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Icequake source location using seismic data in Dålk Glacier, East Antarctica

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Icequakes are closely associated with glacier movement and rupture, and their temporal and spatial distribution patterns can portray the dynamics of glaciers. In this study, we used the seismic data recorded by 34 short-period Smartsolo seismometers deployed in Dålk Glacier, East Antarctica for about 60 days to detect and locate icequakes. The array was deployed at the edge of the Dålk Glacier and across the grounding line previously generated by satellite observations. The recorded data were strongly affected by Antarctica storms and we selected two days with little wind noise for preliminary analysis. Using time-frequency analysis and particle motion, we found that the seismic events are either dominated by body waves or surface waves, which likely correspond to deep icequakes or near-surface crevasse icequakes. Since the propagation of surface waves is easier to analyze and possible detections of crevasse icequakes are more likely to be verified from satellite images, we chose to focus on surface wave signals in this preliminary analysis. We first filtered records to 5-20 Hz and manually examined records with clear surface wave arrivals. We then produced templates using these events to scan through our records. We successfully identified 89 events within the two-day period. Lastly, these signals were located using a grid-search approach for their latitudes and longitudes, together with an average group velocity for each event. Nearly half of the incidents were concentrated on the edges of rock outcrops, which suggests they were generated by the relative movement between the glacier and outcrops. The other half of the events was found in the eastern region, where a large number of surface crevasses were observed on satellite imagery. In addition, the optimal velocity from the grid search is ~2.8 km/s for events from the North and West, while the optimal velocity for events from the East is ~1.8 km/s. The difference in wave velocity suggests the existence of a boundary between rock and ice at a depth of about 100-150m within or near our seismometer array. By analyzing the amplitude variations of incidents in different directions recorded at various stations, we observed that this boundary is within our array and its location and geometry can be estimated. Compared to the grounding line predicted from satellite observations, our result shows that the boundary is offset to the East by ~100 m. The reason for this discrepancy will be further discussed in the meeting.