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Greenland glaciers dynamics in relation to surface melt and sea-surface temperature

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The relative influence of meltwater drainage and calving mechanisms on the contemporary ice-flow dynamics of Greenland outlet glaciers is of considerable interest (IPCC, 2007). This is because changes driven by fjord processes will be self-limiting as the ice sheet retreats beyond the influence of the ocean, while surface meltwater driven processes will provide an ongoing link between climate change and dynamic thinning (Shepherd et al., 2007).

Here we investigate the links between the acceleration of Greenland glaciers and the remotely-sensed expression of fjord and ice surface influences. Reynolds sea-surface temperature (SST), based on in-situ and satellite data (Reynolds et al., 2002), provide a proxy for the influence of changes in fjord sea-ice and ice-front melt rate. Ice surface melt area, derived from the Envisat Advanced SAR in Global Monitoring Mode at 1 km spatial resolution, provides a measure of the timing and variability in the availability of surface meltwater for potential drainage to the bed. Surface velocities are measured using feature tracking between ERS and Envisat SAR data in Image Mode (Luckman et al., 2006).

The relations between these datasets provide insights into the relative importance of meltwater drainage and calving processes on the seasonal speed-up and on step-change events such as the exceptional speed-up and retreats seen at Jakobshavn, Kangerdlugssuaq and Helheim. The spring speed-up appears to begin in May, at the same time that SST suggests a retreat of sea-ice, whereas significant surface melt does not occur until June or July. There is also an intriguing relation between SST anomalies and the timing of significant retreat events, suggesting that abnormally high SST

may have triggered a retreat phase of a tidewater glacier cycle in some glaciers.

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