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Observing transient subglacial conditions with passive seismic observations

J.P. Winberry (1), S. Anandakrishnan (2), and R.B. Alley (2)

(1) Central Washington University, Geological Sciences, Ellensburg, United States (winberry@geology.cwu.edu), (2) Penn State University, Geosciences, University Park, United States

Discharge from Earth's large ice sheets is dominated by ice streams and outlet glaciers. Basal motion, either sliding or till deformation, often accounts for greater than 90 percent of an ice stream's velocity. However, recent observations have shown that the physical conditions that permit this rapid motion are transient in both space and time. We present results from a 12 station passive seismic network with 1 km station spacing that operated for six weeks near the grounding line of MacAyeal Ice Stream (formerly Ice Stream E). We will focus on two classes of seismic events that document spatial and temporal variability in subglacial conditions. The first class of events are long duration (greater than ten minutes) harmonic tremors. These events are characterized by the nearly monochromatic arrival of 3 Hz energy and the slow migration of source location during the course of the tremor. We hypothesize that these events document the drainage and migration of subglacial water between two small subglacial ponds. The second class of events are small basal icequakes similar to those observed on other West Antarctic ice streams that likely originate from regions of enhanced basal shear stress. During the experiment isolated locations at the bed nucleated thousands of events. However, the temporal activity from a single location is irregular, suggesting variable basal conditions. We will present maps showing the spatial and temporal variability of icequake activity. Our results highlight the utility of passive seismic observations for studying the subglacial environment.