International Arctic Research Center
Annual Report 2013

IARC’s mission is to foster Arctic research in an international setting to help the nation and the international community to understand, prepare for, and adapt to the pan-Arctic impacts of climate change. IARC serves as both mediator and driver to advance international collaboration aimed at comprehensive studies of the Arctic system by integrating strengths unique to university, state, federal, and international support levels.

Larry Hinzman, IARC Director
John Walsh, IARC Chief Scientist and President’s Professor of Climate Change
Elena Sparrow, IARC Education/Outreach Director

The polar bear (Nanook, from Inupiaq nanuq) is the UAF mascot and a symbol of the Arctic. As the central figure in the IARC logo, the bear looks over its shoulder to the Arctic region, the focal point of our mission. The globe highlights IARC’s international connections. Sea ice in the Arctic Ocean symbolizes IARC’s research and brings attention to climate change observed in the region.

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A Message from the Director

Fifteen years ago, in September 1998, IARC hosted the opening reception of the Arctic Division of the American Association for the Advancement of Science’s annual meeting. It was the first science-related event to be held in our new, but unfinished building. Through a close partnership between the Japan and US governments, IARC was created to foster and promote international collaborations in Arctic regions. Initially, and to this day, our closest research partnerships have been with Japan and Russia, but they have grown to include Korea, China, Canada, Norway, Sweden, Germany, Denmark and many other nations.

IARC has grown and flourished since its inception. There were many struggles along the way, but we can look back on our first 15 years with pride and honestly say that IARC has made important contributions to international science. IARC has worked with our local, state, and federal officials to create better policy that incorporates Arctic science. We have engaged extensively in outreach, helping our public and the next generation to better understand Arctic science. And, we have worked rigorously to build bridges among scientists around the world to make greater and more rapid advancements in science by sharing our data and our understanding. These achievements were only possible due to the international partnerships and the dedicated efforts of our combined faculty, staff, and students. This has been, and will continue to be a team effort, with collaborative arms extended to our sister research institutes and to other Arctic researchers throughout the globe. IARC has been successful, but that success is not because of a building, it is because of the devoted efforts of the people here and around the world who view cooperation and collaboration as an essential part of advancing Arctic research.

The research problems inherent to Arctic regions are of critical importance and have global implications impacting many nations. Many nations must bear partial responsibility in addressing these problems and collaborate if we hope to address these issues on a short time frame. Some of these issues include climate change, ecosystem dynamics, contaminant transport, and engineering analyses. There are processes that have been studied intensively in some regions but remain little understood in other regions. Multi-national collaboration enables broader regional validation of algorithms, facilitating more economical assessments of models. International collaboration enables more rapid, and perhaps, more technically correct, solutions to important research questions. IARC remains committed to these ideals, devoted to our long-standing partnerships while we continue to open doors to new collaborations and new partnerships with scientists and research institutes around the world.

As part of a significant transition for the organization in 2013-14, IARC is observing the productive conclusion of two of its most noteworthy international partnerships, the IARC-JAXA Information System (IJIS) and the JAMSTEC-IARC Collaboration Study (JICS). In addition, IARC is embarking on a number of new and exciting collaborations, including long-term projects with Japan’s National Institute of Polar Research (NIPR), the Japan Consortium for Arctic Environmental Research (JCAR), and the Green Network of Excellence (GRENE) Program.

In particular, IARC recognizes the conclusion of an important stage in its own development marked by the IJIS and JCS partnerships. Since IARC’s founding in 1999, IJIS has represented an essential part in both the world-class scientific collaboration and the groundbreaking Arctic research for which IARC is known. Specializing in satellite imaging and Arctic modeling/visualization projects, IJIS has boasted a long resume of successful, innovative science.

In its early stages, IJIS focused on remote sensing and detection, completing projects that revealed Arctic sea ice change, interactions resulting from boreal forest fires, variations in the organic production of the Bering Sea, and the dynamics and effects of volcanic eruptions. In 2003, IJIS led a major collaborative survey of fisheries throughout the Bering and Chukchi Seas, and in 2007, a general study of the relationships between large Arctic rivers, sea ice, and marine ecosystems began with the deployment of research buoys into ice-laden portions of the Yukon River.

During IJIS’s most recent stages, distinguished by the division of projects into Terrestrial/Wildfire and Ocean/Sea Ice categories, the partnership has tightened its focus. Regarding land-based and wildfire research, IJIS has over the last five years studied interactions between fires and insect behavior, lightning conditions and tundra wildfire ignition, Arctic forest greenhouse gas budgets, and vegetation restoration and damage prevention measures. Meanwhile, sea ice and ocean researchers have investigated ice thickness and dynamics, variability of phytoplankton over space and time, the effects of Yukon River discharge upon mixing behavior, and the long-term effects and mechanisms of recent and historical sea ice reductions.

Meanwhile, the more recently developed JICS collaboration has played a significant role in IARC’s mission to produce Arctic system studies.
that emphasize a broad integration/synthesis (I/S) perspective of the region. Recognizing and investigating the effects of a warming climate and the subsequent changes to the Arctic’s biologic, hydrologic, and human systems, JICS has focused its groups’ research on the complex interplay of the physical, chemical, biological, and social processes that make up the Arctic world.

Faced with an Arctic system that may be entering a state never before seen in the historic period, JICS researchers have observed that it will be impossible to understand future trajectories without developing more fully holistic perspectives of the complete system. This requires study of the Arctic’s complex network of linkages, feedbacks, and multi-dependent interactions, made up not only of individual physical and biological processes, but especially the various underlying drivers and inherent connections among system components. To this point, JICS has been maintained upon the premise that the development of a more integrated and comprehensive understanding of the Arctic system will lead to improved modeling capabilities and projections of future climate dynamics and system responses.

Prompted chiefly by the drastic changes that have occurred in the Arctic climate system and the enhancement of Arctic-lower latitude climate interactions, JICS has observed more frequent extreme climate events, such as record-low sea ice cover in 2007 and 2012 and the extreme winter cold across Eurasia to Japan over the past decade. The partnership has developed several integrated sets of assimilation procedures for the ice–ocean system, enabling gridded data sets that are physically consistent and optimally constrained to observations of sea ice and ocean parameters. JICS has also discovered that ocean eddy activity will likely impact sea ice loss and primary production in the Arctic.

JICS has further demonstrated that frozen ground, snow, and vegetation constitute a critical environmental subsystem of the Arctic eco-climate, through interactions of energy, water, and materials (carbon, nitrogen, etc.) and their feedbacks. This subsystem has shown an enhanced response to the recent global warming trend. In addition, JICS’s recent operation of its terrestrial supersite at the Poker Flat Research Range has provided a wide variety of research scientists with reliable and consistent measurements that accurately portray the physical system and ecosystem responses to physical drivers.

Through IJIS and JICS, IARC has worked to examine common problems of mutual interest to Japan and the United States. These organizations have sought and engaged challenges best suited to collaborative investigation. IJIS and JICS research has demonstrated that greater advancements are possible when organizations across the global scientific community share resources, understanding, data, and efforts, working together to achieve more.

For these reasons and many others, IARC is very pleased to mark a series of new collaborations with groups that include NIPR, JCAR, and GRENE. Working from a dynamic I/S mission similar to IARC, NIPR provides a natural fit for research in the Arctic that aims to derive and understand evidence of global climate change, study the Arctic’s response to this change, and describe and facilitate a more sustainable earth environment. And together with JCAR, IARC will be able to maintain an emphasis on the practical functions of collaborative science, creating and organizing the systems needed to produce and communicate clear and effective research to the scientific community and public stakeholders. In addition, along with Japan’s recently established (2011) GRENE program, IARC will continue specific and essential I/S projects to understand the specific Arctic mechanisms that amplify warming; evaluate widespread impacts of changes in the Arctic upon other weather, climate, and marine ecosystems; and model/forecast sea ice conditions and distributions into the future.

IARC is very proud of the productive, collaborative work to which the organization has contributed since its founding. Across the international scientific community, the spirit and desire for this type of diverse and shared research has only grown in the recent past, and there is no question that the types of partnership organizations IARC helps to design, sustain, and model will be of greater interest, with worldwide emphasis so clearly focused on innovation and efficiency. With this in mind, IARC looks to the future of collaborative Arctic I/S science with confidence and hope.

![The above graph shows daily updates for Arctic sea ice extent, monitored by IJIS’s Arctic Sea Ice Monitor.](http://www.jis.iarc.uaf.edu/en/home/seacie_extent.htm)
IARC Ecohydrology Shows Unique Results

At the Caribou-Poker Creeks Research Watershed (CPCRW) near Chatanika, Alaska, IARC’s Ecohydrology team, composed of Bob Bolton, Jessie Young, and Bob Busey, has been conducting a wide array of innovative and revealing research into Arctic and Subarctic water dynamics. These scientists and their work are driven by a sophisticated knowledge and continued curiosity regarding the unique conditions controlling plants and the movement of water in Alaska—in particular, how plants and water interact to shape the surrounding ecosystem.

The study of Ecohydrology—how ecosystems and water interact—is a rich pursuit in Interior Alaska, as the landscape is underlain by discontinuous permafrost. The ecosystems associated with discontinuous permafrost profoundly affect the storage, flow, and movement of water throughout the Interior’s ecosystems. The presence of permafrost creates an aquitard, or impermeable layer, which prevents surface water from percolating into the deeper subsurface soils. The primary study area for the IARC Ecohydrology team is in the Caribou-Poker Creeks Research Watershed (CPCRW), located approximately 50 km northeast of Fairbanks.

The presence or absence of permafrost drives most or all of Interior Alaska’s (including CPCRW’s) ecohydrological processes, including the dynamics of stream flow, soil moisture, evaporation, and transpiration (the movement of water through and out of a plant), as well as the type and distribution of the region’s distinctive vegetation. Areas with permafrost (like north facing hillslopes and valley bottoms) tend to have ecosystems dominated by small-statured coniferous (black spruce) trees and a thick mossy layer on the soil. Areas without permafrost (like south facing slopes) tend to be dominated by deciduous trees (birch and aspen) and a bare understory. The team’s work focuses on the combined effects of permafrost presence/absence and how vegetation distributions affect ecosystem water balance and streamflow, using both observational and modeling approaches.

The effect of boreal trees on hydrological processes is relatively understudied. To better determine the amount and timing of tree water use (including uptake from the soil, storage in the trunk, and flux to the atmosphere), Young has placed different types of sensors in coniferous and deciduous trees at CPCRW. She has discovered that the deciduous trees are very active in the boreal water cycle, by taking up, storing, and fluxing an order of magnitude more water than the coniferous trees. In particular, deciduous trees may use a great deal of snow melt water, thereby limiting how much snow melt water reaches the stream or groundwater. Additionally, since transpiration is the flux of water vapor from plants to the atmosphere, trees have the potential to affect local climate through increasing humidity. By better understanding the role of trees in the boreal water cycle, the group can better predict how changes in climate, permafrost, and vegetation distributions will affect the water cycle in the future.

Among other products, the group’s findings represent ongoing contributions to improving parameterizations in regional scale hydrologic models. As most of the current freshwater input into Arctic Ocean originates within the boreal forest, changes to factors such as permafrost presence and vegetation composition would have an indirect impact on Arctic Ocean processes. Since the group has identified significant discrepancies in the models’ representation of variables such as thaw depth and transpiration across the Subarctic/boreal forest region, it has become increasingly important that fine-scale dynamics occurring within the Subarctic/boreal forest ecosystem are reflected in meso-scale hydrologic models.

With regard to modeling in particular, the team’s research has been focused on quantifying uncertainty within existing research and hydrologic models through Bayesian analyses. Through this approach, the IARC Ecohydrology team hopes to quantify the uncertainty associated in both field measurements and modeling efforts.
Alexeev’s Box Model Systems Provide Big-Picture Perspective

Throughout his career, IARC researcher Vladimir Alexeev has pursued many of the analytical tools that math and physics have to offer. From early projects in engineering and fluid dynamics to his current work in climate and circulation modeling, Alexeev’s work has long been driven by sophisticated measurements and the many ways they can drive a system. What distinguishes Alexeev’s pursuits from many other modeling efforts, however, is their emphasis on basic foundations. “I’ve always worked with box models,” Alexeev states. “Box models are very useful for studying large-scale phenomena.” In recent years, Alexeev has published extensively about the changes in climate that have occurred on a large scale within, and many times across, the world’s climate regions, including the Arctic and the North Atlantic Ocean. “The Tropics, for example, are very different from the Extratropics to the north, and especially the Arctic,” he notes.

Though these box modeling processes may sacrifice some details regarding internal feedbacks and smaller subclimates, they are able to achieve a scale of perspective most other climate studies are not. As a result, Alexeev’s work has yielded new and broader realizations. He has observed that northern Eurasia, including parts of Siberia and Japan, have bucked the global warming trend and have actually seen cooling temperatures. “This type of realization is only possible by studying large-scale, long-term interactions,” Alexeev says. “Only by recognizing gradual changes in atmospheric circulation and the amount of heat exchanged across the oceans and large land masses of the Northern Hemisphere can we understand how and why some parts of the world show unexpected consequences.”

As Alexeev observes, a main reason for using box models is that it allows the isolation and comparative study of large and distinctive portions of the global climate—regions that can otherwise be (at times) disregarded and mismatched for comparison. As part of box modeling, these regions are simplified to individual, uniform presentations. This process effectively reduces the resolution of a highly diverse and intricate ecosystem to a larger image marked by dominant or averaged characteristics.

In Alexeev’s case, these box models depict large-scale perspectives of high-latitude climate systems, such as the Arctic and other northern regions. Since the Arctic and other northern regions display conditions that are very distinct from the tropical regions like the Equator, it is sometimes convenient to separate the two to study their specific conditions. By doing so, Alexeev can more easily identify the trends and characteristics that affect the climate, such as the circulation of the ocean and atmosphere, in each region.

Two-box ‘mixed layer ocean planet’ + land

A conceptual model of energy exchange between low and high latitudes, and between ocean and land at high latitudes. This model reproduces the recent ‘polar amplification’ and winter cooling in Siberia that is taking place as a result of disappearing sea ice. Orange arrows denote net downwelling (air exchange) and reflected solar light; “OLR” and “AHT” denote outgoing longwave radiation and atmospheric heat transport between boxes, respectively. Ocean box 1 has temperature $T_1$; Box 2 is made up of separate ocean (with temperature $T_2$) and land ($T_3$) sub-boxes. Land and ocean sub-boxes may be covered with snow and ice, respectively, depending on where temperature crosses the freezing temperature line. Brighter snow (or ice) covered surfaces reflect some solar light back to space.

Climatologist Xiangdong Zhang Leads Improvements to High Resolution Arctic Weather Forecasting and Simulations

Under the guidance and funding of the Bureau of Ocean Energy Management (BOEM), IARC researcher Xiangdong Zhang has been leading the collaborative “Weather Research and Forecasting (WRF) Model for the Chukchi and Beaufort Seas” project, vastly improving the climate modeling community’s understanding about Arctic coastal and ocean meteorology. Armed with its new and developing information, this study’s further promise includes improved accuracy of ocean-circulation models and oil spill trajectories, as well as additional enhancements to BOEM’s Oil Spill Resource Assessments for the Alaska Outer Continental Shelf. “Since the Chukchi and Beaufort Seas surround very large and prominent oil production facilities,” Zhang notes, “the potential benefits of better understanding of sea ice and climate dynamics of the area are very great.”

In particular, this BOEM study has focused on understanding variability and changes in Chukchi and Beaufort storms, surface winds, sea and mountain breezes shaped by the region’s orography (mountainous and elevated terrain), and complex dynamical ocean and sea ice forcing. The surface environmental variables entailed, including along-shore and cross-shelf components for wind velocities, wind direction, temperature, humidity, and radiation, have achieved greatly improved accuracy. As a result, stronger data is now available.
across the Arctic climate, oceanography, and modeling communities.

Together with a project team that includes Drs. Jing Zhang (North Carolina A&T) and Martha Shulski (University of Nebraska Lincoln), as well as collaborators from the Woods Hole Oceanographic Institution and other government and private organizations, Zhang has also worked to establish greater context for this improved data, enacting a 30-year (1979-2009) data assimilation to define and ensure daily to seasonal variability and long-term trends. This modeling context provided is then used to locate and document high-resolution climatological features of the Chukchi/Beaufort sea-surface winds, including analysis of interannual variability and long-term change, as well as the physical processes and mechanisms that shape Chukchi/Beaufort seas wind field climatology.

The practical components to this study have been many. The project’s in-situ (observational) collection of data for the long-term (1979-2009) period was compiled into a summarized database for BOEM, now available for further use and study. As part of the group’s own collection efforts, they deployed two high-functioning meteorological buoys into the open-water Chukchi and Beaufort, to supplement third-party data from other meteorological stations, ships, well sites, and QuikSCAT satellite readings.

For the modeling component, the group conducted multiple rounds of development, testing, and analysis to ensure results’ proper sensitivity and validity. As a trial, first a shorter five-year (2005-2009) simulation was conducted, before confirming the model’s capability to manage the full 30 year (1979-2009) run. These model results were analyzed to produce the study’s resulting WRF modeling context.

Final modeling and observational outcomes were combined and analyzed to produce the WRF study’s final Climatological Analysis. As a result of this study, BOEM and the research community now have access, for the first time, to a fully three-dimensional, geospatial, and meteorological database for the Chukchi and Beaufort Seas and the adjacent coastal areas; a physically optimized Chukchi and Beaufort mesoscale (medium-scale) meteorology model and assimilation system; and an analytical description of the high-resolution climatological features of the region’s surface winds, including the physical processes and mechanisms that shape the Seas’ wind fields and climates.

From the components of this study, it is clear that government organizations such as BOEM, IARC, and the rest of the climate science community, as well as private industry, will have additional and better tools with which to forecast and adjust to changes in weather, climate, and emergencies such as oil spills or extreme weather events. “To assess climate change impacts on sea ice and oil-spill and pollution dispersion,” Zhang states, “we must develop a dynamically and thermodynamically consistent, spatially and temporally well-covered, high-resolution atmospheric data set. This study does well to accomplish this.”
Ice Watch and GINA Combine to Offer New Sea Ice Monitoring Capabilities

Two components of IARC, the newly formed Ice Watch ASSIST Data Network (http://www.iarc.uaf.edu/icewatch) and the Geographic Information Network of Alaska (GINA) research unit, have made long strides in 2013 toward a more detailed and complete system for monitoring and communicating Arctic sea ice observations to scientists and other observers around the world. In a time when the Arctic Ocean and sea ice are experiencing drastic and historical changes, the continued development of these data networks represents an innovative and essential resource.

Ice Watch, developed at IARC in the summer of 2012 to collect and distribute onboard data from the numerous sea ice research cruises taking place yearly and throughout the Arctic, has been able to coordinate observations dating back to 2006. Ice Watch aims to build its database through the participation of a growing fleet of icebreaker ships from around the world, including Russia, Japan, South Korea, China, Germany, Norway, Canada, and the US.

Through its own specially developed ASSIST (Arctic Shipborne Sea Ice Standardization Tool) software, Ice Watch has used the IARC Data Archive (IDA; http://climate.iarc.uaf.edu/geonetwork/srv/en/main.home) to archive cruise data in multiple, flexible formats for broad distribution and use. By this process of sharing in situ observations and data, Ice Watch addresses goals including the standardization of shipborne sea ice observations throughout the Arctic; the archive and rescue of visual sea ice observation data; and the support of data collection, archiving, and visualization.

Using ASSIST, scientists aboard icebreaker ships email observations directly from the cruise ship for near-real-time posting to the data facility hosted by GINA. The Ice Watch software and data network support uploads of full data records, including metadata, photos, and additional comments regarding cruise observations. Historic shipborne sea ice data submissions can be converted into the ASSIST format, shared, visualized, analyzed, and archived in coordination with the IARC ASSIST team.

In addition, the GINA research unit’s observational capabilities now provide additional leading-edge satellite processing tools, using the Suomi NPP satellite’s VIIRS Instrument and the Aqua/Terra MODIS instrument bands to contribute to the organization’s sea ice data. Using these bands in combination, GINA can produce a hybrid, differential feed that provides both land cover and true color visuals, enabling imagery that distinguishes effectively between ice and clouds.

In addition, GINA works to provide this satellite imagery, in near-real time, to the public and the scientific community, via their Puffin Feeder website at http://feeder.gina.alaska.edu, enabled through the IDA.

Researchers and institutions across the climate science community, including the Alaska National Weather Service (NWS), have already begun partnering with GINA to use these resources toward promising ends. The Weather Service’s Sea Ice Program, for example, uses GINA data to provide year-round graphic analyses of sea surface and sea ice temperatures, as well as five-day sea ice forecasts (http://pafc.arh.noaa.gov/ice.php). GINA resources are also used for an NWS sea ice blog that highlights notable satellite images and sea ice developments for the public.

Together, Ice Watch and GINA have contributed greatly to next-stage sea ice observation and study. By focusing jointly on the innovative collection and broad distribution of raw and useful data, their efforts have emphasized IARC’s position as a leading hub for Arctic and international scientific collaboration. These resources will play a prominent role in the coming years, as sea ice science continues to grow in global interest and importance.
IARC Information System Convenes Wide Partnerships to Deliver Advanced ACE Visualization Tool

In collaboration with the UAF Arctic Region Supercomputing Center (ARSC), IARC is proud to host the newly developed Arctic Collaborative Environment (ACE), a web-based, open-access, environmental research and decision support system focused on the Arctic region. A joint project with NASA, the U.S. European Command, and the North American Aerospace Defense Command (NORAD), among other organizations, ACE integrates existing data with environmental models to provide monitoring, analysis, and visualization. Target users include researchers, students, search-and-rescue operators, and native hunters, all of whom can draw from the open-access data.

This collaborative visualization system provides general capabilities for geo-referenced imaging and information sharing, which users may customize for many purposes. Within the program, users have access to a rich catalog of public data sources already on the Internet, including searchable metadata and/or private data layers created by the user. Further, users can share their own private data files and “Workspaces” with individuals (e.g., researchers, rescuers, educators), or with the general public, all in real time. These Workspaces can visualize multiple, concurrent data layers; integrate customized maps, websites, and other data views; and deliver online group chatting functions as part of specified public or private collaborations. As ACE Administrator Jim Long notes, “ACE Workspaces are truly unique in their combination of potent data and custom interface functions.”

ACE was designed to integrate environmental remote sensing, modeling, and observational data across both terrestrial and maritime domains. Currently, ACE supports collaborative planning and visualization of activities in the Arctic, such as field operations, search-and-rescue, humanitarian response, recovery operations, strategic movement, training, education, and research. This visualization and collaboration tool allows users to layer operational, observational, and environmental geo-referenced data. Fundamentally, ACE enables greater Arctic understanding and allows users to share this understanding in a controlled and sustainable manner.

For access to the system, users need only an email address, a modern web browser, Internet access, and the Google Earth browser plug-in. Capitalizing on data gathered during the International Polar Year (IPY), ACE fosters and promotes an international exchange of data, informational awareness, joint proposal formulation, and modeling research, and provides a common forum for those interested in the North. IARC is happy to be involved in the delivery of such an innovative and inclusive tool.

Example Scenario:

By using the remotely sensed Synthetic Aperture Radar (SAR) imagery in ACE overlaid with the US National Ice Center’s Marginal Ice Zone (MIZ) product, the ice analyst is about to validate the analysis.
Continuing its long and exciting history, the IARC Summer School program conducted a month-long Arctic expedition for young researchers in August and September of 2013, rounding the Arctic Ocean aboard the Russian research vessel Akademik Fedorov. Sponsored and coordinated by the IARC Nansen and Amundsen Basin Observational System (NABOS), with funding from the National Science Foundation as a joint Arctic expedition, this project prompted Summer School participants to collaborate with specialists in Arctic oceanography and climate to experience the thrill and challenges of Arctic climate and oceanographic observations and modeling.

For the first time since 2006, Summer School students toured the Arctic at sea, gaining experience increasingly popular and useful among young climate scientists. During their trip, students benefited from hands-on field experience; shared perspectives regarding key issues in Arctic field research with experts in observation, diagnostics, and modeling; and learned methods for collecting information essential to understanding the dynamics of the Arctic Ocean.

Participants also attended a variety of lectures from the exceptional cadre of world class climate scientists, on topics from mechanisms of ice/air/ocean interactions to broad-scale Arctic system interactions and feedbacks, as well as introductions to the rapidly evolving discipline of global climate modeling. In addition to ongoing fieldwork, students also took part in small-group projects, in collaboration with expedition instructors and researchers.

The Summer School partnered with NABOS, which works to develop greater understanding of ocean circulation patterns and effects on high-latitude climate change. NABOS provided students this unique opportunity to participate in such an expedition at an especially stirring time for Arctic climate scientists.

In particular, participants were able to observe the ongoing effects of extraordinary freshening and warming of upper and intermediate water layers of the Arctic Ocean, as well as other exceptional high-latitude changes pointing to a potentially permanent shift in the Arctic Ocean to a new climate state. The cruise occurred during the annual sea ice minimum, and following the historical low sea ice extent of 2012, these young scientists along with the rest of the Arctic research community were anxious to see if 2013 would bring another historic minimum. Although no new records were set this year, the sea ice extent did degrade to the 6th lowest in recorded history. This may have presented an even greater educational experience to the students, as the ship was forced to break ice to reach several sampling and mooring locations.

Such changes, and their continued observation and study by this generation of scientists and those to come, have important implications for the Arctic Ocean’s marine ecosystem—especially for those components that depend on sea ice, temperature, or stratification.

Further, this summer’s edition has also continued the Summer Schools’ recent emphasis on skills and training for communicating science across the disciplines and to the public—skills critical in today’s world, where Arctic system research, more than ever, has global implications and applications. These experiences continue to offer new generations of scientists the chance to collaborate with IARC and UAF faculty and lecturers from around the world. In addition, Summer School participants actively develop their potential and tangible qualifications, by regularly presenting findings and
Another Successful Year for IARC’s Education/Outreach Program

Training K-12 teachers, locally and globally...

In these ways, “Climate Change in the Arctic Ocean” has served to maintain and bolster the IARC Summer Schools’ capability to assemble young scientists, graduate and undergraduate students, and adult learners together with experts in a wide range of Arctic science and research, for extended periods of study and interaction. As with this research voyage, participants receive abundant world-class background, instruction, and experience in the field of Arctic science. These programs immerse participants in the opportunities and challenges of Arctic science through expertise, technical sessions, and in-depth discussions led by specialists in their fields and prominent scientists from IARC, UAF, and other universities around the world.

leading project-based discussions with peers and specialists.

At each Summer School, project leaders have ensured strong theoretical and observational components throughout the unique and dynamic ecosystems accessible from Subarctic Fairbanks, through expert instruction, conversation, and field visits. Now and in the future, IARC’s ongoing Summer School series highlights for participants both the challenges and the range of opportunities for young researchers in Arctic climate research.

Members of the 2013 IARC NABOS and Summer School collaborative expedition.
Inspiring future generations...

Guided by IARC PhD student Molly Tedesche, elementary school girls discover how pH paper works, during a week-long Girl Scouts Camp in the village of Nondalton. The camp was part of the Girl Scouts of Alaska South West region program, where camp counselors are sent for the summer to conduct camps for girls in the region.

Students look for “bugs” (macroinvertebrates) in samples collected from a local stream during the camp.

Guided by an IARC scientist, sixth graders build and test a thermometer.

IARC PhD candidate Chas Jones shows students how an infrared camera can detect heat during their science field trip from Healy, Alaska to IARC.

An image captured with an infrared camera shows second graders leaving a thermal signature of their handprint on a wall.

IARC PhD candidate Chas Jones shows students how an infrared camera can detect heat during their science field trip from Healy, Alaska to IARC.

IARC’s Martha Kopplin engages elementary school students in a discussion about clouds.

Middle school students celebrate a day of hard work with IARC postdoctoral fellow Alessio Gusmeroli (fifth from the left) during a week-long Earth Science camp at Ilisaġvik College in Barrow.

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Financial statements for IARC

IARC Total Revenue $18.1 million

- Federal (52%)
- Foreign (15%)
- Indirect Cost Recovery (9.5%)
- State Support (14%)
- Other (9.5%)

IARC - Central (62%)
- CSC (12%)
- ACCAP (3%)
- CGC (3%)
- SNAP (10%)
- GINA (10%)

Expenditures $18.2 million

- Personal Services (50%)
- Travel (5.5%)
- Contractual Services (12%)
- Commodities (3%)
- Student Aid (1%)
- Capital Expenditures (8%)
- Indirect Costs (16%)
- Other (4.5%)

GINA: Geographic Information Network of Alaska
SNAP: Scenarios Network for Alaska & Arctic Planning
CSC: Alaska Climate Science Center
CGC: Center for Global Change & Arctic System Research
ACCAP: Alaska Center for Climate Assessment and Policy
Photo credits

Cover: Wildlife in the Arctic Ocean photographed from the Russian research vessel Akademik Fedorov during the 2013 IARC NABOS and Summer School collaborative expedition. Photo by Ioana Colfescu.

Inside cover: Photo by Yuri Bult-Ito

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Page 7: Photos by Bob Bolton

Page 15: Example scenario photos (from left to right) by NASA, Zagasi News, Francis Laterille/ADO

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Page 18 (top): Photo by Alice Orlich

Page 18 (bottom): Photo by Ioana Colfescu

Page 19 (from top, clockwise): Jessie Young, Bob Bolton, Workshop participants, and Martha Kopplin photos by Yuri Bult-Ito; GLOBE Plant Color Chart, Teachers, GLOBE Seasons and Biomes professional development workshop photos courtesy of Elena Sparrow.

Page 20 (from top, clockwise): Molly Tedesche and Camp photos by Anne Gore; Martha Kopplin, Sixth graders photos by Yuri Bult-Ito; Infrared camera image by Chas Jones; Chas Jones photo by Yuri Bult-Ito; Alessio Gusmeroli photo by Skye Sturm.

Page 21 (from top, clockwise): Elena Sparrow and Arctic Challenge photos by Yuri Bult-Ito; Georgina Gibson photo by Jenny Hutchings; Will Fisher photo by Dayne Broderson; Japanese students photo by Hirohiko Nagano; Landform Quiz young visitor photo by Elena Sparrow; Hajo Eicken photo by Nokinba Acker.

Page 24 and inside back cover: Fresh snow blanketing cake-sized floes of first-year ice in the Laptev Sea, formed during the winter of 2012-2013. Photo by Alice Orlich.

Back cover: Sea ice in the Arctic Ocean photographed from the Russian research vessel Akademik Fedorov during the 2013 IARC NABOS and Summer School collaborative expedition. Photo by Ioana Colfescu.
Understanding the Arctic as a System

The International Arctic Research Center is a focal point of excellence for international collaboration. IARC provides the Arctic research community with an unprecedented opportunity to share knowledge about science in the Arctic, with an emphasis on global change research.