Glacier holds clues to rising sea levels

In recent years, the Jakobshavn Glacier in Greenland has become something of a poster child for global warming. Already the world's fastest moving glacier, Jakobshavn has doubled its speed over the past decade, with far more icebergs calving off and drifting down the Ilulissat Fjord to melt in the ocean.

No one knows for sure why Jakobshavn is speeding up, but there are two theories in the scientific community. "The atmospheric scientists say it's because the atmosphere is warmer," says Dr. Ralf Bachmayer of the NRC Institute for Ocean Technology in St. John's. "While the oceanographers say it's because the oceans have warmed, and warm water must be getting underneath the glacier and melting it from below."

The answer is probably a combination of both, but while satellite photos provide a good picture of the portion of the glacier that sits above the water, "the bottom is a mystery," says Dr. Bachmayer, who is helping to develop an underwater vehicle that could travel beneath the ice in search of clues to the glacier's acceleration.

It's a mystery worth solving, since understanding the mechanics of the melting process is the only way that scientists can
accurately predict how fast the ice will melt, and how much sea levels will rise. While climate scientists generally agree that the melting of the ice sheets over Greenland and Antarctica will lead to higher ocean levels, predictions vary wildly, from hardly any rise at all to the estimate heard in Al Gore's film *An Inconvenient Truth*, which warned that ocean levels could rise by up to 20 feet (6.1 metres).

**Fastest Glacier in Greenland Doubles Speed**

A NASA article showing the retreat of the glacier's calving front from 2001 to 2003. (Note: This third-party content is available in English only.)

Last summer, Dr. Bachmayer joined an international team heading to Greenland to study one piece of the puzzle – whether water from a warming ocean is travelling 40 kilometres up the Ilulissat Fjord to flow underneath the glacier. The project, led by Dr. David Holland of New York University, included partners from Memorial University of Newfoundland and NRC.

![Team members clockwise from top left: Dr. David Holland of New York University, Denise Holland, Dr. Ralf Bachmayer of NRC, Professor Brad de Young, and technician Jack Foley of Memorial University of Newfoundland.](image)

The team travelled by boat to the mouth of the fjord where melting icebergs enter the ocean. Navigating among icebergs up to 40 storeys high, they lowered instruments to the ocean floor and took measurements of water flow, temperature and salinity outside the entrance to the fjord. What did they find?

"Basically, the water out there is 'warm', by which I mean about two degrees Celsius," says Dr. Bachmayer. "The key question now is: does that warm water travel over the mouth of the fjord and up underneath the glacier, where it could melt it from below?"
Answering that question will require going underneath the ice that stretches from the calving zone of the glacier down the length of the fjord, something no one has been able to do so far. "It's dangerous," says Dr. Holland. "How do you take measurements in a place where icebergs bigger than skyscrapers are constantly falling?"

The solution could involve sending an unmanned vehicle into the iceberg-filled fjord. Dr. Bachmayer, who specializes in underwater vehicles, was on hand to test an instrumented mini submarine called a Slocum underwater glider. The hope is that the glider, or a similar vehicle, could travel under the ice across the width of the fjord to measure the water temperature.

Dr. Bachmayer says that the glider, which includes sensors for oxygen, temperature, conductivity and depth, performed well in the waters at the mouth of the fjord. The biggest challenges were negotiating the complex currents around the icebergs, and controlling the vehicle while it was under the ice. "Now we're looking into new vehicle concepts that take the environment there into account in a better way," he says.

A solution for Jakobshavn could have larger implications for research into the melting of ice sheets worldwide. "There is a glacier in Antarctica that is an order of magnitude larger and poses similar challenges," says Dr. Bachmayer. "If we develop a solution here, it could be used to take measurements there as well."

And that could lead to better predictions of rising sea levels. "It's pretty obvious that ice on the planet is going to melt and sea levels are going to go up a lot," says Dr. Holland. "But more important is when. If we can solve one piece of this – how warm water gets near ice, and what it does to it – then we can build a computer model, and with a model, we can make a prediction."
The ultimate goal is to predict which coastal cities are likely to flood, and when that could happen, whether it's in a hundred years or a thousand years.

"NRC is making a very important contribution to the environment with this work," says Dr. Holland. "It's not a problem that's going to show up tomorrow morning, but it will be a big issue for our children and grandchildren. It's our job to address it."

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Date Published: 2007-12-03