

Ambient Seismic Recordings and Distributed Acoustic Sensing (DAS): Imaging the firn layer on Rutford Ice Stream, Antarctica

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Introduction

A comparison of noise interferometry and frequency-wavenumber (f-k) domain stacking is provided in Text S1 and Figure S1. DAS noise from 0.01 to 1 Hz is shown in Figure S2. f-k transform of cross-correlations in Figure S3. Variations of dispersions curves in Figure S4. Located shear margin seismic events using the geophone array in Figure S5.

Text S1. Noise interferometry vs. raw data f-k transform

Both cross-correlation (CC, with spectral whitening, thus equivalent to cross coherent) and deconvolution (DC) are applied to retrieve impulse responses, with a

virtual source at a 10 m distance. As shown in Figure S1 a and b, DC suppressed the generator oscillations at 33 and 66 Hz, and produce a cleaner image, while CC preserves the oscillations. From the f-k transform in Figure S1 c and d, we also learn that DC suppresses the higher modes, and at the same time produces a less shaper fundamental mode. Frequency leakages are observed around 33 and 66 Hz, on both CC and DC f-k plots, but not for the raw data f-k transform.

Compared with noise interferometry processes, the stacked raw data f-k transform (Figure S1 e) can also be used for dispersion, as in this case study, the noise source is stable likely from the generator, and in-line with the linear fibre.

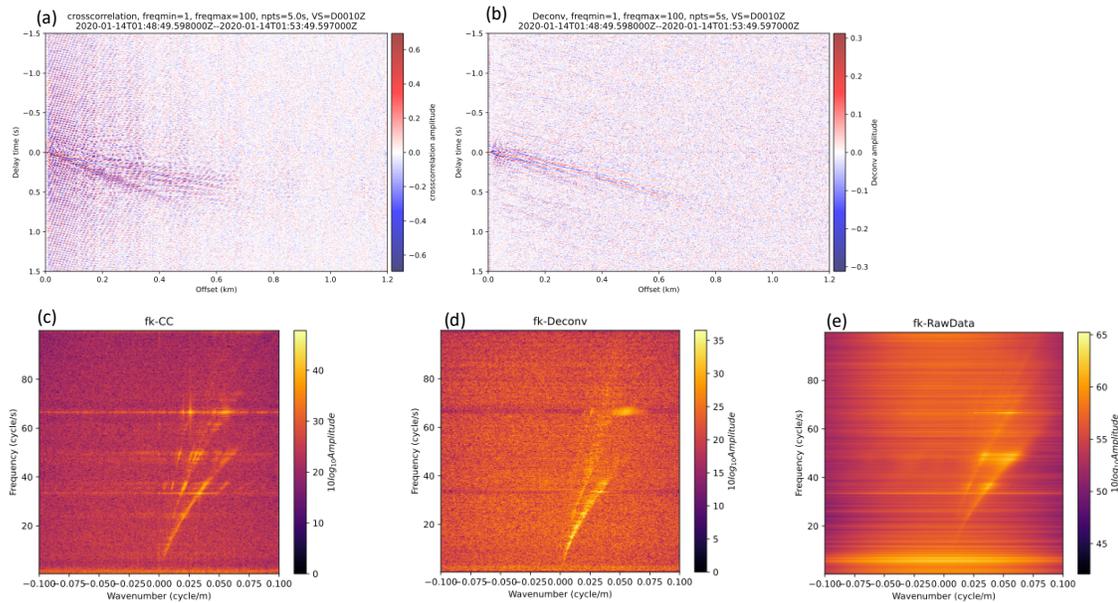


Figure S1. (a) Cross-correlation interferometry using the 200-second signal as shown in Error! Reference source not found., with a virtual source at channel 10 m. (b) Deconvolution interferometry using the same signal and virtual source, with water-level 1e-5. (c) F-K transform of the CCs. (d) F-K transform of the deconvolutions. (e) stacked F-K transform of the raw data, without interferometry processing.

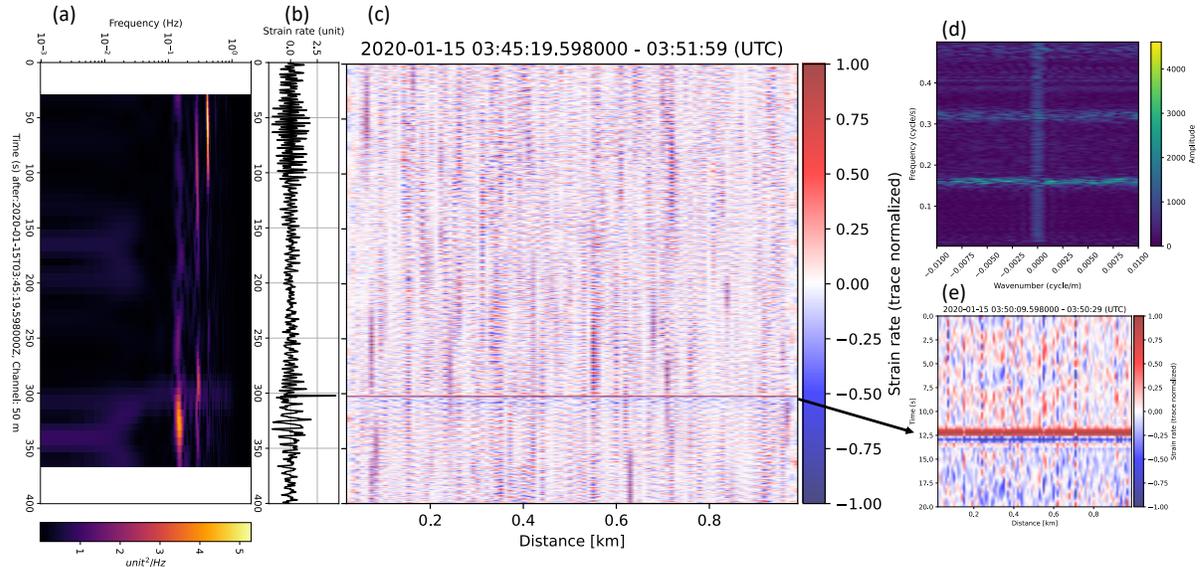


Figure S2. (c) a 400-second example of noises between 0.01 to 1 Hz. (a) spectrogram of the channel at distance of 50 m. Time series is plotted in panel (b). (d) f-k transform of (c). (e) zoom in of (c) as indicated by the arrow.

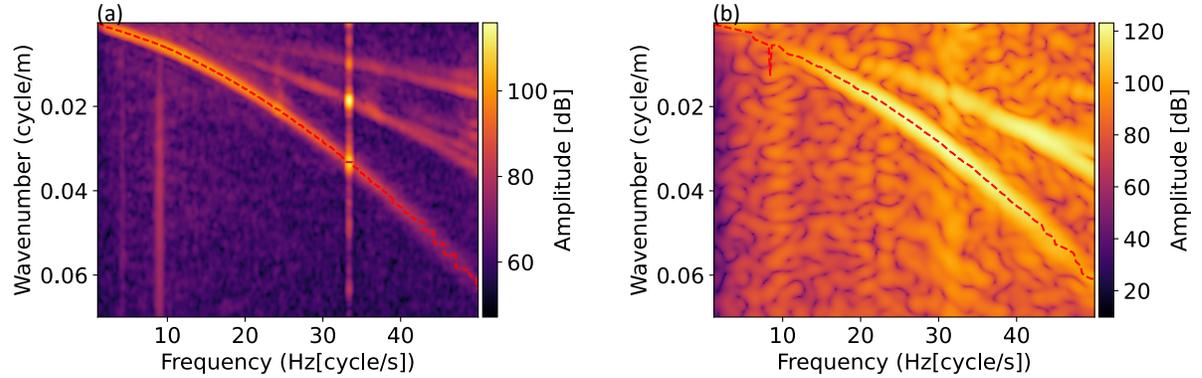


Figure S3. Plots of f-k domain amplitude spectrum. (a) f-k for selective stacked cross-correlations (CCs), with picks of fundamental mode surface wave shown by a dashed line. (b) The same as (a) but for one active shot gather.

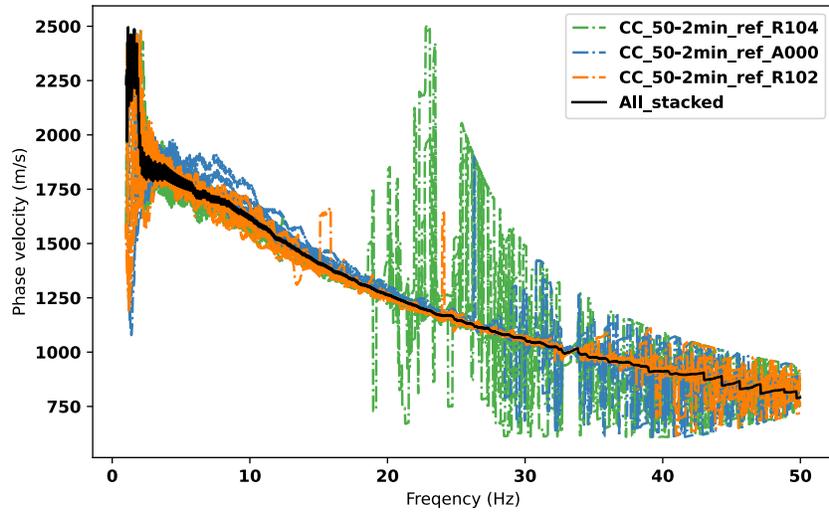


Figure S4. Variation of dispersions from all 50-2min-CC stacks, compared with the stack over all selected 2-min CCs.

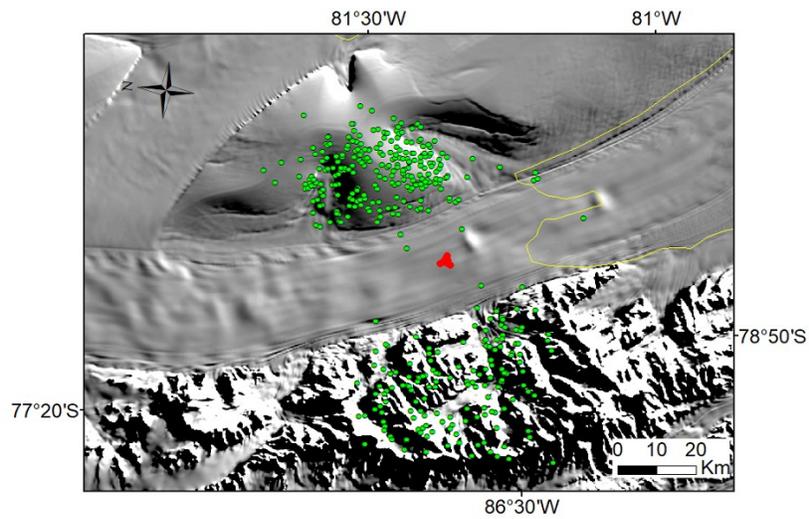


Figure S5. Localized surface wave events using the geophone array, using travel time difference obtained from waveform cross-correlation.