On Ice Station SHEBA: A Cold Look at Warming

Global Team Searches the Arctic Pack for Clues to Climate
[FINAL Edition]

The Washington Post - Washington, D.C.
Author: Curt Suplee
Date: May 11, 1998
Section: A SECTION
Document Types: News
Text Word Count: 2945

Minutes after take-off from Point Barrow, Alaska, the pilot points the nose north and the world turns white. From horizon to horizon lies one unbroken, glaring sheet of wind-scarred sea ice. The next solid land mass in this direction is 1,600 miles away in Russia.

For more than two hours, nothing changes but the drone of the small plane's propellers and the pattern of cracks in the surface below. Then suddenly a tiny smudge appears in the distance. It slowly reveals itself to be a ship, frozen solid into the gleaming desolation of the Arctic ice pack.

It is here that the National Science Foundation is spending $19 million on a landmark research program named SHEBA (for "Surface Heat Budget of the Arctic Ocean"), in an urgent attempt to comprehend the planet's enigmatic climate, and particularly the threat of global warming.

Headquarters is the 322-foot-long Canadian icebreaker Des Groseilliers, which was halted about 350 miles north of Alaska in October. It is now a full-time research station and de facto hotel, surrounded by sea ice a couple of yards thick -- and by several dozen scientists busily and often painfully trying to comprehend what until now has been a great unknown. Namely, how clouds, air, snow, ice and water exchange energy in this sparsely studied region where winter temperatures can dip to minus 40 degrees Fahrenheit and wind-chills routinely hit minus triple digits.

Their tools range from state-of-the-art sensors costing tens of thousands of dollars to trowels, whisk brooms and shovels. "You look a little silly shoveling snow up here," said SHEBA chief scientist Donald Perovich from the U.S. Army's Cold Regions Research and Engineering Laboratory (CRREL) in New Hampshire. "But it's all part of the job."

Already they have found evidence of phantom clouds where there didn't appear to be any, surprisingly large amounts of melt-water under the ice, and temperature differences as great as 8 degrees Fahrenheit between two seemingly identical patches of snow less than 50 feet apart.

'Fairly Stupendous' Amount of Melt

When they're through, they hope to have a comprehensive physical portrait of the Arctic ice formation, a titanic floating refrigerator the size of the United States that serves as the heat sink for the Northern Hemisphere.

Its extent has been shrinking ominously for the past 20 years, at 2 percent to 3 percent per decade. But "we don't know if what we're seeing is a big surprise that's part of a trend" or just normal variability in conditions, said SHEBA project director Richard E. Moritz of the University of Washington's Polar Science Center. One thing is certain: "The amount of melt was fairly stupendous in 1997," he said. It's probably an effect of El Nin~o, "though the expert opinion was: Don't look for an El Nin~o signature this far north."

That's worrisome, because the Arctic sea-ice cover is expected to be a disproportionately important factor in potential worldwide climate change. Many scientists believe that the slight global warming observed during this century is the result of a growing atmospheric concentration of "greenhouse" gases, such as carbon dioxide, that trap heat in the air.

To project the future consequences of that increase, climate analysts use computer simulations of the Earth's heat-exchange processes. But those models are only as good as the real-world physics on which they are based. And for many parts of the world, conspicuously including the Arctic Ocean, the physics is largely guesswork.

As a result, some computer models show that a doubling of carbon dioxide in the air would melt all the Arctic sea ice in 50 years. Other simulations, using different assumptions, yield dramatically different results. But all agree that the Arctic will be especially sensitive to atmospheric effects because it is so susceptible to "positive feedback loops" -- conditions in which a little bit of warming makes more warming likely.

"Right now I do not have confidence that changes in sea ice and clouds are done correctly in climate models," said Kevin Trenberth, head of climate analysis at the National Center for Atmospheric Research in Boulder, Colo. "The annual cycle is not correct in many models, so why should it be correct in climate change {projections}?"

Unfortunately, what little is understood about the Arctic is often based on fragmented and uncoordinated research conducted at different times by different kinds of investigators.

SHEBA, which is also supported by the Office of Naval Research and the Japanese government, intends to do it right. So for 13 months, which is as far as the funding extends, scientists from several nations, universities and U.S. agencies are taking simultaneous readings throughout a representative cylindrical "column" of Arctic environment that extends all the way from clouds and air masses 15 miles high to snow and ice at ground level to the sea water 500 feet or more beneath the ice.

Free and tethered balloons and occasional research aircraft sample the upper air. U.S. Navy submarines scope the bottom when they are around. By the time the program ends in October, it should have produced a year-long comprehensive "budget" -- a meticulous accounting of the way radiation and heat move among the various components of the Arctic environment.

"There's never been a concerted, interdisciplinary effort like this," said Perovich. And there have been few posts as tough on the scientists, most of whom rotate in and out of camp on six-week cycles. While on duty, they shuffle to and fro nearly mummified in layer upon layer of Arctic gear, sporting boots that are the bulk equivalent of wearing a basketball on each foot, and toting rifles or shotguns amid the threat of marauding polar bears.

Those seven-foot-long, 1,200-pound creatures pad around in wraithlike invisibility. Several SHEBA scientists noted that their ivory-hued fur gives off no infrared radiation of the sort seen in military night vision devices; only their noses appear warm against the snowscape. In late April and early May, one has wandered into the area every couple of days. So far, they've been shooed away by the racket of snowmobiles. But no one leaves the ship without notifying the bridge and carrying a weapon and a radio.

For much of November, December and January here, the sun never rises above the horizon. But this time of year, it's light around the clock, and the scientists are out morning and night. When they're not collecting data, they're tearing into the meals provided by the icebreaker's French Canadian galley staff with a gusto that might seem gluttonous elsewhere but makes sense on the ice, where a person of average size can easily burn 5,000 calories a day -- two to three times the normal expenditure.

Infrared Discovers Invisible Clouds

Of course, some jobs are less physically demanding than others. Taneil Uttal, from the National Oceanic and Atmospheric Administration, needs to do little more than monitor computer screens as radar and lidar (a radar-like device that uses green light instead of microwaves) signals bounce off clouds. Including those that don't seem to be there. "I would have said that it was excellent visibility. It looked completely clear," Uttal said. But her instruments showed that there was a cloud two miles thick that was "extremely visible in the infrared." What was it made of? She's not sure.

Yet the action of clouds is crucial. How much incoming sunlight do they let through? How much do they block? And how much reflected radiation from the snow do they trap and transfer to the surrounding air? All these affect Arctic climate. Yet "the climatology of clouds is very poorly known," Uttal sighed. But that may change somewhat after SHEBA. At any rate, she said, "I'll be occupied by these data sets for the rest of my career."

At the opposite extreme of obligatory exertion is Matthew ("I love snow!") Sturm, a native New Mexican who is now a snow physicist with CRREL's Alaska office. His project is measuring the contour, depth and subsurface characteristics of the snow that covers the Arctic ice to an average depth of 25 inches around SHEBA.

By the time he's done, he'll know a lot about the water content, density, permeability, crystal structure and other properties of the snow within a six-mile radius of the ship. All those qualities affect snow's insulating ability in slightly different ways. And because insulation is a key factor in heat exchange, it is critical to the program.

Sturm already has tennis elbow from plunging long, pencil-thick sensor rods into the snow tens of thousands of times, and is at perpetual risk for frostbite because he, like many other scientists, takes notes with uncovered hands. (With a pencil. Pens, as unwitting reporters discover, tend to freeze in minutes. And ordinary laptop computers are out of the question. "By the time it boots up," said Perovich, all it can tell you is that the battery is dead." He modified his field laptops to run on big lead-acid auto batteries.)

Sturm has seen more kinds of snow than most people would wish. "Some," he said, "have the thermal properties of glass, and some are like fiberglass insulation." But when he saw a huge temperature difference between two adjacent spots, he started digging as though he was auditioning for "Treasure Island," scowling at the boundary where compressed flakes give way to a lower layer of crunchy, hole-pocked ice bits called "depth hoar."

It could be a case of water molecules that evaporated off the top of the relatively warm sea ice and penetrated the snow layer, turning it crusty and highly insulating. Or it might have been the site of one of last summer's melt ponds. "I need to talk to an ice guy," he said. At most field sites, that would be impossible. But this is SHEBA, and there's one a few yards away -- W.B. "Terry" Tucker from CRREL in New Hampshire.

After much poking with whisk brooms and kitchen spatulas, they agreed that the crunchy stuff had probably been a melt pond.

'Nobody Ever Cared Much About Snow'

On the sled he pulls behind his snowmobile, Sturm carries a microscope for detailed field exams. After all, it's virgin territory. "This area has always been in the purview of oceanographers and ice people," he said. "Nobody ever cared much about snow."

SHEBA does. Perovich and Tucker's group is conducting an audit of exactly how much light of each of 500 different wavelengths is absorbed, reflected or conducted by each element of the Arctic surface -- essential information for understanding how the region warms and cools.

Group members take measurements around the area, using instruments that measure the total incoming sunlight, the amount reflected, the amount absorbed and even -- via a fiber-optic probe that they snake under the ice sheet -- the trickle of photons that make it all the way through to the water beneath.

These data will eventually be correlated with Uttal's cloud information, Sturm's analysis of the snow layer, pressure and stress readings from the ice sheet, water currents and numerous other factors to provide a detailed audit.

"We all have a piece of the puzzle," Perovich said. "A year from now, we'll begin to understand."

Other researchers keep their equipment at fixed locations. Spread across the ice around the ship are clusters of tents and plywood shacks containing various experiments. Each site has been whimsically given a name such as Baltimore, Seattle, Atlanta and Ocean City. One nylon-covered tent city, containing the manhole-sized apertures through which divers descend to sample the algae that grow on the bottom of the ice sheet, is known as "Blue Bayou" for its distinctive hue.

Some of the instruments require constant tending. Some, such as the 60-foot tower array that continuously measures air speed, temperature, humidity and other qualities, are almost entirely automatic.

Not that anything can be left unattended very long in this strange environment. Ask Roger Andersen, a University of Washington field engineer who is maintaining a set of sensors that record sea water motion, temperature and salinity below the ice. Some he lowers by hand. One, dubbed the "yo-yo," is raised and lowered every 15 minutes by a power winch. All are prey to Arctic surprises.

One day Andersen was watching his read-outs on a computer screen when he saw the data suddenly go haywire. "Oh no," he muttered, "I've been slimed!" Hauling up the sensor proved him right: An Arctic jellyfish the size of a birthday cake had gotten stuck in the fan-blades that measure water motion. Andersen scooped it away with a snow shovel and now keeps it outside the yo-yo hut as a souvenir.

Already SHEBA oceanographers have found dramatic changes since 1975, when a research program called AIDJEX sampled the seawater in the same area.

The topmost layer of water immediately under the ice is "much fresher and much warmer than it was," Andersen said, noting new findings by Washington state ocean physicist Miles McPhee and colleagues.

Those conditions may or may not have affected the rate at which cracks form near the ship, often driving one part of the ice sheet over the other to create a sudden mini-mountain range called a "pressure ridge" out of thick, upended slabs of mesmerizingly blue ice.

Back in March, for example, "all hell broke loose," as Moritz later described it. Near the ship's bow, a 150-foot-wide channel abruptly gaped open, ripping out power lines to research sites, swallowing a snowmobile shed (and nearly devouring a bunch of parked snowmobiles), cracking the runway and halting research operations. Within two weeks, however, all experiments were operating again.

Not only is the ice shifting incessantly, but the whole Arctic ice pack is moving -- and so is the ship, even though the Des Groseilliers' 14,000- horsepower engines are still. The wind blows clockwise around the North Pole, and drags the sea ice along with it like a gelid carousel. So the ship has moved over a jittery course since October, traveling about 800 miles to end up about 400 miles west of its original location. The largest shift was around 20 miles in 24 hours; the least was about 75 feet.

SHEBA's land-based logistics operation has shifted accordingly, from Deadhorse, Alaska, at Prudhoe Bay to Barrow, an industrious whaling town of about 4,000 year-round residents, most of them Inupiat Eskimo. Record high temperatures in the summer can reach the sweltering mid-70s. Will Rogers and Wiley Post died there in a 1935 plane crash, but things have been comparatively placid since. (Alcoholic beverages are not sold in town, and visitors prone to stereotypical Yukon recreations may need reminding. "If you are drunk and disturb other guests," reads a sign on the door of one of the town's hotels, "you will be asked to leave the hotel with no refund.") From there it's a 2 1/2-hour flight to SHEBA in a De Havilland Twin Otter, a sturdy little plane designed for take-offs and landings in very short spaces.

That's good, because sometimes the way the ice breaks prohibits runways much longer than a couple thousand feet. By the end of April, the ice near the end of one runway was "only about 5 or 6 inches thick," said heavy-equipment honcho John "Jumper" Bitters. The industrial-strength New Zealander and ex-commando, who plows runways and handles other support services, is said to be the only man to have parachuted over both the North and South Poles -- a distinction not widely coveted.

In fact, the biggest worry for SHEBA's scientists is that the station will drift into the thin edge of the ice too soon, before complete measurements are made. "If we have a problem, that's where it's gonna be," said Moritz. But whatever happens, "we'll be here to study it."

[Illustration]
Map,,Brad Wye; PHOTO,,Curt Suplee; INFO-GRAPHIC,,Mickey Edwards CAPTION: Science on Ice Researchers with SHEBA are trying to understand the planet's climate better by studying how clouds, air, snow, ice and water exchange energy in the Arctic region. The SHEBA project ("Surface Heat Budget of the Arctic Ocean") is funded by $19 million from the National Science Foundation. - The 322-foot-long Canadian icebreaker Des Groseilliers, stuck in the ice 350 miles north of Alaska, now is home to 35 scientists and technicians, and 15 crew from the Canadian Coast Guard. - The Arctic ice pack varies in depth from three to 12 feet. It constantly cracks and breaks into chunks and later refreezes. Above a latitude of 75 degrees North, the ocean is almost permanently ice-covered. Pushed by wind and sea currents, the polar ice pack spins clockwise around the North Pole. - Many of the scientists come from U.S. universities and federal agencies, including: the Army's Cold Regions Research and Engineering Laboratory, the National Oceanic and Atmospheric Administration and the Department of Energy's Atmospheric Radiation Measurement Program. - During the coldest months, temperatures can plummet to minus 40 degrees Farenheit, with windchill routinely hitting minus triple digits. - Under the ice cap, the ocean water runs as deep as 11,000 to 13,000 feet. The water temperature hovers at 30 degrees Farenheit. (Although fresh water freezes at 32 degrees, the salty content of sea water lowers its freezing point.) SOURCES: Encyclopedia Brittanica, World Almanac, National Geographic Atlas of the World CAPTION: Ice Station SHEBA, housed in icebound Canadian icebreaker Des Groseilliers, serves as headquarters to scientists studying the Arctic's role in Earth's climate. CAPTION: "You look a little silly shoveling snow up here," said SHEBA chief scientist Donald Perovich, who is from the Army's cold regions research laboratory. CAPTION: Matthew Sturm, a native New Mexican, is a snow physicist whose project is measuring the contour, depth and subsurface characteristics of the snow that covers the Arctic ice.

Credit: Washington Post Staff Writer

Reproduced with permission of the copyright owner. Further reproduction or distribution is prohibited without permission.