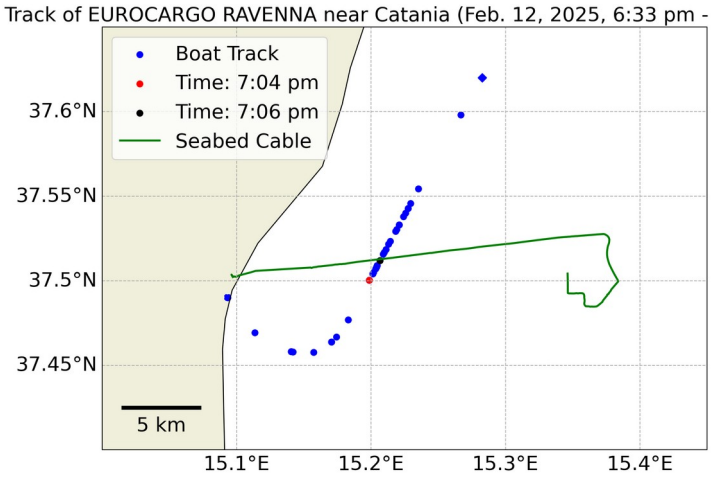
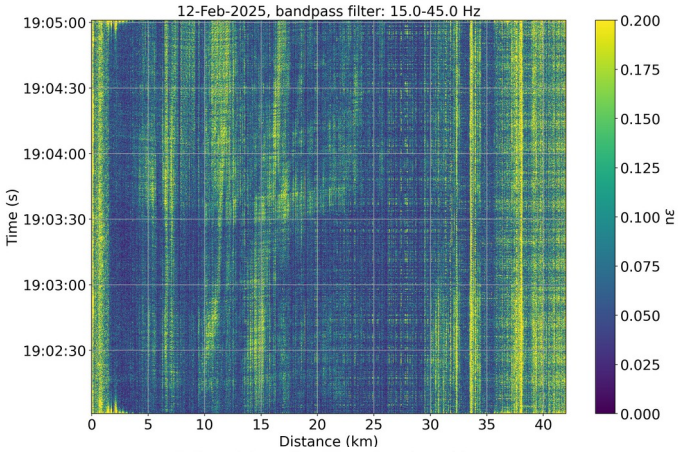
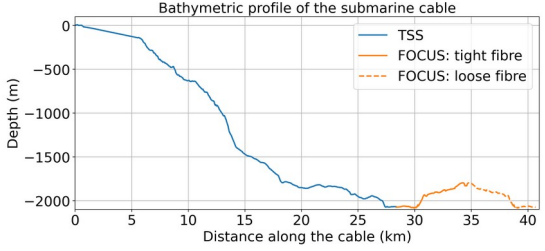
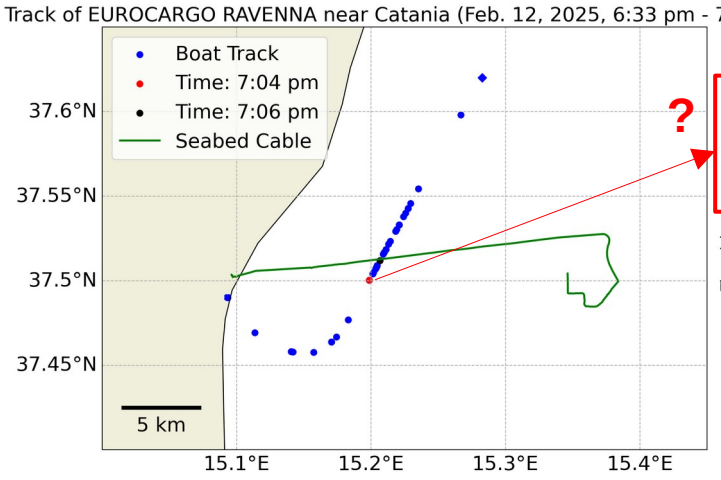


Time – distance plot → **f – k (frequency – wavenumber) plots**

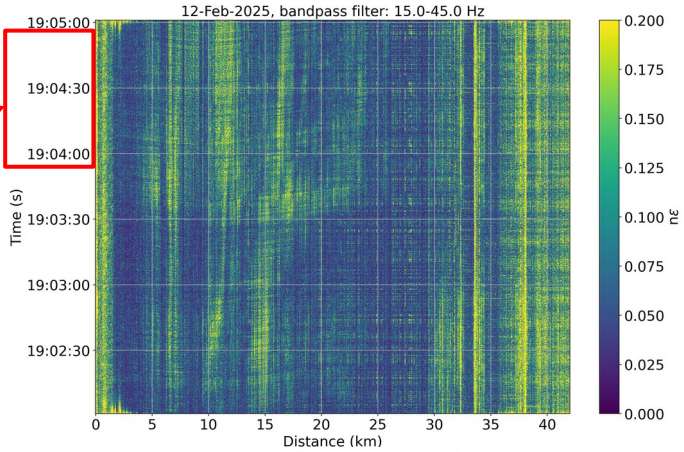


2D distance to cable at 7:04 pm: 1292.71 meters
3D distance to cable at 7:04 pm: **1415.26 meters**
Closest cable position: Depth: -569.39 m, Distance from shore: **9.19 km**





Time – distance plot → **f – k (frequency – wavenumber) plots**



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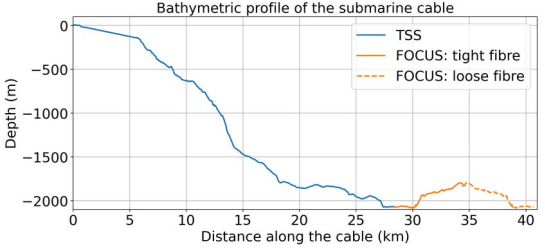

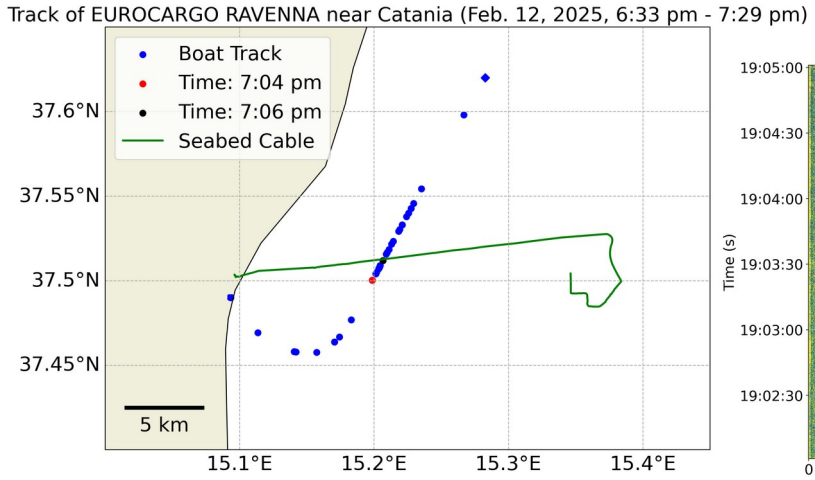

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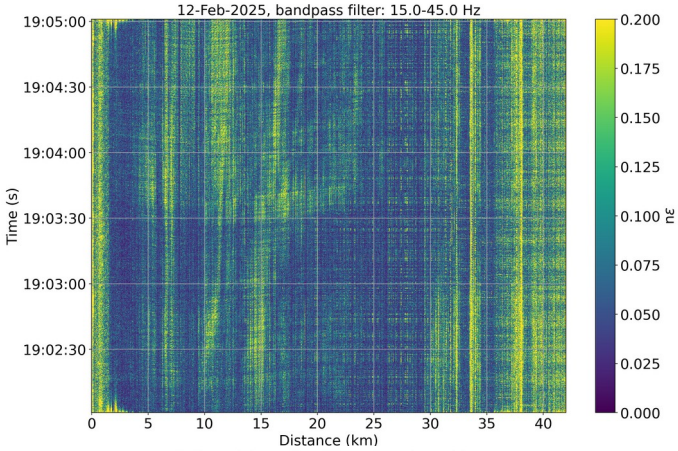
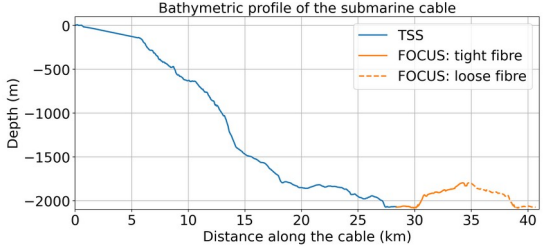
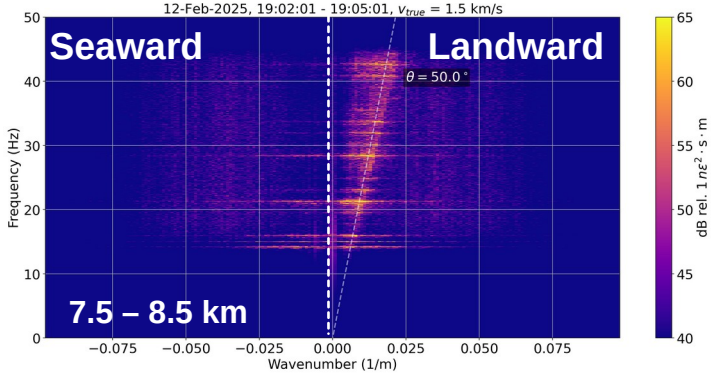
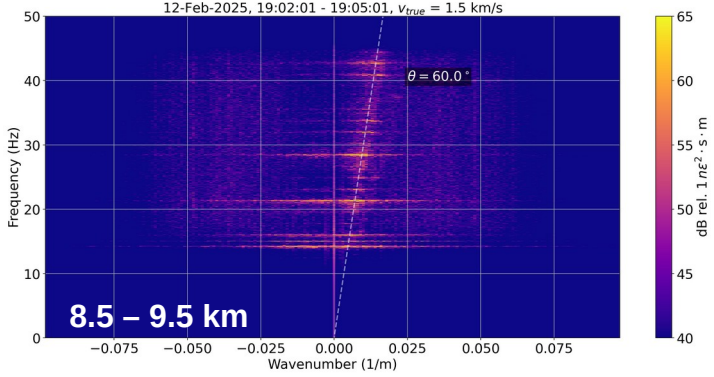
Time – distance plot

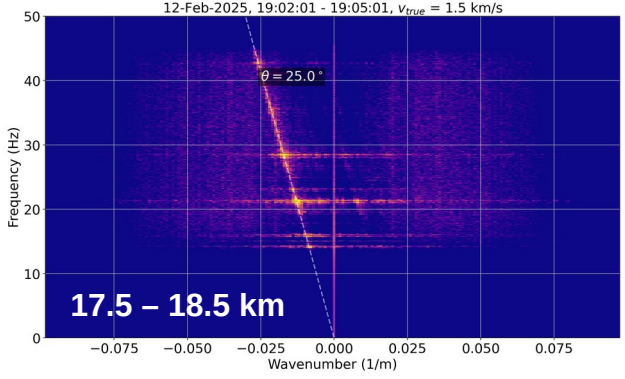


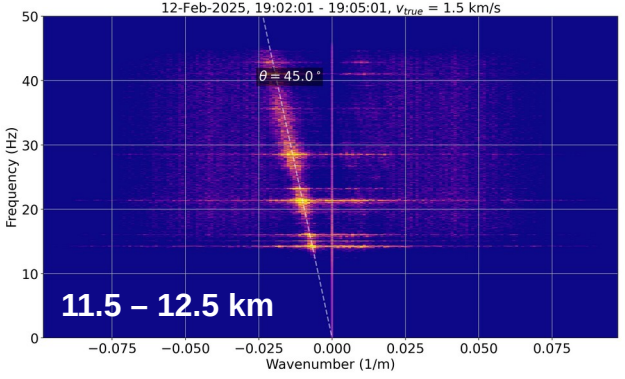


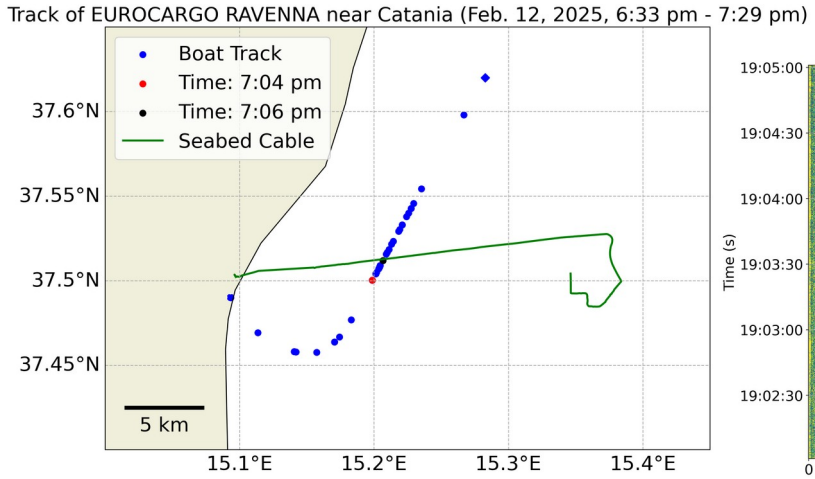
f – k (frequency – wavenumber) plots





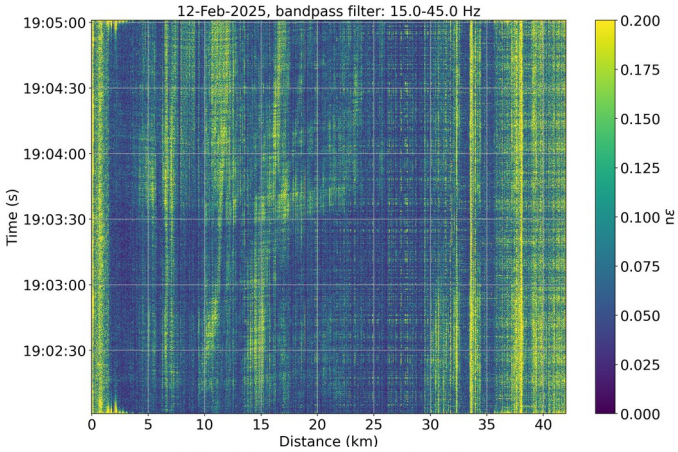


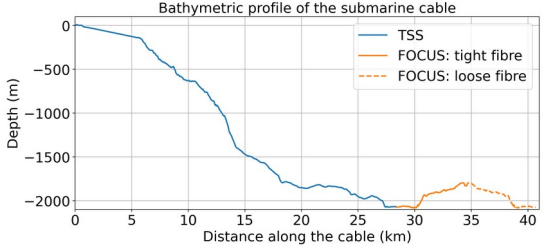




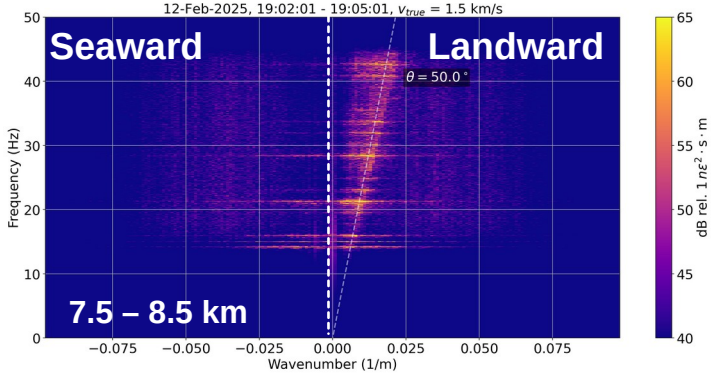
2D distance to cable at 7:04 pm: 1292.71 meters
3D distance to cable at 7:04 pm: **1415.26 meters**
Closest cable position: Depth: -569.39 m, Distance from shore: **9.19 km**

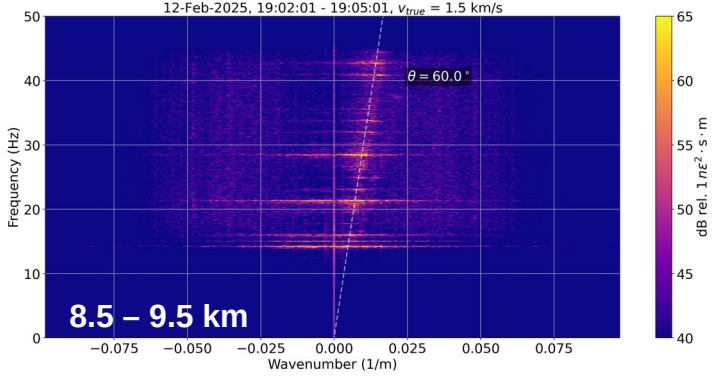
Time – distance plot

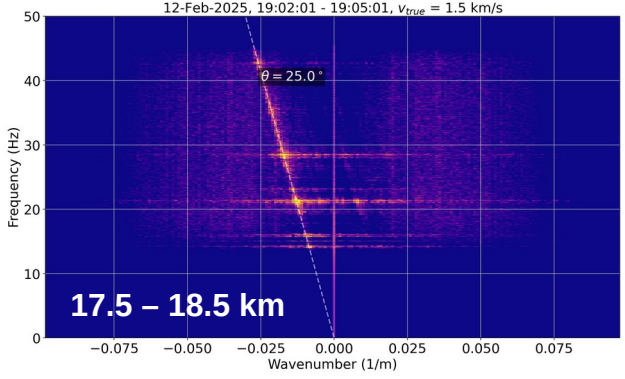


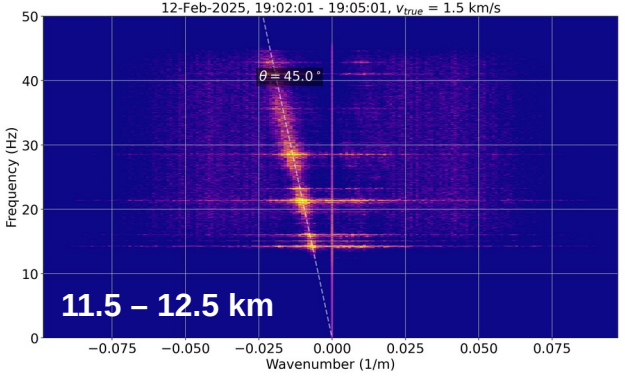


f – k (frequency – wavenumber) plots



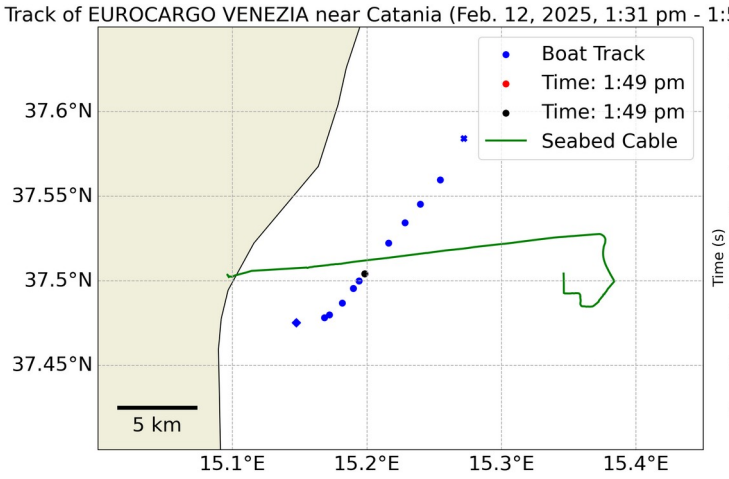




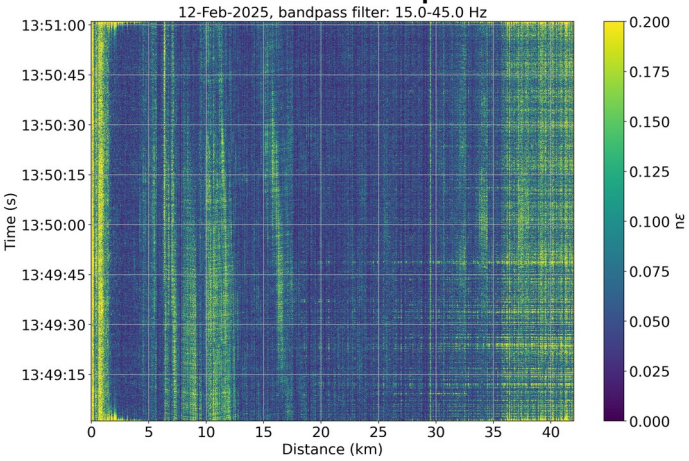


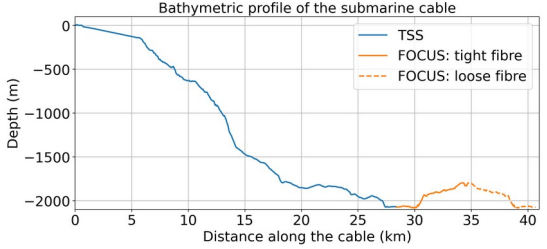
What is causing the energy smearing along different wavenumbers?

- Cable turns? Straight cable section
- Another ship?



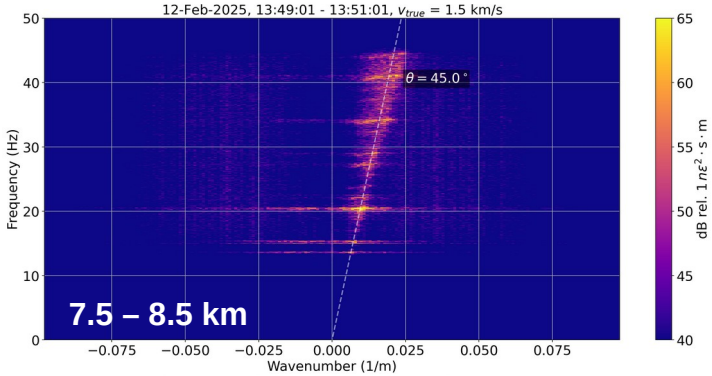
Time – distance plot

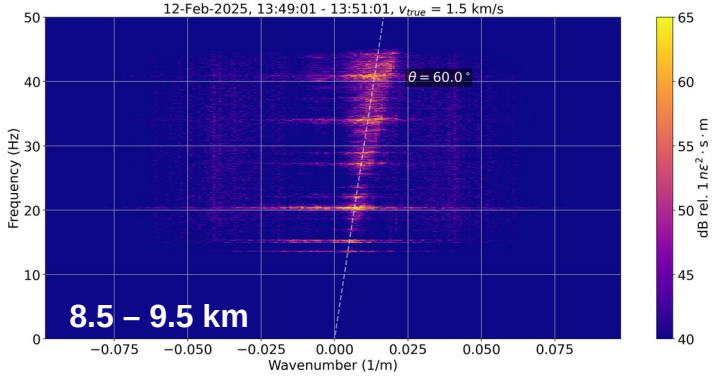




2D distance to cable at 1:49 pm: 858.46 meters
3D distance to cable at 1:49 pm: **1034.92 meters**
Closest cable position: Depth: -569.39 m, Distance from shore: **9.19 km**

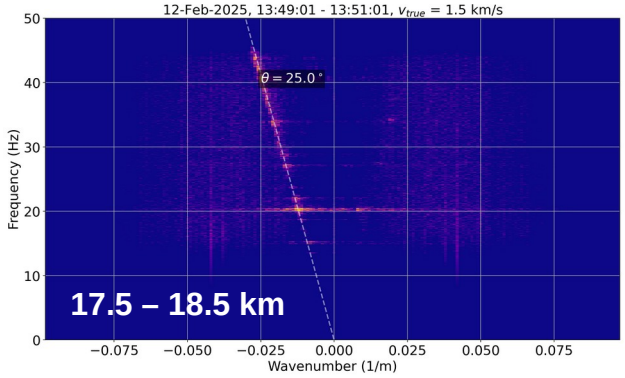
f – k (frequency – wavenumber) plots

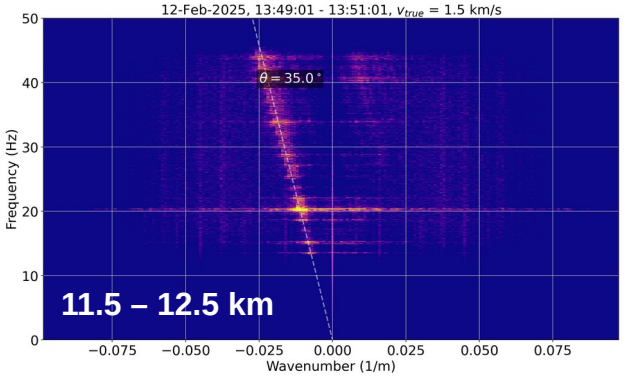




Same day but different ship with similar path and similar ship-cable distances compared to the previous one

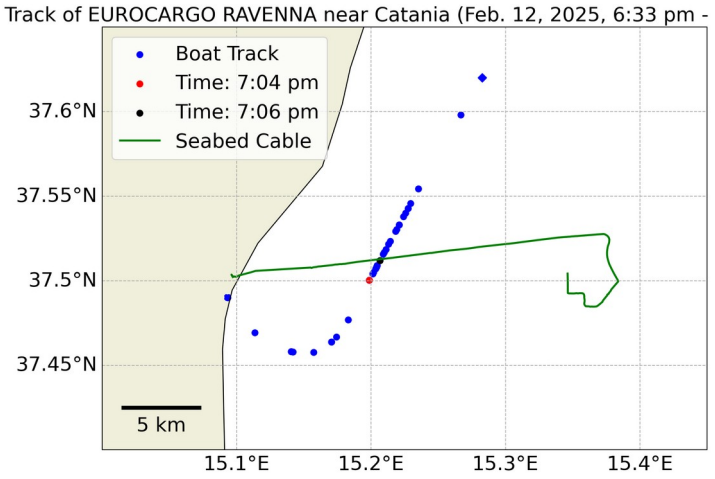
f-k signals are less intense for further away distances (compared to the previous case) but the smearing effect is still there





What is causing the energy smearing along different wavenumbers?

- Cable turns? Straight cable section
- Another ship? Unlikely
- Effect of considering big spatial windows?



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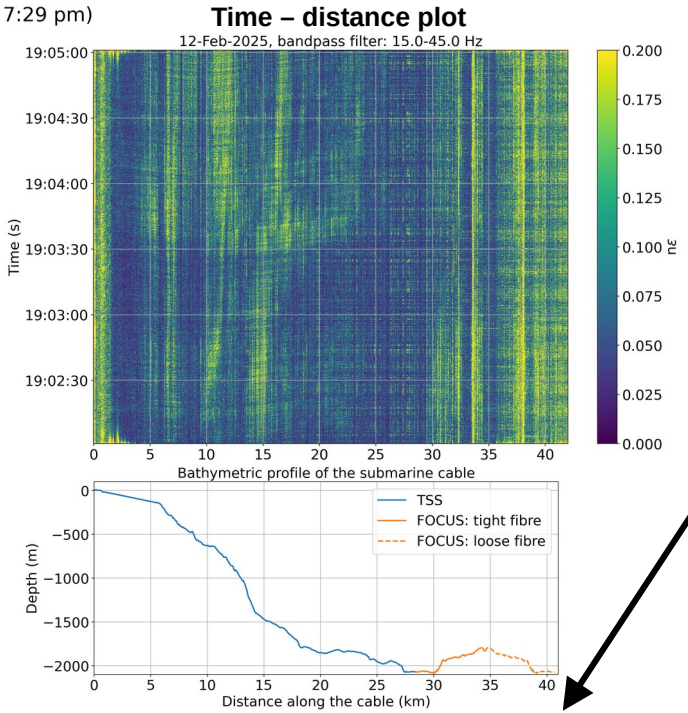
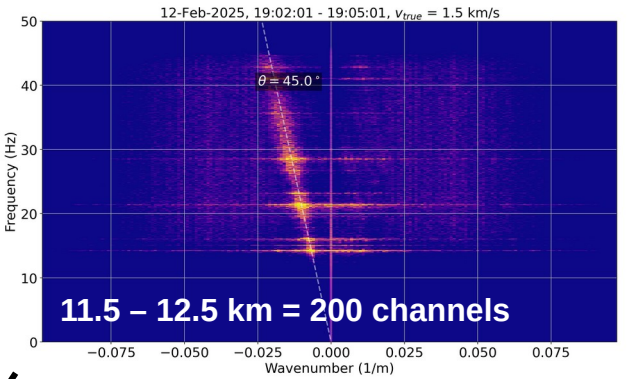
Time – distance plot



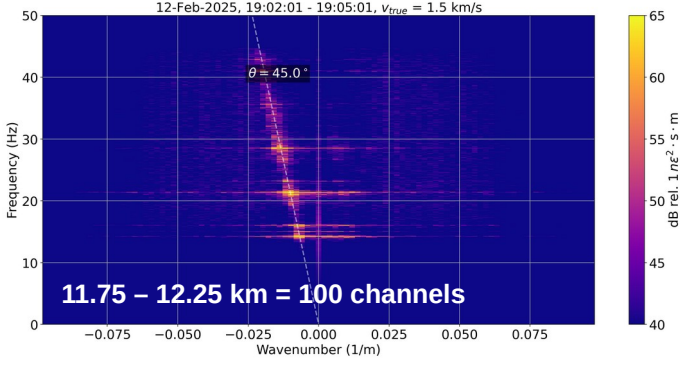
f – k (frequency – wavenumber) plot

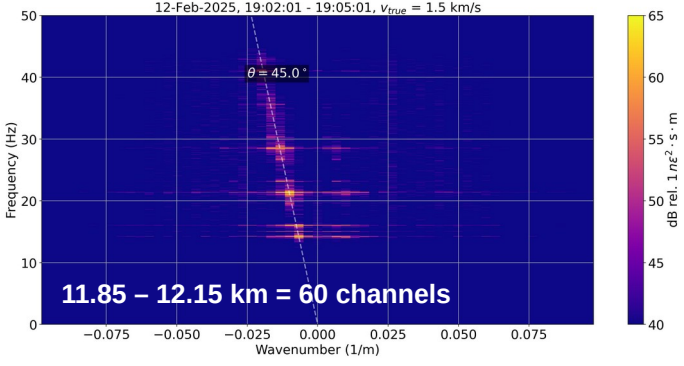


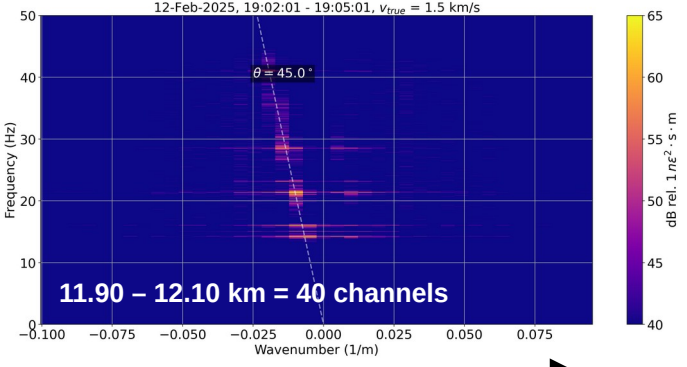
What is causing the energy smearing along different wavenumbers?

- Cable turns? Straight cable section
- Another ship? Unlikely
- Effect of considering big spatial windows? If yes, this effect seems small
- Steep bathymetric changes?
- Reverberations in the water column?
- Suggestions?

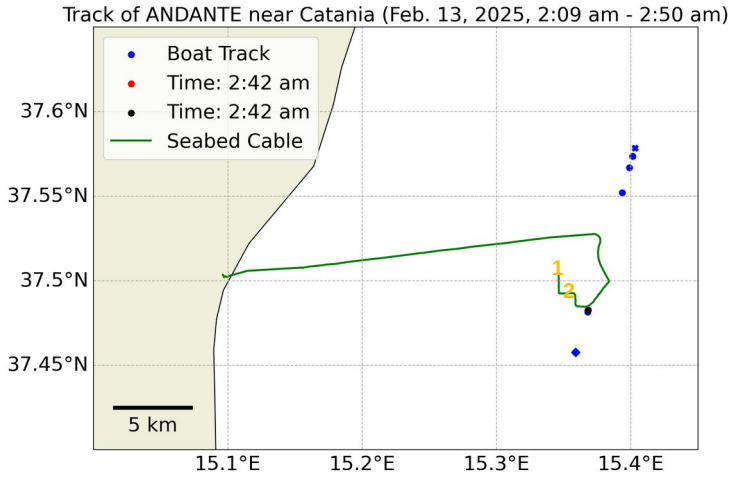
How does a smaller spatial window affect the wavenumber resolution?





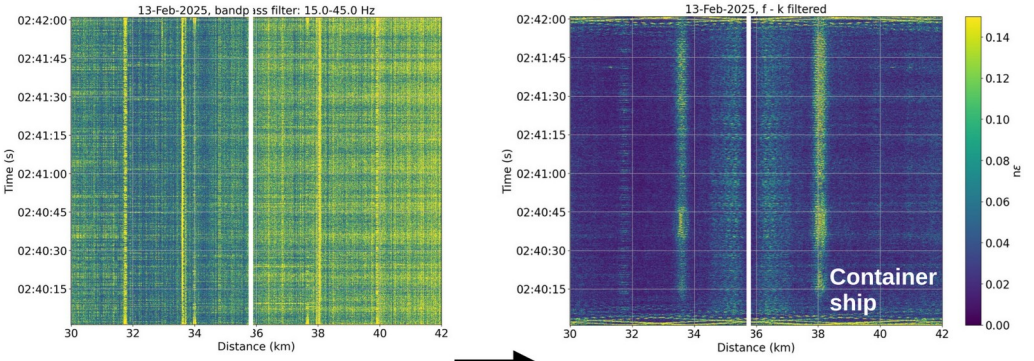


Reducing spatial window



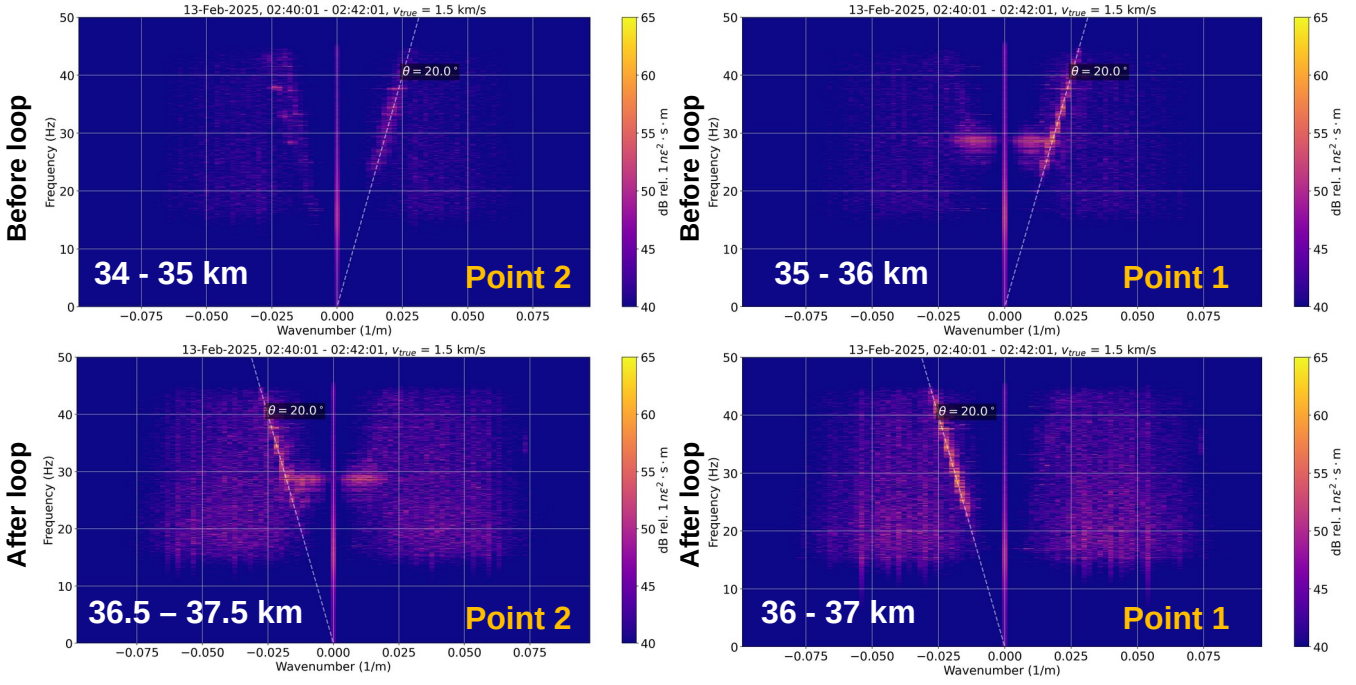
2D distance to cable at 2:42 am: 238.94 meters
3D distance to cable at 2:42 am: **1963.22 meters**
Closest cable position: Depth: -1934.49 m, Distance from shore: **30.83 km**

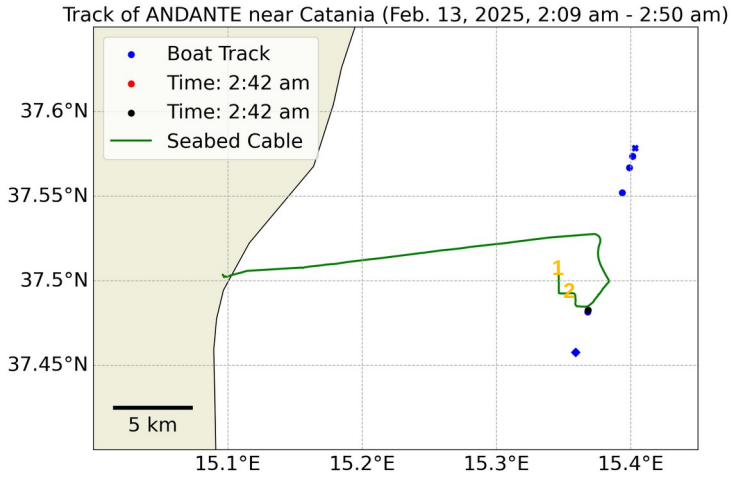
Time – Distance plots



De-noised via f-k filter

f – k (frequency – wavenumber) plots





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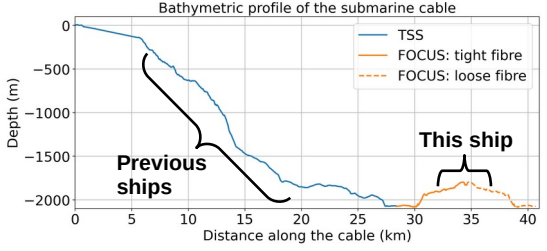
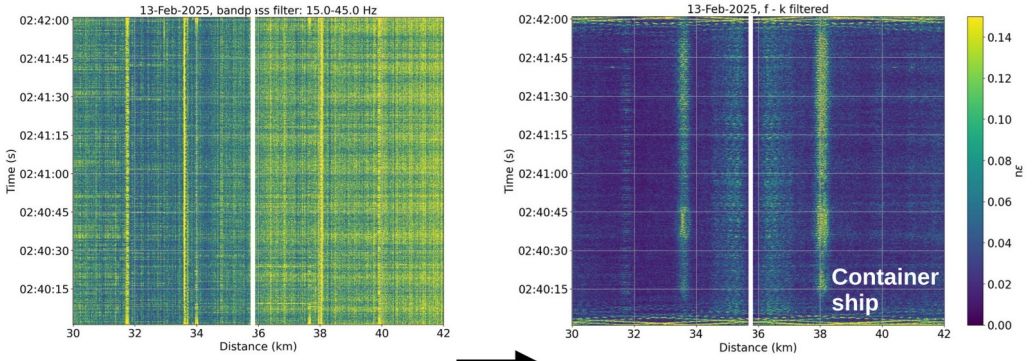


What is causing the energy smearing along different wavenumbers?

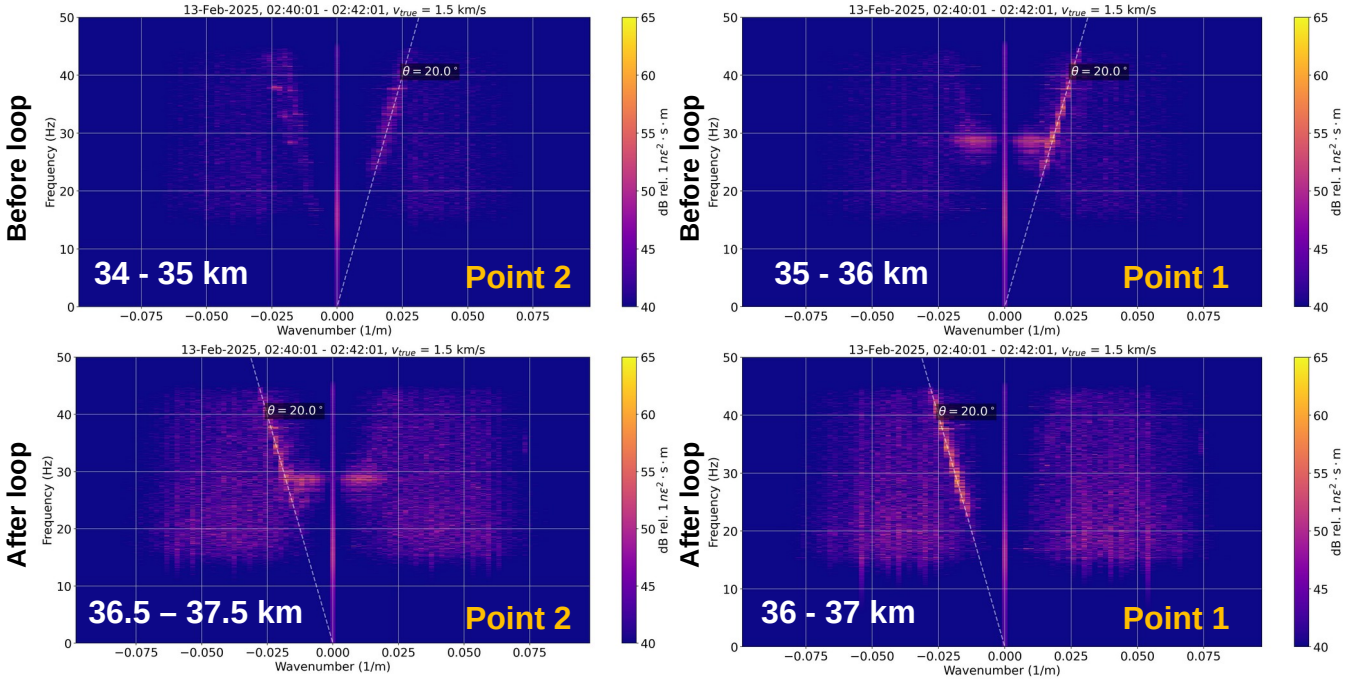
- Cable turns?
- Another ship? Unlikely
- Effect of considering big spatial windows? If yes, this effect seems small
- **Steep bathymetric changes?**
- Reverberations in the water column?
- Suggestions?

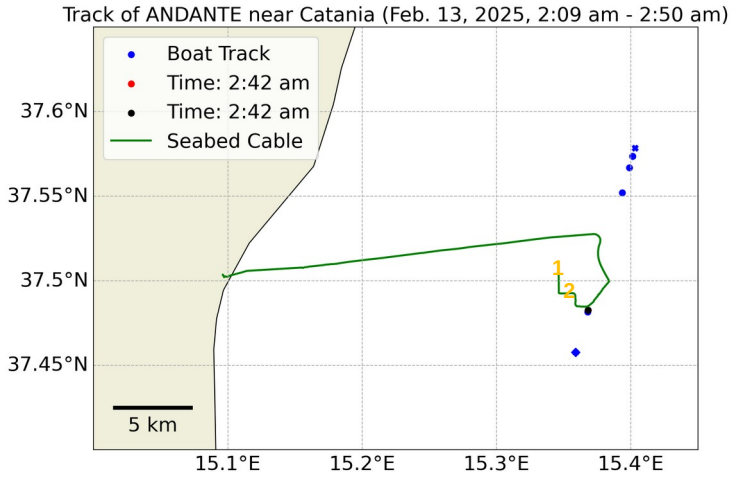
Time – Distance plots



De-noised via f-k filter

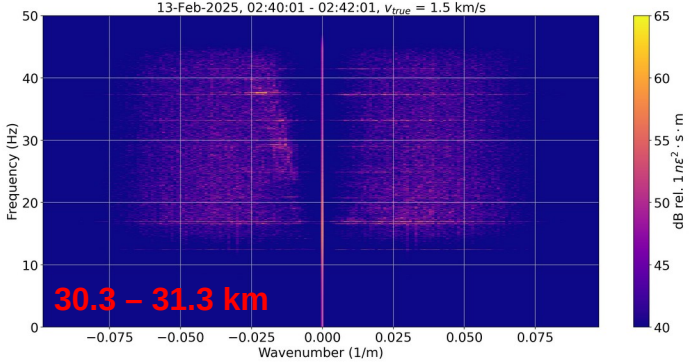
f – k (frequency – wavenumber) plots



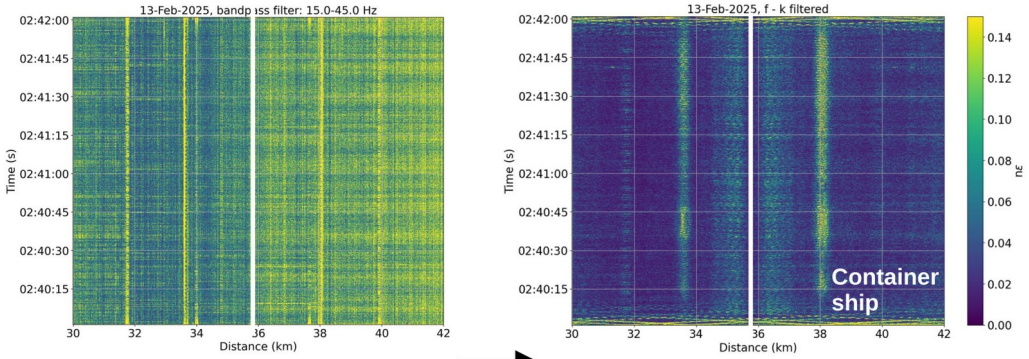


2D distance to cable at 2:42 am: 238.94 meters
3D distance to cable at 2:42 am: **1963.22 meters**
Closest cable position: Depth: -1934.49 m, Distance from shore: **30.83 km**

Smearing effect is visible at the Closest Point of Approach (CPA) around 30.8 km but the signal is almost invisible <= DAS is blind to signals arriving from a direction closely perpendicular to that of the cable

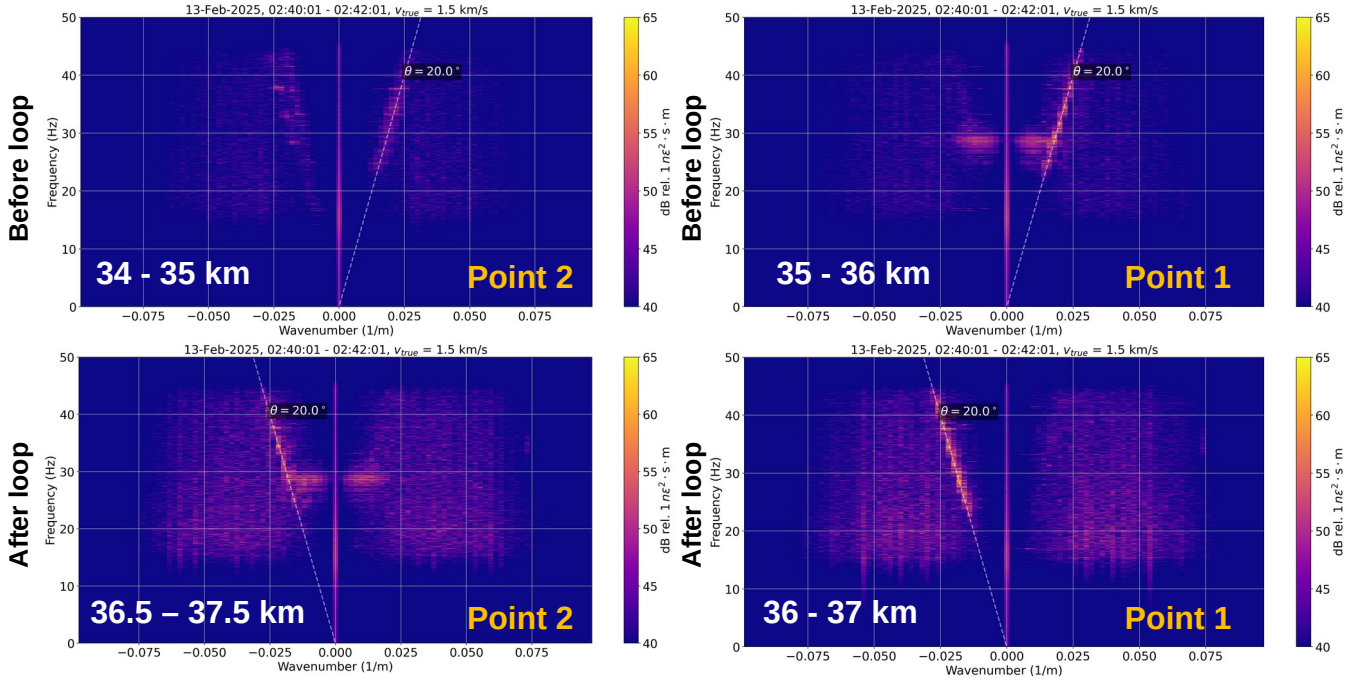


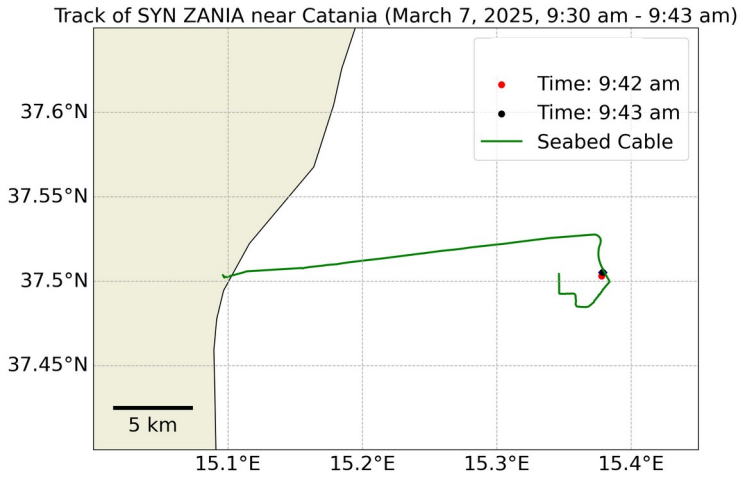
Time – Distance plots



De-noised via f-k filter

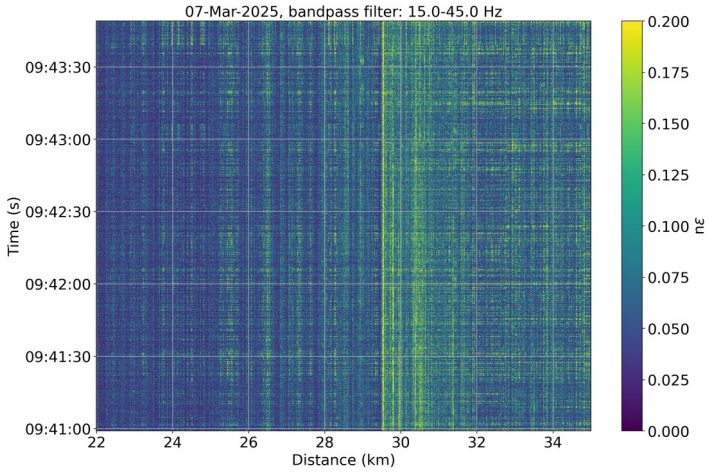
f – k (frequency – wavenumber) plots



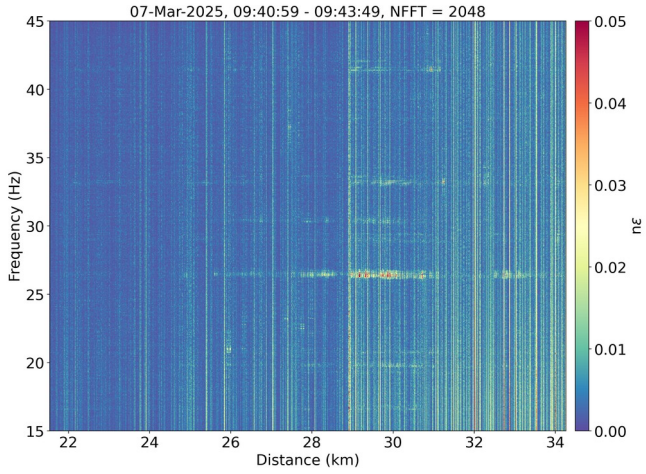


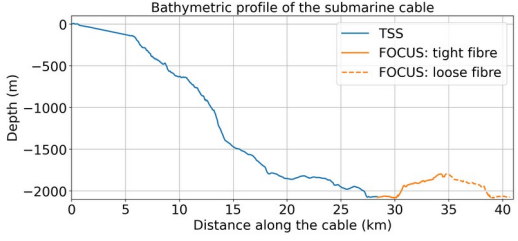
2D distance to cable at 9:43 am **(CPA)**: 108.86 meters
3D distance to cable at 9:43 am **(CPA)**: **2070.58 meters**
Closest cable position: Depth: -2013.46 m, Distance from shore: **27.21 km**

Time – distance plot



Frequency – distance plot

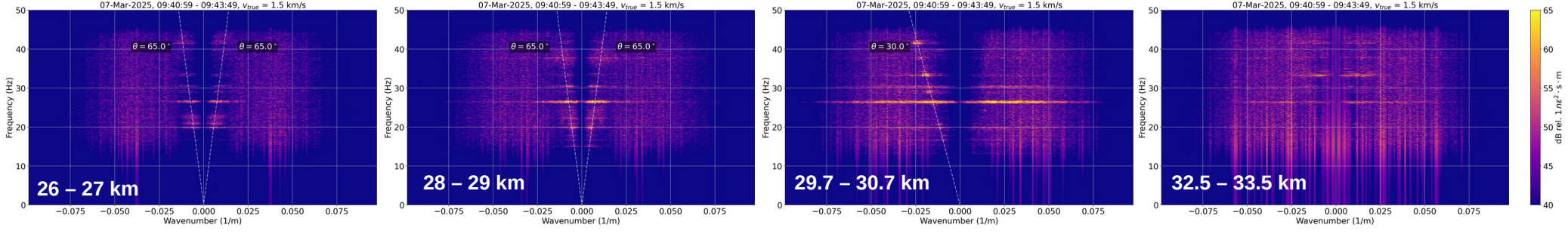


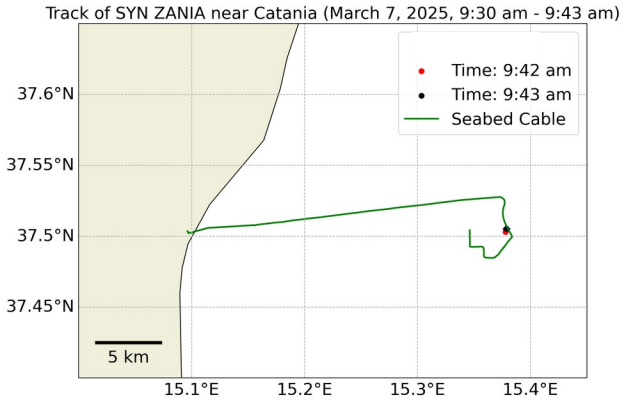


Main characteristics of the analysed signal:

- Ship crossing the cable in the section between 26 and 29 km => not clear wave propagation direction
- Smearing effect present
- Maximum detection range spans only ~ 3-4 km distance along the cable (in deep waters)

f – k (frequency – wavenumber) plots





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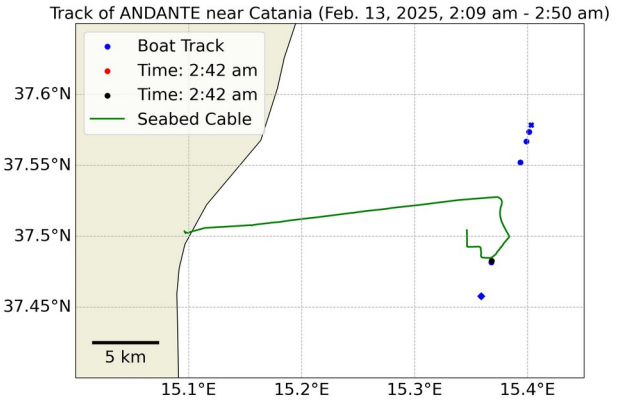
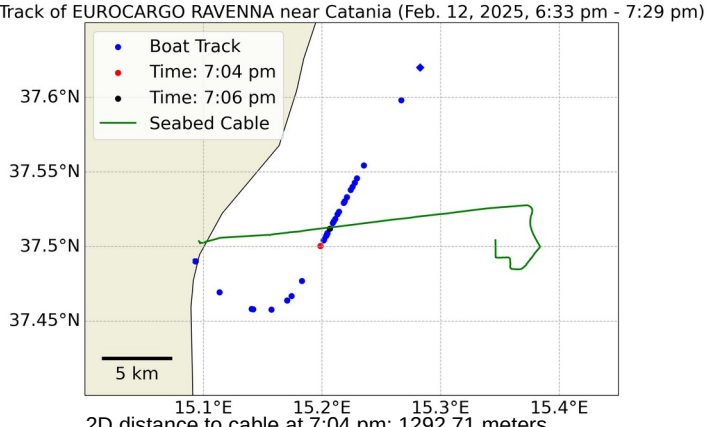
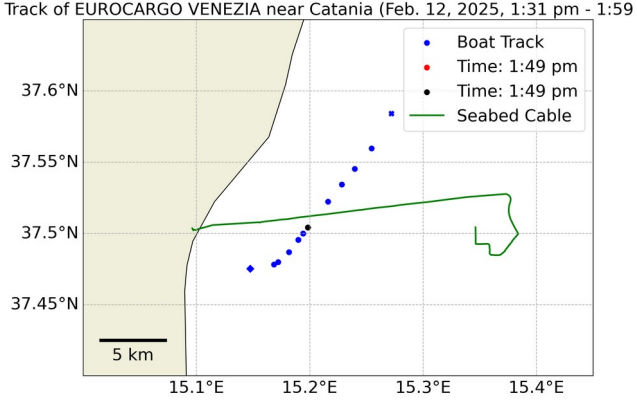


2D distance to cable at 2:42 am: 238.94 meters
3D distance to cable at 2:42 am: **1963.22 meters**
Closest cable position: Depth: -1934.49 m, Distance from shore: **30.83 km**

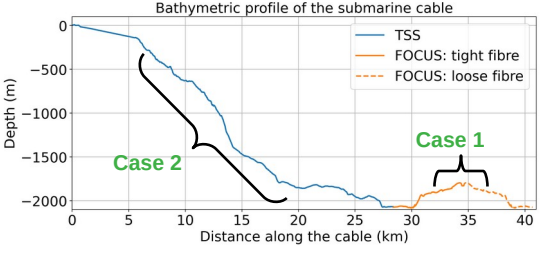
- **Maximum detection range in deep waters spans only ~ 3-4 km along the cable (case 1)**
- **Maximum detection range in shallow to intermediate depths spans ~ 15-20 km (case 2)**
- **Which effect is the one that contribute the most: the depth or the boat-cable distance?**

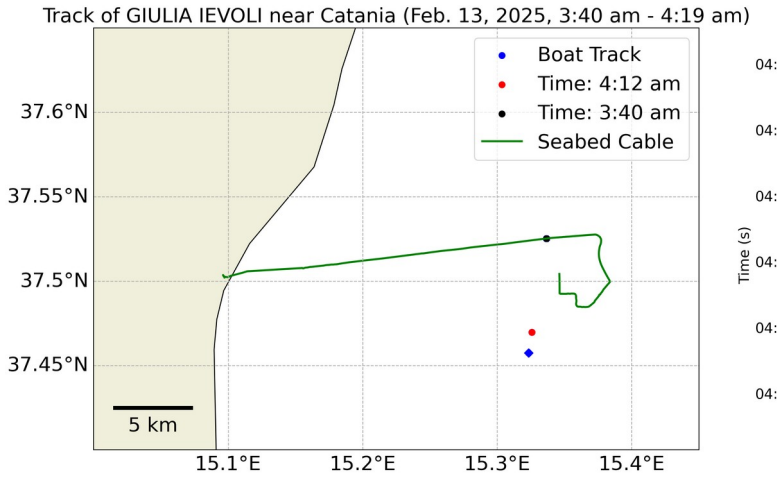


2D distance to cable at 7:04 pm: 1292.71 meters
3D distance to cable at 7:04 pm: **1415.26 meters**
Closest cable position: Depth: -569.39 m, Distance from shore: **9.19 km**



2D distance to cable at 1:49 pm: 858.46 meters
3D distance to cable at 1:49 pm: **1034.92 meters**
Closest cable position: Depth: -569.39 m, Distance from shore: **9.19 km**

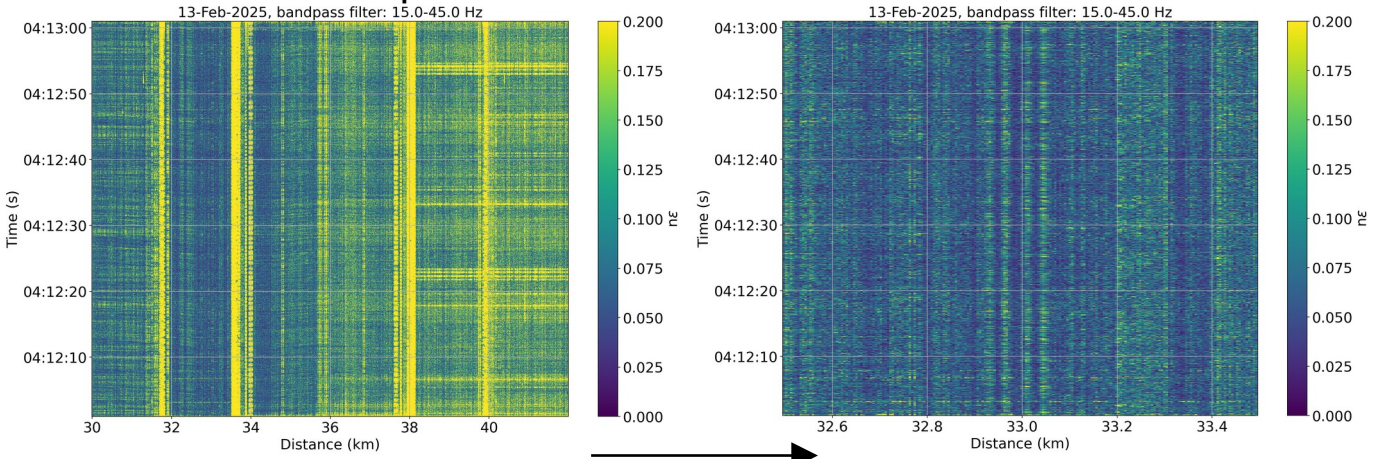




2D distance to cable at 4:12 am: 3141.50 meters
3D distance to cable at 4:12 am: **3653.57 meters**
Closest cable position: Depth: -1865.35 m, Distance from shore: **33.23 km**

Detection range limit?

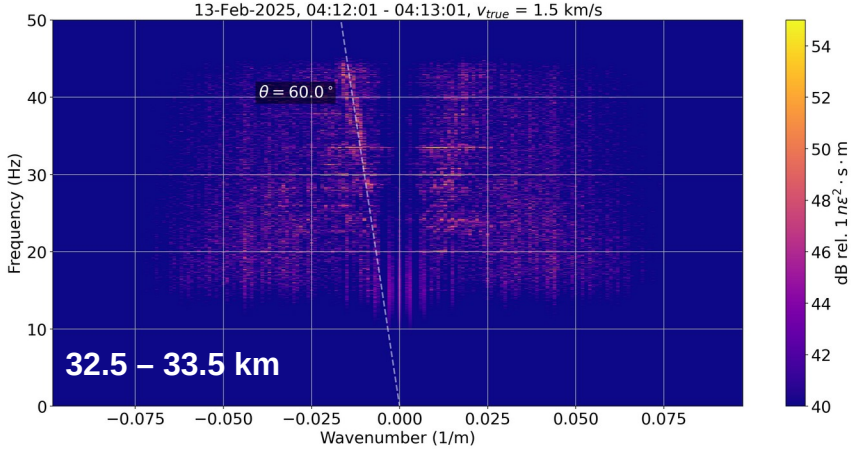
Time – distance plot



zoom

?

f – k (frequency – wavenumber) plots



de-noised