On top of the world

Every summer, fresh water pours into the Arctic Ocean, affecting circulation in the world's oceans and having an impact on global climate.

The water comes from Siberian rivers and from pack ice, which almost covers the ocean during the seemingly endless winter but begins to retreat when temperatures climb. All this fresh water mixes with the salty water of the Arctic.

"Freshwater discharge from the Arctic to the northern Atlantic Ocean is a crucial factor controlling global climate," according to Andreas Münchow, MS '88M, '92PhD, associate professor of physical ocean science and engineering in the graduate College of Marine Studies. "Recent changes in the amount of fresh water being discharged have fueled a great deal of interest in the role that the Arctic Ocean plays in the climate."

This past summer, Münchow spent four weeks conducting research in the Arctic aboard the 420-foot U.S. Coast Guard icebreaker *Healy*, which is specially designed to break the pack ice that chokes the northern waters. More specifically, his work focused on the discharge of fresh water through the Nares Strait, a narrow channel in the Canadian Archipelago that lies between Canada's Ellesmere Island and Greenland.

"The Nares Strait is slightly less in width than the distance from Cape Henlopen, Del., to Cape May, N.J., and yet it represents a major pathway for Arctic water to reach the Atlantic Ocean," Münchow says. "This area has never been studied before because it had never been of any strategic importance, but the global change scenario has added relevance, and so now, it's worth a look."

Andreas Münchow, associate professor of physical ocean science and engineering, conducts research in the ice-covered waters of the Arctic Ocean.

The Canadian Archipelago Throughflow Study is a five-year collaborative research project that involves about 35 scientists from the United States, Canada and Japan. UD received more than $2 million from the National Science Foundation's Office of Polar Programs for the project. UD's team, led by Münchow, who is a co-principal investigator, included research associate David Huntley, marine studies graduate student Melissa Zweng, junior Lauren Brown and high school physics teacher Robert McCarthy, AS '84, MS '86M, '91PhD.

The UD team collected such oceanographic data as the salinity and temperature of the surface water, as well as information to generate a map of the ocean floor, from instruments mounted on the hull of the ship. Data streamed in from these instruments 24 hours a day, seven days a week, requiring constant monitoring by the team.

"My shift started at 7:30 a.m. and ended at 3:30 p.m.," Brown says. "Every half hour, my partner and I would check to make sure everything was functioning properly. Sometimes, the files would not be updating correctly or the data coming in was bad, so we would either fix the computer problem by creating new files or the bad data problem by changing the settings on the instruments. In addition, we sometimes helped collect water samples or deploy the instruments that needed to be put in the water. There was always something exciting going on."

The data already have answered one question that previously mystified scientists, how salt water from deep in the Arctic Ocean can cross the Nares Strait, which is only 200 meters (approximately 650 feet) deep, and then plunge to a depth of 2,500 meters (1.5 miles) in Baffin Bay, located south of the strait.

"Coastal upwelling on the Greenland side acts together with the water's southward flow to bring salt water up close enough to the surface so that it can cross the strait," Münchow says of the team's findings. "Think of it like an elevator. You have to bring that salt water up, move it across and then drop it down on the other side. We are the first to observe this mechanism."

A major accomplishment of the research cruise was the installation of an ocean observing system in a type of "picket fence" pattern across the strait. A total of 23 oceanographic instruments—many more than traditionally have been used in such a small area—were moored to the bottom with heavy weights, where they will remain for more than three years. These instruments will record such information as velocity of the current, temperature and salinity at different depths and ice thickness in various areas.

Münchow will use the data from these instruments to determine the direction and amount of fresh water being transported from the Arctic Ocean to the northern Atlantic through the Nares Strait. "The salinity tells us the amount of fresh water, and the current tells us the direction," Münchow says. "You put those two properties together, flow flux and salinity, and this gives the freshwater flux."

The remote and hostile environment of the Arctic provides many challenges for the scientists who study this ocean at the top of the world. Its ice-covered waters are accessible for just a short time each year, putting a tremendous amount of pressure on the researchers to accomplish their goals. The scientists aboard *Healy* often worked around the clock, giving up sleep to collect data that they might never have the chance to collect again.

"There is so much going on that I had to force myself to sleep," Münchow says. "Every minute, I had to make decisions that impact data collection: Do I have to change something? Can I improve on what I am doing? Am I missing something?"

In addition, much of the equipment had to be custom made to withstand the extreme conditions of the Arctic Ocean.

Polar weather also can create obstacles for the scientists, making their work dangerous and, in some cases, stopping work. However, Münchow notes that the team was lucky last summer, encountering only one storm.

A special feature of the project was its outreach component. McCarthy wrote daily logs, which then were posted on a web site designed to share the excitement of polar research with the public. (See related article below.)

"I am so very grateful for the experiences I had on the cruise," Brown, who was responsible for uploading the daily logs, says. "I had a chance to work with some brilliant scientists and Coast Guard members and to take part in exciting research. It was an opportunity for me to expand my knowledge of the way research and data collection works, and that will help me as a student with future endeavors."

Münchow will return to the Nares Strait in spring 2005 with a small group of scientists to recover the instruments that were deployed. After downloading the data, they will return the instruments to the water. The five-year study will provide important information about the impact of freshwater discharge on the Earth's climate.

—Kari K. Gulbrandsen, EG '91M

Healy, the 420-foot U.S. Coast Guard cutter, steams into the Arctic Ocean. The ship is the United States' newest and most technologically advanced icebreaker.

David Huntley (left), research associate in the College, and Suzanne Scrivens, a marine science technician with the U.S. Coast Guard, deploy an instrument.

Ship-to-shore science lessons

The last time Robert McCarthy had stepped aboard a research vessel was almost 15 years ago, when he was a graduate student in the College of Marine Studies.

But, his hiatus from the sea didn't stop him when he was presented the opportunity to spend four weeks last summer in the ice-covered waters of the Arctic Ocean aboard the U.S. Coast Guard icebreaker *Healy*. McCarthy, who earned his master's and doctoral degrees from the College, says he "just packed a lot of warm clothing and a lot of film," and he was off.

A teacher at Gov. Mifflin High School in Shillington, Pa., he returned to sea as a member of a UD research team led by Andreas Münchow, MS '88M, '92PhD, associate professor of physical ocean science and engineering in the College. According to Münchow, experiences like the one offered to McCarthy are increasingly encouraged as a way to inform the public about scientific research and to promote science education.

UD's team was part of a collaborative effort involving 35 scientists from Oregon State University and the Institute of Ocean Sciences in British Columbia to study the movement of fresh water in the Arctic Ocean. As teacher-on-board, McCarthy wrote a daily log geared to high school students, describing his experiences aboard the 420-foot research vessel. Every day, his log was uploaded to a web site dedicated to the project, enabling his students and the public to travel along with him.

McCarthy stood watch from 3:30-11:30 p.m. each day to ensure that the shipboard equipment was recording data properly. He says it was a challenge to adjust to the Arctic's 24 hours of continuous daylight. "When my shift was over, it didn't feel as if it was late at night," he says. "I didn't have the visual clue that it was almost midnight."

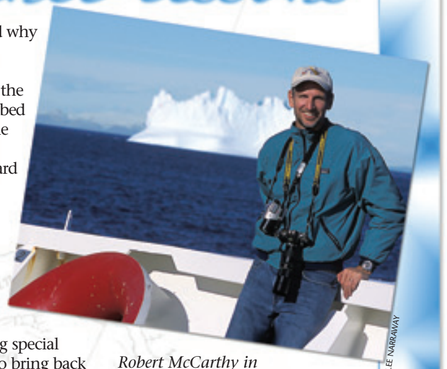
McCarthy spent mornings taking photos and writing a rough draft of his day's article, which he later revised and edited. In those logs, he explained how and why the scientists used various pieces of equipment aboard the ship. He also described the weather and the scenery, as well as how the Coast Guard crew maintained morale while far from home.

McCarthy says highlights of the cruise included scraping ice off an iceberg and tasting it, collecting special stones and shells to bring back as souvenirs to his wife and children and what he calls the "ride of a lifetime" in one of the two helicopters aboard *Healy*. But, he says, the best part of the voyage was watching the ship break through the ice. While cruising at 3 knots (about 3.5 mph), *Healy* can break through 4.5 feet of ice.

"We were privileged to stand right at the bow, where we could look straight down," McCarthy says. "The ship would momentarily slide up onto the ice a few feet, before the sheer weight of the ship would break through the ice. It was very cool and very loud!"

He summarizes his Arctic experience as the opportunity of a lifetime. "To be that far up in latitude, on board a state-of-the-art research vessel, was something I'll treasure forever," he says.

To read more about the trip and to learn about Arctic research, visit [http://newark.cms.udel.edu/~cats].



LEE NARAWAY

Robert McCarthy in a quiet moment aboard the icebreaker Healy *in the Arctic Ocean last summer.*