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Subglacial Controls on the Short Term Dynamics at the Margin of the Greenland Ice Sheet: Seismic Experiments

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A critical gap in our current understanding of glaciers and ice sheets is how high sub-glacial water pressure controls the coupling of the glacier to its bed. Some models predict that the Greenland Ice Sheet (GrIS) will lose ice in an accelerated manner through a feedback effect: High melt rates at the surface provide melt water which is routed through the sub-glacial drainage system and reduces basal friction, leading to high ice flow velocities and accelerated surface draw-down. This effect might induce a rapid decay of the ice sheet, and consequently produce rising global sea levels. Processes at the base of an ice sheet are inherently difficult to investigate due to their remoteness. Investigation of the sub-glacial environment with passive seismic methods is an innovative, rapidly growing interdisciplinary and promising field. In combination with observations of surface motion, ice deformation and basal water pressure, seismic measurements are ideally suited to localise and quantify frictional and fracture processes occuring during periods of rapidly fluctuating sub-glacial water pressure with consequent stress redistribution at the contact interface between ice and bed.

From June to August 2011 we plan to deploy a dense seismic network of surface and borehole seismometers in order to monitor seismic activity and change in seismic velocities over a $\sim$1km3 portion of the GrIS, near the SwissCamp site $\sim$70km West of Ilulissat. The seismic field campaign will be accompanied by a co-located glaciology field campaign to measure water pressure, ice deformation, and basel motion. In this presentation we introduce the scientific goals of the projects and the design of the observational network. The seismic component of the network will consist of 14 near-surface seismometers (Lennartz LE-3D 1s and Nanometrics Trillium Compact sensors). To reduce the effect of tilt due to ablation the majority of these seismometers will be installed in one meter deep shafts that will be covered with white blankets. This type of installation has been successfully used in similar experiments on mountain glaciers in the Alps. Three sites will consist of shallow borehole seismometers (2-3 meter deep), which will be retrieved at the end of the field campaign. This near-surface network will be augmented by three deep, irretrievable borehole seismometers (150-300 m deep; Geospace GS-11D 8 Hz sensors). Data will be recorded on Nanometrics Taurus digitizers at high sampling frequencies (250-500 Hz). We will use a new generation of Li-ion Polymer batteries charged by solar panels as a power supply for the instruments. Layout of the network will be optimized to allow for high-precision hypocenter locations of icequakes and for seismic noise analysis. Aperture of the array will be 400-600 m, which corresponds to the ice sheet thickness at the study site.