Arctic adventure gives pair of Maine glaciologists close-up view, and surprise

Glaciologists Leigh Stearns and Gordon Hamilton have spent countless hours poring over satellite photos of several glaciers in East Greenland, watching as the mountains of ice gradually retreat into their valleys and become the first casualties of global warming. But the unexpected chance to catch a ride on a Greenpeace boat and visit research sites far inside the Arctic Circle earlier this summer was tantalizing, the University of Maine researchers said.

"That's why we're in it. We love the adventure component as much as the science," Stearns said.

Visiting the Arctic — by ship, no less — was a fantasy for the glaciologists, both of whom grew up reading about the adventures of Arctic explorers.

"The idea of sailing to the polar regions is something you read about in books," Hamilton said. "I've got the best job in the world."

When they boarded the Greenpeace ship in June, there was no guarantee they could even approach the glaciers they hoped to study, much less clamber over their icy ridges.

Just getting the ship close to the glaciers, maneuvering around icebergs "half the size of Orono," was a challenge for its captain, said Hamilton, a professor at the University of Maine Climate Change Institute.

Riding in a small helicopter that travels on the ship, the Maine researchers swooped in to find suitable sites to take satellite measurements of the glaciers' movement over a 24-hour period.

To conduct their research — measuring the speed at which the glaciers are moving — the scientists then had to climb atop the unsteady ice to set up their instruments. High-tech global positioning systems were mounted in the ice and their components recorded. The scientists returned several days later to take another measurement.

The experiment's design was simple. The research was not. Just finding a flat space the size of a desk on which to land the craft could take hours. One wrong step, and the researchers — or their escape vehicle — could have plummeted into a canyon. Hundreds of miles from the ship, rescue was all but impossible.

"The margins of error were so small, we had to make sure we took every precaution," Hamilton said. "Every time we got out [of the helicopter] it was like: 'This could be it.' [But] we knew that if we could actually get on the glaciers we'd get some really important measurements," he said.

While working on her dissertation at UMaine, Stearns has studied satellite photos of these glaciers for weeks at a stretch. She thought she knew every mound of ice, every crevasse. But the icy canyons were unrecognizable, with sharp cliffs creating far more rugged landscape than the scientists had believed.

"Then you get there, and it looks totally different," Stearns said.

Each time the helicopter successfully lifted off, the $30,000 of borrowed GPS equipment they left behind was just a speck on the white, featureless abyss of the glacier.

With each of the five glaciers they visited, the two grew more confident. They refined their techniques, took their measurements, and verified the incremental changes other scientists have documented for decades. Other researchers had visited the glacier over the last four decades, and the scientific community believed the terminus of Kangerdlugssuaq had been relatively stable, moving almost imperceptibly since 1962.

When Stearns and Hamilton reached the Kangerdlugssuaq glacier, however, the Maine researchers discovered that the ice had melted at an incredible rate since measurements were last taken by others in 2001. While the ship was traveling to the glacier, Hamilton had used satellite photos to plot out the GPS positions of likely research sites. But when the helicopter made its first approach, his sites weren't on ice at all. They were in the middle of the fjord.

"[The pilot] said, 'Well, we're here,' and I looked down and there was no glacier anymore. It was gone," Hamilton said.

Measurements revealed that the glacier had increased the speed at which it was retreating. So much so, in fact, that it could be captured on film, traveling the length of a football field in 48 hours. The final glacier they had selected, Helheim, showed similarly shocking rates.

Stearns and Hamilton had expected to record the glaciers' slow retreat as a result of increasing global temperatures, but the rate they recorded peaked at nearly three times what they had anticipated.

Dark spots on the satellite photos, which Stearns had believed to be cloud shadows, turned out to be huge pools of melted water that the scientists believe are the reason for the glaciers' accelerated retreat. Researchers know that the two glaciers together account for 8 percent of all of the annual melting from the entire Greenland ice sheet; but previous modeling hadn't accurately predicted how much that water would speed the glaciers' melting, the researchers said.

The researchers are publishing their data, and expect to track the glaciers' behavior in the coming years. If their conclusions hold true, the research could allow glaciologists to predict much more accurately the speeds at which glaciers melt.

"We were both stunned. … that sort of thing doesn't happen very often in science," Stearns said.

"It's going to be hard to top it," she said.

Arctic climate trends

Warming in the Arctic is causing changes in both physical and natural systems

Impacts on physical climate system
Rising temperatures
Rising river flows
Declining snow cover
Increasing precipitation
Thawing permafrost
Diminishing lake and river ice
Melting glaciers
Melting Greenland Ice Sheet
Retreating summer sea ice
Rising sea level
Ocean salinity change

Impacts on natural systems
Wetland changes
Vegetation shifts
Increasing fires and insects
Northward species shifts
Marine species at risk
Land species at risk
Ultraviolet radiation impacts
Old-growth forest loss
Carbon cycle changes

Increasing global concentrations of carbon dioxide and other greenhouse gases due to human activities, primarily fossil-fuel burning, are projected to contribute to additional Arctic warming of about 4-7 degrees Celsius over the next 100 years.

The Arctic melt

Arctic average temperatures have risen at almost twice the rate as the rest of the world in the past few decades, causing glacier and sea ice melt and rising permafrost temperatures.

An acceleration of these trends is projected to occur during this century, due to ongoing increases in greenhouse gases in Earth's atmosphere. As melting Arctic glaciers contribute to rising sea levels around the globe, planetwide effects are expected.

Rising sea level

The rise in sea level has the potential to affect societies around the world in significant ways. Climate change alters sea level by affecting both the density and the amount of water in the oceans. As water warms, it expands; such "thermal expansion" is projected to be the largest component of the rising sea level over the next 100 years and will persist for many centuries. Warming also increases the melting of glaciers and ice caps (land-based ice), adding to the amount of water flowing into the oceans.

Ocean circulation

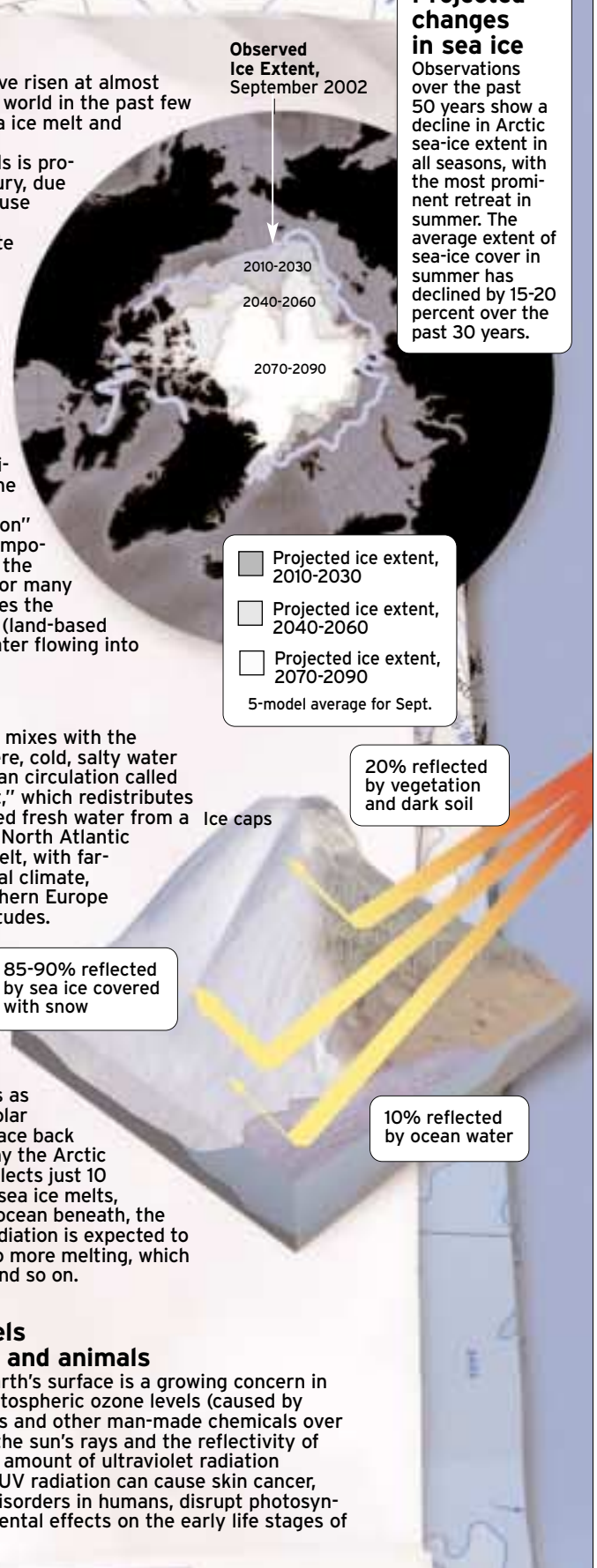
The Arctic Ocean flows into and mixes with the waters of the North Atlantic. Here, cold, salty water sinks down, driving a global ocean circulation called the "Great Ocean Conveyor Belt," which redistributes heat around the planet. Increased fresh water from a warming Arctic flowing into the North Atlantic could shut down the conveyor belt, with far-reaching consequences for global climate, including drastic cooling of northern Europe and further warming of mid-latitudes.

Surface reflectivity

The cryosphere interacts with the climate in important ways, including how it reflects sunlight. Because they are bright white, the snow and ice that cover much of the Arctic reflects as much as 85-90 percent of the solar energy that reaches Earth's surface back into space. This is one reason why the Arctic remains so cold. Ocean water reflects just 10 percent of that energy. Thus, as sea ice melts, revealing more and more of the ocean beneath, the increasing absorption of solar radiation is expected to add to global warming, leading to more melting, which in turn leads to more warming, and so on.

Ultraviolet radiation levels will affect people, plants and animals

Ultraviolet radiation reaching Earth's surface is a growing concern in the Arctic. Clouds, depleted stratospheric ozone levels (caused by emissions of chlorofluorocarbons and other man-made chemicals over the last 50 years), the angle of the sun's rays and the reflectivity of Earth's surface, all influence the amount of ultraviolet radiation reaching the surface. Increased UV radiation can cause skin cancer, cataracts and immune-system disorders in humans, disrupt photosynthesis in plants and have detrimental effects on the early life stages of fish and amphibians.



Projected changes in sea ice

Observations over the past 50 years show a decline in Arctic sea-ice extent in all seasons, with the most prominent retreat in summer. The average extent of sea-ice cover in summer has declined by 15-20 percent over the past 30 years.

Sea-level threat

A rise of just 50 centimeters – 20 inches – would typically cause a shoreward retreat of coastline of 50 meters – 165 feet – if the land is relatively flat, such as is found in most coastal plains.

Monday, June 27, 2005
Eastern Greenland, 40 miles west of Scoresby Sund

The captain is constantly trying to find leads (pathways with no ice) to navigate through. The ship bounces and jolts quite a bit when it tries to break through ice, and we've all had some near falls while walking around the cabins. … There is sea ice for miles and miles, buttressed by enormous and dramatic mountains. I've never been on a ship before, and am really appreciating the slow approach to land … on a boat, you are given the details in tiny increments, and you can cherish each one.

— Leigh

Tuesday, June 28
Scoresby Sund

Scoresby Sund is the world's largest fjord system … also one of the deepest fjords in the world. … Polished rock walls plunge vertically into the water on both sides of the fjord, and numerous waterfalls cascade down the steep cliffs. The icebergs are huge. Several kilometers long in some cases. Each one is unique and a constant source of photographic material for those watching from the ship's deck. At night, it is difficult to pull ourselves away from the ever-changing views and get some sleep.

— Leigh

Saturday, July 2
Vestfjord, Scoresby Sund

The sun was shining and the pools filled by crystal clear mountain streams were too tempting to resist a quick swim. Yeah, it was cold, but not that cold!

— Gordon

Thursday, July 7
At sea: off the coast of Northwest Greenland

The same characteristics of Arctic Sunrise that make it an excellent ice-class vessel unfortunately also mean that it is very unstable in the open ocean. … Pete, the chief mate, likes to say that the Arctic Sunrise has all the hull stability of an egg. So, what is it like plowing through 20-foot waves in an egg? Everybody staggers around a lot. Things tend to fly off shelves and tables. People lose their appetite. (I wonder why.) Eating is an interesting experience — you get a fork full of food just before your plate slides down the table, but hopefully by the time you've chewed that mouthful, you have your plate back. Or someone's plate, at least.

— Gordon

Saturday, July 9
At sea: off the coast of Northwest Greenland

We saw our first polar bear! It was foggy so viewing conditions were not perfect. Still, the sight of a large male bear 20 meters away, off the starboard side of this ship, was very impressive. It looked at us for a while, then seemed to get bored, jumped across a lead between two ice floes and wandered off into the fog. Just as it disappeared, Leigh returned from the bathroom and wondered why everyone was leaning over the side of the ship.

— Gordon

Sunday, July 17
Denmark Strait

After being up at 74 N. [degrees North latitude] for the last week or so, it was quite a change to be "back down south" at 68 N. We definitely noticed the difference — there was something approaching a sunset at 12:30 a.m. (the sun really only went behind some mountains). … It was the kind of constantly changing light that kept us out on the bow taking photographs way past our bedtimes!

— Gordon

Wednesday, June 29
Daugaard-Jensen glacier

I was speechless and dumbfounded when we entered the northern part of Scoresby Sund. The fog lifted slowly, giving us spectacular views. … I can hardly describe our surroundings, except to say that it's the type of adrenaline-inducing landscape that makes you want to laugh and do push-ups and become a better person. Or maybe that's just me … Geology features that I'm used to observing in hand samples took up entire fjord walls. … We were sailing through textbooks of geological processes … and I could hardly contain my excitement.

— Leigh

Global positioning system receivers are used to measure the shifting and melting of glaciers

1777
George Washington and the Continental Army are snowbound at Valley Forge, Pa., a consequence of the Little Ice Age.

1815
Tambora erupts in Indonesia. The volcano directly kills 50,000 people, but cooling effects on the world's climate linger for months, resulting in what has been called the "Year Without a Summer" in 1816.

1846
The Irish potato famine begins, with the unusually damp, cool weather pattern a major factor in the crop's failure.

1878
The Staples family starts keeping records of ice-outs on West Grand Lake in Washington County. Descendants continue the practice today, providing one of Maine's longest-running direct climate records.

1896
Swedish scientist Svante Arrhenius publishes a paper in which he coins the phrase "the greenhouse effect" and predicts that increasing the amount of carbon dioxide in the atmosphere would raise Earth's temperature by several degrees.

1900
A Category 4 hurricane strikes Galveston, Texas, killing more than 6,000.

1913
American scientists use data from the 1883 eruption of Krakatoa in Southeast Asia to prove that volcanoes can affect global climate, a theory proposed by Benjamin Franklin more than a century earlier in response to his observations of climate impacts when Laki erupted in Iceland in 1783.