

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

Wen Zhou^{1,4}, Antony Butcher¹, J. Michael Kendall²,
Sofia-Katerina Kufner³, and Alex Brisbourne³

¹University of Bristol, ²University of Oxford, ³British Antarctic Survey (BAS)

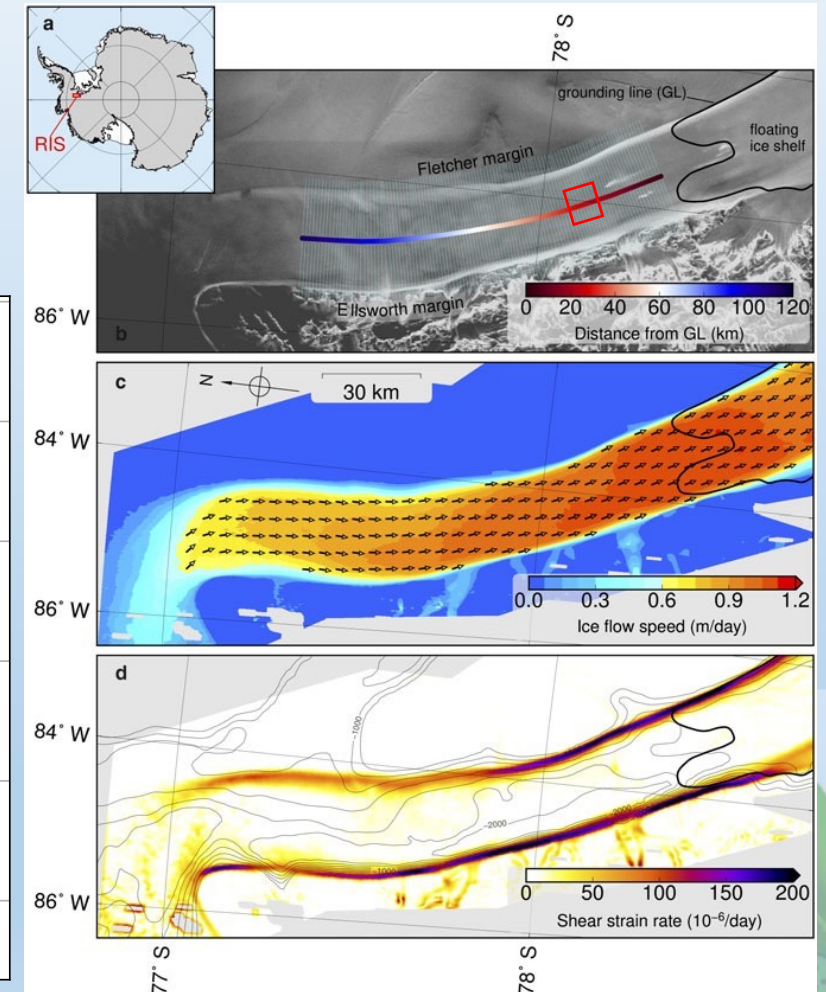
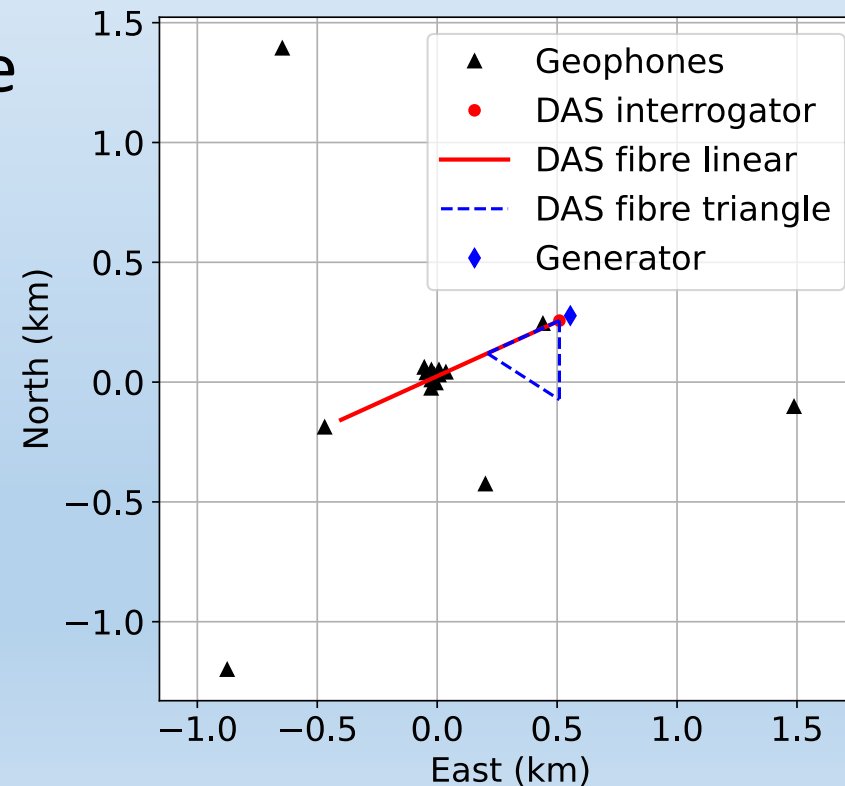
⁴Delft University of Technology



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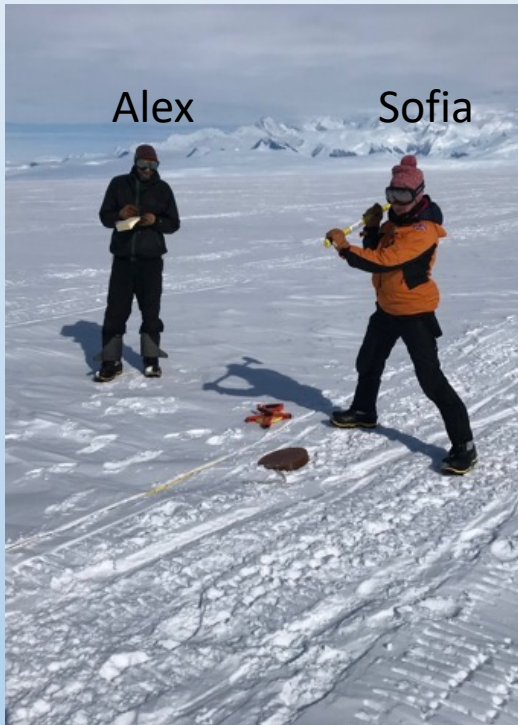
Introduction: Antarctica dataset

- Rutherford Ice Stream
- ~400 m/y flow rate
- Little topography
- DAS (linear and triangular) + geophone array



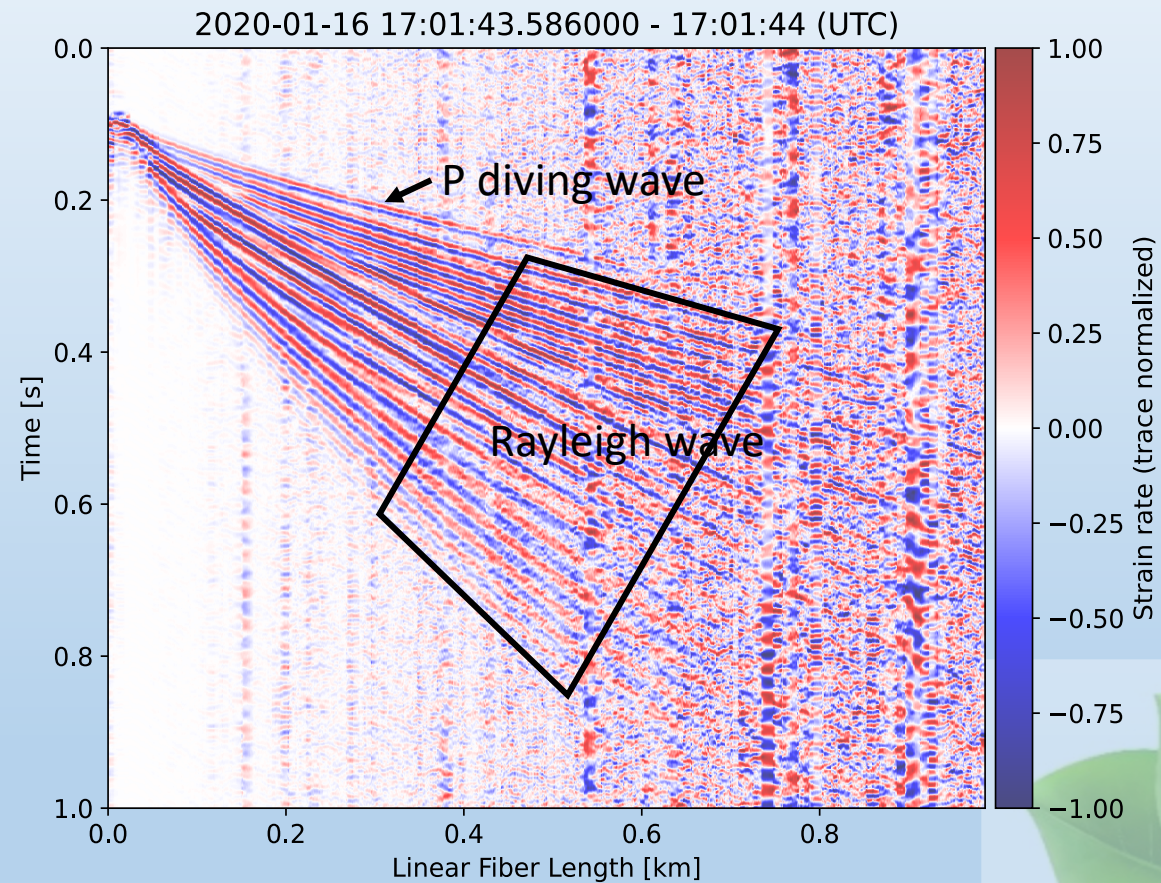
(Minchew et al, 2018)

Linear DAS + active shots at Rutford Ice Stream:

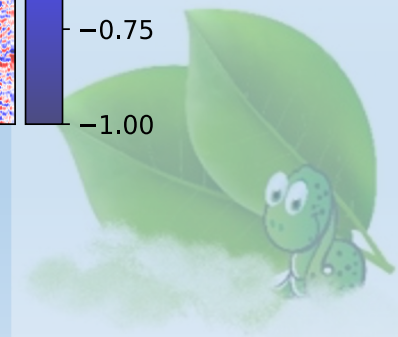


Hammer source

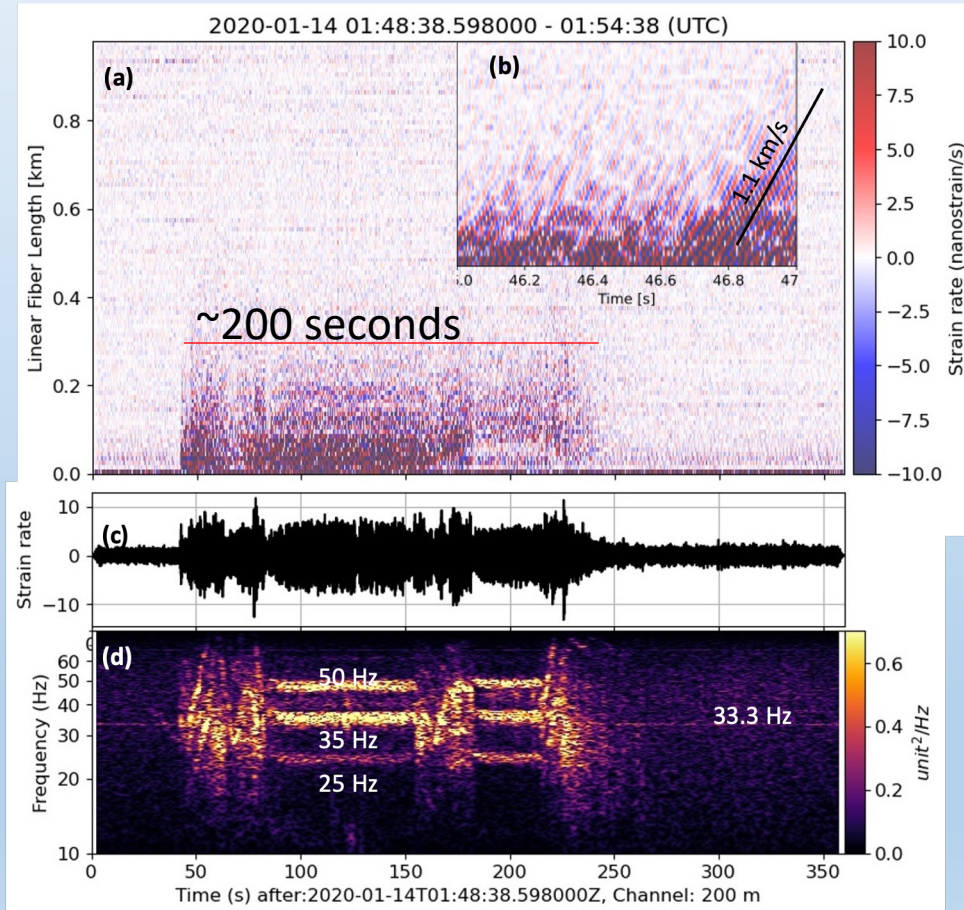
To verify the noise approach.



Shot gather



Linear DAS + passive at Rutford Ice Stream: anthropogenic noise



Anthropogenic noise

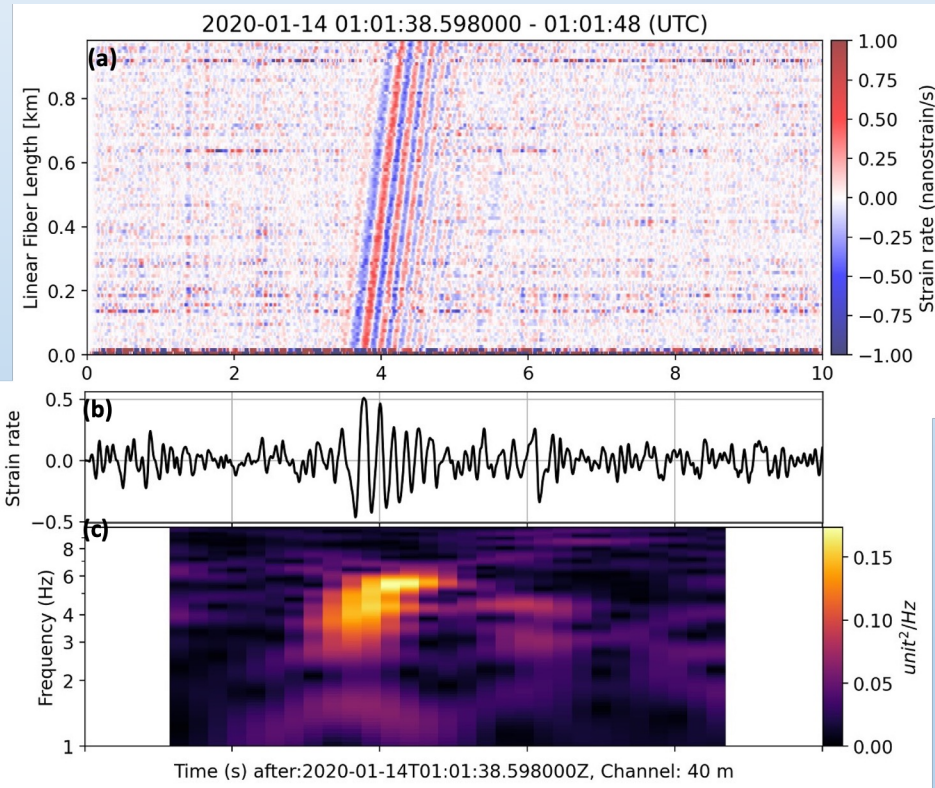
Passively recorded 5 days



Petro generator

'Traffic' noise

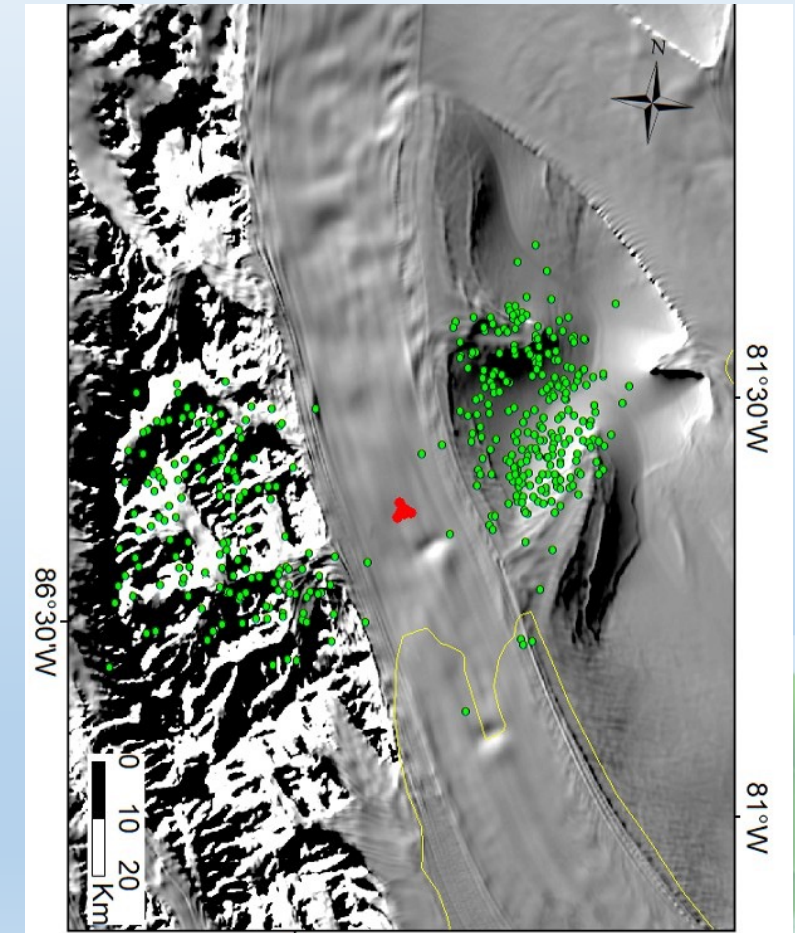
Linear DAS + passive at Rutford Ice Stream: crevassing events



Surface wave transient signal
No clear body waves
→ Shallow events



Forming of crevasses
(Julian Spergel 2017)

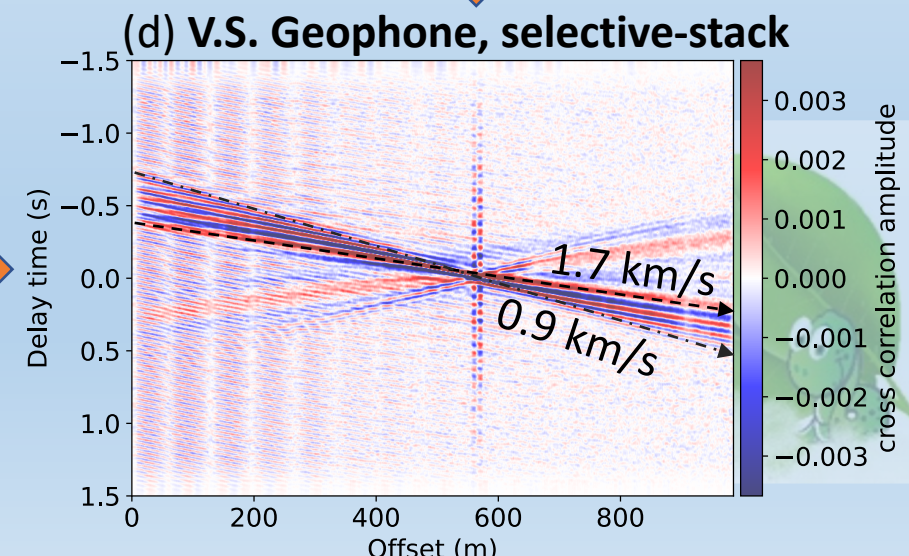
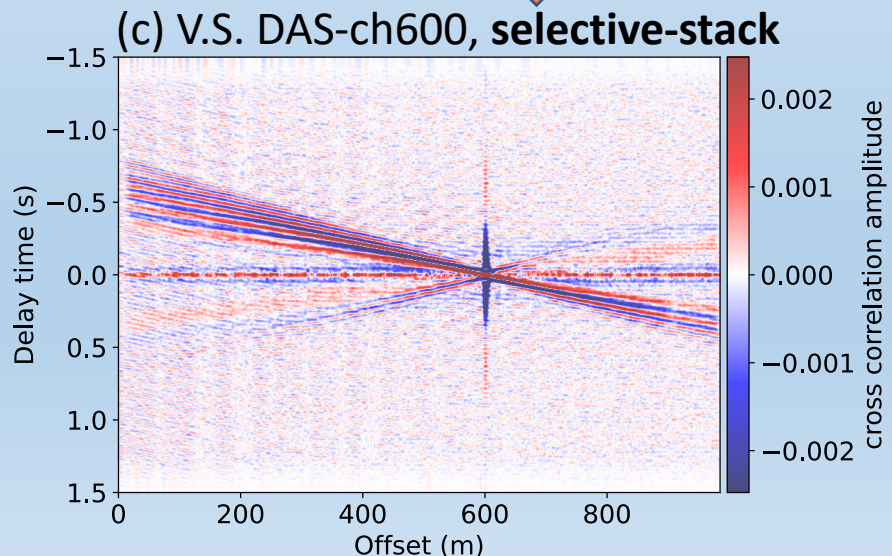
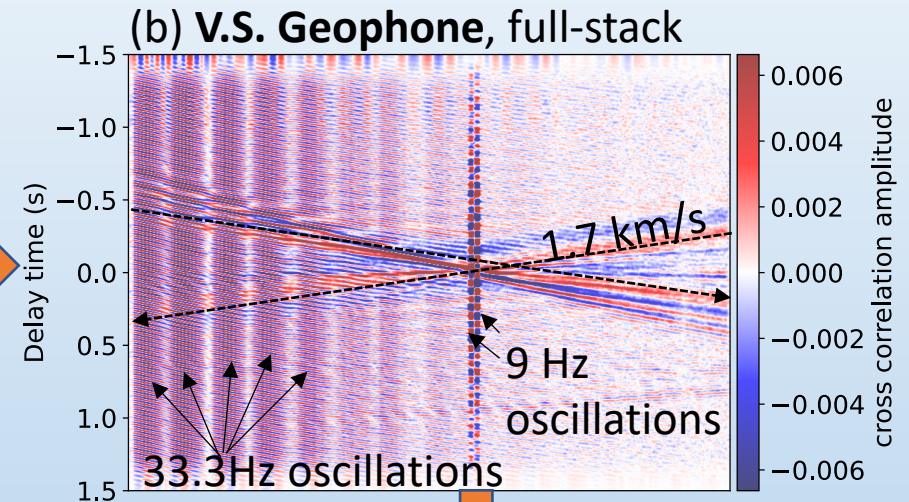
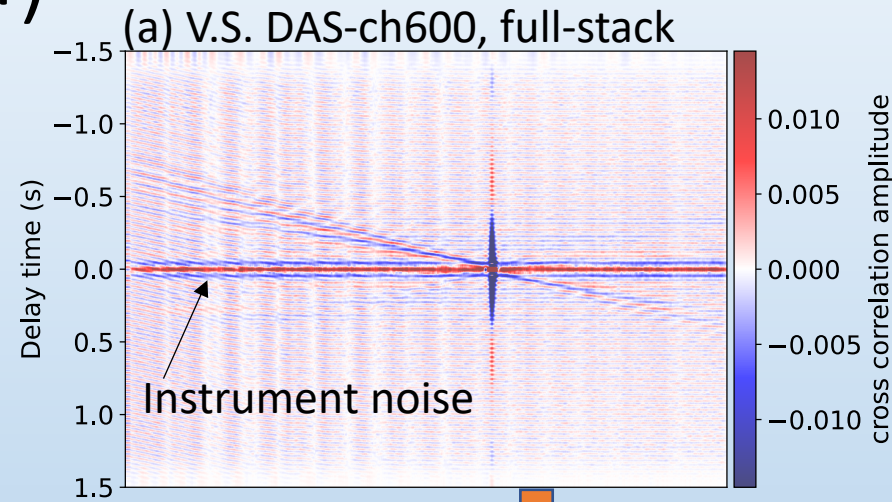


Events distribution

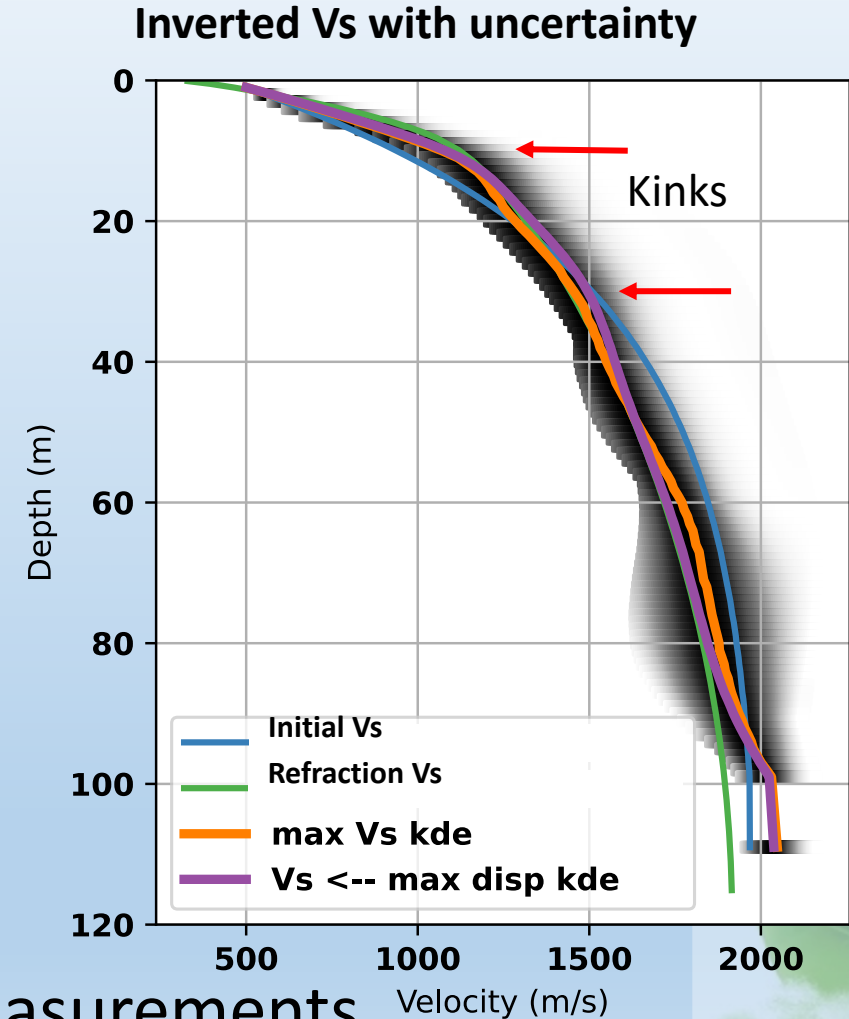
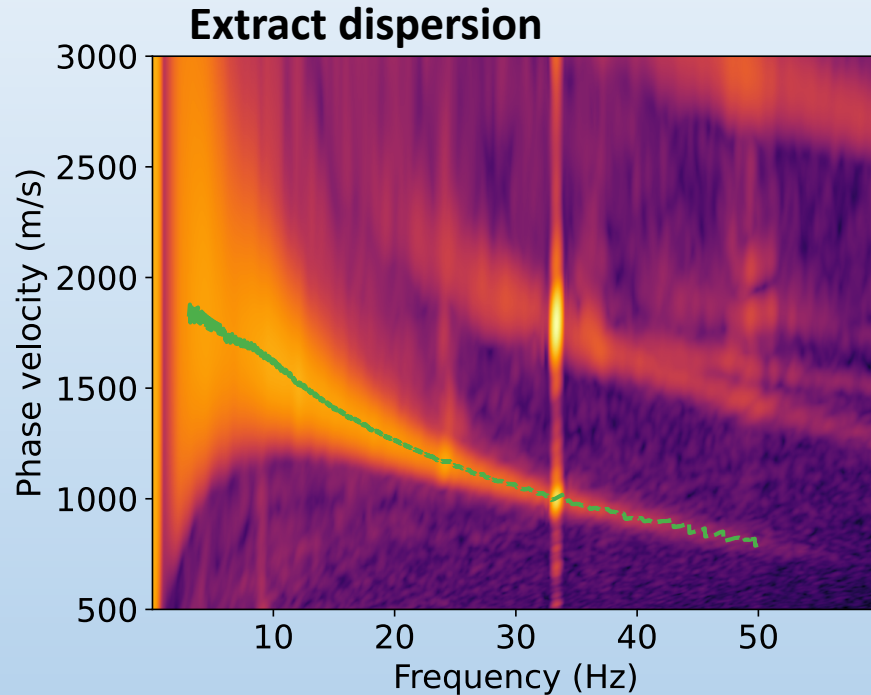
Linear DAS + Noise interferometry (cross correlation)

Using a geophone as a virtual source:
Breaks the coherent instrument noise

Selectively stack CCs:
Focus on the desirable seismic phases

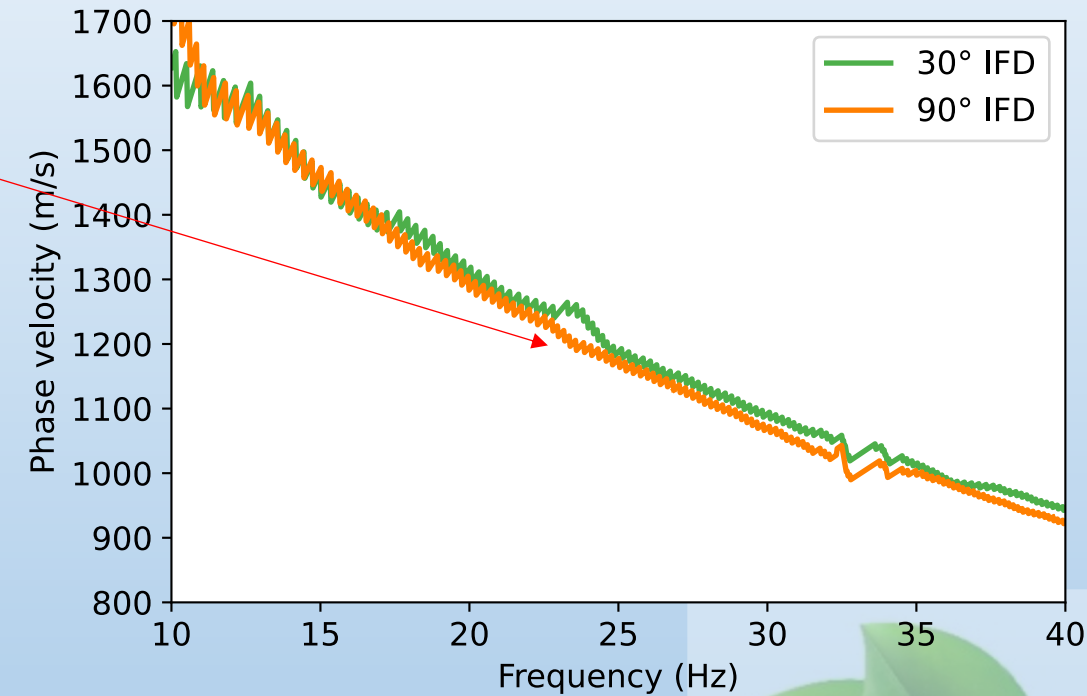
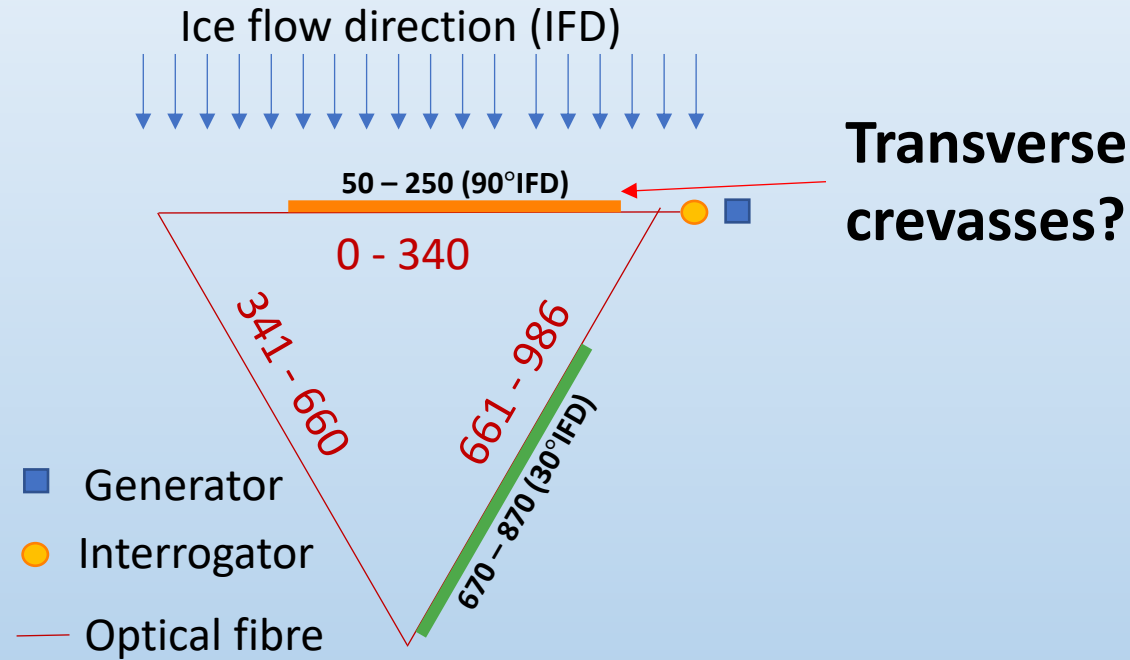


Linear DAS + Surface wave inversion

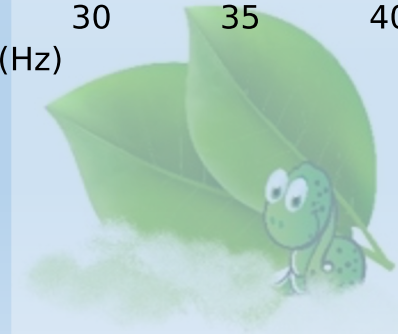


- Rayleigh 0 mode is extracted from 3 to 50 Hz
- **S velocity (V_s)** is inverted from dispersion measurements
- **Critical density changes** in the firn are visible as '**kinks**' on the V_s profile

Triangular DAS + Is the firn seismically isotropy?



- Comparing dispersion curves from two directions.
- **No signature of transverse crevasses, but maybe**
--> the forming of longitudinal crevasses? Or just apparent velocity?



Take home messages

- A high-resolution **S-wave velocity profile** can be derived from the **surface wave inversion**.
- Seismic anisotropy of firn is investigated with a triangular array, we see **no signature of transverse crevasse**.
- Cross-correlation (CC) between a geophone or a seismometer and DAS channels (**hybrid instrument CC**), improves the quality of DAS CCs.
- **Selectively stacking** CC panels improves the convergence of (DAS) CCs.

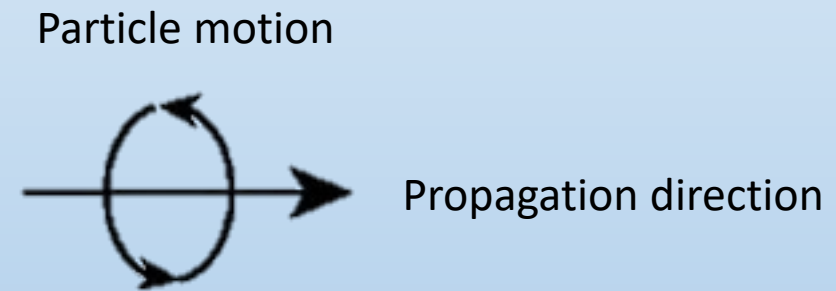
Preprint of this study:

<https://doi.org/10.1002/essoar.10510377.1>



Questions?

- Does it make sense to correlate vertical component geophone with DAS that is mainly sensitive to horizontal strain?
 - The seismic signal retrieved is dominantly **Rayleigh wave**.



- The correlation between geophone and DAS, which means between particle motion and strain, does produce a phase shift.