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Quantification of Glacier Frontal Ablation through Passive Seismic Monitoring at Kronebreen, Svalbard

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Global glaciers and ice caps loose mass through calving, while existing models are currently not equipped to realistically predict dynamic ice loss. This is mainly because long-term continuous calving records with high temporal resolution do not exist, that would help to better understand fine scale processes and key climatic-dynamic feedbacks between calving, climate, terminus evolution and marine conditions. Combined passive seismic/acoustic strategies are the only technique able to capture rapid calving events continuously, independent of daylight or meteorological conditions. We have produced such a continuous calving record for Kronebreen, a tidewater glacier in Svalbard, using data from permanent seismic stations between 2001 and 2015. Efforts are undertaken currently to not only detect calving, but also to quantify the ice loss directly from seismic data. Independent calibration data is required to derive 1) a realistic estimation of the dynamic ice loss unobserved due to seismic noise and 2) a robust scaling of seismic calving signals to ice volumes. Here, we use the seismic calving record at Kronebreen and independently, directly observed calving flux in a first attempt to quantify ice loss directly from seismic data. The direct observations are frontal ablation rates with weekly to monthly resolution derived from satellite remote sensing data between 2007 and 2013. We derive and discuss a statistical model that allows to model frontal ablation from seismic calving detections and, to take into account the varying detection threshold, indicators of the seismic noise level. This allows for the first time to estimate a time series of calving volumes more than one decade back in time (2001-2015). Improving our model requires to incorporate more precise, high-resolution calibration data. A new field campaign will therefore combine innovative, multi-disciplinary monitoring techniques to measure calving ice volumes and dynamic ice-ocean interactions simultaneously with terrestrial radar scanning and a temporary seismic/underwater-acoustic network. We also compare and discuss the relation between seismic and underwater-acoustic calving signals. Our data set from Kronebreen shows that both monitoring methods are sensitive in different frequency bands which allows to study and better understand the calving process and different types of calving.