In 1997 the Jakobshavn Isbrae glacier on Greenland’s west coast switched from a regime of slow thickening to rapid thinning. Explanations had ranged from extra meltwater increasing lubrication between the bedrock and the ice, to break-up of the floating ice tongue that helped keep the glacier in place. But now researchers in the US, Canada, Denmark and Greenland have used data taken as part of a fishing study to link the change to a sudden influx of warmer waters.

"The break-up during the late 1990s of the floating tongue of the Jakobshavn Isbrae and the subsequent doubling of speed of the inland Jakobshavn Isbrae had come as quite a surprise to me and other researchers," David Holland of New York University told environmentalresearchweb. "We did not think that the behaviour of ice sheets could change so quickly."

Holland and colleagues from EG&G Services, US, Memorial University, Canada, the Danish Meteorological Institute, and Greenland Institute of Natural Resources suspected that the ocean might have played a role in the altered behaviour of Jakobshavn Isbrae. With this in mind, they used data from the Greenland Fisheries Surveys for northern shrimp, which measured ocean bottom temperatures at trawl sites from 1991 to 2006.

The measurements revealed a substantial jump in bottom temperature across the western Greenland continental shelf during the second half of the 1990s. In 1995 the mean value for the survey area was 1.7 °C but by 1998 it had reached 3.3 °C. What’s more, the data reveal that a pulse of warm water arrived in Disko Bay, at the mouth of the fjord into which Jakobshavn Isbrae flows, in 1997, a date which corresponds to the glacier's change in behaviour.

"[We] showed for the first time a clear cause-and-effect between warming ocean
temperatures and the sudden response of an ice sheet," said Holland. "This subsequently raised the question of why the warm waters – the Irminger waters – had appeared. It turned out that this was due to a change in the atmospheric winds called the North Atlantic Oscillation."

The North Atlantic Oscillation (NAO) describes the state of the relative strength of the high atmospheric pressure system above the Azores and the Iceland low pressure system. The NAO index is high when the difference in pressure between the two systems is relatively high. This tends to lead to stronger westerly winds and warmer and wetter winters in Northern Europe. In the winter of 1995-1996, the NAO changed from a prolonged positive phase to a negative phase.

According to the researchers, this weakened the subpolar gyre – a counterclockwise ocean current – allowing warmer subpolar waters to spread westwards beneath colder surface polar waters, and onto the west Greenland continental shelf.

"It has been recently found by others that subtle changes in the winds over the North Atlantic Ocean cause changes in the circulation of the ocean waters in the sub-polar gyre," said Holland. "In our research we showed that these changes had a domino effect on the ice at the periphery of the Greenland Ice Sheet, causing it to break up and to then double the speed of inland ice into the ocean. Given that the speedup of ice sheets into the ocean causes global sea level to change, this is an important mechanism to uncover in nature."

Holland says the main implication of the team’s findings is that subtle changes in atmospheric circulation during the present century and beyond, forced by natural solar variability, volcanic activity, greenhouse gases, aerosols, and the ozone hole, may force warm water to the edge of the Greenland and Antarctic Ice Sheets, causing a retreat of the ice and a rise in global sea level.

"The science community has not yet developed computer models of this process and thus we are currently unable to predict the likelihood of this actually occurring," he said. "Given what is at stake in terms of economic impacts etc., the scientific community needs to develop this predictive capability."

Now the team is continuing observational work in Greenland and Antarctica and developing computer models of ice sheet behaviour within the climate system.

The researchers reported their work in *Nature Geoscience*. 
About the author

Liz Kalaugher is editor of environmentalresearchweb.
Image taken from the town of Ilulissat, which is adjacent to the mouth of the Jakobshavn fjord, in August 2007. The photo shows icebergs at the mouth of the fjord which have recently calved from the Jakobshavn Isbrae some 50 km further upstream in the fjord. Image credit: Denise Holland.