## Abstract

The Greenland ice sheet is losing mass, and is currently contributing 1 mm/year to global sea level rise. The large majority of these changes can be attributed to the recent acceleration in flow of marine-terminating outlet glaciers within the last several decades. Such fast ice flow is characterised by ice deformation, as well as basal motion. However, there are few direct observations of either of these contributing mechanisms due to the difficulty of accessing the subglacial environment. In particular, although basal melt rates have been measured on ice shelves for decades, there exist almost no equivalent observations for grounded ice sheets. We present the first time series of directly-measured rates of basal melting at the bed of Store Glacier, a major outlet glacier flowing into Uummannaq Fjord in West Greenland. The measurements were obtained using a phase-sensitive, frequency modulated continuous wave (FMCW) radar system installed 30 km upflow of the calving terminus at a location where the surface velocity of the glacier is 700 m/year. Radar data were recorded every 4 hours from 26 July to 11 December 2014. The same site was used to instrument 610-m-deep boreholes drilled to the bed as part of the Subglacial Access and Fast Ice research Experiment (SAFIRE). With internal and basal reflector ranges captured at high spatial (millimetre) and temporal (hourly) resolutions, we obtained a unique, 6-month-long time series of ice deformation and basal melting coincident with englacial and subglacial borehole measurements. Here, we report sustained basal melting of 3 m/year during winter, and maxima of 20 m/year during summer when basal motion is enhanced by surface water delivered to the bed. The lower, but more constant rate of winter basal melting is likely to be driven by frictional heat generated from basal sliding. These discoveries indicate that basal melting beneath Greenland's fast flowing outlet glaciers is considerably higher than basal melting reported from Antarctic ice streams. We hypothesise that the basal production of meltwater in Greenland comprises an important, but so far overlooked freshwater flux to the ocean.