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S-wave velocity profile of an Antarctic ice stream firn layer with ambient seismic recording using Distributed Acoustic Sensing

Wen Zhou[1], Antony Butcher[1], J. Michael Kendall[2], Sofia-Katerina Kufner[3], and Alex Brisbourne[3]
[1]School of Earth Sciences, University of Bristol, Bristol, UK (wz18709@bristol.ac.uk)
[2]Department of Earth Sciences, University of Oxford, Oxford, UK
[3]British Antarctic Survey, Cambridge, UK

Measurements of the seismic properties of Antarctic ice streams are critical for constraining glacier dynamics and future sea-level rise contributions. In 2020, passive seismic data were acquired at the Rutford Ice Stream, West Antarctica, with the aim of imaging the near-surface firn layer. A DAS (distributed acoustic sensing) interrogator and 1 km of optic fibre were supplemented by 3-component geophones. Taking advantage of transient seismic energy from a petrol generator and seismicity near the ice stream shear margin (10s of km away from the DAS array), which dominated the ambient seismic noise field, we retrieve Rayleigh wave signals from 3 to 50 Hz. The extracted dispersion curve for a linear fibre array shows excellent agreement with an active seismic surface wave survey (Multichannel Analysis of Surface Waves) but with lower frequency content. We invert the dispersion curves for a 1D S-wave velocity profile through the firn layer, which shows good agreement with the previously acquired seismic refraction survey. Using a triangular-array geometry we repeat the procedure and find no evidence of seismic anisotropy at our study site. Our study presents challenges and solutions for processing noisy but densely sampled DAS data, for noise interferometry and imaging.