'Hidden plumbing' helps slow Greenland ice flow

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A moulin is a hole in a glacier that funnels meltwater from the surface to the bedrock beneath. This flow of water has importance consequences for the speed at which the glacier moves. Credits: J. Box

Hotter summers may not be as catastrophic for the Greenland ice sheet as previously feared and may actually slow down the flow of glaciers, according to new research.

A letter published in *Nature* on 27 January explains how increased melting in warmer years causes the internal drainage system of the ice sheet to 'adapt' and accommodate more melt-water, without speeding up

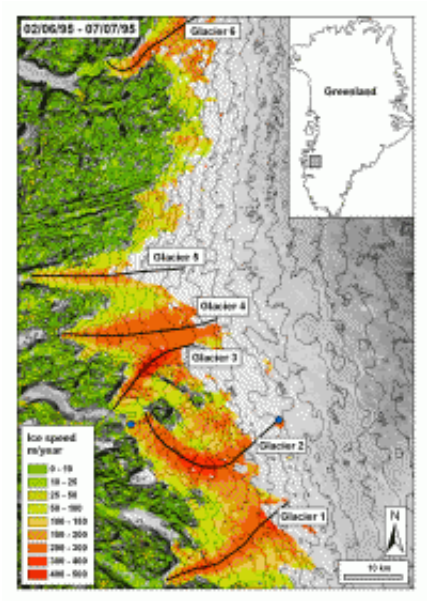
the flow of ice toward the oceans. The findings have important implications for future assessments of global sea level rise.

The Greenland ice sheet covers roughly 80% of the surface of the island and contains enough water to raise sea levels by 7 metres if it were to melt completely. Rising temperatures in the Arctic in recent years have caused the ice sheet to shrink, prompting fears that it may be close to a 'tipping point' of no return.

Some of the ice loss has been attributed to the speed-up of glaciers due to increased surface melting. Each summer, warmer temperatures cause ice at the surface of the sheet to melt. This water then runs down a series of channels to the base of the glacier where it acts as a lubricant, allowing the ice sheet to flow rapidly across the bedrock toward the sea.

Summertime acceleration of ice flow has proved difficult for scientists to model, leading to uncertainties in projections of future sea level rise.

"It had been thought that more surface melting would cause the ice sheet to speed up and retreat faster, but our study suggests that the opposite could in fact be true," said Professor Andrew Shepherd from the University of Leeds School of Earth and Environment, who led the study.



An example of a two-dimensional ice-velocity map of the study area in southwest Greenland. The map is derived from Synthetic Aperture Radar images from ESA's veteran ERS-1 satellite separated by 35 days: 2 June to 7 July 1995. Credits: University of Leeds

"If that's the case, increases in surface melting expected over the 21st century may have no affect on the rate of ice loss through flow. However, this doesn't mean that the ice sheet is safe from climate change, because the impact of ocean-driven melting remains uncertain."

The researchers used satellite observations of six landlocked glaciers in south-west Greenland, acquired by the European Space Agency, to study how ice flow develops in years of markedly different melting.

Although the initial speed-up of ice was similar in all years, slowdown occurred sooner in the warmest ones. The authors suggest that in these years the abundance of melt-water triggers an early switch in the plumbing at the base of the ice, causing a pressure drop that leads to reduced ice speeds.

This behaviour is similar to that of mountain glaciers, where the summertime speed-up of ice reduces once melt-water can drain efficiently.

More information: 'Melt-induced speed-up of Greenland ice-sheet offset by efficient subglacial drainage' by Aud Venke Sundal, et al. *Nature*, January 27, 2011.

Provided by University of Leeds