Too much. Ice coming off Jakobshavn Isbræ glacier surged after warm ocean water arrived.

GLACIOLOGY

Winds, Not Just Global Warming, Eating Away at the Ice Sheets

The surge of glaciers draining both the Greenland and West Antarctic ice sheets has alarmed scientists and the public alike. Global warming appeared to be taking an early toll on the planet's largest stores of ice while accelerating the rise of sea level. But two new studies point to random, wind-induced circulation changes in the ocean—not global warming—as the dominant cause of the recent ice losses through those glaciers. In Greenland, at least, "you're going to have trouble blaming this on global warming," says glaciologist Richard Alley of Pennsylvania State University in State College. But he says the results underscore the threat of global warming by showing how warmth can "hit ice sheets where it hurts," as glaciologist Robert Bindschadler of NASA's Goddard Space Flight Center in Greenbelt, Maryland, puts it.

The losses long puzzled glaciologists because the atmosphere over the glaciers didn't seem to have warmed enough to trigger them. Meltwater didn't lubricate glacial flow enough to explain the losses either (*Science*, 18 April, p. 301). Could the culprit be ocean waters? They can carry lots of heat to glaciers that float out onto coastal waters, but oceanographers had not been taking the ocean's temperature off the ice sheets.

So physical oceanographer David Holland of New York University and his colleagues turned to scientists of a different stripe: fisheries researchers. They had recorded bottom temperatures off southwest Greenland while surveying shrimp populations from 1991 to 2006. Holland and colleagues reported online this week in *Nature Geoscience* that an influx of warmer, saltier water in 1997 "coincided precisely" with the rapid thinning and subsequent acceleration of Jakobshavn Isbræ glacier, Greenland's most prolific outlet for ice. The warm water must have melted the glacier's exposed underside and weakened it, they say, leading to the breakup of the ice shelf that had been bracing the glacier against the shore and helping to hold it back. "I think it's fantastic," says Bindschadler. They've "got this nailed in Greenland."

Holland and colleagues traced the influx of ocean warmth back to the atmosphere over the North Atlantic. An abrupt weakening of winds due to a natural atmospheric phenomenon called the North Atlantic Oscillation drove more waters from the Irminger Sea near Iceland around the tip of Greenland, up onto the shelf, and under the ice.

A similar natural process may have been at work in recent heightened ice losses off West Antarctica, researchers reported in the 18 September *Geophysical Research Letters*. Glacier modelers Malte Thoma of the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany, and colleagues, including Holland, had no water temperature data there, but they did have wind observations. When they plugged those numbers into an ocean-ice model, the shifting winds drew deeper, warmer offshore waters in the model up onto the continental shelf and under the ice at the same time in the mid-1990s that the real glaciers draining the West Antarctic Ice Sheet sped up. The wind shift may have been natural or caused by global warming, says co-author Adrian Jenkins of the British Antarctic Survey in Cambridge, U.K. Therefore, "whether we're going to see a continuation of [those losses] is not clear."

The vagaries of the atmosphere may be sending some confusing signals about global warming, researchers say, but that's no reason to stop worrying about the ice. "The really important thing is," says Alley, "when you look at [climate] projections, you have warming around Greenland." And that warmth now has an obvious way to get at the ice.

–RICHARD A. KERR

measure the light particles, that very act will "collapse" the two-way-at-once photons into either vertical or horizontal ones. Bob and Alice can detect that by comparing some randomly chosen bits.

A few companies make quantum systems to connect two users through a single link. The Vienna project weaves six disparate systems into an automated network. "You just make a connection to one node and can connect to any other user," says Andreas Poppe, a physicist at the Austrian Research Centers in Vienna.

In fact, the network will not be a fully quantum network, which would let Alice pass photons to Bob across any number of nodes. That would require devices called "quantum repeaters" that are at least a few years away. In the Vienna network, each user generates a key that is stored as classical (nonquantum) 0s and 1s in the node he or she links to. Those classical bits flow from node to node as needed, quantum mechanically encrypted as they cross each link. "What our network assumes is that you can trust each of the intermediate nodes," says Andrew Shields, a physicist with Toshiba Research Europe in Cambridge, U.K.

Nobody will be invited to try to hack the network, either. That's because hackers would likely ignore the quantum mechanics and attack the system's conventional parts, which wouldn't test the new concept, Poppe says.

Still, researchers hope the demonstration will signal the emergence of the new technology, especially for private networks. Some experts are skeptical. "I think the impact on the actual practice of cryptography is likely to be small," says Ronald Rivest, a computer scientist at the Massachusetts Institute of Technology in Cambridge. Current techniques, which rely not on shared secret keys but on mathematical manipulations that are practically impossible to work backward, already work well, says Rivest, who predicts that the niche for the quantum systems will be small.

Network developers hope for more. "I think, on our scale of things, it will be a historic day," says physicist Nicolas Gisin of the University of Geneva, Switzerland. The question is, will technologists and market analysts see it that way, too?

–ADRIAN CHO

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Published by AAAS