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A Comparison of Seismic Records of Calving Glaciers

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Glacier calving is a key process in the cryosphere's contribution to sea level rise. It is responsible for virtually all of Antarctica's ice mass loss to the ocean and about half of Greenland's negative mass balance. As glacier calving is a highly complicated and variable phenomenon, its physical laws are poorly understood. For this reason "dynamical mass loss" is one of the critical mechanisms that have yet to be incorporated into large-scale ice sheet models that aim to predict future sea level variations. As calving environments are almost always difficult to access, data pertaining to calving processes are usually gathered remotely. Seismometers have recently proven to be a valuable tool for studying calving, even though they may be located far away from the calving front. Pre-existing global and regional seismic networks thus constitute a valuable resource for the study of glacier calving as they allow for automatic detection and monitoring of calving activity.

Various sources occurring nearly simultaneously give rise to calving seismicity. Potential source mechanisms include fracturing, hydraulic transients, glacier acceleration, ocean wave action, and icebergs scraping the fjord walls, bottom, or terminus. Fracturing and hydraulic transients emit seismic energy above 1 Hz and are only recorded locally, whereas glacier acceleration, iceberg scraping, and ocean waves may produce waveforms with periods of 100's or 1000's of seconds and can be recorded by far-field seismometers. We present examples of such low-frequency seismicity from Jakobshavn Isbrae, Greenland, and Columbia and Yahtse Glaciers, Alaska. Finally, we discuss the possibility of remotely investigating calving behavior by comparing the seismic signature of individual calving events from different glaciological settings.