2006. Book of extended abstracts 2006.

Updated Mass balance data 2002, tables.

Jania, J., Hagen, J.O. (editors) 1996. Mass balance review of Arctic Glaciers. IASC-report no 5. 95 pp. MAGICS Science Plan 1996.

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# Polar Archeology Network

The Polar Archaeology Network (PAN) is an international network based on voluntary efforts of a steering committee and different working groups. Institutions, organizations, individual researchers, and students dealing with Arctic and Antarctic archaeology and early history are encouraged to participate.

Archaeological sources of environmental, social and cultural data are frequently overlooked in broad arctic science initiatives, including those that have an applied component. Yet in many recent national and international science plans and initiatives understanding past arctic states, including human dimension, is identified as critical for developing accurate projections of future changes and for managing and adapting to change (see for example Michel et al. 2009; NRC 1993; LAII 1997; OC 2000; BEST 2004; SEARCH 2005, Allison et al., 2007, 2009; etc). Outside of the polar regions, archaeology has shown it's potential for illumination of global and regional environmental change events, particularly with respect to changes in ecosystems, upper trophic levels, and human systems (Redman 1999; Etnier 2004; Yang et al, 2004; Murray 2008).



PHOTO: LASHIPA

In order to develop accurate projections of future changes and for managing and adapting to change it is critical to understand past arctic states, including the human dimension.

Arctic archaeological sites, especially those that are permafrozen, contain a wealth of baseline biological and downscale climatological data in the form of preserved flora, fauna and in sediments. Archaeological time series can be used for developing downscale models of changes in arctic ecosystems and ecosystem services. These data are necessary for developing effective local and regional scale climate change remediation strategies, ecosystem restoration activities and management practices (Murray 2008).

## Historical and cultural records

Importantly archaeological sites also record the history and culture of arctic peoples. They reflect longstanding interactions between people and the arctic environment. Archaeological sources of arctic ecosystem, climate and socio-ecological data are increasingly threatened by arctic and global change. The loss of baseline information is rapid, ongoing, and comes from multiple sources including:

- Coastal erosion
- Thawing permafrost
- Industrial development
- Increased tourism

## PAN is working towards:

- Identification and rescue of threatened data sets
- Identification and synthesis of existing datasets
- Building and maintenance of an international circumpolar archaeological observing network
- Integration of diverse data streams
- Integration of relevant archaeological data and archaeological approaches into larger Arctic Change research programs
- Collection of new circumpolar-scale time series on arctic environmental change, especially change among the marine, terrestrial, and human components of the arctic system
- Development of proxies for past climate and environmental change episodes



## Archeological sites at risk

PAN is in the process of planning an international workshop with the express purpose of formulating a coordinated, international approach for responding to and alleviating the detrimental effects of global climate change on the polar archaeological record. Among other topics to be covered will be means by which to identify and evaluate present and future risk to archaeological sites; especially those with good preservation of organic materials necessary for advancing arctic change research. Given the threats to the arctic terrestrial environment, this is an urgent priority. The possibility of losing key-elements of the human and environmental heritage of the Arctic is very real and is of cultural, political, and scientific concern. The first PAN workshop is designed to be interdisciplinary, drawing on expertise from within the archaeological community, and from the cryospheric, hydrologic, coastal geomorphological and predictive modeling communities among others. As planning information becomes available it will be posted on the IASC website.

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<http://polararchaeologynetwork.blogg.no>

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# Arctic Palaeoclimate and its Extremes (APEX)

Arctic Palaeoclimate and its Extremes (APEX) is an IASC endorsed scientific network with the main objective to better understand the magnitude and frequency of past Arctic climate variability, especially the 'extremes' versus the 'normal' conditions of the climate system. APEX is strongly interdisciplinary and as an ICSU/WMO Joint Committee selected IPY 'cluster' lead-coordinating program. It has provided a forum for a number of different IPY research projects with participating scientists from fifteen European countries, Russia, Canada, USA and Australia. The network is led by a Steering Committee consisting of members from the participating countries and its activities have continued after the IPY. In particular, the APEX yearly International Workshop and Conference is now viewed among the network scientists as perhaps the most important venue during the year where new field results as well as long standing scientific questions on arctic paleoclimate can be discussed in a focused manner.

## **APEX activities 2009**

The Third International APEX Conference and Workshop 2009 was hosted by the Natural History Museum in Copenhagen. The main focus for the venue was on the three key components of the Arctic climate-ocean-cryospheric system the palaeo-records (millennial, centennial, or decadal resolution) and natural variability of 1) the Greenland Ice Sheet, 2) Arctic Ocean sea ice, and 3) Arctic ice shelves. With the focus on these three themes, a special APEX issue in the journal *Quaternary Science Reviews* is planned to be published in 2010. Judging from the wealth of presentations during the Copenhagen meeting, this issue has the

prospect of forming a considerable contribution on arctic paleoclimate research.

The momentum of the International Polar Year (IPY) 2007-2008 was kept high during 2009 within the APEX community as exemplified by several large field campaigns that were carried out in 2009 and from an abundance of results that begin to appear in the scientific literature. The Fourth International APEX Conference and Workshop will be carried out jointly with the Meltwater routing and Ocean-Cryosphere-Atmosphere response project (MOCA) on Iceland in May 2010. Below follow some of the 2009 scientific highlights from the APEX community. However, these snapshots only scratch the surface of the APEX activities. Our website provides abstract volumes from our previous meetings and further insight into our activities.

## **Fluctuations of sea ice cover in an Arctic key region during the past 30,000 years**

A German-British group of marine geologists and chemists has succeeded in reconstructing the sea ice conditions in the Fram Strait, a narrow passage between eastern Greenland and Spitsbergen, during the past 30,000 years. Based on fossilized algal remains in a sediment core, researchers from the Alfred Wegener Institute for Polar and Marine Research (AWI) in collaboration with colleagues from the University of Plymouth, Great Britain, worked out a uniform picture of the expansion of sea ice in this area that is particularly important for worldwide climate conditions. Results were published in the periodical *Nature Geoscience* (Müller et al., 2009).

The examination of a sediment core from the northern Fram Strait, the only deep-water connection between the central Arctic Ocean and the Atlantic Ocean, provides clues for extreme sea ice fluctuations during the past 30,000 years. By means of fossil organic molecular remains, so-called biomarkers, which are preserved in the layers of the sediment cores, the researchers were able to verify the dates when the Fram Strait

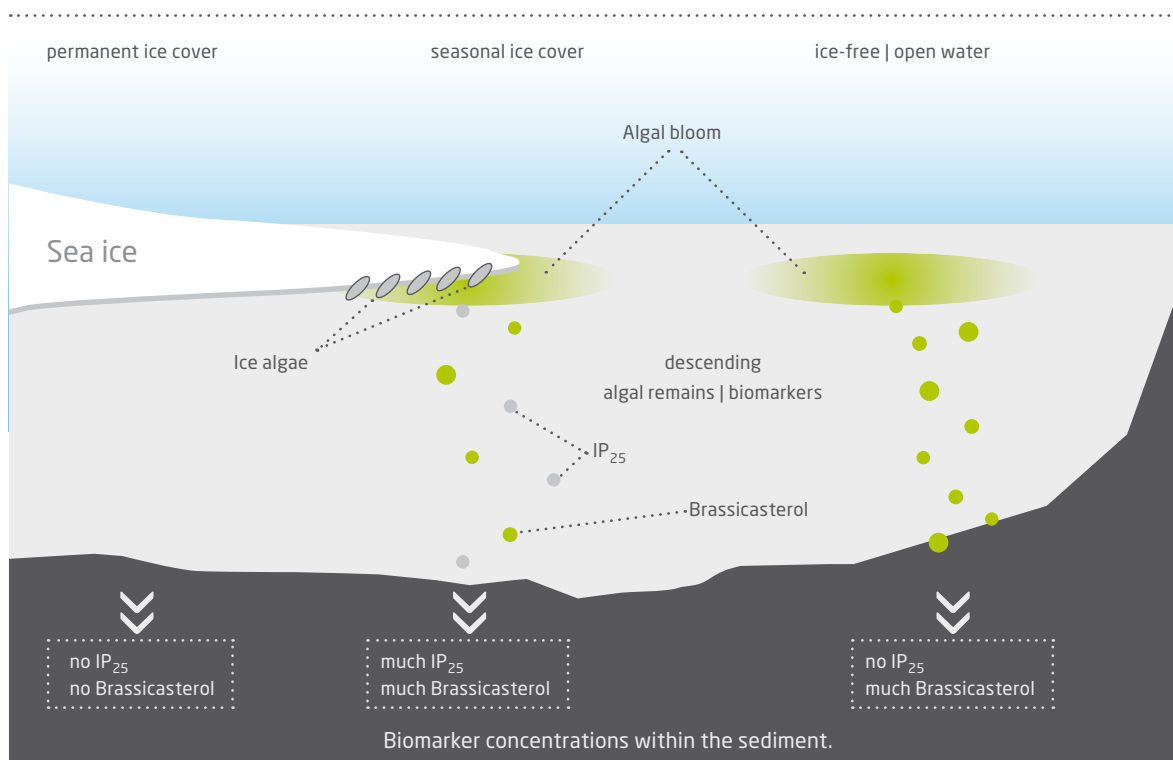
was either ice-covered or ice-free. The biomarker IP<sub>25</sub>, a unique molecule produced by algae living in the sea ice, was found in varying concentrations in the sediment; it was used as an indicator for the ice cover. A second biomarker called brassicasterol, which is produced by algae living in the open water was used as counterpart in the analyses. The presence of brassicasterol in the sediments indicates ice-free periods. The combination of these two parameters enables the researchers to reconstruct different ice conditions.

For a period of extremely cold climate conditions, the last glacial maximum of about 20,000 years ago, the absence of these two biomarkers indicates permanent ice cover in the northern Fram Strait. The lasting lack of light and nutrients under the thick ice shield minimized the growth of the ice algae. A short but significant warming of the climate about 15,000 years ago, the early Bølling, caused the arctic sea ice to melt so far that the Fram Strait remained ice-free during the winter months. The ice marker IP<sub>25</sub> is absent in the sediment layers of this period, while the content of

brassicasterol is highly increased. The simultaneous occurrence of both biomarkers in sediments of the past 5,000 years, the late Holocene, shows that the strait was only ice-covered during the winter and spring months. This seasonal change between ice-covered and ice-free water surface therefore enabled the growth of both algal species.

### New high-resolution sediment records from the central Arctic Ocean: further potentials for sea ice studies

The Swedish-Danish expedition Lomonosov Ridge off Greenland II (LOMROG) with icebreaker Oden during the summer of 2009 targeted the central part of the Lomonosov Ridge close to the North Pole. The main goal for the participating APEX scientist was to retrieve high-resolution sediment records for studies of paleoceanography and the Quaternary history of the Arctic Ocean sea ice. Cores were taken from a local basin formed in the Lomonosov Ridge morphology where previous studies showed that water mass exchange between the Amerasian and Eurasian basins



Sketch of sea ice scenarios for various periods within the last 30.000 years: Glacial Maximum with permanent ice cover, Holocene with seasonal ice coverage, and early Bølling period with no sea ice. Source: J. Müller (AWI Bremerhaven)

takes place and thickened sediment sequences exist. From this 'intra basin' high-resolution sediment records were retrieved in cores with apparently complete stratigraphy reaching back to at least Marine Isotope Stage 7. One core was taken in the Makarov basin and shows a striking resemblance to typical geophysical and lithological sequences found on the Lomonosov Ridge, thus opening up for a much needed correlation between records from the Amerasian and Eurasian basins. This new cache of material will provide the required high-resolution sediment archives from the central Arctic Ocean required to further address the Quaternary history of the Arctic Ocean sea ice.

### **Fossil find on Svalbard highlights the natural history of the polar bear**

For most, the polar bear (*Ursus maritimus*) is closely connected to the Arctic Ocean pack ice. During fieldwork on Svalbard a well-preserved polar bear fossil mandible was discovered. On the basis of osteological studies of the mandible it is concluded to be from a fully-grown male. A <sup>14</sup>C age determination shows that it is older than 45,000 years, and an OSL age determination and the stratigraphic position of the bone suggests that it is 130,000-110,000 years old. This makes the find the oldest fossil remain of a polar bear ever discovered.

The combined evidence of the fossil record and molecular (mtDNA) studies of evolutionary relationships among polar and brown bears suggest that polar bears probably developed from brown bears <200,000 years ago. If true, the present interglacial is at least the second the species has to endure, and it will have consequences for our understanding of how polar bears cope with extremes in seasonal sea ice extent. This study is presented by Ingólfsson and Wing (2009).

### **The Greenland Ice Sheet**

Both terrestrial field campaigns and offshore cruises were carried out around Greenland during the summer

months in 2009. APEX associated projects collected new relative sea-level (RSL) observations from salt marsh and isolation basin deposits at several sites along the west coast, including Disko Bugt, Sisimiut, Nuuk, Paamiut, and south to Nanortalik (Long et al., 2009; Woodroffe and Long, 2009). The intention is that these data will provide new constraints on Holocene and recent trends in ice sheet history, and provide a long-term context for interpreting present day crustal motions indicated by the GPS data.

Together with American colleagues, the Danish led RINK project (University of Copenhagen) investigated how the Inland Ice margin responded to warming in the near past along Greenland's coasts. Three periods of warming were studied: 1) The rapid warming 11,700 years ago, which ended the Last Ice Age: how did the Inland Ice react to this warming, which was both larger and more rapid than the predicted greenhouse warming? 2) The postglacial warmth optimum from c. 9,000 to c. 6,000 years ago. During this period the inland ice and sea ice adjusted to temperatures c. 2° warmer than now similar to a situation that we might meet in the near future according to some predictions. 3) The warming following the 'Little Ice Age', which in Greenland culminated between 1880 and 1920. Material was retrieved from lake sediments reflecting the behavior of the ice sheet margin and meltwater routing into the lakes.

Preliminary results show that this approach, supported by cosmogenic dating of bedrock surfaces and erratic boulders, will give us a record of Holocene ice sheet margin variability. Recently, a new three-dimensional glaciological model of the Greenland Ice sheet from the Last Glacial Maximum to present-day, predicts a strong response to Holocene Thermal maximum where the ice margin retreated behind its present-day position by up to 80 km in the southwest (Simpson et al., 2009).

A comprehensive record of cosmogenic exposure ages is beginning to emerge from the western coast of



Greenland. Using cosmogenic exposure ages, Roberts et al. (2009) manage to constrain the ice thickness during Last Glacial Maximum at the southwestern sector and link it to sustained ice stream activity until the early Holocene. A substantial number of new samples have been collected between Uummannaq and Store Gletscher, north of Disko bay, Jakobshavns Isbræ area and southwards along the coast that will allow an estimate of the synchronicity/asynchronicity of the behavior in the different ice regime sectors.

In terms of offshore work near Greenland, APEX members conducted a cruise to west Greenland with the RRS James Clark Ross (cruise JR175) as part the project "Marine geophysical and geological investigations of past flow and stability of a major Greenland ice stream in the late Quaternary". The project goal is to reconstruct the Late Quaternary behavior of Jakobshavns Isbrae, the fastest ice stream to drain the Greenland Ice Sheet.

The cruise took place from August to September 2009. It was led by Durham University (UK) and involved an international team of scientists from a number of other universities and institutes including the Scott Polar Research Institute, Cambridge (UK), the Institute of Arctic and Alpine Research at the University of Colorado (USA), University Centre in Svalbard (Norway), University of Loughborough (UK), GEOTOP, Université du Québec à Montréal (Canada) and the British Geological Survey. Blocks of multibeam swath bathymetry, sub-bottom profiler data and over 50 sediment cores (vibro-, gravity- and box-cores) were collected in Disko Bay and across the adjoining shelf, slope and abyssal plain during the cruise, as well as further north in the Umanak fjord system and adjoining cross shelf trough and submarine fan.

From these data we have been able to reconstruct the dimensions of past ice sheet outlets on the shelf, the extent of the last ice sheet advance, the nature of

PHOTO: NAJA MIKKELSEN

The international GreenArc tent camp is set up in the sea ice just north of Greenland. After unexpected break-ups of the sea ice earlier in April 2009, the camp had to be evacuated and was moved closer to the shore line.

the associated sedimentation both on the shelf and to the large trough mouth fans further offshore. Other offshore work includes ongoing analysis of Holocene marine sediment archives from Disko Bugt and also a new program examining the deglaciation and Holocene palaeoceanographic evolution of Fosters Bay, northeast Greenland, the latter as a collaborative project between Durham University and the Baltic Sea Research Institute.

### **Further insights into the Northern Eurasian ice age development**

APEX's predecessor was the Quaternary Environment of the Eurasian North (QUEEN) program, which among other activities included several years of fieldwork in northern Russia and Siberia. This region has not at all been excluded from APEX. For example, the Norwegian-Russian IPY-project "Ice Age Development and Human Settlement in Northern Eurasia" (ICEHUS) explores the Quaternary history in Northern Russia with a focus on the development in the Ural Mountains. During 2009, this project retrieved sediment cores from several lakes in the Polar Urals. One of the cored lakes is the Bolshoye Shuchye, presently the largest and deepest lake in the entire Ural mountain chain. Seismic profiles reveal that this basin contains more than 130 m of acoustically laminated sediments that possibly accumulated over several interglacial-glacial cycles. The retrieved sediment cores from 2009 were up to 24 m long and there is great hope that they may contain unique high-resolution records of the climate and glacial history during a substantial part of the last Ice Age.

The first results from studies of the lake cores reveal that the mountain valleys, where the lakes are located, have remained essentially ice free throughout the last 50,000 years and that only small mountain glaciers existed in this region during the Last Glacial Maximum some 20,000-25,000 years ago. Much larger glaciers existed during a foregoing cold period that culminated at around 70-60,000 years ago, at which time the northern mountain valleys were inundated

by a major ice sheet centered on the continental shelf in the Barents-Kara Sea. The ICEHUS project is also studying traces of Ice Age humans that have been found in these northern landscapes. These findings have opened up new perspective on the earliest human colonization of the continent, the period when the ancient Neanderthal population was replaced by our own ancestors descending from Africa.

The previous work carried out by QUEEN further to the east, e.g. on the Taimyr Peninsula and Severnaya Zemlya, has been at rest for a few years. However, new field expeditions are planned for 2010 and 2011 within the frame of the Swedish-Russian IPY project "Taimyr revisited – a quest for former Eurasian Ice Sheet margins and mega-fauna extinction during the last glacial cycles". Former work on Taimyr centered on the northern areas, which clearly indicated that maximum glaciation occurred in the early stages of the last glacial cycle, the early Weichselian. However, not much work was on the marginal areas of former Kara Sea-based ice sheet expansions towards the south, as marked by huge end-moraine zones recently mapped from LANDSAT satellite images.

APEX scientist now aim to investigate the spatial and temporal relations of former ice sheet marginal zones in terrestrial Arctic Siberia and from these studies reconstruct near-frontal ice sheet dynamics. When examining the sedimentary archives, sampling will also be done for unraveling environmental change in Late Pleistocene to Holocene flora and fauna, based on mitochondrial and chloroplast DNA analyses. Main emphasis will be on establishing 'last' appearance dates on megafauna and potential vegetation change around times of extinction for different genera.

The above provides a few glimpses into the APEX activities during 2009 that together with much more will form the agenda for the Iceland APEX Fourth Conference and Workshop that will be held jointly with MOCA in May 2010.

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# Arctic Coastal Dynamics (ACD)

The Arctic Coastal Dynamics (ACD) project was established in 2000 to focus and coordinate circumpolar research on physical processes that are unique to cold coasts in the northern regions. The presence of sea ice and ground ice in both onshore and offshore sediments distinguishes arctic coastal systems from temperate and tropical coastal zones, rendering them highly sensitive to climate shifts at multiple spatial scales in a region currently undergoing rapid change. The scale and pace of climatic warming and environmental change vary and with them responses to these changes.

## Achievements and results

ACD activities are currently framed within the recommendations from several international initiatives, most notably the Arctic Climate Impact Assessment (ACIA), the Second International Conference on Arctic Research Planning (ICARP II), and the International Polar Year (IPY) project: Arctic Circumpolar Coastal Observatory Network (ACCONet). The goals of this most recent phase of the ACD project are outlined in the ACD II Science and Implementation Plan which is available online.

ACD has received substantial financial and in-kind support from IASC, the International Permafrost Association (IPA), Land-Ocean Interactions in the Coastal Zone (LOICZ), the Arctic Centre (University of Groningen, Netherlands), as well as several government agencies and the home institutions of individual project members. These same institutions have also acted as the hosts for annual workshops. Secretariat activities have been financed by the Alfred Wegener Institute for Polar and Marine Research (Potsdam, Germany) and McGill University (Montreal, Canada). Current efforts to expand ACD resources and continue our



activities have included several applications for large-scale funding (the European Polar Board's Polar Climate call and a proposal to the Helmholtz Society for a German-Russian joint research group). ACD has also just recently entered into collaboration with the MORSE project, a joint initiative being launched by the Canadian and European space agencies (CSA and ESA) to exploit satellite observation resources in support of research and industry needs in arctic coastal zones.

In furtherance of ACD objectives, the project has recently spearheaded or participated in a series of reporting initiatives which help to broaden the project's scope and field of action.

### **Snow, Water, Ice and Permafrost in the Arctic (SWIPA) report**

Currently being produced through the coordinated action of a number of organizations spearheaded by AMAP and IASC, the SWIPA report is a response to a request of the Arctic Council in April 2008 to extend the conclusions and breadth of the 2004 Arctic Climate Impact Assessment (ACIA). SWIPA updates scientific information on changes in the Arctic since ACIA. ACD has contributed sections to the report on the arctic coastline and coastal dynamics and on on and offshore permafrost. SWIPA will be presented to the Arctic Council in 2011 and integrated into the IPCC's 5th Assessment Report.

### **State of the Arctic Coast (SAC) report**

In preparation since November 2007, the State of the Arctic Coast report calls together a highly interdisciplinary group of researchers working on arctic coastal issues. The report is sponsored by AMAP, IASC, IPA and the LOICZ project. Having reached an initial draft form, the document will be ready for international review in early 2010 and includes physical, ecological and socio-economic analyses of the state of the arctic coastal system. To create a document useful to stakeholders, integrative assessments of approaches and responses to arctic coastal change

PHOTO: JANICE LANG - POLAR CONTINENTAL SHELF PROJECT | NATURAL RESOURCES CANADA

Andrew Hamilton checks out the rocky shoreline during a helicopter stopover near Belcher glacier, Devon Island (Canada). The helicopter pilot and passengers had to wait for the fog to clear before they could fly to their camp.



move beyond the traditional disciplinary assessment format. This includes specific recommendations for priorities and prerequisites for coordinated and socially useful monitoring systems in this unique environment.

## Meetings

A number of meetings in 2009 and in 2010 highlight efforts to coordinate terrestrial, coastal and marine sciences in an effort to understand responses and sensitivities to change in the arctic coastal system. A special session on coastal environments as the link between land and sea in the Arctic was organized together with members of the Marine Science Roundtable of the Arctic Ocean Sciences Board at the Arctic Science Summit Week in Bergen (Norway) in March 2009. An Arctic Coastal Processes special session was held at the European Geophysical Union meeting in Vienna (Austria) in April 2009. The Marine Science Roundtable organized a meeting on the Arctic in Rapid Transition (ART) in Fairbanks, Alaska, in November 2009, and included a plenary talk on coastal issues. In June, two meetings include cross-cutting sessions: the IPY Oslo Science Conference (Norway) in June 2010 will hold a special session on Coastal, Near-shore and Upper Shelf Processes and Pathways in Polar Regions session and the 3rd European Conference on Permafrost (EUCOP III) includes a session on coastal and offshore permafrost.

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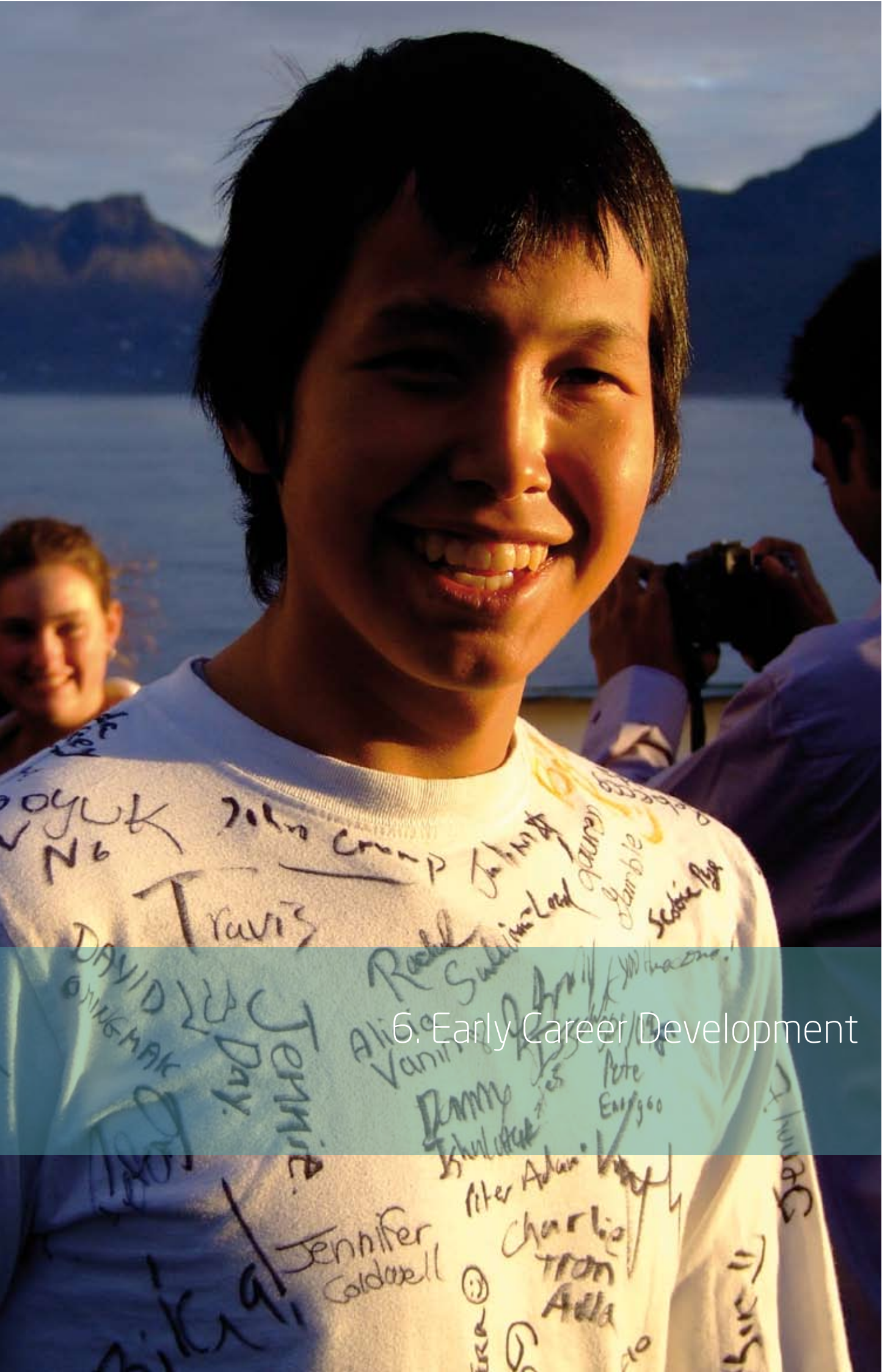
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[www.arcticportal.org/acd](http://www.arcticportal.org/acd)

PHOTO: JENNIFER COLDWELL

Bryan Kimiksana on board of the Lubov Orlova on the final days of the STUDENTS ON ICE Arctic Expedition 2009. STUDENTS ON ICE aims to provide students, educators and scientists from around the world with inspiring educational opportunities at the ends of the Earth and, in doing so, help them foster a new understanding and respect for the planet.



## 6. Early Career Development

## » 6 Early Career Development

### IASC Stimulates Early Career Scientists

IASC recognizes that new and next generations of researchers will be faced with increasingly critical challenges due to the impacts of climate change on these regions and their global significance. The Committee therefore believes that it is of great importance to foster these young researchers and promotes and involves early career scientists working in the Arctic by:

- Striving for representation of early career researchers in the organization;
- Providing endorsement, support and dissemination of information on activities, projects and request for participation and;
- Providing travel grants to early career scientist for selected conferences.

A larger representation of young researchers at workshops, in science planning and research programs: that is what IASC hopes to achieve by providing travel support for early career scientists. In this respect the Science Symposium at the Arctic Science Summit Week in Bergen, turned out to be a great success. Young scientists, of who nineteen received an IASC

travel grant, were well represented. The thematic sessions created a perfect opportunity for them to present their ideas and exchange information with an international and renowned group of arctic scientist; giving both parties a chance to learn from each other.

Two other supported activities in 2008/2009 where the Annual Workshop of the Network on Arctic Glaciology (NAG) and the Third International Conference and Workshop Arctic Palaeoclimate and its Extremes (APEX). As attendee Sarah Woodroffe put it: *"It was stimulating and worthwhile to learn about other peoples recent work and informally discuss research plans and potential collaboration."* In this paragraph you can read more experiences from sponsored attendees and you can see why it makes a difference.

#### **ASSW 2009, Dmitry Kaverin and Alexander Patsukhov, Institute of Biology Komi SC UB RAS**

*"The ASSW Open Science Conference 2009, offered a great opportunity to make new scientific contacts for further collaboration and a chance to learn more about a variety of interesting topics and get familiar with new science technologies. We were the only scientists from our large northern region of Russia, the Komi Republic. We presented in the session on the Evolution of Arctic Ecosystems, but were also very interested in following the presentations from the other disciplines."*

*In our eyes, the conference showed an increasing world-wide ecological, political and economical interest in the Arctic. The event helped us understand changes in all the field of arctic science on a global level."*

### **NAG Annual Workshop 2009, Anne Chapuis, Norwegian University of Life Science**

*"During this three day conference, I witnessed very interesting presentations and took part in compelling talks. Some talks were directly related to my project and some a bit more unfamiliar to me, which was very enriching. Although the range of topics was quite large, I was very glad to see that so much attention was raised towards my topic, iceberg calving. It really demonstrated how important it is to study this particular topic and gave me a lot of confidence for the relevance of my research.*

*The talk I gave was both very challenging and enjoyable. Challenging, because it was my first talk at an international conference. Conversely it made me realize how much I liked to present my work and raise comments and questions related to it. Participating at this conference by presenting my research really made me feel like I am now part of the glaciology community."*

### **Third International Conference and Workshop Arctic Palaeoclimate and its Extremes, Sebastian Wetterich, Alfred Wegener Institute**

*"In scientific regard my participation in the workshop was very informative, because I used the opportunity to attend numerous talks of leading arctic scientists working in the Northern Hemisphere. I was impressed by the broad research spectrum represented by APEX members. I really enjoyed the familiar atmosphere and used the chance to get in contact with renowned arctic scientists.*

*Through my poster presentations I could draw the attention of APEX members to my current and future field of research, and exchange information with interested colleagues. For my work in Siberian permafrost regions the participation in the Arctic palaeoclimate section of the workshop was helpful and constructive, because concrete questions of my topic were discussed and new research attempts and ideas were developed."*

It is because of this range of opportunities – learning platforms stimulating the exchange of knowledge, cross fertilization and collaboration – that opens up by attending these meetings, that IASC hopes to keep supporting early career scientists in the future.



PHOTO: JULIA LAROCHE  
APECS workshops, panel discussions, field schools and much, much more help prepare 'young' polar and cryosphere researchers for successful and balanced careers.

| Meeting     | Name             | Institution   |
|-------------|------------------|---|
| <b>NAG</b>  | A. Izykowska     | Institute of Geophysics Polish Academy of Sciences                      |
|             | C. Nuth          | University of Oslo, Norway  |
|             | A. Chapuis       | University of Life Science, Norway                                      |
|             | C. Delcourt      | Université Libre de Bruxelles, Belgium                                  |
|             | T. Dunse         | University of Oslo, Norway  |
|             | G. Moholdt       | University of Oslo, Norway  |
|             | M. Grabiec       | University of Silesia, Poland   |
|             | R. Mottram       | Geological Survey of Denmark and Greenland                              |
| <b>APEX</b> | A. Ludikova      | Institute of Limnology, Russian Academy of Science                      |
|             | S. Wetterich     | Alfred Wegener Institute, Germany                                       |
|             | S. Woodroffe     | Durham University Science Laboratories, United Kingdom                  |
|             | H. Krogh         | University of Tromsø, Norway  |
|             | H. O. Fredin     | Geological Survey of Norway   |
|             | N. Zaretskaya    | Geological Institute of Russian Academy of Science                      |
| <b>ASSW</b> | A. Chetverova    | St. Petersburg State University, Russia                                 |
|             | M. Pisareva      | Lomonosov MSU, Russia   |
|             | P. Glazov        | Institute of geography, Russian Academy of Science                      |
|             | N. Chae          | Korea Polar Research Institute  |
|             | S. Li            | Shenyang Institute of Automation, Chinese Academy of Science            |
|             | R. M. Salokangas | University of Alberta, Canada   |
|             | A. Urban         | Permafrost Institute, Yakutsk, Russia                                   |
|             | L. Frolova       | Kazan State University, Russia  |
|             | A. Lupachev      | Institute of Phys., Chem. And Biol. Issues in Soil Science, RAS, Russia |
|             | A. Patsukhov     | Institute of Biology Komi SC UB RAS, Russia                             |
|             | D. Kaverin       | Institute of Biology Komi SC UB RAS, Russia                             |
|             | W. D'Andrea      | University of Massachusetts Amherst, USA                                |
|             | A. Pavlov        | Arctic and Antarctic Research Institute, Russia                         |
|             | K. Frey          | Clark University, USA   |
|             | K. Parewick      | Memorial University, Canada   |
|             | M. Kondo         | National Institute for Environmental Studies, Japan                     |
|             | M. Tsukernik     | National Center of Atmospheric Research , USA                           |

» Figure: Overview of supported Early Career Scientists «

In 2008 IASC and the Scientific Committee on Antarctic Research (SCAR) signed a Memorandum of Understanding with the Association of Polar Early Career Scientists (APECS). The agreement underlines the common goal of working internationally and across disciplines to increase the understanding of

Earth's polar regions and their connections to the global system. It simultaneously identifies a joint commitment to the professional development of early career polar researchers and the need for a continuum of leadership in polar research.

# Association of Polar Early Career Scientists (APECS)

WRITTEN BY: Daniela Liggett  
APECS President

The Association of Polar Early Career Scientists (APECS), sponsored by SCAR and IASC, has been recognized as one of the major IPY legacies with over 2000 members from approximately 40 countries. With a focus on preparing 'young' polar and cryosphere researchers for successful and balanced careers that have a significant impact on the way polar science, policy and education are conducted, APECS has run various panel discussions and workshops at numerous international conferences over the last few months (such as Gordon Conference on Polar Marine Science, the Arctic Science Summit Week, the SCAR Biology Symposium and the Antarctic Climate Evolution Conference, just to name a few). APECS also ran an IPY Polar Field School on Svalbard in June together with UNIS and the University of the Arctic.

In the same spirit, APECS hosted and will host two interdisciplinary career development workshops for early career researchers 2009: the International IPY Early Career Research Symposium in Victoria, BC, 4-8 December 2009 (sponsored by the Canadian IPY Federal Programme Office) and the APECS Professional Development Workshop at the IPY Oslo Science Conference 5-7 June 2010 (sponsored by the Research Council of Norway). APECS thanks AOSB and IASC for their generous travel support for many of the participants.

Other core activities that APECS was heavily involved in over the last year are education and outreach projects aimed at bringing the polar regions closer to the wi-



der public and into schools. APECS members enthusiastically contributed to the International Polar Week and are collaborating with the IPY Education and Outreach Committee to develop a polar resource book for teachers, university student and young scientists who wish to bring polar lessons into the classroom.

Increasingly, APECS' work is recognized by leading scientific bodies and polar organizations. Invitations have been extended to APECS to nominate members for international committees such as the SCAR Scientific and Standing Committees, the ICSU Earth Sciences Visioning Committee, and the IPY Oslo Science Conference Steering Committee and Science Sub-Committees. APECS acknowledges and appreciates the significant support provided by many organizations and individuals in this regard.

Other exciting developments over the past year include the establishment of our International Directorate Office at the University of Tromsø. We have also launched a redesign of our website thanks to the tireless efforts of the Arctic Portal team and our Director. New features of the website such as a literature discussion forum and a virtual poster session forum have been added to enable more efficient and in-depth discussion and exchange of ideas. APECS gratefully acknowledges the generous funding received from the Nordic Council of Ministers to develop these new projects.

[www.apecs.is](http://www.apecs.is)

PHOTO: SEBASTIAN WETTERICH

A young scientist is resting after a long day of fieldwork, collecting samples and mussel shrimps from a polygonal pond.

## » ANNEX

### Annex 1

Merger Agreement between the Arctic Ocean Science Board (AOSB) and the International Arctic Science Committee (IASC)

#### **Background**

In recognition of the growing integration of Arctic programs; the increased number, and variety of scientific programs in the Arctic; the proliferation of Arctic science programs that cut across more than one scientific field; the strategic need to address issues affecting not only the physical sciences but also the social sciences and to develop programs that reach out to local residents, indigenous populations and the global community; the inherent benefits of combining resources and scientific talent to impact politicians and funding officials and the resulting economies of scale; the Arctic Ocean Sciences Board (AOSB) and the International Arctic Science Committee (IASC) hereby enter into an agreement to merge.

Under this Agreement, AOSB will become the Scientific Standing Committee for Marine Sciences within IASC. As AOSB is merging with IASC as an already functioning and independent organization, the name AOSB will remain attached to the IASC Scientific Standing Committee. Hence, the name will be: "AOSB: the Scientific Standing Committee for Marine Sciences".

The mission of AOSB, "to facilitate research in the Arctic Ocean and surrounding seas through the support of multinational and multidisciplinary natural science and engineering programs" will remain unchanged. It will be carried out, however, within the broader mission of IASC which is, "to encourage and facilitate cooperation in all aspects of arctic research, in all countries engaged in arctic research and in all areas of the Arctic."

Membership in AOSB: the Scientific Standing Committee for Marine Sciences will be limited to maximum two representatives from each IASC member country. Members will be appointed by their National Adhering Bodies and will come from a variety of marine science disciplines. The current chair of AOSB will act as an interim chair of the AOSB: the Scientific Standing Committee of Marine Sciences until the committee is fully established and he will serve as an ex officio member of the IASC Council. When fully established, AOSB: the Scientific Standing Committee for Marine Sciences will elect one Chair and two Vice Chairs from three different countries.

The budget for AOSB: the Scientific Standing Committee for Marine Sciences will be determined by IASC. Funding for AOSB programs will come from IASC dues. Secretariat services will be provided by AOSB until September 30, 2009, after which all secretarial support will be provided by IASC.



Annual meetings of AOSB: the Scientific Standing Committee for Marine Sciences will be held each year during the ASSW prior to the IASC Council meetings.  
Signed this 27th day of March, 2009,

**Harald Loeng**

Chair AOSB

Date 27 March 2009

**Kristján Kristjánsson**

President IASC

Date 27 March 2009

## Annex 2

### Letter of Agreement (LoA) between the Pacific Arctic Group (PAG) and the International Arctic Science Committee (IASC)

#### 1. General Introduction

ASC was founded in 1990 in the context of post-perestroika renewal of international arctic cooperation. Initial members included the USSR and several European and North American nations. Over time membership evolved and grew to accommodate the changing status of original member nations and the growing interests in Arctic science in many other nations, including several from Asia, who joined IASC. To provide a focal point for discussion of science of particular interest to the new Asian members, and also to enhance discussion of arctic science issues from a Pacific perspective, IASC agreed in 1999 to create PAG as a subset of IASC, with its own leadership and secretariat. In 2008, IASC developed a plan for restructuring itself and determined that PAG had developed sufficient strength that it could stand on

its own as a separate organization, and the PAG members agreed. Yet the scientific interests of PAG and IASC retain much in common, and it is in the interests of both groups to maintain strong coordination and collaboration. This Letter of Agreement sets forth the rationale and objectives for continued strong interaction between the two groups.

#### 2. PAG

##### a. INTRODUCTION

The arctic marine environment is of significant scientific concern to the nations on the Pacific side of the Arctic. PAG has adopted 10 science themes that describe its interests and provide motivation for the work of the involved nations and scientists.

**Theme 1:** Undertake seasonal and interannual ocean observations in the Pacific Arctic Sector where recent maximum sea ice retreat is occurring.

**Theme 2:** Understand oceanic and atmospheric processes in the Pacific Arctic, including the feedback loops, that are critical to mid-latitude climate variability.

**Theme 3:** Monitoring fresh water input via precipitation, riverine input, oceanic input, glacial and sea ice melt in the Pacific Arctic sector will improve our understanding of mid-latitude climate variability and provide additional information to support theme 1.

**Theme 4:** Identify and monitor ecosystem and biological and chemical indicators (ice, water column, benthic, higher trophic organisms) of climate change in the Pacific Arctic.

**Theme 5:** Investigate sea ice thermodynamics including sea ice thickness, extent, and its interactions with ocean and atmospheric forcing in the Pacific Arctic region. Investigate sea ice dynamics such as sea ice drift, interactions between different ice packs.

**Theme 6:** Investigate CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub> in the air and surface water in the sea ice retreated waters to estimate their sea-air fluxes in the western Arctic Ocean and the Pacific Arctic waters and evaluate their role of global ocean carbon and nitrogen cycles and relative to seawater acidification.

**Theme 7:** Understanding the connectivity of warm Atlantic inflow to the Pacific sector, heat flux throughout Arctic, and associated biodiversity/invasion of Atlantic-species into the region. Physical gateways should be mapped and monitored, including out-flow through the Canadian Arctic Archipelago.

**Theme 8:** The Arctic Ocean is very poorly mapped from the seafloor to the ice above. Significant information gaps include the bathymetry, biodiversity, and knowledge of ocean currents and their variability over space and time. Exploration of the unknown Pacific Arctic region is essential for the construction of base maps necessary for the planning of future monitoring efforts.

**Theme 9:** The Pacific water inflow through the Bering Strait region is a key conduit for heat, salt, nutrients, and biological material (including genetic material) to the Arctic basin that influences sea ice cover, halocline formation, and the carbon cycle.

**Theme 10:** Nearshore coastal processes and subsea permafrost dynamics are important processes in the shallow Pacific shelf areas are subject to climate change impacts.

**Theme 11:** The open and closing of the Pacific gateway has occurred over geological time periods with dramatic impact on the Arctic system. The paleo-record provides a long-term record for comparative evaluation of climatic processes relative to contemporary studies in prior themes.

#### b. DEFINITION OF THE PACIFIC ARCTIC REGION

The Pacific Arctic Region is loosely defined as the area lying between Russia and Alaska (Bering Strait) and extending northward including the Beaufort Gyre and Arctic Ocean and southward including the Bering Sea. The area also includes seasonally ice-covered seas. PAG activities may extend beyond these boundaries based on project objectives.

#### c. PAG OBJECTIVES

PAG has four basic objectives: 1) To facilitate and coordinate science operations among PAG member

countries; 2) To promote and facilitate data accessibility and integrated data bases for the region; 3) To serve as a forum for information exchange on Pacific Arctic Region (PAR) science programs; and 4) To establish and maintain a direct link between PAG and other relevant science organizations.

#### d. PAG GENERAL MEMBERSHIP

The PAG general membership consists of at least one member from each country or institution represented by the PAG area of interest. The membership consists of both Scientists and Program Managers and should reflect an appropriate balance between the principal PAG science themes: climate, contaminants, human dimensions and structure and function of Arctic ecosystems.

#### e. PAG CHAIR AND EXECUTIVE COMMITTEE

The PAG Executive Committee consists of a Chair, Vice Chair, Executive Member and Project Coordinator. As members depart, nominations for membership to the Executive Committee are evaluated by the Committee. In addition, the Executive Committee may, from time to time, strike an "ad hoc" committee to deal with a specific issue.

#### f. PAG PROJECT COORDINATOR

The PAG Project Coordinator acts as the liaison between the interests of the Executive Committee and the project groups. The Project Coordinator will serve as a resource to provide scientific support for consensus and assist in promoting approved projects. The Project Coordinator is nominated by the PAG Executive Committee.

#### g. PAG SECRETARIAT

The functions of the PAG are supported by a small Secretariat, the location of which will rotate among member countries. The Secretariat will be directed by the Executive Committee and work closely with the Project Coordinator and project groups as appropriate.

### 3. IASC

IASC was established in 1990, began operations in 1991 and today comprises 18 member countries. The IASC member organizations are national science organizations covering all fields of Arctic research. Each national member organization has a mechanism to provide ongoing contact between its IASC council member and its Arctic science community.

IASC draws on its structure to identify scientific priorities, members of working groups, etc. An international science program planned or recommended by IASC should be of high priority to Arctic or global science. The organizational needs of IASC are served by the IASC Secretariat located in Potsdam, Germany. IASC is an international associate of the International Council for Science, ICSU, and an observer in the Arctic Council. IASC also has connections to numerous international arctic organizations. Representatives of national scientific organizations from all 18 member countries form the IASC Council. The President of IASC is elected by Council, who also elects 4 Vice-Presidents to serve on the Executive Committee. Council usually meets once a year during the Arctic Science Summit Week, ASSW. IASC Executive Committee operates as a board of directors and manages the activities of IASC between Council meetings. The Chair is the President of IASC.

### 4. Common Interests

During its brief history, PAG has demonstrated a strong interest in science related to the Arctic Ocean and its peripheral seas, including physics of the ocean and sea ice, ecology and biogeochemistry, geology, and environmental modeling. IASC has demonstrated its strong interest in these areas by establishing as part of its restructuring a Marine Systems Scientific Standing Committee.

### 5. Declaration of Intent

Recognizing the large area of common interests, PAG and IASC intend to work together to advance scientific knowledge in mutually agreed areas, to jointly support education and outreach efforts, and to jointly provide advice to policy- and decision-makers who require scientific information as the basis for their actions. By working closely together, IASC and PAG can avoid costly duplication of efforts, and identify opportunities for sharing to reduce costs on each individually.

This Letter of Agreement does not alter the terms of reference or organizational structure of either group and carries no financial implication.

To facilitate coordination and collaboration, the PAG and the IASC agree in particular:

- a.** To consult each other regularly regarding science interests and priorities and to develop collaborative or synergistic efforts whenever appropriate;
- b.** To involve PAG in the preparation and participation of the annual ASSW;
- c.** To invite each other to meetings, including the IASC Marine Systems Scientific Standing Committee
- d.** To link each other's web sites

**John Calder**

Chair PAG

Date 27 March 2009

**Kristján Kristjánsson**

President IASC

Date 27 March 2009

## Annex 3

### Memorandum of Understanding (MoU) between the International Permafrost Association (IPA), the Scientific Committee on Antarctic Research (SCAR) and the International Arctic Science Committee (IASC)

#### 1 The Parties

The Parties to this MoU are the International Permafrost Association (IPA), the International Arctic Science Committee (IASC), and the Scientific Committee on Antarctic Research (SCAR).

##### 1.1 INTERNATIONAL PERMAFROST ASSOCIATION

The International Permafrost Association (IPA), founded in 1983, has as its objectives to foster the dissemination of knowledge concerning permafrost and to promote cooperation among persons and national or international organizations engaged in scientific investigation and engineering work related to permafrost and seasonally frozen ground. The Association's primary responsibilities are to convene International Permafrost Conferences, undertake special projects such as preparing databases, maps, bibliographies, and glossaries, and coordinate international field programs and networks. Membership is through adhering national or multinational organizations or as Associate Members in countries where no Adhering Body exists. The IPA is governed by an Executive Committee and a Council. The day-to-day operations of IPA are supported by its International Secretariat.

##### 1.2 INTERNATIONAL ARCTIC SCIENCE COMMITTEE

The International Arctic Science Committee (IASC) is an International Scientific Associate of ICSU, and was established in 1990. IASC's main aim is to initiate, develop, and co-ordinate leading edge scientific activity

in the Arctic region, and on the role of the Arctic region in the Earth system. It also provides objective and independent scientific advice to the Arctic Council and other organizations on issues of science affecting the management of the Arctic region. The decision-making organs of IASC are the Council and the Executive Committee. The day-to-day operations of IASC are supported by its Secretariat headed by the Executive Secretary. IASC's geographical remit covers the Arctic Ocean and the surrounding landmasses.

##### 1.3 SCIENTIFIC COMMITTEE on ANTARCTIC RESEARCH

The Scientific Committee on Antarctic Research (SCAR) is an Interdisciplinary Body of ICSU. It was established in February 1958 to continue the international coordination of Antarctic scientific activities that had begun during the ICSU-led International Geophysical Year of 1957- 58. Its main aim is to initiate, develop, and coordinate high quality international scientific research in the Antarctic region, and on the role of the Antarctic region in the Earth system. In addition it provides objective and independent scientific advice to the Antarctic Treaty Consultative Meetings and other organizations on issues of science and conservation affecting the management of Antarctica. The decision-making organs of SCAR are the Meeting of Delegates and the Executive Committee. The day-to-day operations of SCAR are supported by its Secretariat headed by the Executive Director. SCAR's remit covers Antarctica and the surrounding Southern Ocean including the Antarctic Circumpolar Current south of the Subantarctic Front.

#### 2 Rationale for the MoU

The Parties share common goals of working internationally and across disciplines to increase our understanding of permafrost and Earth's polar regions and their connections to the global system. There are strong grounds for a closer linkage between these three bodies to bring benefits to all parties, not least in an exchange of views and experience on impor-

tant scientific topics. A link between them at this time is encouraged to ensure that all three communities together make an integrated and comprehensive contribution to meeting the goals of the International Polar Year (IPY 2007-2009) and developing the IPY legacy.

The three organizations have agreed that a tripartite link between them should be developed by means of this Memorandum of Understanding, which will be signed during the IASC Council Meeting at the Arctic Science Summit Week in Bergen, Norway, on March 27 2009.

The three organizations share a number of common interests and practices, which will make it relatively easy for them to work together, for example in arranging workshops, conferences, and reports on topics of mutual scientific interest, in developing integrated plans for permafrost and polar research as well as the linkages between the inner aspects of polar research, and in providing advice to policy makers.

### 3 Terms of Agreement

This MoU identifies a joint commitment to the excellence in the field of permafrost and polar research, to the pursuit of scientific advances, public awareness and advice to policy makers as well as professional development of young researchers.

SCAR, IASC and IPA intend to combine their efforts in permafrost and/or polar activities (to be decided by mutual agreement) so as to raise the level of impact of all three organizations. To facilitate the process, SCAR, IASC and IPA agree:

- i.** to invite each other to attend the meetings of their major bodies (SCAR Delegates' Meeting, IASC Council and IPA Council);
- ii.** to encourage representation of each organization in their relevant working committees (SCAR Expert Groups, IASC Scientific Standing Committees, IPA Working Groups);

- iii.** to encourage appropriate linkages between the relevant existing SCAR, IASC and IPA science projects and to develop joint projects and approaches in appropriate fields;

- iv.** to work together in arranging workshops, conferences, and reports on topics of common scientific interest;

- v.** to exchange ideas on best practices in data and information management; and to foster involvement of the parties in their respective data management committees;

- vi.** to foster and promote integration of observing efforts lead by each organization (SCAR Pan-Antarctic Observing System, IASC Sustaining Arctic Observing Networks, IPA International Network of Permafrost Observatories) by ensuring adequate representation of each party in these entities;

- vii.** to exchange members updates, newsletters, publications and advertise each other's newsletters, publications and web sites on their own web sites;

- viii.** to develop a combined approach to communicating the relevance of permafrost and polar research to societal issues with the wider community, including providing advice to political entities such as the Arctic Council and Antarctic Treaty bodies; and

- ix.** to work together through their respective young researcher organizations to encourage involvement of young researchers to participate in participating in business, strategy, planning, and other meetings and activities.

### 4 Financial Implications of the Agreement

Parties to this Agreement will continue to be responsible for the costs of their own activities, but this does not preclude one party meeting or contributing to the occasional or ongoing costs of another if they so wish. Actual financial contributions to the activities and other implications of this MoU will be considered and agreed to by representatives of the Parties as they arise, and may be changed in accordance with the Parties requirements without any effect on the substance of this Agreement.

## **5 Non-binding Implications of the Agreement**

This agreement is between IPA, IASC, and SCAR. It does not preclude the Parties agreeing to other MoUs with other programs and organizations, or bilaterally between the Parties.

## **6 Duration, Revision and Termination of this MoU**

This MoU remains in force for 5 years, at which time it will be reviewed for possible extension. No action by any of the parties will result in the cancellation of this MoU. The MoU may be revised at any time by mutual agreement between the Parties. Any of the parties may propose alterations to the MoU. Parties wishing to withdraw from this agreement should do so by a formal letter signed by the President and head organizational manager (i.e. Executive Secretary, Executive Director or Secretariat) of their respective organization.

### **Hans-Wolfgang Hubberten**

President IPA

Date 27 March 2009

### **Mahlon C Kennicutt II**

President SCAR

Date 27 March 2009

### **Kristján Kristjánsson**

President IASC

Date 27 March 2009

PHOTO: KIERAN O'DONOVAN

An adult muskox on a ridge overlooking a river valley that drains into Vesle Fiord on the east coast of Ellesmere Island, Nunavut (Canada).

## Annex 4

### List of Acronyms and Abbreviations

| Acronym        | Full name   |   |   |
|----------------|---|---|---|
| <b>AC</b>      | Arctic Council  | A |   |
| <b>ACCE</b>    | Antarctic Climate Change and the Environment              |   |   |
| <b>ACCOnet</b> | Arctic Circumpolar Coastal Observatory Network            |   |   |
| <b>ACD</b>     | Arctic Coastal Dynamics                                   |   |   |
| <b>ACEX</b>    | Arctic Coring Expedition                                  |   |   |
| <b>ACIA</b>    | Arctic Climate Impact Assessment                          |   |   |
| <b>AHDR</b>    | Arctic Human Development Report                           |   |   |
| <b>AHHEG</b>   | Arctic Human Health Experts Group                         |   |   |
| <b>AMAP</b>    | Arctic Monitoring and Assessment Programme                |   |   |
| <b>AOSB</b>    | Arctic Ocean Sciences Board                               |   |   |
| <b>ART</b>     | Arctic in Rapid Transition                                |   |   |
| <b>ASI</b>     | Arctic Social Indicators                                  |   |   |
| <b>ASSW</b>    | Arctic Science Summit Week                                |   |   |
| <b>ATCM</b>    | Antarctic Treaty Consultative Meeting                     |   |   |
| <b>AWI</b>     | Alfred Wegener Institute for Polar and Marine Research    |   |   |
| <b>BEST</b>    | Bering Ecosystem Study                                    | B |   |
| <b>BipAG</b>   | Bipolar Action Group                                      | C |   |
| <b>CALM</b>    | Circumpolar Active Layer Monitoring                       |   |   |
| <b>CAML</b>    | Census of Antarctic Marine Life                           |   |   |
| <b>CEFAS</b>   | Centre for Environment, Fisheries and Aquaculture Science |   |   |
| <b>C-GTOS</b>  | Coastal Global Terrestrial Observing System               |   |   |
| <b>CliC</b>    | Climate and Cryosphere Project                            |   |   |
| <b>CMIP</b>    | Coupled Model Intercomparison Project                     |   |   |
| <b>COMNAP</b>  | Council of Managers of National Antarctic Programs        |   |   |
| <b>COP15</b>   | 2009 United Nations Climate Change Conference             |   |   |
| <b>CPE</b>     | Comité Polar Español                                      |   |   |
| <b>CryOS</b>   | Cryosphere Observing System                               |   |   |
| <b>CSA</b>     | Canadian Space Agency                                     |   |   |
| <b>EPB</b>     | European Polar Board                                      |   | E |
| <b>ERICON</b>  | European Research Icebreaker Consortium                   |   |   |
| <b>ESA</b>     | European Space Agency                                     |   |   |
| <b>ESF</b>     | European Science Foundation                               |   |   |
| <b>ESRI</b>    | European Strategy Forum on Research Infrastructures       |   |   |
| <b>EUCOP</b>   | European Conference on Permafrost                         |   |   |

| Acronym          | Full name   |   |
|------------------|---|---|
| <b>GEOTOP</b>    | Quebec inter-university network on advanced studies and research in geosciences                     | G |
| <b>GFCS</b>      | Global Framework for Climate Services   |   |
| <b>GGD</b>       | Global Geocryological Database  |   |
| <b>GIN</b>       | Greenland-Iceland-Norwegian seas  |   |
| <b>GLACIODYN</b> | Dynamic Response of Arctic Glaciers to Global Warming   |   |
| <b>GOOS</b>      | Global Ocean Observing System   |   |
| <b>HERMIONE</b>  | Hotspot Ecosystem Research and Man's Impact On European Seas  | H |
| <b>IACS</b>      | International Association of Cryospheric Sciences   | I |
| <b>IAMAS</b>     | Association of Meteorology and Atmospheric Science  |   |
| <b>iAOOS</b>     | integrated Arctic Ocean Observing System  |   |
| <b>IAPSO</b>     | International Association for the Physical Sciences of the Oceans                                   |   |
| <b>IASSA</b>     | International Arctic Social Sciences Association  |   |
| <b>ICARP</b>     | International Conference on Arctic Research Planning  |   |
| <b>ICEHUS</b>    | Ice Age Development and Human Settlement in Northern Eurasia  |   |
| <b>ICEMASS</b>   | Response of Arctic Ice Masses to Climate Change   |   |
| <b>ICES</b>      | International Council for the Exploration of the Sea  |   |
| <b>ICSIH</b>     | The International Commission for Snow and Ice Hydrology   |   |
| <b>ICSU</b>      | International Council for Science   |   |
| <b>IG</b>        | Initiating Group  |   |
| <b>IGY</b>       | International Geophysical Year  |   |
| <b>IHP</b>       | International Hydrological Programme  |   |
| <b>INAC</b>      | Indian and Northern Affairs Canada  |   |
| <b>INVEST</b>    | New Ventures in Exploring Scientific Targets  |   |
| <b>IODP</b>      | Integrated Ocean Drilling Program   |   |
| <b>IPA</b>       | International Permafrost Association  |   |
| <b>IPY</b>       | International Polar Year  |   |
| <b>IPY IPO</b>   | International Polar Year International Program Office   |   |
| <b>IUGG</b>      | International Union of Geodesy and Geophysics   | J |
| <b>JC</b>        | Joint Committee   | L |
| <b>LAII</b>      | Land-Atmosphere-Ice Interactions  |   |
| <b>LANDSAT</b>   | Series of Earth-observing satellite missions jointly managed by NASA and the U.S. Geological Survey |   |
| <b>LoA</b>       | Letter of Agreement   | M |
| <b>LOICZ</b>     | Land-Ocean-Interactions in the Coastal Zone   |   |
| <b>LOMROG</b>    | Lomonosov Ridge Greenland expedition  |   |
| <b>MAGICS</b>    | Mass balance of Arctic Glaciers and Ice sheets in relation to the Climate and Sea level changes     |   |
| <b>MOCA</b>      | Meltwater routing and Ocean-Cryosphere-Atmosphere response project                                  |   |



| Acronym        | Full name  |   |   |
|----------------|--|---|---|
| <b>NERI</b>    | National Environmental Research Institute                                  | N |   |
| <b>NRC</b>     | National Research Council  |   |   |
| <b>NSF</b>     | National Science Foundation  |   |   |
| <b>OSC</b>     | Oslo Science Conference  | O |   |
| <b>OSL</b>     | Optically stimulated luminescence  |   |   |
| <b>PAG</b>     | Pacific Arctic Group   | P |   |
| <b>PAN</b>     | Polar Archeology Network   |   |   |
| <b>PAR</b>     | Pacific Arctic Region  |   |   |
| <b>PROMICE</b> | Programme for Monitoring of the Greenland Ice Sheet                        | Q |   |
| <b>QUEEN</b>   | Quaternary Environment of the Eurasian North                               |   |   |
| <b>RINK</b>    | Respons af Indlandsisen til Naturlige Klimaændringer                       | R |   |
| <b>RRS</b>     | Royal Research ship  |   |   |
| <b>RSL</b>     | Relative sea-level   |   |   |
| <b>R/V</b>     | Research Vessel  | S |   |
| <b>SAC</b>     | State of the Arctic Coast  |   |   |
| <b>SAON</b>    | Sustaining Arctic Observing Networks                                       |   |   |
| <b>SCAR</b>    | Scientific Committee on Antarctic Research                                 |   |   |
| <b>SCOR</b>    | Scientific Committee on Oceanic Research                                   |   |   |
| <b>SDWG</b>    | Sustainable Development Working Group                                      |   |   |
| <b>SEARCH</b>  | Study of Environmental Arctic Change                                       |   |   |
| <b>SG</b>      | Steering Group   |   |   |
| <b>SIOS</b>    | Svalbard Integrated Earth Observing System                                 |   |   |
| <b>SOOS</b>    | Southern Ocean Observing System  |   |   |
| <b>SPICE</b>   | Space-borne Measurements of Arctic Glaciers and Implications for Sea Level |   |   |
| <b>SSC</b>     | Scientific Standing Committee  |   |   |
| <b>SWIPA</b>   | Snow, Water, Ice and Permafrost in the Arctic                              |   |   |
| <b>TSP</b>     | Thermal State of Permafrost  |   | T |
| <b>UNESCO</b>  | United Nations Educational, Scientific and Cultural Organization           |   | U |
| <b>UNFCCC</b>  | United Nations Framework Convention on Climate Change                      |   |   |
| <b>UNIS</b>    | The University Centre in Svalbard  |   | W |
| <b>WCC</b>     | World Climate Conference   |   |   |
| <b>WCRP</b>    | World Climate Research Programme   |   |   |
| <b>WMO</b>     | World Meteorological Organization  |   |   |

