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Area-volume scaling of calving based on terrestrial laser scanning and video data

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Calving, the mechanical loss of ice from glaciers and ice shelves is the largest component of ablation. Even though recently there has been an important progress in modeling of the long-term calving rates, still little is known about the volume distribution of calving at the scale of single events. One of the reasons for that is the difficulty to collect field data and thus quantify the calving processes. The long-term studies are generally based on remote sensing methods rather than direct field measurements and usually have time resolution coarser than the processes involved. Detailed quantitative observations at the timescale of single events are still missing. The method that has been among the most used is the time lapse photography as it provides data in a relatively high spatial resolution and usually up to hourly sampling interval. Nevertheless, usually it is unable to produce quantitative results as a stand-alone method. Terrestrial laser scanning (TLS) offers many advantages over other surveying techniques, among others its speed, precision, spatial resolution and range.

Calving from Air Force Glacier, Greenwich Island, Antarctica, is investigated using a combination of terrestrial laser scanning and video monitoring. In this work we present a new method of calving monitoring based on a statistical calving volume-area model calibrated with TLS and video data. Area, volume and frequency distribution of calving events was quantified over a calibration period of two weeks. A series of repeated TLS surveys of the glacier front was done in order to calculate the ice volume lost by calving over the time elapsed between individual scans. The quantitative classification into individual events was done by analysis of the video and manual delineation of calved area on a video frame taken immediately after calving took place. The measured number of pixels that a single ice-block covered on the video frame was then related to the volume change as measured by TLS. In this way, after the volume-area scaling relation was estimated over a calibration period, the size- and volume distribution of calving events can be deduced using only the video sequence.

We observed 61 calving events over a period of 21 January – 4 February 2012, of which 12 were used for the calibration of volume-area scaling. The total measured volume of calving during this period was 37520$\pm$5400 m^3, while the sum of individual event volumes calculated by volume-area scaling is 41330$\pm$11630 m^3, giving the relative error of 10$\pm$31%.