Pine Island Glacier sensitive to climatic variability

January 2 2014

A new study published in *Science* this month suggests the thinning of Pine Island Glacier in West Antarctica is much more susceptible to climatic and ocean variability than at first thought. Observations by a team of scientists at British Antarctic Survey, and other institutions, show large fluctuations in the ocean heat in Pine Island Bay. The team discovered that oceanic melting of the ice shelf into which the glacier flows decreased by 50 per cent between 2010 and 2012, and this may have been due to a La Ninã weather event.

Pine Island Glacier has thinned continuously during past decades driven by an acceleration in its flow. The acceleration is thought to be caused by thinning of the floating ice shelf created as the glacier slides into the sea. Understanding the processes driving ice shelf thinning and the glacier's response is key to assessing how much it will contribute to rising sea levels.

It's now known that much of the thinning is due to a deep oceanic inflow of Circumpolar Deep Water (CDW) on the continental shelf neighbouring the glacier. This warmer water then makes its way into a cavity beneath the ice shelf melting it from below.

The passage of this warmer water was made easier by the unpinning of the ice shelf from an underwater ridge. The ridge had, in effect, acted as a wall preventing warmer water from getting to the thickest part of the shelf. This ungrounding event was one of the major driving forces behind the glacier's rapid change.

In 2009, a higher CDW volume and temperature in Pine Island Bay contributed to an increase in ice shelf melting compared to the last time measurements were taken in 1994. But observations made in January 2012, and reported now in *Science*, show that ocean melting of the glacier was the lowest ever recorded. The top of the thermocline (the layer separating cold surface water and warm deep waters) was found to be about 250 metres deeper compared with any other year for which measurements exist.

This lowered thermocline reduces the amount of heat flowing over the ridge. High resolution simulations of the ocean circulation in the ice shelf cavity demonstrate that the ridge blocks the deepest ocean waters from reaching the thickest ice. So its presence enhances the ice shelf's sensitivity to climate variability since any changes in the thermocline can alter the amount of heat filtering through.

The fluctuations in temperature recorded by the team may be explained by particular climatic conditions. In January 2012 the dramatic cooling of the ocean around the glacier is believed to be due to an increase in easterly winds caused by a strong La Ninã event in the tropical Pacific Ocean. Normally the winds flow from the west.

The observations suggest there is a complex interplay between geological, oceanographic and climatic processes. The study stresses the importance of both local geology and climate variability in ocean melting in this region.

Lead author, Dr Pierre Dutrieux, from British Antarctic Survey (BAS) said: "We found ocean melting of the glacier was the lowest ever recorded, and less than half of that observed in 2010. This enormous, and unexpected, variability contradicts the widespread view that a simple and steady ocean warming in the region is eroding the West Antarctic Ice Sheet. These results demonstrate that the sea-level contribution of

the ice sheet is influenced by climatic variability over a wide range of time scales."

Co-author, Professor Adrian Jenkins, also from BAS, added: "It is not so much the ocean variability, which is modest by comparison with many parts of the ocean, but the extreme sensitivity of the ice shelf to such modest changes in ocean properties that took us by surprise. That sensitivity is a result of a submarine ridge beneath the ice shelf that was only discovered in 2009 when an Autonomous Underwater Vehicle mapped the seabed beneath the ice. These new insights suggest that the recent history of ice shelf melting and thinning has been much more variable than hitherto suspected and susceptible to climate variability driven from the tropics."

More information: *Science* 2 January 2014. Page 1 DOI: 10.1126/science.1244341

Provided by British Antarctic Survey