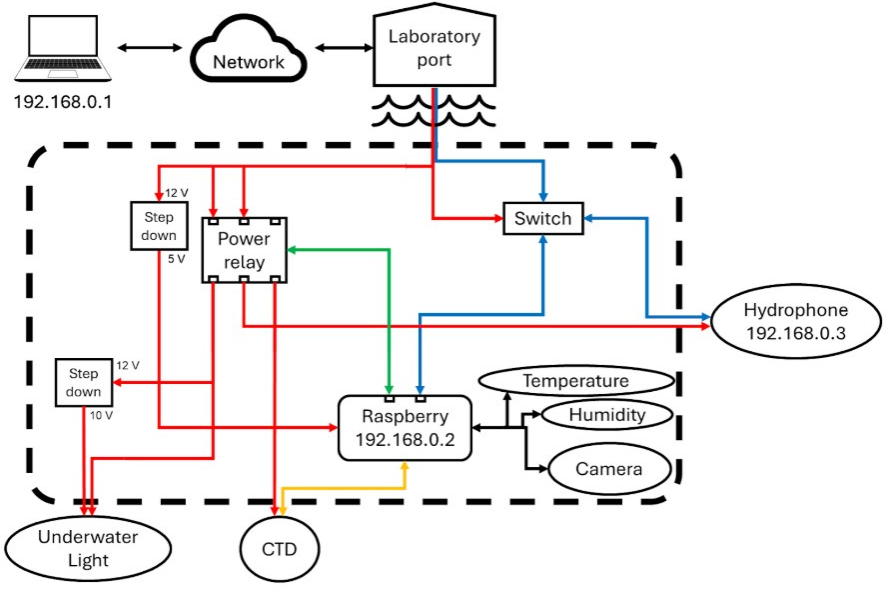
VONGOLA Project

(Visual and nOise-eNhanced AI analysis for marine biodiversity MonitorinG, Observation and LeArning)

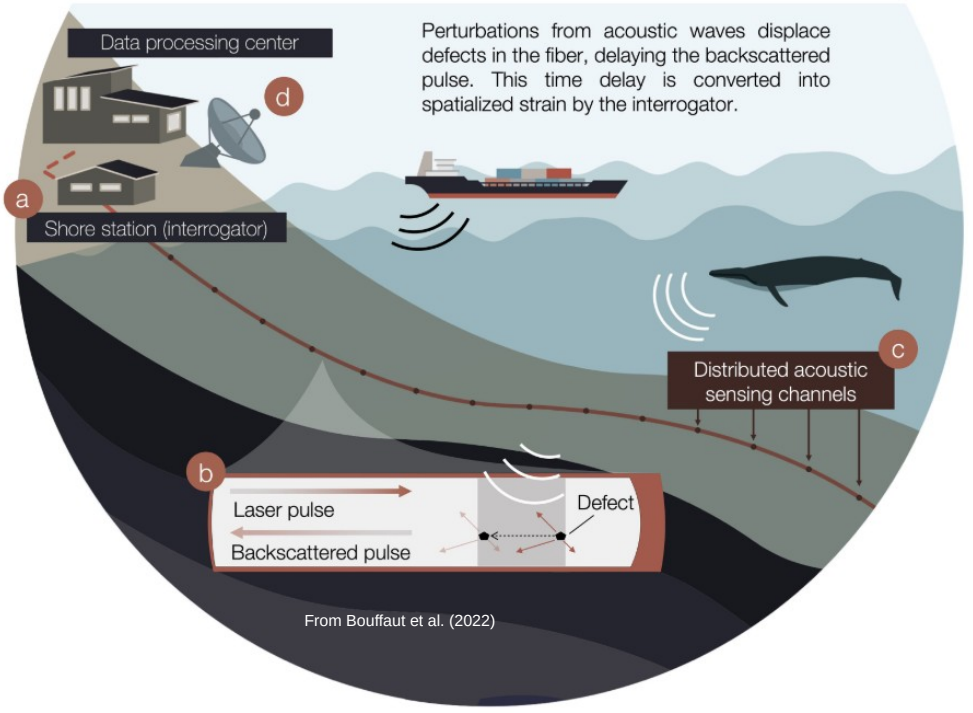
General goals:

- To development of advanced technologies to monitor marine life in the Ionian Sea
- To enhance real-time identification of marine fauna via environmental sensing
  - **acoustic monitoring**
  - video recording
  - chemical-physical CTD (Conductivity, Temperature and Depth) probes

Acoustic Monitoring Station

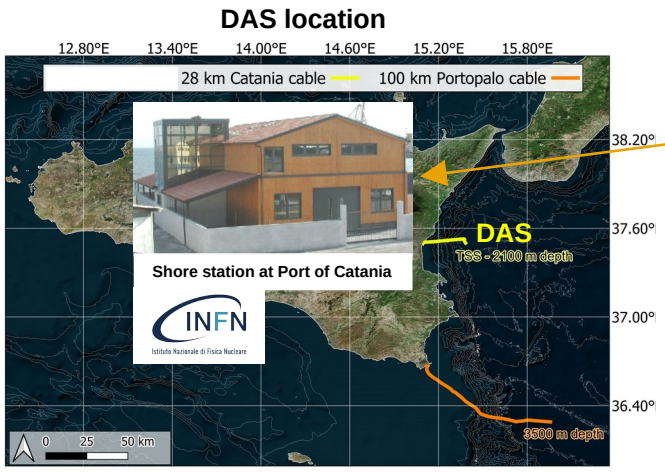


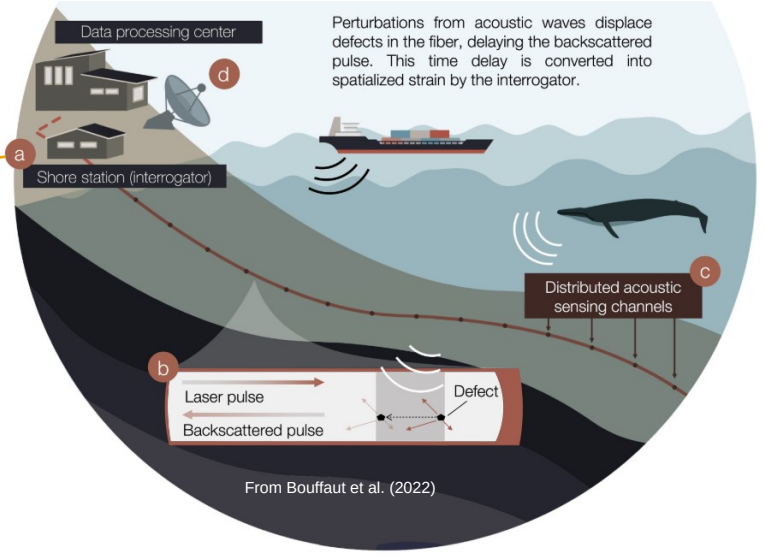
Distributed Acoustic Sensing (DAS)



From Bouffaut et al. (2022)

Distributed Acoustic Sensing (DAS)





Goals with DAS:

- Detection of Fin whales
- Assess the acoustic pollution levels:
  - Marine soundscape
  - Vessel traffic

DAS characteristics:

- Continuous real-time recording and streaming
- High resolution in space (~ 5 m) and time (0.5 ms)
- Huge volume of data (~ 2.9 TB per day) => deleting after 2 days

Examples of events detected by DAS

AIS (automatic identification system) positioning data

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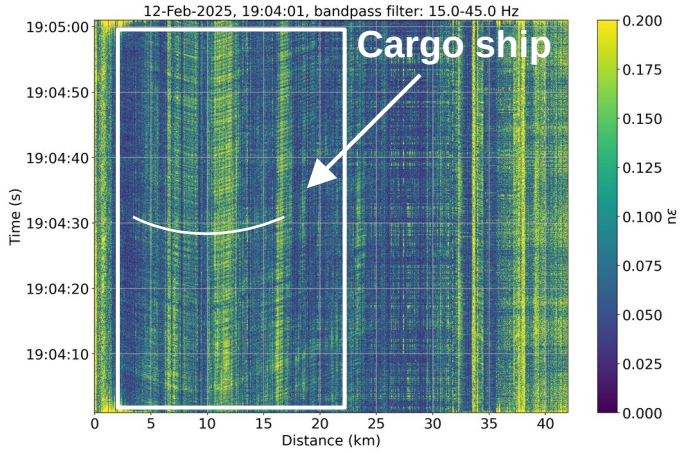
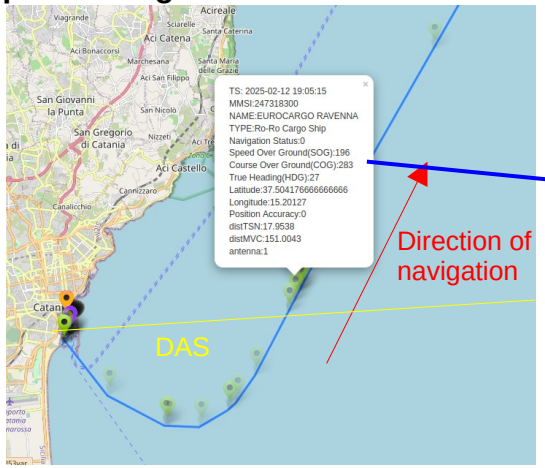
Time – Distance plots of DAS recordings



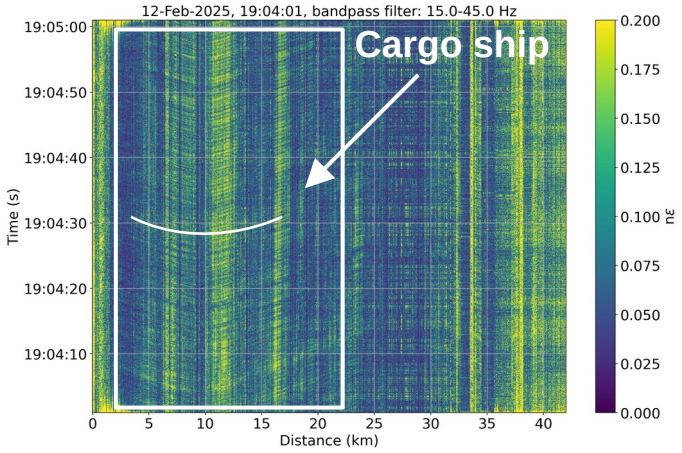
Catania port — Horizontal axis: Distance → **Sea**

Examples of events detected by DAS

AIS (automatic identification system) positioning data

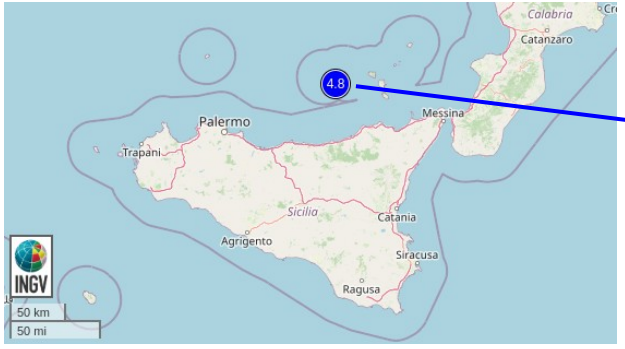


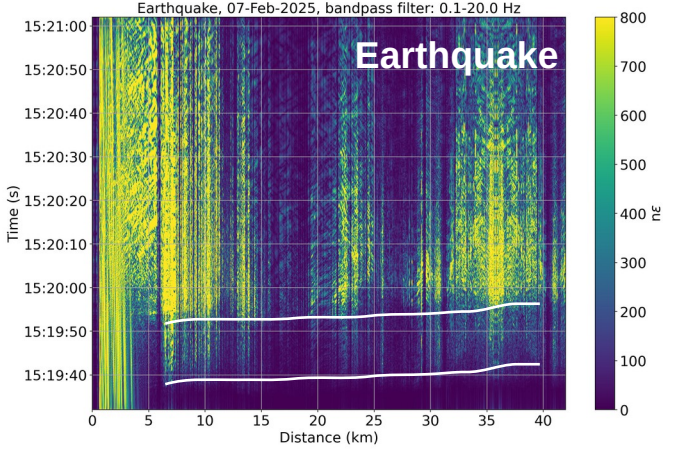
Time – Distance plots of DAS recordings



Catania port → Horizontal axis: Distance → **Sea**

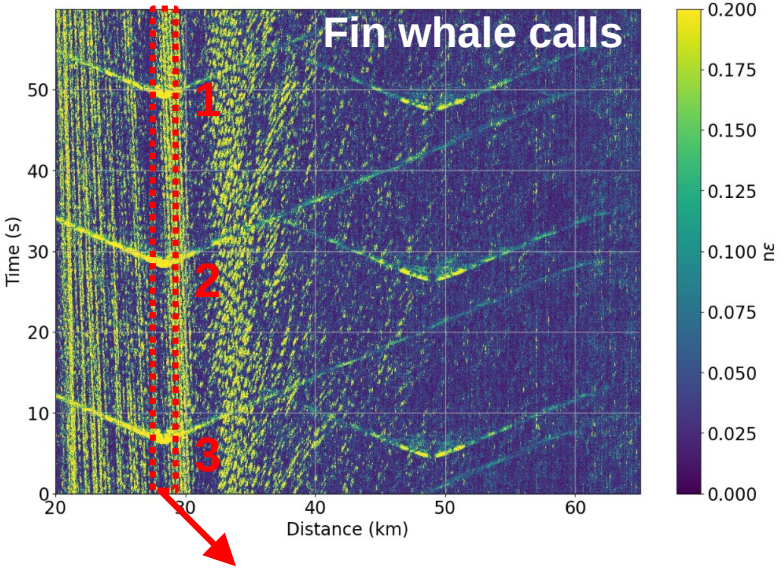
Earthquake from Aeolian Islands, 7-Feb-2025, ML = 4.8



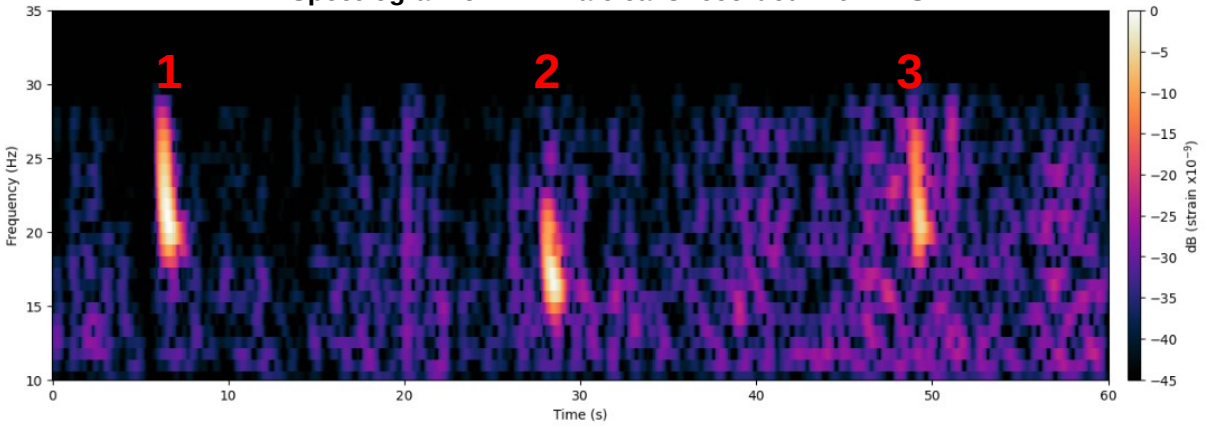


Examples of events detected by DAS

Time – Distance plots of DAS recordings

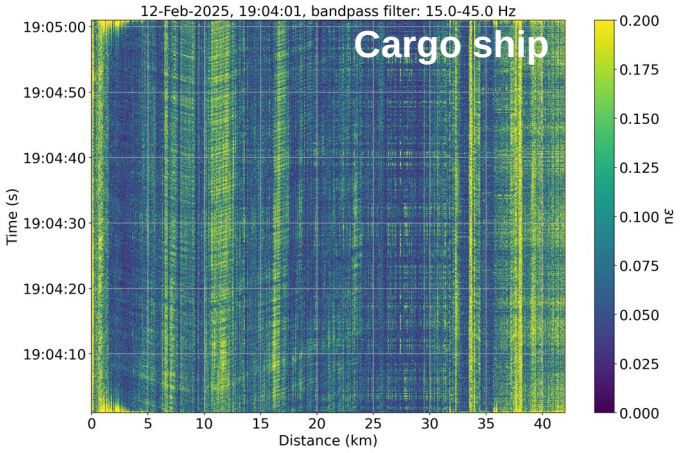


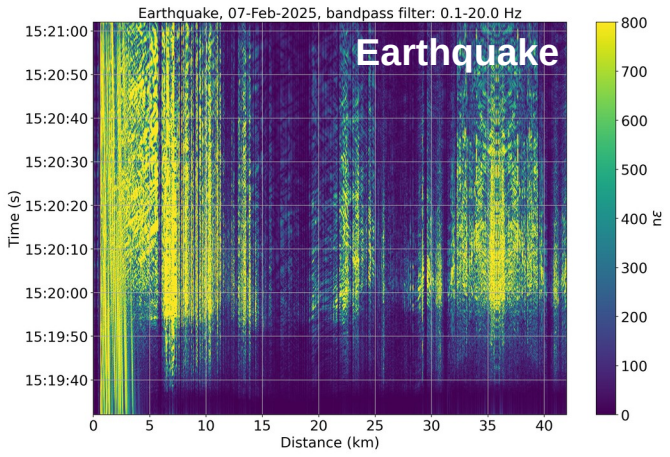
Spectrogram of Fin whale calls recorded with DAS

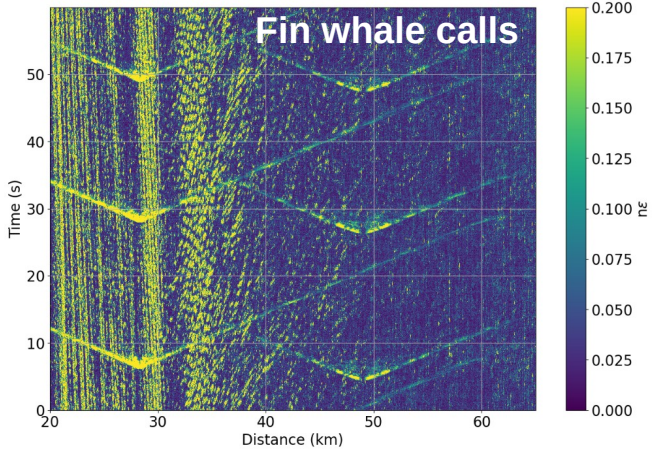


Triggers for ML-based event classification?

Time – Distance plots



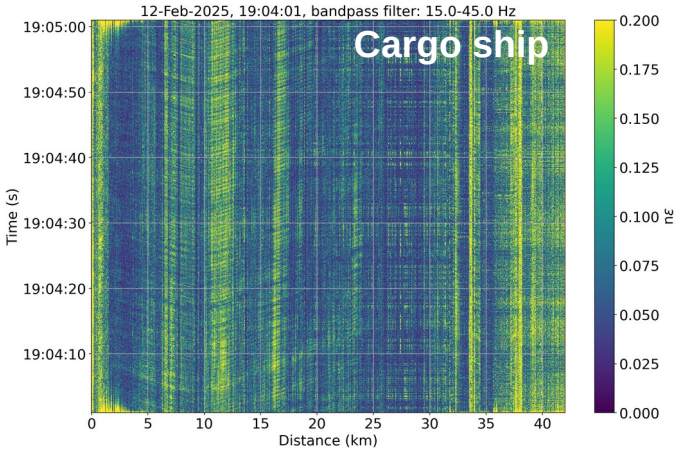


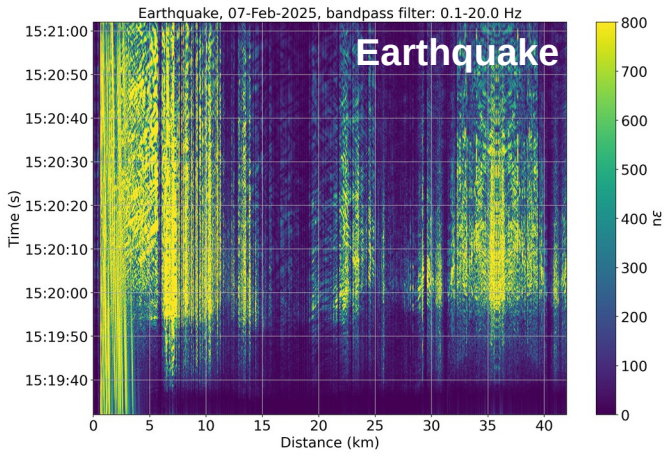


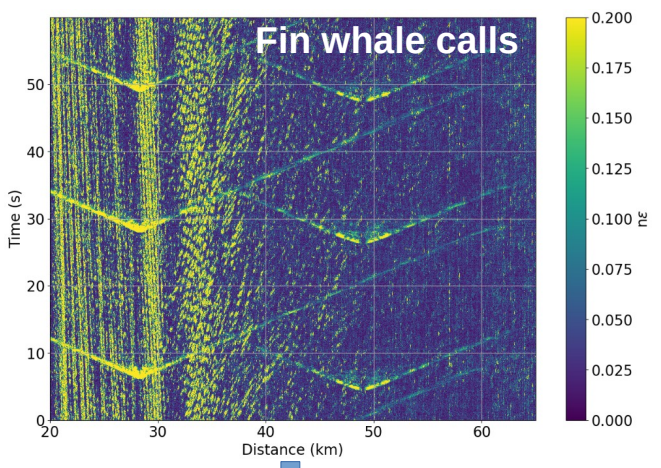
Frequency – Distance plots

Triggers for ML-based event classification?

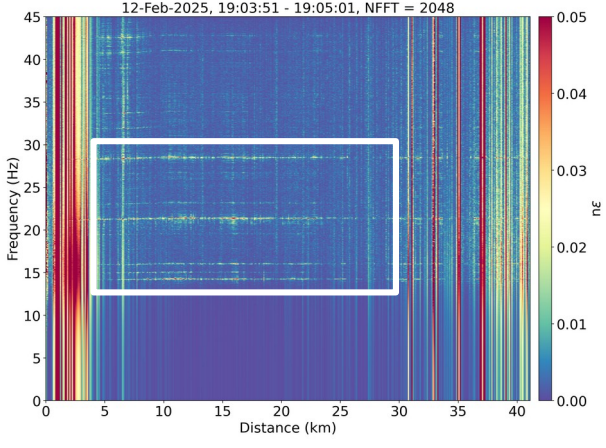
Time – Distance plots

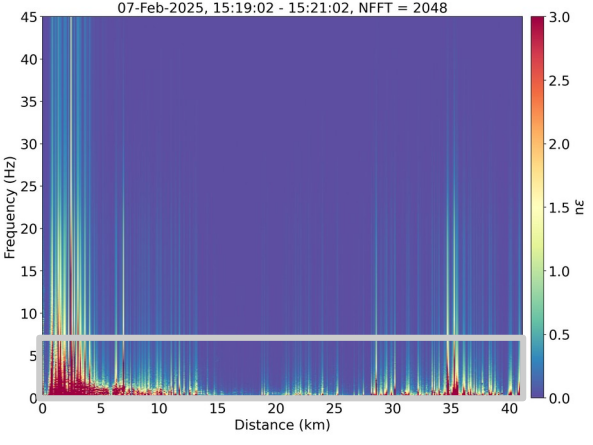


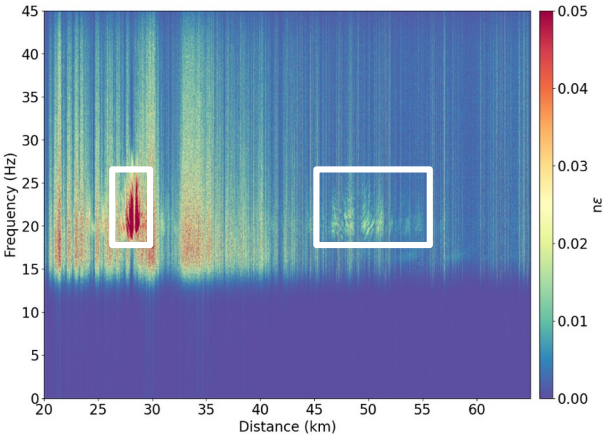




Frequency – Distance plots







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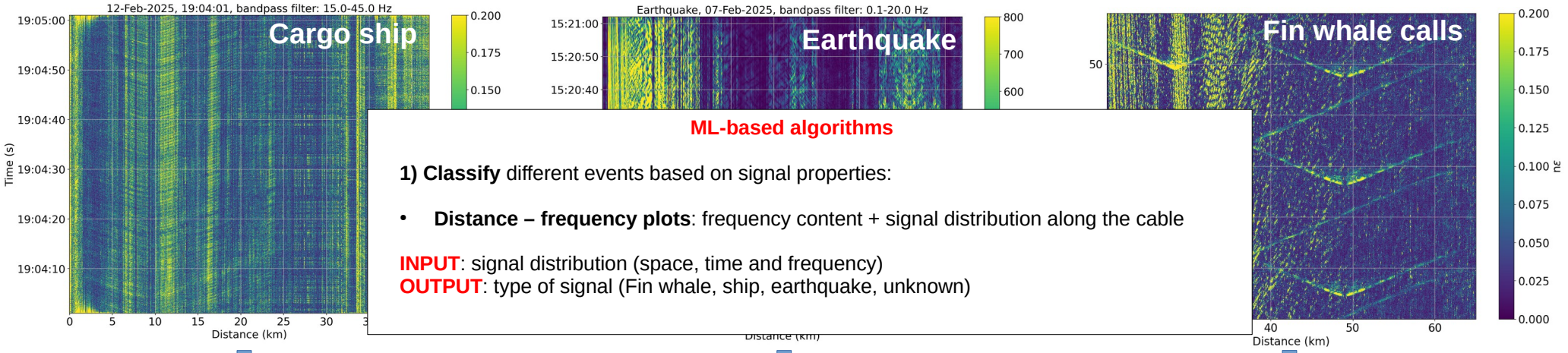
Time – Distance plots



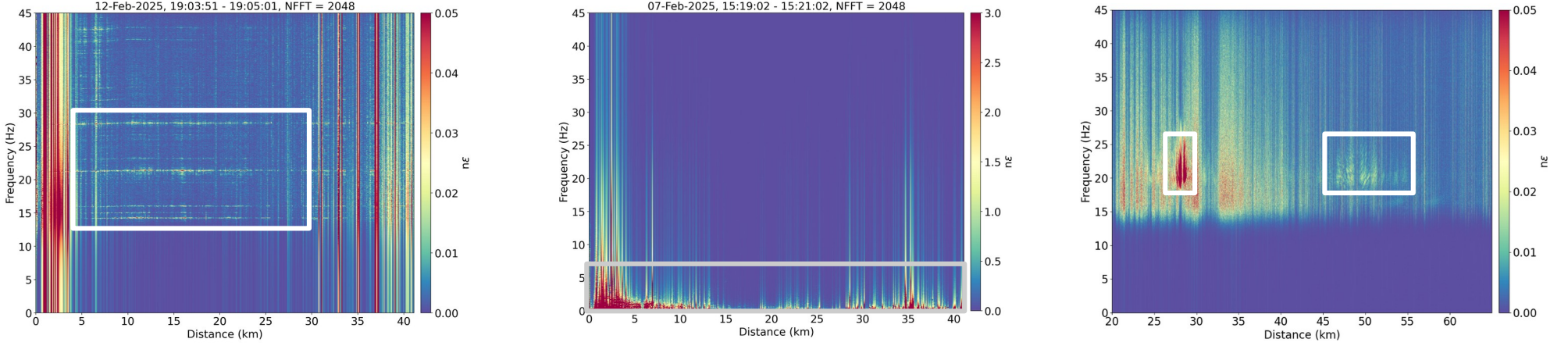
ML-based algorithms

1) Classify different events based on signal properties:

- **Distance – frequency plots**: frequency content + signal distribution along the cable

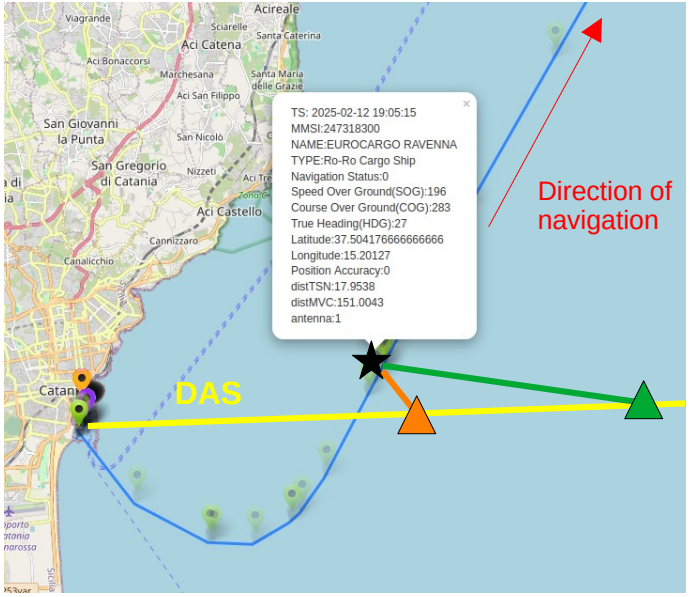
INPUT: signal distribution (space, time and frequency)
OUTPUT: type of signal (Fin whale, ship, earthquake, unknown)

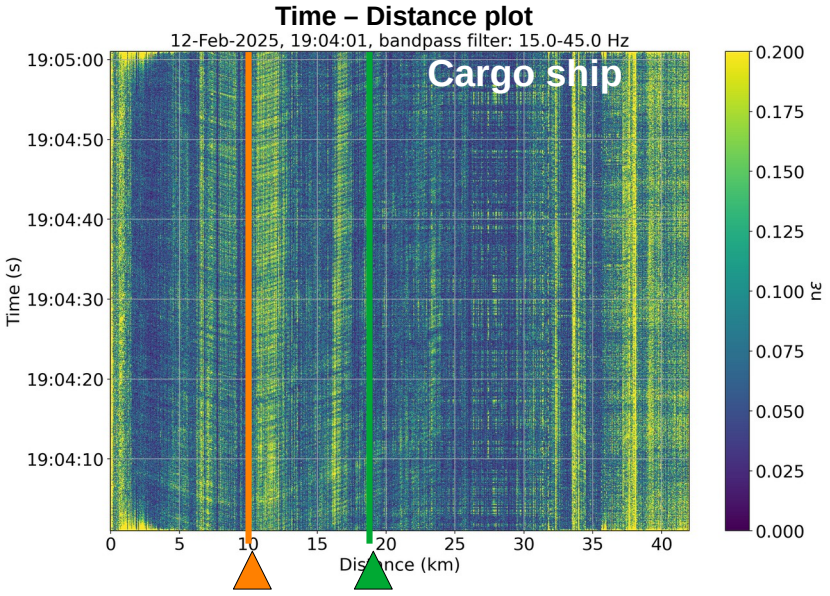
Frequency – Distance plots



Triggers for ML-based event classification?

AIS (automatic identification system) positioning data

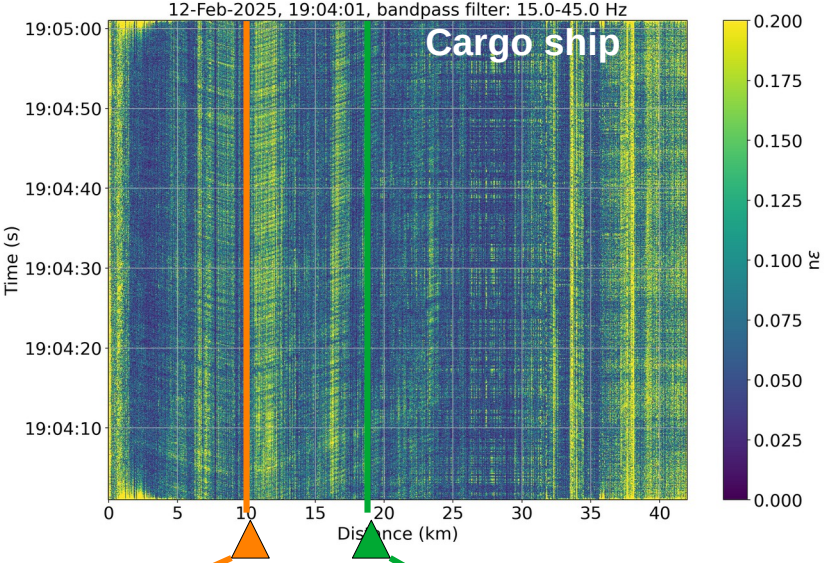




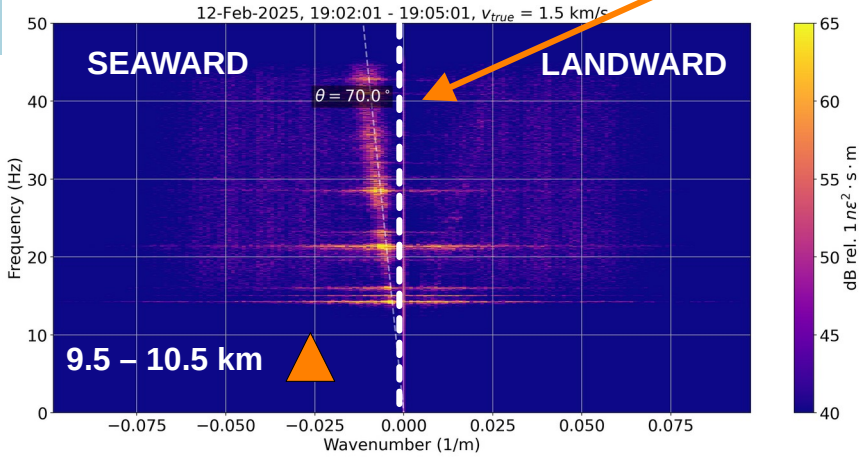
Triggers for ML-based event classification?

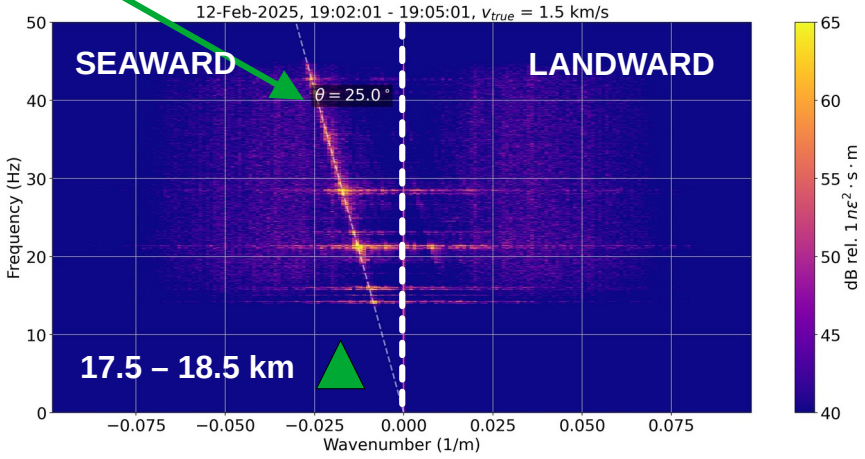
AIS (automatic identification system) positioning data

Time – Distance plot



f-k (frequency – wavenumber) analysis

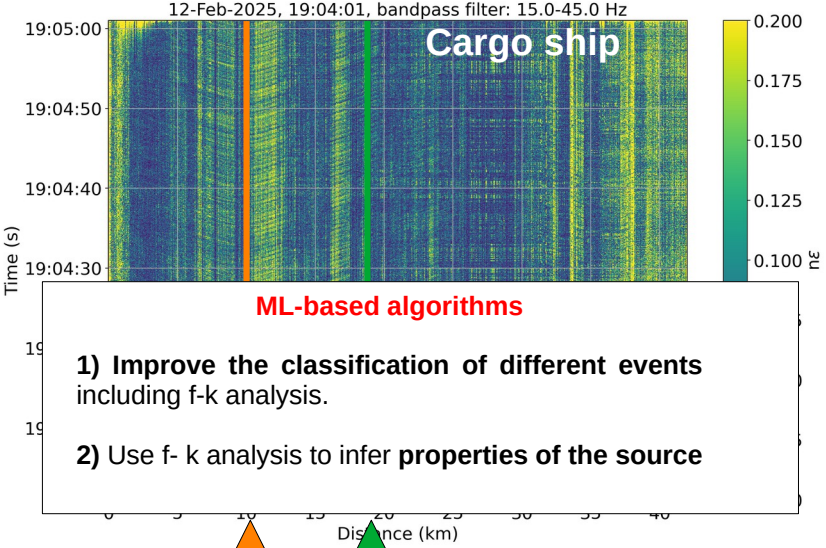




Triggers for ML-based event classification?

AIS (automatic identification system) positioning data

Time – Distance plot



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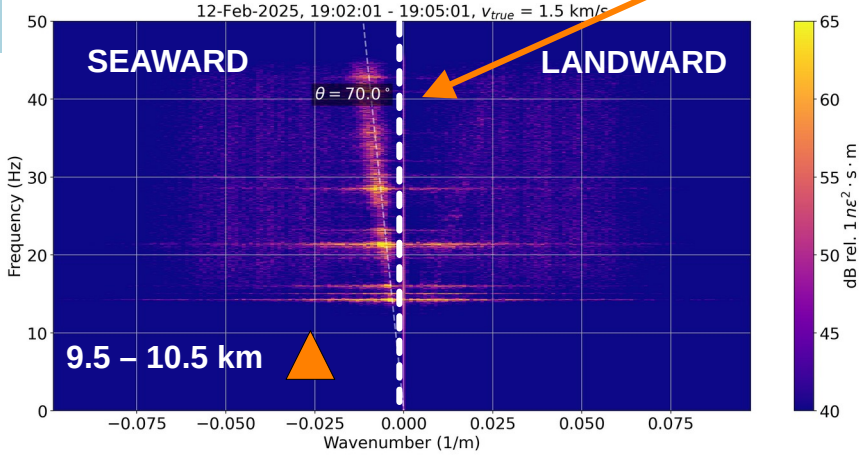
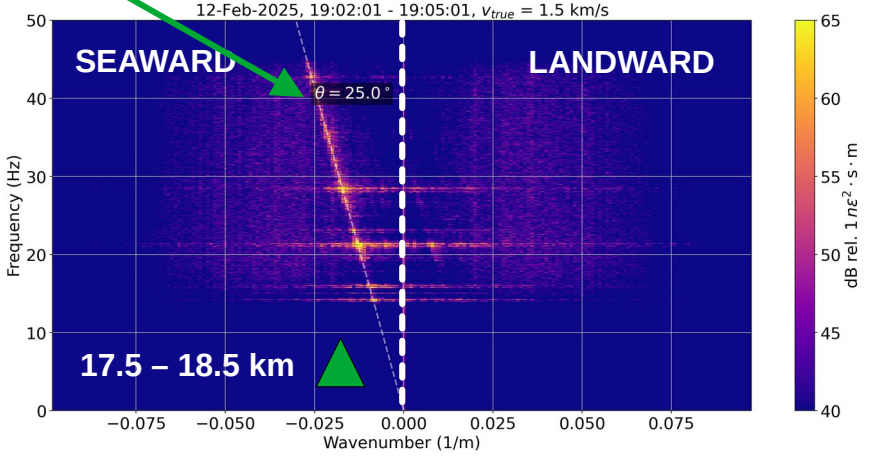
ML-based algorithms

1) Improve the classification of different events including f-k analysis.

2) Use f- k analysis to infer **properties of the source**

f-k (frequency – wavenumber) analysis





ML-based algorithms

1) Classify different events based on signal properties:

- **Distance – frequency plots**: frequency content + signal distribution along the cable
- **f – k plots**: speed of the source + direction of propagation + frequency content

INPUT: signal distribution in **space, time and frequency + apparent speed and relative orientation from the cable**
OUTPUT: type of signal (Fin whale, ship, earthquake, unknown)

2) Use f- k analysis to infer **properties of the source**:

- How far is the source from the cable based on the angle?
- Type of source: ships and Fin whales

INPUT: **apparent speed and relative orientation from the cable**
OUTPUT: distance between source and receiver