Arctic dreams

Growing our understanding of climate change

Alaskan North Slope site offers new insights to climate researchers

INSTRUMENT CLUSTERS near Barrow, Alaska, gather data useful in refining global climate models. (Photo by Mark Ivey)

By Darrick Hurst

On the cold tundra near the Arctic Ocean in northern Alaska, researchers from around the world are transforming scientists' understanding of what the future may hold for the Earth's climate.

Located just east of Barrow along the coast of the Chukchi Sea, the North Slope of Alaska (NSA) site's unique location provides researchers with a rare, ground-based window into the cloud and radiative processes that take place in the earth's atmosphere at high latitudes. The research performed here has resulted in NSA arguably being today's most successful atmospheric research program.

Rune Storvold, Geophysical Institute, University of Alaska-Fairbanks

"What makes the North Slope site important is that climate processes differ depending on where on Earth they occur," says Bernie Zak (6338), science liaison for the North Slope site. "At the North Slope and in other cold regions, different processes are important because water there is mostly in solid, rather than liquid, form."

Sponsored by DOE's Office of Science and managed by its Office of Biological and Environmental Research, NSA is one of three global locales operated by the Atmospheric Radiation Measurement (ARM) Program's national user facility for interdisciplinary studies of earth systems, the ARM Climate Research Facility (ACRF). Along with sites in the US southern Great Plains and the tropical western Pacific, these primary, fixed locations are equipped with an extensive array of instruments for obtaining atmospheric data. In 2005, the ACRF added a mobile facility to its suite of research capabilities.

"Using a closely integrated team of national laboratory partners, the ACRF provides the complex physical infrastructure and data systems needed for national and international research efforts related to global climate change," says Mark Ivey (6338), NSA site manager for the ACRF. "We provide the facilities, support, and atmospheric measurement data for an international group of scientists. At the NSA, we've also been incredibly fortunate in receiving the support of native Inuit — what we call Eskimo — communities in the vicinity of the site."

MARK IVEY at the North Slope site. (Photo by Eli Mlawer)

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Researchers on ice

Extending south to the vicinity of Atqasuk, west to Wainwright, and east toward Oliktok, the extended NSA locale has become a modern-day center for atmospheric and ecological research activity. These high latitudes are receiving increased attention by climate researchers as they work to better understand the interactions of the atmosphere-land-ocean system. The Arctic, specifically, is predicted to undergo more intense warming than any other region on earth because water undergoes a specific seasonal phase change there. Scientific evidence indicates, in fact, that this warming is already happening.

Born at Sandia, raised in the Arctic

Mark Ivey's first job with the Atmospheric Radiation Measurement program was to manage the team that integrated and tested the first Atmospheric, Radiation, and Cloud Station (ARCS) mobile instrumentation unit.

"The first ARCS ended up in the tropical western Pacific," says Mark. "We had a great team that worked on the ARCS unit at a site near the Eubank gate at 20th and H streets."

The extended ARCS team included colleagues from Los Alamos, Argonne, Pacific Northwest, Brookhaven, Oak Ridge, and the National Renewable Energy Laboratory.

Work at the ARCS integration and testing site came to an end in late 2000 or early 2001 after the ARCS was deployed to other locations around the globe.

"We integrated and tested the Polar ARCS (or PARCS) at the North Slope of Alaska site with help from our colleagues at the Pacific Northwest National Lab," says Mark. "The PARCS was a polar version of the ARCS that was used on the icebreaker for the Surface Heat Budget of the Arctic Ocean (SHEBA) experiment, where an icebreaker was driven into the pack ice and left there for a year. An international team, including researchers sponsored by ARM, investigated the arctic atmosphere and ocean from onboard that ship. That PARCS' instrumentation was placed at the NSA in Atqasuk after the SHEBA experiment concluded.

(Photo by Rune Storvold, Geophysical Institute, University of Alaska-Fairbanks)

"The arid cold during winter at the North Slope provides a 'window' into space," says Bernie. "Under these conditions, infrared radiant energy can escape more easily through the atmosphere — it's something that's part of the earth's natural energy balance. This is one of the ways that high latitudes are quite different from temperate or tropical regions, and reinforces the importance of our research here."

The value of these different regional factors is that the researchers have the chance to study how longwave energy gets trapped to varying degrees inside the atmosphere by different conditions from chemical constituents that include water vapor, carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, and liquid water droplets that absorb the energy emitted by the surface of the Earth.

"Essentially, our work at these facilities enables us to contribute to improvements in climate models that simulate global climate change," Bernie says.

Such global climate models are tools for calculating atmospheric, land, and oceanic conditions all over the earth. By providing cloud and radiative transfer information to climate modelers, say Bernie and Mark, the site's data will help to improve the performance of general-circulation and related models of the atmosphere as tools for predicting future global and regional climate changes.

"Because the North Slope site is fairly cold year-round, we often observe clouds that are composed of ice or ice and water in mixed phases," says Mark. "In 2004, the ACRF sponsored a field experiment to specifically study mixed-phase clouds in the arctic. The results of the Mixed-Phase Arctic Cloud Experiment — or MPACE — have changed our understanding of arctic clouds and how they should be represented in climate models."

"Our high-latitude NSA location also allows researchers the opportunity to study surface optical properties with and without snow and/or ice cover as a function of temperature history," says Bernie. "Snow and ice surfaces are more reflective to visible light than soil or vegetation, and that plays an important role in high latitude and global climate."

A strong indicator of the value of the site's work is the number of researchers who make use of the data obtained there. Academic, foreign, domestic, and other researchers from many different areas of research use data collected from the NSA. Many also come to the site for field campaigns to temporarily add their own unique measurement capabilities to the existing instrumentation suite and study specific phenomena.

"People are still publishing peer-reviewed articles based on the 2004 MPACE data," says Bernie. "We found far fewer ice nuclei than had been expected — that is, far fewer aerosol particles capable of nucleating ice crystals. This means that water was staying liquid even at very low temperatures. That has direct implications, not only for climate, but for the Federal Aviation Administration as well, because when this liquid water comes into contact with planes, it instantly converts to ice. These icing conditions can bring down aircraft."

"Our work isn't just limited to climate research," says Mark. "The Army has done research on the atmospheric phenomena that cause the twinkling of the night sky, and how distant objects can be seen more easily through the atmosphere at certain times of the day, under certain meteorological conditions. Our location and instruments at the North Slope provide data sets that are useful to a wide range of research interests. That is one of the reasons the NSA locale was chosen as part of the ACRF."

At the end of a hard day of work, Bernie and Mark say the thing they're most grateful for is the caliber of the team members they work with.

"The NSA is a cold place with a lot of equipment and little in the way of creature comforts — without guys like Jeff Zirzow (6338), and our local native technicians, Walter Brower and Jimy Ivanoff, I don't know how we'd get anything done," says Mark.

International Polar Year and International Geophysical Year

2007 marks the International Polar Year (IPY), when scientists the world over will focus research on the Arctic and the Antarctic.

This year is also the 50th anniversary of the International Geophysical Year (IGY), a similar international scientific effort that occurred from 1957 to 1958.

Organized through the International Council for Science Unions (ICSU) and the World Meteorological Organization, this is actually the fourth polar year, following those in 1882-1883, 1932-1933, and 1957-1958.

In order to have full and equal coverage of both the Arctic and the Antarctic, IPY 2007-2008 covers two full annual cycles, from March 2007 to March 2009, and will involve more than 200 projects, with thousands of scientists from more than 60 nations examining a wide range of physical, biological, and social research topics.

Similarly, the IGY was proposed by the ICSU in 1952 and initiated a comprehensive series of global geophysical activities to span the period July 1957-December 1958. The IGY was modeled on the International Polar Years of 1882-1883 and 1932-1933, and was intended to allow scientists from around the world to take part in a series of coordinated observations of various geophysical phenomena. Although representatives of 46 countries originally agreed to participate in the IGY, by the close of the activity, 67 countries had become involved.

The seeds of current concerns about global climate change were planted during the IGY. Prior to IGY, it was not known that the burning of fossil fuels was progressively changing the composition of the global atmosphere.

ICEBERG in the Beaufort Sea off the northern coast of Alaska during the Arctic summer. (Photo courtesy of NOAA)