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Millimetre-wave radar observations of glacier calving at Hansbreen (Svalbard) correlated with TLS, time-lapse camera images and seismic records

William D. Harcourt et al.

The release of icebergs into the ocean through glacier calving is a major source of mass loss from tidewater glaciers across the Arctic. However, there are very few direct measurements of calving activity in Svalbard at daily to sub-daily resolution which impedes our understanding of how these processes influence ice discharge and therefore regional patterns of mass balance. Quantifying ice loss from Svalbard is important because the archipelago contains ~10% of the total Arctic glacier area and holds a sea-level equivalent of ~1.5 cm. In this contribution, we generate an 8-day time series from August 2021 of calving activity at sub-daily resolution for the Hansbreen tidewater glacier in Svalbard using a suite of state-of-the-art remote sensing instruments. Millimetre-wave radar at 94 GHz (called AVTIS2) was used to map the 3D structure of the Hansbreen frontal ice cliff, so that terminus change could be tracked and the volume of ice released through calving quantified. Millimetre-wave radar can map glacier surfaces at high angular resolution and through most weather conditions, hence is not impeded by poor weather conditions unlike instruments such as Terrestrial Laser Scanners (TLS). AVTIS2 mechanically scans across the scene of interest, measures radar backscatter along each Line of Sight (LoS) and generates 3D point clouds by calculating the range to maximum received power along each LoS. In this study, an angular area of 83° (azimuth) x 5° (elevation) was scanned which ensured the entire marine-terminating portions of the ice front were measured throughout the study period. The 3D AVTIS2 point clouds were validated using a coincident survey from a TLS (Riegl LPM-321) and a time-lapse camera deployed at the same location to provide additional validation and knowledge of environmental conditions throughout the study period. Calving events from both datasets were correlated to seismic activity recorded by two networks of geophones deployed in the vicinity of the glacier terminus. We will report on the following: (1) the calving rate of Hansbreen in August 2021, (2) the volume of ice released into the ocean through calving during the 8-day study period, (3) the capabilities of millimetre-wave radar for monitoring glacier calving fronts versus optical approaches (TLS and time-lapse camera images), and (4) calving processes at Hansbreen. This study pushes forward our understanding of frontal ablation processes in Svalbard and demonstrates new possibilities for ground-based remote sensing of ice-ocean interactions.

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