Arctic Forum 2005

Abstracts

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Cover Photos:
Top: Inuit hunters on the ice edge in Qeqertarsuaq, Kalaallit Nunaat (Greenland)
Photos by Richard A. Caulfield

Middle: Girls in downtown Nome, Alaska
Photo by Birte Horn-Hanssen

Bottom: Toolik Field Station by Toolik Lake, Alaska
Photo by Sarah Behr

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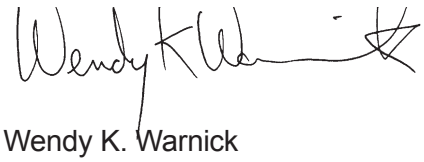
Foreword

Each year the Arctic Research Consortium of the U.S. (ARCUS) hosts the Arctic Forum in conjunction with the ARCUS annual meeting. The goal of the Arctic Forum is for arctic researchers in all disciplines to interact with colleagues and agency representatives. This collection of abstracts showcases the oral presentations and poster session at the Arctic Forum held 19–20 May 2005, in Washington, D.C.

The ARCUS annual meeting and Arctic Forum are the culmination of our efforts each year to represent the arctic research community on behalf of ARCUS' 48 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 theme for 2005 Arctic Forum was "Arctic Climate Change and Public Literacy: What's at Stake?" Michael MacCraken of the Climate Institute gave the keynote address.

As executive director of ARCUS, I appreciate the efforts of the many researchers who shared their results with the community through the Arctic Forum. We thank Bruce Forbes and Stephanie L. Pfirman for chairing the Forum and the National Science Foundation for supporting this opportunity. Birte Horn-Hanssen of ARCUS was the managing editor for this abstract volume and designed the layout. Tina Buxbaum and Sarah Behr of ARCUS also edited this publication. We invite you to join us at the Arctic Forum in May 2006.



Wendy K. Warnick
Executive Director

Introduction to the Session Arctic Climate Change and Public Literacy: What's at Stake?

Bruce Forbes, University of Lapland; Stephanie L. Pfirman, Barnard College (Arctic Forum Co-Chairs)

Observations of climate change in the Arctic—including warming air temperatures, melting glaciers and sea ice, rising sea levels, and thawing permafrost—have significant consequences for plant, animal, and human communities and have generated increased attention by scientists and arctic stakeholders alike. There is also growing public awareness of the Arctic and its role in climate change, partly resulting from recent developments in arctic climate science, including the publication of the Arctic Climate Impact Assessment synthesis report in 2004.

As the general awareness of arctic climate change expands, the research community's role in communicating the science behind the headlines takes on greater significance. To what extent are researchers responsible for public education and literacy on arctic climate change? What are the most effective means to communicate research results and uncertainties to the general public and policy makers? How should science and scientists contribute to public knowledge and policy?

The *Arctic Forum 2005* focused on the relationship among scientists, media, policy-makers, and the public. In addition to arctic researchers, speakers included journalists, behavioral scientists, policy analysts, agency staff, and representatives of indigenous communities. The presentations highlighted current science on arctic climate change and future scenarios; the media's role and its portrayal of arctic climate change; how arctic climate change is perceived by the public; how information is used by decision-makers; and how scientists can best communicate the science of arctic climate change and its consequences for the future of the region and the globe. *Arctic Forum 2005* highlighted ways in which people and organizations can work together to understand, anticipate, and respond to the changes of today and those that may come in the future.

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Presentation Abstracts

Reporting Climate Change—The Front Line

Richard Black, British Broadcasting Company

For scientists working with climate and global change, the media can be a source of immense frustration. It does not always put "the message" across as scientists would want; reporting is frequently perceived as unbalanced; key details are often missed. Yet without the media, how can the scientific case be made to the public, which may then induce the public to put pressure on political leaders?

From more than a decade of reporting climate change, I will argue—as point of fact rather than principle—that most of the media as presently constituted does not have a duty to inform the public about such issues. I will also argue that meaningful political action can and does take place without public support.

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Local and Regional Policy: Needs for Science Information and Communication

Arnold Brower, Jr., Alaska North Slope Borough

The Iñupiat have lived along the arctic coast for thousands of years. Their survival depended almost entirely on the nutritional value of wildlife. As a result, they have become keen observers of the natural world in the far north. They witness the effects of unusual weather or shifting ice conditions and variations in snowfall or temperature over the years, and they pass it on to the young people.

This is fundamentally different from western science. Western science gets its authority by being detached, while traditional knowledge is engaged. It contains information that is useful to western science, but it is actively connected to cultural values. This difference made it difficult for scientists to interpret and apply indigenous knowledge, and the detachment of western science made it difficult for Native people to appreciate the useful applications of science in their world. But western science and traditional Native knowledge have important similarities when it comes to wildlife management. Western science is based on the principle that wildlife should be available for future generations. Traditional Native knowledge has the same motivation. Protection is the underlying value in both cultures, and that is where they come together.

The 1977 bowhead harvest crisis was a turning point for science, for policy making, and for cross-cultural communication in the Arctic. It led to international acceptance of a unique management agreement between the federal government and the Alaska Native whaling community. It convinced the Iñupiat they had to begin talking to the international community in a language it understood and accepted—the language of science. So the North Slope Borough—the regional government for northern Alaska—established the Department of Wildlife Management.

Scientists were encouraged to talk to local Native experts. At first, there was suspicion on the part of local people and confusion on the part of scientists. But because the scientists lived in the community and took the time to get to know the hunters as people, not just as scientific informants, they gradually became accepted in the community.

As a result, scientists, hunters, and elders have learned to work together. That means you get science that conforms to western standards but also benefits from Native knowledge. It is the best of both worlds. Increased interest in the Arctic as an early warning system for global warming and a growing body of scientific research, together with a solid record of cooperation between researchers and local experts, makes us better positioned than ever to make informed public policy decisions in the Arctic.

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Context and Climate Change: Lessons from Barrow, Alaska

Ronald D. Brunner, University of Colorado

For several years my colleagues and I have worked with people in Barrow, Alaska to expand the range of informed choices for the community in adapting to climate change and variability. Our approach has been intensive, centered on one community, comprehensive in consideration of many factors affecting its vulnerability to coastal erosion and flooding, and integrative in the focus on a series of damaging storms in which these factors interact. The results of this approach suggest reconsideration of the interconnected roles of science, policy, and decision-making structures.

First, profound uncertainties are inherent in unique interactions among the many natural and human factors affecting Barrow's vulnerability. Science cannot significantly reduce these uncertainties through extensive approaches, but intensive approaches can reconstruct and update local trends, clarify the underlying dynamics, and harvest experience for policy purposes. Second, sound policies to reduce Barrow's vulnerability must incorporate these profound uncertainties and the multiple values of the community. Minimizing vulnerability to climate change is only one of the community's interests, and it must compete with other interests for limited time, attention, funds, and other resources. Third, the community itself is in the best position to understand its own context, to decide on sound policies, and to take responsibility for those decisions. In short, context matters in adapting to climate change and variability.

In our experience, effective communications with the community and its leaders depend not only on sustained interactions but also on research focused on their local experience and concerns. Motivations to continue are reinforced by partial research results of value to the community and new damaging storms.

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Constructing Partnerships with Arctic Research to Further Education, Outreach, and Scientific Literacy

Renée D. Crain, National Science Foundation

Current scientific research is a gateway to engage people in both the process of science and the essential body of information that defines scientific literacy. Arctic research provides an interesting context for studying basic scientific concepts for both audiences in and outside of the Arctic. Education and outreach partnerships with arctic researchers convey the relevance of the Arctic to the global system and illustrate the process of science as an inquiry-based human endeavor.

Developing the next generation of scientists and engineers, increasing the diversity of individuals in science and engineering to be representative of the population, and providing the public and policy makers with current information are important objectives of the National Science Foundation (NSF). The proposal review criterion known as Broader Impacts ensures NSF-funded projects have impacts beyond the team proposing the work. The broader impacts stipulation in combination with cutting-edge research sponsored by NSF in science and engineering, as well as research in learning and teaching are the backdrop for a number of successful partnerships of arctic researchers with education and outreach. This talk describes examples and outcomes of some of these projects and opportunities for arctic researchers to continue to develop successful partnerships during the International Polar Year and beyond.

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Adolphus Greeley: Raising Arctic Consciousness

Gino Del Guercio, Boston Science Communications, Inc.

Gino Del Guercio is a documentary filmmaker specializing in science, medicine, and technology. He began his career in television as a producer for WGBH in Boston, and for the past 18 years has worked on projects for WGBH, Thirteen/WNET, OPB, KTCA, Discovery Channel, and A&E. He was series co-producer and producer of two programs for the recent Thirteen/WNET series *Red Gold: The Epic Story of Blood.*

In 2000, he produced *"Transistorized!"* which won Science Documentary of the Year from the American Association for the Advancement of Science. He is currently directing a 90-minute historical documentary titled *"In Search of Greeley, "* about the worst arctic disaster in American history, and a two-hour special for PBS with host Jane Pauley and MacNeil/Lehrer Productions about the science of learning.

The content of the film "In Search of Greeley" will be discussed at the meeting.

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“North to the Future”: Communicating to and from the Arctic Front Lines of Climate Change

Lisa Dilling, University of Colorado Boulder

As far as climate change is concerned, the already apparent impacts in the Arctic may well be considered planetary “early warning signals” for problems yet to manifest in other parts of the world. Few in the polar region may need further “proof” that global warming is underway; many will at least recognize that something strange is going on. And yet, to truly engage the public and decision-makers on this topic is likely to be as challenging there, as in many other regions. Far from the northern latitudes, removed from the evidence on the ground, people are even less concerned with the issue. Research suggests that the American public’s understanding of climate change is rather limited and on several counts erroneous. Even those who do understand the issue and show great concern do not necessarily translate their worries into action.

This presentation will:

1. examine the reasons why scientists have had only limited success in getting through to the public and to policy-makers with their message,
2. look at the impacts of past efforts to communicate climate change on the audience, and
3. suggest strategies for how to improve outreach in a way that takes advantage of the regional evidence and context.

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When the Arctic Becomes Subarctic: Seabirds Respond to Three Decades of Climate Change

George J. Divoky, University of Alaska Fairbanks

Changes in the distribution and abundance of higher trophic level species can provide compelling evidence of climate change that is easily understood by the public. While seabirds are excellent monitors of marine ecosystems at all latitudes, their affinity or avoidance of sea ice makes them even more sensitive to climate related changes in high latitude oceans.

The seabird colony on Cooper Island, Alaska, 25 miles east of Point Barrow, has been studied annually from 1975–2004, a period of rapid climate change in the western Arctic. Monitoring of the diversity, abundance, and breeding success of the island's seabirds provides one of the few examples of a biotic response to the well-documented atmospheric and oceanographic changes occurring in the region. The Black Guillemot, an arctic seabird dependent on ice-associated prey, prospered in the 1970s and 1980s but experienced reduced breeding success and a declining population after 1989, when a shift in the Arctic Oscillation resulted in earlier and greater retreat of the summer pack ice. Concurrently, the Horned Puffin, a subarctic seabird that feeds primarily on schooling fish, underwent a northward expansion, first breeding on the island and northern Alaska in 1986 and increasing throughout the 1990s. The 2003 and 2004 field seasons saw unprecedented breeding failure for Black Guillemots and record numbers of Horned Puffins on the island. This relatively rapid switch in the nearshore marine ecosystem has implications for a number of arctic and subarctic marine species, some of which are important in the subsistence harvest of the region's indigenous people.

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Arctic Climate Change: Russia's Indigenous Peoples' View

Yana Dordina, Russian Association of Indigenous Peoples of the North

The northern coast of the Russian Federation stretches along half of the arctic coast, and climate change in this region has an impact on climate throughout the world. This is why data from the Russian Federation is so vitally important to the decision making process on climate change.

Unfortunately, there are very few projects focusing on the traditional knowledge indigenous peoples have gathered on climate change in Russia over time and space. The Russian Association of Indigenous Peoples of the North (RAIPON) hopes to fill this information gap by proposing projects that study traditional knowledge and at the same time serve the interests of a scientific study of the planet's climatic and atmospheric conditions.

Environmental knowledge is part of indigenous peoples traditional knowledge. It changes over time and adapts to environmental changes. Discussing weather and climate change is an important aspect of indigenous peoples' everyday life. Systematic data collection and the creation of a network of indigenous informants (hunters, reindeer herders, and fishermen) will provide a broad range of information and data on climate change from different places and time periods. Traditional knowledge, independent of current theories on climate change, plays an important part in both short and long-term climate change predictions.

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Examples of climate change observations by ordinary people—hunters, reindeer herders, and fishermen—in their homelands include:

- Early spring: early snow melt followed by hard frosts and blizzards cause young reindeer to die; reindeer calves are born prematurely
- Ice-covered tundra: difficult for reindeer to access lichen
- Very cold winters: the land thaws late, hard for reindeer to find food (mushrooms, moss, berries, lichen)
- Early opening of ice bound rivers: the regime of fish shifting from winter to summer pools is changing, affecting fish reproduction behavior
- Frozen lakes: lakes freeze to the bottom because of very cold winters, which causes fish to die
- It rains more: water in rivers rise and fish don't bite (fail to take bait)
- Less snow cover: animal tracks are not observed in the snow; the land is unable to warm up over winter; and the ground absorbs less moisture, which causes berries to mature later in the season
- Extreme cold winters: animal skins are of low quality and they do not have a commodity value
- Droughts: shortage of rain, contributing to forest fires that destroy plants and animals
- In the north, southern animal species are being observed that were earlier not found in those areas, i.e. red deer species

Climate Change in the Arctic and Public Health

Paul R. Epstein, Harvard Medical School

Just as we underestimated the rate at which climate would change, we have underestimated the biological responses to those changes.

Temperature constrains the range of microbes and vectors while weather affects the hosts and timing and intensity of disease outbreaks. Ticks in Sweden are trekking north as winters warm, and models project a similar shift in the U.S. and Canada. The West Nile virus (WNV) is spreading in the Americas, and the bird-biting *Culex pipiens* mosquitoes survive in warm winters and thrive in shallow pools of foul water that remains in drains during droughts. Over the hot, dry summer of 2002 (absent snow pack in the Rockies), the WNV raced across the nation, stopped in 44 states, reached California and five Canadian provinces, and infected 230 species of animals, including 37 species of birds along the way. Warming will provide the conditions allowing the WNV to potentially move into Alaska.

Global warming is also retarding repair of the 'ozone shield, " meaning higher levels of UV radiation for years to come. On the other hand, tailpipe emissions combine rapidly in the heat to form ground-level ozone or photochemical smog—a cause of asthma and other respiratory illnesses.

The drought from 1998 to 2004—"the worst in 500 years"—weakened trees by drying the resin that normally drowns beetles as they bore through bark, while warming allowed beetles to overwinter, expand into higher latitudes and altitudes, and sneak in an extra generation each year. Alaskan forests—essential habitat—are threatened by numerous infestations, including spruce bark beetles, spruce budworms, and leaf miners. Terrestrial and marine food webs are being disrupted. Alaskan Inuits also report an increase in accidents walking on thin ice, and increasing rates of depression and alcoholism, as thawing permafrost undermines their homes and villages.

We may also have underestimated the benefits of ending our addiction to fossil fuels. Given the proper incentives, energy efficiency, hybrid technologies, distributed generation with tidal, solar, fuel cells, wind and geothermal sources, can constitute the engine of growth for the 21st Century; a clean one that can propel us into a healthier future.

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Arctic Indigenous Peoples Facing Climate Change—A Saami Perspective

Rune Fjellheim, Saami Council

The Arctic is warming at an alarming rate. The Saami people, as one of many arctic peoples, have experienced the change first hand, and have joined with academia to document the changes. In the Arctic Council, a co-operation where indigenous peoples work side by side with the eight arctic states, we have found a sound atmosphere for collaboration and exchange of knowledge.

The Arctic Climate Impact Assessment is an example of science and traditional knowledge working together to identify causes, effects, and possible implications of the complex topic of climate change.

This presentation will touch on the following topics:

- Brief overview of the Saami experience
- Short and long term challenges
- Dealing with increased access to the Arctic as a consequence of a warmer climate—a Saami and indigenous view

The Arctic is warming and poses a gigantic threat to people, animals, and our precious eco-systems. It is alarming that some governments and many multinational enterprises seem to be most impressed by the fact that a warmer Arctic may become a more accessible Arctic. They are seemingly unconcerned about solving the single largest challenge facing humankind—runaway warming of our planet.

The fact is that as long as our rights are not recognized, the access and opportunities are for others to exploit. We are just left with the challenges and problems. That is clearly unacceptable.

Nobody knows the exact effects of the current changes, and the peoples and residents of the Arctic simply have to adapt. Our peoples, with a history in the Arctic of many millennia, have experienced and survived climate changes before. The difference this time is that we now know who caused it. We can and will adapt, but we will also address the causes and do what we can to prevent our lands from being destroyed in the process.

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Conservation Strategies for Responding to Climate Change

Lara Hansen, World Wildlife Fund

Climate Change is one of the greatest conservation challenges we have ever faced. Its effects are seen around the world, but nowhere more so than in the Arctic. The ever increasing temperatures, the melting of sea ice, glaciers and ice shelves, the change in precipitation from snow to rain, and the arrival of new species are just some of the many dramatic changes we are seeing in this region.

Additionally, effects in the Arctic further affect the rest of the planet through altered physical and biological processes. As a result, it is crucial that we develop new conservation strategies to respond to climate change and build resilience. World Wildlife Fund supports an approach that incorporates four basic tenets:

1. Protect adequate and appropriate space
2. Reduce all non-climate stresses
3. Employ active, adaptive management and monitor as you go
4. Work to reduce greenhouse gas emissions

Further background on this work can be found in our publication, *Buying Time: A User's Manual to Building Resistance and Resilience to Climate Change in Natural Systems*, available on the web at www.panda.org/climate/pa_manual.

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Climate Change in the American Mind

Anthony Leiserowitz, Decision Research

Public risk perceptions are critical components of the socio-political context within which policymakers operate. Such perceptions can fundamentally compel or constrain political, economic, and social action to address particular risks, including global climate change. This presentation will report results from a recent national study on American climate change risk perceptions, policy preferences, and behaviors. It found that affect, cognitive imagery, and cultural values are each strong predictors of public risk perceptions and attitudes. In addition, this study identified several distinct "interpretive communities" within the American public that are predisposed to exaggerate, deny, or misunderstand scientific information about climate change. Communication about climate change risks can be enhanced by tailoring messages (and messengers) for these different groups.

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The Arctic Climate Impact Assessment: Taking the Next Steps

Michael MacCracken, Climate Institute

The Arctic Climate Impact Assessment (ACIA), which was conducted from 2001 to 2004, documented how changes in climate over the past few decades have already begun to cause significant impacts on the environment, on ecosystems that all in the Arctic depend upon, and on indigenous communities. Even projections of climate change for the 21st century that are near the lower bounds of what seems likely make clear that much greater changes lie ahead. Even if the international community is able to significantly reduce emissions of greenhouse gases over the next several decades, climate is expected to change for many additional decades. Because high-latitude climate change will be greater than the global average change, adaptation to these continuing changes will become even more of a requirement for those living in the Arctic. Such adaptation will be greatly complicated by significant disruptions in terrestrial and marine ecosystems, by more extensive melting back of glaciers, sea ice, permafrost, and the Greenland Ice Sheet, and by the rise in sea level that, along with the presence of open water during winter storms, will erode and endanger coastal communities. Coordinated expansion of research and assessment efforts by the scientific community and by indigenous and other regional experts is needed in order to provide the specialized knowledge that will be needed to limit the adverse outcomes likely to result from changes in climate and its intensifying environmental and societal impacts.

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Panel Discussion: Communicating Arctic Climate Change

Stephanie L. Pfirman, Barnard College; Renée D. Crain; Hunter Cutting; Lisa Dilling; George J. Divoky; Rune Fjellheim; Andrew Revkin; C. Sean Topkok

Stephanie L. Pfirman of Barnard College moderated a panel discussion entiteled "Communicating Arctic Climate Change". The purpose of this panel discussion was to explore the relationship between arctic researchers, the media, and the public. The panelists discussed the public perception of arctic climate change; communication strategies and their effectiveness; and the role of the research community in public literacy.

Panelists responded to the following questions:

- What is the message on arctic climate change and who's the audience?
- What is the role of the scientific community in communicating arctic climate change?
- What mechanisms can be used most effectively to convey to the public arctic climate change science and its implications for arctic and non-arctic people?

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Special Presentation

Greenland Cultural Presentation

Henriette Rasmussen, Greenland Home Rule Government

In her speech at the ARCUS annual reception, the Honorable Henriette Rasmussen, Greenland Minister for Culture, Education, Research, and Church addressed how contemporary society in Greenland is based on cultural and societal traditions, as well as knowledge and technology.

The Greenland Home Rule has, in its 25 years of existence, emphasized the importance of Greenland's involvement and participation in research, and several research institutions have been built during those years.

Greenland offers a unique place for research on arctic climate change. Established Greenlandic research institutions offer opportunities for international collaboration in addition to the many research opportunities the physical and societal environment of Greenland offers in itself.

Please go to page 72 to read the speech by Henriette Rasmussen at the ARCUS annual reception.

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Fire and Ice: The Challenges and Opportunities in Communicating the Causes, Consequences, and Complexities of Arctic Climate Change

Andrew Revkin, New York Times

The Arctic provides all the necessary ingredients for compelling journalism. There is the long history of adventure, misadventure, and persistent mystery, not to mention scurvy, death, and cannibalism. There is the linkage of the Arctic to things that people care about, ranging from Santa Claus to those arctic blasts on weather forecasts.

There is news, in the form of significant changes in climate and ice conditions that may have a human cause and may eventually result in a profoundly changed Earth (with one white pole and one blue pole in summer). There is an abundance of great imagery and sound (all that crunching, humming, ticking sea ice).

The Arctic also has another vital ingredient: great stories to tell. These include the stories of the indigenous peoples who are already pushed to the edge of cultural survival and now see global warming as the final nudge.

They also include the story of science on the edge of the possible, in situations where professors with Ph.D.s have to get down on their knees on the sea ice and fix a broken winch, eating frozen sandwiches.

These are the kinds of stories that can inspire and excite young people, or anyone who occasionally tunes into *Fear Factor*, even by accident.

But there are great challenges as well, mostly related to the lack of clear understanding "in a long-term context" of the causes of recent arctic change. Uncertainty and complexity and long time scales do not do well in the modern newsroom, where space or airtime is shrinking and science stories face stiff competition from stories about diet, sports, or celebrity trials.

Yet it's vital for scientists to be honest and forthright about the limits of understanding. Some decisions are going to have to be made in persistent uncertainty. Scientists don't always concede that.

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Poster Abstracts

Toward a Cabled Observatory at Barrow, Alaska

Dale N. Chayes, Lamont-Doherty Earth Observatory, Columbia University; Bernard Coakley; Andrey Proshutinsky; Thomas Weingartner

The scientific potential of a cabled seafloor observatory in the Arctic was explored by participants of an NSF-funded open workshop titled, “Science and Education Objectives for a Seafloor Cabled Observatory on the Beaufort Shelf, Alaska,” held in Barrow, Alaska on 7–8 February, 2005.

Thirty-two people representing academia, government, private industry, and citizens of Barrow participated. Discussions of what permanently installed seafloor instrumentation could accomplish for science and for Barrow ranged widely across the broad spectrum of disciplines including chemical, biological and physical oceanography, geology and geophysics, and marine mammal and ice canopy studies.

The key questions and problems addressed included: How to design a cabled observatory for arctic studies? Where and how should it operate? What are the current engineering and science constraints for this facility in the Arctic? What are the science and education objectives for such project?

A workshop report has been submitted for publication in EOS. We are assembling a proposal to address the long lead-time issues including permitting and detailed survey work for cable routes and shore landing.

A technical working group will meet in late 2005 in Monterey to develop a technical approach including a conceptual design and implementation plan that addresses the science.

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Solid Precipitation Reconstruction Using Snow Depth Measurements and a Land Surface Hydrology Model

Jessie Cherry, Lamont-Doherty Earth Observatory, Columbia University; Bruno Tremblay; Stephen Dery; Marc Stieglitz

The amount and distribution of snowfall in the Arctic has significant effects on global climate. However, measurements of snowfall with gauges are strongly biased. A new method is described for reconstructing snowfall from observed snow depth records, meteorological observations, and running the NASA Seasonal-to-Interannual Prediction Project Catchment Land Surface Model (NSIPP CLSM) in an inverse mode. This method is developed and tested with observations from Reynolds Creek Experimental Watershed.

Results show snowfall can be accurately reconstructed based on how much snow must have fallen to produce the observed snow depth. Root mean square error of reconstructed solid precipitation is reduced by 30%, and mean snowfall increased, relative to that from a corrected gauge for eleven snow seasons. The intended application of this method is the pan-arctic landmass, where estimates of snowfall are highly uncertain but where more than sixty years of historical snow depth and air temperature records exist.

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Impacts of the North Atlantic Oscillation on Scandinavian Hydropower Production and Energy Markets

Jessie Cherry, Lamont-Doherty Earth Observatory, Columbia University; Heidi Cullen; Martin Visbeck

Dramatic swings in the North Atlantic Oscillation (NAO) during the 1990s motivated the authors to build a statistical model of NAO impacts on hydropower production and energy markets in Scandinavia. Variation in the NAO index is shown to explain 55% of the variance of streamflow in Norway and up to 30% of the variance in Norway's hydropower output. It is also possible to identify the influence of NAO anomalies on electricity consumption and prices. Government liberalization allowed a financial market to grow around the international trading of electricity, which in Norway is produced almost entirely from hydropower. The model offers a possible tool for predicting the effects of future NAO movements on hydropower production and energy prices in Scandinavia. The potential influence of skillful climate prediction is discussed.

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Arctic Science Education: Partnerships Build Bridges Across the Learning Continuum

Renée D. Crain, National Science Foundation

The Arctic Sciences Section at the National Science Foundation supports the integration of scientific research with science education at all levels. Support from the Arctic Research and Education program has enabled arctic researchers to involve K–12 students, teachers, journalists, arctic residents, and the broader public in their research. Researchers, including graduate-level students, convey the latest theories and questions in arctic science in an active, inquiry-based way that engages learners. Researchers impart to their audiences the importance of the polar regions to the global system, act as role models for young people seeking career opportunities, and provide invigorating collegial interactions for teachers and other professionals.

This poster describes some of the projects supported by the Arctic Sciences Section to involve students and the public in arctic research, with an emphasis on including and providing experiences for arctic residents. The results have provided thousands of students and many others with unique and informative experiences in arctic science. With support from the Arctic Sciences Section, researchers are finding new avenues to ensure the broader impacts of their research while they gain new perspectives about science teaching and learning through these enriching activities.

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Investigating the Economic and Environmental Resilience of Viliui Sakha Villages: Building Capacity, Assessing Sustainability, Gaining Knowledge

Susan A. Crate, George Mason University

This research project investigates the local resilience of rural post-Soviet agro-pastoralist native communities of northeastern Siberia, Russia in the face of economic and environmental change. The four-village, three-year study is a collaborative effort involving native specialists and field assistants, the active participation of village inhabitants, and the in-country research community. The project is funded by the National Science Foundation Office of Polar Programs.

The project is founded on the Primary Investigator's fifteen years of ongoing research and work with Viliui Sakha communities and her fluency in both the Sakha and Russian languages. The research questions are: How do local populations define "sustainability" based on community goals? How can household and community-level adaptation to economic and environmental change be assessed based on a locally determined definition of sustainability? How can elder knowledge be used to inform locally determined definitions of sustainability and thereby support contemporary household and community-level adaptation? To these ends, the project has three interdependent research areas:

1. "Building Capacity" to work with inhabitants to develop local definitions of sustainability and to define appropriate measures to assess sustainability on a household and community level
2. "Assessing Sustainability" to gather and analyze both qualitative and quantitative research data based on those measures
3. "Gaining Knowledge" to investigate what aspects of village elder knowledge inform the locally-produced model of sustainability

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Arctic Sea Ice Characteristics and Atmospheric/ Oceanic Forcing in 20th Century IPCC Coupled Model Simulations

Richard I. Cullather, Lamont-Doherty Earth Observatory, Columbia University; Irina V Gorodetskaya; Bruno Tremblay; Robert Newton

Realistic simulations of the present arctic climate are critical for the projection of future climate scenarios. Such predictions have received increased attention in light of the present downward trends in arctic sea ice extent over the satellite observational era. This poster presents an analysis of 20th century simulations of arctic sea ice concentration and thickness from six coupled models participating in the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report. The sea ice distributions are then related to oceanic forcing and to terms of the surface energy balance including radiative, sensible, and latent heat fluxes. These terms are compared to available observations with particular focus on SHEBA data. The emphasis of this study is to attribute differences between the various models and observation with respect to the spatial distribution, the annual cycle, and interannual variability.

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Survey at 78 Degrees: Archaeological Investigations in Inglefield Land, Northwest Greenland

John Darwent, University of California; Christyann Darwent; Genevieve LeMoine

The Inglefield Land archaeology project (ILAP) is a long-term archaeological research project led by Christyann Darwent of the University of California Davis and Genevieve LeMoine of The Peary-MacMillan Arctic Museum, Bowdoin College in collaboration with Hans Lange of the Greenland National Museum and Archives and David Qaavigaq of the Thule Museum in Qaanaaq.

Located at the northern end of the North Water polynya, Inglefield Land has been an attractive place for maritime hunters to live for millennia. Its prehistoric role as the "gateway to Greenland" and its historic role as a base for Euro-American exploration parties, as well as the destination of one of few documented Inuit long-distance migrations, means it is well suited for studying the complex interactions of cultures in a changing environment.

Here, we describe the results of the first year fieldwork at two locations along the coast of Inglefield Land, Force Bay, and Marshall Bay. In this early stage of research, our work focused on systematic archaeological survey, documenting the rich archaeological resources of this region.

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Adventure Learning: Bringing the Arctic and Climate Change to K–12 Classrooms, Public, and Policy Makers Worldwide

Aaron H. Doering, University of Minnesota; Paul L. Pregont; Mille Porsild

Adventure learning provides learners with opportunities to explore real-world issues through authentic learning experiences within collaborative online learning environments.

The adventure learning program uses the allure of an arctic dogsled expedition to engage learners as they experience scientific research firsthand. Anchored in comprehensive, inquiry-based K–12 curricula, each program reflects an arctic locale and its associated culture. A multimedia online learning environment is developed concomitant to deliver live field updates and scientific and cultural findings synched real-time to the curriculum. Field research includes collection of traditional ecological knowledge (TEK) and hydro-meteorological data with the Office of Polar Programs at the National Science Foundation and National Aeronautics and Space Administration.

The free adventure learning program "Arctic Transect 2004," reached more than three million learners in fifty states across the nation and internationally. Student academic motivation significantly increased to study global climate change, the Arctic, and the Inuit culture when using the adventure-learning program.

Fifty million media impressions and team members speaking to U.S. Senators at Capitol Hill as well as Members of the House of Parliament (UK) extended the program far beyond classroom walls.

Recent research data on adventure learning for environmental education, copies of the K–12 curriculum, showcasing of the online learning environment, and a multimedia overview of Arctic Transect 2004 will be presented. Finally, an introduction to Go North!, a five-year project (2006–2010) to circumnavigate the Arctic in five annual programs, will be showcased.

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The Stress and Strain-Rate Kinematics of Sea Ice at 1, 15, and 200 km

Cathleen A. Geiger, Cold Regions Research and Engineering Laboratory; Jacqueline A. Richter-Menge; Bruce Elder; Keran J. Claffey

A synopsis of stress, drift, and strain-rate from three major field experiments in the Beaufort Sea within the last decade is available at: http://www.crrel.usace.army.mil/sid/SeaIceDynamics/index.htm.

The Sea Ice Mechanics Initiative (SIMI–1992/1993), the Surface Heat Budget of the Arctic Ocean (SHEBA–1997/1998) and Beaufort 2001/2002 include three kinematic studies from the Beaufort Sea at scales of 1, 15, and 200 km, respectively. The data serve as a wonderful resource for improving and validating sea-ice and climate models, with instructive documentation for students, teachers, and researchers. The data archive includes raw and cleaned versions of thermal and dynamic stress; Lagrangian drift and strain-rate; coincident winter synthetic aperture radar (SAR) scenes as archived at the Alaska SAR Facility (ASF); and documentation detailing the experiments, instrument calibration, and data processing. Poster illustrated examples of stress and strain-rate kinematics are used to highlight interesting differences at the three scales.

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The Influence of Landscape Factors on Non-game Fish and Invertebrate Species in Southeast Alaska Lakes

Dave Gregovich, University of Alaska Fairbanks; Mark S. Wipfli; Brian Frenette

Little is known about non-game fish species distributions in Southeast Alaska. Identification of important habitats for non-game fishes is lacking and is needed in order to properly manage their habitats. An assessment of the landscape-level variables that may influence non-game fish species presence is being undertaken based on existing data. Field investigations will test and further hypotheses generated from the initial data set. Analyses are being conducted on fish data from 60 lakes sampled in 1979–1981 in relation to lake elevation, size, outlet stream gradient, and riparian wetlands composition. Influential variables identified will be used as stratification factors in a region-wide study of sculpin and stickleback presence in lakes of varying gross physical characteristics. Preliminary results suggest that elevation is a major determinant of fish species presence. This research will result in a species-presence likelihood model based on lake geographic attributes that can be used by managers.

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A Web-based System for Sharing Digital Geospatial Information in the Polar Regions

Cheryl A. Hallam, U.S. Geological Survey; Douglas J. Tallma; Jerry L. Mullins

The sharing of data is one of the most important forms of communication within the polar research community. Capabilities for the display and download of data are widespread and have provided an important service to researchers and educators, but the growth of Internet access and speed has created an even more promising form of data transfer and sharing. In the southern polar regions, web services are being implemented to provide access to antarctic data through the development of map and feature services. The databases to support these services are being developed through collaboration among Scientific Committee on Antarctic Research member nations through the Geographic Information Expert Group.

Many researchers who work in the Antarctic also work in the Arctic. We can best serve the polar researchers if we collaborate in the development of databases and dissemination techniques. The International Polar Year provides a unique opportunity for the two data communities to work together to develop a set of polar data management and dissemination tools.

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Analyzing North Slope River Plume Suspended Sediment with MODIS Reflectance Data

Anne Hickey, University of Colorado; James Maslanik

Rivers function to integrate terrestrial processes and climatic conditions occurring in a watershed and deliver the product of these processes and conditions to the ocean. As a result, changes in the terrestrial system may be observed in nearshore river plumes. Two vectors of environmental change currently affecting the terrestrial system on the North Slope of Alaska are warming temperatures and oil and gas development, both of which alter the tundra's thermal regime and lead to increased erosion. The advent of recent Earth observing satellites providing daily coverage in the Arctic, and the development of methods to extract suspended sediment information from visible and near-infrared (NIR) satellite reflectance data provide the ability to develop a cost-effective program to monitor suspended sediment from North Slope rivers remotely, providing information about changes in terrestrial processes. In developing such a program, it is first necessary to know the degree to which "external" factors, such as wind-induced entrainment of offshore sediments, might be contributing to the satellite-observed river plume reflectances. Preliminary results comparing Moderate Resolution Imaging Spectroradiometer (MODIS) NIR reflectance data from Alaskan North Slope river plumes with wind and river discharge data indicate that wind resuspension of nearshore sediment significantly contributes to the NIR signal from the Sagavanirktok River plume, contributes to the Kuparuk River plume primarily at higher wind speeds, and appears to have a negligible effect on signals from the Colville River plume.

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Migration in the Arctic: Subsistence, Jobs, and Well-being in Urban and Rural Communities

Lee Huskey, University of Alaska Anchorage; Matthew D. Berman; Lance Howe; Wayne Edwards; Robert Harcharek; Jack Hicks

This project studies patterns of migration of North American arctic indigenous people between rural communities, larger regional centers, and urban areas over the past several decades. It has four primary research objectives:

1. Develop improved methods for analyzing migration decisions of individuals participating in mixed subsistence and cash economies
2. Apply these methods to improve understanding of Inuit migration decisions in a comparative multi-decadal study of Alaska and arctic Canada
3. Develop and make available to other researchers metadata for research and policy applications
4. Involve arctic local governments in policy-relevant research

We address questions about the causes and consequences of migration such as the roles of subsistence opportunities and community quality of life amenities, gender differences, and national policies on migration decisions. Comparing the Iñupiat regions in Alaska to the Nunavut Territory of Canada, we ask whether Canadian Inuit are less mobile than Alaska Iñupiat; and if so, to what extent can this be attributed to differences in policies in the two nations? We also investigate the long-term consequences of migration decisions: is mobility on balance improving living conditions in arctic communities, especially the poorest places, or is it draining leadership to larger settlements and exacerbating inequalities?

Working with participating organizations, we are developing research protocols for analyzing microdata collected from the late 1970s to the present, including the U.S. Census, the Survey of Living Conditions in the Arctic, North Slope Borough Censuses, Statistics Canada's Aboriginal Peoples Survey, and other household survey data from Nunavut and Alaska. A key step in the research is the creation of a new large-sample household-level dataset from 1990 and 2000 Decennial Census Long Form data, in cooperation with the U.S. Census Center for Economic Studies.

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The Dynamics of Greenlandic Language

Birgitte Jacobsen, Ilisimatusarfik—University of Greenland; Mette L. Lyberth; Lona N. Lynge; Katti Frederiksen; Margrethe T. Knudsen; Marianne Hansen

Throughout history Greenlandic has adopted many words (loan-words) from other languages, for historical reasons most of them from Danish. Today English words are also finding their way into the language, as they are in many other language societies. The language contact situation is somewhat controversial and there is still a certain amount of purism in the general debate. However, the linguistic climate leaves space for variation, both dialectal and otherwise. The innovative use of language(s), e.g., in Greenlandic chat-rooms and in different youth groups, indicates the dynamics of Greenlandic language and the ability of the young generation to face the challenges and utilize the possibilities of linguistic and cultural contact.

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A Review of the Greenlandic Writer Kelly Berthelsen's Short Story: *NASA's Most Secret Secret* (Kelly Berthelsenip oqaluttualiaa: "NASA-p isertaasa isertugaanersaat" misissoqqissaarlugu)

Karen Langgaard, Ilisimatusarfik—University of Greenland

As part of my research about Greenlandic literature I would like to exhibit a poster concerning a short story, *NASA's Most Secret Secret,* written by a young Greenlandic author, Kelly Berthelsen. The poster will give headlines of the development of Greenlandic literature, which, apart from hymns, started in the beginning of the 20th century.

Berthelsen's story will be analyzed and related to general tendencies in Greenlandic literature, especially tendencies during the last decade. Copies of the story rendered in English will be available and a video with an interview with the author will be shown.

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Arctic Science Discoveries

National Science Foundation Office of Polar Programs

The past five decades of intense research have increased our understanding of the Arctic, but much remains to be learned. The Arctic Sciences Section of the National Science Foundation (NSF) funds basic research on the Arctic through the Arctic Natural Sciences, Arctic Social Sciences, and Arctic System Science programs, with field research support from the Research Support and Logistics program. Some recent research results are presented both as answers to important questions and leads to future research directions.

Studying Arctic Change: The Study of Environmental Arctic Change (SEARCH) is an interagency, interdisciplinary, multiscale program to study changes occurring in the Arctic and their potential impacts.

Ringed Seal Migration: Working with Alaska Native hunters, researchers attached a satellite tracking device to follow a ringed seal as it migrated northward with the melting ice of the Chukchi Sea in spring.

Photochemistry in Greenland Snow: Light-mediated chemical reactions (photochemistry) occur at the air-snow interface and significantly impact the chemical composition of air trapped in ice and of the air overlying the snow.

Small Streams on the Move: Small streams contribute more to removing nutrients such as nitrogen from water than do their larger counterparts. Based on data collected initially from streams in NSF's Arctic Tundra Long-Term Ecological Research site in Alaska, the findings were confirmed by data from 12 sites across the country.

Living Conditions in the Arctic: This international effort involves a partnership of researchers and indigenous organizations across the Arctic to advance our understanding of changing living conditions among Inuit and Saami peoples and the indigenous peoples of Chukotka.

On the Gakkel Ridge: The Gakkel Ridge is the slowest spreading center in the world, giving scientists the opportunity to explore Earth's inner layers as the mantle spreads at about 1 cm per year onto the ocean floor near the North Pole.

Understanding the Arctic Ocean: The Western Arctic Shelf Basin Interactions (SBI) project is investigating the impact of global change on physical, biological, and geochemical processes over the Chukchi and Beaufort Sea shelf basin in the western Arctic Ocean. The closely affiliated Chukchi Borderlands project studies the region where relatively cold, fresh, and nutrient-rich water from the Pacific Ocean meets warmer, saltier, and deeper water from the Atlantic Ocean over a bottom tortuously rife with slopes, ridges, and deep-sea plateaus.

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CALM II: The Circumpolar Active Layer Monitoring Program's Second Five-Year Plan, 2004–2009

Frederick E. Nelson, University of Delaware; Nikolay I. Shiklomanov; Jerry Brown

Several factors converged in the late 1980s and early 1990s to encourage development of long-term geocryological monitoring, and to make the resulting data sets freely available to interested users:

1. Publicity about the impacts of climate change followed two decades of unprecedented resource development in the cold regions and raised concerns about the stability of associated infrastructure
2. The global nature of climatic change made apparent the need for widespread cooperation among permafrost scientists who became increasingly aware of the importance of their subject in the context of recent climate change
3. International agreements were signed and governments became concerned with facilitating data exchanges with interested users
4. Permafrost scientists became increasingly aware of the benefits accruing from free exchange of data

The Circumpolar Active Layer Monitoring (CALM) network is a highly successful geocryological monitoring program that developed in the 1990s in accord with the principles of data rescue, archiving, and exchange developed during the previous decade. CALM now consists of more than 125 observation sites in both polar regions, as well as several mid-latitude mountain ranges. The CALM program is allied closely with several comprehensive international global climate change programs. CALM recently received its second five-year block of support from the U.S. National Science Foundation. This presentation discusses the main features of CALM II, which include measurements of active-layer thickness, the thermal regime of the active layer and shallow permafrost, and frost heave and thaw settlement. In addition, CALM II includes several sites at which critical field experiments are conducted. CALM II and it companion program, Thermal State of Permafrost (TSP), constitute the Global Terrestrial Network for Permafrost (GTN-P), a comprehensive global-change permafrost monitoring program.

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Ilullisat—A Greenlandic World Heritage Site

Henriette Rasmussen, Greenland Home Rule Government

Ilullisat on the west coast of Greenland is one of the most beautiful and unique areas in the world. Many glaciers traveling along the coast of Greenland and Canada originate here. UNESCO declared it a world heritage site in 2004.

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Exhibition: Whose Eyes are Watching? Kiap Isaanit Isigalugu

Jette Rygaard, Ilisimatusarfik—University of Greenland; Birgit K. Pedersen; Mette L. Lyberth; Lona N. Lynge

During a week in 2001 and 2003, we delivered disposable cameras and diaries to two groups of Greenlandic youth (10–12 years of age and 12–19 years of age). The purpose was to focus on the "voices of young people and the role of media in their everyday life. By using this research method, we received insightful information, which we would not be able to obtain otherwise. In this poster session, we would like to exhibit two posters concerning this project and ten selected photos from each age group (i.e., twenty photos in total).

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Protecting Species Threatened by Global Warming Under the U.S. Endangered Species Act: Case Study of the Polar Bear

Kassie R. Siegel, Center for Biological Diversity; Brendan R. Cummings

The United States Endangered Species Act (ESA) is designed to prevent extinction of plant and animal species via significant protection of species listed as "threatened" or "endangered." Under the Act, a species is "threatened" if it is likely to become in danger of extinction within the "foreseeable future." We demonstrate that the polar bear currently meets the definition of a threatened species, primarily due to the current and projected melting of its sea-ice habitat from global warming. The listing of the polar bear under the ESA will provide significant protection to the species, will aid in educating the American public about the consequences of global warming, and should provide additional mechanisms for achieving reductions in United States greenhouse gas emissions. For these reasons, in February 2005 the Center for Biological Diversity submitted a petition to the United States Fish and Wildlife Service to formally list the polar bear as a threatened species under the ESA.

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Availability of Near-Realtime Arctic Climate/ Ecosystem Change Indicators

Nancy N. Soreide, National Oceanic and Atmospheric Administration; John Calder; James E. Overland

The Arctic Change website provides information on the state of the Arctic in an accessible, understandable, and scientifically credible format: www.arctic.noaa.gov/detect/. Areas include climate change, global impacts, ice processes, and land, marine, and human ecosystems. The Arctic Change website provides a near-realtime update for the key findings of the Arctic Climate Impact Assessment (ACIA) report. Users entering the website see a summary of core issues at a glance, succinct narrative status reports, and time series documenting change are available with a single mouse click. Information for each core issue also includes recent news headlines and prominent scientific articles. The website has become an important source of arctic information, being near the top of Google Search with an average of about 9,000 hits per day. Future directions are a peer-reviewed state of the arctic report and a summary of model forecasts for arctic climate based on the Intergovernmental Panel of Climate Change Fourth Assessment Report (IPCC AR4). NOAA's objectives are to inform dialog with reliable scientific evidence, raise issue awareness, and support decision making.

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White Spruce Performance Variation Across Latitudes and Altitudes in Alaska

Bjartmar Sveinbjörnsson, University of Alaska Anchorage; Tumi Traustason; Matthew R. Smith; Roger Ruess

White spruce performance was assessed in paired treeline and forest sites in three watersheds in the Chugach Mountains, the White Mountains, and the Brooks Range. Soil and air temperatures and season length decreased with latitude and in the two southern mountains also with altitude, while the reverse altitudinal pattern was found in the Brooks Range. Average wind speeds were lowest in the Brooks Range but similar in the White Mountains and the Chugach Mountains, although frequency of extreme wind speeds was higher in the Chugach Mountains.

Needle longevity increased with latitude but decreased with altitude in two southern mountains. Leader death, canopy damage, and lateral branch needle loss decreased with latitude but increased with altitude in the White Mountains and especially the Chugach Range. The relationship between diameter and height varied between altitudes in the two southern mountains but not in the Brooks Range. Tree height and density generally decreased with altitude but not with latitude.

Branch extension growth decreased latitudinally and most years it declined with altitude in the two southern mountains. In two years out of eleven, annual branch growth was greater or equal at treeline to that in the forest in the southern mountains, while in the Brooks Range extension growth was generally greater at treeline than in the forest.

The entire tree branch non-structural carbohydrate needle pool size was primarily controlled by needle mass and carbohydrate concentration—geospatial variation in needle production and needle loss affected this pool size. The non-structural carbohydrate pool in the three youngest annual needle cohorts of each tree branch explained 85% of the site variation in branch growth across latitudes and altitudes.

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Facilitating Collaborative Scientific and Technical Research in the Arctic Sciences and Geosciences

Marianna Voevodskaya, U.S. Civilian Research and Development Foundation; David Lindeman; Shawn Wheeler

The U.S. Civilian Research and Development Foundation (CRDF) is a private, nonprofit, grant-making organization created in 1995 by the U.S. Government (National Science Foundation).

The CRDF promotes international scientific and technical collaboration, primarily between the United States and Eurasia, through grants, technical resources, and training. The Foundation's goals are to support exceptional research projects that offer scientists and engineers alternatives to emigration and strengthen the scientific and technological infrastructure of their home countries; advance the transition of foreign weapons scientists to civilian work by funding collaborative non-weapons research and development projects; help move applied research to the marketplace and bring economic benefits both to the U.S. and the countries with which the CRDF works; and strengthen research and education in universities abroad.

Three CRDF programs provide support to U.S. and Russian scientists engaged in collaborative arctic and geosciences-related research. First, under a contract with the National Science Foundation, CRDF provides an office and personnel in Moscow to assist Office of Polar Programs (OPP) and Geosciences Directorate (GEO) grantees and collaborators with programmatic activities, including identifying and communicating with individual and institutional partners, navigating government agencies, facilitating travel and visas, and providing on-site office support to visiting U.S. travelers. Second, the CRDF Cooperative Grants Program allows U.S.-Russian collaborators in arctic sciences and geosciences to apply for two-year R&D grants averaging approximately $65,000. Third, the CRDF Grant Assistance Program (GAP) enables U.S. government agencies, universities, and other organizations to utilize CRDF's financial and administrative infrastructure to transfer payments, purchase and deliver equipment and supplies, and carry out other project management services to collaborators in Russia and elsewhere in Eurasia.

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Synthesis of Arctic Science at the University of New Hampshire

Cameron P. Wake, University of New Hampshire; Jack Dibb; Mark Twickler; Charles Vörösmarty; Richard Lammers; Alexander Shiklomanov; Mark Fahnestock; Steve Frolking; Xiangming Xiao; Changsheng Li; Michael Rawlins; Marc Lessard; Roger Arnoldy; Larry Mayer; Andy Armstrong; Jim Gardner; Martin Jakobsson; Lawrence Hamilton; Cliff Brown

Several different research groups at the University of New Hampshire (UNH) are currently active in a wide variety of arctic research. Over the course of the next few years, we hope to synthesize this arctic research to develop a broader understanding of change in the Arctic. Brief overviews of areas of arctic research excellence are outlined below. More information on arctic research at UNH is provided online at: http://arctic.unh.edu.

Tracking Atmospheric Transport of Contaminants to the Arctic: The arctic troposphere carries chemicals emitted from natural and anthropogenic sources, with many of the source regions long distances upwind in more populous regions in North America, Europe, and Asia. During intercontinental-scale transport to and within the Arctic, these are mixed and chemically processed with additional emissions from surface sources in the Arctic (cities, forests, tundra, the ocean, and, surprisingly, sunlit snow across the entire basin) and with air injected from the stratosphere. Many of the natural and pollutant chemicals are removed from the arctic troposphere by dry deposition and precipitation, with snow falling onto glaciers throughout the Arctic preserving a valuable record of the past composition. Our group has advanced the understanding of this complex system through airborne and surface-based

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atmospheric sampling, detailed study of the two-way exchange between the troposphere and surface snow, and the recovery and interpretation of high-resolution glaciochemical records from Greenland and throughout the North American Arctic.

Land Surface Hydrology: One of the key research objectives of the Water Systems Analysis Group is to understand the variability of the pan-arctic hydrological budget over space and time. We work closely with partners to assemble integrated and harmonized data sets covering the full pan-arctic domain, involving remote sensing derived data layers (e.g., primary thaw day from SeaWinds Scatterometer, station based data, and modeled data). One of our fundamental tasks has been to identify the major storage and flux terms over the Arctic and to determine the extent of fresh water budget closure.

Upper Atmospheric Physics: This research in the Arctic is largely centered around auroral phenomena and associated processes. While aurora provides spectacular visual displays, it is also the last link in a complex chain of events involving the transfer of energy from the Sun to Earth. Investigations to study aurora are carried out with ground-based instrumentation as well as sounding rockets launched into space above the aurora.

Mapping the Continental Shelf: Under the direction of the U.S. Congress, the Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC) is conducting a detailed analysis of current U.S. data holdings relevant to a potential claim and identifying regions where the collection of new ocean mapping data could substantially improve the quality of a claim. Among these areas, the Arctic is outstanding in that the existing database is far too sparse to support a well-defended claim, especially in areas where the perennial ice cover has prevented surface ships from operating. Thus the CCOM/JHC has been exploring means to collect modern mapping data in ice-covered regions and undertaken a series

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of cruises on a multibeam sonar-equipped icebreaker (*Healy*) to collect data relevant to a potential claim under Article 76. In addition to directly addressing Law of the Sea issues, the new data collected also significantly adds to data needed to support the growing recognition of the critical role that the Arctic Ocean plays in the climatic and tectonic history of the Earth. The new bathymetric data (as well as associated CTD measurements) will help define the nature of deep circulation in the Arctic Basin as well as the history and distribution of ice in the region, a key component of the global climate system.

The North Atlantic Arc: The NAArc project examines human-environment interactions through case studies of recent changes experienced by fisheries-dependent societies in Newfoundland, Greenland, Iceland, the Faroe Islands, and Norway. The interdisciplinary case studies integrate information about oceanographic and marine-ecosystem change with fisheries, demographic, and other social-change data.

Methane Bubbling from Siberian Thaw Lakes: A Positive Feedback to Climate Change

Katey M. Walter, University of Alaska Fairbanks; Sergei A. Zimov; Jeffery P. Chanton; F. Stuart Chapin, III

Ebullition is often the dominant pathway of methane release from aquatic ecosystems, yet it has seldom been carefully measured due to heterogeneity in the spatial distribution and episodic release of gas bubbles. This likely results in an underestimation of total methane emission.

We took advantage of ice formation over lake surfaces in Northeast Siberia to map patterns of methane bubbles trapped in lake ice. We located "hot-spot" ebullition sites as holes in the ice that remain open throughout winter due to exceptionally high rates of methane bubbling. Through random and selective placement of underwater/under-ice chambers we measured "background" and "hot-spot" fluxes annually. The combination of mapping and chamber measurements among different types of thermokarst lakes enabled us to

- improve estimates of methane emissions from Northeast Siberian lakes, and
- identify thermokarst erosion as a landscape process that enhances methane production and emission.

Ebullition comprised 96% of total methane emission from lakes. Hotspot sites, which occurred along thermokarst margins, released up to 23 g CH_4 m^{-2} d^{-1}. Extrapolation of our methane bubbling measurements to all North Siberian thermokarst lakes would increase the estimate of methane emissions from northern latitude ecosystems by 9–58%.

Thermokarst lakes in North Siberia comprise a large proportion of the world's high latitude lakes, yet they are understudied. Melting of ice-rich (50–90% ice) permafrost soil along lake margins (thermokarst erosion) deposits organic-rich (~2%) mineral soil into anaerobic lake bottoms, providing a fresh, labile substrate for methanogenesis. Stable isotope and radiocarbon age dating of methane bubbles reveal the importance of Pleistocene-age organic matter as a source for methane production in lake sediments. Increased thermokarst erosion with climate warming would provide a positive feedback to methane production and emission from lakes. Results from this study suggest ebullition may be a more important pathway of methane emission from aquatic ecosystems than previously reported.

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Arctic Logistics Information and Support (ALIAS)

Wendy K. Warnick, Arctic Research Consortium of the U.S.; Josh Klauder

The ALIAS website is a gateway to logistics information for arctic research, funded by the U.S. National Science Foundation and created and maintained by the Arctic Research Consortium of the U.S. (ARCUS). ALIAS supports the collaborative development and efficient use of all arctic logistics resources. It presents information from a searchable database, including both arctic terrestrial resources and arctic-capable research vessels, on a circumpolar scale.

With this encompassing scope, ALIAS is uniquely valuable as a tool to promote and facilitate international collaboration between researchers, which is of increasing importance for vessel-based research due to the high cost and limited number of platforms. Users of the website can search for and identify vessels as potential platforms for their research, examine and compare vessel specifications and facilities, learn about research cruises the vessel has performed in the past, and find contact information for scientists who have used the vessel, as well as for the owners and operators of the vessel.

The purpose of this poster presentation is to inform the scientific community about the ALIAS website as a tool for planning arctic research generally, and particularly for identifying and contacting vessels which may be suitable for planned ship-based research projects in arctic seas.

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Teachers and Researchers Exploring and Collaborating (TREC)

Helen V. Wiggins, Arctic Research Consortium of the U.S.; Janet Warburton; Wendy K. Warnick

In Teachers and Researchers Exploring and Collaborating (TREC), K–12 teachers participate in arctic field projects, working closely with researchers to improve science education through experiences in scientific inquiry. TREC builds on the scientific and cultural opportunities of the Arctic to link research and education through topics that naturally engage students and the wider public. In addition to arctic field research experiences, TREC supports teacher professional development and a sustained community of teachers, scientists, and the public through workshops, Internet seminars, an e-mail listserve, and teacher peer groups.

While in the field, teachers and researchers communicate extensively with classrooms and the public using a variety of internet tools such as online teacher and researcher journals, message boards, photo albums, real-time presentations and calls from the field, and online learning resources. Researchers interact with students during visits to schools before and after the field experience. The online outreach elements of the project convey these experiences to a broad audience far beyond the classrooms of the TREC teachers.

TREC 2005 features seven field expeditions across the Arctic including expeditions to Toolik Lake, Alaska; Thule, Greenland; Svalbard, Norway; Yukon and Mackenzie Rivers, Alaska and Canada; the Arctic Ocean aboard the icebreaker *Healy*; and the Ikpikpuk River Delta, Alaska.

Funding for TREC is provided by the NSF Office of Polar Programs, and administered by ARCUS with logistical support from VECO Polar Resources. For more information, see the TREC website: www.arcus.org/trec.

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Arctic Forum Program

Thursday, 19 May 2005

8:00 a.m.	Continental Breakfast and Registration	
8:30 a.m.	Welcome and Introductions	Arctic Forum Co-Chairs: Bruce Forbes University of Lapland Stephanie L. Pfirman Barnard College
8:45 a.m.	The Arctic Climate Impact Assessement: Taking the Next Steps	Michael MacCracken Climate Institute
9:25 a.m.	Context and Climate Change: Lessons from Barrow, Alaska	Ronald D. Brunner University of Colorado
9:55 a.m.	When the Arctic Becomes Subarctic: Seabirds Respond to Three Decades of Climate Change	George J. Divoky University of Alaska Fairbanks
10:25 a.m.	Break	
10:55 a.m.	Constructing Partnerships with Arctic Research to Further Education, Outreach, and Scientific Literacy	Renée D. Crain National Science Foundation
11:25 a.m.	"North to the Future": Communicating to and from the Arctic Front Lines of Climate Change	Lisa Dilling University of Colorado Boulder
12:00 p.m.	Lunch	

1.30 p.m.	Climate Change in the American Mind	Anthony Leiserowitz Decision Research
1:55 p.m.	Fire and Ice: The Challenges and Opportunities in Communicating the Causes, Consequences, and Complexities of Arctic Climate Change	Andrew Revkin New York Times
2:20 p.m.	Reporting Climate Change—The Front Line	Richard Black BBC News
2:45 p.m.	Adolphus Greeley: Raising Arctic Consciousness	Gino Del Guercio Boston Science Communications, Inc.

3:10 p.m. Break

3:40 p.m. Panel Discussion: Communicating Climate Change
Moderator: Stephanie L. Pfirman, Barnard College

- Hunter Cutting, Resource Media
- Renée D. Crain, National Science Foundation
- Lisa Dilling, University of Colorado Boulder
- George J. Divoky, University of Alaska Fairbanks
- Rune Fjellheim, Saami Council
- Andrew Revkin, New York Times
- C. Sean Topkok, Alaska Native Knowledge Network/ARCUS

4:25 p.m. Panel Question and Answer and Participant Discussion

ARCUS Annual Reception and Special Presentation

Reception: 5:15 p.m.—National Association of Home Builders Atrium

Greenland Cultural Presentation Introduction

Henriette Rasmussen, Greenland Minister of Culture, Education, Research, and Church

Special Presentation

Greenland Aavaat Choir

Friday, 20 May 2005

8:00 a.m.	Continental Breakfast and Registration	
8:30 a.m.	Welcome and Introductions	Arctic Forum Co-Chairs: Bruce Forbes University of Lapland Stephanie L. Pfirman Barnard College
8:45 a.m.	Arctic Indigenous Peoples Facing Climate Change—A Saami Perspective	Rune Fjellheim Saami Council
9:10 a.m.	Arctic Climate Change: Russia's Indigenous Peoples' View	Yana Dordina Russian Association of Indigenous Peoples of the North
9:35 a.m.	Local and Regional Policy: Needs of Science Information and Communication	Arnold Brower, Jr. North Slope Borough, Alaska
10:00 a.m.	Break	
10:30 a.m.	Conservation Strategies for Responding to Climate Change	Lara Hansen World Wildlife Fund
10:55 a.m.	Climate Change in the Arctic and Public Health	Paul R. Epstein Harvard Medical School
11:20 a.m.	Closing Comments	
11:30 a.m.	Adjournment	

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Special Presentation

ARCUS
17th Annual Meeting and Arctic Forum

Poster Session and Annual Reception

The ARCUS 17th Annual Meeting and Arctic Forum poster session and annual reception features posters on arctic research, a special presentation, buffet, and hosted bar. The public is welcome and there is no charge for attending.

The Aavaat Choir

The Honorable
Henriette Rasmussen

Special Presentation

The Honorable Henriette Rasmussen, Greenland Minister for Culture, Education, Research, and Church will introduce guests to the unique qualities of Greenland. The Aavaat Choir will also give a special performance. The Aavaat Choir sings both traditional and modern Greenlandic music and will perform in their national costume.

Thursday, 19 May 2005 at 5:15 p.m.
National Association of Home Builders Conference Facility

Speaking Notes from Greenland Cultural Presentation

Henriette Rasmussen, Greenland Home Rule Government

Ms. President – Ladies and Gentlemen,

Thank you for the invitation and the opportunity to say a few words at the Arctic Forum. I find the items on the agenda for the Arctic Forum very important. That goes for the question of climate change as well as the question of communicating research projects and research results to politicians and citizens in the Arctic.

Our contemporary society in Greenland is based on our cultural and societal traditions– but also on a basis of knowledge and technology brought to us by science. Therefore all of us have need for understanding and relating to science.

In previous times in Greenland researchers came, observed and after that returned home to work up data and write reports. Today the Greenland Home Rule Government emphasizes the importance of participation of the society in the research.

The Home Rule has thus built up several research institutions in Greenland through the last 25 years. As examples I can mention the University of Greenland, the National Museum and Archives, the Greenland Institute of Natural Resources and Asiaq, and the Greenland Survey. Representatives of these institutions are present in Washington and some of them will give lectures at the Smithsonian the next couple of days.

The latest initiative is Ilimmarfik—the University Campus of Greenland. Ilimmarfik will comprise the present University of Greenland, the National Library, the Language Secretariat, the School of Social Work, the School of Journalism, the Institute of Education, the National Archives as well as Statistics Greenland.

Ilimmarfik is situated next to the Institute of Natural Resources. My hope is that multidisciplinary cooperation crossing faculty borders of the natural sciences, the social sciences and the humanities will come out of this. The challenges of climate change clearly show the need for such cooperation. My hope and expectation is that the cooperation, the dialog, will go further by including the knowledge of the hunters and fishermen. This form of cooperation is in its beginning.

Just a couple of weeks ago, a new scientific report on the conditions of the hunters and fishermen was launched. More than 60% of the respondents have remarked signs of climate change. Negative consequences of the change especially refer to problems with the ice–the quality of the ice or the fact that the ice is coming later and breaking up earlier.

Greenland research institutions have been established during the 25 years of Home Rule. This also means that Greenland has something

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to offer in scientific cooperation aside from the many research opportunities the Greenlandic nature and ice cap in itself offers, e.g. research on climate change. That is one of the reasons why I greatly appreciate the signed Memorandum of Understanding between the National Science Foundation and the Home Rule. I am confident that the agreement will create mutual benefits for research in Greenland and be an advantage not only for Greenland and the United States but also for the international scientific society. Greenland has great expectations to the agreement and is convinced that capacity building and transfer of knowledge to Greenland research institutions will be a result of the agreement.

Communication of research is very important as the issues of this Arctic Forum shows. But I will like to emphasize the importance of interaction between research and education on all levels, as well. I find it very important that also children and young students get knowledge and understanding of science. They are the ones to take over and develop our society further. New knowledge ought to be an integrated part of their daily life. I am very happy that the NSF agreement gives us the chance to cooperate in this field and am looking forward to seeing the results.So

- there is no doubt about climate change will have decisive influence on development and living conditions in the Arctic;
- research, research cooperation, and research communication will be of rising importance; and
- Greenland and the Greenland population are ready to join efforts with U.S. research institutions to meet these challenges.

Thank you.