Modeling the freshwater contribution from an East Greenland glacier

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Increasing evidence indicates that changes at the marine margin of Greenland's tidewater glaciers may have triggered their recent acceleration and retreat and sizably increased Greenland's contribution to sea level rise and freshwater fluxes. One of the proposed mechanisms involves changes in submarine melting at the ice-ocean interface. Yet the parameters and processes controlling the submarine melt rate are largely unclear.

We have investigated the influence of the glacial forcing (from submarine melting and subglacial discharge) and the forcing from the continental shelf (e.g. wind events) on fjord dynamics and submarine melting of Helheim Glacier, a large outlet glacier of the Greenland Ice Sheet.

We use a numerical, non–hydrostatic ocean model (the MITgcm) with an

ice–shelf parameterization initialized with data collected from Sermilik Fjord, where Helheim discharges.

Our results show that the glacier experiences significant seasonal variability both in the vertical distribution and magnitude of submarine melting, largely due to discharge from the glacier.
In summer, the glacier strongly influences the submarine melting which is one order of magnitude larger than in winter and with a maximum near the glacier grounding line. In winter its maximum occurs near the interface between the two water masses characterizing the fjord stratification.
However, in winter, when the glacier forcing has a smaller contribution to the dynamics, the continental shelf variability regulates the submarine melting by varying the water properties at the glacier head.
Finally, our results compare favorably to recent findings based on oceanic data and idealized laboratory experiments.