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Greenland Ice Sheet Flow Driven by Short-Term Weather Extremes, Not Gradual Warming, Research Reveals

Sudden changes in the volume of meltwater contribute more to the acceleration -- and eventual loss -- of the Greenland ice sheet than the gradual increase of temperature, according to a University of British Columbia study.

The ice sheet consists of layers of compressed snow and covers roughly 80 per cent of the surface of Greenland. Since the 1990s, it has been documented to be losing approximately 100 billion tonnes of ice per year -- a process that most scientists agree is accelerating, but has been poorly understood. Some of the loss has been attributed to accelerated glacier flow towards ocean outlets.

Now a new study, published in the journal Nature, shows that a steady meltwater supply from gradual warming may in fact slow down glacier flow, while sudden water input could cause glaciers to speed up and spread, resulting in increased melt.

"The conventional view has been that meltwater permeates the ice from the surface and pools under the base of the ice sheet," says Christian Schoof, an Assistant Professor at UBC's Department of Earth and Ocean Sciences and the study's author. "This water then serves as a lubricant between the glacier and the earth underneath it, allowing the glacier to shift to lower, warmer altitudes where more melt would occur."

Noting observations that during heavy rainfall, higher water pressure is required to force drainage along the base of the ice, Schoof created computer models that account for the complex fluid dynamics occurring at the interface of glacier and bedrock. He found that a steady supply of meltwater is well accommodated and drained through water channels that form under the glacier.

"Sudden water input caused by short term extremes -- such as massive rain storms or the draining of a surface lake -- however, cannot easily be accommodated by existing channels. This allows it to pool and lubricate the bottom of the glaciers and accelerate ice loss," says Schoof, who holds a Canada Research Chair in Global Process Modeling.

"This certainly doesn't mitigate the issue of global warming, but it does mean that we need to expand our understanding of what's behind the massive ice loss we're worried about," says Schoof.

A steady increase of temperature and short-term extreme weather conditions have both been attributed to global climate change. According to the European Environment Agency, ice loss from the Greenland ice sheet has contributed to global sea-level rise at 0.14 to 0.28 millimetres per year between 1993 and 2003.

"This study provides an elegant solution to one of the two key ice sheet instability problems identified by the Intergovernmental Panel on Climate Change in their 2007 assessment report," says Prof. Andrew Shepherd, an expert on using satellites to study physical processes of Earth's climate, based at the University of Leeds, the U.K.

"It turns out that, contrary to popular belief, Greenland ice sheet flow might not be accelerated by increased melting after all," says Shepherd, who was not involved in the research or peer review of the paper.

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