

**Application for Consent to Conduct Marine Scientific Research  
in Areas Under National Jurisdiction of**

**Norway /Svalbard**

(name of coastal state)

**Date:**

**1. General Information**

1.1 Cruise name and/or #: HLY0503

1.2 Sponsoring institution:

Name: National Science Foundation

Address: 4201 Wilson Boulevard, Arlington, Virginia 22230, USA

Name of Director: Dr. Arden L. Bement, Jr.

1.3 Scientist in charge of the project (include CV and passport photo):

Name: Dennis A. Darby (CV and photo attached)

Address: Dept. of Ocean, Earth, & Atmospheric Sciences,  
Old Dominion University,  
Norfolk, VA 23529, USA

Telephone: 757-683-4701

Fax: 757-683-5303

Email: [ddarby@odu.edu](mailto:ddarby@odu.edu)

1.4 Scientist(s) from coastal state involved in the planning of the project:

Name(s): Professor Yngve Kristoffersen

Address: Department of Earth Science  
University of Bergen  
Allegaten 41  
N-5007 Bergen  
Norway

Phone: 47-5558-3407

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Email: [yngve.kristoffersen@geo.uib.no](mailto:yngve.kristoffersen@geo.uib.no)

1.5 Submitting officer:

Name and address: David Forcucci

1519 Alaskan Way S  
Seattle, WA 98134 USA

Nationality: USA

Telephone: 206-217-6648

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## 2. Description of Project (Attach additional pages as necessary)

### 2.1 Nature and objectives of the project:

#### **Coring Project Summary**

It is widely acknowledged that the Arctic Ocean plays an important role in regulating global climate. However, there is a striking paucity of paleo-climate records for this sensitive area, a critical database to enable a better understanding and prediction of climate change. This collaborative research is to core and investigate selected seafloor targets in the Arctic Ocean as part of an envisioned trans-Arctic crossing by the Swedish icebreaker, Oden and the USCGC Healy in 2005. The goals of this research are to establish a pan-Arctic stratigraphy and paleoclimate record back to at least the last major interglacial, with special emphasis on the Chukchi region north of Alaska. Acoustical surveys (shallow penetration) will permit locating sites with high sedimentation rates. The initial post-cruise work will focus on establishing a pan-Arctic chronostratigraphy using several dating and stratigraphic tools. Responsibility for and results of chronostratigraphic analyses such as radiocarbon dates, luminescence dates, paleomagnetic intensities, and  $^{210}\text{Pb}$  mixing rates will be shared with both the USA/Canadian team and European colleagues funded through other agencies. The acoustical surveys and sediment physical parameters will be measured by the European team, while the USA/Canadian team will analyze several sediment proxies for paleo-environmental and paleo-circulation reconstructions. These include foraminiferal assemblages, stable and radiogenic isotopes, ice-rafted detritus provenance, and dinocysts transfer functions for the reconstruction of surface drift and paleoclimates (sea surface temperature, salinity, and ice cover, etc.). The joint results will improve the understanding of short- and long-term variations in sea-ice, circulation (net drift), and the glacial history of the Arctic Ocean.

Several advisory documents to NSF (PARCS, SEARCH, SBI, Marine Science in the Arctic, etc.) mandate finding high resolution (>20 cm/ka) sediment cores in the Arctic to develop a paleoclimate record. [Thus, this research links with ARCSS](#) and the Global Climate Change Program [through the proposed documentation of the role of the Arctic Ocean in global climate change. In particular, this research will provide valuable data for the Western Arctic Shelf-Basin-Interaction \(SBI\) project.](#) The Canadian Shelf Environment Study (CASES), [the Study of Environmental Arctic Change \(SEARCH\)](#), and will help ocean and climate modellers to test the capability of numerical models to simulate the Arctic climate under extreme conditions such as the Last Glacial Maximum (LGM) or the warm phase of the Early Holocene, notably within the framework of the Paleoclimate Model Intercomparison Project (PMIP). Expected outcomes of this proposal are: providing new insights into the paleoclimatic history of the Arctic Ocean, and obtaining a unique cache of sediment cores to serve as research material for the coming decades.

#### **Underway Geophysics Project Summary :**

Over the last few years, the Arctic Ocean has been revealed through the acquisition of new data by airplanes, icebreakers, and submarines. These data have been compiled into publicly available grids of bathymetry, gravity, and magnetic data that provide a basic description of the region. This enormous international investment stems from the wide recognition that fundamental problems in the Earth Sciences, from paleoclimate and paleoceanographic issues to basic plate tectonics can be answered there.

To unravel the history of the region and gain a deeper understanding of the evolution of the Arctic Ocean it is necessary to image ridge structures and the accumulated Mesozoic and Cenozoic sediments with multi-channel seismic reflection data (MCS) and the deeper crust with seismic refraction data.

This underway geophysical data project will collect a transect of high resolution MCS and seismic refraction data across the entire Arctic Ocean basin. The new data will be acquired with an Arctic adapted MCS system (~100 meter streamer) and sonobuoys starting on the Chukchi Shelf, west of Point Barrow, Alaska and ending near Svalbard, Norway. The transect will cross the Chukchi Borderland, the Mendeleev Ridge, the Alpha Ridge, the Makarov Basin, the Lomonosov Ridge, and finally the Gakkel Ridge. These new data will illuminate the sedimentary layers and the upper crust of the Arctic Ocean. This is critical to determine the internal structure of the ridges and plateaus that subdivide the basin, and will establish the stratigraphy of the intervening basins.

Knowledge of this structure is required to test hypotheses regarding the history of the basins and ridges as well as the type and location of plate boundaries in the Amerasian Basin, the last pocket of resistance to the plate tectonic revolution. The objectives of this program reach beyond a local understanding of the Arctic and bear directly on understanding the global plate tectonic circuit for the Mesozoic.

During the combined programs *Healy* will collect an unprecedented, integrated underway geophysical data set consisting of multi-beam swath bathymetry and sidescan, sub-bottom profiler, multi-channel seismic reflection and seismic refraction data.

#### **Outreach Project Summary:**

While the focus of this proposal is on the structure and stratigraphy of the Arctic Ocean, the data will have uses beyond the work proposed here. The integrated data set collected from USCG *Healy* will be the beginning of a site survey database for the Arctic Ocean. This will build on the success of the first dedicated scientific drilling in the Arctic which take place on the Lomonosov Ridge during the summer of 2004. prepare for future scientific drilling operations in the Arctic Ocean and substantially increase international cooperation in Arctic Research.

[The cores and underway geophysics collected during the trans-Arctic cruise will provide extraordinary opportunities for participation by US and foreign scientists in a large collaborative international effort that is likely to have wide media coverage. College and pre-college students will have the opportunity to follow and participate in the proposed expedition and the core studies that follow via several venues, including the NSF Teachers and Researchers Exploring and Collaborating \(TREC\), links to a special web site, and work on selected projects. Media coverage is planned on the cruise to document the coring activities and provide video for news, documentary, and educational purposes.](#)

A number of students from both the US and Europe (eg Norway, Sweden and Russia) will participate in this cruise, learning about the Arctic Ocean and icebreaker operations. Now is the last opportunity to pass on the experience and knowledge of retiring scientists trained on ice islands and during the International Geophysical Year (IGY) to a new generation of scientists.

#### 2.2 Relevant previous or future research cruises:

The relevant previous research cruises would be the recent Arctic Coring Expedition (ACEX) last summer that drilled several boreholes on the Lomonosov Ridge and the coring expedition led by Lloyd Keigwin in 2002 that collected the longest piston core in the Arctic Ocean along the Alaskan continental slope. Of historical note is the 1994 Ocean Section joint crossing of a US and Canadian icebreaker.

### 2.3 Previously published research data relating to the project:

Darby, D. Bischof, J. Cutter, G., de Vernal, A., Hillaire-Marcel, C., Dwyer, G., McManus, Osterman, L., J., Polyak, L., and Poore, R., 2001, New record of pronounced changes in Arctic Ocean circulation and climate. *EOS*, 82(49): 603-607.

Darby, D.A., Bischof, J.F., and Jones, G.A., 1997. Radiocarbon chronology of depositional regimes in the western Arctic Ocean. *Deep-Sea Research*, 44:1745-1757.

Darby, D.A., Bischof, J., Spielhagen, R., Marshall, S., and Herman, S., 2002, Arctic ice export events and their potential impact on global climate during the late Pleistocene. *Paleoceanography*, 17(2): 15.1-15.17.

Edwards, M.H., Polyak, L., and Coakley, B.J., In prep. for G-Cubed, Glacigenic bedforms in the Arctic Ocean as mapped by the SCICEX/SCAMP seafloor survey.

Edwards, M., 2000, CNN Special Report: The Science of SCICEX. On-line website available at <http://www.cnn.com/SPECIALS/2001/icerun/scientist>.

Edwards, M., 2001, "Arctic Ocean Scicex Explorations". In: S. Earle (ed.), *National Geographic Atlas of the Ocean: The Deep Frontier*, National Geographic Society, Washington, D.C. pp.142-143.

Hovland, M., Backman, J., Coakley, B., Collett, T., Darby, D., Foucher, J.P., Francis, T., Gelfgat, M., Gorshkovsky, A., Jokat, W., Kaminski, M., Kristoffersen, Y., Takahashi, K., Thiede, J., Wiley, C., and Aachos, J., 2001. *The High-Arctic Drilling Challenge: Excerpts from the Final Report of the Arctic's Role in Global Change Program Planning Group*. *Joides*, 27 (1): 7-20.

Jakobsson, M., 1999, First high-resolution chirp sonar profiles from the central Arctic Ocean reveal erosion of Lomonosov Ridge sediments, *Mar. Geology*, 158: 111-123.

Jakobsson, M., Cherkis, N., Woodward, J., Coakley, B., and Macnab, R., 2000, A new grid of Arctic bathymetry: A significant resource for scientists and mapmakers, *EOS Transactions, American Geophysical Union*, 81(9): 93, 96.

Jakobsson, M., Mayer, L.A., Armstrong, A. and Gardner, J.V., 2003, A pan-Arctic transect for linking Eurasian and Amerasian records to constrain the paleoenvironmental evolution of the Arctic Ocean, Proposal to NSF.

Jakobsson, M., Lovlie, R., Arnold, E.M., Backman, J., Polak, L., Knutsen, J.O., and Musatov, E., 2001, Pleistocene stratigraphy and paleoenvironmental variation from Lomonosov Ridge sediments, central Arctic Ocean. *Global and Planetary Change*, 31: 1-22.

Lubinski, D.A., L. Polyak, and S.L. Forman, 2001, Deciphering the Latest Pleistocene and Holocene inflows of freshwater and Atlantic water to the deep northern Barents and Kara seas: Foraminifera and stable isotopes, *Quaternary Sci. Rev.*, 20: 1851-1879.

PARCS, 1999: The Arctic Paleosciences in the Context of Global Change Research – PARCS, Paleoenvironmental Arctic Sciences. ESH Secretariat, AGU, Wahsington, D.C., 95p.

Polyak, L., M.H. Edwards, M. Jakobsson, and B.J. Coakley, 2001, Existence of Arctic ice shelves during the Pleistocene inferred from deep-sea glaciogenic bedforms, *Nature*, 411: 453-457.

### 3. Methods and Means to be Used

3.1 Particulars of vessel:
Name: USCGC Healy Nationality (Flag state): USA Owner: United States Coast Guard Operator: United States Coast Guard Overall length (meters): 128 Maximum draught (meters): 8.9 Displacement/Gross tonnage: 16,000 LT Propulsion: Diesel Electric Cruising & Maximum speed: 12knots & 15 knots Call sign: NEPP Method and capability of communication (including emergency frequencies): INMARSAT (A, B & C), UHF, HF, VHF, 156.800 mHz emergency frequency Name of master: Captain Daniel Oliver, USCG Number of crew: 90 Number of scientists on board: 45

3.2 Aircraft or other craft to be used in the project:
Helicopters to transfer science crew to the pack ice to collect dirty ice and perform ice reconnaissance in advance of the ship.

3.3 Particulars of methods and scientific instruments		
Types of samples and data	Methods to be used	Instruments to be used

Water samples-hydrography	CTD-rosette casts	Seabird CTD-911+SBE32 Carousel
Current profiling	ADCP's	75kHz and 150 kHz in-hull
Bottom mapping	Single and multi- beam echosounders	Bathy2000, Knudsen 320 br Seabeam 2112 Swath mapper
Long sediment cores (= 30 m)	Piston corer, multi-corer, box-corer	Broda 30-m design
Crustal thickness/velocity profiles	Seismic Refraction recording returned acoustic energy at long offset (km)	Sparton AN/SSQ-57 SPC expendable sonobuoys
Gravity Anomaly Data	Underway gravity measurement	Bell BGM-3 Underway Marine Gravimeter
Expendible temperature profiles	XBTD deployment	TSK-XBD's
Multi-Channel Seismic Reflection	Firing airguns and recording returned energy at short offsets (~100 m)	Composite custom built system.

3.4 Indicate whether harmful substances will be used:

No

3.5 Indicate whether drilling will be carried out:

Only piston coring to depths of less than 25 meters below the sediment-water interface.

3.6 Indicate whether explosives will be used:

No

#### 4. Installations and Equipment

Details of installations and equipment (dates of laying, servicing, recovery; exact locations and depth):

No equipment will be installed on the seafloor.

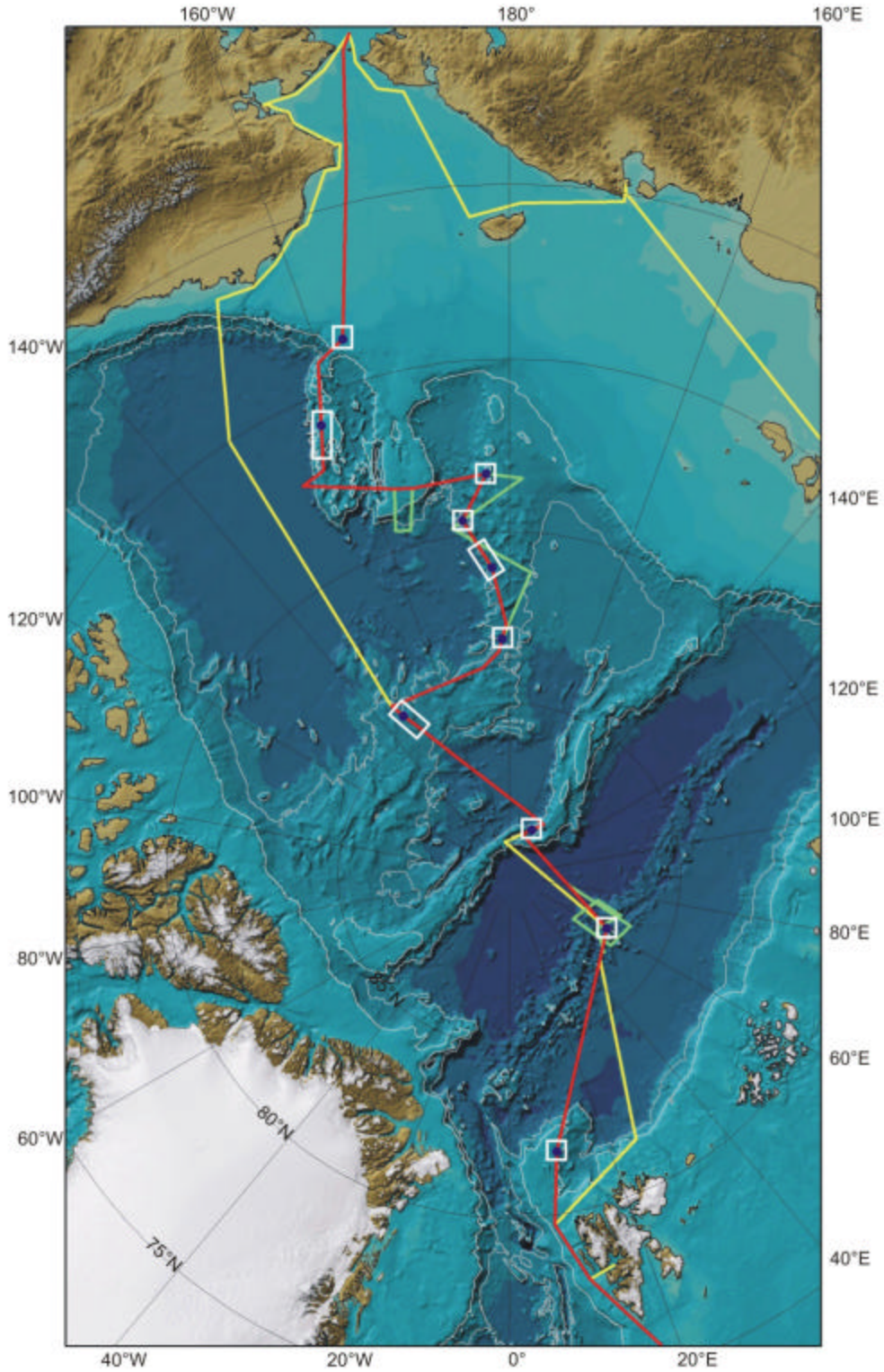
#### 5. Geographical Areas

5.1 Indicate geographical areas in which the project is to be conducted (with reference in latitude and longitude):

Underway geophysical data acquisition from 82.5° to 69° N and 0° to 20° E (continuous to Tromso).

Coring between 82° to 82.5° N and 2° to 3° E. Yermak Plateau

5.2 Attach chart(s) at an appropriate scale (1 page, high-resolution) showing the geographical areas of the intended work and, as far as practicable, the positions of intended stations, the tracks of survey lines, and the locations of installations and equipment. Healy Proposed track (red) with coring areas (white rectangles).



## 6. Dates

6.1 Expected dates of first entry into and final departure from the research area of the research vessel:

September 23, 2005 to September 30, 2005

6.2 Indicated if multiple entry is expected:

No

## 7. Port Calls

7.1 Dates and names of intended ports of call:

30 September, 2005 Tromso, Norway

7.2 Any special logistical requirements at ports of call:

None

7.3 Name/Address/Telephone of shipping agent (if available):

Not available at this time

## 8. Participation:

8.1 Extent to which coastal state will be enabled to participate or to be represented in the research project:

Several researchers, technicians and students from Norway will participate in this research and be onboard the Healy.  
The Norwegian Petroleum Directorate (NPD) has provided substantial funding for this cruise, supporting the participation of Yngve Kristoffersen and the preparation, shipping, operation and demobilization of his multi-channel seismic reflection equipment from the University of Bergen.

8.2 Proposed dates and ports for embarkation/disembarkation:

Embark Dutch Harbor, Alaska August 5, 2005, disembark Tromso, Norway, September 30, 2005

## 9. Access to data, samples and research results

9.1 Expected dates of submission to coastal state of preliminary reports, which should include the expected dates of submission of the final results:

October 30, 2005

9.2 Proposed means for access by coastal state to data and samples:

Project web site will be established and will include data collected during the entire cruise. Samples will be temporarily stored at the University of Stockholm and then permanently archived at Ohio State University, Byrd Polar Research Center. Yngve Kristoffersen will walk off the Healy with a complete geophysical data set from the cruise. He will make this available to the NPD and others in Norway as soon as data processing is complete.

9.3 Proposed means to provide coastal state with assessment of data, samples and research results or provide assistance in their assessment or interpretation:

A cruise report will contain documentation on the sediment cores collected and their geologic context as well as documenting the quality and quantity of underway geophysical data acquired during the program.

9.4 Proposed means of making results internationally available:

In addition of the cruise report, several publications will result from this research.

(Revised June 5, 2002)

## BIOGRAPHICAL SKETCH OF DENNIS A. DARBY

Department of Ocean, Earth, & Atmospheric Sciences,  
Old Dominion University, Norfolk, VA 23529, U.S.A.



### Academic Positions:

Old Dominion University, Dept. of Ocean, Earth, & Atmospheric Sciences, Professor (1995-pres.), Dept. of Geological Sciences, Professor (1988-1995), Assoc. Prof. (1978-1987), Assist. Prof. (1974-1977)

Hunter College of the City University of New York, Dept. of Geology & Geography, Assist. Prof. (1971-1974).

New York University, Dept. of Geology, Lecturer (1973-74).

### Education:

B.S. (Geology): 1966, University of Pittsburgh, Pennsylvania, U.S.A.

M.S. (Geology): 1968, University of Pittsburgh, Pennsylvania, U.S.A.

Ph.D (Geology and Oceanography): 1971, University of Wisconsin, Madison, Wisconsin,

### Selected Publications:

Darby, D. A. and Bischof, J.F., 2004. A Holocene record of changing Arctic Ocean ice drift, analogous to the effects of the Arctic Oscillation, *Paleoceanography*, v. 19, PA1027, doi:10.1029/2003PA000961, 9 p.

Hillaire-Marcel, C., A. deVernal, L. Polyak, and D. Darby, 2004, Size dependent isotopic composition of planktic foraminifers from Chukchi Sea vs. northwest Atlantic sediments – Implications for the Holocene paleoceanography of the western Arctic. *Quat. Sci. Rev.* 23(3-4): 245-260.

Darby, D. A., 2003, Sources of sediment found in sea ice from the western Arctic Ocean, new insights into processes of entrainment and drift patterns. *J. of Geophy. Res.*, v. 108, C8, doi:10.1029/2002JC001350, 10p.

Polyak, L., W. B. Curry, D.A. Darby, J.F. Bischof, and T.M. Cronin, 2003, Contrasting glacial/interglacial regimes in the western Arctic Ocean as exemplified by a sedimentary record from the Mendeleev Ridge. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 203(1-2): 73-93.

Darby, D.A., Bischof, J., Spielhagen, R., Marshall, S., and Herman, S., 2002, Arctic ice export events and their potential impact on global climate during the late Pleistocene. *Paleoceanography*, 17(2): 15.1-15.17.

Darby, D. Bischof, J, Cutter, G., de Vernal, A., Hillaire-Marcel, C., Dwyer, G., McManus, J., Osterman, L., J., Polyak, L., and Poore, R., 2001, New record of pronounced changes in Arctic Ocean circulation and climate. *EOS*, 82(49): 603-607.

Bischof, J. and Darby, D., 1999, Quaternary ice transport in the Canadian Arctic and extent of Late Wisconsinan glaciation in the Queen Elizabeth Islands. *Canadian J. Earth Sciences*, 36:2007-2022

Bischof, J.A. and Darby, D.A., 1997, Mid to Late Pleistocene ice drift in the western Arctic Ocean: evidence for a different circulation in the past. *Science*, v.277: 74-78.

Darby, D.A., Bischof, J.F., and Jones, G.A., 1997. Radiocarbon chronology of depositional regimes in the western Arctic Ocean. *Deep-Sea Research*, v.44:1745-1757.

Darby, D.A. and Bischof, J.F., 1996. A statistical approach to source determination of lithic and Fe-oxide grains: an example from the Alpha Ridge, Arctic Ocean. *Journal of Sedimentary Research*, v.66, p.599-607.

Darby, D.A., A.S. Naidu, T.C. Mowatt and G.A. Jones, 1989. Sediment composition and sedimentary processes in the Arctic Ocean, *In*: Y. Herman (ed.), *The Arctic Seas: Climatology, Oceanography, Geology, and Biology*. VanNostrand Reinhold, New York, p.657-720.

**Recent Service:**

NSF ARCSS Ocean, Atmosphere, Ice Interaction Science Steering Committee (1997-2004)

NSF Arctic Marine Science Strategic Planning Committee (1998-1999)

NSF Western Arctic Shelf-Basin Interaction Project Science Steering Committee (1999-2003).

Invited participant to 1999 COMPLEX meeting to plan for Ocean Drilling Program beyond 2002, NSF, Vancouver, BC.

Invited participant to US/Norwegian Collaborative Arctic Research Workshop in Svalbard, Norway, ARCUS, NSF, Aug., 1999.

Arctic Program Planning Group of JOIDES charged with developing a science plan for the initial Arctic Deep-Sea drilling dealing with global climate problems, 2000-2001

**Synergistic Activities**

Chair of Arctic Research Consortium of the United States (ARCUS) student research paper award selection committee in earth science, spring 2001.

Icebreaker Committee for the Canadian Arctic Shelf Exchange Study (CASES) site visit in Quebec, Canada, March 2-4, 2002.

JEODI Workshop on the future of Deep-Sea Drilling in the Arctic Ocean. Copenhagen, Denmark, Jan. 2003.

Talk entitled: "The role of the Arctic Ocean in global climate", at the Dept. of Geology, William and Mary College, March 1, 2000, and at the Dept. of Ocean, Earth, & Atmospheric Sciences Seminar Series, Old Dominion University, Fall 2000.

Talk entitled: "The Arctic in Global Climate Change and Millennial-Scale Change", at the Institute of Marine Sciences, University of Alaska, Fairbanks, March 2001 and at the Depts. of Geology and Anthropology, University of Alaska, Anchorage, March, 2001.

**Directed 16 graduate theses and a post-doctoral fellow (Jens Bischof)**

**Thesis Advisor** : Dr. David L. Clark, University of Wisconsin, Professor Emeritus

**Recent Collaborators**

William Curry and Lloyd Kegwin, Woods Hole Oceanographic Institute; Leonid Polyak, Ohio State University; Geln Berger, Desert Research Institute, University of Nevada; Lee W. Cooper, University of Tennessee; Margo Edwards, University of Hawaii; Claude Hilliare-Marcel and Anne deVernal, GEOTOP, Universite Montreal; Greg Cutter and Jens Bischof, Old Dominion University.