Shelf-forced fjord circulation and heat transport at the terminus of a major outlet glacier

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Greenland's fjords form a key conduit between the open ocean and the ice sheet. While recent studies link ocean variability with glacier behavior, little is known about the processes by which oceanic changes on the shelf can reach outlet glaciers. Resolving fjord dynamics, therefore, is crucial for understanding controls on submarine melting and glacier retreat. Here, we present analysis of circulation and heat transport in a major outlet of the ice sheet – Sermilik Fjord, into which Helheim Glacier drains - using a novel ten-month velocity profile of the upper 400 m and water property records throughout most of the water depth. We find that the mid-fjord velocity field is dominated by fast, highly sheared, oscillatory flows, with peak variability on synoptic timescales. Frequent energetic velocity pulses (typically lasting 1-3 days) are driven by changes on the shelf, near the fjord's mouth. The majority of shelf variability, in turn, is driven by along-coast winds. This remote forcing, or intermediary circulation, dominates for the majority of the year, rendering the circulation from glacial inputs (meltwater and runoff) secondary as a mechanism for driving exchange with the shelf. These fast, shelf-forced flows are central to resolving the heat budget of the fjord; they flush a substantial fraction of the fjord, change the fjord's heat content, and affect heat transport to the glacier.