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Wintertime Fjord-Shelf Interaction in Southeast Greenland

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In southeast Greenland, acceleration and retreat of the marine-terminating glaciers contributes significantly towards global sea level rise. Circulation in the fjords which accommodate these glaciers is thought to be driven both by freshwater input in summer and by barrier wind-driven shelf exchange in winter. Due to a scarcity of data, particularly from winter months, the balance between these two mechanisms is not fully understood.

A realistic numerical model was constructed with the aim of better understanding the interaction between Kangerdlugssuaq Fjord and the adjacent continental shelf, and quantifying heat exchange during winter. The model was initially run in an idealised configuration with winter climatological forcing fields, incorporating a parameterisation for melting at the terminus, and used to test the impact of barrier wind events. The Earth's rotation played a crucial role in the nature of the circulation and exchange in the fjord, with inflow on the right (looking up-fjord) and outflow on the left. While the heat delivered into the fjord-mouth was smaller than that observed in summer, the background internal circulation was found to efficiently distribute waters through the fjord without external forcing, and the heat delivered to the glacier terminus was comparable to summer values. Barrier winds were found to excite coastally-trapped internal waves which propagated into the fjord along the right-hand side. The process was capable of doubling the heat delivery. The process also enhanced the background circulation via Stokes' Drift. The model was then adapted to simulate winter 2007-08 under historical forcing conditions. Time series of glacial melt rate, as well as the heat flux through fjord cross-sections, were constructed and compared to the variability in wind forcing. Long periods of moderate wind stress were found to induce greatly enhanced heat flux towards the ice sheet, while short, strong gusts were found to have little influence, suggesting that the timescale over which the shelf wind field varies is a key parameter in dictating wintertime heat delivery from the ocean to the Greenland Ice Sheet.