news from the

Arctic Ocean Sciences Board

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The International Polynya Symposium 2001: Polynyas in Changing Polar Seas

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On the evening of September 9, 2001, in the Explorers Hall of the Auberge St. Antoine in the historic district of Quebec City, Canada, local convener Dr. Louis Fortier (Professor, Université Laval) welcomed over eighty participants from ten different countries to the opening reception of the International Polynya Symposium 2001 (IPS'01). For the next four days, we immersed ourselves in dynamic presentations and discussions of the latest findings in polynya research, examining connections between models and measurements, physics and biology, Arctic and Antarctic settings. We benefited from the insights expressed by five invited speakers, thirty-one contributed talks, and as many posters. We were supported in concept by the Science Coordinating Group of the International Arctic Polynya Program (IAPP) and the Arctic Ocean Science Board; in practice by grants from the U.S. National Science Foundation and the Ministere de la Recherche, de la Science et de la Technologie du Quebec; and in spirit by strong desires and commitments to collaborate freely across national and scientific borders in the continuing pursuit of knowledge and understanding of polynya processes in changing polar seas.

This collective spirit held us together in the face of the tragic and incomprehensible events of September 11, 2001. Speakers thereafter showed focus and resolve in the continuing high quality of their talks, which helped us all to maintain balance and a sense of purpose. In a shared moment of silence, we offered our respects to lost

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lives and struggling rescuers and sought courage in the face of uncertainty. Though our numbers in Quebec would have been greater, had late-comers been able to travel to Quebec as intended, we eighty, representing a microcosm of the global scientific community, will not soon forget our time together at this defining moment in history. Because many of us could not leave Quebec as planned, our scientific and philosophical discussions continued in workshop and subgroup mode, enabling the development of new collaborations and directions for polynya research and polar inquiries in general. We are grateful to the local Quebecois hoteliers, restaurateurs and general citizens who facilitated our unexpectedly extended stay within their very supportive community.

Six years ago, the first International Polynya Symposium, held in Helsingor, Denmark, brought together researchers involved in the first IAPP-fostered polynya project on the Northeast Water (NEW) Polynya off the coast of NE Greenland (fieldwork in 1992-1993). The IPS'01 in Quebec represented an historic advance in polynya research by encouraging the participation of all disciplinary and interdisciplinary investigators of all polynyas, Arctic and Antarctic, IAPP-fostered or not. We thus had a remarkable mix of speakers and investigators from multiple disciplines addressing polynyas as diverse as the biologically productive and intensely studied North Water (NOW) Polynya, northern Baffin Bay (fieldwork in 1997-1999), and the elusive Mertz Glacier Polynya, in Antarctic waters, known until recently only from satellite imagery.

The maturity of the field and our understanding of polynya processes—from physical mechanisms of formation and closing to the intimate connections between ice features, biological activity and the survival of keystone species--was evident from the talks and posters alike. Importantly, we recognized ways in which the results of polynya research, often characterized by highly focused interdisciplinary research endeavors (harder to achieve for more generalized areas of the Arctic or Antarctic), can provide windows into the behavior of polar seas and their inhabitants in general. For example, although heightened primary production along marginal ice zones (also inherent to polynyas) was well known before concerted polynya studies, both the regional and global factors influencing its timing and magnitude can now be recognized in more powerful ways as a result of the confluence of ground-truth and remote measurements brought to bear in IAPP-style (fully international and interdisciplinary) polynya studies, as demonstrated masterfully by Jean-Eric Tremblay (Research Scientist, McGill University, Montreal) in his invited talk. Although members of the upper trophic levels in polar ecosystems have long been cornerstones even of elementary school education, the precise and intimate connections between the timing, location and persistence of ice formations that define polynya boundaries and the feeding, breeding and survival success of marine birds were shown unambiguously for polynyas from both poles by Nina Karnovsky (Doctoral Candidate, University of California, Irvine) in her invited talk. The additional invited Symposium speakers and contributed talks and posters can be viewed at hyperlink http://www.fsg.ulaval.ca/giroq/now/IPS2001. I have highlighted talks by Tremblay and Karnovsky, the two most junior invited speakers, because they revealed so clearly that the future of polar research is in good hands.

The need to better understand interannual variability in the internal and external forcing functions of polynyas, and consequent effects on biology and biogeochemical fluxes, was emphasized independently by both speakers and discussants alike. Decadal-scale time-series research, as is being pursued in lower latitude oceans, is the essential and overdue step in polar marine research. Without such databases, ongoing shifts in ocean-ice-atmosphere parameters, biodiversity and biogeochemical processing cannot be evaluated adequately in relation to climate change. Predictive science will remain elusive. An ability to advise local northern governments and native peoples on the future of their icy regions (raised in a special discussion on the possibility of polynyas as protected marine areas) will be limited. The emerging consensus from the IPS'01 and follow-on deliberations as we remained sequestered in Quebec, including non-polynya researchers intentionally invited to attend the meetings, is that polynyas provide ideal locations--from scientific, logistical, international and human-resource perspectives--to pursue effective, long-term time-series research. This conclusion pertains especially to the Arctic, where signs of rapid change continue to confront us and challenge current understanding of polar processes. Members of the IAPP Science Coordinating Group, who met in Quebec before, during and after the Symposium, have fully embraced this consensus and will work together towards achieving international collaborations that can help to further this ambitious goal. By all measures, and given the sobering world events unfolding in parallel, we all agree that the IPS'01 was a remarkable success.

Arctic Sea Ice Thickness

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Sea-ice thickness is a critical climate parameter, particularly in the Arctic where models suggest that, in percentage terms, sea-ice thickness will change more rapidly with changing climate than will sea-ice extent. Some recent measurements indicate that this is indeed already the case. While satellite data indicate a decrease of approximately 3% per decade over the last 20 years in Arctic, sea-ice extent (for example, Cavalieri et al., 1997; Serreze, et al., 2000), measurements from submarines show a decrease of over 40% in thickness over a similar period (for example, Wadhams, 1994; Rothrock et al., 1999). However, this extremely large decrease has been disputed with some suggestion that the sea ice has been redistributed rather than removed (Holloway and Sou, 2001).

Our knowledge of sea ice thickness is hampered by a lack of good sea-ice thickness data. A number of techniques have been used to measure sea-ice thickness, but unfortunately all of them have limitations.
Direct measurement by drilling through the ice is the most accurate method of measurement, with typical errors of approximately 1 cm. However, the labourious and often dangerous nature of the technique means that it is impractical for giving broad coverage of the Arctic basin, particularly during ice formation and break-up. In addition, there can be significant variations over even short distances of seemingly uniform ice.

Visual measurements from ships provide a reasonably effective method of measuring ice thickness, especially when carried out by experienced observers. But access to all areas is again a problem, as is the bias produced when ships are deliberately steered towards areas of thinner and more broken ice.

Upward looking sonars can be either moored to the seabed or mounted on submarines. These provide estimates of ice draft and hence thickness. Moored sonars have been given Doppler capability to also estimate ice velocity, and can therefore be used to yield estimates of ice export from the Arctic Basin, as has been done for Fram Strait. However, expense and deployment difficulties mean that they have not been used to cover large areas of the Arctic.

Submarines have the mobility to cover large areas, but cannot provide the time series that can be obtained from moored instruments. In addition, there have been problems of access to data, collected by submarines whose primary function during the Cold War was military. The end of the Cold War has not helped much in this regard, as the number of cruises has dropped as military requirements in the region are reduced. However, many of these data are now becoming available to climate scientists with help from military authorities.

Satellite data may ultimately help to fill the gaps left by other techniques, giving broad coverage of the Arctic at frequent intervals. Radar altimeters can provide a direct measurement technique, while methods are being developed to model thickness based on age and motion derived from other satellite sensors. However, this type of measurement is still in the development stage, and it may well be some years before adequate climatological coverage is available.

In seeking to determine the current status of knowledge on Arctic sea-ice thickness, the AOSB is collaborating with the WCRP Arctic Climate System Study (ACSYS) and Climate and Cryosphere (CliC) projects. The ACSYS/CliC Observation Products Panel will discuss the status of measurement techniques, sea-ice thickness data sets and scientific understanding of Arctic sea-ice thickness at their meeting in this fall.

The Panel, chaired by Prof. Koni Steffen (USA), and including Joey Comiso (USA), Ron Kwok (UK), Seymour Laxon (UK), Vladimir Smirnov (Russia) and Jinro Ukita (Japan), will provide a report with the help of the International ACSYS/CliC Project Office to the AOSB for

discussion at their next meeting in April. The AOSB and ACSYS/CliC will coordinate efforts to try to ensure that the most critical scientific gaps identified in the report are addressed in order to improve our understanding of this vital climate parameter.

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Hydrochemical Atlas of the Arctic Ocean

Peter McRoy
International Arctic Research Center
University of Alaska

The first phase of a joint project to compile hydrochemical data for the Arctic Ocean and marginal seas into an atlas is now complete and is available as a CD ROM from the IARC Frontier Program (rcolony@iarc.uaf.edu). The aim of the present atlas is a description of hydrochemical conditions in the Arctic Ocean using up-to-date methods of analysis and electronic forms of information presentation.

Data are primarily from Russian expeditions aboard icebreakers, drift ice camps, and research ships over the years 1948 to 2000. Included are water column parameters of major nutrients--phosphate, nitrate, nitrite and silicate--dissolved oxygen, pH and alkalinity. The atlas includes observations for 17,318 stations and 134,642 specific depth measurements. The bulk of the data, present in both primary and gridded format, is for the Arctic Basin and marginal seas of the Russian Arctic but limited observations from all marginal seas are included. In general the scope is intended to exclude the Barents and Bering seas. Of the present data, the largest number recorded are dissolved oxygen, silicate and pH observations (greater than 10,000 stations each) with alkalinity and nutrient measurements numbering from 1,900 to 5,500 stations.

The atlas uses the Ocean Data View software (copy included on disk) for visualization and analysis of data profiles and sections. The project is a joint effort led by Leonid Timokhov of the Arctic and Antarctic Research Institute (AARI), Russian Federal Service for Hydrometerology and Environmental Monitoring, and Roger Colony of the International Arctic Research Center (IARC) at the University of Alaska Fairbanks.

The present atlas is a prototype for the anticipated eventual product. The next phase of the project is to expand the database to include data from expeditions to the western Arctic and to fill other gaps. This effort now has the sponsorship of AOSB and this insures that results will be available to all interested researchers.

We seek your help in this effort. We request comparable hydrochemistry data from your expeditions/institutions.

As with any project of this scope, quality control is an essential feature of the database. Data contributions require description of methods and estimation of accuracy of values. To submit data set contributions contact Roger Colony (rcolony@iarc.uaf.edu) or Peter McRoy (ffcpm@uaf.edu) for specific guidance.

Progressing ASOF from Science Plan to Implementation

Bob Dickson,
Chairman, ASOF ISSG

The origins of the Arctic-Subarctic Ocean Flux (ASOF) array and progress towards developing an ASOF Science Plan were described in earlier AOSB newsletters in May 1999 and February 2001 [1,2]. The present article provides a brief update of progress in advance of the first meeting of the International Science Steering Group (ISSG) in Washington, 29 November –1 December.

1) Background. During 2000 a detailed Science Plan for ASOF was developed based on three international Discussion Meetings plus a number of written contributions. That Science Plan is available as 'Strawman 3' on ASOF websites in pdf form.

Our purpose now is to move beyond that stage to develop the ASOF Science Plan into an Implementation Plan. It is useful to think of this change as taking place in two phases. In Phase One, roughly from the present until December 2003, the ISSG will be concerned with identifying the main science issues to be tested, thinking out the appropriate way to address these, attempting to see how ASOF plans might fit in with the plans of other ocean programs to mutual benefit, designing the optimal observing system with modelling in support, organising comparative equipment trials, identifying the likely/possible sources of funds, shiptime and other resources, trying to predict from these what the purchase-and-deployment schedule might be for new gear, and deploying such equipment as exists to keep vital time series going in the meantime.

By the beginning of Phase Two then (say, early 2004), the ASOF ISSG should have developed a rationale, based on present knowledge, for the observing system that will best meet its aims, and can thereafter work to put that plan in place. Naturally, as further observations come in or new techniques are developed, the plan will change since 'present knowledge' will have changed. But at the beginning of Phase 2, the aim should be to have developed a defensible basis for a sustainable ASOF array and have some of it in the water.

2) Preparations for First ISSG Meeting, NSF Washington 29 November - 1 December. The business of thinking out the 'ways and means' questions of our Implementation Plan (see above) is underway in advance of the first ASOF ISSG Meeting in Washington. As has been our way of working from the start, the intention is that individual Steering Group members will prepare draft plans for each component of the program intersessionally, to be tabled and discussed at the meeting. These illustrated texts will simply be combined, after discussion and amendment, to form the first draft of the ASOF Implementation Plan. Throughout the remainder of Phase 1, that draft will be refined by encouraging the widest range of opinion, comment and criticism.

The full agenda for the first ISSG Meeting, describing the main components of our intended program, can be found on the ASOF websites at the University of Washington and the Norsk Polarinstitutt, Tromso (see below). However since these issues will form the business of ASOF into the foreseeable future, it is worth providing a summary of ISSG agenda topics as follows:

- Measuring the Fram Strait ice and freshwater flux
- Measuring the heat, salt and mass transports passing west of Norway to the Arctic Ocean via the Barents Sea and Fram Strait.
- Observing the temporal switching of the sources of overflow

- Measuring the freshwater flux and dense overflow off SE Greenland.
- Measuring the two-way exchanges of heat salt and mass passing between the Nordic Seas and Atlantic between Iceland and Scotland
- Instrumenting the Iceland-Faroe Ridge
- Observing large-scale thermohaline changes in the Labrador Sea and Davis Strait.
- The 25N Array: Observing the rate of the Meridional Overturning Circulation (MOC) in the North Atlantic.
- A glider program for ASOF
- Aspects of the Large Scale Circulation of Arctic and Subarctic Seas of relevance to ASOF'
- First steps to measuring the Canadian Arctic Archipelago (CAA) throughflow: the instrumenting of a passage.
- Plans for comparative trials of sub-ice profiling systems
- Technology development in ASOF
- A Hydrography Tracer program for ASOF I: Nordic Seas and CAA Throughflow
- A hydrography tracer program for ASOF II: Overflows and southwards
- Links to the near-field of the Arctic Ocean: watermass conversion and moorings at the Nordic:Arctic Boundary
- ASOF in the broader context of the CLIVAR Atlantic Program
- A time stepping and scale stepping role for models in ASOF. Part I: experiment design, mooring support, process to basin scale
- A time stepping and scale stepping role for models in ASOF. Part II: Model/data comparison (the look back) and prediction/forecast (the look forward)
- Progress in the Interagency Working Group
- Developing ASOF funding in Canada under the Northern S & T Initiative
- A summary of ASOF bids to the October Call for EC Framework 5
- The current state of NoClim funding
- The current state of funding for the NERC Rapid Climate Change thematic RCC

Future progress on the development of these topics towards implementation can be tracked on the ASOF websites and will be reported in future issues of this Newsletter.

Relevant Websites ;

- The ASOF Science Plan (Strawman 3), giving the detailed rationale for ASOF and a full agenda for the first ISSG meeting can be found on the SEARCH and NPI websites [http://www.psc.apl.washington.edu/search/ASOF and http://www.npolar.no/asof].

- ASOF-WEST has now introduced a dialogue over implementation which can be seen at http://www.ocean.washington.edu/research/gfd/asof.html.

- The recent bilateral *UK-Norway Initiative on Abrupt Climate Change* proposed to address related issues by the two Prime Ministers in 1998 has been developed subsequently into a new thematic programme on Rapid Climate Change by the UK Natural Environment Research Council [http://www.nerc.ac.uk/funding/thematics/thc/index.htm], and into the NOClim programme by the Norwegian Research Council [http://www.noclim.org].

- CLIVAR Atlantic Implementation Panel. Concerned with three large scale phenomena and their interactions within the Atlantic sector: The North Atlantic Oscillation, the Thermohaline Circulation and the Tropical Atlantic Variability. Details are provided at http://www.clivar.org

Future Related Events:

- AGU Ocean Sciences Meeting Hawaii, February 11-15 2002. Session OS45 The North Atlantic Ocean and Its Changing Climate [Conveners: Bob Dickson,CEFAS, Terrence M. Joyce, Woods Hole Oceanographic Institution, and Jens Meincke, Universitat Hamburg], will review new information about the general circulation and the nature of its decadal and longer time scale changes, with a special focus on the changing properties of the Deep Western Boundary Current from the northern overflows to the equator. Details and deadlines are at http://www.agu.org/meetings/os02top.html

- Arctic Science Summit, Groningen, The Netherlands, April 21-26.

- Second ASOF ISSG Meeting Hamburg Germany, October 2002.

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2. Dickson, RR, 2001. Developing plans for an Arctic-Subarctic Ocean Flux array (ASOF). AOSB Newsletter, **5** (1) pp 1-6, (February 2001).

ARCTIC SCIENCE SUMMIT WEEK

21-26 April 2002
Groningen, the Netherlands

The Arctic Science Summit week is held during April each year. This year it will be held in Groningen, the Netherlands. An initiative of IASC, its rationale is to provide a focus for opportunities for co-ordination, collaboration and complementarity in all areas of Arctic science**,** and to combine science and management meetings to save time and travel. The week comprises a series of meetings of circumarctic science organizations, organised around a joint science day focussed on topical issues of concern and around a joint project day which provides an overview of various Arctic programs. AOSB will hold its 21st meeting during the week of April 21. More information on the ASSW and the AOSB meeting will be available on the AOSB website at www.aosb.org and at the ASSW web site at www.let.rug.nl/assw.

The 21st Arctic Ocean Sciences Board Meeting

21-23 April 2002

Groningen, The Netherlands

For more information:

www.aosb.org

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