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RESEARCH NEWS
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This news release accompanies the press conference, "Greenland Glaciers: What Lies Beneath," to be given Wednesday, December 16, 2009, at 9:00 a.m. PT (12:00 NOON ET) at the American Geophysical Union Meeting in San Francisco (Press conference room, MW 3012).

*Scientific sessions (to be held in **MW 3014**):*
***C34A-02**, Wednesday, December 16, 2009 at 4:15 p.m. PT*
***C54A-06** and **C54A-07,** Friday December 18, 2009 at 5:15 p.m. and 5:30 p.m. PT*

GREENLAND GLACIERS: WHAT LIES BENEATH

Researchers learning more about how water beneath glaciers contributes to ice loss

San Francisco -- Scientists who study the melting of Greenland's glaciers are discovering that water flowing beneath the ice plays a much more complex role than they previously imagined.

Researchers previously thought that meltwater simply lubricated ice against the bedrock, speeding the flow of glaciers out to sea.

Now, new studies have revealed that the effect of meltwater on acceleration and ice loss -- through fast-moving outlet glaciers that connect the inland ice sheet to the ocean -- is much more complex. This is because a kind of plumbing system evolves over time at the base of the ice, expanding and shrinking with the volume of meltwater.

Researchers are now developing new low-cost technologies to track the flow of glaciers and get a glimpse of what lies beneath the ice.

As ice melts, water trickles down into the glacier through crevices large and small, and eventually forms vast rivers and lakes under the ice, explained Ian Howat, assistant professor of earth sciences at Ohio State University. Researchers once thought that this sub-glacial water was to blame for sudden speed-ups of outlet glaciers along the Greenland coasts.

"We've come to realize that sub-glacial meltwater is not responsible for the big accelerations that we've seen for the last ten years," Howat said. "Changes in the glacial fronts, where the ice meets the ocean, are the real key."

"That doesn't mean that meltwater is not important," he continued. "It plays a role along these glacial fronts -- it's just a very complex role, one that makes it hard for us to predict the future."

In a press conference at the American Geophysical Union (AGU) meeting in San Francisco on Wednesday, December 16, 2009, Howat will join colleagues from the University of Colorado-Boulder/NOAA Cooperative Institute for Research in Environmental Sciences (CIRES) and NASA's Jet Propulsion Laboratory (JPL) to discuss three related projects -- all of which aim to uncover how this meltwater interacts with ice and the ocean.

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Their work has implications for ice loss elsewhere in the world -- including Antarctica -- and could ultimately lead to better estimates of future sea level rise due to climate change.

Howat leads a team of researchers who are planting inexpensive global positioning system (GPS) devices on the ice in Greenland and Alaska to track glacial flow. Designed to transmit their data off the ice, these systems have to be inexpensive, because there's a high likelihood that they will never be recovered from the highly crevassed glaciers.

Howat will describe the team's early results at the AGU meeting, and give an overview of what researchers have learned about meltwater so far.

John Adler, a doctoral student at CIRES, works to calculate the volume of water in lakes on the top of the ice sheet. These lakes periodically drain, and the entire water volume disappears into the ice. He uses small unmanned aerial vehicles to measure the ice's surface roughness -- an indication of where cracks may form to enable this drainage to happen. Other members of his team are releasing GPS-tagged autonomous probes into the meltwater itself, to follow the water all the way down to the base of the ice sheet and out to sea.

"My tenet is pushing the miniaturization of technology, so that small autonomous platforms -- in the sea, on the surface, or in the air -- can reliably gather scientific information in remote regions," Adler said.

All these efforts require cutting-edge technology, and that's where Alberto Behar of JPL comes in. An Investigation Scientist on the upcoming Mars rover project, Behar designs the GPS units that will give researchers the data they need.

Howat's team placed six units on outlet glaciers in Greenland last year, and this year they placed three in Greenland and three in Alaska. The units offer centimeter-scale measurements of ice speed, and Behar designed the power and communications systems to keep the overall cost per unit as inexpensive as possible.

Howat has found that glacial meltwater at the base of the ice sheet has little influence on ice loss along the coast -- most of the time.

All over Greenland, meltwater collects beneath the ice, gradually carving out an intricate network of passageways called moulins. The moulins form an ever-changing plumbing system that regulate where water collects between the ice and bedrock at different times of the year. According to Howat, meltwater increases as ice melts in the summer, and decreases as water re-freezes in winter.

In the early summer, the sudden influx of water overwhelms the subglacial drainage system, causing the water pressure to increase and the ice to lift off its bed and flow faster, to the tune of 100 meters per year, he said. The water passageways quickly expand, however, and reduce the water pressure so that by mid-summer the glaciers are flowing slowly again.

Inland, this summertime boost in speed is very noticeable, since the glaciers are moving so slowly in general.

But outlet glaciers along the coast are already flowing out to sea at rates as high as 10 kilometers per year -- a rate too high to be caused by the meltwater.

“So you have this inland ice moving slowly, and you have these outlet glaciers moving 100 times faster. Those outlet glaciers are feeling a small acceleration from the meltwater, but overall the contribution is negligible,” Howat said.

His team looked for correlations between times of peak meltwater in the summer and times of sudden acceleration in outlet glaciers, and found none. “Some of these outlet glaciers accelerated in the wintertime, and some of accelerated over long periods of time. The changes didn’t correlate with any time that you would expect there to be more melt,” he added.

So if meltwater is not responsible for rapidly moving outlet glaciers, then what is responsible? Howat suspects that the ocean is the cause.

Through computer modeling, he and his colleagues have determined that friction between the glacial walls and the fjords that surround them is probably what holds outlet glaciers in place, and sudden increases in ocean water temperature cause the outlet glaciers to speed up.

Howat did point out two cases in which meltwater can have a dramatic effect on ice loss along the coast: it can expand within cracks to form stress fractures, or it can bubble out from under the base of the ice sheet and stir up the warmer ocean water. Both circumstances can cause large pieces of the glacier to break off.

At one point, he and his colleagues witnessed the latter effect first hand. They detected a sudden decrease of sub-glacial meltwater inland, only to see a giant plume of dirty water burst out from under the ice at the nearby water’s edge.

The dirty water was freshwater -- glacial meltwater. It sprayed out from between the glacier and the bedrock “like a fire hose,” Howat said. Since saltwater is more dense than freshwater, the freshwater bubbled straight up to the surface. “This was the equivalent of the pipes bursting on all that plumbing beneath the ice, releasing the pressure.”

That kind of turbulence stirs up the warm ocean water, and can cause more ice to melt, he said. “So you can’t just say, ‘if you increase melting, you increase glacial speed.’ The relationship is much more complex than that, and since the plumbing system evolves over time, it’s especially hard to pin down.”

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Editor’s note: During the AGU meeting, Howat can be reached through Pam Frost Gorder at (614) 668-3585. Images are available to accompany the story [see reverse].

DSC_0642.JPG: Researchers are deploying GPS units on glaciers in Greenland and Alaska to track the flow of ice out to sea. Team members from Ohio State University, NASA's Jet Propulsion Laboratory, and the University of Colorado-Boulder/NOAA Cooperative Institute for Research in Environmental Sciences reported their early results at the American Geophysical Union meeting in San Francisco. Here a helicopter carries members of a research team from base camp to a Greenland glacier. Photo courtesy of Alberto Behar, Jet Propulsion Laboratory.

DSC_0738.JPG: Alberto Behar, an Investigation Scientist at the Jet Propulsion Laboratory, climbs out of a helicopter onto a Greenland glacier. He is tethered to the helicopter for safety, and a GPS unit is at his feet. Photo courtesy of Alberto Behar, Jet Propulsion Laboratory.

DSC_0707.JPG: A member of the research team installs GPS equipment in Greenland. Photo courtesy of Alberto Behar, Jet Propulsion Laboratory.

DSC_0783.JPG: Mist escapes from the ice at the edge of a Greenland glacier. Photo courtesy of Alberto Behar, Jet Propulsion Laboratory.