

ARCTIC OCEAN SCIENCES BOARD (AOSB)
Thirteenth Meeting (AOSB-XIII)

8-10 March 1994
Scheveningen/The Hague, The Netherlands

OPENING OF THE MEETING

Dr. Pentti Mälkki, Chairman of the AOSB, opened the meeting and welcomed the participants. Scientists from twelve countries were in attendance, including for the first time, Russia. Representatives from the Arctic Monitoring and Assessment Programme (AMAP) and the European Community were also present. It was noted with regret that the Dr. Jan Stel of The Netherlands Geosciences Foundation, had not been able to join the meeting. The Board was welcomed to Scheveningen by Drs. Raymond Schorno, also of the Foundation. The draft agenda was reviewed and adopted.

THE INTERNATIONAL ARCTIC POLYNYA PROGRAMME (IAPP)

The Chair of the Scientific Coordinating Group (SCG) for the IAPP, Dr. Louis Legendre, introduced the discussions and later presented the recommendations which had been developed at the SCG Meeting held just prior to the AOSB Meeting. Discussions focused on the Northeast Water Polynya Project (NEW), especially the results of field studies undertaken in 1993. Reports were presented on the various components of the field programs including remote sensing; physical oceanography, which emphasized studies of the ocean/ice boundary and turbulence; biological and chemical oceanography, including nutrients, microplankton, zooplankton, benthos and shallow-water benthos; marine mammals, birds and polar bears; botany; and archaeology.

The Northeast Water Polynya Project (NEW)

Satellite observations of the Northeast Water were carried out most of the year based on an intensive acquisition plan. These observations coincided with the cruise of the USCG *Polar Sea* during the period 20 July to 15 August 1993. The resulting data sets are comprised of NOAA AVHRR and ERS-SAR data, including data on average velocities of floes which could be identified from consecutive SAR scenes. These data sets have been collected in an annotated catalogue.

The polynya was of average extent in 1993 in contrast to 1992 when the polynya was about 25% smaller than average. The polynya was found to open in the beginning of May in 1993; be at its maximum by the end of August; and close rapidly by September. The floe drift in the polynya confirmed the presence of an anticyclonic gyre surrounding Belgica Bank with a northward surface current along the coast of Greenland. Ingof Fjord and Dijnphna Sund became

almost clear of ice in 1993 and the characteristic 'ice bridge' between the coast and Henrik Krøyers Holme broke off. Two major break-offs of shorefast ice occurred: (a) a large piece of the shorefast ice north of Nordostrundingen broke off and drifted with the East Greenland Current along the continental shelf break; and (b) another large piece of the ice extending from 79-Fjorden broke off and drifted northward with the current along the coast. The observing period also included 2 days of strong wind from the north that reduced the polynya area by almost 50%. The major storm which closed down the polynya substantially was followed by a change in wind pattern which opened the polynya again at the shoreline. A great number of surface slicks were also observed indicating biological activity.

During the first leg of the 1993 RV *Polarstern* cruise, from 21 May-24 June, the vessel operated along the northern coastal current, remaining close to the shoreline due to the presence of heavy pack ice. During the second leg from 25 June-4 August, the *Polarstern* entered the southern trough and continued with repeated transects across the northern coastal current to the northern trough. The *Polarstern* rendezvoused with the *Polar Sea* around 22/23 July and methods used on both ships were calibrated. Data from the 1993 *Polarstern* cruise report is currently being analyzed. Because of the large amount of data collected, the cruise report will be published in two parts.

The mechanisms responsible for the opening of the NEW include mechanical barriers, i.e., the Norske Ø Ice Barrier and the Ob Bank Ice Barrier which block the impact of ice into the polynya; the wind; the coastal current (northward) which carries away ice floes from the coastal area and causes upwelling; and insolation which is absorbed by open water generated by the above mechanisms. The shape and extent of the polynya was influenced by the fast ice patterns which can block or open the flow of ice into the polynya.

When the sun strikes the glaciers, rivers develop at the surface which result in substantial freshwater inflow into the polynya. Ocean ice boundary and turbulence were two foci of the oceanographic work, much of which was done from the ice. One extremely interesting finding was the enormous ice algae on the underside of the ice, with strands up to ten meters long. However, since this was unexpected, the group was not fully prepared for sampling on the scales necessary. The productivity of these algae is not understood. Perhaps it is dependent in some way on the kinds of ice in the area—some permitting light to penetrate and others not. After ice melting, the algae was gone in about one or two weeks and is assumed to have sunk. The sinking of such a tremendous biomass must contribute greatly to the carbon flux in the area.

Schools of up to 100 narwhals were observed. Walrus, which migrate to feed at the polynya and use it as a nursery ground, were also observed in the area. About twenty polar bears were studied. Transmitters were put on eight female bears; some were tracked out on pack ice in mid-November as far as half-way to Svalbard. Interestingly, it was found that bears can den on the pack ice to give birth.

The 1993 *Polar Sea* cruise visited the area for the same period of study as in 1992, that is, between mid-July and mid-August. CTD casts, sediment trap studies and experimental work was done in both years. Both the northern and southern sections of the polynya were characterized in 1992 by high stratification throughout the region driven by salinity differences. Surface nutrient levels were very low. The productivity of polynya waters is higher than surrounding waters, but not to a great degree, and the relationship between new production and irradiance in the polynya is not clear. It appears that nutrient concentrations limit productivity. The various estimates of productivity generally indicate that it was modest.

One goal of the program was to see if the region was a large sink for CO₂. A model of the inorganic carbon fluxes was developed to determine if the polynya potentially is a sink for atmospheric carbon dioxide. In winter there is ice cover, low respiration and production, and thorough vertical mixing, but as irradiance increases, vertical stability is created, production begins, and CO₂ drawdown occurs. In the summer there is a substantial reduction in CO₂ in the water column due to production and vertical flux to depth. In autumn CO₂ from the atmosphere potentially invades the water column prior to complete ice formation, hence acting as a net sink of carbon. Again, during winter vigorous vertical mixing occurs and the seasonal cycle is reinitiated. The 1993 data are currently being analyzed, and U.S. scientists are scheduled to meet in May to discuss publication plans.

The land-based program, NEWLand, which studied birds, mammals, archaeology, botany and quaternary history, was exceptionally productive. The team operated from mid-May until mid-August. As a result of these studies, it appears that over-winter operations from the present shore sites are feasible relying on fixed-wing aircraft and helicopters for support and on pre-positioning of equipment and supplies during the summer.

The bird studies indicated that there was an early migration of King Eiders (± 1000) into the region. A large breeding concentration of Common Eiders (± 2500) was also found; land-breeders were fairly sparse. At Henrik Krøyers Holme, there were substantial bird populations, probably as this was a fox-free year. It is not yet clear whether birds forage primarily within the polynya or not. A mammal survey found more walruses than expected, along with some ringed seals, bearded seals, narwhals and polar bears.

The botany program included lake corings, lee-side deposits and general surveys. One objective was to delimit the arctic desert zone. Twenty-three species were observed in the coastal zone, as opposed to about seventy varieties of vascular plants inland; only five species were found at Henrik Krøyers Holme.

The quaternary geology program focused on the glacial history of the region and on isostatic adjustment. A shallow benthos program complemented studies in deeper waters from the *Polarstern*.

The archaeology program was very successful. The area proved to be the richest study area in the history of East Greenland. There had been settlement all around the polynya and a large number of sites were located and studied. There were around ten Neoeskimo (Thule) sites from the period 1100-1800 AD, with thirty houses and many bones and tools found. Many Paleoeskimo (Dorset) sites from the period 900-600 BC were explored, including around 300 settlements, with a few tombs and large amounts of bones also uncovered. Only a few pre-Dorset sites were located. A follow-on study is being planned for 1995.

It was noted that the original objective of the IAPP had been to develop intercomparisons among three polynyas: the Northeast Water Polynya (NEW); the North Water Polynya (NOW); and the St. Lawrence Island Polynya (SLIP). It was recognized that the development and implementation of the NEW program in 1992 and 1993 had attracted both first-rate scientists and resources and is already yielding valuable scientific results. Thus, the IAPP has made a substantial contribution to the advancement of polynya research. This having been said, the much slower development of scientific planning for field programs in NOW and SLIP suggests that the original goal of developing three major simultaneous or overlapping polynya studies was probably unrealistic, given the limited scientific and financial resources and specialized facilities available for polynya research and for arctic research in general. Accordingly, the SCG presented, and the Board acted on, the following recommendations as indicated:

- (1) The SCG reported on the implementation of the organization of a NEW Polynya Symposium, endorsed by the Board at its 1993 meeting. The Symposium will be held in Helsingør, Denmark, 1-5 May 1995. The SCG recommended to the International Scientific Committee that the 1995 NEW Polynya Symposium be opened to studies conducted in other polynyas, with aspects related to NEW, for comparative purposes.
- (2) The SCG recommended that the AOSB prepare a Newsheet on the progress of NEW research to date and inform scientists of the plans for the NEW Symposium. **The Board agreed and asked the Secretariat to work with the Steering Committee to draft and issue the Newsheet within a month.**
- (3) The SCG recommended that additional multidisciplinary studies, possibly of limited spatio-temporal scope, be conducted in the NEW Polynya in the autumn, winter and early spring, using shore-based facilities in Greenland. Studies should draw on the experience of Danish and Polish scientists conducting winter operations in the Arctic. **The Board approved this recommendation in principle, emphasizing that small-scale focused projects be included. The Board asked the SCG that the authorities in Greenland be kept apprised of the planning effort through the Danish Polar Center in order to assure that needs for proper approval of research, logistics arrangements, rescue capabilities and insurance are addressed.**
- (4) The SCG noted with interest that polynya research other than NEW, NOW and SLIP is taking place in other arctic polynyas, including the Laptev Sea and the Canadian Northwest Territories—these studies not necessarily being, so far, interdisciplinary in nature. The SCG is also aware of polynya research in Antarctica. **The Board concurred that the SCG invite scientists involved in these projects to inform the SCG about their research.**
- (5) **The Board concurred with the SCG recommendation that the next meeting of the group be held just following the 1995 NEW Symposium and that the meeting agenda include discussions on the future of the IAPP, taking advantage of and**

building on the results of the Symposium. The SCG was also invited to report to the Fourteenth Meeting of the AOSB on significant developments prior to that meeting. The Board asked Dr. Peter Wadhams to bring to the attention of the International Arctic Buoy Programme (IABP) the results of the NEW project and to encourage the IABP to consider developing buoy studies in the polynya area to complement the work already done. Dr. Wadhams agreed to do so.

In order to coordinate the analysis and synthesis of data collected within each discipline during the NEW Polynya Project, the SCG recommended to the Scientific Steering Committee (SSC) for NEW that they take immediate action for the initiation of joint analysis by the two research groups of data in each discipline to be completed before the 1995 Symposium. The SSC should circulate information on action taken and progress made to all those participating in the NEW Polynya Project. The SCG views this as a first step towards interdisciplinary synthesis of the data, to be conducted in preparation, before, during and after the 1995 Symposium.

THE GREENLAND SEA PROJECT (GSP)

The second intensive field phase of the GSP, the WGSP '93 (Winter GSP), was intended to repeat the GSP 1988-1989 survey in order to obtain a second description of the Greenland Sea convective condition at possibly a different mean state of the Nordic Seas system. Studies on convection processes, acoustics, oceanography and ice were conducted. The survey was carried out in the period mid-February to mid-June involving the research vessels *Valdivia*, *Mosby*, *Northern Horizon*, *Prof. Multanovski*, *Polarstern* and *Oceania*, plus four research aircraft from the United Kingdom and Germany. Although harsh winter weather conditions limited the vessels' activities until the end of February/mid-March, the program from then on was carried out according to schedule.

With respect to one of the main goals of the GSP, to understand the convective water and transformation in the Greenland Sea, the results of the WGSP '93 can be summarized as follows. There have been no substantive changes in the convective activities since the 1980's. Such convection continues to affect the Greenland Sea to only intermediate (~1500m) depths. There has been no convective renewal of the Greenland Sea deep water. As a consequence this deep water is warming and becoming saltier as a result of advective changes imprinted from the large body of Arctic Ocean deep water. It is to be expected that a long-lasting change from local convective renewal to advective renewal from remote sources will eventually lead to changes of today's convection to intermediate depths and therefore lead to changing the supply of overflow water masses to the global thermohaline circulation.

In addition to these general results, more details from process studies on convection have become available. The final evaluation of the data from the GSP acoustic tomography array has resulted in a description of the development of the convective regime in the central Greenland Sea as a function of time through the winter 1988/89. On the small- (plume-) scale the results from longer-term moored acoustic doppler current meters clearly show convective events

throughout the upper 1300 meters with maximum downward speeds of three cm/s. However, the events are rare and only last for a few hours. Averaging over days and longer, there is no net vertical motion observed, indicating that convective processes have to be considered effective mixing rather than vertical advection.

An effort by the European Subpolar Ocean Programme (ESOP), which is essentially a component of the GSP, sought to measure plumes acoustically. However, no plumes were detected. Studies of carbon flux, fresh-water fluxes and sea-ice-ocean interactions in the convective region are priorities under the program. ESOP is a three-year program running through 1996 and funded at a level of about eight million ECU under the MAST II (Marine Science and Technology) program. Funding can be sought for activities under this program until mid-1996. The Steering Committee for ESOP will hold its next meeting in April 1994 to discuss an extension of ESOP's activities.

All data from the first intensive field phase of the GSP has been delivered to be processed for retransmission to the International Council for the Exploration of the Seas (ICES). ICES is also the data center for all ESOP oceanographic data, but ice data is held separately. It was noted that it would be helpful to have all GSP data in one center and was suggested that the AOSB consider recommending issuance of the complete GSP data set on CD-ROM.

The GSP Symposium, scheduled for 6-8 March 1995 in Hamburg, is intended to review the results of the GSP and consider needs and opportunities for future research. The first announcement and call for papers are expected to be disseminated by the end of March 1994.

U.S. PROGRAM ON RADIOACTIVITY IN THE ARCTIC

The Board received a report which summarized a recent U.S. study of nuclear waste disposal by the Former Soviet Union in the Arctic Ocean. The results of this study indicate that there is little evidence of increases in levels of radioactive decay products in the Kara and Barents Seas, which some had expected as a result of the dumping. **The Board asked the U.S. Member to assure distribution of the complete report to those participants who expressed an interest.**

THE ARCTIC MONITORING AND ASSESSMENT PROGRAMME (AMAP)

A report on the scope of AMAP was presented to the Board. The main objective of AMAP is to monitor levels of pollutants in the Arctic and assess effects of pollution in all parts of the arctic environment, including freshwater and marine environments. An assessment report on the state of the arctic environment is being prepared by AMAP and is scheduled for presentation at an Arctic Ministers Meeting in 1997. AMAP thus has been charged to design the monitoring and assessment programs needed; harmonize existing programs; develop needed cooperation and quality assurance; develop a directory of arctic projects; establish databases and develop links with existing databases; etc.

The monitoring program is intended to address a range of pollutants, including heavy metals, persistent organic pollutants, radionuclides, stratospheric ozone, etc. This program, which is largely comprised of existing national programs, is directed at a first assessment to be completed by 1996, a deadline which a scientific audit of AMAP recently questioned. AMAP is interested in establishing links with international organizations involved in Arctic Ocean research which could contribute to AMAP objectives. It was suggested that the AOSB might contribute to AMAP by identifying research programs and experts that could contribute to the objectives of the program and be included in the AMAP directory.

The Board noted that the report which AMAP has been called upon to prepare could be very important to both policymakers and scientists. However, concern was expressed that the report was not being developed as a bottom-up, science-driven effort as have been the very well-received Intergovernmental Panel on Climate Change (IPCC) reports and assessments. It was suggested that there is a possible discrepancy between the goal and the process. In the long run a science-driven approach would engender government support, and it was suggested that this point be emphasized to AMAP. The Board was informed, however, that, although AMAP was established as part of a political process, the AMAP assessment will indeed take the form of a scientific assessment which will produce the basis for arctic environmental protection initiatives.

The Board indicated its strong interest in continued interaction with AMAP. The Board also noted its willingness to identify scientists who could participate in the AMAP assessment process and who could identify the new science that is planned and underway in the Arctic Ocean. The Board also suggested that key AMAP scientists consult with those scientists instrumental in the IPCC process to benefit from their experience.

EUROPEAN COMMITTEE ON THE OCEAN AND POLAR SCIENCES (ECOPS)

ECOPS is promoting four "Grand Challenges" one of which is the "Dynamics of the Arctic Ocean". The program is intended as a ten-year program to achieve an understanding of the role the Arctic plays in the global energy and climate system. The European Community (EC) will consider funds for implementation. A Science Plan will be discussed at an European Science Foundation (ESF)/Commission of the European Communities (CEC) European Research Conference in Helsinki in September 1994. **The AOSB agreed to offer to cosponsor this meeting with ECOPS and the International Arctic Science Committee (IASC).**

POLISH-RUSSIAN COOPERATION IN ARCTIC RESEARCH

The Board received a report on the active cooperation between Polish and Russian institutions and scientists in the Arctic Ocean over the past year.

RUSSIAN ACTIVITIES IN THE ARCTIC

A report was presented on recent Russian activities in the Arctic Ocean. These included sections in the southern part of the Greenland Sea which will provide additional input to the GSP. It is planned to repeat the cruise in April/May 1995 in which scientists from other countries are invited to participate.

Over 140 stations were occupied in the Kara and Barents Seas in the summer of 1993 to study thermohaline fine structure and fronts resulting from freshwater inflow. There is also interest in repeating this expedition next year. A joint Russian-German project is studying the Laptev Sea where Russian cruises have collected physical and chemical data and some ecological information. A major expedition is planned to conduct sections required in support of the Arctic Climate System Study (ACSYS) in 1996.

NANSEN CENTENNIAL ARCTIC PROGRAMME (NCAP)

The Board noted with regret that it had been necessary to not conduct this program due to lack of funds.

INTERNATIONAL ARCTIC BUOY PROGRAMME (IABP)

It was reported that increasing numbers of buoys are being deployed in the Arctic Ocean, primarily to study ocean circulation. Active consideration is being given to the building of additional buoys in St. Petersburg for arctic deployment. **The Board asked the Secretary to obtain and distribute to Members a progress report on IABP.**

EUROPEAN SPACE AGENCY (ESA) ACTIVITIES

The ERS-1 satellite still functions well and is expected to continue operating for another two years assuming that no major breakdown occurs. All the data is archived and ESA assures maintenance of data quality. The ERS-2 is on track and the satellite is expected to be launched in February 1995. If this schedule is maintained, two identical ERS satellites will be operating simultaneously for a year or more. Presently, operation of the two satellites in the same orbit in a 35-day repeat cycle is being considered. They will be phased so that coverage is obtained with a one-day interval in one period and with an 8-day interval in another. This will dramatically increase the collection of Arctic Ocean data and enable short-term studies of ice dynamics.

In addition, if the present schedules are maintained, the ERS successor, ENVISAT, will be launched in late 1998 and the meteorological satellite METOP in 2000. Unprecedented amounts of data will thus be obtained from the Arctic Ocean region in due course. Of special interest is the design by ESA of a Multichannel Imaging Microwave Radiometer (MIMR) to be flown on METOP and perhaps also an EOS platform to continue the long time series of passive microwave radiometer data already acquired by NIMBUS-7 and the DMSP satellites, SMMR and SSM/I, respectively. However, it is essential to develop plans for the processing and archiving of the data in order to maximize its effective utilization.

ERS-1 data together with other satellite observation data are collected under the MAST II project concentrating on the area of the Greenland Sea where the Bukta/Odden phenomenon occurs. Studies of sea ice radar signatures are part of the program, attempting to improve retrieval of ice parameters from passive microwave radiometer data.

Sea ice monitoring of the Greenland Sea and other Greenland waters is carried out routinely by the Danish Meteorological Institute for the compilation of standard sea ice charts published once per week. The major part of this activity is based on NOAA AVHRR data supplemented by SSM/I data and ERS-1 SAR data.

ARCTIC OCEAN DATA MANAGEMENT

Previously, Mr. Geoffrey Holland reported that he had approached the Working Committee of the International Oceanographic Data Exchange (WC/IODE) of the Intergovernmental Oceanographic Commission (IOC) to investigate the possible establishment of a "Responsible National Oceanographic Data Centre " (RNODC) for the Arctic which would provide a focal point for all Arctic Ocean data. The IODE officers agreed and asked an IODE Group of Experts to develop Terms of Reference for such an Arctic RNODC which will be discussed with the AOSB. The AOSB was asked to nominate a Member to serve on this group. Two countries have already expressed interest in hosting such a center.

It was recognized that the Service Hydrographique within ICES serves as a data center for the Greenland Sea Project. The Board considered that the designation of an RNODC for Arctic Ocean data would complement and certainly not eliminate the need for ICES to continue in this capacity. It was agreed that a single window from which scientists can obtain data, data inventories and assistance in locating and acquiring data is needed. The importance of effective data management was reaffirmed, especially the issues of quality control and data exchange. Efforts to assure the management of data must be recognized as an intrinsic part of funded research. An international effort is currently underway on "Data Archaeology" to assure that data in danger of being lost is preserved and made available for use by scientists.

The Board noted with appreciation the response of the IODE Committee to their request for the establishment of a data center. **The Board agreed to assist in the development of the Terms of Reference for such a center and prepared the following guidelines for the IODE Group of Experts that was assigned the task. The Board requested that an Arctic Data Center should ideally consider the following:**

- **physical ocean data**
- **chemical ocean data**
- **contaminant data**
- **biological data**

- **geological data**
- **sea-ice data**
- **satellite data**
- **bathymetry data (unless adequately available from other sources)**

It was realized that IODE may neither consider itself capable nor able to address all the above categories of data. However, it was felt that the interests of the Board should be fully outlined, so that the IODE would be aware of the full scope of the data concerned and could respond accordingly.

IODE was asked to take account of (a) the need to consider historical data sets and (b) the possibility of using a distributed system which could make the best possible use of existing facilities and communication networks. The experience within IODE for ensuring standardization of formats and for the quality control of data was well recognized.

A detailed discussion of AOSB data needs resulted in the following general guidelines for data policy:

- A commitment should be established for the establishment of a management system for high-quality, long-term data sets.
- There should be an agreed principle for full and open sharing of Arctic Ocean data sets.
- Historical data sets should be quality controlled and preserved.
- Accessibility to data should be simple and straightforward.
- National and international standards should be used to the fullest extent possible.
- Data should be made available at the lowest marginal cost of reproduction and preparation.
- Data should be forwarded to the data center with the minimum possible delay by Principle Investigators.

The AOSB decided to establish an ad hoc Working Group on Arctic Ocean Science Data Management that would draft a "Data Management Policy for AOSB Sponsored Research" that would build on the progress being made by the Committee on Earth Observation Satellites (CEOS) and other national and international organizations, leading towards better access, availability and quality of Arctic Ocean science data. The Working Group would also work within AOSB to facilitate the implementation of such principles on data management that the Board decides to adopt. It was also decided that a member of this Working Group would provide the liaison requested by IODE in the development of the Terms of Reference for the Arctic Ocean Data Center. The AOSB encouraged all the participating governments to support the preparation and adoption of data management principles and to actively implement such adopted principles in their respective programs.

RESEARCH VESSEL COOPERATION

It was noted that the International Ship Operators' Meeting (ISOM) had been established to promote the exchange of shiptime among the members. ISOM has since broadened its terms of reference to address a range of issues associated with research vessel operations. AOSB took note with great interest of the report of the most recent ISOM Meeting in November 1993. Many countries with Arctic research capabilities and interests (such as Norway, Denmark, Sweden and Poland) had not been represented and little attention had been paid to Arctic Ocean needs.

The Board agreed to recommend that ISOM include on the agenda for its next meeting an item on development of a specific Arctic Ocean database within OCEANIC. The Board decided to recommend to ISOM that other Arctic countries (as noted above) be encouraged to participate in ISOM and invited to submit information on ship operations in the Arctic. The AOSB will also encourage AOSB Members to participate in ISOM and to submit for inclusion in the ISOM database information on research vessel and icebreaker operations in the Arctic Ocean for inclusion in OCEANIC.

NANSEN ARCTIC DRILLING PROGRAMME (NAD)

The Board took note of the report which it had received on drilling in the Arctic Ocean. Such drilling was initiated in the summer of 1993 under the Ocean Drilling Program (ODP). The Nansen Arctic Drilling Program is considering a drilling site in shallow seas, possibly in the Mackenzie River delta, in conjunction with commercial oil drilling in order to make cost-effective use of the equipment which may be available as a result of these commercial operations. A site in the Laptev Sea is also being considered using Russian drilling techniques. Resources need to be developed and safety requirements have to be addressed for the latter projects. The NAD is also considering expansion of conventional and piston coring to Arctic Ocean sites. It was recognized that the scientific objectives of NAD and ODP in the Arctic Ocean are similar and the programs have a strong connection in terms of participating scientists.

GLOBAL CHANGE IN THE ARCTIC

It was reported that the International Geosphere-Biosphere Programme (IGBP), the International Council of Scientific Unions (ICSU) and the International Group of Funding Agencies for Global Change Research (IGFA) are undertaking a review of the IGBP at the five-year point. It was noted that the IGBP, like the World Climate Research Programme (WCRP), is becoming more interested in polar regions, but that it is the responsibility of organizations like AOSB and IASC to make the polar regions more visible. The Human Dimensions of Global Environmental Change Programme (HDP) was reviewed. The program focuses on human influences of global change and the socio- and economic impacts and responses to global environmental change.

Based on data available from sixteen countries, approximately \$3 billion U.S. is being allocated to global change research on an annual basis. Of these funds, 10% is allocated to the organized programs under the WCRP, IGBP and the HDP; 30% is allocated to closely-related programs; and 60% is allocated to nationally-defined global change research programs. It appears that mature programs are funded at about 50-80% of the needs originally estimated by scientists; immature programs at about the 10-20% level. This seems to reflect about a two-year lag between the identification of scientific needs and the major funding of programs.

Regional institutes are being developed for global change research in the Americas (Inter-American Institute [IAI]), Europe/Africa (European Network for Research in Global Change [ENRICH]), and Asia and the Pacific (Asia Pacific Network for Global Change Research [APN]). The Global Change System for Analysis, Research and Training (START) program has identified the Arctic as a region of importance for global change research and IASC is discussing appropriate networking needs for the region. IASC has set up a Working Group on Global Change to develop a plan for a multidisciplinary global change research program for the Arctic.

ARCTIC CLIMATE SYSTEM STUDY (ACSYS)/THE CANADIAN-UNITED STATES TRANSECT

These items were addressed jointly since the Canadian-U.S. effort is a contribution to ACSYS. ACSYS was established on 1 January 1994 and is a ten-year component of the WCRP. The aim of ACSYS is to understand the arctic climate system and its sensitivity to global change. A number of arctic sections are proposed to develop the necessary database. A Canadian-U.S. Transect in the summer of 1994 will involve the vessels CCS *Louis St. Laurent* and the USCG *Polar Sea*, with a team of about sixty scientists conducting primarily physical and chemical oceanographic sections across the Arctic Ocean beginning at and returning through the Bering Strait.

This Canadian-U.S. Transect will study ocean currents; the flow of pollutants and contaminants; the production of plankton; and the geology of the ocean floor. A shelf variability project is planned for the Beaufort Sea. Canada is also collecting historical datasets for ACSYS use.

The Board asked the U.S. Member for information to be distributed on a related U.S. program on the Surface Heat Budget of the Arctic Ocean (SHEBA).

THE INTERNATIONAL ARCTIC SCIENCE COMMITTEE (IASC)

The science initiatives being undertaken by IASC were outlined. These include Global Change Research; the International Science Initiative in the Russian Arctic (ISIRA); Effects of Increased UV Radiation; Arctic Marine Geology; Geophysical Compilation and Mapping; Arctic Glaciology; Human and Social Sciences; and Health Sciences. In December, the IASC Executive Committee identified the first three as science priority initiatives. The next meeting of the IASC Council and the Regional Board is scheduled for May 2-6, 1994, in Ilulissat, Greenland.

An IASC-sponsored Arctic Science Conference is tentatively scheduled for late 1995 in the United States. It is intended to be a scientific planning conference and is expected to identify key arctic science issues regarding which IASC can play an important role in the next five or six years.

The IASC Board met twice in 1993; reaffirmed its unique role in the IASC structure; decided to be more pro-active; and agreed to open its activities to other countries when appropriate. The three priority scientific issues for IASC emphasize the interdisciplinary nature of IASC. This defines to a large extent the complimentary relationship between IASC and the AOSB, which is focused on marine sciences. The IASC Scientific Conference is likely to be an important meeting for the AOSB in that it will address a number of science issues that will include and impact on ocean sciences.

THE INTERNATIONAL COUNCIL ON THE EXPLORATION OF THE SEAS (ICES)

The cod and climate program and data archaeology are two priority activities of ICES which are relevant to AOSB. The ICES Service Hydrographique serves as the center for GSP data and may be asked to serve as the data center for AMAP as well. In this case, governments supporting AMAP would be expected to provide additional resources.

THE ROLE OF THE EUROPEAN COMMUNITY IN ARCTIC OCEAN SCIENCES

The European Community goal in relation to Arctic Ocean research is to understand changes on both a global and regional scale. Science and technology as well as environmental policies are driving principles of the EC effort which bring together the scientific capabilities of member countries for coordinated initiatives not achievable by any one country. The EC supports projects such as the Greenland Ice Sheet Project (GISP); the Polar North Atlantic Margins (PONAM) program; EPOCH; MAST II (Marine Science and Technology)-ESOP; PELICAN; and other projects in related areas such as stratospheric ozone.

Under its next work program, the EC is likely to implement a broad range of programs of interest to the AOSB. The EC is already developing approaches to cooperate with IGBP core projects, such as the Global Change and Terrestrial Ecosystems program (GCTE), the Land-Ocean Interactions in the Coastal Zone program (LOICZ) and the International Global Atmospheric Chemistry project (IGAC). The EC is also actively supporting planning and implementation of the European Network for Research in Global Change (ENRICH). While most EC funding is allocated for member countries only, some monies are available to Eastern and Central European non-member countries. Because the EC is a political body, scientific priorities are defined on a regional, i.e., European basis, which limits the priority focus of the Arctic region. It was recognized, however, that the full participation of Nordic countries in the EC will strengthen arctic research interests.

The Board noted with great interest the many projects in the Arctic to which the EC has contributed and that the next EC framework program may include even more substantial activities in the Arctic. **The Board decided to continue to invite the EC to be represented at AOSB Meetings.**

THE ROLE OF THE AOSB IN ARCTIC PROGRAMS

Needs for Arctic Ocean research have been identified and programs to address these needs have been developed in many ways at national and international levels on both a non-governmental and governmental basis. It was noted that the Organisation for Economic Co-operation and Development (OECD) has defined two different kinds of megascience: that which centers around a central facility and that which functions through a distributed program. Arctic Ocean science includes elements of both. It was recognized that countries participate in programs if they perceive participation as advantageous and as providing strategic benefits. It was agreed

that international cooperation in Arctic Ocean research is vital because no one country has the

expertise, resources, facilities or access to regions and data to resolve the complex scientific issues that face the Arctic Ocean.

The AOSB has a unique track record for planning and implementing research programs in the Arctic Ocean which achieve internationally recognized results. The GSP was the first such program, having brought together scientists, scientific institutions, facilities and funds to address a complex interdisciplinary problem. The IAPP has also been successful in the planning and implementation of NEW research, although the attempt to develop comparative studies of three polynyas was perhaps an overly ambitious goal. The AOSB serves other functions as well, including serving as a forum for the exchange of information on Arctic Ocean research. The AOSB has been careful not to duplicate other programs but has kept informed about them.

From a funding agency perspective, the AOSB provides a useful link to the international scientific community in arctic research. The AOSB has undertaken only those projects that it has the collective capability to respond to, addressing achievable objectives within national capabilities. The AOSB facilitates the funding of Arctic Ocean research, especially on an interdisciplinary basis.

For smaller countries, the AOSB provides essential links to international cooperation. For some, participation in the GSP and maintenance of arctic stations is possible only through international bodies such as the AOSB which act as an umbrella for activities. The aggregation of national scientific and financial resources through international cooperative science programs permits achievement of scientific objectives beyond the capability of any single national program. It was suggested that the AOSB in effect sets priorities for ocean science in the Arctic through its endorsement and implementation of programs such as the GSP and the IAPP.

The AOSB provides a means for making national facilities for Arctic Ocean research available to the wider scientific community. The new tools that will become available in the 1997-2002 time frame, especially in remote sensing, will be impressive. In light of this and of the complexity of the scientific concerns and financial limitations, it may be appropriate for the AOSB to consider setting longer-term scientific priorities.

For the AOSB to open up additional channels with IASC would be mutually beneficial. The AOSB could assist with setting scientific priorities for IASC, especially with regard to Arctic Ocean science.

It was agreed that the AOSB should improve and expand its interactions with other international organizations involved in Arctic Ocean and/or related research. To this end, it was agreed to develop an institutional directory for Arctic Ocean research, based on inputs from AOSB Members. Such a directory could be broadened in the future to include information on scientific programs and possibly individual scientists as well.

It was agreed to update the AOSB Long-Term Mission and Strategy statement as adopted at the 1992 Meeting of the Board. It was also decided that reassessment of the "Background" paragraph of the statement should be done on an annual basis and this should be reflected on future meeting agendas. It was also suggested that the AOSB establish an improved information network for Arctic Ocean scientists and better communicate its own agenda to the international community.

Here follows the revised Mission and Long-Term Strategy statement:

The Mission of the AOSB is to facilitate Arctic Ocean research by the support of multinational and multidisciplinary natural science and engineering programs.

The AOSB Long-Term Strategy is to achieve its mission and provide additional value through AOSB involvement by

- 1) encouraging and supporting science-led programs by offering planning, coordination, and access to funding and logistics;
- 2) cosponsoring international activities and encouraging cooperation between various programs;
- 3) ensuring that information on Arctic Ocean research is exchanged between nations and disseminated to Arctic Ocean scientists in each nation;
- 4) providing networks for Arctic Ocean scientists, for example, on access to facilities/logistics and access to data;
- 5) establishing telemail interconnections for information exchange;
- 6) establishing means of initiating and maintaining long-term data capture systems (via moorings, buoys, satellites, etc.);
- 7) establishing means of initiating and maintaining systems for long-term archiving, cataloging and exchanging arctic oceanographic data;
- 8) ensuring that there is interaction, where appropriate, between the international Arctic Ocean science community and those concerned with Arctic policies; and
- 9) promoting symposia and educational activities.

The reasons for carrying out research in the Arctic can be categorized under the following headings

- Basic Research
- Climate
- Contaminants
- Global Change
- Resource Exploration and Development
- Transportation/Engineering

Background

At the present time of economic restraint the priority for curiosity-driven research, that is basic research, is low. Resources from the Arctic have been dominated by oil and gas extraction and again the present situation has seen a downturn in this activity due to the relatively low and stable prices for hydrocarbons. The related need for transportation and engineering research also translates to a low priority. Global change research is of high interest but the greater urgency is for climate change. Effects of anthropogenic contamination have reached significant levels in the Arctic, and the problem must be addressed and resolved. For the next five to ten years the two priority areas for arctic research are therefore seen to be climate and contaminants.

ARCTIC PALEOENVIRONMENT INITIATIVE

A recommended research program on Quaternary River Discharge in the Arctic Ocean and Climate Change, developed by Dr. Dieter Fütterer was presented to the Board. This program, suggested at the last meeting of the Board in Seattle, would concentrate on: (a) modern riverine processes and (b) glacial and inter-glacial change in riverine processes and the paleoceanographic significance. Elements of the proposed program include the study of arctic oceanography; fresh water input; sea-ice formation; ice transportation; and deep water formation in the Eurasian Shelf Seas. The program would also examine the natural history of global change and could include biological studies.

In order to implement such a program, it will be necessary to develop a means of measuring and sampling rivers and offshore seas. It was emphasized that the program should address a number of river systems rather than just one, especially for comparative purposes. It was recommended that the Mackenzie River, the Laptev Sea system, the Ob and Yenisei river system, and the Pechora river system be studied. National efforts are already underway in these areas; Germany, for example, has already allocated three years of funding to the study of the Laptev Sea, in cooperation with Russian institutions.

A complementary proposal was presented to the Board by Dr. Jan Marcin Weslawski for the study of freshwater input to the Arctic Ocean from glaciers and icebergs. A proposal for the study of the Laptev Sea system by Dr. Leonard Johnson, Chair of IASC Arctic Marine Geology Working Group, was distributed.

It was noted that any coordinated program should involve cooperation with ACSYS, and if implemented could be considered as an AOSB contribution to ACSYS.

A task group was established to design a proposal for a coherent and focused research program on arctic river discharge. The group was asked to work intersessionally by telemail and prepare a draft proposal by August for distribution to AOSB. The group was asked to incorporate comments received by AOSB Members and circulate this draft throughout the community for feedback by November. The Board will consider and take action on this proposal at the next meeting. It was recommended that Members contact perspective scientists within their countries about participation in such a program. It was

also emphasized that most discharge is from Russian waters and therefore important to ensure involvement from Russian organizations. Dr. Fütterer was asked to follow up on this communication.

OTHER BUSINESS

It was suggested that at the 1995 GSP Symposium a final report be prepared with recommendations to end or extend the program. There was some question as to the status of the North Water Polynya project, and Mr. Geoffrey Holland agreed to check the status of work being conducted in the area. It was suggested that the future of both NOW and SLIP be examined to determine the future of these projects in relationship to the IAPP. It was also recommended that the project leaders of the IAPP and the GSP be asked to provide the Board with a schedule of planned future activities under the programs.

The Board requested that, in addition to the newsletter devoted to NEW, the Secretariat prepare an issue on the GSP and a general issue that includes the revised AOSB Long-Term Mission and Strategy statement to be circulated throughout the community. It was also suggested that a calendar be included in newsletters to keep the Board and the community abreast of upcoming meetings and workshops.

ARRANGEMENTS FOR THE NEXT MEETING

Dr. Dieter Fütterer extended an invitation to the Board to hold its Fourteenth Meeting in Bremerhaven. The Board accepted this offer with thanks and decided to meet in Bremerhaven, following the GSP Symposium in Hamburg in March 1995.

CLOSE OF THE MEETING

The Chairman thanked the Geosciences Foundation of the Netherlands for hosting the meeting. The Chairman then closed the meeting.

APPENDIX I

Arctic Ocean Sciences Board Thirteenth Meeting

MEMBERS

STAFF

OBSERVERS

APPENDIX II

**Summaries of
National Arctic Ocean Science Programs**

CANADA-have

DENMARK-have

FEDERAL REPUBLIC OF GERMANY-have

FINLAND

FRANCE-have

ICELAND

JAPAN-have

THE NETHERLANDS-have

NORWAY

POLAND-have

RUSSIA-have

SWEDEN

UNITED KINGDOM

UNITED STATES-have

APPENDIX III

Acronym List

APPENDIX IV

**Arctic Ocean Sciences Board
Thirteenth Meeting (AOSB-XIII)**

8-10 March 1994

Scheveningen/The Hague, The Netherlands

AGENDA