Event Relations and Sources of Icequakes at the Grounding Line of Rutford Ice Stream, West Antarctica

Ian Lee (1), Sridhar Anandakrishnan (1), Richard B. Alley (1), Alex M. Brisbourne (2), and Andrew M. Smith (2)
(1) Pennsylvania State University, Department of Geosciences, University Park, PA, USA (2) British Antarctic Survey, Natural Environment Research Council, Cambridge, UK

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Introduction

- One shortcoming of numerical glacier flow models used to quantify Antarctica's future contribution to global mean sea level rise is the poor modeling of the sliding process.
- Due to lack of detailed bed information.
- Basal microseisms, or icequakes, that are generated at the bottom of glaciers as the ice flows over the bed can grant us valuable insights about features and deformation processes that occur at the bed.

Research Site – Rutford Ice Stream

- We installed several seismic arrays during the 2018 – 2019 austral summer, including one located close to the grounding line.

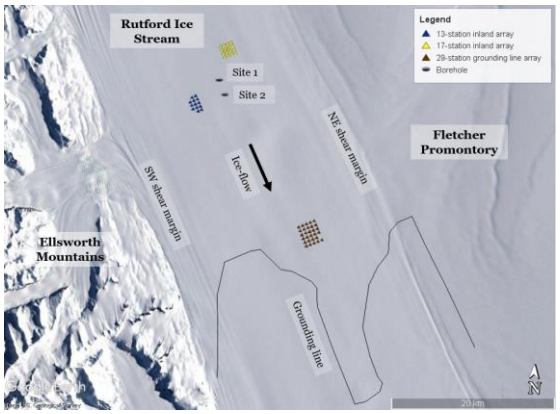

Figure 1. Rutford Ice Stream research site with labeled seismic arrays and drill sites, as part of the British Antarctic Survey (BAS)'s BEAMISH Project. The Rutford Ice Stream is situated in the West Antarctic Ice Sheet (WAIS) and drains into the Ronne Ice Shelf.

Repeating Signals

- We detected multiple groups of highly consistent repeating signals in our 3-month record.

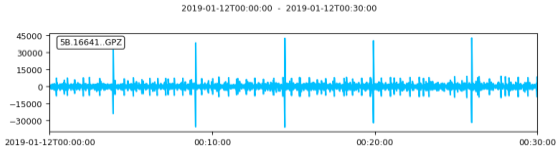

Figure 2. Station vertical (GPZ) trace showing a ~5 min repeating signal among the many smaller repeating signals.

Event Location

- Located icequakes (or events) using QuakeMigrate, which detects and locates earthquake by utilizing a waveform migration and stacking algorithm.
- Relocated events using HypoDD, which uses the double-difference earthquake location algorithm of Waldhauser & Ellsworth (2000).

Physical Significance

- A group of repeating signals located at the same source suggests sticky spot(s), localized regions of high basal drag (Alley, 1993) with stick-slip sliding.
- Ice stream basal shear stresses are largely supported on sticky spots (Anandakrishnan and Alley, 1994).
- Temporal and spatial event relations grant us insights into the sliding process on ice streams.

Event Clustering

- Performed density-based spatial clustering of applications with noise (DBSCAN) of events.

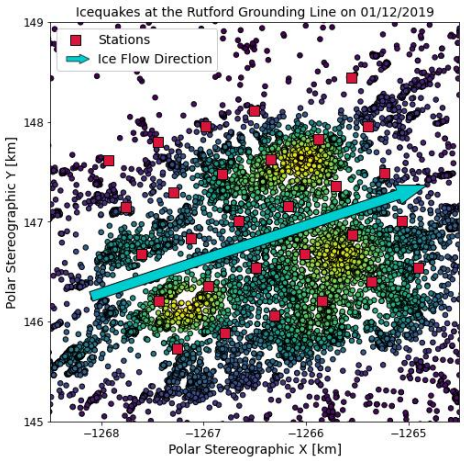

Figure 3. ~33,000 located icequakes at the Rutford grounding line over a 24-hour period. Lighter colors indicate higher event density and is derived from a kernel-density estimate using Gaussian kernels.

Results (In Progress)

- Three end-member bed deformation types (Kufner et al., 2021).
- Cluster inter-event times reflect event load and slip, and sticky spot dimensions.
- Detected teleseisms and crevasse formation.

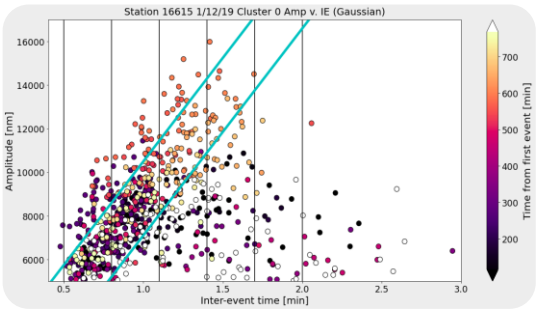

Figure 4. Plot of event amplitude against inter-event time. Two teal lines are plotted to illustrate slope fit to the data.

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