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Ice dynamics of Bowdoin tidewater glacier, Northwest Greenland, from borehole measurements and numerical modelling

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The observed rapid retreat of ocean-terminating glaciers in southern Greenland in the last two decades has now propagated to the northwest. Hence, tidewater glaciers in this area, some of which have remain stable for decades, have started retreating rapidly through iceberg calving in recent years, thus allowing a monitoring and investigation of ice dynamical changes starting from the early stages of retreat.

Here, we present an ice dynamical study from Bowdoin Glacier, a tidewater outlet glacier located at the north-western margin of the Greenland Ice Sheet. The glacier surface experiences lowering at a rate of 1.5 m/a since 2007. A rapid calving front retreat of 260 m/a was also observed since 2008, while no significant changes occurred during the previous 20 years. From July 2014 to July 2015, we monitored, 2 km upstream from the calving front, subglacial water pressure changes in boreholes, internal ice deformation through tilt sensors at different depths, englacial ice temperature profiles from the glacier bed to the surface, and high resolution surface motion from GPS records. These measurement show that the glacier is temperate-based, yet internal deformation accounts for about 10 % of the annual surface motion. A seasonal increase in both deformation and sliding at the onset of the melt season is associated with a drop in water pressure in part of the subglacial system. These observations are used to calibrate the Parallel Ice Sheet Model (PISM) for numerical simulations of ice flow in the Bowdoin Glacier catchment, aiming for a better understanding of iceberg calving processes in relation to changes in internal and basal ice dynamics.