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# Polar Research: In the View of US/European Cooperation


## Kurzfassung

Die arktische Forschung ist die Leidenschaft meines Lebens und ich bin glücklich, feststellen zu können, dass diesbezüglich bedeutende Fortschritte gemacht worden sind. Es hat eine Entwicklung vieler neuer Technologien und eine Flotte neuartiger Eisbrecher gegeben. Die russische Arktis ist nun zugänglich und gemeinsame Forschungsprogramme mit russischen Forschern sind inzwischen zur Normalität geworden. In wissenschaftlicher Hinsicht hat man den arktischen „Eisschleier" gelüftet und als Ergebnis der deutsch-amerikanischen Forschungsergebnisse von 2001 ist der Gakkel-Ridge der am besten erfasste Abschnitt des „World-Rift"-Systems. Die Bedeutung der Arktis als Steuerungsfaktor der Klimaveränderung ist nun offensichtlich. Die Erkenntnis, dass die Arktis eine große Bedeutung sowohl für die Wissenschaft als auch für die Gesellschaft hat, hat sich durchgesetzt.

## Abstract

Arctic research has been my life's passion and I am fortunate to be able to note significant progress. There has been development of new technologies and a fleet of new icebreakers. The Russian Arctic is now open and joint programs with Russian scientists are a normal occurrence. Scientifically the icy veil that has enshrouded the Arctic has been lifted and indeed as a result of the 2001 German/U.S. multibeam survey, the Gakkel Ridge is the best surveyed segment of the world rift system. The importance of the Arctic as a harbinger of climate change is now apparent. The recognition of the importance to both science and society of the Arctic has arrived.

## Résumé

La recherche arctique est la passion de ma vie et je suis heureux de pouvoir constater des progrès importants à ce sujet. Il y a eu un développement de beaucoup de technologies nouvelles et une flotte de brise-glaces modernes. Maintenant l'Arctique russe est ouvert au public et entretemps c'est bien normal de faire des projets de recherche en commun avec des explorateurs russes. On a levé „le voile glaciaire" de l'Arctique scientifiquement et comme résultat des travaux de recherche germano-américains de l'année 2001, le Gakkel-Ridge en est la partie la mieux explorée du système du „World Rift". Or, il est évident que l'Arctique joue un rôle très important en étant une force régulatrice du changement de climat. On en est arrivé à constater que l'Arctique est d'une grande importance non seulement pour la science mais aussi pour la société.



## Keywords

Arctic, International Science

## 1. Introduction

It is an overwhelming honor to be mentioned in connection with the renowned scientist Georg von Neumayer, let alone be awarded his medal. Two former awardees Tore Gjelsvik and Gotthilf Hempel I have had the honor of knowing. They were truly great leaders in Arctic science. I am truly humbled by this honor. Certainly a share of it goes to all those who have helped me in so many ways. Bruce Heezen was my mentor at Lamont Doherty who instilled in me a great curiosity for the sea floor and all the processes which sculpt it. I remember discussions with a grand old man of science George Wust who too was at Lamont and was so open and understanding as I learned by practical experience the rudiments of Physical oceanography and its major effect on the sea floor. Later on I was fortunate to work with Peter Vogt and Pat Taylor at the Oceanographic Office where we were at the right place at the right time as plate tectonics was unfolding and we had unlimited data and ship access. Many other colleagues such as Yngve Kristoffersen, Olav Eldholm and Jack Sweeney too broadened my scientific base. Arne Noe-Nygaard too was an inspiration as were Arkady Karasik and Fridjof Nansen. My next step was to become an administrator at ONR. Here again I was lucky and budgets were sufficient to launch major new programs like MIZEX and Fram ice stations. Also I was able to witness the birth of two new centres of Arctic research: The Nansen Center by Ola Johannessen and GEOMAR by Jörn Thiede. Jörn Thiede has too been an inspiration to me with his vision. The two most recent examples being the establishment of the Otto Schmidt Laboratory in St. Petersburg and the Aurora Borealis project.

## 2. Polar Research since the 1980s

Reflecting back there has been a blossoming of Arctic research. The first impetus for both sides was the Iron Curtain and subsequent military activity in the Arctic. This concentrated on submarine warfare and countermeasures both of which required complete environmental knowledge of the sea bed and marine environment. Then the cold war ended which was both good and bad. On the negative side funds for Arctic research dried up and the massive Russian effort disintegrated. On the positive side it opened the door for western scientists to the entire Arctic. The Germans were the first to take advantage with epic cruises of the "Polarstern" in 1987 and several years later with the Swedish icebreaker "Oden" to reach the pole in 1991 (FUETTERER et al. 1992; THIEDE & VORREN 1994). Just now the U.S. is coming on line with the new research icebreaker „Healy" which has completed a successful joint cruise 2001 with "Polarstern". A major Russian-German multiyear research effort the Laptev Sea system was initiated in 1994 with annual joint research efforts from the coastal plain out to the Gakkel Ridge.

Only a decade ago Arctic research also was severely limited by conventional methods and equipment in use since the 1950s. These included icebreakers of limited scientific usefulness, ice stations, airborne landings on sea ice, and remote sensing of the magnetic field by conventional aircraft. Within the past decade, however, a number of advances have occurred making it possible to greatly increase the efficiency of the investigations and the scope of obtained data. A number of new subsurface methods are now utilized (JOHNSON & BRASS 1989). Perhaps, foremost was the use of Sturgeon class nuclear powered submarines for annual unclassified science cruises to the Arctic Ocean known as the Scientific Ice Expeditions (SCICEX) program (LANGSETH & COAKLEY 1996). Started in 1993, SCICEX has collected water samples and conductivity-temperature-depth casts from surface stations as well as oceanographic and geophysical data, using gravity, narrow and side scan echo sounders across the entire deep Arctic Basin. The last cruise in this series was in 1999 by the USS Hawksbill. At present the program is in abeyance due to lack of available platforms within the Navy caused by retirement of the ice-capable submarines and focus on operations in other regions. On a smaller

scale there has been a resurgence of interest in use of autonomous underwater vehicle (AUV) systems in the Arctic. This has been triggered by technological advances in battery life, computers and electronics. During autumn 2001 Odyssey II was deployed to track Atlantic layer intrusion into Arctic basin by following the 1300 m isobath of Nansen Basin, with occasional excursions of approximately 50 kilometres. The vehicle will run at a depth of 275 m, and will obtain daily full water column profiles. For this mission, the vehicle is expendable – data is reported by telemetry buoy (BELLINGHAM et al. 1995).

Another climate-change-related program is to measure and analyse changes in the temperature and extent of ice cover using acoustic thermometry. Its goals are to synoptically monitor the Arctic temperature and depth of the thermocline on a regular basis using acoustic travel times based on tomographic methods. The initial configuration consisted of a transducer north of Franz-Josef-Archipelago and receivers seaward of Barrow, Alaska, and in the Lincoln Sea. The transmission paths were over 2600 km and 900 km, respectively, for the acoustic signal of 20Hz. The array in the Lincoln Sea was recovered in the spring of 2001 with a healthy data set after two years of recording. The acoustic sections compared with the SCICEX sections have shown, that measurement of the average temperature in the Atlantic Layer is easily and very reliably accomplished with the acoustic thermometry measurements (MIKHALEVSKY et al. 2001). The system is presently inoperative awaiting a replacement source and installation of hydrophone arrays.

Increasingly sophisticated instrument buoy systems are also a major scientific tool in monitoring the atmospheric and oceanographic conditions of the Arctic Ocean. The International Arctic Buoy Program is an ongoing program with between 40–50 buoys deployed. Data are transmitted via the Global Telecommunications System and include pressure, temperature, and ice motion, thus determining synoptic scale fields to support real-time operations in meteorology and oceanographic research. Some buoys also provide information on one or more of the following: wind speed and direction, sea surface temperature, snow and sea-ice properties, and subsurface oceanographic variables.



Fig. 1: Polar research in the Arctic Ocean – Leonard Johnson tossing a sonobuoy from Swedish vessel ODEN (August 2001) – Photograph courtesy of Y. Kristoffersen

Airborne measurements by plane or satellite also have developed in both sophistication and capability in the last decade. The airborne magnetic surveys of the Arctic have been and are still being conducted by the Naval Research Laboratory (NRL with the recently added use of long-range aircraft and interferometric Global Positioning System navigation to collect low altitude, high-quality broadband aerogravity, and aeromagnetic profiles. Present plans are to continue surveys on the Gakkel Ridge. Using Longyearbyen as the logistic base (KOVACS et al. 1998).

Satellite radar altimetry also provides the means to derive marine gravity anomalies through accurate measurement of the mean sea surface topography albeit at coarser scale than the low flying aircraft. Techniques have been developed to reprocess the individual return echoes in order to significantly reduce ice noise and allow marine gravity anomalies to be extracted in the usual manner (LAXON & MCADOO 1989). Present data extends only to 82°N, the Geoscience Laser Altimeter System scheduled for launch in March 2002 by NASA will extend coverage to 86°N latitude.

## 3. Wishes for 2007

Karl Weyprecht organized the IGY 1882 and 2007 will be 125 years. As a dream I would hope by then:

- An international Polar Year is initiated as called for in the Neumayer Declaration of 2001 (JOHNSON 2001).
- The Aurora Borealis Program is realised and functional with scientific drilling answering some of unknowns concerning the paleoenvironmental history, structure and evolution of the Arctic.
- Autonomous sea-floor observatories will be in place in the Arctic. An example could be patterned after the Endeavor sea-floor observatory to continuously monitor temperature, flow rate, chemistry and samplers to take time series of fluids heat flux and to explore chemical and biological linkages in hydrothermal systems. The Sites would also be selected for biologic hot spots and to monitor processes and change within the Arctic environment (TIVEY et al. 2001).

## 4. U.S./European Cooperation

A word on how we operate in the U.S. Mission agencies such as NASA, NOAA and ONR know what they want to do and acquire the necessary logistics and then promulgate an Announcement of Opportunity to draw up science plans, and participation. NSF on the other hand requires proposal pressure from the scientific community before they take any action. They need to be sure this proposed action is what the U.S. science community supports.

Thus we have pro-active program managers in the mission agencies and more passive ones in NSF. NSF too in general has restrictions against non-U.S. scientists as it is designed for the U.S. community. It is thus important for European initiatives where U.S. scientific participation is desired to cultivate the U.S. scientific community to add proposal pressure to the NSF.

Areas where I see potentially particularly good opportunities for European and U.S. cooperation are:

- Nansen Arctic Drilling (NAD) was initiated as international cooperative effort about a decade ago to promote scientific drilling in the Arctic. The efforts of NAD have provided impetus for several Arctic research drilling efforts. Specifically, the Russian-German Laptev Sea Program succeeded last summer in drilling two sites; A Bering Land Bridge drilling proposal for the Norton Basin has been submitted to Earth Systems

History at the National Science Foundation, but declined. Alternative support will be sought. The proposal to drill the Lomonosov Ridge has been ranked as the highest priority in the ODP/JOIDES review system. The JOIDES Detailed Planning Group (DPG), (the Arctic's Role in Global Change) has presented the final report to JOIDES SCICOM. They endorsed it and moved to recommend the drilling within the joint framework of ODP and its successor, the Integrated Ocean Drilling Program. I view this as the possible useful precursor to a concentrated program by the Europeans to drill multiple sites with a proposed multipurpose Arctic icebreaker: The Aurora Borealis. This vessel has a proposed drilling capability that fulfils the needs of the Integrated Ocean Drilling Program (IODP) for an "Alternate Platform" to drill in deep, ice-covered basins. I would hope, that the U.S. community would have the foresight to participate in this program (THIEDE 2001).

- Arctic Climate Impact Assessment (ACIA) was developed to address the complex suite of significant, interrelated, atmospheric, oceanic and terrestrial changes which have occurred in the Arctic in recent decades. There is an implementation plan for an assessment of the consequences of climate variability and change and the effects of increased UV in the Arctic Region. It is being developed by an "Assessment Steering Committee (ASC)", with representatives of AMAP, CAFF, IASC, Arctic indigenous peoples, and others. The development of this Implementation Plan is in response to a proposal submitted to and encouraged by the Senior Arctic Officials of the Arctic Council in May 1999 and again in November 1999.

- SEARCH (Study of Environmental Arctic Change) Arctic and Sub-arctic Ocean Flux (ASOF) study is being developed to monitor the Arctic Straits and also make measurements in the subarctic seas to understand the overturning circulation. ASOF grows out of the European Community VEINS and MAIA projects and an UK-Norway Laughton/ Meincke/Norwegians program to measure the flow through Fram Strait and in the Greenland Sea. It is taking steps to achieve long-term funding internationally and will be part of SEARCH responsible for strait monitoring (MORISON 2001).

- In FY 2002, the NOAA Arctic Research Office intends to organize a research cruise to the Arctic as part of NOAA's Ocean Exploration Initiative. Especially, see therefore http://oceanpanel.nos.noaa.gov for the full report on which NOAA's Ocean Exploration Initiative is based. As the first step in planning for this cruise to the Arctic, the Ocean Exploration Office and the Arctic Research Office of NOAA convened a planning workshop in Washington, DC. NOAA subsequently released a competitive Announcement of Opportunity that included the arctic research cruise.

- As mentioned earlier, another climate-change-related program is to measure and analyze changes in the temperature and extent of ice cover using acoustic thermometry is the Arctic Climate Observations Using Underwater Sound (project). International participation would be welcome and indeed does exist with Russia and a Fram Strait program by U.K. and Norway.

- Infrastructure support from engineering perspective. The NSR cuts off 4,800 nautical miles from transit through the Suez Canal between Hamburg, Germany and Yokohama, Japan. The route is presently used during four months each year, mainly for cargo transport between Russian ports. If the warming trend continues, the NSR could become a profitable alternative international shipping route. Research conducted by CRREL indicates 40,000-ton and larger polar-class cargo ships could become competitive on the NSR for at least eight months of the year. This type of pragmatic (applied) research has major benefit to all circum-Arctic nations.

- The NSF is assessing community interest and pursuing discussions toward developing a Circumarctic Environmental Observatory Network (CEON). Primarily land based in the present concept. The marine area in my opinion too should be a prime area with

observatories on the spreading centre, marine biologic hot spots, and key oceanographic sites to monitor processes and environmental change. The proposed Aurora Borealis with its enhanced capability for AUVs and dynamic positioning for precise instrumentation emplacement will be the key.

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