International Collaboration and Cooperation in Arctic Environmental Change Programs

Planning for the Future

Report from the meeting
"International Collaboration and Cooperation in Arctic Science: Planning for the Future"

30 May - 1 June 2011
International Arctic Research Center,
University of Alaska Fairbanks, Fairbanks, Alaska

Citation

Murray, M.S., H. Eicken, P. Schlosser, J.C. Gascard, D. Barber, U. Bhatt, M. Biuw, M. Fortier, E. Struzik, E. Topp-Jørgensen, S. Fox, L. Hinzman, H. Enomoto, V. Ivanov, D. Jin, H. K. Lee, K. Michiyo-Yamamoto, D. Perovich, M. Pitt, K. Pletnikoff, H. Sagen, V. Sergienko, G. Shaver, K. Shimada, R. Shnoro, .J. Walsh, H. Wiggins, and J. Zhao, 2011. *International Collaboration and Cooperation in Arctic Environmental Change Programs: Planning for the Future*. International Study of Arctic Change (ISAC) Program Office, Stockholm.

Acknowledgements

This meeting was made possible by support from the International Arctic Research Center (IARC), University of Alaska Fairbanks, the U.S. National Science Foundation, and the Swedish Research Foundation (Vetenskapsrådet). We are particularly grateful to Larry Hinzman, Director International Arctic Research Center (IARC), for enabling this opportunity, and to the IARC staff, and especially Tohru Saito for logistical support. The meeting organizers would also like to thank the staff in the International Study of Arctic Change (ISAC) Program Office in Stockholm and the SEARCH Project Office in Fairbanks for facilitating the preparation of background materials.

This material is based upon work supported by the National Science Foundation under Grant No. 0943320. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

TABLE OF CONTENTS

INTRODUCTION

From 30 May – 1 June 2011, a meeting was held at the International Arctic Research Center (IARC, www.iarc.uaf.edu), University of Alaska Fairbanks (UAF), Fairbanks, Alaska to discuss international collaboration and cooperation in arctic science and planning for the near and long term. The meeting was organized by the International Study of Arctic Change International Program Office (ISAC IPO, www.arcticchange.org), with support from IARC and the Study of Environmental Arctic Change (SEARCH) Project Office (www.arcus.org/search/index.php).
The overall goal of the meeting was to move toward an agreed upon strategy for international cooperation, collaboration and joint planning of arctic environmental change science programs and related observing activities. The major objectives were to:

1. Identify mechanisms for improving international cooperation in arctic environmental change research programs;

2. Begin planning for an Arctic Observing Summit;

3. Implementation of the Responding to Change component of the ISAC Science Program.

Day One of the meeting was devoted to an overview of a selection of existing national arctic environmental change programs, presentation of relevant existing and past formal international collaborations, and a discussion of the ways in which networks and partnerships may be enhanced in the near future. The needs for planning and implementation of pan-Arctic environmental change research programs, and new ways to collaborate to enhance the use of technology, data recovery and data sharing were emphasized. Consideration was also given to how various initiatives might be synchronized under an overarching, international program such as the International Study of Arctic Change (ISAC).

Day Two focused on planning for an Arctic Observing Summit (AOS) and included an overview of ongoing long term observing programs. Discussion centered around ways to improve coordination and connections among existing observing activities and programs, and the development of recommendations for national programs and initiatives. This included planning discussions for a recurring AOS, the first of which would be scheduled for the latter half of 2012.

Day Three discussions were centered on the concept of Responding to Arctic Change (RtoC) including an overview of some of the major initiatives currently underway or in the planning stages that are consistent with the RtoC framework as outlined in the ISAC Science Plan (Murray et al. 2010; www.arcticchange.org). There was an effort to identify relevant stakeholder communities and to consider how these vary among nations and how national needs for scientific information about arctic

change also vary. Meeting participants provided input on a planned ISAC RtoC workshop scheduled for 30 January – 1 February 2012 at Queen's University in Kingston, Canada.

MAJOR OUTCOMES

1. A detailed overview of many existing programs and collaborative agreements among nations and institutions.

2. Expansion of the planning process to include scientific communities who were, up to now, not integrated into international arctic environmental change programs;

3. Agreement on the need to continue to pursue and expand such collaborations, in particular to avoid duplication of efforts and improve coverage of observation programs;

4. Itemization of key questions/issues that need to be addressed to expand and improve international collaboration and coordination in arctic research;

5. Identification of specific actions to be undertaken by ISAC to facilitate information flow and collaboration;

6. Development of recommendations for activities leading to an AOS;

7. Agreement on next steps in AOS planning including suggestions for potential members of an AOS Organizing Committee, and the scope and structure of the Summit;

8. Identification of different stakeholder communities in various nations;

9. Recommendations for the scope and structure of the first ISAC Responding to Change workshop and identification of potential sources of support.

Figure 1. Meeting participants represented ten different nations and 12 different organizations involved in arctic research and in arctic research planning activities. Photo: Y. Kim

IMPROVING INTERNATIONAL COLLABORATION IN ARCTIC SCIENCE

Background

Planning for the meeting in Fairbanks began during *International Day* (Day 4) at the *State of the Arctic Conference* (www.soa.arcus.org), held 16-19 March 2010, in Miami, Florida, U.S.A. It became clear at that conference, and through subsequent analysis of recent trends in arctic research (Eicken et al. 2011), that there is a strong awareness of increased societal needs for scientific information on a changing Arctic. Consistent with this observation, the International Study of Arctic Change has an overarching goal to see the production timely, relevant, and accessible scientific information for response to rapid arctic change. The international research community has substantial scientific capital to offer and consensus is converging on key scientific questions and issues. The research community is also greatly enhancing the dialogue with a broad stakeholder community to hear first hand about the problems caused by arctic environmental change. The needs of both the scientific and the stakeholder communities should be included in the planning of research programs to facilitate the translation of research results into information that is of direct use for stakeholders. To achieve this goal, the synchronization among **understanding, observing and responding** to change activities has to be accomplished. Enabling synchronization requires further definition of the research agenda, and capacity building in all areas in the context of an international framework that cuts across disciplinary, national and institutional boundaries.

Meeting Goals

The primary goal for Day 1 was to review the existing national arctic research programs that were able to participate in the meeting and to consider how they are and can be integrated into international programs and initiatives. Particular emphasis was placed on the last two decades of progress by the arctic research community in fostering international collaborations on environmental change research, and on appropriate goals and enhancement of these collaborations over the longer term.

National Activities

There were presentations on arctic environmental change research conducted by Canada, China, Greenland and Denmark, France, Japan, Korea, Norway, Russia, Sweden, the United States, and the European Union. Each presenter was asked to address the same series of questions:

1. How do national arctic research programs work in your country?

    a. How are they organized; are they mission-oriented or driven by basic research?

    b. How are they funded and what is the long-term outlook for funding?

2. What has been learned from the national program(s)?

3. What are the major accomplishments with respect to collaboration within your country?

Canada

In Canada, momentum continues following the International Polar Year (IPY). Canada's Northern Strategy includes the development of a new high arctic research station at Cambridge Bay, Nunavut. This is now in the design stage and the science mandate is being defined. The Canadian Polar Commission (www.polarcom.gc.ca), has been reactivated with a new Chairperson and recently appointed commissioners. Canada is committed to building the icebreaker CCGS *Diefenbaker* but plans for building new icebreakers and the Canadian Climate Research program are presently on hold. The CCGS *Amundsen* remains a dedicated research icebreaker and Canada has seven other icebreakers, almost all of which support some research, usually funded by international partners. The Government of Canada created the Arctic Research Infrastructure Fund for improving existing terrestrial infrastructure. A total of $85 million CAD were awarded to 20 different projects (www.aadnc-aandc.gc.ca/eng/1100100037415) including $11 million CAD to the Polar Continental Shelf Project (polar.nrcan.gc.ca). Canada continues to develop the Polar Data Catalogue (PDC, http://polardata.ca/), initiated during the IPY. The PDC provides dataset description, indexing, data discovery, and full metadata archiving and sharing.

China

During the IPY, China made two cruises to the Arctic and Chinese scientists participated in eight others. In China the focus of research is on how the Nordic seas influence China's climate and rising sea level in south China. Other emphases include the physical processes of the Arctic Ocean, and the evolution of arctic

ecosystems. China has a ten-year strategy focused around these areas with plans to finish a new icebreaker by 2014. There is persistent support for polar observation activities through a special funding program and increased attention to arctic science and technology.

France

France is making a major contribution to arctic research through the Ice Atmosphere Ocean Observing System (IAOOS) project. This is funded through 2019 for deploying and maintaining a network of 40 drifting platforms in the Arctic. Fifteen platforms will be deployed every year over the next 5-7 years. These will be equipped with lidars (atmosphere), ice mass balance bouys (IMBs), and Conductivity, Temperature and Depth (CTD) ocean profilers. This continues the efforts initiated in the EU funded Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies (DAMOCLES) project and supports ongoing expansion of an Arctic Observing System.

Greenland and Denmark

Research and monitoring activities in Greenland are carried out by both Greenlandic and Danish institutions, and universities from many other countries around the globe.

There is no centrally coordinated strategy on research and monitoring in Greenland, but in 2011 Denmark, Greenland and the Faroe Islands signed an "Arctic Strategy" which included the identification of some key areas of research and monitoring in the Arctic. These are: climate change and effects on environment and society; pollution and effects on environment and society; research and monitoring of living resources to ensure sustainability; knowledge sharing; and international collaboration.

The funding agencies and ministries in both Greenland and Denmark influence research and monitoring activities in Greenland through their funding mechanisms. Primary supporters of research and monitoring in Greenland are the Government of Greenland (through direct support of the Greenland Institute of Natural Resources, ASIAQ (Greenland Survey) and through support of individual projects), and The Government of Denmark (through the Ministry of Science, the Ministry of Energy and the Ministry of Environment).

The Government of Greenland is responsible for management of Greenland's living resources and participates in species oriented networks and conventions such as the North Atlantic Marine Mammal Commission (NAMMCO), the Joint Commissions on Narwal and Beluga (JCNB), and the Oslo-convention (Polar Bears), etc., while Denmark leads the involvement in the larger biodiversity oriented conventions such as the Convention on Biodiversity (CBD). The Greenlandic funding available for

research and monitoring is focussed on local management issues and harvesting of living resources, while Danish funding is focussing on broader monitoring and understanding of biodiversity and climate change effects.

The Commission for Scientific Research in Greenland is one of Denmark and Greenland's joint advisory bodies for the Danish Research Ministry and the Greenland Home Rule Member for Research. The commission provides economic support for initiatives and development projects which can promote and support Danish–Greenlandic co-operation in arctic research across a range of scientific fields of expertise.

Science and monitoring strategies and programmes are developed by individual networks or institutions, but somehow governed by funding agencies. The palette of programmes may thus change with changes in the focus of the funding agencies. The main lesson learned from the National Programmes is that the coupling of research, monitoring and logistics ensures efficient use of resources. Long-term monitoring combined with targeted research is essential to understanding systems dynamics and processes. Interdisciplinary research and monitoring programs ensure better understanding of processes and analysis of long-term monitoring data and international collaboration increases activities and outputs.

In Greenland and Denmark the establishment of new research institutions has been key to success. These include:

1. Greenland Institute of Natural Resources (GINR, est. 1995) which is responsible for research and monitoring of living resources (5 year monitoring plans) and which operates two satellite research stations. (www.natur.gl)

2. Greenland Climate Research Center (GCRC, est. 2009) which conducts research and monitoring on expected impacts of climate change on Arctic marine, limnic and terrestrial environments and on the Greenland society, including adaptation and prevention strategies. (www.natur.gl/en/climate-research-centre)

3. ASIAQ – Greenland Survey which is engaged in long term monitoring of climate, hydrology and permafrost. (www.asiaq.gl)

4. Geological Survey of Denmark and Greenland (GEUS, est. 1995 by fusion of the Danish Geological Surveys (1888) and Greenland Geological Surveys (1946)). GEUS is responsible for research and monitoring of geological surveying, sea ice, glaciers, Greenland Ice Sheet, hydrology, climate, geology, etc. (www.dmi.dk/eng/index/om_dmi.htm)

5. Danish Meteorological Institute (DMI, est. 1990 by fusion of three institutes established 1872 to 1953)). DMI produces sea ice charts, wave forecasts, weather forecast (climate), etc. (www.dmi.dk/eng/index/om_dmi.htm)

6. Universities. Danish universities coordinate larger long-term research and monitoring programmes, operate four permanent research stations and support individual research and monitoring projects.

Japan

Japan began arctic research in the 1950's. Since that time, research has been housed at universities and in government agencies. Recently Japan began to reorganize research on the Arctic and activities are promoted at the Ministry level. The Strategic Committee on Arctic Research has suggested establishment of a research consortium, called the Japan Consortium for Arctic Environmental Research (JCAR) for arctic climate change research. It has a five-year mandate; further funding beyond that period is not guaranteed but it is proposed to have a longer life. The National Institute of Polar Research (NIPR, www.nipr.ac.jp) will manage the research projects, infrastructure, research platforms, and data archives to support the activities of the consortium. The Japanese Agency for Marine-Earth Science and Technology (JAMSTEC, www.jamstec.go.jp) will also support the project.

As of August 2011 there were 270 people registered in the consortium and a series of five-year projects are planned. These will focus on warming in the Arctic, arctic and global climate now and in the future; the influence of arctic change on climate and weather in Japan and East Asia including influences on marine ecology, biology and fisheries; and sea ice forecasting and the availability of the Northern Sea Route. Japan views continued collaboration with international partners as key to its arctic program.

Korea

The Korea Polar Research Institute (KOPRI, www.kopri.re.kr), which is under the auspices of the Korean Ministry of Education, Science and Technology, manages polar research for Korea. KOPRI is an autonomous research institute developed from the Korea Ocean and Development Research Institute, and while primarily an ocean research institute, is also building an atmospheric and a terrestrial research component in the polar regions. In 2009 Korea launched the icebreaker Araon, in which is installed state of the art scientific equipment. Until 2014, when Korea is scheduled to complete its second Antarctic research station Jan Bogo in Terra Nova Bay, Antarctica, the Araon can be utilized for Arctic research during mid July-early September every year. For 2011 the KOPRI budget was 54 million USD with 22 million dedicated to research.

Domestically, KOPRI developed the P-Science Program (PAP) to enhance Korean universities and research institutes polar activities. Currently the PAP program commits one million USD for university polar activities annually, supporting 10 projects each year. In the future PAP is expected to expand.

The Korean research community makes extensive use of the Araon and the arctic station Dasan at Ny Alesund, Spitzbergen, and the Antarctic King Sejong Station. KOPRI's major achievements in recent years include establishing the Dasan Station, building the ocean science program, and expanding that into the Chukchi Sea, and the 2011 cruise to that area. Ongoing projects include 1.6 million USD dedicated to Arctic Ocean monitoring, 1.2 million USD dedicated to arctic multi-disciplinary research, and a focus on recent warming in the western Arctic Ocean.

In the near future KOPRI plans to enhance its existing programs and strengthen its network of partnerships. The goal is to contribute to the world's efforts to understand climate change and its relation to the earth system, with full operation of the Araon. KOPRI plans to conduct annual research cruises in both the polar seas and set up monitoring sites focused on atmospheric and terrestrial research in the Arctic. Also, KOPRI will expanded outreach to build scientific capacity within Korea and to serve as a national node for polar international programs. KOPRI is looking to participate in newly developing international programs, and already is part of the Svalbard Integrated Earth Observing System (SIOS).

Norway

The Research Council of Norway (RCN) is the main agency for development of strategic research plans and funding for arctic research in Norway (www.forskningsradet.no). RCN is supported by the Norwegian National Committee on Polar Research, which is an advisory strategic Committee. Norwegian policy documents have defined high-level strategies and objectives for Norwegian activities in the Arctic. These include research in several thematic areas such as climate change, marine research, technology development, resource exploitation, environment, biodiversity and social sciences. Projects are normally funded for three to five years. Long-term research and monitoring activities are funded directly by the government through Norwegian Polar Institute, Institute of Marine Research and other governmental institutes. In addition to the project funding from the NRC, several research institutes working with Polar research obtain annual basic funding directly from the government.

A substantial amount of Arctic research is carried out by the Universities in Bergen, Oslo, Tromsø, Trondheim, and others. The establishment of the University Center in Svalbard (UNIS, www.unis.no) in Longyearbyen has strengthened Arctic research and education both nationally and internationally. UNIS offers undergraduate, graduate and postgraduate levels in arctic biology, geology, geophysics and technology as well as excellent logistic facilities and infrastructure for arctic field research. Arctic research is also conducted in several research institutes such as the Nansen Environmental and Remote Sensing (NERSC, www.nersc.no), the Norwegian Institute for Air Research (NILU, www1.nilu.no/index.cfm), the Norwegian Institute for Water Research (NIVA, www.niva.no), SINTEF (www.sintef.no), the Center for International Climate and Environmental Research (CICERO, www.cicero.uio.no)

and others located in various cities in Norway. The Fram Center located in Tromsø (www.framsenteret.no), has recently been established by 19 member institutions to further strengthen Norway's focus on the management of environment and natural resources in the North.

Russia

In Russia, different agencies and ministries develop their own programs for arctic research, but the main institutions are ROSNEDRA (www.rosnedra.com), ROSHYDROMET (www.meteorf.ru/en_default.aspx), and the Russian Academy of Sciences (RAS). The Far Eastern Branch of the RAS conducts basic scientific research (FEBRAS, www.febras.ru/index_.html). The Russian Arctic Doctrine, introduced in 2008, is in development.

Sweden

Arctic research from Sweden is conducted in the context of regular calls for research from the Swedish Research Council (Vetenskapsrådet, www.vr.se) and other agencies such as Swedish Council for Working Life and Social Research (FAS, www.fas.se). There is no national program of coordinated arctic research, but Sweden recently took over the Chair of the Arctic Council (through 2013), and has established as a priority the development of an Arctic Resilience Report (ARR). The ARR will be managed by the Stockholm Resilience Center/Stockholm Environment Institute in collaboration with the Resilience Alliance. The aim is to assess the resilience of arctic social-ecological systems including the need for necessary transformational change. The purpose is to prepare decisions makers for managing arctic social-ecological systems in a period of rapid change with large uncertainties.

In addition, MISTRA, The Foundation for Strategic Research has funded five projects under the call *Arctic Futures in a Global Context* (www.mistra.org/english). These projects, focused on forestry impacts, tourism, governance, modeling, and peace, conflict and cooperation in the Arctic, are funded for three years for a total of 38 million SEK. If successful they may become the foundation of a longer-term arctic program under the MISTRA umbrella. The Swedish Polar Research Secretariat (SPRS) is providing coordination for the projects. SPRS has also taken on the management of the Abisko research station. SPRS continues to maintain responsibility for research activities on the icebreaker Oden, however the Swedish Maritime Administration has determined that Oden will stay in Swedish waters during winter 2012) and not go to Antarctica and McMurdo as planned. How this decision will impact research in the Arctic and Swedish collaborations there is unclear.

United States of America

The U.S.A. supports arctic research through several different agencies, including the National Science Foundation (NSF), the U.S. Geological Survey (USGS), and the National Oceanic and Atmospheric Administration among others. The Study of Arctic Environmental Change (SEARCH) is a major, long-term interagency program aimed at observing, understanding and responding to arctic change. The observing component of SEARCH is implemented through the U.S. Arctic Observing Network (AON). Access to data from the AON can be obtained at www.aoncadis.org.

International collaboration is seen as key to improving national collaboration and SEARCH is actively looking for partnership with other countries (programs and institution/organizations). A first step in this regard is the Sea Ice Outlook. The SEARCH Sea Ice Outlook is an international effort to provide a community-wide summary of the expected September arctic sea ice minimum. Monthly reports released throughout the summer synthesize community estimates of the current state and expected minimum of sea ice—at both a pan-arctic and regional scale (www.arcus.org/search/seaiceoutlook).

SEARCH is now moving to implement the Responding to Change (RtoC) component of the program and is looking forward to working with other organizations under leadership of ISAC; the ISAC-led RtoC workshop will be particularly relevant.

European Union

There is an increasing tendency for European nations to join efforts in research through the European Union Framework (EUF) funding programs. This high level of Framework funding is such that a critical mass of researchers can be involved, and is leading to improved logistics and better quality work. There is no guaranteed funding for arctic research in the EU so coordinated efforts have to be ready to go at anytime there is an appropriate call for research. Under the Sixth Framework Programme for Research and Technological Development (FP6) relevant arctic projects included Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies (DAMOCLES). Search4Damocles (jointly funded with the U.S. National Science Foundation) and the DAMOLCES TTC extension. Under the 7th Framework Programme there are several arctic projects, including Acoustic Technology for Observing the Interior of the Arctic Ocean (ACOBAR), Arctic tipping Points (ATP) (http://www.eu-atp.org/), ArcRTisk (www.arcrisk.eu/page/about-arcrisk/3), Ice2Sea (www.ice2sea.eu) and Arctic Climate Change, Economy, and Society (ACCESS). DAMOCLES, Search4Damocles, ACOBAR and ACCESS are described in more detail below as these projects were represented at the meeting.

Summary

The discussion of national activities and overview of the EU Framework programs demonstrated an increasing formalization of arctic environmental change research programs and the development of a wide range of new infrastructure. Research portfolios are expanding and diversifying and the discussion of needs for international collaboration is increasingly explicit in many countries where there is a move toward a post-IPY paradigm, (i.e., the need for sustained studies, across domains, of arctic change on a pan-arctic scale requiring stable, and in some cases, increased funding. Although the issues driving national interests in the Arctic differ, there is also much common ground, including the impact of arctic change on climate and weather outside the Arctic, the development of arctic resources, and the impacts of change on fisheries, and on human populations.

Existing and Past Formal Collaborations

Examples of formal collaborative agreements between and among nations and institutions as well as specific collaborative activities funded in the context of competitive calls for research activity were reviewed and discussed. Each presenter was asked to address the same series of questions:

1. How did your collaborative program(s) develop?

2. What kind of formal mechanisms for collaboration have you used in the past?

3. What are the major accomplishments with respect to the collaborations?

4. What are the major impediments to collaboration?

Projects

Arctic Climate Change, Economy and Society (ACCESS)

ACCESS is a project financed in response to the "Ocean of Tomorrow" call of the European Union 7th Framework Programme Research and Development. The Ocean of Tomorrow program includes two other projects. Vectors of Change in European Marine Ecosystems and their Environmental and Socio-Economic Impacts (VECTORS) and Sub-sea CO^2 Storage: Impact on Marine Ecosystems (ECO2).

ACCESS began on March 1st, 2011 and will end on March 1st, 2015. There are 27 partners from nine European countries including Russia. The main objective is to assess climatic impacts on marine transportation (including tourism), fisheries, marine mammals and the extraction of oil and gas in the Arctic Ocean, and Arctic governance and policy.

There are five working groups addressing the following:

1. Monitoring and modeling arctic climate change involving ocean, atmosphere and sea ice;

2. The opening of the northern passages to marine transportation, (north of Europe and Siberia - North-East Passage and through the Canadian Archipelago – the North-West Passage), and the impact of increased transportation activities on marine ecosystems and society;

3. Climate change impacts on arctic fisheries, aquaculture and livelihood, mainly in the sub-Arctic sectors such as the Barents Sea;

4. The influence and potential effects of climate change on the extraction of offshore oil and gas;

5. Arctic governance options emerging from the findings of the other four groups.

An open forum will be created for stakeholders interested in the ACCESS consortium and in crosscutting research. Leading experts working in the ACCESS fields of study will sit on the ACCESS advisory board. To ensure international dissemination of ACCESS activities, specific links will be set up with internationally renowned organizations such as the Arctic Information Center from the University of Lapland in Rovaniemi (Finland). ACCESS has close links with international organizations overseeing international research in the Arctic and specifically with the International Arctic Science Committee (IASC) via ISAC.

Acoustic Technology for Observing the Interior of the Arctic Ocean (ACOBAR)

The goal of ACOBAR is to develop components of an observing system for the Fram Strait and the interior of the Arctic Ocean based on underwater acoustic methods including tomography, data transmission and communication to/from underwater platforms, and navigation of gliders. While the primary geographical area for fieldwork is the Fram Strait, the long-term goal is to implement an acoustic network that covers the entire Arctic basin for acoustic tomography, passive acoustics and navigation/positioning of gliders/floats under ice. Such technology exists but implementation requires expanded international and inter-disciplinary planning and collaboration. An environmental assessment of long-term employment of acoustic sources for scientific use in the Fram Strait, and a similar assessment for the interior of the Arctic are planned (see http://acobar.nersc.no). The main foci of ACOBAR are:

1. To implement and exploit an integrated ocean observing system consisting of gliders and a multi-purpose acoustic network in the Fram Strait for tomography, navigation of gliders and passive listening to marine mammals and ambient noise;

2. To develop advanced ice-tethered platforms equipped with transducers for navigation/positioning of gliders/floats and modems for two-way communication with gliders and floats;

3. To investigate the assimilation of acoustic and oceanographic data into high-resolution ocean models;

ACOBAR has benefited from the excellent facilities at UNIS, Longyearbyen, the willingness from the Norwegian Coast Guard to use their icebreaker KV Svalbard and the University of Bergen providing ship time with the RV Håkon Mosby.

Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies (DAMOCLES)

DAMOCLES (www.damocles-eu.org), was an EU Framework project (2005-2010) focused around an integrated ice-atmosphere-ocean monitoring and forecasting system designed for observing, understanding and quantifying climate changes in the Arctic. It was specifically concerned with the potential for a significantly reduced sea ice cover, and the impacts this might have on the environment and on human activities, both regionally and globally. The DAMOCLES structure complemented the structure of the U.S. SEARCH program (with emphasis on observing, understanding, responding), although DAMOCLES had eight different work packages. Joint meetings among the work package groups resulted in important advances in research, including integration of aspects of socio-economics into related modeling initiatives. Nine ships were used during program, with seven ships active in the Arctic in the summer of 2008. DAMOCLES was highly successful with over 150 publications and a book in progress for release at the IPY 2012 Conference in Montreal, Canada.

Because of the consortium of nations involved, DAMOCLES was from the outset an international effort. The large group initially involved expanded to include others (eg., China, U.S.A.), demonstrating that major arctic programs are relevant to the interests of many. Both ACCESS and the ACOBAR (see above) follow from DAMOCLES with some membership of the DAMOCLES consortium in each, as well as other new partners. The DAMOCLES Publishable Final Activity Report can be downloaded from the website.

Greenland Ecosystem Monitoring (GEM, Aarhus University)

GEM (www.dmu.dk/en/arctic/climate_change/gem_uk/) is an interdisciplinary long-term research and monitoring programme initiated in 1995. The programme is currently carried out at two sites, Zackenberg (Northeast Greenland) and Nuuk

(West Greenland), with the intention of up-scaling to a Greenland scale. The programme is divided into five sub programmes: BioBasis (terrestrial and limnic ecology), GeoBasis (fluxes, geophysics and hydrology), ClimateBasis (fluxes, weather), GlacioBasis (glaciers) and MarineBasis (marine geophysics and ecology).

Programme for Monitoring of the Greenland Ice Sheet (PROMICE, GEUS)

The overall aim of PROMICE (promice.dk/about_us_uk/main.html) is to assess and understand changes in the mass budget of the Greenland Ice Sheet (initiated 2007). The programme will provide projections for the potential global environmental, social and economical implications of ice sheet change, and provide the decision-makers with a firm knowledge base.

EcoGreen (Greenland Climate Research Center)

The overall focus of the EcoGreen consortium (www.natur.gl/en/climate-research-centre/research-projects/ecogreen) is to establish the scientific basis for long-term ecosystem-based management of marine resources in West Greenland. EcoGreen was initiated 2006.

FreshNor (DMI)

FreshNor's (http://freshnor.dmi.dk) overall aim is to improve the understanding of the hydrological cycle in the Nordic Seas and in climate change model simulations for the Nordic countries and the Arctic region (initiated 2009).

North Greenland Eemian Ice Drilling (NEEM, University of Copenhagen)

The overall aim of NEEM (http://neem.dk) is to understand the dynamics of the climate system (initiated 2007). Ice core samples from the Eemian will contribute to the understanding of the dynamics of climate under conditions similar to those of a future warming climate and improve our ability to make good climate change scenario projections.

SEARCH for DAMOCLES (S4D)

S4D (www.damocles-eu.org/TBA5/index.shtml) was a formal partnership between SEARCH and DAMOCLES with joint funding provided by the U.S. NSF and the EU. S4D fostered, through workshops and meetings, advances in instrumentation and research infrastructure. Developments included new float technology and sea gliders operating under the sea ice. In addition the use of Ice Tethered Platforms (ITPs) had huge impact on data collection. The joint workshops enabled concrete advances, especially with respect to instrumentation.

Svalbard Integrated Earth Observing System (SIOS)

The Research Council of Norway (RCN) is coordinating the Svalbard Integrated Arctic Earth Observing System (SIOS, www.sios-svalbard.org) preparatory phase project from 2010 to 2013. SIOS will coordinate the developing European Research Infrastructures (ESFRI) for Arctic Research using Svalbard as the focal point. SIOS has 27 member institutions from Norway and 10 European countries as well as China and South Korea. SIOS is envisaged to be a major building block of a Sustained Arctic Observing System (SAON), building on the recommendations for the AON (NRC 2006).

Networks

ArcticNet Network of Centres of Excellence of Canada (ArcticNet)

ArcticNet (www.arcticnet.ulaval.ca) has successfully secured a second round of funding with seven years of support though 2017. In the long-term, ArcticNet has as its goal, development into a national polar institute. The current funding comes from the three Canadian funding agencies, the National Science and Engineering Council of Canada (NSERC), the Social Science and Humanities Research Council of Canada (SSHRC), and the Canadian Institutes of Health Research (CIHR). Total funding for ArcticNet from 2003-2018 is $113,208,000 CAD. ArcticNet involves collaboration among scientists and managers in the natural, human health and social sciences with their partners from Inuit organizations, northern communities, federal and provincial agencies and the private sector to study the impacts of climate change in the coastal Canadian Arctic. Over 145 ArcticNet researchers from 30 Canadian Universities, eight federal and 11 provincial agencies and departments collaborate with research teams in Denmark, Finland, France, Greenland, Japan, Norway, Poland, Russia, Spain, Sweden, the United Kingdom and the USA. ArcticNet has developed and continues to expand collaborations with industry for funding, equipment, and research; these partnerships produce non-proprietary research. A major goal for this phase of ArcticNet is to translate our growing understanding of the changing Arctic into impact assessments, national policies and adaptation strategies.

The Arctic Regional Ocean Observing System (Arctic ROOS)

The Arctic Regional Ocean Observing System (Arctic ROOS, http://arctic-roos.org), has been established by 16 European institutions from nine countries in order to develop and promote long-term observing systems with focus on the Nordic Seas and the European sector of the Arctic. Arctic ROOS members have has established a series of research projects to develop and test various *in situ* observing systems as well as to exploit new satellite data. An operational ocean monitoring and forecasting system is presently implemented with funding from EU under the

project MyOcean, where Arctic ROOS members are responsible for the Arctic component of the system (http://myocean.met.no/). Arctic ROOS is led by NERSC.

International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT)

INTERACT (www.eu-interact.org) is a circumarctic network of terrestrial field stations. The project is financed primarily by the European Union 7th Framework (2011-2014, 9.36 million Euro in total), under the infrastructure program (I3) which stipulates cooperation, transnational access to research stations and joint research activities across stations. The INTERACT consortium developed out of SCANNET (for which funding ended in 2004, www.scannet.org) and now consists of 33 terrestrial research stations in ten countries around the Arctic.

A major goal of INTERACT is building capacity for identifying, understanding, predicting and responding to change in the Arctic. There are eight work packages under the three themes; i) Coordination, ii) Transnational Access and iii) Joint Research Activities.

INTERACT stations provide a platform for ecosystem/site-based research and monitoring focused on developing regional climate change scenarios, and identifying trends, establishing biodiversity baselines and monitoring activities, phenology and species performance, etc. INTERACT specifically seeks to build capacity for research and monitoring in the Arctic by providing a platform for collaboration and communication between Station Managers, researchers and organisations.

The work packages on joint research activities and international cooperation will help develop more efficient observing networks to measure changing environmental conditions and make data storage and accessibility more efficient through a single portal.

Research communities will be offered access to Arctic terrestrial infrastructures though the Transnational Access component, while partner organisations will be invited to annual meetings of the consortium with a chance to be involved in relevant work package activities. INTERACT also works closely with local communities to have their perception on climate change, its impacts and mitigation measures.

INTERACT and ISAC have recently signed a Letter of Agreement for collaboration and cooperation.

Institutional Level Partnerships

Center for Earth Observation Science (CEOS), University of Manitoba/Greenland Climate Research Center (GCRC) Partnership

CEOS (http://umanitoba.ca/ceos/) and GCRC (http://www.natur.gl) have a new collaborative partnership with a geographic focus on the Greenland/North American Arctic with nested research priorities in Baffin Bay and joint programs across that interface. There is an ongoing field program on the west side of Greenland with support from Polar Continental Shelf in Resolute Bay and from Churchill. There is also use of the Canadian icebreaker CCGS *Amundsen*, mainly in Baffin Bay. Funding to support the partnership comes from existing support in Canada, Greenland and Denmark on the order of 80 million CAD. The partnership involves sharing of personnel, resources, and infrastructure. The goal is to expand this Arctic Science Partnership to more countries to further build capacity with respect to both personnel and platforms.

International Arctic Research Center (IARC)/Alfred Wegner Institute (AWI) Memorandum of Understanding

IARC has approximately two dozen international MoUs. These provide a stable framework for interaction within a certain period of time. For example the MoU between IARC and the AWI in Germany (http://www.awi.de/en/home/) promotes joint activities that foster the acquisition and analysis of long–term records of polar processes. The MoU also facilitates data exchange and cooperation in data archiving, the joint use of facilities, and student and young researcher exchanges. High priority research activities are focused on the ocean and sea ice, permafrost, and arctic system modeling. The IARC/AWI MoU is expected to lead to strong collaboration between the two institutes.

Korea Polar Research Center (KOPRI)

KOPRI has many institutional-level bilateral MoUs, including one with IARC. In some cases there is government allocated funding on both sides for focal point projects developed through meetings and workshops. The most successful agreements have come out of science-driven initiatives. Recently KOPRI has been involved in developing the Asian Forum for Polar Sciences; this forum is still at the information sharing stage but the goal is to develop future joint polar projects and publish a joint journal among the Asian nations. KOPRI has acknowledged the importance of international collaboration in Polar Sciences and endeavored to enhance international collaborations.

Russian Collaborations

Russian scientists and institutions are cooperating on a wide range of scientific activities and there are over 100 international and multilateral agreements in place. In recent years major partners in arctic research have included the U.S.A., China, Japan, and Korea along with longstanding partnerships with European nations. Agreements usually include provision for visas, access to research platforms, and in the case of oceanographic research, access to Exclusive Economic Zones (EEZ). FEBRAS has an extended collaboration with Sweden that includes among other activities a workshop planned for fall 2011 in connection with the upcoming RUSWE-C3 expedition with the Swedish icebreaker Oden to the Siberian shelves.

Keys to Successful Collaboration

Formal MoUs enable joint planning of research among entities and institutions that often have longer-term plans than that supported through the normal funding cycles. Such agreements enable entities to prioritize and avoid duplication of effort, and maintain activities over a longer period of time. Shared or joint research platforms can further multilateral participation as other entities see the benefits of formalized collaboration. With respect to data sharing, MoUs help move the community towards institutionalized data centers (permanent housing), which can protect against uneven funding and create continuity of archives and access to those archives.

Understanding that partners may have different institutional objectives and long-term goals and knowing what those are enables success. MoUs must be articulated clearly with terminology that is understood by all partners. This is especially important with respect to data sharing and publication. The most effective agreements involve compatible partners and support exchange of scientists. There needs to be a focal point project or research program; the most successful partnerships are focused on a specific problem or set of problems. Agreements between entities that have matching or complementary research infrastructure and platforms are also particularly effective.

The major stumbling block to expanding collaborations seems to be the difficulty in coordination among funding sources, both nationally and internationally. Increased collaboration and coordination is critical to developing the science that is both beneficial to society and of scientific merit. There is a need for mechanisms to synchronize funding, especially among programs that are primarily supported through a soft money system, although it is not clear how tractable this may be. It may be more realistic to stimulate international cooperation through collaboration on reaching scientific goals that would otherwise be unattainable.

EMERGING QUESTIONS

1. How can the arctic research community support the case for intergovernmental agreements on research?

2. How can the arctic research community facilitate general agreement on collaboration and more specific MOUs among institutions and nations?

3. To what extent can we synchronize existing and future science plans among nations and international entities?

4. In cases where funding models require collaboration, how effective are these efforts to collaborate compared to those developed at the grassroots level?

5. Can diverse EU projects be coordinated into even larger collaborations or consortia?

6. How can programs funded through the EU framework program be turned into long-term initiatives?

7. How are shortcomings in existing programs being handled? For example, how are arctic environmental change programs incorporating socio-economic research into their research agendas?

PLANNING FOR AN ARCTIC OBSERVING SUMMIT (AOS)

Objectives

The main objectives for Day 2 of the Fairbanks meeting were to review the rationale for convening an Arctic Observing Summit (AOS), to identify key topics, activities, outcomes and products of such an AOS and to review progress to date in AOS planning and to provide guidance on further planning.

Background

The origins of planning for an Arctic Observing Summit (AOS) in the U.S.A. grew out of an emerging consensus among the PIs and supporters of the Arctic Observing Network (AON) that there is a need for a (recurring) international forum that allows for coordination of observing activities between disciplinary groups, and sectoral or regional “themes”. Such a forum should bring together research scientists, stakeholders, and funding agencies to plan for specific actions required to complete implementation of an integrated pan-Arctic observing system and identify means to sustain it while adjusting it to changing needs. A number of international groups, including ACCESS, ArcticNet, ISAC, SCANNET and SEARCH developed a proposal for

an AOS and submitted it to the Arctic Council's Sustained Arctic Observing Network (SAON) group in early 2011. This proposal has since been endorsed by SAON.

Goals

AOS goals include:

1. Providing a platform for exchange on design and implementation of long-term, cross-domain, international, system-scale arctic observing system;

2. Creating a recurring international venue for coordinating, joint planning and reviewing of (long-term) observing activities in the Arctic to increase coverage, improve coherence and compatibility while minimizing overlap in effort and gaps;

3. Improving interagency and international communication and coordination of (long-term) observations aimed at advancing understanding and responding to change in the Arctic.

Expected Outcomes

Expected outcomes from an AOS include:

1. A network plan with priorities and agreed-upon actions (near, mid-, long-term);

2. A roadmap for sustained observations in the context of an internationally coordinated network that addresses important science and operational needs;

3. A synthesis of findings from the existing observing network to guide design and further optimization of the system;

4. Identification of information from the observing systems that feeds into large-scale synthesis and assessment efforts;

5. New synergies with respect to technological advances and data management.

6. Improved communication with stakeholders and decision-makers;

Projects such as the SEARCH AON, the Integrated Arctic Ocean Observing System (IAOOS, http://aosb.arcticportal.org/programs.html#iaoos), and the observing activities of ArcticNet, will play an important role in the planning and convening the AOS. The Arctic Council (May 2011), has approved the SAON Implementation Plan the SAON process is in its second phase, with a series of endorsed tasks identified, of which the AOS is one. SAON will help to bring about national partnerships under the Arctic Council umbrella to promote and facilitate sustained observations. The national SAON committees are responsible for identifying funding agencies and bringing commitments to the table. SAON is working closely with the Exchange for

Local Knowledge in the Arctic project (ELOKA, http://eloka-arctic.org/) to integrate local and indigenous perspectives and observations.

Discussion in Fairbanks highlighted the need to reconcile different perspectives and approaches taken by SAON as a top-down entity as compared to bottom-up scientific initiatives. Given the different roles and priorities of national SAON committees and IASC, which is co-chairing SAON, it is important to ensure that these different groups are not working at cross-purposes. An AOS will help address these concerns as well as engage representatives from IASC and Arctic Council working groups and representatives from different stakeholder communities.

Review of Major Long-term Research Observing Programs

Prior to the Fairbanks meeting, the ISAC IPO prepared a set of documents that provided a survey of key Arctic long-term observation programs, both at the national and international level. These included a summary of the SAON project inventory as well as information obtained from other sources. Follow-up and summary of this survey is needed and will be made available by the ISAC IPO.

Summary of Breakout Group Discussions

Improving Coordination and Connections in Arctic Observing

Three breakout groups explored, in more depth, the context for and preparation needed for a successful AOS. Key points and activities identified as critical are noted below. These range from fairly simple action items that can be completed by the ISAC IPO and other similar entities, to more complicated and complex tasks that will require significant planning and collaboration among groups. Two key goals for the AOS are to bring scientists/science programs and funders together to synchronize their views on a set of priorities for observing assets on the ground and to promote internationally coordinated calls for proposals. One important objective will be to advance a coordinated plan for observing system design. The AOS can also serve as a forum to balance bottom-up and top-down approaches in observing system design, implementation and coordination.

Near-Term Activities

1. Identify overlaps in all existing science plans *vis a vis* observing initiatives in the Arctic.

2. Work within the community to ensure that the AOS is on the agenda of upcoming meetings such as IPY 2012.

3. Identify new and creative ways of expanding the use of existing platforms.

4. Conduct a gap analysis. Prior to the AOS there should be a circumpolar inventory of monitoring stations and variables measured. The purpose is to identify needed additional sites and measurements, and to share the results with the scientific community in preparation for the AOS. The appropriate avenues for achieving this goal may be through ISAC, IASC, regional groups such as the Pacific Arctic Group, international working groups or through other, yet unidentified, entities.

5. Arrange pre-AOS opportunities to bring scientists and funders together to work out a set of priorities for observing assets.

6. Promote discussion of a common open data policy; this includes an evaluation of what data are the most easily shared, the identification of levels of difficulty in accessing data, and a review of national data sharing policies.

7. Improve coordination among terrestrial programs. Coordination among the Circumpolar Biodiversity Monitoring Programme (CBMP Arctic Council), IASC, and INTERACT should be underway; developing agreement on priorities between CBMP and IASC can inform the AOS agenda.

8. Ocean coordination. There is potential for improved coordination in planned cruises and placement of moorings. For example, China has specific national priorities already but international input into identification of observational gaps and documentation of priorities would be useful for future planning and for securing funding. It is recommended that IASC and the Marine, Atmosphere and Cryosphere Working Groups coordinate with ISAC to organize formal discussions of long-term ocean observations, possibly in the context of a working group to coordinate moorings, or other platforms.

9. Capacity building. Planning for the AOS should involve the Association of Polar Early Career Scientists (APECS) and members of the Arctic in Rapid Transition (ART) program, among others, to engage junior researchers (through service on working groups, panels, etc.) whose support will be critical in sustaining observations.

Recommendations for AOS Planning and Organization

Organizing Committee

There was consensus among meeting participants that ISAC should play the lead role in organizing the AOS, with Craig Lee (Co-Chair of SEARCH Observing Change Panel) continuing to lead the process as Co-Chair of the Organizing Committee. Committee members need to represent the full disciplinary and international breadth of the different communities to be present at the meeting. The participants of the meeting proposed members and the ISAC Science Steering Group was charged

with final review and invitation of Organizing Committee members. Martin Jakobssen(Sweden) and Jinping Zhao (China) have agreed to serve as Co-Chair(s) with Craig Lee and committee members are currently being recruited.

Scope and Structure of the AOS

The AOS organizing committee will develop the scope and structure of the first Summit in detail. In Fairbanks the following aspects of the Summit were identified as important:

1. A main objective of the AOS should be to consider how an observing system should be designed;

2. Data should be a major theme of the meeting, including data handling policies at the national level, identification of organizations or people managing and in particular those using data from an arctic observing system;

3. The AOS should include some high-level broad-based science presentations to focus discussions (e.g., international expert on observing system design);

4. The AOS should include time for sub-groups to meet and for the Summit participants as a whole to arrive at more broadly relevant consensus decisions;

5. Sub-groups could self-identify or be organized into thematic areas (i.e., terrestrial, freshwater, ocean and ice, atmosphere, human systems, marine ecosystems, cryosphere, etc.), or into interdisciplinary or integrated projects that cross themes;

6. Sub-meetings for discussion of large-scale budgets (heat, carbon, etc.) or that focus on interfaces and associated fluxes (coastal regions, arctic gateways, etc.) may be productive;

7. Inviting input on Summit sub-meetings from the Arctic Council Working Groups and Task Forces may be a good way to link to stakeholders and funding agencies.

8. A prize should be created for the most innovative or effective approach in using observing system data for the benefit of society (with award made at meeting); the applicants will thus provide a survey of different approaches.

Preparation for the AOS

Thorough preparation for the AOS at the national and research program levels is critical to its success. Two key aspects of preparation are:

1. National meetings to achieve consensus on key issues at the national level and to allow for concrete achievements and agreements at the AOS; SAON national working groups may help with this;

2. The preparation of white papers submitted by research community groups and reviewed prior to the summit, with final papers produced after the summit to provide perspectives on key themes and achieve consensus. High-level representation at the meeting in this manner ensures direct linkages to the broader community; the OceanObs 2009 process may be a model for this approach. (www.oceanobs09.net/cwp/index.php)

Participants

To keep the meeting effective and affordable, the total number of participants should not exceed about 250, with roughly 100 representatives from the scientific community, and 50 each from funding agencies, stakeholders and other groups. Participants in the meeting should represent a broader program derived from communication and synthesis within the country of origin or within (inter)disciplinary working groups representing wider efforts. Thought needs to go into how to ensure that participants can speak for these broader groups (e.g., representation of only very few people from the US Arctic Observing Network instead of large representation of the ca. 70 principle investigators), rather than for personal research interests.

Timing

The AOS should be short enough (e.g., 3 to at most 4 days) to allow for pre- or post-meeting workshops. A summit every other year (i.e., 2012, 2014, etc.) appears to be optimal. There was broad consensus that partnering with IASC would be beneficial and that the AOS might alternate with the biannual Arctic Science Summit Week (ASSW) Science Symposium. An AOS event affiliated with the ASSW would be of great value and while not possible for 2012, it could then lead to a sequence of meetings in association with the ASSW in 2014, 2016, etc. For 2012, because of the complexity of the tasks and the need for careful organization it was apparent that the AOS would only be viable in the second half of the year.

Location

The location of the AOS will be determined by a combination of factors that include ease of access for participants from other countries, affiliation with the country that provides major funding and organizational support, and overall costs of a meeting in different locations. Partnering with IASC on a joint Summit would constrain the choice of location; this may or may not be disadvantageous.

Logistics

When location and key sponsorship have been addressed, the organizing committee will have to identify a suitable partner to provide the necessary support for the meeting on-site and in the run-up to the Summit.

IMPLEMENTING A RESPONDING TO CHANGE COMPONENT IN COLLABORATIVE ARCTIC RESEARCH

Background

The Responding to Change (RtoC) component of the ISAC Science Plan provides a framework for initiating a pan-Arctic RtoC program. However, major tasks for implementation of RtoC activities remain, including the identification of representative stakeholders, and the identification of tractable science questions that align with stakeholder needs for information. Mechanisms useful for starting the implementation process include workshops, white papers, and participation in the upcoming IPY 2012 Conference through a series of planned roundtable discussions and focused sessions. The main goals of the discussion in Fairbanks were to:

1. Further refine what is meant by RtoC within the scientific community;

2. Move forward plans for a first ISAC RtoC Workshop;

3. Begin the process of identifying key stakeholder groups;

4. Identify potential sources of workshop support.

In order to achieve these goals meeting participants were asked to address three questions during breakout sessions;

1. How can the scientific results of the varied efforts discussed over the previous two days be improved with respect to responding to change needs?

2. To what extent do existing observing systems meet stakeholder needs for information? How can observing systems be improved?

3. How can synchronization between researchers and stakeholders be improved, including better identification of immediate and longer-term societal problems stemming from arctic environmental change?

Summary of Breakout Group Discussions

Communication needs to improve among scientists and with the broader community. Stakeholders differ somewhat from region to region and among nations, especially between the Arctic and non-Arctic nations. Because the stakeholder community can potentially include everyone, some selection needs to occur to facilitate RtoC implementation.

Immediate priorities for ISAC should focus on working with partners to identify stakeholders by developing a mechanism that will allow stakeholders who want to participate in building an RtoC initiative to self-identify. Any RtoC planning that takes place in the next year should feed into the AOS as part of the process of expanding and improving observing systems, and aligning societal and scientific observing needs.

Information flow between the scientific community and various stakeholder communities is conceptualized below. Dashed arrows represent activities where stakeholders provide input on activities in which they may or may not be directly involved, for example, collecting data or running models.

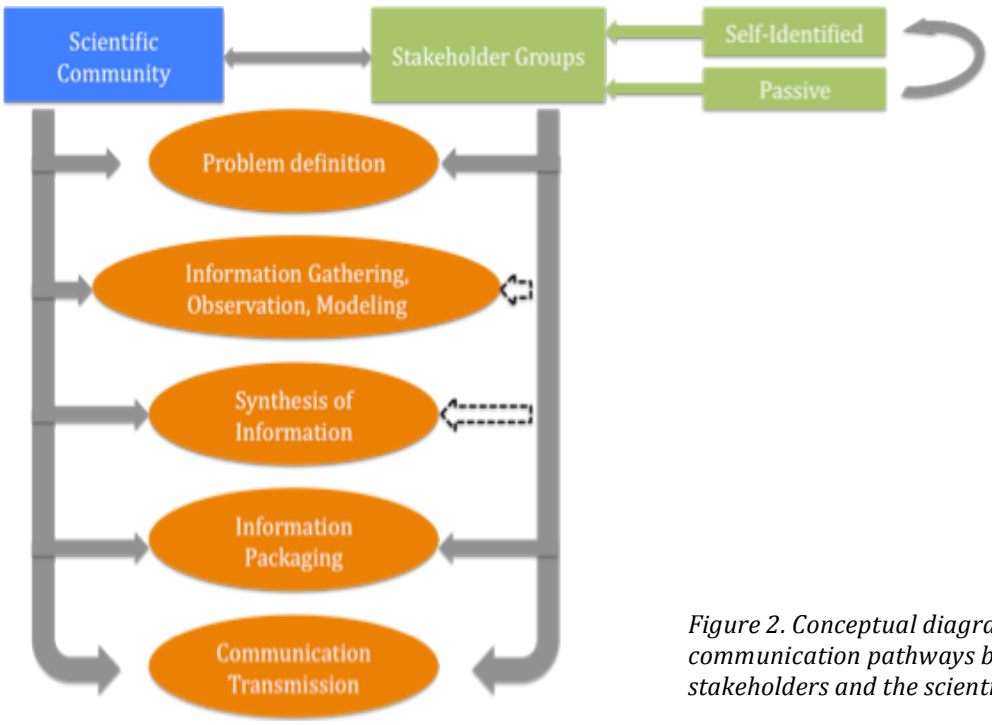

Figure 2. Conceptual diagram illustrating communication pathways between stakeholders and the scientific community.

Responding to Change Workshop Planning

Planning for a first ISAC Responding to Change Workshop is underway. The Fairbanks meeting helped to refine priorities for the workshop including identification of stakeholder communities in non-Arctic nations. The workshop is scheduled for the week of 30 January-3 February 2012, and will be hosted by the School of Policy Studies at Queen's University, located in Kingston, Ontario, Canada. Additional support is sought from agencies in Europe, the USA and Asia. Previous planning documents are available on the ISAC website (www.arcticchange.org).

Some of the identified goals for the workshop are:

1. Development of a clear definition of 'responding to change;

2. Identification of the type of information stakeholders need and assessment of the alignment of those needs with current observing activities.

The number of participants should be under 100 to keep the workshop manageable. The biggest issue is getting diverse representation while recognizing that not everyone can be included. As with the AOS, participants should be able to represent groups, rather than individual interests. Suggestions for the workshop organizing committee were noted and this committee has been formed and is moving forward with planning.

Workshop products may include a best practices document, recommendations or a draft framework on how stakeholders can interact and have input into the design and implementation of observing networks in the Arctic, and/or a framework for achieving a balance between scientific and stakeholder needs. Special papers for the Planet Under Pressure Conference (www.planetunderpressure2012.ne) and the IPY 2012 Conference have been proposed, and a follow-up meeting, perhaps roundtable format, at the IPY 2012 conference is also planned (www.ipy2012montreal.ca).

CONCLUSION: THE WAY FORWARD

Over the three days of the Fairbanks meeting, participants discussed a variety of ways that international collaboration can be achieved and ways in which ISAC, in partnership with others, can further such collaborations. Suggestions included organization of a series of concrete projects such as the AOS, the RtoC workshops, and possibly a coordinated, international modeling project. There is a general acceptance of the ISAC Science Plan. It is now time to refine it and develop a more detailed implementation strategy with broader international input.

The questions underpinning the ISAC Science Plan may need reconsideration in light of the need to map them on to real-world situations and stakeholder needs. While the research community seems to have converged on the big questions, the most

important science questions, there is still a disconnect with user needs for information. A smoother transition from high level science questions to activities that are relevant to societal needs may be encouraged through both AOS and RtoC implementation. This can include consideration of emerging tools for such things as Marine Spatial Planning and Ecosystem-Based Management.

There are some problems that are ready to be tackled in in both national and international contexts. For example, the international Arctic Search and Rescue Agreement signed in May 2011 will rely on the infrastructure of various scientific programs that are now in operation (www.arcticportal.org/features/features-of-2011/arctic-search-and-rescue-agreement). One possible approach that addresses both observing and responding needs could consist of a detailed evaluation of how this infrastructure can be improved for search and rescue purposes while simultaneously meeting scientific needs for improved understanding of particular aspects of physical and biological changes in the Arctic Ocean.

ACTION ITEMS

International Collaboration

1. The ISAC IPO will develop a newsletter that provides information to partner organizations about activities within different countries. This would be particularly useful for communication with the Asian nations.

2. The ISAC IPO and SSG will work with SSG members from China and Japan to plan the next series of ISAC meetings in those countries. This will help to strengthen partnerships and facilitate better flow of information.

3. ISAC and INTERACT will complete an MoU regarding cooperation and collaboration on activities of mutual interest.

4. The ISAC IPO will post links to the relevant websites of participants at the Fairbanks meeting.

Arctic Observing Summit

1. The ISAC SSG will forward relevant national science plans to the ISAC IPO, and the ISAC IPO will follow up with nations not represented within the SSG, with the goal to determine overlaps and new information since publication of ISAC science plan.

2. The ISAC Program Office will complete survey of key long-term observation projects and post on ISAC web site.

3. ISAC will work with other efforts to create a survey of inventories of long-term observing activities building on the early-stage product.

4. The ISAC IPO will identify key national data centers.

5. ISAC and the AON Design and Implementation Task Force will conduct an informal survey to identify key research groups and major centers working on observing system design.

6. Each participant in the Fairbanks meeting should provide a list of relevant stakeholder entities or organizations in their home nation.

Responding to Change

1. The ISAC IPO and SSG will submit, in partnership with relevant entities, a series of requests for workshop support.

2. The ISAC SSG will develop the RtoC workshop organizing committee.

3. The ISAC IPO will work with Queen's University in Canada to submit a series of abstracts/organize a session on RtoC for the IPY 2012 conference in Montreal.

4. The ISAC IPO will develop an inventory of relevant RtoC programs in the pan-Arctic.

5. Meeting participants will provide a list of suggested stakeholder groups to the ISAC IPO from their home nations/associated projects and programs.

REFERENCES CITED

Eicken, H., B. Forbes and H. Wiggins, 2011. State of the Arctic Conference 2010: International Perspectives on Progress of Research Responsive to Decision-Makers. *Ambio* DOI: 10.1007/s13280-011-0153-5.

Murray, M.S., L. Anderson, G. Cherkashov, C. Cuyler, B. Forbes, J.C. Gascard, C. Haas, P. Schlosser, G. Shaver, K. Shimada, M. Tjernström, J. Walsh and J. Wandell, Z. Zhao, 2010. *International Study of Arctic Change: Science Plan*. ISAC International Program Office, Stockholm.

NRC, Committee on Designing an Arctic Observing Network, National Research Council 2006. Towards an Integrated Arctic Observing Network (AON). The National Academies Press, Washington, D.C.

Participants

David Barber
University of Manitoba, Canada
dbarber@cc.umanitoba.ca

Uma Bhatt
University of Alaska Fairbanks, USA
usbhatt@alaska.edu

Martin Biuw
International Study of Arctic Change (ISAC), Sweden
martin.biuw@polar.se

Martin Fortier,
Arctic Net, Laval University, Canada
Martin.Fortier@arcticnet.ulaval.ca

Edward Struzik
Queen's University, Canada
estruzik@shaw.ca

Elmer Topp-Jørgensen
National Environmental Research Institute (DMU), Denmark
jetj@dmu.dk

Jean Claude Gascard
Université Pierre et Marie Curie, France
gascard@locean-ipsl.upmc.fr

Hajo Eicken
University of Alaska Fairbanks, USA
heicken@alaska.edu

Susan Fox
Arctic Research Consortium of the US, USA
fox@arcus.org

Larry Hinzman
University of Alaska Fairbanks, USA
lhinzman@iarc.uaf.edu

Hiroyuki Enomoto,
National Institute of Polar Research, Japan
enomoto@mail.kitami-it.ac.jp

Vladimir Ivanov
Arctic and Antarctic Research Institute, Russia
vivanov@iarc.uaf.edu

Dongmin Jin
Korea Polar Research Institute, Korea
dmjin@kopri.re.kr

Hong Kum Lee
Korea Polar Research Institute, Korea
hklee@kopri.re.kr

Kawai Michiyo-Yamamoto
Tokyo University of Marine Science and Technology, Japan
michiyo@kailodai.ac.jp

Maribeth S. Murray
ISAC, University of Alaska Fairbanks, USA
msmurray@alaska.edu
murray@arcticchange.org

Donald Perovich
Cold Regions Research and Engineering Laboratory, USA
donald.k.perovich@erdc.usace.army.mil

Mare Pitt
International Arctic Science Committee, Germany
mare.pit@iasc.info

Karen Pletnikoff
Aleutian/Pribilof Islands Association, USA
karenp@apiai.org

Hanne Sagen
Nansen Environmental and Remote Sensing Center, Norway
Hanne.Sagen@nersc.no

Peter Schlosser
Columbia Earth Institute, USA
schlosser@ldeo.columbia.edu

Valentine Sergienko
Far Eastern Branch, Russian Academy of Sciences, Russia
sergienko@hq.febras.ru

Gus Shaver
Woods Hole, USA
gshaver@mbl.edu

Koji Shimada
Tokyo U of Marine Science and Technology, Japan
koji@kaiyodai.ac.jp

Reija Shnoro
Arctic Research Consortium of the US, USA
reija@rarcus.org

John Walsh
University of Alaska Fairbanks, USA
jwalsh@iarc.uaf.edu

Helen Wiggins
Arctic Research Consortium of the US
helen@arcus.org

Jinping Zhao,
Ocean University China, China
pzhao@ouc.edu.cn

Organizing Committee

Maribeth S. Murray, ISAC
Hajo Eicken, SEARCH
Peter Schlosser, ISAC
Jean Claude Gascard, ISAC, ACCESS
Martin Fortier, ARCTICNET
Martin Biuw, ISAC