Seasonal variability of submarine melting and circulation in an East Greenland fjord

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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. 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. It is unclear how seasonally varying processes, such as subglacial discharge or ocean property changes, impose a seasonal variability on the melt rate. Here, we examine the seasonal variation in the submarine melt rate, and the circulation driven by glacial melting, at the edge of Helheim Glacier, a large outlet glacier of the Greenland Ice Sheet. We use a numerical ocean model (the MITgcm) with an ice thermodynamics parameterization and initialized with data collected from Sermilik Fjord, and forced by observed subglacial discharge. Our results show that the glacier experiences a significant seasonal variability both in the vertical distribution and magnitude of submarine melt rate, largely due to the subglacial discharge. In summer, the submarine melt rate is one order of magnitude larger than in winter and its maximum occurs near the glacier grounding line, while in winter its maximum occurs near the interface between the two water masses characterizing the fjord stratification. Simulated submarine melt rates are consistent with those inferred from simplified one–dimensional models based on the theory of buoyant plumes.

These results leave open the question on whether externally forced circulations (i.e. local

winds, continental shelf dynamics) can significantly alter the buoyancy driven circulation generated by the glacier.