Abstracts from the

Arctic Forum

1999

Cover: Hunters help push a sled loaded with bowhead meat through a series of pressure ridges on the ice (© Bill Hess, Running Dog Publications).

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March 1999

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This report is published by ARCUS with funding provided by the National Science Foundation (NSF) under Cooperative Agreement OPP-9727899. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the NSF.

This publication may be cited as:
Arctic Forum 1999. The Arctic Research Consortium of the U.S. (ARCUS), Fairbanks, AK. 1999. 87 pp.

Table of contents

Foreword

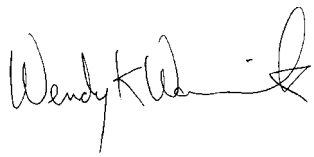
This collection of abstracts represents oral and poster presentations at the 1999 *Arctic Forum*, hosted by the Arctic Research Consortium of the U.S. (ARCUS) in Arlington, Virginia. The *Arctic Forum* is an interdisciplinary meeting of arctic researchers, which brings together investigators, officials of the National Science Foundation (NSF) and other agencies, educators, and student winners of the ARCUS Award for Arctic Research Excellence. ARCUS began hosting the *Arctic Forum* in conjunction with its annual meeting in October 1994. This abstract series begins with the 1998 *Arctic Forum*.

ARCUS represents the arctic research community on behalf of its 35 U.S. and international member institutions. ARCUS provides leadership in advancing knowledge and understanding of the Arctic by:

1. Serving as a forum for planning, facilitating, coordinating, and implementing arctic research;
2. Synthesizing and disseminating scientific information relevant to state, national, and international programs of arctic research; and
3. Encouraging and facilitating the education of scientists and the public in the needs and opportunities of research in the Arctic.

ARCUS also serves as a communication channel, providing information about current research activities and arctic issues to the scientific community as well as to agencies and the public. This work is done at many levels, including newsletters and other publications, electronic communications, K-12 education projects, workshops, and symposia like the *Arctic Forum*.

As executive director of ARCUS, I thank the many researchers who share their results with the community through the *Arctic Forum* and the National Science Foundation for supporting this opportunity. Renée Crain of ARCUS edited this abstract volume and prepared the layout and design based on the original design by Anne Sudkamp; Diane Wallace, Sue Mitchell, Alison York, Dan LaSota, and Alison Carter provided editorial and technical assistance. Abstracts from the *Arctic Forum* will be published annually. Please join us at the 2000 *Arctic Forum*.



Wendy K. Warnick
Executive Director
ARCUS
December 1999

Arctic system response to recent climate changes

Wieslaw Maslowski, Naval Postgraduate School (Session Chair)

A combination of field and modeling studies concentrating on arctic climate variability during the last few decades has shown this system to be much more active than previously thought. Recently reported shifts in the sea ice and ocean circulation and in the upper ocean water mass structure appear to be an integral part of the arctic system response to climate change. Analyses of atmospheric parameters over the Northern Hemisphere during the 20th century indicate that the Arctic Ocean is a center of atmospheric variability, which extends from the surface to the stratosphere. Other studies demonstrate that the northern land regions play an important role in arctic system dynamics as well. For example, the permafrost surface temperatures in Alaska and East Siberia have risen by 1–4 K over the last 50 years. Such environmental changes have dramatic consequences for human infrastructure (*e.g.*, due to an increase of permafrost active-layer thickness), ecosystem stability and, in general, on life quality of northern region societies (*i.e.*, northern Europe, Alaska, northern Canada, the Russian Arctic).

Another important aspect of arctic system variability is its feedback to lower latitude climates. Some of the most important processes in the Arctic Ocean, including maintenance of the permanent sea ice cover, deep water formation, and freshwater export, are of global significance. Such processes control, to some degree, both global ocean and atmospheric circulation, hence also weather and climate. Finally, some global climate simulations with increased concentrations of greenhouse gasses suggest changes in the Arctic that we recently have been witnessing are of the type that could be expected under a greenhouse warming scenario.

The *Arctic Forum* 1999 brought together an interdisciplinary group of scientists who reported on some key findings related to recent changes in the arctic system. The talks in this session covered topics ranging from sea ice, hydrological, and climate variability, through changes in permafrost behavior, to a large-scale ecological regime shift in the Northwest Atlantic due to human activities. Results from modeling and observational studies were presented by established researchers, as well as graduate students selected by the community for their outstanding work. The interdisciplinary nature of the *Arctic Forum*, and the combination of authors representing young and senior scientists, resulted in a high quality and successful scientific event.

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Modeling variability in the Arctic Ocean during 1979–1993

Wieslaw Maslowski, Naval Postgraduate School (Session Chair)

Significant changes in the sea ice and ocean circulation as well as in the upper ocean water mass structure have been detected in the Arctic Ocean during the 1990s. These changes seem to be at least in part driven by variability in the atmospheric circulation over the northern high latitudes during the last two decades. Recent analysis of the sea level pressure field and its variability over the Northern Hemisphere (NH) suggests that changes in the Arctic region are possibly a part of large scale climate variability, which can be described by the leading annular mode of the NH atmospheric extratropical circulation, or the so-called Arctic Oscillation (AO).

In an ongoing effort to model the Arctic Ocean response to and role in the recent climate variability, Pan-Arctic and global ocean models are used with prescribed realistic atmospheric forcing. The Pan-Arctic model is a basin-wide, high resolution, coupled ice-ocean model. It has been integrated for about 250 years, including a simulation using the reanalyzed 1979–1993 atmospheric fields from ECMWF (European Center for Medium-range Weather Forecasting). Results showing transition of sea ice and ocean circulations during that time are presented. Animations of multiple river tracer fields are shown, which depict changes in the circulation of fresh water in the central Arctic and its export into the North Atlantic. Some preliminary results from the 1/3-degree global ocean model forced with the ECMWF re-analyzed atmospheric fields are discussed with emphasis on adequate representation of exchanges between the Arctic and the North Atlantic and Pacific Oceans.

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Simulation of the interannual variability of the wind driven Arctic Sea ice cover during 1958–1998

Gilles Arfeuille, McGill University (Winner of the ARCUS Award for Arctic Research Excellence); Lawrence A. Mysak

A thermodynamic-dynamic sea ice model based on a granular material rheology (Tremblay and Mysak, 1997) is used to study the interannual variability of the Arctic sea ice cover during the 41-year period 1958–1998. Monthly wind stress forcing derived from the National Centers for Environmental Prediction (NCEP) Reanalysis data for this period is used to determine the year-to-year variations in the sea ice circulation and thickness. Special attention is given to analyzing the interannual variability of the sea ice volume in the Arctic Basin and the subsequent changes in the export of sea ice from this region into the Greenland Sea via Fram Strait. The contribution of the Fram Strait sea ice thickness and velocity anomalies to the sea ice export anomalies are first investigated, and the former is shown to be particularly important during several large export periods. The sea ice export anomalies are next related to the prior sea ice volume anomalies in the Arctic Basin. The origin and evolution of those sea ice volume anomalies are then related to the sea ice circulation and atmospheric forcing patterns in the Arctic. It is shown that the large sea ice export anomalies are generally preceded by large volume anomalies formed along the East Siberian Coast due to anomalous winds. Such ice anomalies develop when the Beaufort High is centered closer than usual to this coastal area. When the Beaufort High relocates near the Beaufort Sea and the Icelandic Low extends far into the Arctic Basin, the ice volume anomalies are transported to the Fram Strait region via the Transpolar Drift Stream. Finally, the link between the sea ice export through Fram Strait and the North Atlantic Oscillation (NAO) index is discussed. Although for some years there is a high correlation between the export and the index, there is not necessarily a causal relation between the wind (associated with the NAO) and the export. Therefore, these results primarily show that the Arctic Basin and its ice volume anomalies must be considered in order to fully understand the export through Fram Strait.

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References

Tremblay L.-B., and L. A. Mysak. 1997. Modeling sea ice as a granular material, including the dilatancy effect. *Journal of Physical Oceanography* 27:2342-2360.

The response of the polar regions to greenhouse warming in a global climate model

John Weatherly, Cold Regions Research and Engineering Laboratory; Warren M. Washington

A global, coupled atmosphere-ocean-ice model is used in simulations of present-day climate and projected future climate with increasing CO_2. The Parallel Climate Model (PCM) is implemented on massively-parallel processor computers, which allows higher resolution ocean and sea ice grids to be used in multi-century simulations of climate change. The sea-ice model uses relatively simple thermodynamics, the elastic-viscous-plastic dynamic ice rheology, and is run on a 27-km grid. The simulation of present-day climate is run for 300 years with insignificant drift in surface variables, but with excessive sea ice extent in both hemispheres. The Arctic sea ice is also thinner than observed by as much as 1 m. The greenhouse climate simulation includes CO_2 increasing to 710 ppmv in 70 years (1% per year) and held constant thereafter for 200 years. The global mean surface temperature increases by 1.5 K, with up to 8 K warming over the Arctic margins where sea ice cover decreases. The Arctic sea ice extent decreases by a relatively small 10%, while concentrations within the ice pack decrease, especially in summer. The Arctic sea ice thins by 0.5 m to 1.0 m, which is the primary response to warmer temperatures and increased radiation. Future and ongoing climate simulations will include the effects of sulfate aerosols, ozone and other trace gases, and changes in solar forcing.

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The fall and future of Newfoundland's cod fishery

*Richard L. Haedrich, Memorial University of Newfoundland; *Lawrence C. Hamilton, University of New Hampshire*

The 1992 collapse of the northern cod undermined a way of life that for centuries had been the foundation of Newfoundland outport communities. This collapse represents just one facet of a large-scale ecological regime shift in Northwest Atlantic waters, driven primarily by over fishing in the decades since World War II. The ecological shift, in turn, has had broad social consequences, starting with the loss of livelihoods for people and places that possess few alternative resources. A biological model helps to explore possible paths to cod fishery recovery, under a range of policy scenarios. We find recovery times on the order of 3–4 decades even under an absolute fishing ban. Reasonable recovery, and eventually substantial growth in jobs, can be achieved under "precautionary" low-fishing policies. A moderate-rate fishery could also be sustainable, but yields much lower levels of long-term employment. Slightly higher rates of fishing could prevent recovery or crash fish stocks completely. They might do so, however, after creating initially more jobs. Interactions among fish populations, catches, and jobs create a policy trap if managed for the very short term. Developments since the 1992 moratorium show the force of this trap, and offer an explanation for why no recovery has yet been seen. Model results highlight the importance of level and time, as specifics that give content to the widely discussed but vaguely defined goal of sustainability.

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Analytic representation of the active layer thickness field, Kuparuk River Basin, Alaska

Nikolay I. Shiklomanov, University of Delaware (Winner of the ARCUS Award for Arctic Research Excellence); Frederick E. Nelson

The initial response of permafrost to global warming could be an increase in active-layer thickness. Given that such changes could have severe consequences for human infrastructure and ecosystem stability, it is important to obtain information about spatial variations of the active layer corresponding to current climatic conditions, and to determine the magnitude of possible near-surface permafrost degradation associated with climatic change. Simple analytical solutions for frost and thaw penetration depth have long been available, but were used primarily for practical applications at point locations in cold-regions engineering. One of these methods, attributed to Kudryavtsev, was used to develop a spatially distributed analytical model that estimates the maximum annual depth of thaw. Kudryavtsev's procedures account for the effects of snow cover, vegetation, soil moisture, thermal properties, and regional climate, and provide estimates of surface temperature and active-layer thickness. GIS techniques were used to incorporate climate records, digital cartographic products, and field data into a spatially distributed estimate of active-layer thickness. Procedures were applied over a rectangular 22,300 km^2 area in north-central Alaska containing complex patterns of topography, vegetation, and soils. Validation procedures indicate that the modified Kudryavtsev approach yields accuracy and spatial resolution comparable to an existing semi-empirical method. The simplicity and low data requirements of the Kudryavtsev solution make it readily adaptable to different geographic scales and areas. The method is well adapted to climate-change studies.

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Permafrost temperature dynamics in Alaska and east Siberia during the last 50 years

Vladimir E. Romanovsky, University of Alaska Fairbanks; Tom E. Osterkamp

Our temperature measurements made over the last two decades show that permafrost has warmed at all sites along a north-south transect that spans the continuous and most of the discontinuous permafrost zones of Alaska from Prudhoe Bay to Glennallen. Modeling indicates that in the continuous permafrost zone, mean annual permafrost surface temperatures vary inter-annually within the range of more than 5 K. In the discontinuous permafrost, the observed warming is part of a warming trend that began in the late 1960s. Total magnitude of the warming at the permafrost surface since then is about 2 K. The last "wave" of the recent warming according to observed data began on the Arctic Coastal Plain, in the Foothills and at Gulkana in the mid-1980s (typically 1986 or 1987) and in areas of discontinuous permafrost about 1990 (typically 1989 to 1991). The magnitude of the observed warming at the permafrost surface is about 3 to 4 K at West Dock and Deadhorse, Prudhoe Bay region, about 2 K over the rest of the Arctic Coastal Plain and south into the Brooks Range and typically 0.5 to 1.5 K in discontinuous permafrost. At some sites in discontinuous permafrost south of the Yukon River, permafrost is now thawing from both the top and bottom. Thawing of ice-rich permafrost is presently creating thermokarst terrain which has significant effect on Sub-Arctic ecosystems and infrastructure.

In Spring 1998, we started a new collaborative project on comparison and analysis of ecological, climatic and permafrost characteristics along the two north to south transects which spans most of the permafrost zone in Sakha Republic (Yakutia) in Russia and in Northern Alaska. This paper presents the very first results of this collaborative research, which include the comparison of the climate permafrost temperature regime dynamics during the last several decades in Yakutia and in Alaska.

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Contaminants in the arctic environment

Stephanie Pfirman, Columbia University (Session Chair); Robie W. Macdonald; Derek Muir; Terry Bidleman

Unacceptably high levels of contaminants have been observed in Arctic people, polar bears, whales, birds and other organisms. In some regions the levels of PCBs, DDT and other pesticides (chlordane, toxaphene, dieldrin), cadmium, and methyl mercury exceed thresholds thought to impair reproduction, damage the immune system, disrupt endocrine systems, interfere with neuro-behavior, thin eggshells, and harm kidneys. What are the sources of these contaminants? How do they get to the Arctic? Why are their concentrations high in some regions or organisms and not others? How long will it take for concentrations to drop to acceptable levels once sources are controlled? We are beginning to learn that these questions cannot be answered until we have a complete understanding of the global and regional pathways along which contaminants move. For contaminants undergoing long-range transport, nasty surprises always arise from unsuspected pathways and it is these "critical pathways" that put contaminants on somebody's dinner plate. The Arctic Ocean is remarkably vulnerable to contaminant delivery and uptake due to its position on the globe, its oceanographic structure, its production of ice and its marine food web. Simple advection from point or regional sources delivers contaminants to the Arctic. But vulnerability is produced by processes such as: cold-trapping of volatiles and semi-volatiles; redistribution by fog and drifting sea ice; hindered exchange due to ice cover; hindered mixing due to stratification; minimum degradation due to low temperatures and light levels; strong recycling of organic carbon and associated contaminants; a multi-level food web that is organized around fat; contaminants that partition strongly into fat; and, finally, a human population strongly dependent on this food web. Although models are now showing success in reproducing global distributions of some contaminants, we do not as yet understand environmental pathways well enough that we can depend on models to protect us. We must, therefore, continue to monitor contaminant concentrations in the Arctic and direct our studies toward understanding how contaminants enter and move along biogeochemical pathways.

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Episodes of contamination in the Arctic: GIS provides means to assess transport pathways, sources, sinks and episodes of events

Kathy Crane, Naval Research Laboratory; Jennifer Galasso

The Naval Research Lab Arctic Contamination GIS provides much needed information to illustrate data gaps, trends and important transport pathways. In addition, use of a GIS provides the data to "ground truth" physical models, and may be useful to help predict future contamination trends in the Arctic.

Information from the GIS suggests that radionuclide contamination in the Arctic changed through space and time. The events ranged from fallout from Novaya Zemyla nuclear testing, fallout and ocean transport from central Pacific, U.S. test sites, 1960s–1970s contamination from the Ob' River, 1970s–1980s contamination from Sellafield, and late 1980s–1990s contamination from the Chernobyl accident. Radionuclides are still reaching the high arctic water and sediments, and probably stem from FSU sources (*e.g.*, not fallout). Some radionuclide contaminants are on the continental shelf north of Alaska. Their source is probably from FSU facilities. The implications are that the contaminants were not transported directly between the Chukchi and Beaufort Sea pathway but via the Trans-Arctic Drift and the Beaufort Gyre. Data suggest that canyons in the Russian continental shelf act as transport highways for contaminants to the inner Arctic. Based on clay and total organic carbon studies, the regions of seafloor most easily contaminanted are the Bering Sea near the Aleutian Islands, the Chukchi Sea east of the Lena Delta, the Kara Sea and the Barents Sea. These data also suggest that should there be a nuclear accident from Murmansk into the Barents Sea, the most likely path of seafloor contamination would be to the northeast along a channel of fine-grained sediments.

In addition, organochlorine and heavy metal contamination is very high along the Russian shelves, in water, ice and sediment. Across the Arctic in North America, one can easily track organochlorines and heavy metals in the marine and terrestrial environments suggesting that a complex combination of wind, water and ice is involved in transporting the contaminants from Eurasia.

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Persistent organic pollutants in the Arctic: Food webs, metabolic processes, and contaminant patterns in the higher marine trophic levels

Paul R. Becker, National Institute of Standards and Technology

The Arctic receives persistent organic pollutants (POPs) through long-ranged transport and subsequent deposition due to cold temperatures. These POPs tend to bioaccumulate; therefore, one would expect the highest levels of these compounds to occur at the higher trophic levels of an ecosystem. Studies of contaminant concentrations in tissues of higher trophic level marine organisms (*e.g.*, marine mammals and birds) have been conducted in the Canadian Arctic for about 20 years and within the U.S. Arctic, on a limited basis, for only about the last 10 years. Higher trophic level marine organisms provide a significant source of food for Native Arctic residents; therefore, there is an increasing interest in evaluating the health of these animal populations and the health of the human populations that depend on these animals. The importance of understanding the food webs supporting marine mammal and bird populations and the metabolic processes affecting the nature of the POPs will be important in understanding the significance of geographic, temporal, species-specific, and population-specific patterns of POP concentrations that occur in the higher trophic level biota.

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Factors affecting organochlorine contaminant concentrations in milk and blood of northern fur seal (*Callorhinus ursinus*) dams and pups from St. George Island, Alaska

Kimberlee B. Beckmen, University of Alaska Fairbanks (Winner of the ARCUS Award for Arctic Research Excellence); Gina M. Ylitalo; Rodney G. Towell; Margaret M. Krahn; Todd M. O'Hara; John E. Blake

Levels of organochlorine contaminants in blood of northern fur seal (*Callorhinus ursinus*) pups and the blood and milk of their dams early in the lactation period are reported here. The contaminants included 15 selected individual polychlorinated biphenyl (PCB) congeners and DDT metabolites identified through high-performance liquid chromatography. Congeners CB-77, -126, and -189 were below the limits of detection in milk and blood samples analyzed. Congener specific concentrations of PCBs in the blood of pups were compared based on the age of their dam (5 years or younger, or more than seven years). Pups of young dams (presumably primiparous) had significantly elevated levels of CBs-101, -118, -128, -138, -153/87, -170/194, and -180 than pups of older dams (multiparous). Congeners CB-128 and CB-170/194 were detected in the blood of pups of young dams but not in the blood of pups of older dams or in any of the dam's blood. Additionally, pups had higher blood levels of 8 of 8 PCB congeners as compared to the blood of dams and 7 of 10 congeners measured in milk when adjusted for lipid content. Levels of DDT metabolites and toxic equivalency quotients of dioxin-like congeners followed similar trends. Lipid-normalized concentrations of CB-101 and total CBs were significantly higher in the blood of dams than in the milk. CB-128, -156, -157, -170/194, p,p'-DDT, o,p'-DDT, p,p'-DDD, and o,p'-DDD were not detected in dam blood samples, but were detected in milk samples. Calculation of "biomagnification factors" from milk to pup blood indicated a biomagnification of CB-101, -105, -118, -138, -153/87, and -180. Significant mean accumulation factors ranging from 1.5 to 7.5. Inter-annual differences in exposure levels and specific congener concentrations in both milk and blood were apparent. Northern fur seal pups, especially first-born, have a substantial exposure to organochlorine contaminants at a critical developmental stage.

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The Evironmental Protection Agency's efforts to bridge traditional knowledge, Arctic environmental research, and decision-making processes

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Building bridges: Indigenous knowledge, education, and science

Sean Topkok, Alaska Native Knowledge Network and ARCUS (Session Chair)

The purpose of the Alaska Rural Systemic Initiative (AKRSI)/Alaska Native Knowledge Network (ANKN) is to bring people together from throughout the state to implement a five-year series of initiatives to systematically document the Indigenous knowledge systems of Alaska Native people and develop educational policies and practices that effectively integrate Indigenous and Western knowledge through a renewed educational system. The emphasis throughout the program is on renewing Native pathways to education, so that traditional knowledge systems, ways of knowing, and world views can be more effectively utilized as a foundation for learning all subject matter, particularly in the context of rural and Native Alaska. Overall guidance for the AKRSI/ANKN is provided by a series of Elders' Councils, and the Alaska Native/Rural Education Consortium, made up of representatives of the partner organizations from thoughout the state.

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An examination of traditional knowledge: The case of the Inuit sled dog

Kerrie Ann Shannon, University of Aberdeen (Winner of the ARCUS Award for Arctic Research Excellence)

This paper suggests why traditional knowledge is relevant for examining the social and cultural importance of sled dogs within Inuit culture, as well as examines traditional knowledge surrounding the care and maintenance of dog teams. Data were gathered during a research project in a Northwest Hudson Bay Inuit community in the winter of 1995/1996. Respondents were interviewed with respect to traditional knowledge concerning dogs and dog teams. This paper focuses on aspects of this traditional knowledge. It was observed that considerable inconsistencies were reflected in the responses and this paper explores some of the possible reasons for these inconsistencies. This paper situates the topic within the contexts of other research and will: 1) define traditional knowledge as used in this paper, 2) explain why traditional knowledge is a relevant aspect of culture to consider, 3) briefly describe research methods used, 4) give an overview of some interview results, 5) examine sources for inconsistencies in some aspects of traditional knowledge.

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The integration of science education and Arctic research: Teachers Experiencing the Arctic and other research/education partnerships

Debra Meese, Cold Regions Research and Engineering Laboratory

Interest in programs in which teachers experience research has increased significantly in the last few years. This interest is reflected in the polar science community, as evidenced by the Arctic Science Education Workshop held by the Arctic Research Consortium of the United States in April, 1997 (ARCUS, 1998) and the call for a significant education component in *People and the Arctic: A Prospectus for Research on the Human Dimensions of the Arctic System* for the National Science Foundation (NSF) Arctic System Science Program (ARCUS, 1997).

Teachers Experiencing Antarctica or the Arctic (TEA) has its beginnings in 1992 in the Antarctic; the Arctic research experience began in 1996 with a pilot program. Both components have been supported by the National Science Foundation's Elementary, Secondary and Informal Education of the Education and Human Resources, and the Office of Polar Programs; a joint funding relationship that reflects NSF's strong commitment to integrating education and research.

Partnership agreements between institutions have also resulted in the integration of research and education, many of which continue through informal programs. Students from Iḷisaġvik College have participated in the Cold Regions Resarch and Engineering Laboratory's (CRREL) research on the North Slope. This program resulted in funding from the Alaska Science and Technology Foundation and a donation of equipment from Campbell Scientific to the College.

In many cases these programs not only allow infusion of the research into the classroom via the teachers research experience, but the teacher and their students may continue to participate in research subsequent to the experience. This can result in a realistic view of research as viewed by the students who then understand the pitfalls and joys, but can also aid the researcher and the research community.

"...I participated in the Arctic West Section 1996 cruise and found it to be a very useful platform for classroom projects over the last two years. The PI from CRREL has been instrumental in providing equipment to my classroom that has allowed Barrow High School biology students to sample near shore ice around Barrow this past school year. Thanks to support from CRREL, ARCUS and ARM (Atmospheric Radiation Measurement), my students have been able to learn more about their immediate environment..." — Tim Buckley, Teacher, Barrow AK.

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People of the Arctic: The photographic wanderings of the Running Dog

Bill Hess, Northern Photographer

The Iñupiat Eskimos have lived and hunted in the Arctic for 5,000 years. Their culture evolved in one of the coldest, most inhospitable climates in the world around the seasonal cycle of ice and migratory animals. In this year's special presentation at the *Arctic Forum*, Bill Hess shares photographs and stories that paint a portrait of subsistence hunting and the culture of Iñupiat Eskimos. Many of these images and experiences can be seen in his book, *Gift of the Whale: The Iñupiat Bowhead Hunt, a Spiritual Tradition*.

For eleven years, 1985–1996, Hess single-handedly produced *Uiñiq*, a quarterly photo magazine covering life in Alaska's North Slope Borough. The Borough covers an area nearly the size of the state of Utah and has a permanent population of about 5,500 people, most of them Iñupiat Eskimo. Hess flew his small airplane, the Running Dog, all about the Borough, to other locations across Alaska, and into Canada's Yukon and Northwest Territories. He also made trips to Greenland and the Russian Far East gathering photos and stories. Prior to beginning *Uiñiq* in 1985, Hess worked for three-and-a-half years as a roving reporter, photographer, and editor for the *Tundra Times*, a statewide newspaper covering Alaska Native issues. Before coming to Alaska in 1981, Hess spent six years living on the White Mountain Apache Indian Reservation in Arizona where he met his Native wife and the mother of his five children. There, he produced a newspaper for the tribe and did freelance work. Hess continues to document life in Alaska and the Arctic through *Village Voices*, a quarterly publication funded by the Rural Alaska Community Action Program (RurAL CAP), and other projects that come along.

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A survey of current research in the Arctic: Poster presentations

Michael Retelle, Bates College (Poster Session Chair)

Each year ARCUS invites the arctic research community to submit posters to the *Arctic Forum*. The *Arctic Forum* is one of few interdisciplinary scientific venues offering arctic researchers an opportunity to exchange information and ideas across disciplines on an annual basis. Numerous submissions from international researchers and international research projects contributed to the diversity of perspectives, issues, and locations in the poster session.

The call for posters is open to all researchers working on questions related to the Arctic. Posters in the 1999 *Arctic Forum* represented a variety of specific research projects, educational programs, and research facilities, in addition to the three themes of the paper sessions, 'Arctic system response to recent climate changes,' 'Contaminants in the Arctic,' and 'Building bridges: Indigenous knowledge, education, and science.' Submissions to the 1999 *Arctic Forum* have been grouped into general categories and abstracts are arranged alphabetically by the first author's last name within these emergent categories. An author index is located on page 86.

Poster abstracts in this volume demonstrate the increasing collaboration among scientific disciplines in such areas as climatic reconstruction and monitoring global climate through sediments, ice, soil, and permafrost; tracing patterns of ice, water, and sediment flow in the Arctic Ocean; measuring interactions between ocean, ice, and atmosphere; and incorporating arctic communities in scientific research and education projects. Several submissions result from the international, multidisciplinary Surface Heat Budget of the Arctic Ocean (SHEBA) research project. Basic scientific research issues, such as monitoring the health of marine mammals and measuring plant response to changing conditions, as well as current scientific research initiatives in the Arctic are represented here.

ARCUS looks forward to future sessions of the *Arctic Forum* and to its ongoing growth and diversification as a symposium for presenting interdisciplinary arctic research.

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Holocene records of river runoff in Arctic Siberia (Laptev Sea)

Henning A. Bauch, GEOMAR; Heidemarie Kassens; Ulrich Struck; Helmut Erlenkeuser; Pieter M. Grootes

The Siberian Arctic and its shelf seas can be regarded as a key region to investigate present and past environmental change on a regional and global scale. The vast and shallow Laptev Sea appears to be particularly important, because here a large amount of riverine water is annually discharged onto the shelf and directly entrained into the Arctic Ocean. The shelf sediments not only contain information of this fluvial runoff, they are also sensitive recorders of those changes which occurred after the last glacial maximum when this region became gradually flooded due to a rising global sea level. We have investigated core PM9462 from the submerged Yana valley in the eastern Laptev Sea. This core was obtained from 27 m water depth and recovered 467 cm of dark gray, organic-rich, silty clay. The lowermost 22 cm consists of a silt, containing high amounts of plant debris (*e.g.*, peat). Radiocarbon dates of peat fragments revealed ages of 11 and 17 ka BP for the upper and lower part of this section, implying a strong terrestrial influence due to fluvial runoff. The remaining part of the core contained numerous bivalves, implying marine conditions. Age determination on these shells shows that these sediments were accumulated during the past 8 ka. Investigations on the total organic carbon and stable carbon isotopes also clearly indicate a rapid decrease in accumulation rates and input of terrestrial matter after 8 ka BP and a gradual change towards more marine conditions since then. Nevertheless, the depositional character of this region remained still variable during the later Holocene. This is corroborated by oxygen isotopes analyzed on benthic foraminifera, indicating variable salinities of bottom waters due to freshwater runoff.

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Holocene vegetational change in northern Siberia as reflected in Arctic Shelf sediments

Henning A. Bauch, GEOMAR; Olga D. Naidina

The depositional environment of the shallow Laptev Sea shelf is dominated today by the input of masses of riverine freshwater. These large Siberian rivers transport high contents of suspended sediments. As surface sediments from the Laptev Sea reveal, the suspension load contains considerable amounts of organic matter of which a substantial part is made up of pollen and spores. Pollen data from near-coastal marine sediments of the Laptev Sea may offer important information of the vegetational history as well as the hydrological cycle and atmospheric circulation of Arctic Siberia through time. The pollen-spores spectra found in surface sediments from the Laptev Sea give clear evidence of this land-to-ocean transportation mechanism. Since the formation of the vegetation cover on land is directly related to temperature and humidity, plants represent a stable and reliable proxy for a changing climate. Thus, variations in taxa compositions of distinct vegetational types as well as significant geographical shifts of vegetational zones through time can be used as indicator for climatic changes. Palynological studies were carried out on a sediment core from the eastern Laptev Sea, covering the past 8.5 ka. Most of the determined pollen taxa can be grouped into several distinct, ecologically significant associations, which today are characteristic of Arctic Tundra, Typical Tundra and Forest Tundra. On this basis, the Holocene time interval is divided into three pollen assemblage zones: Zone I (8.5 to 6.3 ka) cold and wet conditions dominated by sedge associations; Zone II (6.2–4.8 ka) shows increased proportion of arboreal pollen *Pinus pumila*, indicating a warming; during Zone III (4.7 ka to present) the climate and vegetation are close to the present, changing insignificantly between 4.7 to 1.7 ka. Since then temperature has decreased, which is documented by a decline in arboreal pollen and an increase in tundra herbs and grasses.

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Diatom assemblage studies reflect hydrographical changes in the Laptev Sea

Henning A. Bauch, GEOMAR; Yelena I. Polyakova; Holger Cremer; Heidemarie Kassens

In the context of growing concern about the response of the Arctic regions to environmental change and its impact on global climate, the Laptev Sea and its Siberian hinterland are of particular interest. Here, the Lena river discharges onto the Laptev Sea shelf, thereby constituting a key source for the Arctic Ocean's halocline. Further, the shallow Laptev Sea shelf is the major sea-ice production area in the Arctic, ice which is generated in the Laptev Sea Polynya during winter. Given the variability on decadal and on centennial timescales, the dispersal and fate of Lena river discharge and its role on the ice regime as well as on water mass properties are a central issue in understanding long-term changes in the Laptev Sea and the Arctic Ocean. Based on a diatom study, temporal changes in salinity were investigated in radiocarbon dated core PM9482. The distributional pattern of diatoms is characterized by high variability throughout the core section, reflecting the changes in hydrology, sedimentology, and sea-ice conditions north of the Lena Delta during the late Holocene (past 2.7 ka). Three main ecological groups were distinguished: marine planktonic and sublittoral species, sea-ice species, and freshwater species. Freshwater diatoms predominate both taxonomically (2/3 total taxonomical diversity) and quantitatively (up to 85%) throughout the core section, indicating the constant river discharge to the shelf zone north of the Lena Delta during the last 2.7 ka. Although the sea-ice indicating species may be linked to sea-ice production, their temporal variability seems to be linked to productivity processes induced by the Laptev Sea Polynya. Temporal variations in freshwater discharge to the studied site are interpreted from the ratio of freshwater and marine diatom species.

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Preliminary lake coring results from Elgygytgyn Crater, eastern Siberia

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Elgygytgyn Lake, located 100 km north of the Arctic Circle in northeast Russia (67°30' N latitude and 172°05' E longitude), was created 3.6 million years ago (n=11 Ar/Ar ages) by a meteorite impact that generated a crater roughly 20 km in diameter. An international expedition to the lake in May, 1998, successfully recovered sediment cores from the center of the 15 km wide basin for the first time, penetrating 12.5 meters in 175 m water depth using a percussion piston corer from the lake ice surface. The goal of the study is to examine the upper portion of the total sediment package in Elgygytgyn Lake and use it to determine the potential for a long, continuous record for paleoclimatic analysis. The sediments in the basin likely contain unique information concerning the Northern Hemisphere's transition from a forested Arctic to one of permafrost, tundra, perennial sea ice and repeated continental-scale glaciations. Moreover, it likely contains a record of the response of the vast East Siberian region to glacial/interglacial change right up through the Holocene. Preliminary work on the overlapping core segments indicates that the sediments consist of massive to finely laminated grayish to greenish muds

continued on next page

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with discrete intervals containing authigenic vivianite and perhaps lake ice-rafted clay clasts. Gravity cores of the sediment/water interface indicate that the modern lake floor is oxygenated with some bioturbation. Sub-millimeter laminated sections vary in thickness from 10 to 40 cm and may represent intervals when sedimentation outpaced bioturbation or the lake floor became anoxic. Distinct fluctuations in various sedimentological (stratification, clasts), physical (susceptibility), biochemical (TOC, TN, TS, s13TOC), and paleoecological (pollen, diatoms) parameters provide firm evidence that Elgygytgyn Lake and its catchment respond to environmental change. Geochronology on the core, including the timing of pollen transitions, the occurrence of subtle magnetic excursions and three optical luminescence ages, confirms that our 12.5 m core extends back more than 200 ka. If we assume that our very preliminary age model is correct, then Holocene and interglacial sedimentation rates averaged about 8-10 cm/1000 yrs., while rates during the LGM may have been as low as 4 cm/1000 yrs. An average sedimentation rate of 6 cm/1000 yrs. places the base of the core at just over 200,000 years. Extrapolating further, this rate of sedimentation would suggest that the entire 3.6 My history of the basin could be contained in a much as 225 m of basin fill.

Status of the proposed international permafrost monitoring network and service

Jerry Brown, International Permafrost Association; Roger Barry; Frederick E. Nelson

Changes in the permafrost and the overlying active layer can be important indicators of climate change and human-induced perturbations. Temperature measurements in shallow to deep boreholes are carried out at locations throughout the polar and mountain regions. Similarly, active layer temperatures and thickness are commonly observed at research sites in both hemispheres. The locations of existing active layer and borehole measurement sites are marked on the digital circumpolar permafrost map of the Northern Hemisphere (CAPS CD-ROM) and several regional maps.

In the past several years, efforts were begun to coordinate observational programs among different countries. Beginning with the International Tundra Experiment (ITEX), a standard protocol was developed for active layer observations. These sites and methods are now incorporated into a 12-country, 70-site network under the Circumpolar Active Layer Monitoring (CALM) network. A subset of these sites is also measuring temperatures in shallow boreholes. The European Community project Permafrost and Climate Change in Europe (PACE) has begun to instrument boreholes in mountain permafrost from Svalbard to Italy.

The Global Climate Observing System (GCOS), Global Terrestrial Observing System (GTOS) and World Climate Research Program (WCRP) Climate and Cryosphere (CLIC) Task Group have identified Permafrost Thermal State and Permafrost Active Layer as key cryosphere variables and as candidates for their global network (see GCOS report-32, WCRP, 1997).

At the June 1998 meeting of the International Permafrost Association (IPA) Council, Yellowknife, Canada, several steps were taken to bring these developing activities together. The Council approved the concept of a permafrost monitoring network to include both active layer and permafrost temperatures, a supporting data service, and a mechanism to develop an internationally acceptable approach. The IPA Council also established a Working Group on Southern Hemisphere Permafrost and Periglacial Processes, with a primary function to assist in establishing and reporting permafrost and active layer observations in the Antarctic and mountainous regions of the hemisphere.

The first steps in assessing the feasibility and

continued on next page

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resulting structure for such a global network and service were initiated in 1998. The GCOS/GTOS guidelines provide the context for developing the network and service and include the following points:

1. Existing and proposed new sites need to be assessed in the framework of the GCOS/GTOS five tier Global Hierarchical Observing Strategy (GHOST) for surface observations;
2. Participating sites should be capable of collecting, documenting and making freely available the appropriate data; employ generally accepted methodologies that are well documented; and have reasonable assurance of continuity of measurements for the long-term;
3. Sites in under-represented ecosystems have priority over already-represented systems; and
4. All else being equal, sites where research is also carried out are preferred; long-established sites and ones with long-term funding commitments are also preferred, as are readily accessible sites.

The initial role of the permafrost network is to organize systematic collection and distribution of standardized data. Efforts are also needed to assess ongoing changes, in order to detect the impact of long-term climate change on the active layer and permafrost thermal regime, particularly on a regional basis. An official designation as a GCOS/GTOS site or series of regional sites can have a substantial advantage for a group or a national agency when requesting funding. Participation in an international network of sites enables an integrated suite of terrestrial variables to be observed, and therefore, the significance and impact of the measurements are greatly increased. This facilitates direct use of the data by international organizations such as the Intergovernmental Panel on Climate Change (IPCC) and the Arctic Monitoring and Assessment Programme (AMAP).

Further information may be found on the IPA WWW home page: http://www.geodata.soton.ac.uk/ipa.

Canadian High Arctic paleoclimatic reconstruction: Preliminary data from the laminated sediments of Sawtooth Lake

Pierre Francus, University of Massachusetts; Bianca Perren; Douglas R. Hardy; Mark Abbott; Raymond S. Bradley; Carsten Braun

Varved sediments from lakes in the Canadian High Arctic are being used to reconstruct and understand paleoclimate variability over the last few millennia. Several short cores (30 cm) and two long cores (2 m) have recently been retrieved from "Sawtooth Lake" (unofficial name) on Ellesmere Island, located at 79°20' North and 83°51' West. On-site meteorological, hydrological and sedimentological studies are underway to understand how the climatic signal is recorded in the varved sediments. Laboratory work is focused on image analysis, applied to backscattered electron images from thin-sections of the laminations. This technique allows retrieval of data at the lamina scale and characterizes each varve. Diatom analysis are providing ecological data. Grain-size, organic matter analysis, and paleomagnetic analysis are also underway and dating by 210Pb, 137Cs and TL is in progress.

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The Nansen Arctic Drilling Program

Andrea Johnson, Joint Oceanographic Institutions

The Nansen Arctic Drilling Program (NAD) is an international research effort designed to understand the geological evolution of the Arctic Ocean as well as the history of Arctic environmental change and its forcing functions. This knowledge will help predict the future of the Arctic basin and its effect on global processes. NAD is developing strategic plans for acquiring long, high-resolution sediment cores and deep basement cores needed to understand the Cenozoic and Mesozoic paleoceanography, paleobiology, and structural history of the Arctic region. To date NAD has written both a Science Plan and an Implementation Plan to guide its future activities. Current NAD membership includes: Canada, Denmark, Germany, Norway, Russia, United Kingdom, and the United States. France, Japan, Iceland, Sweden, and The Netherlands have also periodically participated in NAD. A NAD Secretariat, housed at Joint Oceanographic Institutions (JOI), distributes The Nansen Icebreaker newsletter and other publications to promote the program and to facilitate the exchange of information and ideas within the Arctic geoscience community.

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Shelf sedimentation in the Siberian Arctic reveal past global changes

Heidemarie Kassens, GEOMAR; Henning A. Bauch; Igor Dmitrenko

The marginal seas of Arctic Eurasia have undergone dramatic environmental changes after the last glaciation, since c. 16 ka. These changes were due to the decay of late Weichselian ice sheets in the course of global postglacial climate warming and contemporaneous eustatic sea-level rise. The modern hydrography of the Laptev Sea shelf today is composed of two main water masses: (i) A noticable influence of marine water masses in the western as well as along the outer-shelf areas; (ii) Water masses with lower salinity waters occur closer to the shore and particularly in the eastern Laptev Sea where the largest amount of freshwater from Lena and Yana rivers enter the shelf. Sediments here are fine-grained and mainly reflect suspension material introduced by these rivers during summer months. They are being deposited chiefly along the submerged paleoriver valleys. Sediment accumulation rates calculated on cores taken from various water depths are used to infer changes in land-ocean interaction during the Holocene. These indicate that during the early Holocene (until 8 ka BP) high accumulation took place in the outer shelf area. Due to the rising sea level the depositional centers gradually migrated southwards until highest sea level was reached around 6 ka BP, leading to extremely low accumulation rates in areas deeper than 50 m water depth since then. The data show that the sedimentation processes on the Laptev Sea shelf during the Holocene can be linked to past global changes.

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Nansen Arctic Drilling Program: Understanding the history and climate of the Arctic through scientific ocean drilling

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Abstract not available.

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Arctic Climate Observations using Underwater Sound (ACOUS)

Peter Mikhalevsky, Science Applications International Corporation; Mike Lents; Dennis Conlon

In October 1998 a 20 Hz acoustic source was deployed from the Russian icebreaker, *Akademic Fedorov* in the Franz Victoria Trough between Spitzbergen and Franz Josef Land. At the same time an acoustic receiver array was deployed in the Lincoln Sea approximately 1000 km away. These are the first installations of an acoustic thermometry grid for the Arctic Ocean as part of the Arctic Climate Observations using Underwater Sound (ACOUS, from the Greek, "akous", meaning "listen!"). The source is autonomous and is designed for a three year life. The array is also autonomous and designed for an 18 month life. In the summer of 2000 a cabled acoustic array is planned for installation in the Beaufort Sea. This array will be cabled to Barrow, Alaska and will include thermisters, salinometers, and current meters as well as a specially designed near-shore horizontal array for marine mammal listening and tracking. A second acoustic source is also planned for installation in 2000/2001, most likely in the central Arctic.

Since the early 1990s inflow of warmer Atlantic Water into the Arctic Ocean has resulted in temperature increases in the Atlantic Layer that are continuing until today. Point measurements from icebreakers in 1991 and 1993 showed temperature increases of several tenths of a degree C over historical climatologies. In 1994 acoustic transmissions were made from a site north of the Svalbard Archipelago across the entire Arctic Ocean to receiver arrays located in the Lincoln Sea and the Beaufort Sea. The travel time measurements revealed an average 0.4°C increase in the Atlantic Layer. This was the first basin scale measurement of this large scale warming. Since 1994 there have been annual trans-Arctic submarine cruises and one trans-Arctic icebreaker cruise that have also observed these changes.

Coupled atmosphere-ice-ocean modeling and analysis of recent data appear to support a possible decadal scale oscillation in the atmospheric and ocean circulation in the Arctic that may explain the recent warming and portend a return to cooler temperatures. The need for year-round real-time data from the Arctic is evident. Acoustic energy propagates across the entire Arctic basin in 30 minutes. An acoustic network that is beginning under ACOUS could provide real-time, year-round, synoptic Arctic

continued on next page

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Ocean temperature data on spatial and temporal scales that are simply not possible by submarine, ice breaker, or ice camp methods. In addition to using the travel time measurements to obtain ocean temperature, research is underway to use the acoustic attenuation changes to measure changes in average sea-ice roughness and thickness, and the use of multiple frequencies to measure the depth of the thermocline and thus the thickness of the upper mixed layer in the Arctic Ocean.

Seascapes of Iceland: Climate change and fisheries history

Astrid E. J. Ogilvie, Institute of Arctic and Alpine Research; Ingibjörg Jónsdóttir

The research presented here is drawn from a project which is supported by the National Science Foundation and which reflects the ARCSS (Arctic System Science) "SIMS" directive. This places a strong emphasis on elucidating and documenting interactions between the physical and human world by the synthesis, integration and modeling of different climatic, environmental and social elements. The main focus of the project is the detailed analysis of records of fisheries from Icelandic waters in the context of marine and land proxy climate records for the North Atlantic region. The time period of study for the fisheries component of the project is ca. AD 1600 to 1900.

Fishing was an important economic activity in Iceland from early settlement times onwards (from ca. AD 874). However, it was not until the twentieth century that it became a major industry (Jónsson, 1994). Much research has been carried out on the relationships between variations in climate and biological responses among fish during the present century (Beverton and Lee, 1965; Malmberg and Magnússon, 1982; Malmberg and Blindheim, 1993; Schopka and Marteinsdóttir, 1994). Such studies show that the dramatic changes in climatic conditions in the waters surrounding Iceland and Greenland that occurred during the present century brought about some of the most radical changes in quantity, distribution and reproduction of the fish fauna ever documented. These changes had a strong socio-economic impact in Iceland and Greenland, especially as a result of the fluctuations in availability of the all-important cod (Vilhjálmsson, 1997; Vilhjálmsson and Jakobsson, 1998). Analysis of environmental effects on fisheries in the past (when overfishing was not an issue) may cast light on current concerns of whether fish stocks are becoming depleted due to overfishing, or environmental changes, or both. A wide variety of documentary data from Iceland are being analyzed for this project. Preliminary analyses show some interesting results (Ogilvie and Jónsdóttir, 1999). Thus, for example, catches during the eighteenth century appear to have declined. In the mid-seventeenth century in the south of Iceland, one man would be expected to catch, on average, about five hundred cod during the winter fishing season, but, after the mid-eighteenth century, three hundred cod were regarded as the maximum catch. One objective of the research is to investigate why and how such changes occurred. In

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continued on next page

particular, to establish if they were driven by climatic or cultural changes, or both. Preliminary results suggest a combination of both. It is known that climatic conditions during the eighteenth century were often severe (Ogilvie, 1992.) Contemporary perceptions certainly linked poor fishing and the presence of sea ice. However, social factors also had an impact on poor fisheries catches. The smallpox epidemic of 1707 to 1708, for example, which wiped out one third of Iceland's population, resulted in a lack of labor to man the fishing boats for many years afterwards.

References

Beverton, R. J. H., and A. J. Lee. 1965. Hydrographic fluctuations in the North Atlantic Ocean and some biological consequences. In C. G. Johnson, and L. P. Smith, eds. *The Biological Significance of Climatic Changes in Britain*. London: Academic Press. 79-107.

Jónsson, J. 1994. Utgerd og aflabrögd vid Island 1300-1900. *Hafrannsóknir 48*. 107 pp.

Malmberg, S.-A., and J. Blindheim. 1993. Climate, cod and capelin in northern waters. ICES 1993/CCC Symposium/ No. 20. 20 pp.

Malmberg, S.-A., and G. Magnússon. 1982. Sea surface temperature and salinity in south Icelandic waters in the period 1868-1965. *Rit Fiskideildar* (Journal of the Marine Research Institute, Reykjavik) 3:1-31.

Ogilvie, A. E. J. 1992. Documentary evidence for changes in the climate of Iceland, A.D. 1500 to 1800. In R. S. Bradley, and P. D. Jones, eds. *Climate since A.D. 1500*. London and New York: Routledge. 92-117.

Ogilvie, A. E. J., and I. Jónsdóttir. 1999. Sea ice, climate and Icelandic fisheries in historical times. Arctic. In review.

Schopka S.A., and G. Marteinsdóttir. 1994. Astand og afrakstur helstu nytjabotnstofna á Islandsmidum. In U. Stefánsson, ed. *Islendingar, hafid og audlindir thess*. Reykjavík: Vísindafélag Islendinga. 107-127.

Vilhjálmsson, H. 1997. Climatic variations and some examples of their effects on the marine ecology of Icelandic and Greenland waters, in particular during the present century. *Rit Fiskideildar* (Journal of the Marine Research Institute, Reykjavik) 15:9-29

Vilhjálmsson, H., and J. Jakobsson. 1998. Relations between environmental fluctuations and fisheries management. North Atlantic Climate Impacts. An International Workshop on Environmental and Climatic Variations and their Impact in the North Atlantic Region. 23-26 September 1998. Reykjavik: Icelandic Research Council. 28-29.

PALE Paleoclimates from Arctic Lakes and Estuaries: Paleoenvironmental research in the Arctic and subarctic

Paleoclimates from Arctic Lakes and Estuaries (PALE)

Abstract not available.

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Sediment transport to the Laptev Sea: Heavy mineral studies of recent and Holocene sediments

Bernhard Peregovich, GEOMAR; Erich Hoops; Henning Bauch; Hans Hubberten; Heidemarie Kassens; Volker Rachold

In the framework of the Russian-German project "The Laptev Sea System", this study focuses on the fluvial sediment transport to the Laptev Sea. The objectives are to distinguish between material transported by individual rivers and to identify the riverine sediments in the Laptev Sea shelf and the Arctic Ocean based on occurrences in the lowermost core-section of Khatanga and Yana Valley, as well as the composition of heavy minerals, which corresponds to the recent Khatanga and Lena sediments, prove the activity of these rivers before the beginning of transgression, as consequently the shelves began to be flooded around 10,000 y. b. p. The increasing amounts of garnet and opaque minerals in the western Laptev Sea during this time show the increasing drainage of the Anabar-shield due to the climatic change. Owing to the rising sea-level the depocenters of the Khatanga Valley shifted landward. The erosive character of transgression is noticeable because of high bulk sediment accumulation rates in the north-eastern Laptev Sea. After reaching the recent sea-level around 6,000 y. b. p., the sedimentation in the Laptev Sea has been mainly determined by fluvial input of sediments, coastal erosion and the prevailing ice conditions. Large amounts of mica in the sediments of the eastern Laptev Sea around 5,000 y. b. p. re-present a short-term, intensive influence of the Yana River, while the amphibols signal the prevailing input of Lena River sediments.

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East Siberian transect of ATLAS/ARCSS

Vladimir E. Romanovsky, University of Alaska Fairbanks; Tom E. Osterkamp; Nikolai I. Shender; Veniamin T. Balobaev; Vladimir G. Rusakov; Catherine D. Copass

Interest in the circumpolar Arctic has increased dramatically in the last decade largely because of scientific (global and climatic change), political, economic and social concerns. The most comprehensive research effort is concentrated in Alaska on a transect from the Prudhoe Bay area to the Brooks Range (ARCSS/LAII/FLUX studies). This effort cannot be duplicated in all regions of the Arctic. Reliable extrapolation of the results of this effort will require additional research in other regions. However, considerable efficiencies can be achieved by synthesizing, integrating and comparing currently available results from other transects in the Arctic with the results from the Alaskan Arctic.

In Spring 1998, we started a new collaborative project on comparison and analysis of ecological, climatic, and permafrost characteristics along the two north to south transects which spans most of the permafrost zone in Sakha Republic (Yakutia) in Russia and in Northern Alaska. This paper presents the very first results of this collaborative research which include the comparison of the climate (mean annual temperatures, thawing degree-days, snow thicknesses), soil temperature regime and active layer thickness variations during the last several decades in Yakutia and in Alaska. The first attempt was made to estimate the reaction of permafrost in Yakutia to the global warming predicted by the global climate circulation models.

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An Arctic Ocean meltwater event at the onset of the Younger Dryas

Robert F. Spielhagen, GEOMAR; Niels Nörgaard-Pedersen; Helmut Erlenkeuser; Pieter W. Grootes; Jan Heinemeier

The role of the Arctic Ocean in disturbances of the global thermohaline convection ("Conveyor") has long been unknown due to the lack of paleoenvironmental records of sufficient resolution to detect short-term meltwater events. Here we present data from sediment cores from the central Arctic Ocean and the Laptev Sea continental margin (135° E) with a high and ultra-high resolution of the last deglaciation. To determine changes in the freshwater budget, stable oxygen isotope records of planktic foraminifers were ^{14}C-AMS dated. The 8-m long sediment core PS2458 from the eastern Laptev Sea continental margin (983 m water depth) records the outflow from the Lena River across the Laptev Sea to the Arctic Ocean. The core site was situated just off the river mouth during the time of glacial lowered sea level. Foraminifers are present, but very rare in the fine-grained, mostly terrigenous sediments, and stratigraphy is based on ^{14}C-AMS datings on small bivalves. Closely spaced, they allow a detailed reconstruction of paleoenvironmental changes at 14-8 ka, with sedimentation rates of ca. 100 cm/ky during the last deglaciation. The oxygen isotope (∂^{18}O) record of *Neogloboquadrina pachyderma* (sin.) shows a strong variability, reflecting the freshwater output from the Lena River into the Arctic Ocean. Most conspicuous is a short-term event (<500 yr) of maximum outflow at 13.0 cal-ka, just before the cold Younger Dryas period. It correlates in time to a planktic oxygen isotope minimum in the central Arctic Ocean (box core 30:3:1 from the Lomonosov Ridge, 2388 m water depth), where the benthic record of *Cibicides wuellerstorfi* also records a synchronous breakdown of Arctic Ocean deep water ventilation. Sediment cores from the western Fram Strait give information about the outflow of the low-saline Arctic surface waters to the deep water convection areas in the Nordic Seas.

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Evidence of the unified factors contributing to the climatic signal in soil temperatures in Russia

Tingjun Zhang, University of Colorado; Roger Barry

Climatic changes at the Earth's surface propagate slowly downward into the ground and modify the ambient thermal regime. Thus, present-day subsurface soil temperature may provide evidence of past climatic change and past climate can be reconstructed by direct measurements and analyses of soil temperature profiles. Such efforts have been made in the Arctic (Lachenbruch and Marshall, 1986; Taylor, 1992) and elsewhere in the world (Pollack *et al.*, 1998) with promising results. However, there are some ambiguities concerning the cause of soil temperature changes. One major obstacle to understanding the linkage between the soil thermal regime and climatic change is the lack of long-term observations of soil temperatures and related climatic variables. Such measurements were made throughout the former Soviet Union, with some records beginning at the end of the 19th century. In this paper, we will use data measured at Irkutsk, Russia to demonstrate how the soil temperature responded to climatic changes over the last century.

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Both air temperature and precipitation at Irkutsk increased from the late 1890s to the 1990s. Changes in air temperature mainly occurred in winter months, while changes in precipitation were mainly during the summer. There was a general anti-correlation between the mean annual air temperature and annual total precipitation, *i.e.*, more precipitation during cold years and less precipitation during warmer years. There was no significant trend of changes in the first date of snow on ground in autumn, but snow steadily disappeared earlier in spring, resulting in a reduction of the snow cover duration.

Changes in the mean annual air temperature and soil temperature at 40 cm depth were about the same magnitude, about 2.0 to 2.5°C, over the period from the beginning of the 20th century to the early 1990s, but the patterns of their changes were substantially different. The mean annual air temperature did not increase until the 1960s, while the mean annual soil temperature almost increased steadily during the entire period. This leads to a conclusion that changes in air temperature alone cannot explain the changes in soil temperatures in this region. Further analysis indicates that soils were actually cooling during summer months by up to 4°C over the period of record while air temperature increased slightly. This cooling in soils may be explained by

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changes in rainfall during summer months. An increase in rainfall during summer months would increase the surface wetness and soil moisture, which results in more energy consumption for evaporation, eventually cooling the ground surface and soils. Soil temperature increased substantially during winter months, up to 9°C over the period of record. The increase of soil temperature during winter months may be due to the combined effect of increases in air temperature and snowfall. Air temperature increased about 4 to 6°C during winter months over the period of record. Although changes in precipitation during winter months were relatively small compared to changes in precipitation during summer months, an increase in snowfall during early winter (October and November) and early snowmelt in spring may play a major role in the increase of soil temperatures during winter months through the effects of the snow insulation and albedo change.

This study demonstrates that when soil temperature is used as evidence of climatic warming, caution is required because changes in soil temperature are a combined product of changes in air temperature and precipitation, especially snowfall and snow cover on the ground.

O_2 and nutrients in deep-sea sediment pore waters of the Arctic Ocean

John P. Christensen, Bigelow Laboratory for Ocean Sciences

Sediment boxcores were collected from the central Arctic Ocean during the Arctic Ocean Section 1994 Expedition. Vertical profiles of O_2, NO_3, NO_2, PO_4, $Si(OH)_4$, Mn^{+2}, Fe^{+2}, titration alkalinity, porosity and resistivity were measured. Fluxes of oxygen into the sediments and dissolved silicate out of the sediments were calculated by the vertical 1-dimensional diffusion equation. O_2 concentrations decreased 53 ugat-O/kg in the top 1 cm (as an average for all cores). Nitrate should increase by 2.68 ugat-N/kg over the same depth interval based on typical stoichiometries, which agrees with the measured nitrate profiles.

1. These O_2 and Si fluxes were among the lowest found in the world's oceans, showing that little organic matter and shell material reaches these deep-sea sediments.
2. Sedimenting material equations predicted that these benthic O_2 fluxes could be supported by a primary productivity in the surface waters of 17 g-C/m^2/yr, similar to recent measurements under the ice. No dramatic geographical distribution in this estimated productivity is evident.
3. A multilinear regression of silicate fluxes onto depth and latitude was statistically significant and showed that downward surface fluxes of particulate silica decreased by 4-fold from the Pacific side of the basin to the Atlantic side, linking silicate-based primary productivity to the strong influence of Bering Strait inflow waters in supplying dissolved silica to the Arctic.

This work was supported primarily by NSF grant OPP-9400058 with additional support from NSF grants OPP-9530774 and OCE-9617960.

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High-resolution measurements of dissolved organic carbon in the Arctic Ocean by *in situ* fiber-optic spectrometry

Christopher K. H. Guay, Oregon State University; Gary P. Klinkhammer; Kelly K. Falkner; Ronald Benner; Paula G. Coble; Terry E. Whitledge; Brenda Black; F. Joseph Bussell; Tim A. Wagner

Here we report results from an extensive survey of dissolved organic carbon (DOC) in the Arctic Ocean, which was achieved by means of a high-resolution, *in situ* UV fluorometer deployed on a nuclear submarine. Based on a strong linear correlation observed between fluorescence (320 nm excitation, 420 nm emission) and organic carbon concentrations determined directly by high-temperature combustion, a continuous record of DOC was produced at a keel depth of 58 m along a 2900-km-long transect north of the Beaufort, Chukchi, East Siberian, and Laptev seas. The DOC record, combined with other physical and chemical measurements, identifies areas where river waters cross the shelves and enter the circulation of the interior Arctic Ocean. Fluvial sources were found to account for 12–56% of the total DOC in parts of the upper Makarov and Amundsen basins.

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Geochemistry of surficial sediments and newly formed ice of the Laptev Sea (Siberia)

Jens A. Hölemann, GEOMAR; Heidemarie Kassens; M. Schirmacher; Andreas Prange

During the formation of new ice on the Siberian shelf seas sedimentary particles and other substances are entrained into the ice and can be transported via the transpolar ice drift to the Arctic Ocean and the North Atlantic. In the shallow Laptev Sea ice formation occurs in close interaction with bottom sediments. It could be shown that this mechanism can result in the incorporation and transport of potentially toxic organic compounds and metals from the coastal areas of the Eurasian Arctic to the Arctic Ocean and further to the Greenland Sea. Although, there is a growing interest in the investigation of these processes only few studies have been devoted to the investigation of geochemical signatures of the major sources of sea-ice sediments, *i.e.,* the surface sediments, the suspended matter and the newly formed 'dirty' sea ice of the Siberian shelf seas. This presentation focuses on the geochemical composition of the surface sediments based on the multi-element analysis of 51 samples covering all regions of the Laptev Sea, and samples of ice-rafted sediments from new ice that formed during the freeze-up period (October 1995) in the Laptev Sea.

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Riverine nutrient flux from Russia to the Arctic Ocean

Robert M. Holmes, Marine Biological Laboratory; Bruce J. Peterson; Charles Vörösmarty; Richard Lammers; Viatcheslav Gordeev; Igor Shiklomanov; Alexander Shiklomanov; Michel Meybeck; Balazs Fekete; Alex Zhulidov

Nutrient flux from the Eurasian continent to the Arctic Ocean influences the productivity of the coastal arctic seas and likely will vary as the Earth's climate changes. In order to facilitate prediction of the impacts of future climate change scenarios and better understand the present day functioning of the Eurasian land-shelf system, we provide new estimates of contemporary nitrate, ammonium, and phosphate fluxes from the Eurasian land mass to coastal seas. Nutrient data for 18 of the largest Eurasian rivers were obtained from largely unpublished archives of the former Soviet Union. Most records cover an approximate 10-year period from the mid 1980s to early 1990s. Mean monthly nutrient concentrations and river discharge are used in our calculations of flux for monitored catchments. Surprisingly, in 17 of the 18 Russian rivers investigated, ammonium concentrations exceeded nitrate concentrations. In some cases there were clear seasonal trends, whereas in other rivers DIN concentrations varied little seasonally. The Ob River, as well as Taz, Pur, and Nadym rivers had the highest ammonium concentrations, generally about 1 mg/L. We are not sure why their ammonium concentrations are so high; possible explanations include natural processes associated with watershed characteristics, anthropogenic influences, or systematic error in the results. We are currently investigating these various explanations. Our estimates are compared to previous calculations that were based on mean annual nutrient concentrations. Longer term records of nutrient concentrations are required to assess temporal trends, and analyses of nutrients in dissolved and particulate organic matter are needed to estimate total nutrient fluxes.

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Variability of freshwater export through Fram and Davis straits from a high resolution model

Stephen P. Murley, Naval Postgraduate School; Wieslaw Maslowski; Robert H. Bourke; Yuxia Zhang; Albert J. Semtner

Fram Strait is the major throughflow for heat, freshwater (including sea ice), and mass into and out of the Arctic Ocean. Another major passage for exchange is Davis Strait connecting the Arctic Ocean to the Labrador Sea via the Canadian Arctic Archipelago (CAA). The Fram and Davis Strait freshwater fluxes (both sea ice and water) are compared and correlated using results from a high-resolution model. Cross sections in Smith and Lancaster Sounds and several cross sections in Baffin Bay and along the East Greenland Current are analyzed in terms of their relation to fluxes through Fram or Davis Straits. The coupled Arctic Ocean/Sea Ice Model developed at the Naval Postgraduate School has a resolution of 18 km and 30 levels and it uses daily averaged ECMWF (European Center for Medium-range Weather Forcasting) atmospheric reanalyzed 1979–1993 data for forcing. The ocean and ice output from the model is analyzed for a period of 15 years using three-day snapshots averaged for each month.

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The influence of clouds on the heat budget of the North Water Polynya—results for 1998

Peter J. Minnett, University of Miami; Jennifer A. Hanafin

Measurements of the components of the surface heat budget of the North Water Polynya were made for about a four month period in the spring and summer of 1998 from the Canadian Coast Guard Ship *Pierre Radisson*. These are being analyzed to determine the effects of clouds on the heat budget. Initial results will be presented.

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Satellite remote sensing for the Atmospheric Radiation Measurements program (ARM) North Slope of Alaska/adjacent Arctic Ocean region

Peter J. Minnett, University of Miami; Ajoy Kumar; Lynn L. Ma

Following the successful completion of the SHEBA project, the DOE Atmospheric Radiation Measurements program (ARM) has begun a decade-long program of measurements in the North Slope of Alaska/Adjacent Arctic Ocean region. Satellite remote sensing provide an important data stream for this and the poster will present examples of satellite data over this area that are processed by the ARM project and available to the arctic research community.

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ARM NSA/AAO: From sea to land

Bernie D. Zak, Sandia National Laboratories; Hugh W. Church

With the successful conclusion of the NSF SHEBA field experiment in Autumn of 1998, the main NSA/AAO effort has shifted back from the mid Arctic Ocean to the North Slope of Alaska. Instrumentation has been installed at the Barrow site, is operational and ready for the first Intensive Operating Period (IOP) to commence in late March, 1999. Instruments are being gathered and made ready for installation at Atqasuk, some 60 miles south of Barrow in the central North Slope. Other sites may be added later during the nominal ten year life of the DOE project.

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The year at the North Slope of Alaska and adjacent Arctic Ocean ARM cloud and radiation testbed site

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Abstract not available.

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SHEBA: An interdisciplinary experiment on the Surface Heat Budget of the Arctic Ocean

The SHEBA Team

SHEBA is a large research program examining the surface heat budget of the Arctic Ocean. The primary goals of SHEBA are: 1) to determine the ice-ocean-atmosphere processes that control the ice-albedo and the cloud radiation feedback mechanisms and 2) to improve the treatment of the Arctic in General Circulation Models. At its heart, SHEBA is an interdisciplinary effort, with a team of researchers using field observations, data assimilation techniques, and models to work towards these common goals. A central component of SHEBA is the recently completed year-long field experiment. The icebreaker CCGC *Des Groseilleirs* served as the base of operations for Ice Station SHEBA from October 1997 through October 1998. The focus of the field experiment was to obtain a dataset of simultaneous and contiguous observations from the top of the atmosphere, through the sea ice and into the upper ocean over an entire annual cycle. The measurements include atmospheric profiles of temperature, humidity and wind speed; cloud properties; longwave and shortwave radiation fluxes; surface albedo; shortwave extinction in the ice; snow depth and snow properties; ice mass balance and ice morphology; the thermohaline structure of the upper ocean; and the turbulent energy exchange between the atmosphere, ice and ocean. Preliminary results indicate that, for the pervasive low cloud conditions of the SHEBA summer, the overall effect is to warm the surface and enhance ice melting. The annual cycle of albedo was a combination of a smooth, gradual seasonal trend and rapid fluctuations caused by synoptic weather events such as rain and snow. This integrated and comprehensive dataset is being used to understand the processes governing the surface heat budget, to develop and test parameterizations suitable for climate models, and to evaluate single column models.

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Development and deployment of a powered tethered balloon system at the SHEBA ice camp for measurements of cloud micro-physical and radiative properties

Randy Borys, Storm Peak Laboratory; Knut Stamnes; Rune Storvold; Paul Lawson

A tethered balloon system that can operate under arctic conditions was developed for deployment at the SHEBA ice camp. This system consists of a winch with a tether line that can transmit data from, and control commands to, the balloon profiler as well as power to continuously operate the instrument package and de-ice the tether line. The balloon profiler consists of a cloud droplet and ice particle videometer, an aerosol counter, a radiometer, a camera and a datalogger. The profiler has been specially developed for deployment from standard, commercially available tethered balloons.

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Seasonal evolution of albedo during SHEBA

Thomas C. Grenfell, University of Washington; Donald K. Perovich; Bonnie Light; Jacqueline Richter-Menge; Walter B. Tucker III; Gary A. Maykut

As part of ice-albedo feedback studies during SHEBA, we measured spectral and wavelength-integrated albedos. Measurements were made every 2.5 m along a 200-m survey line from April through October. Initially this line was completely snowcovered, but as the melt season progressed it became a mixture of bare ice and melt ponds. Observed changes in albedo were a combination of a gradual evolution due to seasonal transitions and abrupt shifts resulting from synoptic weather events. The surface albedo was high (0.8–0.9) and spatially uniform in April. In May there was a gradual decrease in albedo as the snow cover warmed and the snow grain size increased. Rain in late May caused rapid coarsening of the snow and a sharp drop in albedo from 0.8 to 0.7. While this event marked the onset of melt there were periods of cooler temperatures and light snow during the next two weeks, with attendant increases in albedo. After this period of "flickering" there was a steady decrease in average albedo for the remainder of June and July. By the end of July the average albedo along the line was 0.4. The spatial variability in albedo was greatest at this time with values ranging from 0.1 for deep, dark ponds to 0.65 for bare white ice. Starting in late July and early August there were intermittent periods with air temperatures below freezing. During these periods ice skims formed on the surface of ponds and there were occasional snow flurries resulting in an increase of 0.1 in average albedo. Again there were a few weeks of "flickering" during freezeup, with albedos increasing and decreasing depending on the synoptic weather. By the end of August surface temperatures were consistently below freezing and the albedo increased as the snowcover got deeper. By October average albedos returned to their springtime maxima of 0.8 to 0.9 and were spatially uniform.

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Seasonal production and respiration in the central Arctic Ocean: Results from the SHEBA/JOIS biology program

Barry F. Sherr, Oregon State University; Evelyn B. Sherr; Patricia A. Wheeler; Carin J. Ashjian; Robert Campbell; Harold Welch

We collected biological and chemical data during the year-long SHEBA ice camp facility, in order to address questions regarding seasonal cycles of biological and biogeochemical processes in the permanently ice-covered Arctic Ocean. From October 1997 through mid-September 1998, we measured the concentration of inorganic nutrients, particulate and dissolved organic carbon, and dissolved oxygen in the upper 240 m, biomass of autotrophic and heterotrophic microbes in the water column and sea ice, rates of biomass production of bacteria, and respiration rates. We also followed the seasonal standing stock of zooplankton biomass, and rates of zooplankton egg production, in the upper 100 m.

There was a strong seasonal signal. Phytoplankton (chlorophyll-a) increased rapidly after snow melted from the ice surface in mid-June and remained high until the end of August; bacterioplankton activity (leucine uptake rates) responded dramatically to increase in phytoplankton stocks. Integrated 0–50 m bacterial biomass increased along with phytoplankton biomass during the initial under-ice bloom. Zooplankton reproduction preceded the bloom by several weeks, and zooplankton stocks in the upper 100 m were maximal during the brief growing season.

On an annual basis, heterotrophy appeared to exceed primary production. Rates of winter respiration by oxygen decrease in flask experiments, and by decrease in bulk oxygen content of the upper 50 m over time from October to May gave similar results. Rates of respiration during the winter averaged 15.3 (5.6 nmoles O_2 kg-1 h-1). Summer respiration experiments yielded more variable rates, with a 3-fold higher mean 44.6 (34.9 nmoles O_2 kg-1 h-1).

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On an annual basis, these respiration rates yielded a microbial carbon demand of 133 gC m-2 y-1 in the upper 50 m of ice-covered waters in the Central Arctic. This carbon demand far exceeds current estimates of annual primary production (10-20 gC m-2 y-1) in this region.

The many faces of melt

Walter B. Tucker III, Cold Regions Research and Engineering Laboratory; Donald K. Perovich; Jacqueline Richter-Menge; Thomas C. Grenfell; Bonnie Light; Hajo Eicken; Jinro Ukita; Gary A. Maykut; Bruce Elder

During the summer melt season major changes occur in the morphology and the thickness of Arctic sea ice. As part of SHEBA we documented these changes qualitatively through photographs of the ice cover, and quantitatively through mass balance measurements. In late-May the ice was snow-covered and homogeneous in appearance. As the snow melted in June the surface took on a variegated appearance, with melt ponds forming. As melt progressed these ponds grew, both in areal extent and in depth. Throughout June and July the melt ponds deepened, in some cases completely melting through to the ocean. Once a pond had a salt water connection to the ocean, melting accelerated. Average pond depths at the end of July were roughly 0.5 m. In some cases the ice beneath the ponds would weaken to a point where sections would break due to buoyancy and float to the surface. The surface of the unponded ice also changed during melt. In some cases the surface ice would deteriorate into small (1–3 mm) ice grains, with an appearance similar to old snow. In other cases the ice melting would occur at crystal and platelet boundaries. This resulted in surfaces with a "fur-like" appearance or consisting of large (~10 cm) shards of ice. This surface would typically melt faster than the small ice grains. Ablation in ridge sails typically was greater than that in undeformed bare ice. There was little surface

continued on next page

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ablation after the beginning of August, though bottom ablation continued into September. There was about 3–4 m of lateral ablation around the edges of floes. Ice floes continually fragmented into smaller pieces as the cracks and small leads that had formed and froze in the winter melted.

Comparative predator-prey assimilation of polychlorinated biphenyls in polar bears and ringed seals from Barrow, Alaska

John R. Kucklich, National Institute of Standards and Technology; Paul R. Becker; W. D. J. Struntz

The Arctic receives persistent organochlorine pollutants through long-ranged transport and subsequent deposition due to cold temperatures. Marine mammals, including polar bears and ringed seals have differing abilities to assimilate and metabolize organochlorines, especially PCBs. The main difference in assimilation is believed to occur through interactions with cytochrome p-450 enzymes, which may lead to indirect toxic effects. The assimilation of PCBs in both polar bears (predator) and their major prey (ringed seals) were compared and the form of cytochrome p-450 enzyme induction investigated.

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The Alaska Marine Mammal Tissue Archival Project (AMMTAP): An arctic environmental monitoring resource

Lyman K. Thorsteinson, U.S. Geological Survey; Teri K. Rowles; Geoff S. York; Bradley K. Smith; Barbara A. Mahoney; Paul R. Becker; Barbara J. Porter; Stephen A. Wise

The cryogenic archival of environmental specimens for retrospective analysis can be an important resource in environmental monitoring programs and for both present and future research on population genetics, pathology, systematics, and toxicology. The Alaska Marine Mammal Tissue Archival Project (AMMTAP) is a joint project conducted by three U.S. government agencies to collect and archive tissues from Alaska marine mammals, including Arctic species. The project emphasizes the use of standardized sampling and archival protocols, procedures that minimize contamination of samples during collection, and maintaining a detailed record of sample history. Most of the animals sampled are from Alaska Native subsistence harvests; therefore, the project requires cooperation and collaboration with numerous Alaska Native organizations and local governmental agencies. Through AMMTAP, samples are collected for contaminant monitoring in the Marine Mammal Health and Stranding Response Program. In addition, the project has provided samples and/or data for several research programs, both inside and outside the U.S., on a variety of subjects, including: degree of genetic separation in populations, the circumpolar distribution of chlorinated hydrocarbons in beluga whales, baseline levels of trace elements in tissues, the identification of arsenic and mercury species in marine mammal tissues, and studies on potential human health effects of Alaska Native subsistence foods. The AMMTAP protocols and selected recent results are described.

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Alaska standards for culturally responsive schools

Alaska Native Knowledge Network

The following standards have been developed by Alaska Native educators to provide a way for schools and communities to examine the extent to which they are attending to the educational and cultural well being of the students in their care. These "cultural standards" are predicated on the belief that a firm grounding in the heritage, language, and culture indigenous to a particular place is a fundamental prerequisite for the development of culturally healthy students and communities associated with that place, and thus is an essential ingredient for identifying the appropriate qualities and practices associated with culturally responsive educators, curricula, and schools.

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Fixed cabin and camp locations—Barrow and Atqasuk area

Alaska North Slope Borough, Planning Department

This map shows the location of fixed hunting and fishing cabins and camps or ice cellars within the Barrow and Atqasuk area. This map was compiled from interviews with Iñupiaq residents of Alaska's North Slope. The locations were marked on 1:250,000 USGS quads and then entered into the North Slope Borough's Geographic Information System in 1992. This map is currently being updated with GPS technology and improved base map data.

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ARM Science Education and Training (ASET): Community-based education outreach for the Atmospheric Radiation Measurement program (ARM), North Slope of Alaska

Arctic Research Consortium of the United States (ARCUS)

The Department of Energy's (DOE) Atmospheric Radiation Measurement (ARM) program is currently measuring solar and infrared radiation and supporting meteorological data at a Cloud and Radiation Testbed (CART) site on the North Slope of Alaska. This site is one of three in the world. As part of this program, ARM wishes to maintain good relations with the local communities and to provide science education opportunities to North Slope residents in association with the project. The program designed to meet these objectives is the ARM Science Education and Training (ASET) program, administered through a contract with the Arctic Research Consortium of the U.S. (ARCUS) and a subcontract with Iḷisaġvik College in Barrow, Alaska. The Small Contracts program is one part of ASET that supports classroom and community-level science education initiatives. Funding of up to $2000 per applicant is available to educators and community members through a reviewed proposal process. The seed money provided through these small contracts has been effective in meeting the goals of the program to:

1. Expand the involvement of local students in science education on the North Slope;
2. Improve the delivery of science education on the North Slope; and
3. Improve mutual awareness and understanding among science educators, community members, and scientists working in the Arctic on efforts related to climate change.

Projects funded include:

A. Students established an herbarium of indigenous plants and interviewed local Elders about the traditional uses of the plants.
B. Kindergarten and 4th grade students took home materials to perform a simple scientific experiment with a theme relevant to their local environment and asked a Native Elder a question related to the experiment.
C. Kindergartners hosted "Science Nights" by inviting their families to participate in activities related to classroom lessons including astronomy, meteorology, chemistry, and biology.
D. Community members systematically investigated reports by Iñupiat hunters of the existence of dwarf spruce trees in river drainages on the North Slope.
E. The construction of a scale-model solar system and purchase of a telescope in Barrow sparked a local interest in astronomy and inspired a series of related community activities.

An active working relationship with involved and supportive communities will benefit the ARM program and provide opportunities for applicable local knowledge to be integrated into the program.

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Students in Arctic Research (STAR) with the Teachers Experiencing Antarctica and the Arctic (TEA) program

Arctic Research Consortium of the United States (ARCUS)

The National Science Foundation sponsors the Teachers Experiencing Antarctica and the Arctic (TEA) program through the Division of Elementary, Secondary, and Informal Education (ESIE) and the Office of Polar Programs (OPP). Teachers in the TEA program actively participate in research projects that explore the importance of the polar regions to: 1) enhance teacher development through immersion in a research experience; 2) infuse ongoing scientific research into high school classrooms in a way that emphasizes the relevance of science and the scientific process to society and individuals; and 3) establish collaborations among teachers, researchers, students, and communities.

In 1998, the Arctic Research Consortium of the U.S. (ARCUS) assisted in coordinating the arctic portion of the TEA program funded by the Arctic Sciences Section of OPP. Arctic TEA 1998 included the participation of five high school students working with four teachers on field research projects. Students and teachers actively engaged in fieldwork as integral members of the science teams investigating: the chemical and biological properties of Arctic Ocean ice and sediment within the ice; excavating artifacts from the Ipiutak culture in Deering, Alaska; exploring the effects of chronic exposure to hydrocarbons in river otters; and studying landscape/active layer interactions on the tundra of the North Slope of Alaska.

ARCUS refers to student participation in the TEA program as Students in Arctic Research (STAR). The STAR web site: http://www.arcus.org/star/index.html showcases the biographies of each student, their field journals, summary papers, photographs, and information about the program and research projects. Anyone can share the experiences of the STAR participants through the STAR web site in combination with the teacher experiences described on the TEA web site: http://tea.rice.edu. The STAR students have given public seminars, newspaper interviews, and visited classrooms to share their research experience in the Arctic with others. The STAR and TEA programs instill a greater understanding of scientific field research and the polar regions in teachers, students, and community members while developing relationships among researchers, educators, and students.

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Barrow scale model of the Solar System

Earl Finkler; Craig George; Richard K. Glenn

The Iñupiat Eskimos of Alaska's North Slope have been energetic sky watchers for thousands of years, and have a rich sky lore. In the days before radios and space satellites, people would use the stars and planets to navigate around the vast land and water distances, to mark the passage of time, and to welcome the sun back after its lengthy absence. But despite this rich tradition, there was not a lot of supportive material or equipment in Barrow on astronomy. Thus, we developed a Scale Model of the Solar System in Barrow based on a 12 inch diameter sun placed at the Ipalook Elementary School. We constructed a series of metal street signs, several feet square, to show the sun and each planet at a scale which can be walked, but that illustrates the vast distances involved. Funding for this project was provided by the Department of Energy, ARM Climate Change Research Project.

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The Barrow Environmental Observatory (BEO): A window on the future

Richard K. Glenn, Barrow Arctic Science Consortium; Glenn W. Sheehan

The Barrow Environmental Observatory (BEO) consists of 7,466 acres of arctic tundra near Barrow, Alaska, and is permanently set aside for research. The purpose of the BEO is to encourage and facilitate support of long-term observations and new research projects. The land belongs to the Ukpeagvik Iñupiat Corporation (UIC)—the Barrow village corporation and owner of the former Naval Arctic Research Laboratory (NARL). The Barrow Arctic Science Consortium (BASC), a nonprofit organization dedicated to scientist/community collaboration, has been designated by UIC to manage the BEO. The National Science Foundation's Office of Polar Programs has a Cooperative Agreement with BASC to support management of the BEO. The North Slope Borough (northern Alaska's regional government) provides additional support to the BEO. To facilitate BEO research efforts, BASC is undertaking a variety of projects including construction of an all-weather access road to the BEO; "recapturing" and making available scientific data generated by previous researchers; providing electronic access to Geographic Information System-linked mapping and database for the BEO and adjacent areas.

The BEO is a unique testament to the commitment of North Slope Iñupiat Eskimo people to the advancement of science and to collaboration between local people and scientists. The timing of the BEO's creation (1992) coincides with increasing scientific acknowledgment that the key to our understanding of global climate change may lie in the Earth's high latitudes.

Ongoing activities that are currently addressing these issues on or adjacent to the BEO include the:

1. Climate Monitoring and Diagnostics Laboratory (CMDL) of the National Oceanographic and Atmospheric Administration (NOAA);
2. Atmospheric Radiation Measurement (ARM) project of the Department of Energy (DOE); and
3. International Tundra Experiment (ITEX), Circumpolar Active Layer Monitoring (CALM) network, Spectroradiometer Network (Ultraviolet Spectrophotometer Ground Station), and Arctic Transitions in the Land-Atmosphere System (ATLAS) programs funded by the National Science Foundation.

The BASC and Barrow communities welcome the U.S. and international communities to participate in research on and the further development of

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the BEO. A long-term plan for use of the BEO is in preparation and input is welcomed from all. For more information on access to the BEO, data sharing policies and other operational information, contact Dr. Glenn Sheehan at the BASC address or call or send a message to: 907/852-4881 (toll free 1-888/627-5724); fax: 907/852-4882; e-mail: basc@barrow.com.

Reconnaissance survey to confirm reports of scattered small conifer trees in the Ikpikpuk Drainage, North Slope, Alaska

Dave Putnam, Iñupiat Heritage Center; Frank Willingham; Gordon Brower

The North Slope of Alaska is ostensibly free of conifer trees, owing to climatic extremes, the physical barrier of the Brooks Range, or a combination of both. We investigated reports of scattered stands and lone specimens of dwarf, cone-bearing conifer trees along the Chipp/Ikpikpuk River drainage. We held a community outreach meeting to gather first-hand knowledge and information from residents of Barrow who had hunting camps in the targeted area. Based on these accounts, we explored parts of the North Slope and visited several Iñupiat fishing camps. We found no evidence of living spruce trees; however, one shrub, an alder (*Alnus crispa*) on the Chipp River, was considerably north of the published range for that species. At another location, in an area that had obviously been recently flooded by spring snowmelt, the team collected a driftwood sample. It proved to be a small spruce tree, about four feet tall, that had grown approximately 30,900 years ago– during the middle of the last Ice Age. The 102 rings in the basal trunk, which is only 6.5 cm in diameter, corroborate that the tree grew in a cold, dry climate.

The project is on-going, with a hope of returning to additional locations we did not have time to visit in 1998. This project was funded by the Department of Energy, ARM Climate Change Research Project through the ARM Science Education and Training program (ASET).

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Effects of elevated atmospheric CO_2 and needle loss on plant structure and needle anatomy of white spruce seedlings

Raquiba Choudhury, University of Alaska Anchorage; Bjartmar Sveinbjornsson

Because of snow abrasion, trees growing at treeline lose more needles than do trees growing at lower altitude. We conducted a study with one year old white spruce seedlings simulating treeline needle loss on half of them by randomly removing one third of their needles after they had entered winter dormancy. We wanted to explore whether increased atmospheric CO_2 compensates for this premature tissue loss (carbon loss). The seedlings were grown for 100 days under saturating light in growth chambers with either ambient (350 ppm) or elevated (700 ppm) concentration of atmospheric CO_2. All of the seedlings were potted in mineral soil from the treeline in the Chugach Mountains, south-central Alaska. Growth analysis of needles and stems revealed that elevated CO_2 had significant positive effect on the needle and stem growth regardless of needle removal treatments. Thus, stem diameter increased and new needles were shorter and thicker. Length of preexisting needles increased significantly in the seedlings receiving the needle removal treatment under high CO_2 as compared to those with their needles intact. Overall there were significant interaction between morphology, growth and CO_2 treatments.

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Origin of *Populus balsamifera* along the eastern North Slope of Alaska

James D. O'Brien, University of Wisconsin-Madison; James G. Bockheim; Ken M. Hinkel; Jeffrey Munroe

Balsam poplar is found farther north than any other tree species in North America. On the North Slope of Alaska, poplar is confined to 68–69° N latitude and 141–151° W longitude. The poplar groves range from several trees to 0.5 ha in area and occur primarily along principle north-flowing rivers and their tributaries. The groves occur in areas of braided streams with river icings (aufeis) due to discharge of groundwater enriched in calcium carbonate. These areas lack permafrost within the upper 5 m and have soil temperatures considerably warmer than adjacent tundra. The groves are also favored by moisture held in the upper 50 cm of soil by an underlying cobble layer that inhibits soil-water movement. A case study in a poplar grove near the Ivishak River (69° N; 147° W) revealed that the height, diameter, age, and density decreased with distance from the river. Based on radiocarbon dating of buried wood fragments, the Ivishak grove likely has existed for 650 years. Poplar seeds may be carried from groves south of the Brooks Range by orographic low pressure systems and deposited in the headwaters of rivers.

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Arctic Forum program

Monday, 22 March 1999

1:30 p.m. **A Survey of current research in the Arctic: Poster presentations** ..... ***Chair, Mike Retelle***
Bates College

2:30 p.m. **Arctic system response to recent climate changes** ..... ***Chair, Wieslaw Maslowski***
Naval Postgraduate School

2:30 p.m. Modeling variability in the Arctic Ocean during 1979–1993
Wieslaw Maslowski, Naval Postgraduate School

3:00 p.m. Simulating the interannual variability of the wind driven Arctic Sea ice cover during 1958–1998
Gilles Arfeuille, McGill University

3:30 p.m. The response of the polar regions to greenhouse warming in a global climate model
John Weatherly, Cold Regions Research and Engineering Laboratory

4:00 p.m. The fall and future of New England's cod fishery
Larry Hamilton, University of New Hampshire

4:30 p.m. Analytic representation of the active layer thickness field Kuparuk River Basin, Alaska
Nikolay Shiklomanov, University of Delaware

5:00 p.m. Permafrost temperature dynamics in Alaska and East Siberia during the last 50 years
Vladimir Romanovsky, University of Alaska Fairbanks

5:30 p.m. Adjourn to Reception

ARCUS Annual Reception and Banquet
Arlington Hilton Hotel
Reception: 5:30 p.m., Gallery Ballroom Foyer
Banquet: 7:00 p.m., Gallery I

Award Ceremony
3rd Annual ARCUS Award for Arctic Research Excellence

Special Presentation
People of the Arctic: The photographic wanderings of the Running Dog
Bill Hess, Northern Photographer

8:30 a.m.	**Contaminants in the arctic environment** ..... ***Chair, Stephanie Pfirman*** *Lamont-Doherty Earth Observatory*
9:00 a.m.	Episodes of contamination in the Arctic: GIS provides means to assess transport pathways, sources, sinks and episodes of events ..... *Kathy Crane, Naval Research Laboratory*
9:30 a.m.	Persistent organic pollutants in the Arctic: Food webs, metabolic processes, and contaminant patterns in the higher marine trophic levels *Paul Becker, National Institute of Standards and Technology*
10:00 a.m.	Factors affecting organochlorine contaminant concentrations in milk and blood of northern fur seal dams and pups from St. George Island, Alaska *Kimberlee Beckmen, University of Alaska Fairbanks*
10:30 a.m.	EPA's efforts to bridge traditional knowledge, Arctic environmental research, and decision-making processes ..... *Fran Stefan, Tribal Specialist, Office of Waste and Chemicals Management, Environmental Protection Agency*
11:00 a.m.	BREAK
11:15 a.m.	**Building bridges: Indigenous knowledge, education, and science** ..... ***Chair, Sean Topkok*** *Alaska Native Knowledge Network and ARCUS*
11:45 a.m.	An examination of traditional knowledge: A case of the Inuit sled dog *Kerrie Ann Shannon, University of Aberdeen*
12:15 p.m.	The integration of science education and Arctic research: Teachers Experiencing the Arctic and other research/education partnerships *Deb Meese, Cold Regions Research and Engineering Laboratory*
12:45 p.m.	LUNCH, adjourn

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In Memorium to Dr. Troy Péwé

Dr. Troy Péwé at the dedication of the Climate Change Permafrost Reserve on Saturday, 18 September 1999.

We dedicate this volume of the *Arctic Forum* to Troy Péwé, a leader in the study of the geology of permafrost, who died in October 1999. In addition to his many other commitments, Troy served as the representative from Arizona State University to the Arctic Research Consortium of the U.S. (ARCUS) from 1989 until his death. He was an involved and supportive representative, working with the ARCUS staff and other ARCUS members' representatives on the development of research initiatives for national and international arctic research. He was a mentor to many young scientists and, through his own work as well as his support of others, added enormously to our understanding of the Arctic. Troy's dedication to the next generation of arctic researchers contributed to the development of the ARCUS Award for Excellence in Arctic Research, a student paper competition. The 1999 ARCUS Annual Meeting and *Arctic Forum* was the last Troy attended. He missed only one ARCUS Annual Meeting in 11 years.

Just a month before his death, Troy and his family, friends, and colleagues celebrated the dedication of the Troy L. Péwé Climate Change Permafrost Reserve at Gold Hill outside of Fairbanks, Alaska. The reserve, which Troy had worked to protect since 1989, includes a geological record going back about 3 million years.

Troy Péwé was born at home on the second loess-covered terrace above the Mississippi River at Rock Island, Illinois in 1918. He started working on permafrost in central Alaska in 1946 and received his Ph.D. from Stanford University in 1952, working with S.W. Muller. During this work, Troy demonstrated that the layers of silt in the valley bottoms and lower hills of the area were made of dust blown from the silt bars of glacial streams (loess); he vigorously defended this then-controversial interpretation of his results.

Troy was a geologist in Alaska for the U.S. Geological Survey and Professor and Head of the Department of Geology at the University of Alaska. In 1965 he joined the Department of Geology at Arizona State University, where he was also founding Director of the Arizona State University Museum of Geology and active in the creation of the Arizona Geological Survey. In addition to Alaska and Arizona, he conducted research in Antarctica, Svalbard, Tibet, Siberia, and alpine areas of North America and authored more than 350 publications. He supervised more than 40 graduate students.

His many honors included election as a Fellow in the American Association for the Advancement of Science and the Arctic Institute of North America, the Distinguished Career Award from the Geological Society of America, and six years of service on the Polar Research Board. In the words of one of his colleagues, "He was a good scientist and an outstanding geologist. Also, he was my friend." Troy Péwé was friend, mentor, colleague, and leader to many people. He will be missed greatly by all who knew him.

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