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Controls on seasonal variations in iceberg calving at a large Greenlandic tidewater glacier, inferred from time-lapse photography

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The successful prediction of the response of the Greenland Ice Sheet (GrIS) to climate warming relies in part on the accurate estimation of future ice loss from tidewater glaciers. Despite being a major component of ice loss from the GrIS, the mechanisms controlling iceberg calving remain poorly understood. Understanding calving processes requires observations at sufficiently high spatial and temporal resolutions to isolate the critical and potentially ubiquitous controls on calving that will enable more accurate modelling of both past and future glacier dynamics.

Here we present high-resolution (photos every 30 minutes) time-lapse image analysis of calving activity and meltwater plume presence at Kangiata Nunaata Sermia (KNS), southwest Greenland during the 2017 summer melt season (May-Oct) which we analyse in conjunction with satellite-derived ice velocity estimates and modeled estimates of subglacial discharge. Our results suggest that iceberg calving at KNS is likely dominated by variations in runoff and, by extension, the subglacial hydrological system. Early in the melt season, we infer a distributed subglacial hydrological network that promotes widespread submarine melting and terminus undercutting, which subsequently enhances terminus-wide calving and ice loss. Later in the melt season, we suggest an evolution to a channelized subglacial system, due to the observation of meltwater plumes at the fjord surface signalling more focussed emergence of subglacial water. This switch coincides with a reduction in iceberg calving and a transition to a more complex terminus geometry with embayments coincident with the location of meltwater plumes. These observations are indicative of localised preferential melting of the terminus but most importantly, a reduced impact of runoff on terminus-wide calving activity. We suggest that seasonal variations in both runoff volume and subglacial hydrology therefore exert considerable influence on calving activity at KNS. Further work is needed to constrain the influence of runoff and subglacial hydrology on ice loss from tidewater glaciers at an ice-sheet wide scale.