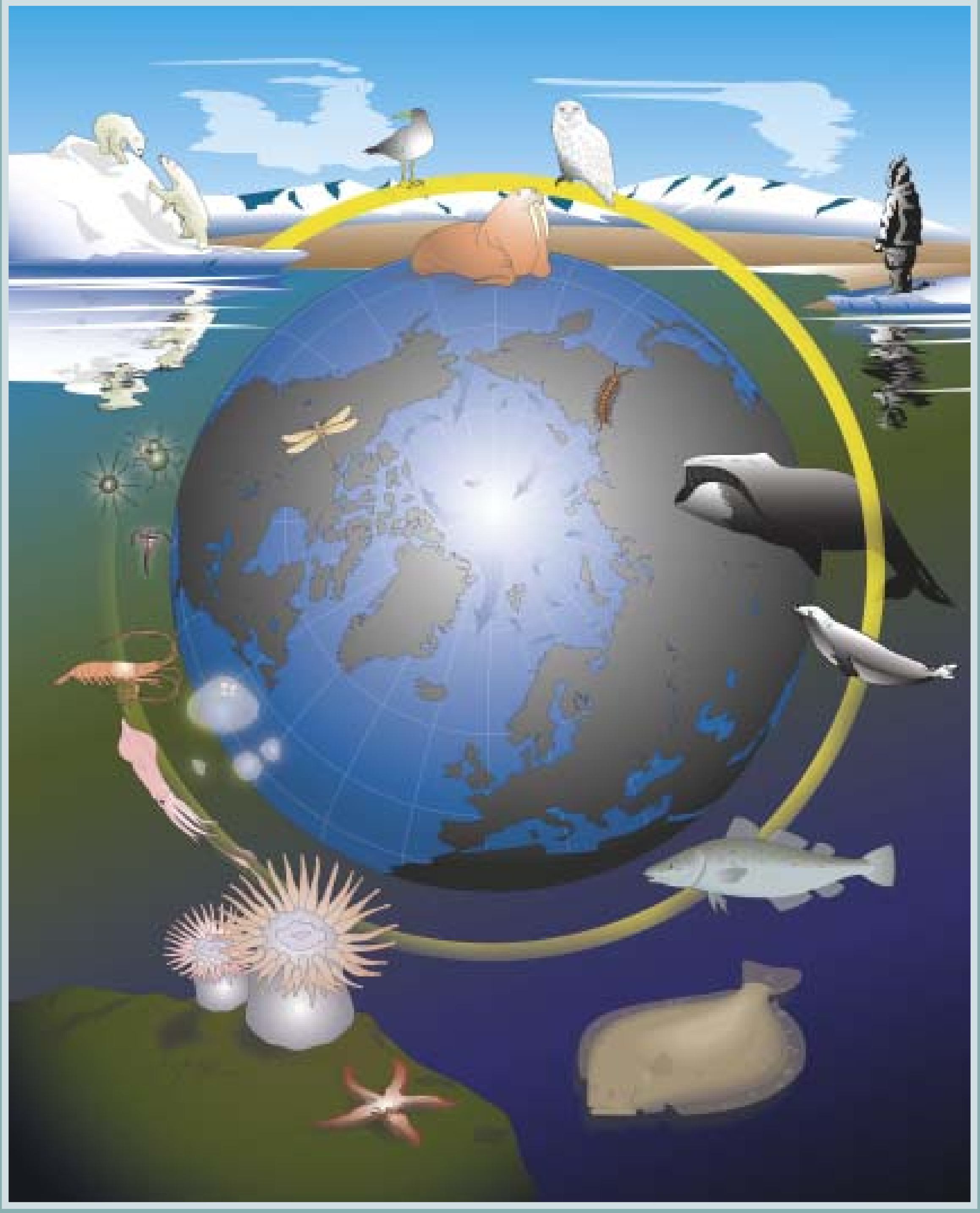

Abstracts from the

Arctic Forum

2002

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Cover: The concept of biocomplexity stresses the richness of biological systems and their capacity for adaptation and self-organizing behavior. The Arctic is a unique laboratory for biocomplexity studies, revealing complex interrelationships among components of arctic ecosystems at many scales. *Artwork by Russell Mitchell.*

Contents

Foreword

The Arctic Research Consortium of the U.S. (ARCUS) hosts the Arctic Forum annually in conjunction with the ARCUS annual meeting so that arctic researchers in all disciplines can interact with colleagues and agency representatives during oral presentations, a poster session, and informal gatherings. This collection of abstracts represents presentations at the Arctic Forum held May 16 and 17, 2002, in Washington, D.C.

The ARCUS annual meeting and Arctic Forum are the culmination of each year's efforts to represent the arctic research community on behalf of ARCUS's 43 U.S. and international member institutions. ARCUS serves its member institutions by acting as a communication channel, providing information about current research activities and arctic science issues to the research community, and informing agencies and the public about arctic research. 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. The Arctic Forum provides access for individual researchers to information on research, education, and facilities outside of their fields, which has led to many successful collaborations. Since its inception in October 1994, the Arctic Forum remains one of only a few interdisciplinary arctic science meetings. The Arctic Forum abstract series begins with *Arctic Forum 1998*.

This abstract volume illustrates the diversity and interdisciplinary nature of arctic research today. The overall theme of the Arctic Forum in 2002 was Biocomplexity in the Arctic. The Forum presentations included the winners of the Sixth Annual ARCUS Award for Arctic Research Excellence in the categories of social sciences, life sciences, physical sciences, and interdisciplinary. Rita Colwell, director of NSF, gave a keynote address.

As executive director of ARCUS, I appreciate the efforts of the many researchers who share their results with the community through the Arctic Forum. We thank Sue Moore and Wieslaw Maslowski for chairing the Forum and the National Science Foundation for supporting this opportunity. Sue Mitchell of ARCUS edited this abstract volume; Diane Wallace provided expert proofreading. We invite you to join us at the Arctic Forum in spring 2003.

Wendy K. Warnick

Wendy K. Warnick
Executive Director

Introduction to the Session: Biocomplexity in the Arctic

Sue Moore and Wieslaw Maslowski, Arctic Forum Co-Chairs

It is clear that the Arctic is changing. In both popular and scientific publications, we read nearly every day about changes to land, ocean, and atmospheric systems. Research has dramatically increased our awareness and knowledge of environmental changes in the polar regions and their potentially important effects on global climate. However, the complexities of interactions between humans and the arctic environment and between the arctic environment and the global climate are just now being fully recognized.

The National Science Foundation's emphasis on biocomplexity extends to the Arctic, as this year's Arctic Forum focus on Biocomplexity in the Arctic emphasized. Rita Colwell, director of NSF, gave a keynote address to the Arctic Forum 2002. Dr. Colwell explained that the biocomplexity initiative stresses the richness of biological systems. She noted that the trends are clear, as evidenced by the papers presented in the Arctic Forum: sea ice cover is shrinking; permafrost is thawing; the Coast Guard is looking at the possibility of the Northwest Passage becoming a viable transportation corridor. Once-shielded artifacts are melting out of glacial ice.

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Investigating the extent to which humans may cause and respond to climate change is a complex problem, and we need broad interdisciplinary research to solve it. One goal of the biocomplexity initiative is to bring together researchers who have not worked together before. We also need to convince both politicians and the public of the importance of studying these complex systems, even though this research may not provide pat answers. The truth is rarely pure and simple.

Dr. Colwell ended her talk by commenting on the importance of looking at the impacts of change on regional societies. This summation provided an excellent link to a presentation by Orville Huntington of Huslia, Alaska, who talked about traditional ecological knowledge in his village and how he grew up listening to stories about the environment and learning how to adapt to change.

Another speaker at the forum, Craig Nicolson, reported on his research on the adaptive strategies of communities. He and his co-researchers quickly realized that climate change and human activities are tied together in many complex, interrelated, and unpredictable ways.

It is these unpredictable interactions that led Fikret Berkes to remind us that climate change is a classic example of a "wicked problem": it has no test for solution and no definitive formulation. It is nonlinear, has no clear

—*continued*

cause and effect, and must be evaluated across various scales.

This volume of abstracts demonstrates the diversity of current research to develop a better understanding of the complex and diverse system that is the Arctic. The work presented at the Arctic Forum represents the cutting edge of efforts to unravel the driving forces and direction of environmental changes in the arctic system and their interactions with people and the global system.

Presentation Abstracts

Rapid Wastage of Alaska Glaciers and Their Contribution to Rising Sea Level

Anthony Arendt, Keith Echelmeyer, Will Harrison, Craig Lingle, Virginia Valentine

We have used airborne laser altimetry to estimate volume changes of 67 glaciers in Alaska from the mid-1950s to the mid-1990s. The average rate of thickness change of these glaciers was –0.45 m/year. Extrapolation to all glaciers in Alaska yields an estimated total annual volume change of –52±7 km^3/year (water equivalent), equivalent to a rise in sea level (SLE) of 0.14±0.02 mm/year. Repeat measurements of 27 glaciers from the mid-1990s to 2000–2001 suggest an increased average rate of thinning of –1.1 m/year. This leads to an extrapolated annual volume loss from Alaska glaciers equal to –91±28 km^3/year, or 0.25±0.08 mm/year SLE, during the last decade. These recent losses are about 78% larger than the estimated annual loss from the entire Greenland Ice Sheet during the same time period, and are much higher than previously published loss estimates for Alaska glaciers. They form the largest glaciological contribution to rising sea level yet measured.

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Winner of the Sixth Annual ARCUS Award for Arctic Research Excellence

Adaptations of Euro-Canadian Schools to Inuit Culture in Selected Communities in Nunavut

Paul Berger

This paper describes a study that explored educators' perceptions of current and desired adaptations of Euro-Canadian schools to Inuit culture in five communities in one region of Nunavut. Participants in the study reported very few instances where community input was solicited, noted as desired, or used in determining the direction of the schools, and few instances where schools explicitly taught Inuit values. Many examples were given of incorporating Inuit curricula into schools, and many practices were documented that were educators' attempts to structure classroom interaction in ways that mirror the cultural expectations of Inuit students.

Many changes were also reported which are in fact current southern practices, teaching ESL methods, or strategies designed to respond to the effects on students of societal problems. These changes may have increased school effectiveness, but did not move them toward Inuit culture.

To increase the success or well-being of Inuit students, the main recommendations from this study were: (1) to increase community ownership of schools through meaningful consultation, (2) to increase the number of Inuit educators in schools and to support them in remaining Inuit rather than adopting Euro-Canadian ways of being/teaching, (3) to base the hiring of teachers for northern schools on their orientation towards change and their ability to work with people, rather than on their academic qualifications, (4) to create an orientation to Inuit culture, learning styles, and communication patterns for new teachers hired from the South, and to train teachers on cultural and ESL issues and strategies, (5) to create and effectively distribute relevant, culturally sensitive curricula and resources in Inuktitut and (ESL sensitive) English, and (6) to create policy that encourages teachers to prioritize the meeting of students' needs.

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Arctic People in Complex Adaptive Systems: The Case of Climate Change

Fikret Berkes

I am going to talk about linking social systems and natural systems as complex systems, and give some examples from the area of climate change. Many of our environmental problems, including climate change, are complex systems problems and are not adequately addressed by the familiar scientific approach of developing and testing hypotheses serially. As well, conventional disciplines are inadequate to deal with problems involving the interaction of humans with their environment. These coupled social and ecological systems (social-ecological systems for short) need to be understood and approached as complex adaptive systems.

What does complex systems theory say about social-ecological systems? I am going to concentrate on lessons from two attributes: scale and emergence. Scale really does matter; reductionist approaches have limited explanatory power because reality has a hierarchical structure. Each level along the hierarchical scale is independent, to some degree, of the levels above and below. Thus, each level requires new concepts and principles. Social-ecological systems can be studied at various levels, with some similarities and some key differences. The human component must be understood in all its social complexity and not treated simply as a black box that produces feedbacks.

In the language of complexity, emergence refers to systems properties that cannot be predicted or understood simply by examining the parts of the system. Emergent properties provide a window for the study of system-wide phenomena. In our work, we have been using the property of resilience (buffering or absorptive capacity in the face of perturbations), for the study of change. Resilience is particularly suitable for the study of change because it deals with the flexibility of responses to stress, and it focuses on the system's capacity for learning, self-organization and adaptation at multiple scales.

While working on the Epilogue of the new ARCUS book, *The Earth is Faster Now,* I had a chance to think about the implications of complexity thinking for climate change and impacts in the Arctic. Cross-scale interactions are occurring both horizontally (geographically) and vertically across institutional levels (community, regional, national, international). No single level is the "correct" one for analysis; levels must be analyzed both separately and simultaneously across scale. The emergent property, resilience, helps focus on the adaptive capacity of communities to deal with climate change. Switching species and adjusting the "where, when, and how" of hunting are strategies for dealing with change—up to a limit. Evolving co-management institutions create additional linkages for cross-scale feedback and help increase resilience.

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Are Goose Nesting Success and Lemming Cycles Linked? Interplay Between Nest Density and Predators

Joël Bêty, Gilles Gauthier, Jean-Francois Giroux, Erkki Korpimäki

The suggested link between lemming cycles and reproductive success of arctic birds is caused by potential effects of varying predation pressure (the Alternative Prey Hypothesis, APH) and protective association with birds of prey (the Nesting Association Hypothesis, NAH). We used data collected over two complete lemming cycles to investigate how fluctuations in lemming density were associated with nesting success of greater snow geese *(Anser caerulescens atlanticus)* in the Canadian High Arctic. We tested predictions of the APH and NAH for geese breeding at low and high densities. Goose nesting success varied from 22% to 91% between years and the main egg predator was the arctic fox *(Alopex lagopus)*. Nesting associations with snowy owls *(Nyctea scandiaca)* were observed but only during peak lemming years for geese nesting at low density. Goose nesting success declined as distance from owls increased and reached a plateau at 550 m.

Artificial nest experiments indicated that owls can exclude predators from the vicinity of their nests and thus reduce goose egg predation rate. Annual nest failure rate was negatively associated with rodent abundance and was generally highest in low lemming years. This relationship was present even after excluding goose nests under the protective influence of owls. However, nest failure was inversely density-dependent at high breeding density. Thus, annual variations in nest density influenced the synchrony between lemming cycles and oscillations in nesting success. Our results suggest that APH is the main mechanism linking lemming cycles and goose nesting success and that nesting associations during peak lemming years (NAH) can enhance this positive link at the local level. The study also shows that breeding strategies used by birds (the alternative prey) could affect the synchrony between oscillations in avian reproductive success and rodent cycles.

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Using Permafrost DNA to Examine the Effects of Environmental Change

Alan Cooper

The Arctic contains many detailed paleoenvironmental records, with important implications for the interpretation of current changes in climate, biodiversity, and human impact. Recent molecular studies have revealed a further record—an Ice Age genetic museum preserved in vast numbers of mammal bones from permafrost deposits. These remains provide an opportunity to examine the genetic effects of climate change throughout the last glacial period (>60–10 Kyr), human invasion of the New World (ca. 13 Kyr), and the megafaunal mass extinction (ca. 11 Kyr)—examples of three major evolutionary phenomena seen throughout the fossil record.

Studies of permafrost DNA from several megafaunal groups (brown bears, bison, and American lions) have revealed extremely dynamic population histories, characterized by localized extinctions, rapid replacements, and evidence of a strongly mosaic environment. Climate change appears to have the most significant effect on bear biodiversity but is mediated through secondary interactions with other environmental factors. By comparing genetic data from a range of species, it should be possible to reconstruct a detailed paleoenvironmental picture for Beringia over the past 60,000 years.

This combination of paleo-genetic, -morphological, -climatic, and -ecological data provides a powerful means to examine the effects of past environmental events and predict the impact of current changes.

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The North Water: An Arctic Ecosystem Poised for Change

Jody W. Deming

A decade of intensive research under the auspices of the International Arctic Polynya Program (IAPP) has resulted in large and very successful interdisciplinary studies of two major Arctic polynyas: the Northeast Water, which forms off the northeast coast of Greenland (77–81°N; 1991–1993 field program); and the North Water, which forms between Greenland and Canada's Ellesmere Island (76–79°N; 1997–1999 field program). The rich comparative database developed in the process has enabled recognition of key physical, biological, and biogeochemical features that determine whether a polynya ecosystem is rich or poor in overall productivity—able or not to support top predators, including human populations. The International North Water Polynya Study (NOW) in particular has revealed clear forcing factors and input terms (climatic and oceanic) required to generate and sustain a high-magnitude phytoplankton bloom over an unprecedented period (at these latitudes) of nearly six months (April to October). The tight coupling between this bloom and the higher trophic levels of the region, enabled by the precocious recruitment of zooplankton (essential prey for fish, birds, mammals), contributes to the North Water being arguably the most productive ecosystem in the Arctic and rivaling other regions of the global ocean.

These and other discoveries have caused the IAPP to develop a new approach to polynya research for the future: dedicated time-series studies on the decadal scale that can recognize and provide a solid basis for predicting the sources and effects of environmental change. Ideally, such work would go forward in multiple Arctic polynyas simultaneously; practically, the effort is proposed to begin in the North Water (to continue that begun through NOW). There, the contemporary signals—physical, biological, and biogeochemical—are as strong and unambiguous as can be expected in a complex natural system; some of them appear poised for change. For example, the seasonal duration of the ice bridge (across Nares Strait), largely responsible for polynya formation (and considered responsive to hemispheric forcing), has been decreasing over the last decade. The moving polar front in the Arctic Ocean may also conceivably (and soon) alter the chemical properties (balance of silicate and nitrate) of the inflow waters to the polynya. A remarkable diversity of phytoplankton awaits the shift away from diatoms, should silicate become limiting; the response of higher trophic levels to an altered food base then emerges as an issue of prime concern. In promoting a new program of long-term time-series research on Polynyas in the Arctic's Changing Environment (PACE), the IAPP aims to help the scientific community and society at large to learn and gain from what these archetypal ecosystems of the Arctic have to teach us about our changing Earth and its resources.

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The Arctic Nearshore Environment: A System Defined by Complex Hydrological and Biogeochemical Linkages and Feedbacks

Kenneth H. Dunton

The nearshore zone of the Arctic Ocean represents a dynamic and physical boundary between arctic coastal plain watersheds and the arctic shelf. The exchange of water, nutrients, and organic materials at the coastal boundary has a distinct effect on the productivity and structure of the nearshore shelf ecosystem. The lateral exchanges of carbon, nutrients, and other materials are largely controlled by distinct physical processes that include coastal erosion, the timing and magnitude of river discharge, sea ice distribution, ice retreat and break-up, and wind direction. The role of these physical events in regulating biogeochemical processes has often been underestimated. For example, recent studies have concluded that contributions of sediment through coastal erosion may equal (Laptev Sea) or exceed riverine input by sevenfold (Alaska Beaufort Sea). The biogeochemical transformation and ultimate fate of this material during its transfer from terrestrial watersheds to the nearshore zone is not well understood. However, the huge influx of allochthonous matter to the nearshore zone provides a focus for the study of nearshore food chains and the efficiency in which C, N, and other constituents are incorporated into consumer organisms. The diversity of marine and terrestrial organisms in nearshore communities are largely defined by the biogeochemical linkages between marine and terrestrial ecosystems, which vary considerably over both spatial and temporal scales. The role of these processes and the hydrological feedbacks between shelf waters and the adjacent terrestrial watersheds is important to our understanding of this complex and highly physical interface between land and ocean. Such knowledge is critical to our ability to predict the impacts of environmental change on indigenous populations of the Arctic.

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Paleogenetic Assessment of Human Migration and Population Replacement in North American Arctic Prehistory

M. Geoffrey Hayes, J. B. Coltrain, D. H. O'Rourke

Common explanations for transitions in the archaeological record include cultural diffusion of new technologies or rapid replacement of a resident population by more recent migrants. The former involves genetic continuity across the transition, whereas the latter suggests a genetic replacement across the transition. Two interesting cases from the North American Arctic allow for an examination of these polar explanations for such transitions. Aleut prehistory is characterized as archaeologically continuous for at least the past 4,000 years, but with an associated skeletal transition from dolichocranic to brachycranic occurring approximately 1,000 years before present. In the eastern Canadian Arctic an early culture complex (the Dorset) was rapidly replaced by a strikingly different culture complex (the Thule) approximately 1000 BP. Our studies compare the genetic relationship across these transitions by examining DNA extracted from archaeologically recovered pre- and post-transition individuals. To date DNA has been extracted and mtDNA amplified from >35 individuals from the Aleutians and >40 individuals from the Hudson Bay region. A comparison of mtDNA haplogroup frequencies, defined by the presence or absence of minimally four to six restriction sites or length polymorphisms, suggests continuity in the Aleutians, since there are no significant differences between pre- and post-transition populations (both approximately 70% haplogroup D, 30% haplogroup A). In the eastern Canadian Arctic, replacement is best supported since the earlier Dorset population is fixed for haplogroup D, while the later Thule population is fixed for haplogroup A.

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Perspectives from the Arctic

Orville H. Huntington

The Alaska Native residents of the Arctic who I have lived with every day for the last 46 years play an important role in understanding and sensibly managing Earth's few resources. Past and present traditional ecological knowledge of Alaska Native tribes provide scientists with an all-encompassing view of many environmental changes, through interactive observation and study that recognize Mother Earth's sensitivity and the place it evolves towards. Arctic scientific research complements traditional Native ecological knowledge and addresses our concerns about maintaining the quality of subsistence land, water, plants, air, fish, animals, and all other elements of the environment. Contaminants continue to be transferred by air currents, water cycles, and fish and wildlife migration to our region of the Arctic, through human activity that has changed the quality of air, water, land, fish, and wildlife. Complex life cycles in the Arctic surround me every day, and everyone in the Koyukuk River ecosystem is impacted by changes in the global environment.

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Biocomplexity in the Arctic: The Bowhead Whale Nexus

Sue Moore, Carin Ashjian, Robert Campbell, Wieslaw Maslowski, Stephen Okkonen, Barry Sherr, Evelyn Sherr, Yvette Spitz, Craig George

The annual migration of bowhead whales *(Balaena mysticetus)* past the northern shores of Alaska has provided opportunities for subsistence whaling to the indigenous peoples of this region for generations. Subsistence whaling remains an integral part of a mixed hunting/wage economy of this region and a key component to maintenance of traditional lifestyles. During the fall migration, bowheads often aggregate to feed on zooplankton concentrations near Kaktovik and Barrow, Alaska, and are accessible to hunters from these communities. Bowhead whale distribution, relative abundance, and availability to the Native subsistence hunters likely are influenced by a complex suite of factors, including near-term oceanographic variability resulting from local (i.e., weather) and basin-scale shifts in atmospheric forcing; longer term global climate fluctuations; and localized human activity such as that associated with oil and gas exploration and production. The subsistence whaling tradition and way of life are particularly vulnerable to changes in resource availability in response both to environmental changes and human-generated pressure.

Numerical modeling of atmospheric and oceanographic conditions during the past 50 years has identified two major climatic regimes for the Arctic Ocean that embody many of the variations in climate, weather, and oceanographic circulation observed in the region.

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These regimes likely have dramatic impacts on the regional ecosystems, with cascading effects through the food chain to bowhead whales. This complex suite of human-environment-whale interactions comprises a biocomplex system of coupled natural and human interactions that is vulnerable both to natural and human-generated change. We propose* to quantify linkages in this system to understand how physical-biological and human-natural coupling in the western Arctic Ocean influences bowhead whale behavioral ecology and Native subsistence harvests. Interactions within the natural-human system will be quantified by combining retrospective analyses with biological-physical modeling of the atmosphere-ice-ocean system and the climatic variability therein. The goal is to identify mechanisms that produce bowhead whale prey aggregations thereby influencing whale distributions and hunting success. Local monitoring (i.e., citizen science) of oceanographic conditions will be conducted to verify model predictions during the period of the study, while collaboration with investigators that target critical components of the system or that expand upon the local sampling program will provide a broader scope of information. The proposed fusion of biological and physical models is a new approach and will lead to an improved understanding of the biophysical linkages involved in the cascading effects of climate variability in the Arctic Ocean ecosystem, and to a better definition of the critical terms in the coupled human-natural system. The proposed work also contains a strong outreach and educational component involving the communities of Barrow and Kaktovik and will incorporate traditional knowledge and local records regarding bowhead whale distribution, bowhead whale feeding behavior, and oceanographic conditions in developing the sampling program and in verifying retrospective modeling predictions.

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* Abstract from Project Summary: NSF Proposal No. 0216045

Climate and Subsistence Hunting: The Sustainability of Arctic Communities

Craig Nicolson, Jack Kruse, Gary Kofinas, Matthew D. Berman, Don Russell, Brad Griffith, Craig George, Harry Brower Jr., Stephen Braund

The arctic climate system is marked by substantial interannual variability, and it determines many of the environmental conditions that influence the distribution of migratory subsistence resources such as bowhead whale and caribou. Will the indigenous communities of the Arctic successfully continue to harvest these resources in the face of a changing climate?

We present two case studies: spring bowhead whale hunting in Barrow, Alaska, and caribou hunting in Old Crow, Canada. In both cases, we present an analytical framework for understanding and quantifying the interactions between the natural and human systems in order to understand the influence of the climate system on local hunting effort and success.

In this presentation we summarize model relationships and data sources, describing in particular how local knowledge contributed to building relationships and assumptions. We then outline how we used a simulation model to explore the interactions between these relationships and to assess how a warmer climate might affect the local subsistence economy and the well-being of residents. Our results suggest that local policies as well as sharing of hunting gear and caribou harvests help ensure that most people are able to meet their subsistence needs despite varying levels of wage employment and money income.

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Biocomplexity of Marine and Terrestrial Environments and Human Populations in Iceland

Astrid Ogilvie

The research described in this talk may be seen in the context of current concerns regarding potential future global and arctic changes, the crisis in the world's fisheries, and issues regarding land use and continuing erosion of land surfaces in Iceland. Possible future climate and environmental changes may radically affect the lives of those living in the Arctic. The consequences of such changes cannot be predicted and understood if there is no knowledge and understanding of the past and present. This talk will focus on present and historical dynamics of linkages and interactions between human populations and the biological and physical environment of Iceland. Both terrestrial and marine components will be considered. From the time of the earliest settlers to the late nineteenth century, the most important economic activity in Iceland has been farming. Because of the unsuitability of the climate for extensive grain-growing, this was based on animal husbandry. The most important livestock animals in Iceland have been sheep, cattle, and horses, and the most important crop has been the grass and hay on which these animals depended for food.

In the past, lack of food for the livestock could ultimately lead to deaths from hunger and malnutrition-related diseases among humans. Land-use activity, in particular sheep grazing, has been a major contributory factor to soil erosion, a serious concern in Iceland. The rate of erosion increased greatly through the eighteenth century and reached a maximum during the nineteenth and early twentieth centuries. During this period, numerous farms were abandoned, especially in southern and northeastern Iceland. Fishing developed rapidly as a major industry in the nineteenth century. Early in the twentieth century, fishers and boat owners gradually replaced the landed elite as the economy shifted from a somewhat stagnant agriculture to expansive fishing. The twentieth century has seen great changes in fisheries catches, partly at least as a consequence of environmental changes. Although Iceland as a whole is considered here, two specific locations are analyzed more closely. These are the Myvatn area in the northeast of Iceland, a community based primarily on land use, and the Vestmannaeyjar (Westman Islands) located off the south of Iceland, mainly a fishing community. Developments and adaptive strategies in these communities are considered in the context of climate variations in Iceland during the twentieth century and earlier, records of hay yield and farm stocking strategies, and fisheries records. Although the research described in this presentation will focus on the present and immediate past, possible future changes are also considered.

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Quantifying Pan-Arctic Environmental Change

James E. Overland

The Arctic has undergone major temperature swings over the last 100 years. Over the past three decades, demonstrable pan-Arctic changes have occurred in many components of the physical and biological system. The areal coverage of sea ice has diminished, and sea-level pressures in the central Arctic have decreased, resulting in a shift of wind and heat flux patterns. Warmer surface temperatures are observed in northern Europe during winter and Alaska and northwest Canada during spring, there is an increase in the frequency of years with cold temperature anomalies in the lower stratosphere over high latitudes, and permafrost temperatures have risen in Siberia and Alaska with increased erosion. Satellite estimates of "greening" have increased over both the eastern and western hemispheres, with longer growing seasons and changes in the character of the tundra. The influence of warm Atlantic water in the Arctic Ocean is becoming more widespread and intense, with implications for the stability of the water column. These changes are robust, and many other biological and physical changes are suggested: increases in cod in the Barents Sea and shrimp off of southern Greenland, increases in calf survival for some caribou populations in North America, and declines and redistributions of marine mammal populations, although causes for these changes are less certain.

Extrapolation of atmospheric and sea ice records from the last 100 years implies a reversal of present trends in 2000–2030, while IPCC climate models imply a continuation of the current course. At present, neither evidence nor understanding is available to unequivocally distinguish between these scenarios. A promising method for future detection of change is to use a multivariate approach. Biological and terrestrial variables are often better indicators of decadal change than physical variables because they integrate over the large meteorological and oceanographic interannual and intraseasonal variability. A data collection for 1965–1995 of 85 variables representing seven data types shows broad pan-arctic covariability for a shift in ecosystems near 1989. Understanding biocomplexity is an important factor in developing an arctic change detection system since extremes in the physical environment lasting one or two years can precipitate biological/ecosystem changes that last several decades.

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Interactions Between Hydrological and Biotic Process in the Arctic Landscape

Joshua Schimel

Traditionally, terrestrial ecology had focused on individual study plots in distinct community types, in which the physical system was largely seen as a driver of biotic activity. This approach, however, has changed dramatically. The tundra is no longer a collection of community types, but an integrated landscape in which physical and biotic systems strongly feed back on each other. In this view, freshwater is a critical integrating force, moving carbon and nutrients across the landscape and into streams, lakes, and ultimately the ocean. One important aspect of this development is an appreciation of winter. We are coming to better understand how winter processes (snow timing and distribution) drive not only hydrology but also the biotic systems, which we used to assume "turn off" during the winter. Strong feedbacks develop through the winter: for example, shrubs trap blowing snow, producing a better insulating layer. Warmer, though still frozen, soils mineralize nitrogen that is available for plant uptake in the spring (or loss at snowmelt). Higher nutrient availability in turn encourages shrub growth, closing a positive feedback loop that has the potential to drastically change the tundra landscape. Such feedbacks may develop on a local scale but apply broadly across the Arctic. Understanding the functioning of these feedback mechanisms has led to major rethinking in our understanding of the arctic system.

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Biocomplexity of Frost Boil Ecosystem on the Arctic Slope, Alaska

Donald A. Walker, Vladimir E. Romanovsky, William B. Krantz, Chien L. Ping, Rorik A. Peterson, Martha K. Raynolds, Howard E. Epstein, Jiong G. Jia, David C. Wirth

The central goal of this project is to understand the complex linkages between biogeochemical cycles, vegetation, disturbance, and climate across the full summer temperature gradient in the Arctic in order to better predict ecosystem responses to changing climate. We focus on frost boils because: (1) The processes that are involved in the self-organization of these landforms drive biogeochemical cycling and vegetation succession of extensive arctic ecosystems. (2) These ecosystems contain perhaps the most diverse and ecologically important zonal ecosystems in the Arctic and are important to global carbon budgets. (3) The complex ecological relationships between patterned-ground formation, biogeochemical cycles, and vegetation and the significance of these relationships at multiple scales have not been studied. (4) The responses of the system to changes in temperature are likely to be nonlinear but can be understood and modeled by examining the relative strengths of feedbacks between the components of the system at several sites along the natural arctic temperature gradient.

We propose to examine disturbed and undisturbed patches associated with frost-boil ecosystems, from polar deserts of northern Canada to shrub tundra systems in Alaska. Frost boils are caused by soil heave in small, regularly spaced, circular, highly disturbed patches, 1–3 m in diameter. The processes of frost-boil formation are currently poorly understood, so full knowledge of the biogeochemical system first requires a better understanding of the process of frost heave itself and how it is modified

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by interactions with climate and vegetation. A recent Differential Frost Heave (DFH) model by Peterson and Krantz provides considerable insight to the self-organization processes in frost boils. This physically based model can predict many phenomena associated with frost boils, including the amount of heave, spacing, and size of the boils. Early model results suggest that the ground-surface temperature is a primary control of frost-boil formation. Vegetation and/or snow cover can constrain the development of frost boils by insulating the soils. Climate and the level of disturbance caused by frost heave strongly influence the rate of organic-matter accumulation and biogeochemical cycles within the tundra soils. We will examine the full implications of this interaction by studying how frost heave affects nitrogen and carbon pools and rates of nitrogen mineralization along the climate gradient. We propose to answer six major questions related to the biocomplexity of frost-boil ecosystems:

1. How does the self-organization associated with frost boils occur?
2. How does the frost heave affect the soil biogeochemical processes within and between the frost boils?
3. How do frost heave and biogeochemical processes affect plant communities?
4. How do the biological processes in turn feed back to control frost heave?
5. How do interactions between biogeochemistry, cryoturbation, and vegetation change along the existing arctic climate gradient?
6. How do the complex patterns associated with frost boils affect the tundra systems in a hierarchy of spatial-temporal scales?

The response of the system to summer temperature is nonlinear. We propose to dissolve the complex system into linear models by examining the relationship between frost heave, carbon, nitrogen, and vegetation at a series of sites within five bioclimatic subzones along the temperature gradient. We will use ordination, path analysis, and information theory to examine the complex multivariate relationships between biogeochemistry, cryoturbation, vegetation, and the environment. We hypothesize that zonal sites in areas with intermediate summer warmth should have the highest measures of several key ecosystem functions (e.g., mineralization rates, nitrogen pools, biodiversity). In years 1 and 2, the field studies will focus along the Dalton Highway in northern Alaska. This region is well known and provides an exceptional opportunity because it has a particularly sharp boundary that demarcates essentially high arctic soils with abundant frost boils from low arctic soils with few frost boils. Extensive ecosystem, snow, and ground-temperature data are available from several sites in this region. In years 2, 3, and 4, we will extend the research into more remote areas in the Canadian Arctic where there are colder bioclimate subzones not represented in northern Alaska.

To arrive at a predictive capability for biogeochemical response and plant community formation, we will use output from the DFH model to help parameterize a vegetation-change model (ArcVeg). The project has four research components: (1) frost boil dynamics, climate, and permafrost, (2) soil and biogeochemistry, (3) vegetation, and (4) modeling nutrient and vegetation dynamics. We also propose a major educational component of the study. Students, as part of Dr. Bill Gould's Arctic Field Ecology course, will interact with the scientists. They will be actively engaged in the research activities as part of expeditions that will allow them to study biocomplexity in the Arctic. We are also proposing to host an arctic biocomplexity workshop early in the project and a synthesis workshop in Year 4.

Poster Abstracts

Association of Canadian Universities for Northern Studies

Frances Abele

The Association of Canadian Universities for Northern Studies (ACUNS) represents Canada's northern and polar researchers working at member universities and colleges. Founded in 1977 in Churchill, Manitoba, as a nonprofit organization, the association has six important functions: (1) to represent interests of members by promoting policies and practices that support northern scholarship, (2) to establish mechanisms through which resources can be allocated to members so as to increase knowledge of the north and ensure northern training, (3) to enhance opportunities for northern people to become leaders and promoters of excellence in education and research important to the north, (4) to facilitate the understanding and resolution of northern issues, (5) to initiate programs which will increase public awareness of northern sciences and research, and (6) to cooperate with other organizations, public, private, and international, concerned with northern studies.

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Sea Surface Temperature Fronts of the Arctic and Subarctic Seas from Satellite Data

Igor M. Belkin

The Arctic/subarctic seas feature a variety of fronts that clearly manifest in the surface layer, both in temperature and salinity. Thermal fronts were studied from the Pathfinder satellite SST fields, 1985–1996, obtained from the AVHRR 9-km twice-daily images (8,364 images in total). The SST fronts were detected from each individual image using the Cayula-Cornillon front detection and declouding algorithms. Long-term (1985–1996) frontal frequencies (normalized on cloudiness) were computed for each 9-km pixel and mapped for the Arctic Ocean marginal seas and the northern North Atlantic subarctic seas. Analysis of synoptic frontal SST maps together with frontal frequency maps allowed us to distinguish a number of new fronts and elucidate important features of some previously known fronts, especially with regard to their spatial structure and its seasonal and interannual variability.

The Arctic Ocean marginal fronts are best developed in the Chukchi and Beaufort seas in summer when the Chukchi Sea and southern Beaufort Sea become ice-free. Most fronts are topographically controlled by shelf break (e.g., in the southern Beaufort Sea), canyons (Herald Canyon, Barrow Canyon), and shelf banks (e.g., Herald Shoal and Hanna Shoal). In both seas the thermal fronts are spatially associated with distribution of biota, including sea birds and marine mammals.

Major fronts of the Nordic Seas are topographically controlled. The East Greenland Front, West Spitsbergen Front, and Norwegian Coastal Front are shelf-slope fronts aligned with the respective shelf breaks/upper slopes; the Norwegian Atlantic Front is controlled by the Voring Plateau's western flank; the Iceland-Faroe Front extends over the Iceland-Faroe Ridge; the Jan Mayen Front is located over the Jan Mayen Ridge and Mohn Ridge. The Iceland Sea frontal pattern is more complex than previously known and displays a "horseshoe" pattern formed by the East Icelandic and Kolbeinsey Ridge fronts. In the Labrador Sea, the West Greenland Front follows the shelf break. The Baffin Front emerges as an independent feature, originated largely in the Baffin Bay. The offshore Labrador Front is fairly stable, aligned with the shelf break. In summer, the newly identified mid-shelf Labrador Front is also observed. This double-front structure sometimes persists through October.

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Subsurface Warming Versus Surface Cooling of the North Pacific Polar Front

Igor M. Belkin, Richard Krishfield, Susumu Honjo

Over 200 meridional sections in the northern North Pacific are analyzed, augmented with a number of surveys in the Gulf of Alaska, in order to map the Polar Front and study its long-term variability (Belkin, Krishfield, & Honjo, 2002). The Polar Front is defined as the southern boundary of the "pure" subarctic vertical structure that features a pronounced, very cold, subsurface temperature minimum (Tmin) underlain by a temperature maximum (Tmax). This boundary is typically associated with enhanced horizontal gradients of most oceanographic parameters. These elevated gradients can be traced down to at least 1500–2000 m depth. The first trans-Pacific map of the Polar Front reveals this important physical and biogeographical boundary extending non-zonally from 40°N off Japan to 57°N in the Gulf of Alaska, where the front retroflects and continues WSW with the Alaska Stream. The Polar Front parameters change downstream and with time. The decadal variability of the front is studied along the 150°E, 170°E, 175.5°E, and 180°E sections, occupied annually. Most time series of the Tmin, Tmax, and T100 temperatures on both sides of the front demonstrate a dramatic long-term subsurface warming between 1978 and 1999. The magnitude of the Tmin warming is at least 1°C over 20 years (up to 2°C along 170°E). Since the Tmin is a remnant of wintertime convection, this warming signals a significant amelioration of the winter climate of the northern North Pacific over the last two decades. At the same time, the summertime SST time series along the Polar Front show a concurrent cooling, about 1°C to 2°C over 20 years. The observed subsurface warming/surface cooling of the Polar Front and associated current are supposed to have been advected by the large-scale circulation to the Gulf of Alaska, Alaskan Stream and eventually, with the Alaskan Stream's northward branches, to the Bering Sea.

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Belkin, I. M., R. Krishfield, and S. Honjo. In press. Decadal variability of the North Pacific Polar Front: Subsurface warming versus surface cooling, *Geophysical Research Letters,* 29.

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Adaptations of Euro-Canadian Schools to Inuit Culture in Selected Communities in Nunavut

Paul Berger

This poster highlights aspects of a study that explored current and desired adaptations of Euro-Canadian schools to Inuit culture in five communities in one region of Nunavut, Canada.

To increase the success or well-being of Inuit students, the main recommendations from this study were: (1) to increase community ownership of schools through meaningful consultation, (2) to increase the number of Inuit educators in schools and to support them in remaining Inuit rather than adopting Euro-Canadian ways of being/teaching, (3) to base the hiring of teachers for northern schools on their orientation towards change and their ability to work with people, rather than on their academic qualifications, (4) to create an orientation to Inuit culture, learning styles, and communication patterns for new teachers hired from the South and to train teachers on cultural and ESL issues and strategies, (5) to create and effectively distribute relevant, culturally sensitive curricula and resources in Inuktitut and (ESL sensitive) English, and (6) to create policy that encourages teachers to prioritize the meeting of students' needs.

The poster includes points from the review of literature dealing with dominant-culture schools in minority-culture settings, a brief description of the methodology employed in the study, selected participant quotes, and a summary of the findings and recommendations.

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The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change

Igor Krupnik and Dyanna Jolly, editors

A new book published by ARCUS, in cooperation with the Arctic Studies Center, Smithsonian Institution, addresses indigenous observations of arctic environmental change and the implications of such change for arctic peoples. Despite all the attention currently being given to climate change globally and in the Arctic, indigenous perspectives are all too frequently overlooked. *The Earth is Faster Now* demonstrates that arctic residents have a great deal to say. Climate change simply cannot be understood and addressed without incorporating their specific and detailed views. The processes by which this can be done, however, take considerable time and effort on the part of both researchers and arctic residents.

The papers collected in this volume focus primarily on documenting and understanding the nature of changes that are being seen by northern indigenous residents. The special emphasis of the papers is not simply on change but also on the ways arctic peoples perceive, influence, and are influenced by their surroundings.

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Evolution of Temperature in the Atlantic Water Core Over the Period 1995 to 2001

John T. Gunn, Timothy Boyd, Robin D. Muench, and Michael Steele

Ocean temperature and salinity have been measured annually from 1995 to 2001 along transects across the central Arctic Ocean using submarine-launched expendable CTD probes. Data from these probes have been integrated with data acquired from surface vessels over the same period. These data, which encompass trans-ocean ridges and circulation gyres interior to the Arctic Ocean, are used to assess interannual variations across the basin. The overall trend was for continued warming in the Atlantic Water (AW) layer throughout the period. In particular, AW temperatures increased in warm cores in the Amundsen and Makarov basins and over the Chukchi Rise in the Canadian Basin. The temperature patterns were also consistent with lateral spreading of these cores. However, this pattern was somewhat patchy both spatially and from year to year. For example, some early cooling was evident in the upper 2000 m of the AW layer overlaying the Lomonosov Ridge and extending slightly into the Makarov Basin, however, the Makarov side of the Lomonosov Ridge showed warming in 2001. Persistent warming in the western Amundsen and Makarov basins probably reflected preferential input to these regions of warmer water from the warm, eastward slope current north of Siberia. Other features, more ephemeral, likely show system responses to fluctuations in the regional wind field and, by association, the Arctic Oscillation.

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World Ocean Database 2001

Sydney Levitus, Margarita Conkright, Todd O'Brien, Timothy Boyer, Cathy Stephens, Ricardo Locarnini, Hernan Garcia, Paulette Murphy, Daphne Johnson, Olga Baranova, John Antonov, Renee Tatusko, Robert Gelfeld, Igor Smolyar

In 1982, Sydney Levitus of NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) published the first global and objectively analyzed fields of temperature, salinity, and oxygen based on all data available from the NOAA National Oceanographic Data Center (NODC)/World Data Center (WDC) in paper as well as electronic form. This product was entitled *Climatological Atlas of the World Ocean*. This was followed in 1994 and 1998 with the publications of the World Ocean Atlas 1994, the World Ocean Database 1998, and the World Ocean Atlas 1998. The World Ocean Database 2001 (WOD01) greatly expands on the 1998 product by including data from new instrument types (such as profiling floats), new variables (such as pCO_2 and TCO_2), and many more historical as well as modern data for the variables in WOD98. WOD01 contains over seven million temperature profiles. The goal in developing and distributing WOD01 is to make available—without restriction—the most complete set of historical ocean profile-plankton measurements possible in electronic form along with appropriate metadata and quality control flags. As with earlier versions of the databases, the data will find use in many different areas of oceanography, meteorology, and climatology. Whether studying the role of the ocean as part of the earth's climate system, conducting fisheries research, or managing marine resources, scientists and managers depend on observations of the marine environment in order to fulfill their mission. The WOD01 is a product based on data submitted to the NODC and the WDC for Oceanography by individual scientists and scientific teams as well as institutional, national, and regional data centers.

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Ilimmarfik: A New University Campus in Greenland

Aqqaluk Lynge, Marianne Stenbaek

Greenland is a remote place, but its population, particularly its youth, wants very much to be part of the modern world. Education and research are seen as the key. The Greenland Home Rule Government together with the already existing institutions of higher learning are therefore planning to build a new American-style University Campus in Nuuk.

The campus will be comprised of the present University of Greenland, the National Library, the Language Secretariat, the School of Social Work, the School of Media and Journalism, the National Archives, and Statistics Greenland. It will be built next to the existing Institute of Natural Sciences. Ilimmarfik is expected to become a major center for research and teaching in the eastern Arctic with strong circumpolar links.

It will welcome both Greenlandic and international students and researchers. The construction is scheduled to begin in late 2002 and the expected opening date will be September 2004.

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Regional Variation in Cloud Radiative Forcing at the Arctic Surface

Peter J. Minnett, Tim N. Papakyriakou, Cristina Ananasso, Erica L. Key, Jennifer A. Hanafin

The effect of the clouds on the radiative fluxes reaching the Earth's surface is an important atmospheric process, and cloud-radiative forcing is a significant factor in the climate system. The Arctic is an important area to study this process because of its particular sensitivity to climate change. Measurements from a ship and coastal sites in the Canadian Arctic are used to investigate the influence of clouds on the surface radiation budget and its variation in terms of local characteristics. It is found that cloud radiative forcing is a nonlinear function of cloud amount over the low-albedo surface of open water of the North Water Polynya, but a nearly linear function over a high-albedo surface of adjacent land-fast ice.

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An Ecological Analysis of the Spread of Tuberculosis Among the Inuit of the Canadian Eastern Arctic

Helle Moeller

Many factors influence the disproportionately high tuberculosis incidence in the Canadian eastern Arctic. Increased knowledge about these factors will improve our ability to tailor appropriate preventative measures, decreasing the incidence of tuberculosis and preventing outbreaks. Some of these factors are systemic, including (a) staff shortage and high turnover rates, both of which compromise surveillance and screening programs, as well as the ability to diagnose tuberculosis; (b) large reservoirs of infected people who may not have been properly treated in the past; and (c) possible lack of adequate education for health care workers and local residents. Other historical, environmental, biocultural, and sociocultural factors may be important as well.

This poster will synthesize findings from the literature among the latter factors. The analysis draws on the author's experience working with tuberculosis outbreaks in communities of the Canadian eastern Arctic, which revealed that certain cultural practices probably contributed to the spread of tuberculosis. Intriguing questions for future research are raised.

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SEARCH: Quantifying Pan-Arctic Environmental Change

James E. Overland

The Arctic has undergone major temperature swings over the last 100 years. Over the past three decades, demonstrable pan-Arctic changes have occurred in many components of the physical and biological system. The areal coverage of sea ice has diminished, and sea-level pressures in the central Arctic have decreased, resulting in a shift of wind and heat flux patterns. Warmer surface temperatures are observed in northern Europe during winter and Alaska and northwest Canada during spring, there is an increase in the frequency of years with cold temperature anomalies in the lower stratosphere over high latitudes, and permafrost temperatures have risen in Siberia and Alaska with increased erosion. Satellite estimates of "greening" have increased over both the eastern and western hemispheres, with longer growing seasons and changes in the character of the tundra. The influence of warm Atlantic water in the Arctic Ocean is becoming more widespread and intense, with implications for the stability of the water column. These changes are robust, and many other biological and physical changes are suggested: increases in cod in the Barents Sea and shrimp off of southern Greenland, increases in calf survival for some caribou populations in North America, and declines and redistributions of marine mammal populations, although causes for these changes are less certain.

Extrapolation of atmospheric and sea ice records from the last 100 years implies a reversal of present trends in 2000–2030, while IPCC climate models imply a continuation of the current course. At present, neither evidence nor understanding is available to unequivocally distinguish between these scenarios. A promising method for future detection of change is to use a multivariate approach. Biological and terrestrial variables are often better indicators of decadal change than physical variables because they integrate over the large meteorological and oceanographic interannual and intraseasonal variability. A data collection for 1965–1995 of 85 variables representing seven data types shows broad pan-Arctic covariability for a shift in ecosystems near 1989. Understanding biocomplexity is an important factor in developing an arctic change detection system since extremes in the physical environment lasting one or two years can precipitate biological/ecosystem changes that last several decades.

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The Arctic Research Consortium of the United States

Wendy K. Warnick, Sue Mitchell

The Arctic Research Consortium of the United States (ARCUS) is a nonprofit membership organization, composed of universities and institutions that have a substantial commitment to research in the Arctic. ARCUS promotes arctic research by improving communication among the arctic research community, by organizing workshops, and by publishing scientific research plans. ARCUS was formed in 1988 to serve as a forum for planning, facilitating, coordinating, and implementing interdisciplinary studies of the Arctic; to act as a synthesizer and disseminator of scientific information on arctic research; and to educate scientists and the general public about the needs and opportunities for research in the Arctic.

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Arctic Alive!

Janet Warburton

Arctic Alive! is an arctic science education program developed by ARCUS and modeled after a program in New Zealand called LEARNZ.

The one-year pilot program is funded through a grant from the National Science Foundation, Directorate for Geosciences.

Arctic Alive! is a distance-delivery program that allows students to interact with researchers in remote arctic locations without leaving the classroom, yet experience "real science" in "real time." A teacher accompanies researchers to the field to serve as a classroom guide. The teacher leads audioconference calls with the students from the field. Students talk directly to researchers and get their questions answered immediately. In addition, a comprehensive web site allows teachers and students to retrieve lessons and follow the expedition. An on-line discussion forum allows researchers and students to continue their interactions.

Educators and students can use the lessons from the web site individually or as a unit. Lessons integrate with the school curriculum and align with National Education Standards in technology, science, and math.

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Arctic Forum Program

Thursday, 16 May 2002

8:00 a.m.	Continental Breakfast	
8:30 a.m.	Welcome and Introductions	Arctic Forum Co-Chair: *Sue Moore* *National Marine Mammal Laboratory, NOAA*

BIOCOMPLEXITY IN THE ARCTIC

8:40 a.m.	The Arctic as a Biocomplex System	*Rita Colwell* *Director, National Science Foundation*
9:30 a.m.	Perspectives from the Arctic	*Orville Huntington* *Department of Subsistence* *U.S. Fish and Wildlife Service* *Vice-Chair, Alaska Native Science Commission*
10:00 a.m.	BREAK	
10:20 a.m.	Biocomplexity in the Arctic: The Bowhead Whale Nexus	*Sue Moore* *National Marine Mammal Laboratory, NOAA*
10:50 a.m.	Climate and Subsistence Hunting: The Sustainability of Arctic Communities	*Craig Nicolson* *Department of Natural Resources Conservation* *University of Massachusetts*
11:20 a.m.	Arctic People in Complex Adaptive Systems: The Case of Climate Change	*Fikret Berkes* *Natural Resources Institute* *University of Manitoba*
11:50 p.m.	LUNCH	

Arctic Forum, Thursday, 16 May 2002, continued

1:30 p.m. Biocomplexity of Marine and Terrestrial Environments and Human Populations in Iceland
Astrid Ogilvie
Institute of Arctic and Alpine Research
University of Colorado at Boulder

1:55 p.m. The Arctic Nearshore Environment: A System Defined by Complex Hydrological and Biogeochemical Linkages and Feedbacks
Ken Dunton
Marine Science Institute
University of Texas at Austin

2:20 p.m. Interactions between Hydrological and Biotic Process in the Arctic Landscape
Joshua Schimel
Department of Ecology, Evolution, and Marine Biology
University of California Santa Barbara

2:45 p.m. Biocomplexity in the Arctic: Summary and Discussion
Arctic Forum Co-Chair: *Wieslaw Maslowski*
Department of Oceanography
Naval Postgraduate School

3:00 p.m. BREAK

3:20 p.m. **The ARCUS Award for Arctic Research Excellence**
Session Chair: *Mark C. Serreze*
Cooperative Institute for Research in Environmental Sciences
National Snow and Ice Data Center
University of Colorado

3:30 p.m. Interdisciplinary Research: Paleogenetic Assessment of Human Migration and Population Replacement in North American Arctic Prehistory
M. Geoffrey Hayes
Department of Anthropology
University of Utah

3:50 p.m. Social Sciences: Adaptations of Euro-Canadian Schools to Inuit Culture in Selected Communities in Nunavut
Paul Berger
Faculty of Education
Lakehead University, Canada

4:10 p.m. Physical Sciences: Rapid Wastage of Alaska Glaciers and Their Contribution to Rising Sea Level
Anthony Arendt
Geophysical Institute
University of Alaska Fairbanks

4:30 p.m. Life Sciences: Are Goose Nesting Success and Lemming Cycles Linked? Interplay Between Nest Density and Predators
Joël Bêty
Biologie (Centre d'Études Nordiques)
Université Laval, Canada

4:50 p.m. Comments on the Award for Arctic Research Excellence *Mark Serreze*

5:00 p.m. Science Education: An NSF Priority *Robert Wharton, Jr.*
Executive Officer, Office of Polar Programs
National Science Foundation

5:15 p.m. Poster Session: Presenting Arctic Science Session Chair: *Henry Huntington*
Gallery II (Hosted Bar and Reception begin)

Introduction of new publication—*The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change* *Igor Krupnik*
Arctic Studies Center
Smithsonian Institution
Dyanna Jolly
Centre for Maori and Indigenous Planning and Development
Lincoln University, New Zealand

ARCUS Annual Reception and Banquet
Reception: 5:15 p.m.—Gallery II
Banquet: 7:00 p.m.—Gallery I

Award Ceremony
ARCUS Award for Arctic Research Excellence

Special Presentation
VINLAND 1000
-Trond Woxen-

Friday, 17 May 2002

8:00 a.m. Continental Breakfast

8:30 a.m. Welcome and Introductions Arctic Forum Co-Chair: *Wieslaw Maslowski*
Naval Postgraduate School

8:40 a.m. Biocomplexity of Frost Boil Ecosystem on the Arctic Slope, Alaska
Donald (Skip) Walker
Institute of Arctic Biology
University of Alaska Fairbanks

9:05 a.m. Using Permafrost DNA to Examine the Effects of Environmental Change
Alan Cooper
Department of Zoology
Oxford University

9:30 a.m. The North Water Polynya: An Arctic Ecosystem Poised for Change

Jody Deming
School of Oceanography
University of Washington

9:55 a.m. Quantifying Pan-Arctic Environmental Change

James E. Overland
Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration

10:20 a.m. Defining Biocomplexity in the Arctic: Closing Comments

Arctic Forum Co-Chair: *Sue Moore*

10:35 a.m. BREAK

AGENCY BRIEFINGS: OPPORTUNITIES IN ARCTIC RESEARCH

11:00 a.m. The Study of Environmental Arctic Change (SEARCH): Progress and Plans

John Calder
Director, Arctic Research Office
National Oceanic and Atmospheric Administration

11:25 a.m. ONR High Latitude Dynamics Research Program

Dennis Conlon
Office of Naval Research

11:45 a.m. Adjourn Arctic Forum

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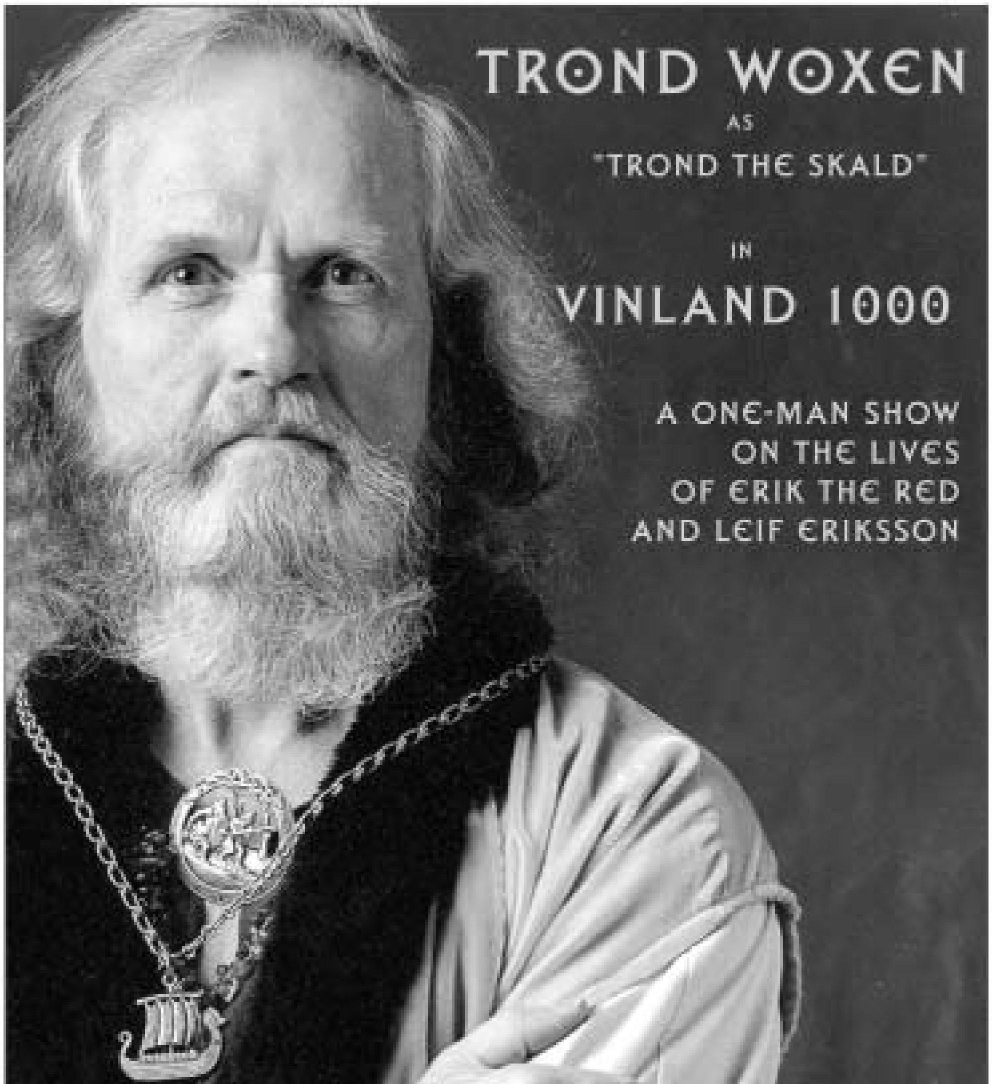
Index

Special Presentation



A special presentation at the ARCUS Annual Banquet: Thursday, May 16th, at 7:00 P.M. in Gallery I, at the Arlington Hilton Hotel.

Trond Woxen's "Vinland 1000" presents the latest information on the Vikings and the new world, in a historically accurate yet humorous one-man show.

Trond Woxen: Actor-Writer and Artistic Director of the Scandinavian Theater Company in Los Angeles. International lecturer and master storyteller. Honorary cultural representative of the Royal Norwegian Consulate General in Los Angeles.