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Automated High-Resolution Tracking of Sea Ice Extent Offshore Oliktok Point, Alaska, using Distributed Acoustic Sensing and Machine Learning

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AGU FALL MEETING
Chicago, IL & Online Everywhere
12–16 December 2022

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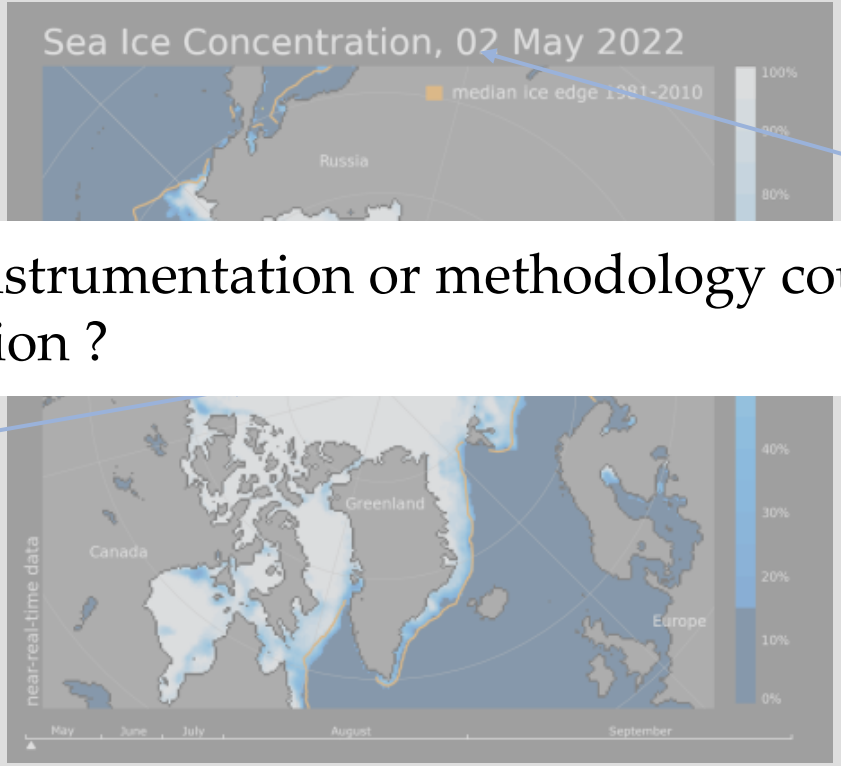
Satellites provides an estimate of ice concentration but with low resolution



Time resolution ~ days

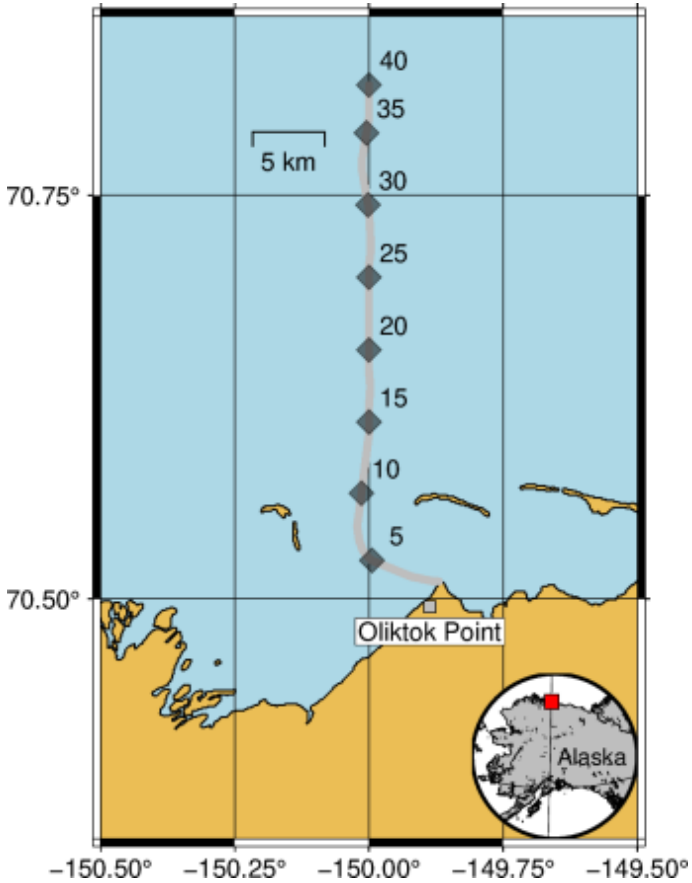
What other instrumentation or methodology could provide a better resolution ?

Spatial resolution ~ kms

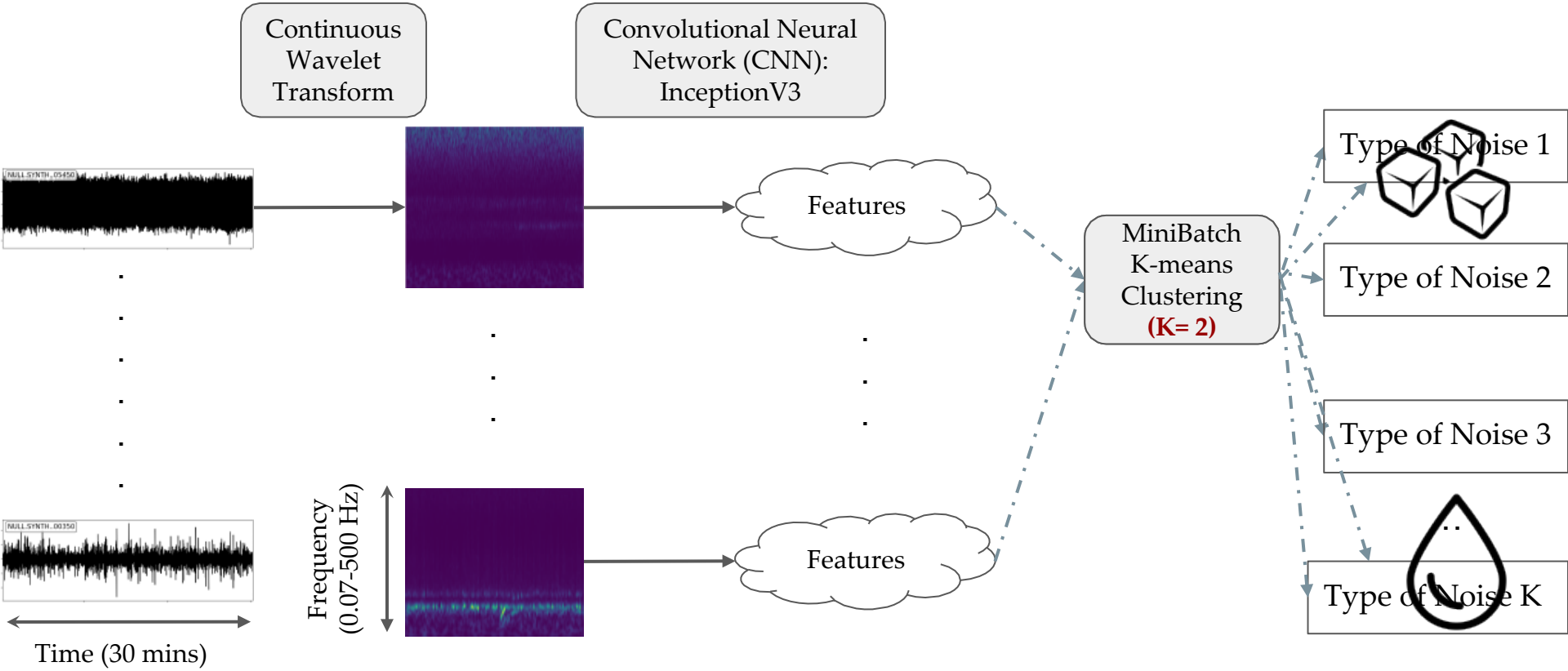
Animation from the National Snow and Ice Data Center

Distributed Acoustic Sensing (DAS) in Alaska could help to better approximate sea ice extent

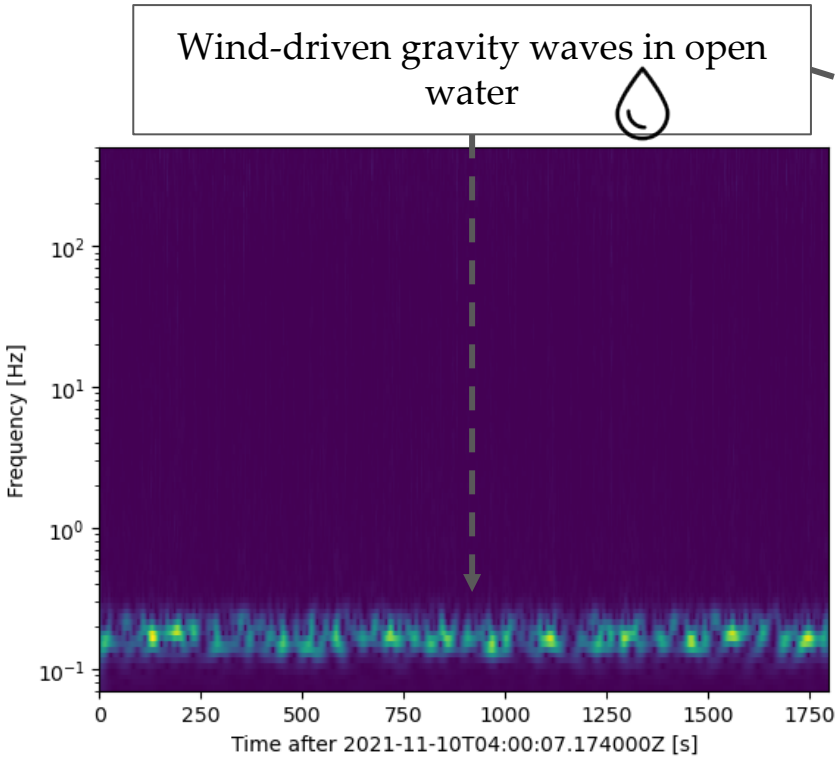
- Record out to 37 km
- Spatial resolution of ~~2~~ 200 m and gauge length of 10 m.
- Sample rate is 1000 Hz
- Two weeks of data:
  - November 2021
  - July 2021
- Data size = 4.0 TBs

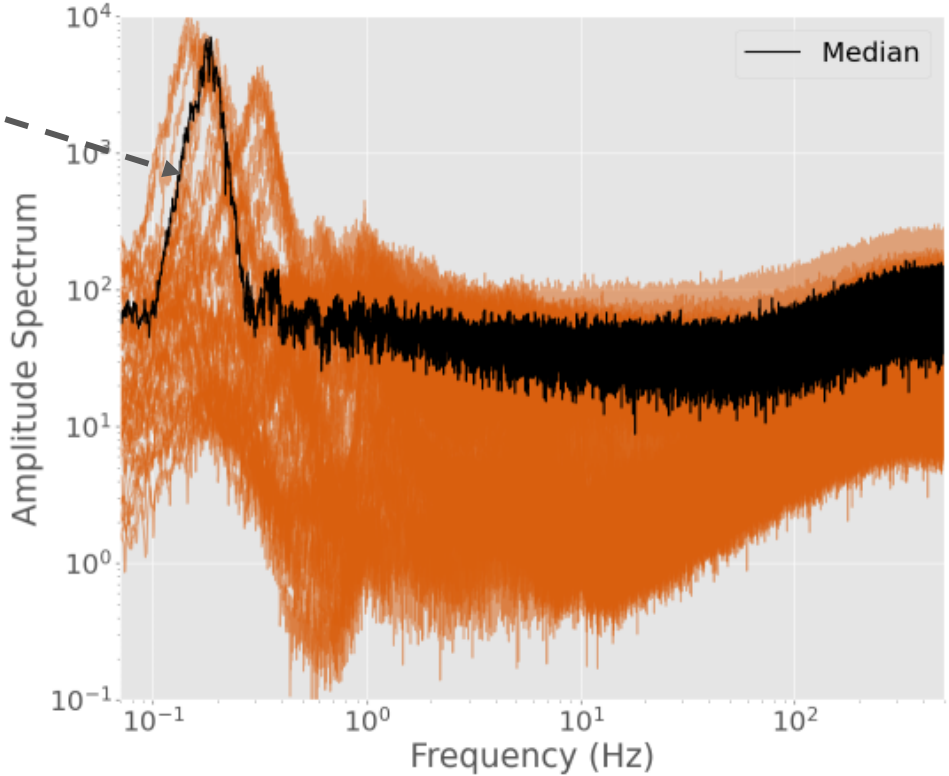


Methodology: From waveforms to clusters



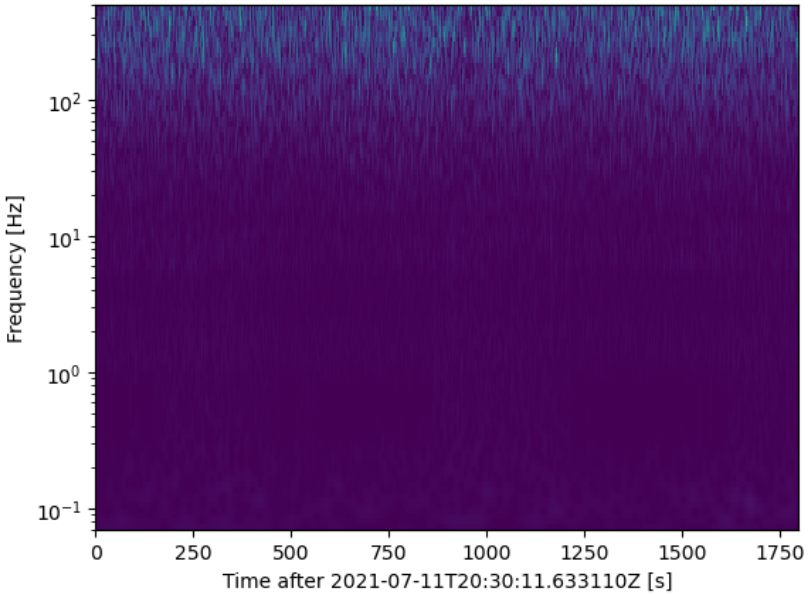
Anatomy of Cluster 1 (Water) = Energy concentrated at 0.1-0.5 Hz

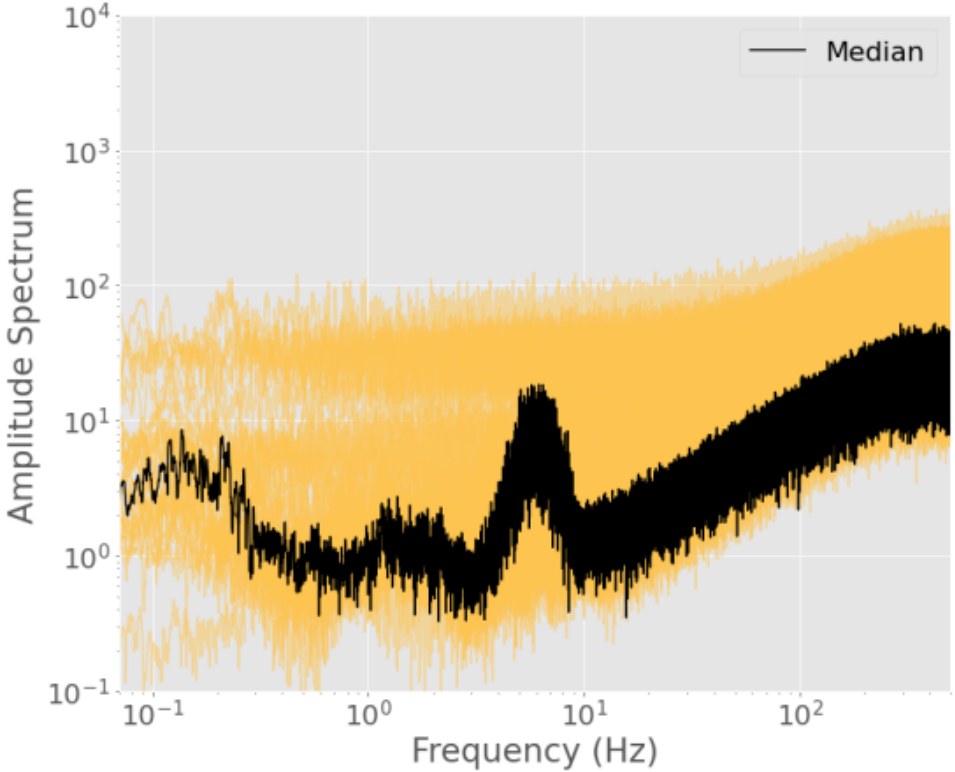




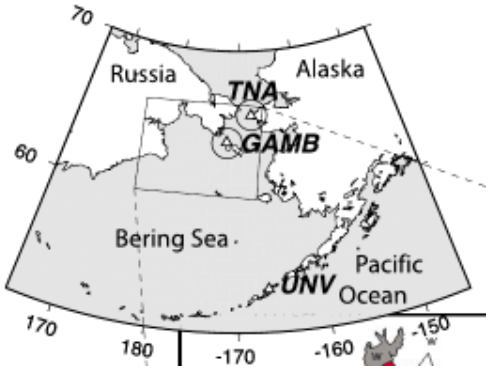
Anatomy of Cluster 2 (Ice) = Low Energy across entire spectrum and minor peak at ~ 6 Hz

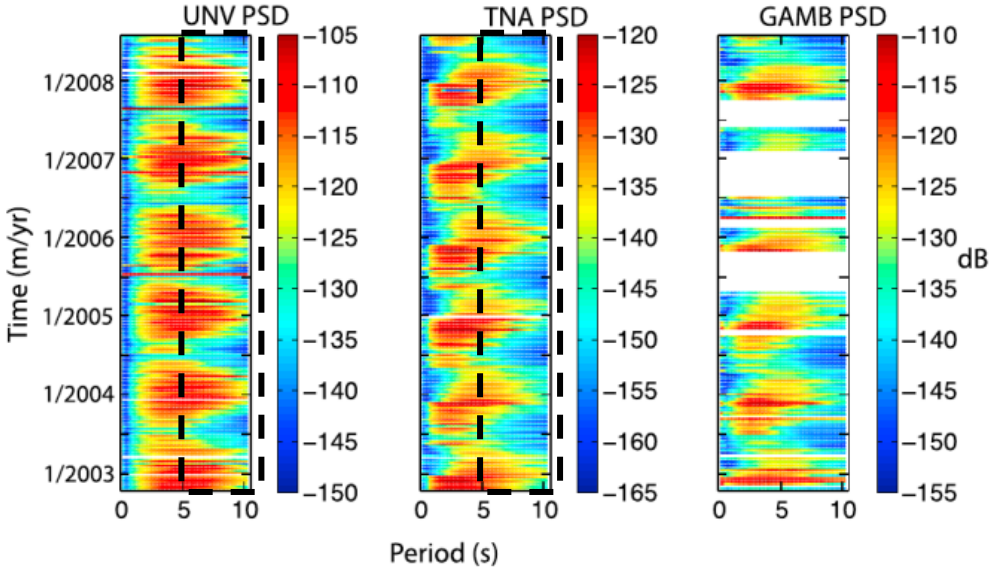
Wave energy attenuated by sea ice





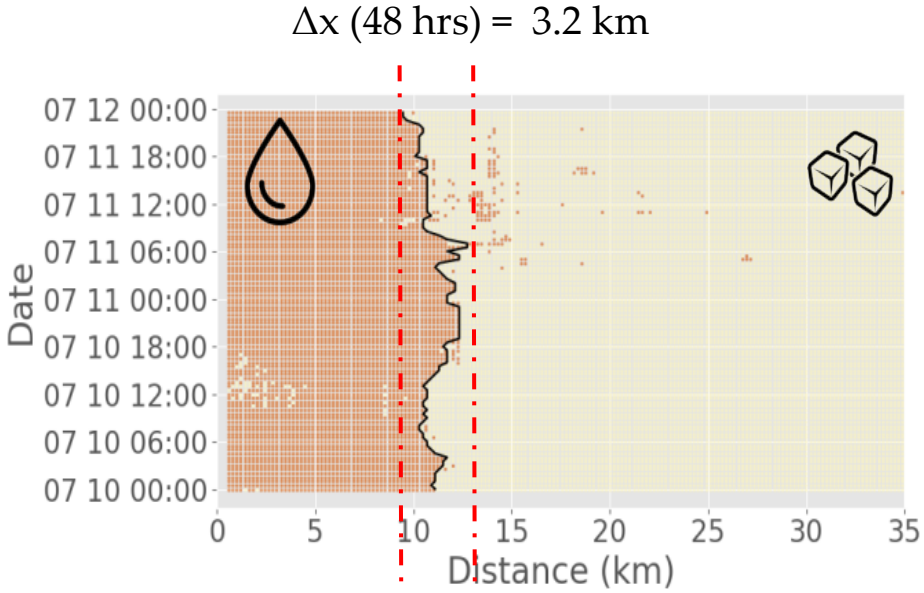
Sea Ice attenuates microseism amplitudes: Antarctica and Bering Sea (Alaska)





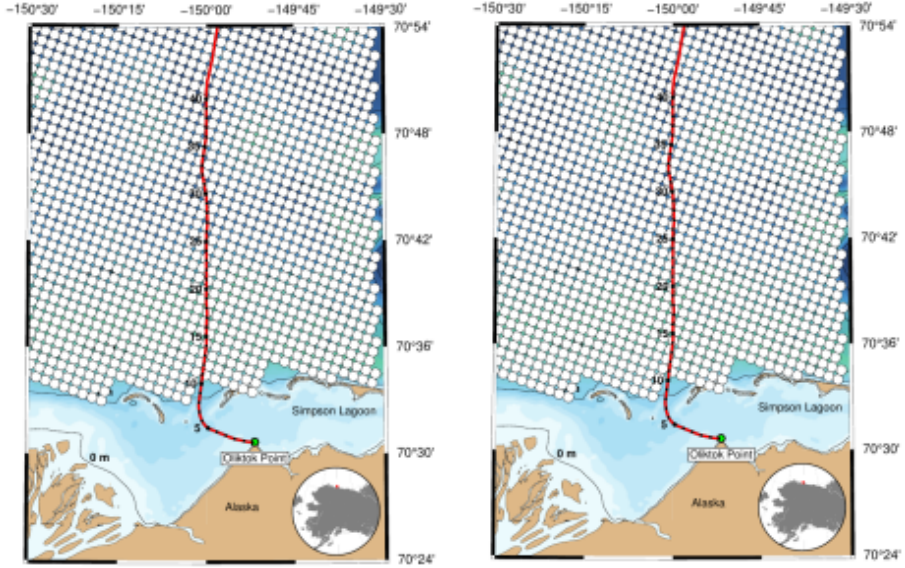
Tsai and McNamara (2011)

DAS reveals sea ice extension with higher resolution than satellites



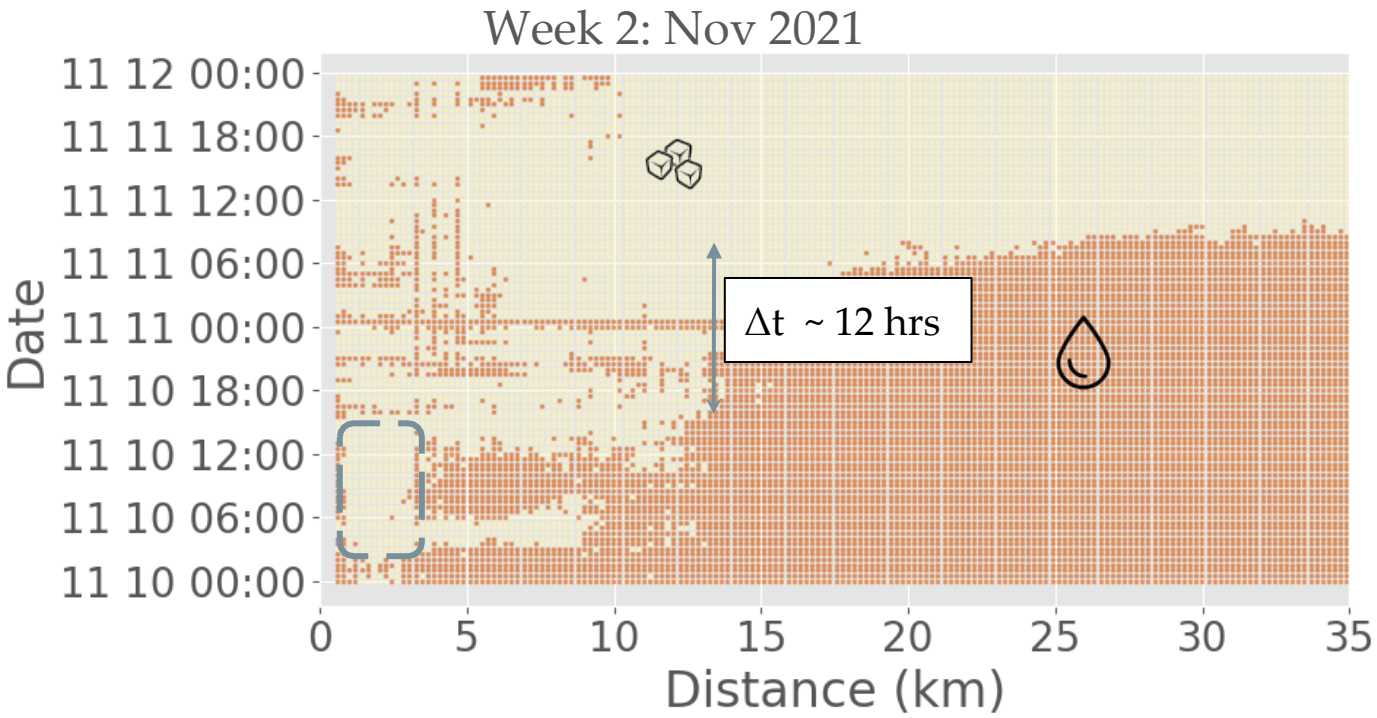
2021-Jul-10 2021-Jul-11

Δx = 0.0 km !!!

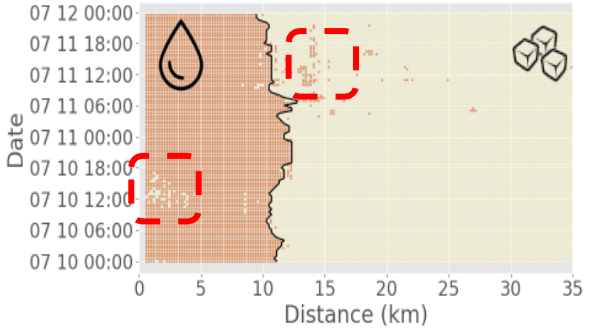


Data obtained from National Snow and Ice Data Center

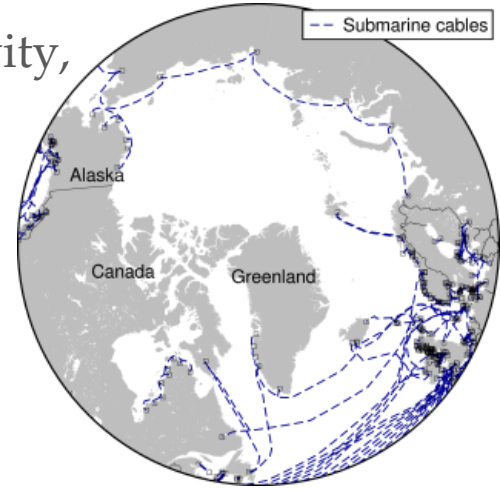
DAS reveals a rapid freezing event during 11th November

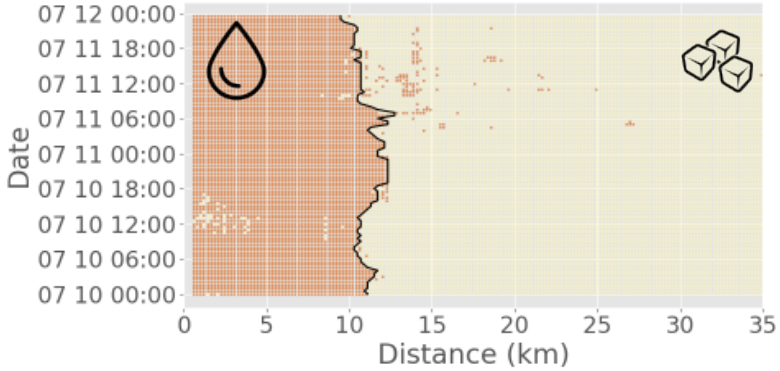


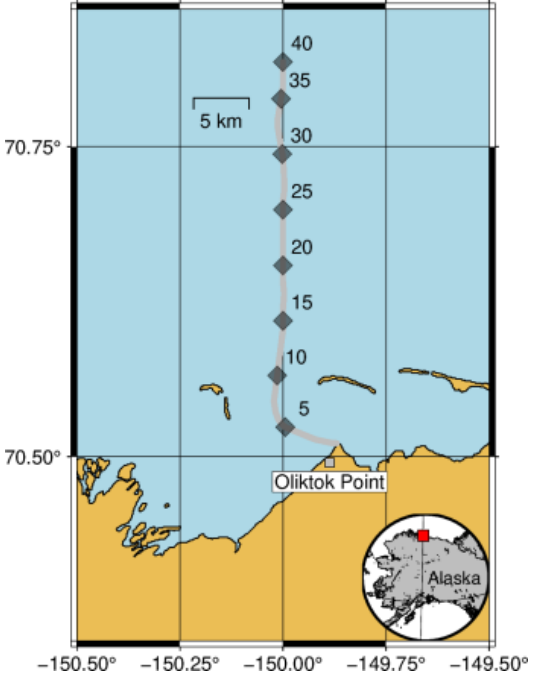
Conclusions and Future Steps



- DAS + ML in polar regions could help to track sea-ice coverage at a high resolution and improve our understanding of sea ice interactions.
- Outliers in classification may be icequakes, industrial activity, marine mammals, or polynyas….(?)
- ……







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Thank You

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