

Going Against the Tide

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Sea ice in the Arctic Ocean is decreasing. Temperatures in the Arctic are climbing. Are we experiencing the first tale-tell signs of global climate warming?

"We might be," said Research Associate Professor Andrey Proshutinsky, who holds the Wadati Chair in Global Change Studies, an academic position funded by nine Japanese corporations.

"Or we might be witnessing a natural cycle of events in the Arctic that mimics other natural cycles in nature, such as the change of seasons or night turning into day," he said.

Proshutinsky and Associate Professor of Oceanography Mark Johnson have developed a theory that suggests natural variations may help explain the unusual warming observed in the Arctic recently. Their theory, which is based on a computer model that simulates the wind-driven movement of ice in the Arctic for a period of 50 years beginning in 1946, suggests that ice in the Arctic Ocean circulates under the influence of wind in a regular pattern during a roughly 15-year oscillation. During the first five-to-seven years of the oscillation, the ice in the Arctic Ocean circulates in a clockwise direction; during the next five-to-seven years, the ice circulates in a counterclockwise direction.

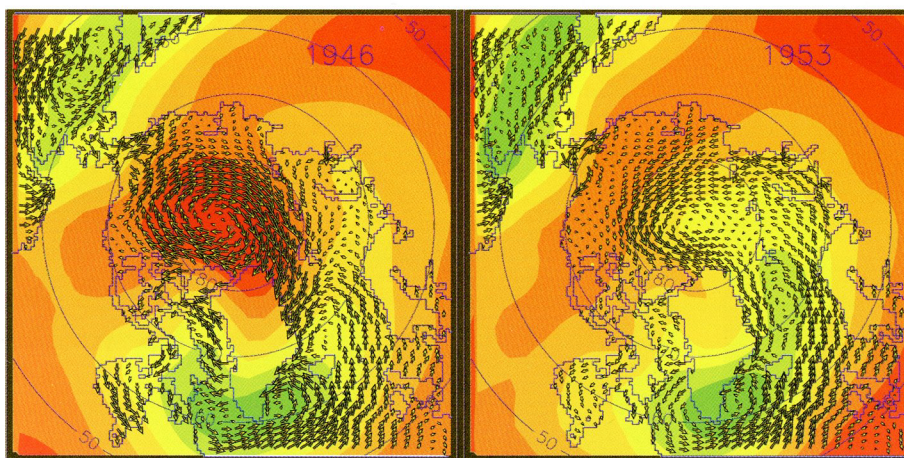
The idea that ice in the Arctic Ocean circulates at all may sound intriguing to some. To researchers, the idea that ice circulates in two directions is radical.

"Scientists have been educated to believe that ice in the Arctic Ocean circulates in one way only—in a clockwise direction," Proshutinsky said. "This is some-

thing we were all taught in school as a fact, like the earth is round."

The computer model designed by Proshutinsky and Johnson shows that when high atmospheric pressure prevails over the Arctic Ocean, wind and ice move in a clockwise direction, generating conditions considered typical of the Arctic, such as cold, dry air.

The few major research expeditions that have gathered field data on ice, wind, and other parameters in the Arctic Ocean occurred in such periods of high atmospheric pressure. Consequently, the data from these expeditions reveal wind and ice moving in the traditional clockwise direction.



Two alternating regimes of surface circulation in the Arctic are shown above. Prior to recent research, scientists believed wind and ice in the Arctic moved only in a clockwise direction.

However, the model also shows that when low atmospheric pressure prevails over the Arctic Ocean, wind and ice move in a counterclockwise direction, generating warm, moist air—two of the "unusual" signs observed in the Arctic recently.

If Proshutinsky and Johnson's theory is accurate, wind and ice in the Arctic Ocean will revert from moving in a counterclockwise direction to moving in the more tra-

ditional clockwise direction in a year or so. The model indicates that this shift will be accompanied by a change in atmospheric pressure and circulation, which will result in colder, drier air in the Arctic.

Proshutinsky said the theory does not negate a possible trend toward global climate warming. The shifts in atmospheric circulation and ice movement evident within the model for roughly 15-year intervals seem to exist in an arena of increasing overall temperatures in the Arctic. And he is quick to add that the theory needs to be

substantiated with more field data, the acquisition of which he hopes soon to pursue. Proshutinsky does not know what triggers the near decadal switch in atmospheric circulation driving ice movement in the Arctic, but he and Johnson suspect a variety of factors, including variations in global atmospheric circulation, changes

in water temperature, and ocean currents.

"We always thought that wind could slow or accelerate the speed of ice, but we did not believe what our computer model shows: that wind can actually change the direction of ice movement in the Arctic Ocean," Proshutinsky said.

In addition to serving as a baseline of comparison for future global climate research, learning more about how climate in the Arctic varies will be useful in helping ships navigate through frozen waters and in helping researchers understand associated natural patterns, such as the migration habits of marine mammals.

The ARM Supporting

A new 10-year, multimillion dollar program funded by the U.S. Department of Energy will turn Alaska's North Slope into a natural cloud laboratory designed to help researchers study global climate change.

The North Slope, a broad expanse between Alaska's Brooks Range and the Arctic Ocean, was selected as a premier place to study clouds because the environment there is similar to the environment found at high altitudes around the world.

"If you go high enough in the atmosphere, even over the tropics, you can find the same cold, dry environment you find close to the ground on the North Slope," said Geophysical Institute Professor Knut Stamnes, the site scientist for DOE's Atmospheric Radiation Measurement (ARM) program in the Arctic.

"Ice clouds" that are similar to ones found extremely high in the atmosphere elsewhere around the globe will be studied at the ARM site. Information about how these clouds form, evolve, and evaporate, as well as how they interact with infrared and solar energy, will be incorporated into

computer models used to forecast global climate change.

"You can't study real clouds in the laboratory; you have to study them in the environment," said DOE's Office of Energy Research Director Martha Krebs. "This site will monitor clouds over large spaces for as long as a decade."

Krebs visited the Geophysical Institute before participating in the official July 1 dedication of the North Slope ARM site in the town of Barrow, where a central facility equipped with ARM instruments was established last spring.

An array of about 50 instruments centered in Barrow and scattered throughout the 200-by-200-mile North Slope ARM site will be operational this winter, according to Site Program Manager Bernard Zak, with Sandia National Laboratories.

Stamnes describes clouds as the wild cards of global climate models because they can affect climate change in two ways: clouds can trap heat close to the earth, keeping the ground warm; or they can

prevent solar energy from reaching the earth, keeping the ground cool.

"A climate model that shows a trend toward global warming on clear days can show a whole range of different results after clouds are added," Stamnes said.

As site scientist, Stamnes will check the quality of data acquired by North Slope ARM instruments. If he detects problems, Phil Utley, an ARM instrument specialist, will fly from the Geophysical Institute to the North Slope ARM site to inspect conditions. Local Barrow residents working under contract with the ARM project will maintain the instruments on a daily basis.

Quality data from the ARM site will be sent concurrently to the Pacific Northwest National Laboratory in Richland, Washington, and to the Oak Ridge National Laboratory in Tennessee, where it will be archived and made available to researchers from around the world. The North Slope ARM site is one of three that will share an annual budget of about \$40 million pro-



Above, ARM Instrument Specialist Phil Utley inspects a microwave radiometer, which measures water vapor and cloud water present in a column extending from above the instrument to the top of Earth's atmosphere.



At left, Utley checks an array of instruments that measures radiation downwelling from the sky. Above, he adjusts instruments that measure reflected light and infrared radiation upwelling from the ground.



Above right, Utley positions a whole-sky imager containing a low-light-level device designed to take pictures of the sky day and night every ten minutes to determine cloud coverage.



Natural Cloud Laboratory

vided by DOE. The other ARM sites are located in the Southern Great Plains on the Oklahoma/Kansas border, and in the Tropical Western Pacific on Manus Island in Papua New Guinea.

Together, the three sites will provide comprehensive information that will help scientists understand how clouds affect global climate change from three varied regions: the tropics, the middle latitudes, and the high latitudes.

In addition to studying clouds, researchers at each ARM site will perform a detailed analysis of one section of the atmosphere. That section will be defined by an imaginary square on the surface of the ground from which will rise a figurative column that will extend high into the atmosphere. Within that column, detailed measurements of all levels of the atmosphere will be made from ground-based instruments oriented at different angles.

In the Arctic, the measurements will be used for more than long-term forecasting

in global climate models; they'll be used to improve short-term weather forecasts.

"Historically, weather forecasting on the North Slope has been difficult because the environment there is so harsh, it is hard to obtain adequate data using traditional means," Stamnes said. "ARM instruments will enable us to get extensive data to the National Weather Service daily."

Information from this hypothetical column also can be used to evaluate data from polar-orbiting satellites.

"Data from satellites orbiting above the Arctic can be interpreted improperly because instruments are not always able to distinguish between clouds and the snowy surface of the earth," Stamnes said. "Information from ground-based ARM instruments can be used to help interpret satellite data to make this distinction."

Starting in the fall of 1997, comprehensive measurements of all levels of the atmosphere also will be taken within a figurative column that starts deep in the Arctic Ocean and extends high above the earth. For 13

months, instruments similar to those used in the ARM program will probe the Arctic Ocean from a research vessel frozen into the perennial ice pack about 400 miles north of Barrow. This experiment, called SHEBA (for Surface Heat Budget of the Arctic Ocean), will be guided by the National Science Foundation and the Office of Naval Research.

At the end of the SHEBA program, instruments from the research vessel will be redeployed to an inland site near Atkasuk, a village 58 miles southwest of Barrow.

Eight DOE laboratories, 14 national laboratories, 19 universities, five private agencies, and six foreign countries are participating in the national ARM program.

Major participants in the North Slope ARM site include the Geophysical Institute, Pacific Northwest National Laboratory, Sandia National Laboratories, NOAA Climate Monitoring and Diagnostics Laboratory, Ukpeagvik Inupiat Corp., Barrow Arctic Science Consortium, the National Weather Service's Alaska Region, Ilisagvik College, and the North Slope Borough.

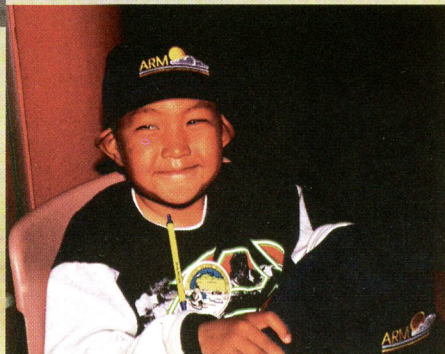


Above to the far left, Ralph Davis, of the North Slope Borough Planning Department, speaks to Cynthia Turney, of the Pacific Northwest National Laboratory, while, directly above, Geophysical Institute Director Syun-Ichi Akasofu and DOE's Office of Energy Research Director Martha Krebs watch a boy from Barrow distribute ARM program hats (below).



At left, ARM Program Director Peter Lunn, Barrow Elder Kenneth Toovak, DOE's Office of Energy Research Director Martha Krebs and North Slope Borough Mayor Ben Nageak (pictured from left to right) speak at the dedication of the North Slope ARM site in Barrow.

Above, Toovak walks with National Weather Service Alaska Region Chief of Data Acquisition Jack Fey, then talks with Geophysical Institute Professor Knut Stamnes (above center) and Richard Glenn with the North Slope Borough Energy Management Department.

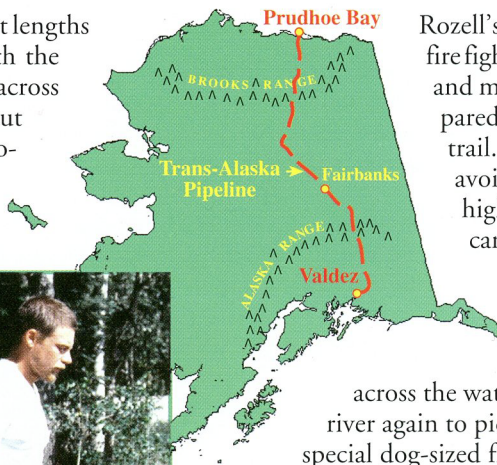


Pipe Hike Celebrates 20 Years of Oil and Science

Geophysical Institute Science Writer Ned Rozell is going to great lengths to compose articles that celebrate the 20th anniversary of both the trans-Alaska pipeline, an 800-mile tube of steel that carries oil across the length of Alaska, and the *Alaska Science Forum*, a column about scientific topics written for the layperson produced by the Geophysical Institute. While hiking against the flow of oil along the pipeline corridor for four months this summer, Rozell is preparing two weekly columns: one about science topics inspired by his daily trek and one about his personal experiences in the field.

Rozell, who began his hike on May 4 in Valdez, is following the trans-Alaska pipeline corridor as it snakes across Alaska until he reaches Prudhoe Bay in September. Along the pipeline route from the Gulf of Alaska to the Arctic Ocean, Rozell and his dog, Jane, will cross 800 rivers and three of the most majestic mountain ranges in North America.

Rozell's hike also commemorates two other events: the 50th anniversary of the founding of the Geophysical Institute and the 80th anniversary of the creation of the University of Alaska Fairbanks.



Rozell's training as a wilderness fire fighter, backcountry ranger, and marathon runner has prepared him for the rigors of the trail. Where possible, Rozell avoids rivers by hiking to highway bridges. When he can not avoid crossing a deep river, he inflates a rubber trail boat, tethers Jane, and ferries his backpack across the water. Then, he crosses the river again to pick up Jane, who wears a special dog-sized flotation pack.

Rozell is carrying a palm-top computer, waterproof notebooks, first-aid supplies, and survival gear in his backpack. He purifies his water through a portable filter and his food is resupplied at weekly intervals. Friends and coworkers check on Rozell's safety throughout the trip by driving out to see him; major highways are never more than 11 miles from the pipeline corridor.

To read the *Alaska Science Forum* or track Ned's progress on the trail, visit the institute's web site at <http://www.gi.alaska.edu/>.

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