Directional acoustic sensing using the NoiseSpotter®

Kaus Raghukumar

Frank Spada

Grace Chang

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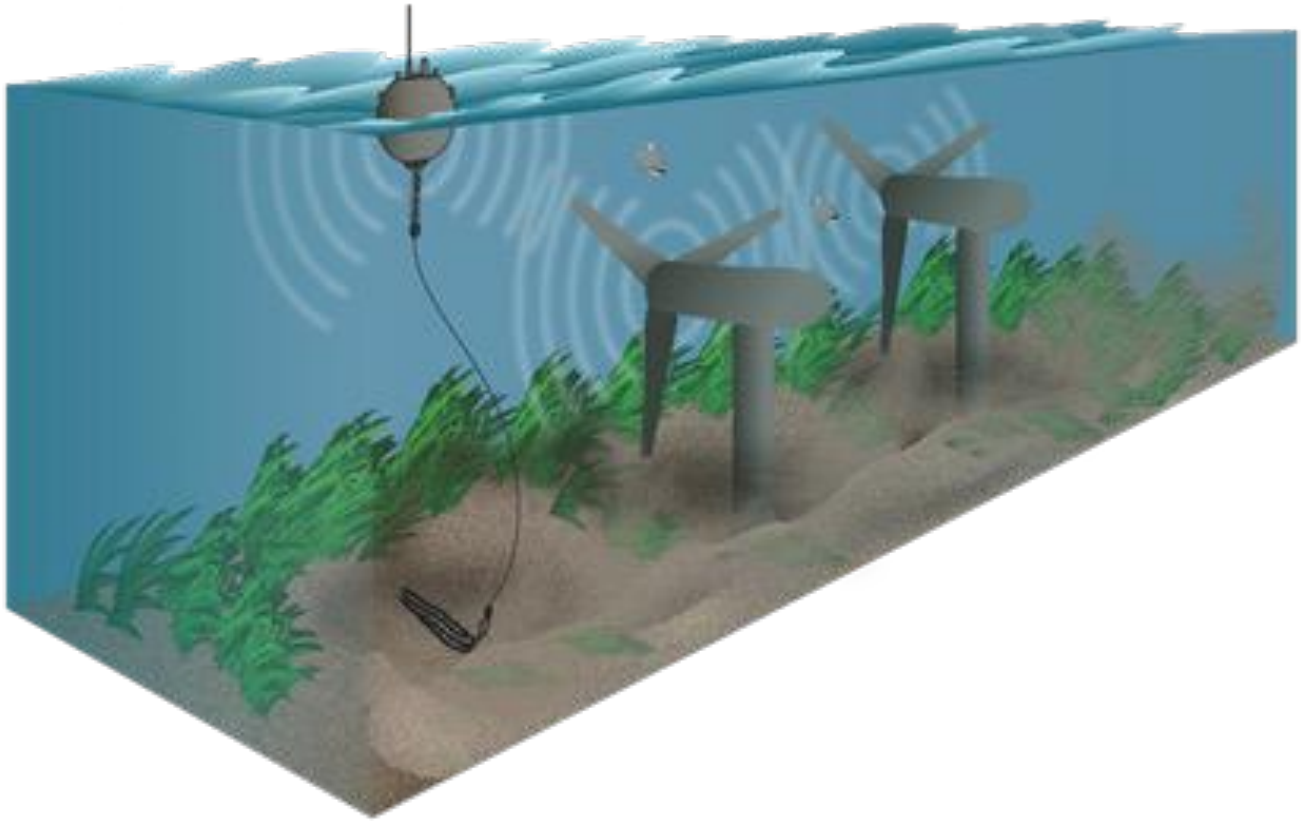
integral consulting inc.

Motivation

- Instrumentation that will facilitate acoustic data collection as a means to reduce risk and streamline environmental permitting
- Expected source intensity levels 106-109 dB re 1 µPa in 125-250 Hz range, 25 m from source (Tougaard et al. 2015)
- Source localization can help isolate device noise from other sounds
- Real-time characterization can help with mitigation efforts.



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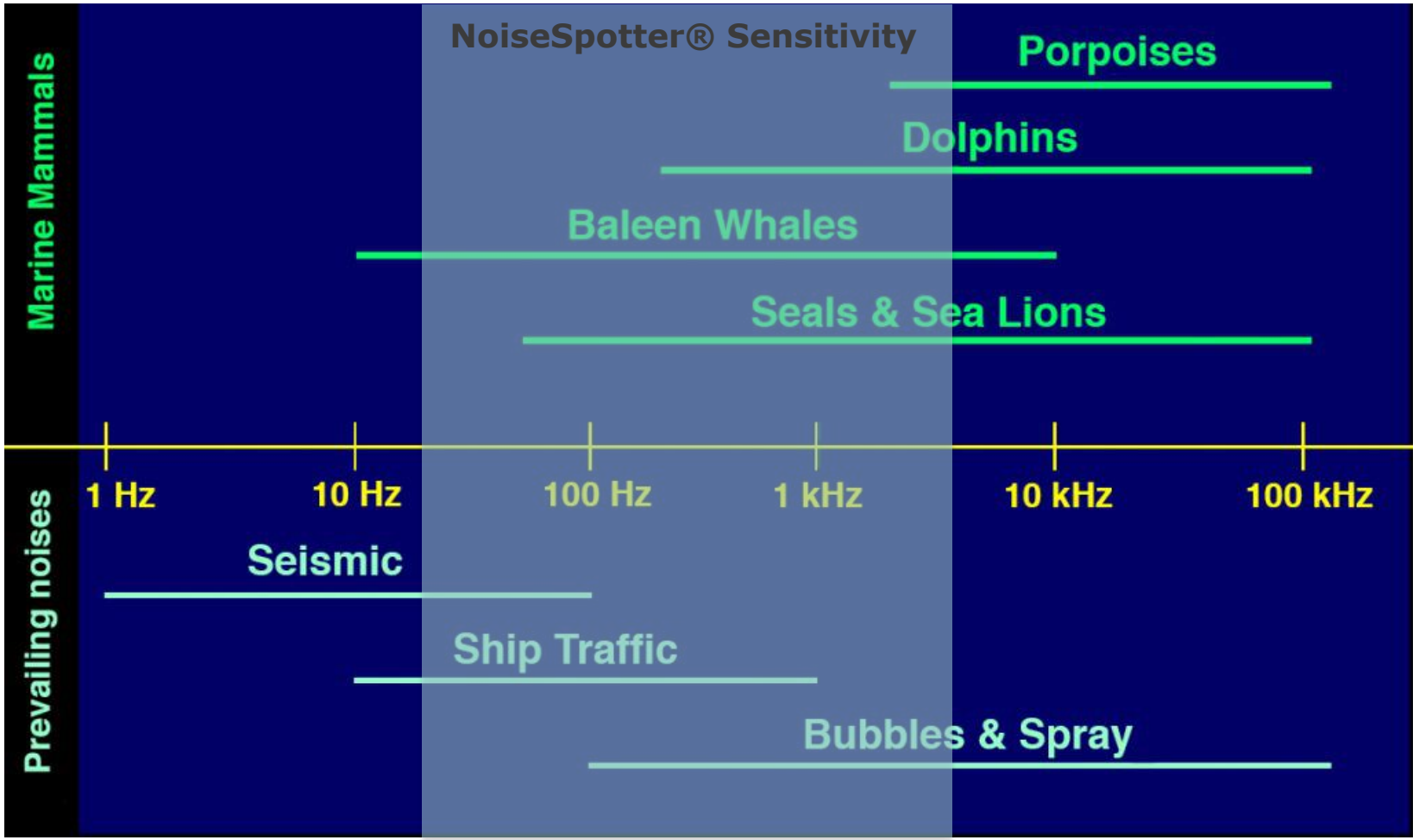
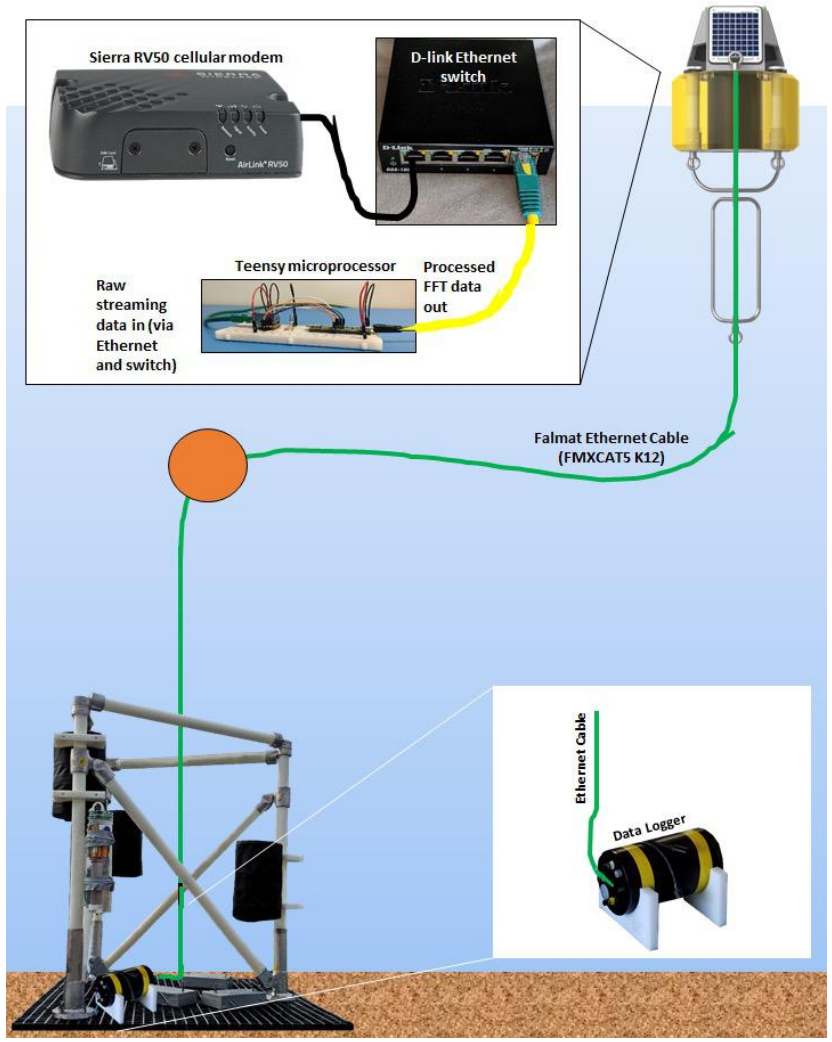
Sources of sound in the ocean

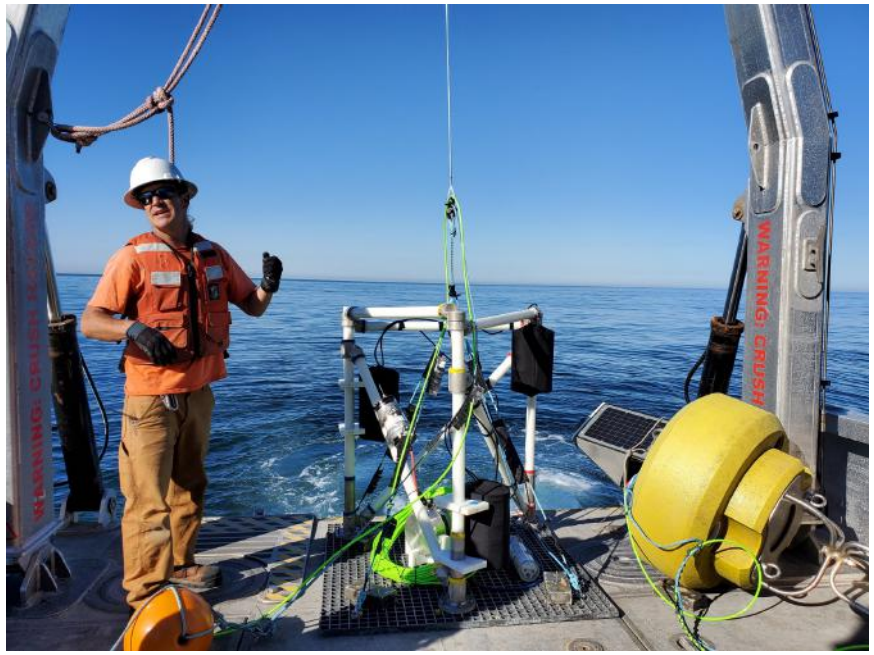


Adapted from www.dosits.org

Methods

- NoiseSpotter® passive acoustic monitoring system offshore of the CalWave xWave™ WEC
- Each sensor measures acoustic pressure and 3D particle motion, 50 Hz-3 kHz
- Water depth 18-25 m
- Sensor spacing:
  - Vertical: 35 cm, 50 cm, 70 cm above sea bed.
  - Horizontal: 1 m separation
- Sensors enclosed in flow noise-removal shields





November 2021 deployment

Date	Objective
November 13	Mobilization
November 14	NoiseSpotter® as drifting system, along with DAISY
November 15-16	Real-time NoiseSpotter®
November 17-18	Non-real time NoiseSpotter®, 100 m and 200 m from WEC along four cardinal directions
November 19-22	Multi-day non-real time NoiseSpotter®
November 22	Demobilization

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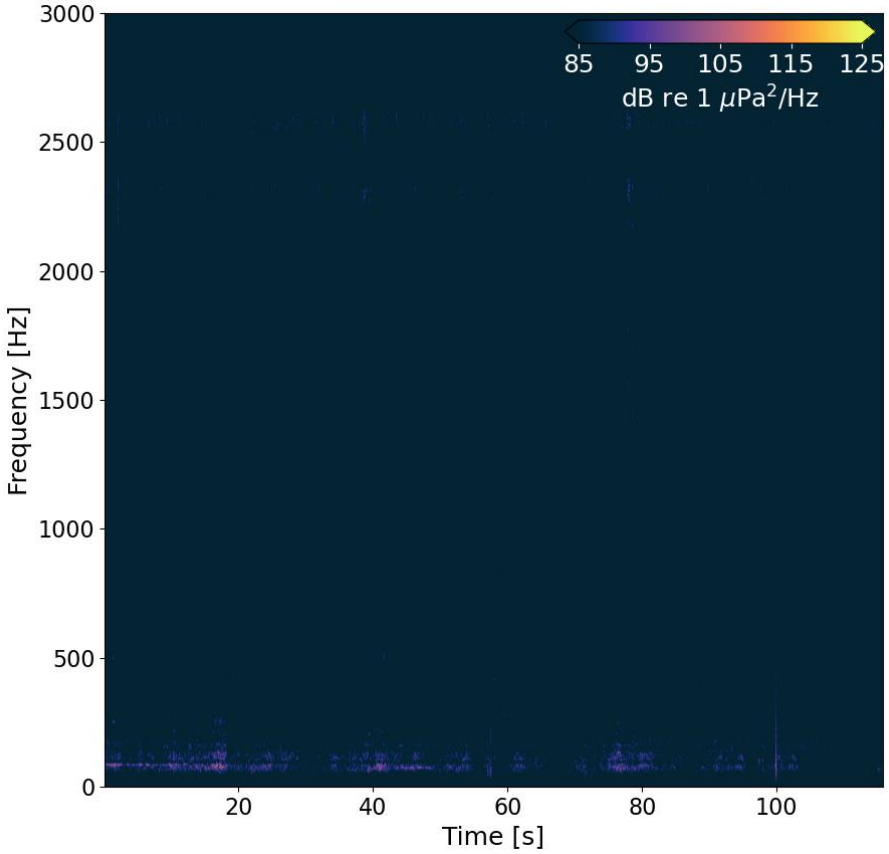
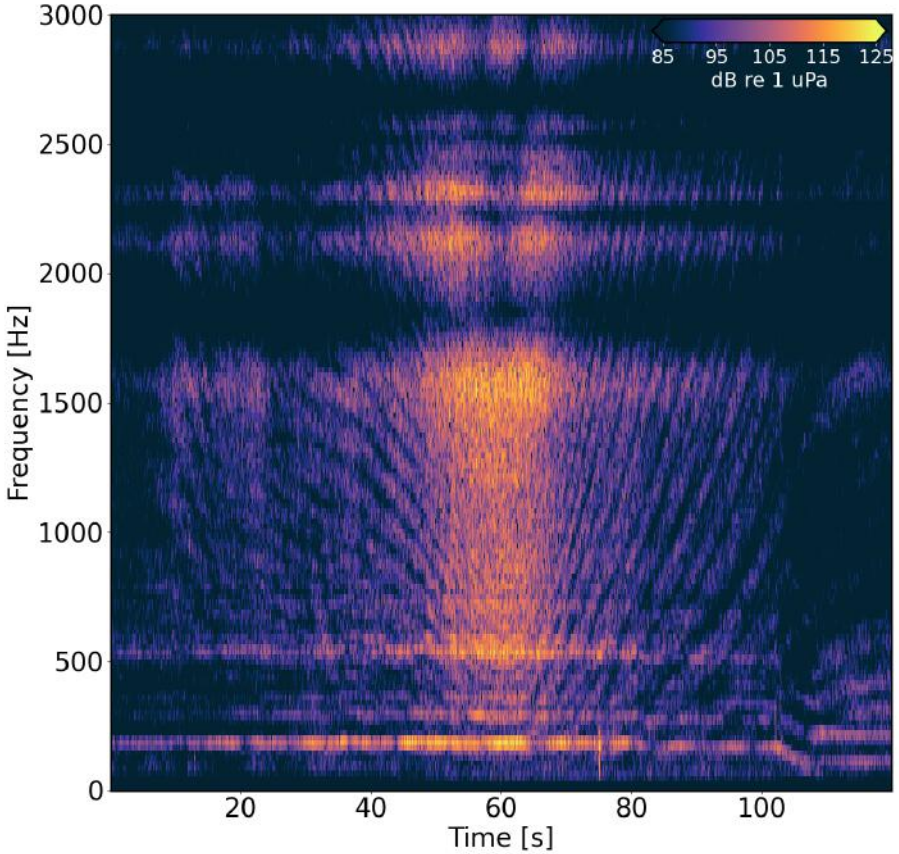
WEC versus boat sounds

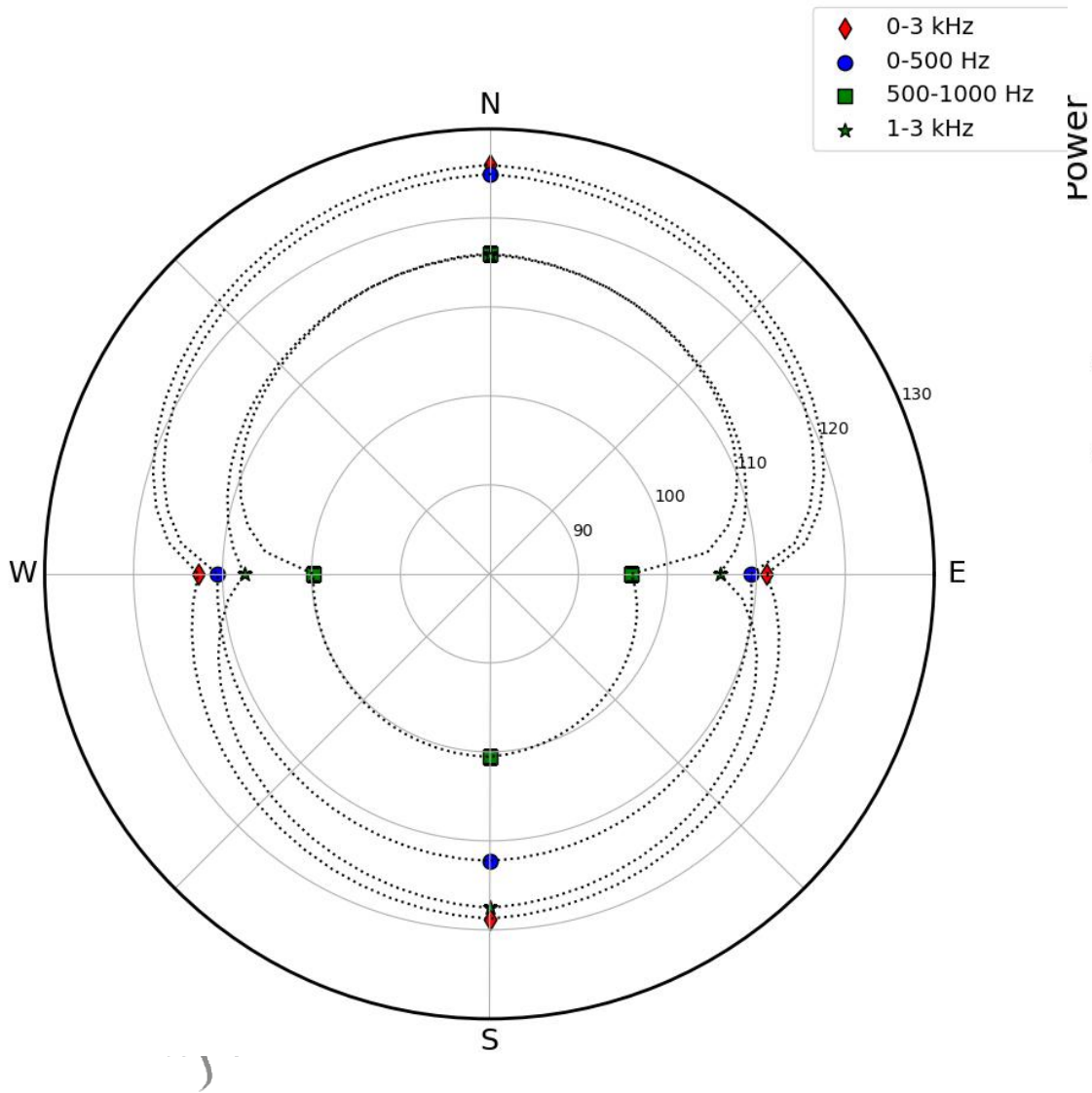
WEC

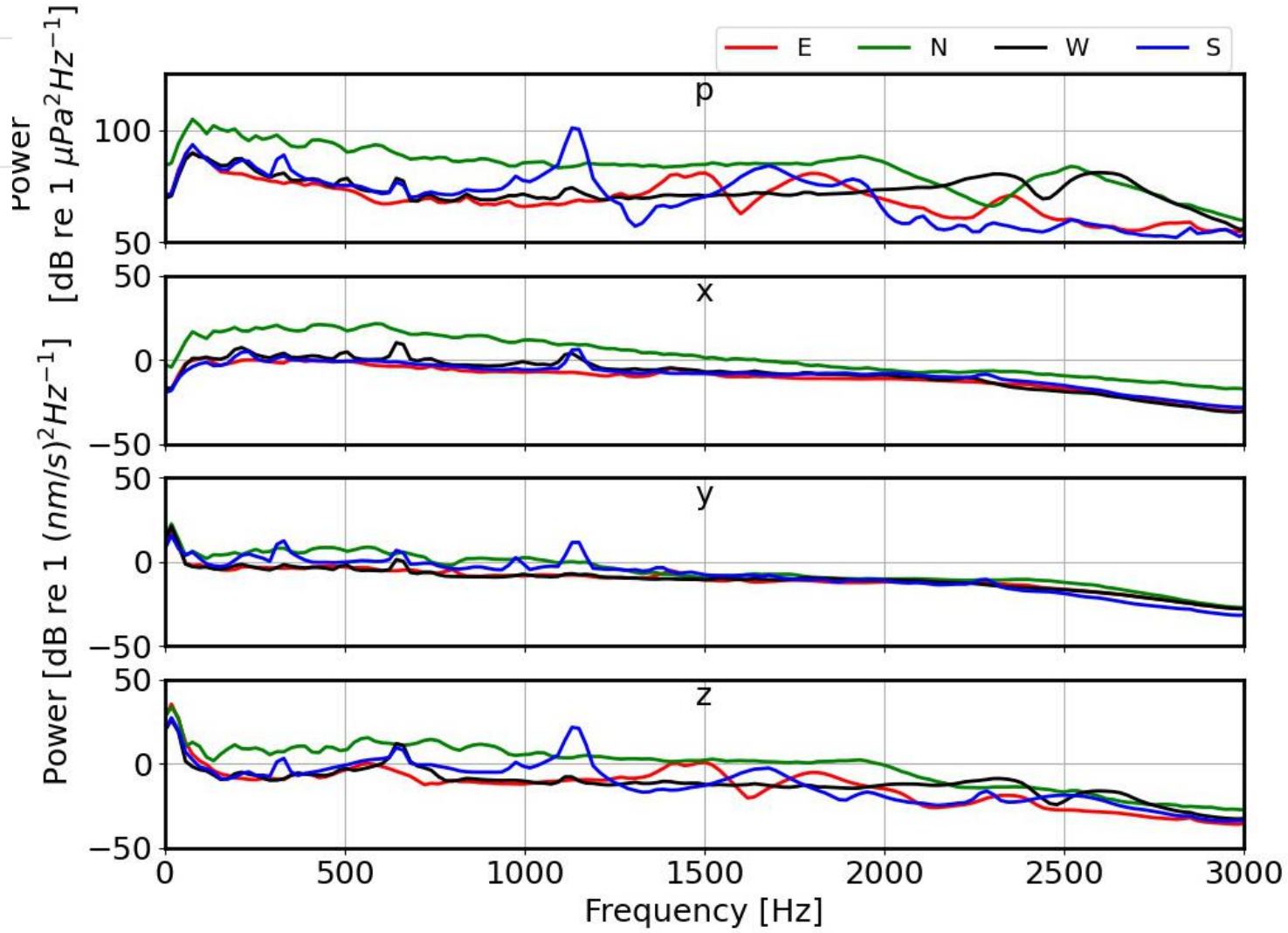


Boat

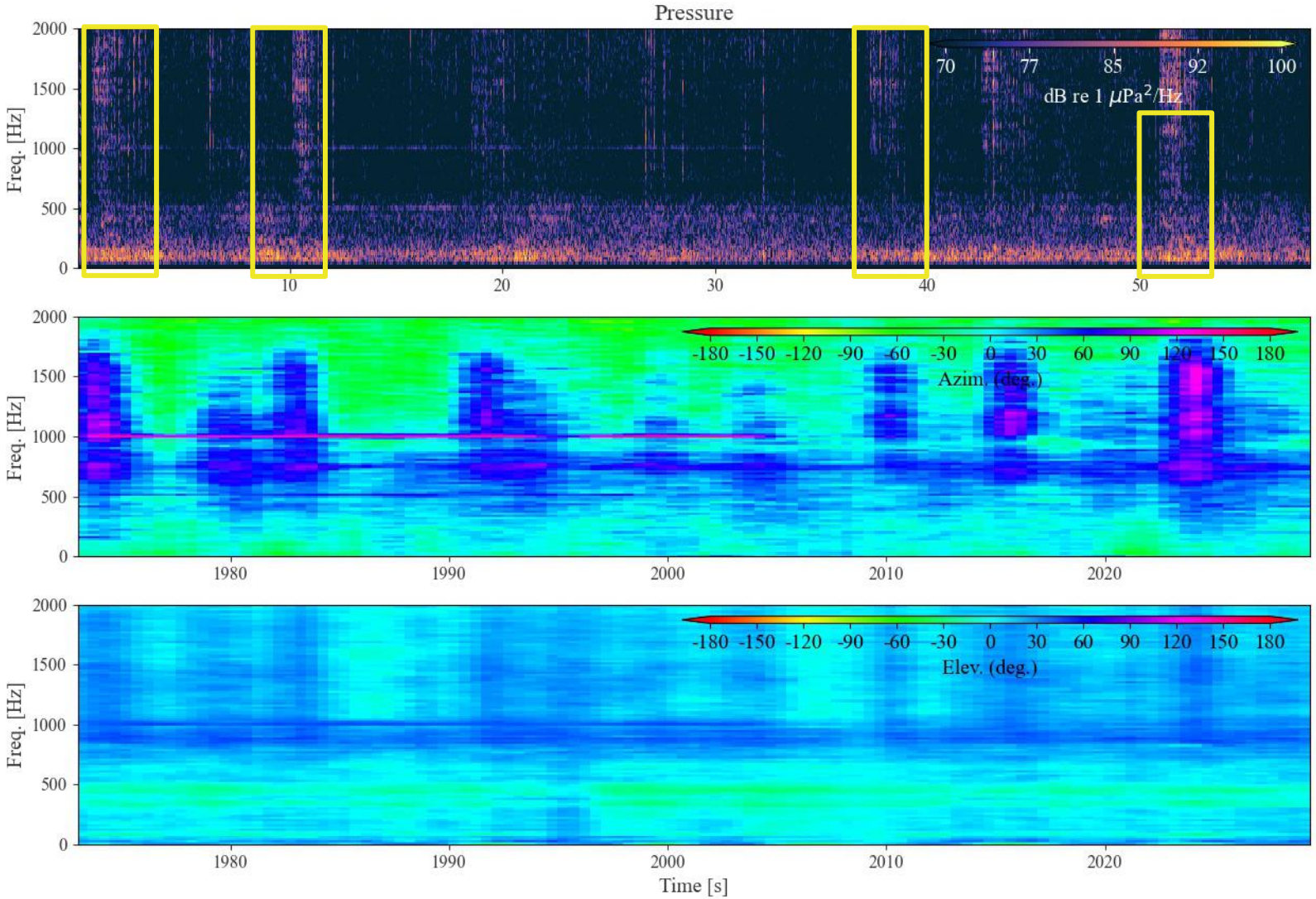


CalWave deployment: azimuthal anisotropy





CalWave WEC sounds



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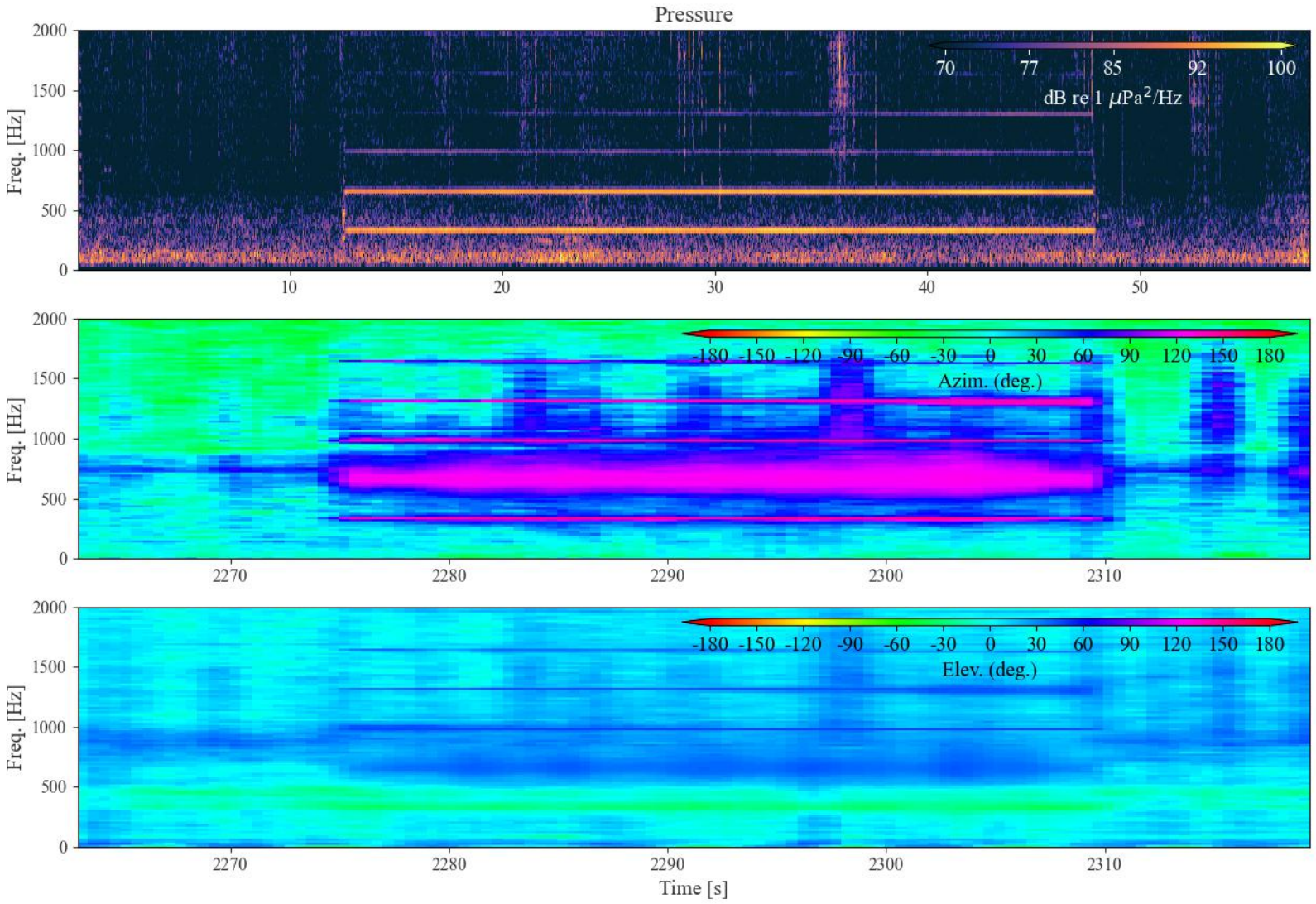
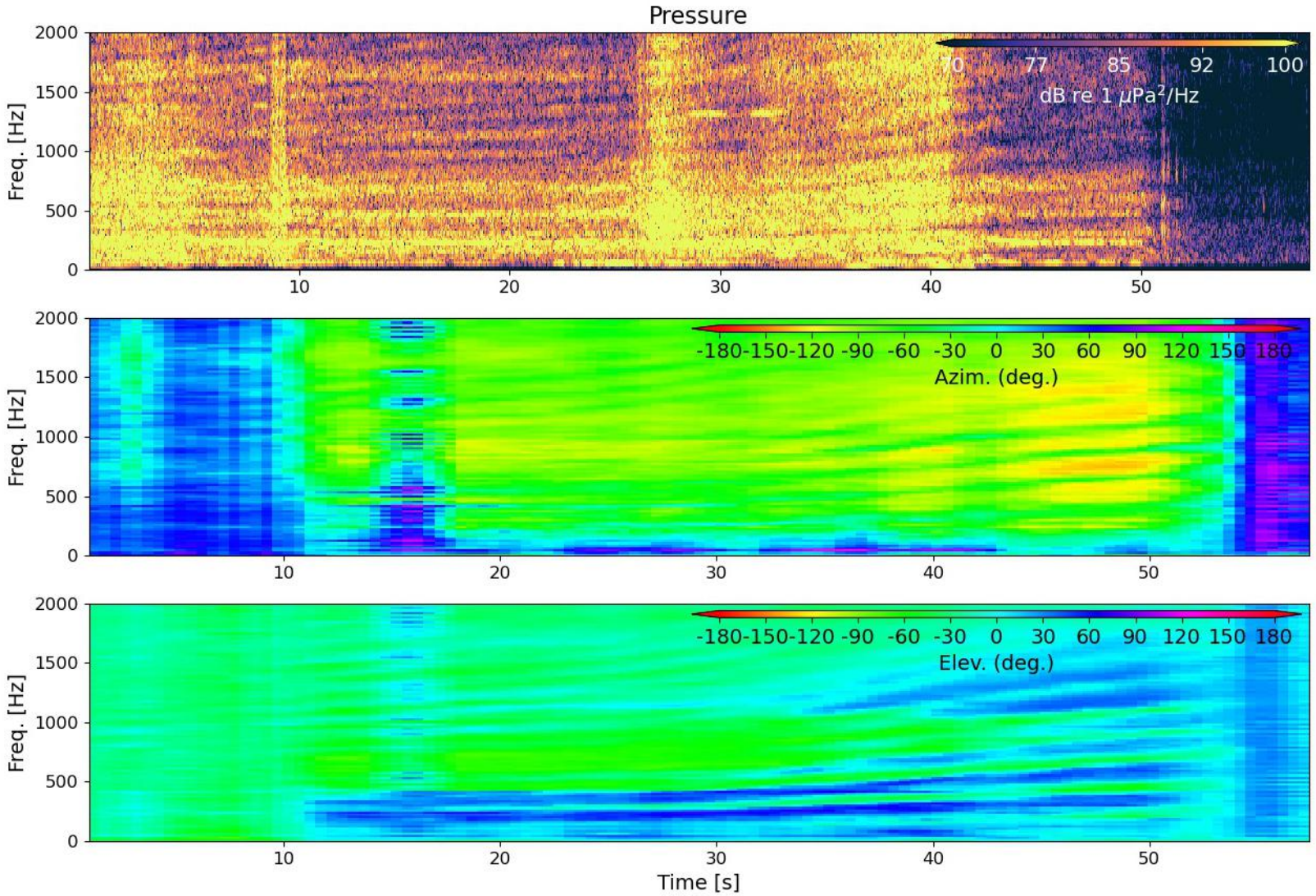
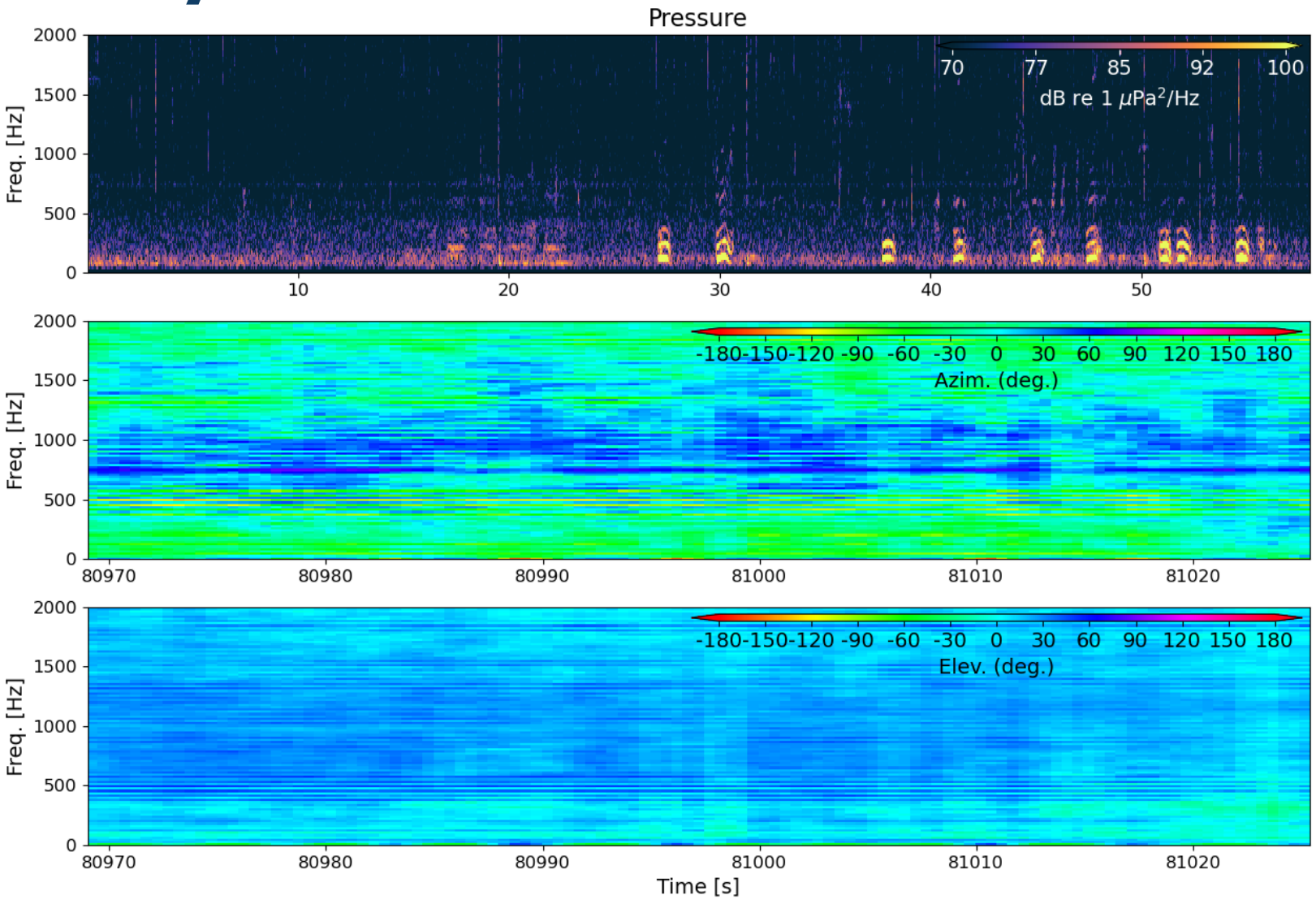
Helicopter sounds



Boat

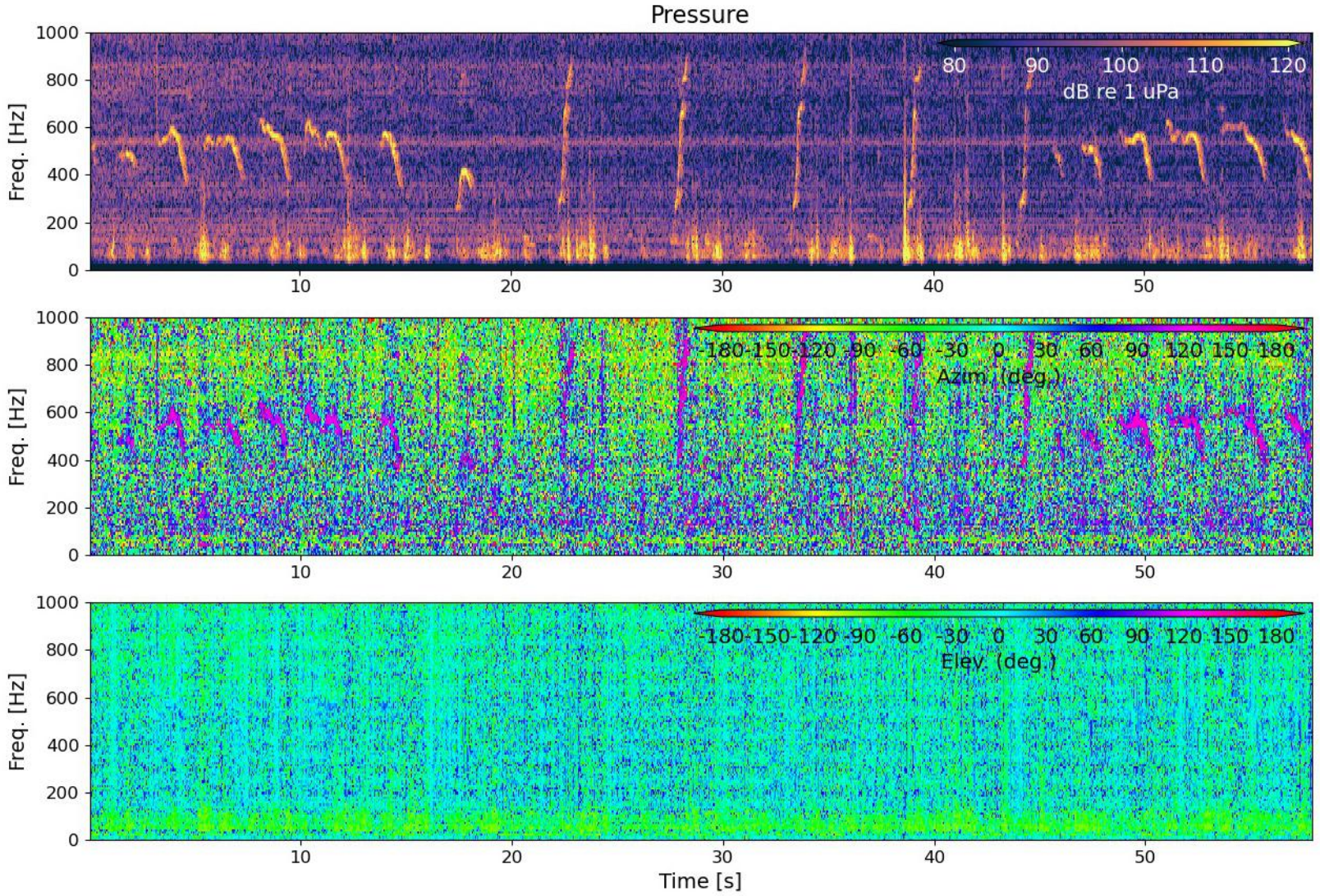

Pressure
Freq. [Hz]
2000
1500
1000
500
0
70
77
85
92
100
dB re 1 µPa²/Hz
10
20
30
40
50
-180-150-120 -90 -60 -30 0 30 60 90 120 150 180
Azim. (deg.)
Elev. (deg.)
Time [s]

Gray whale?

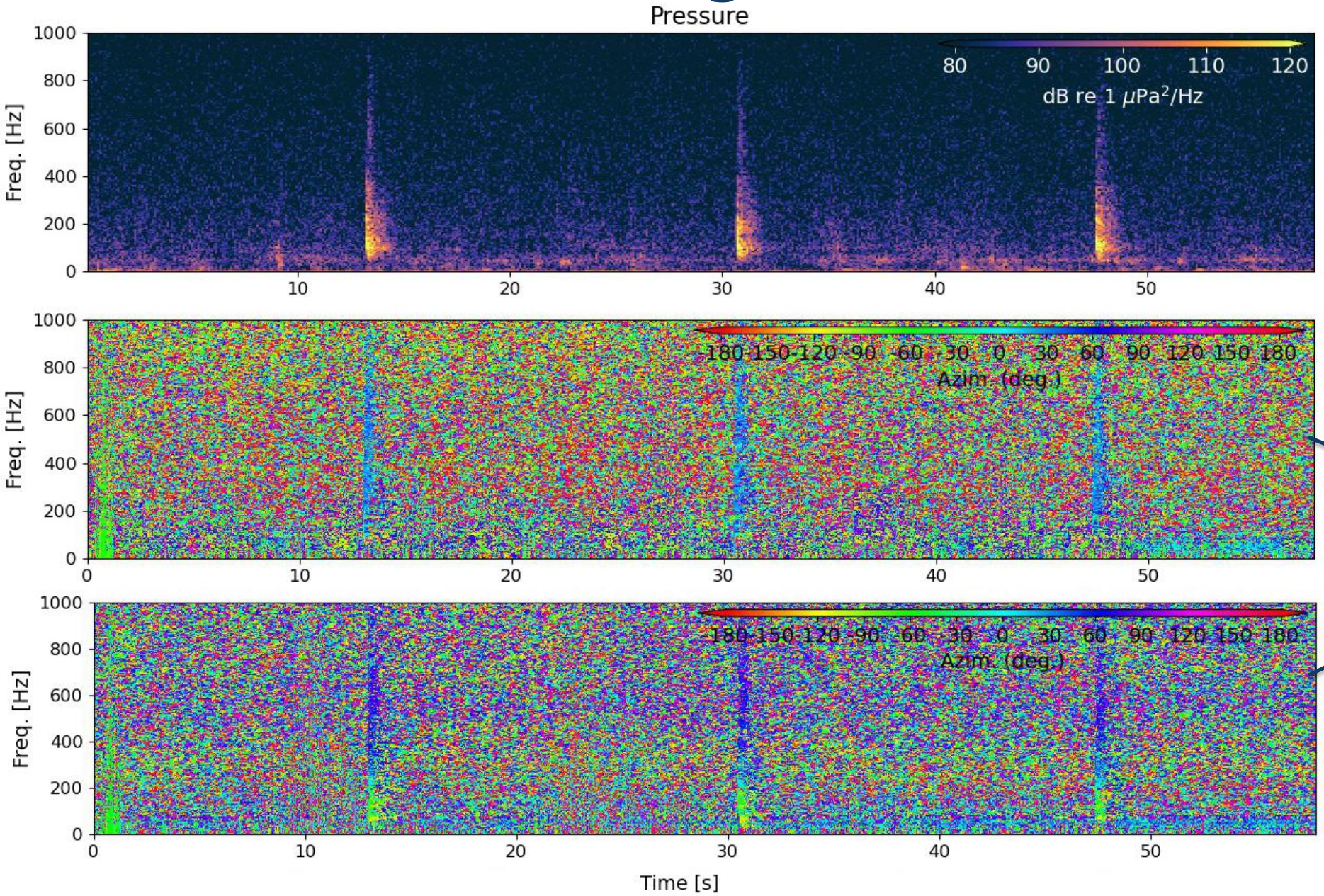


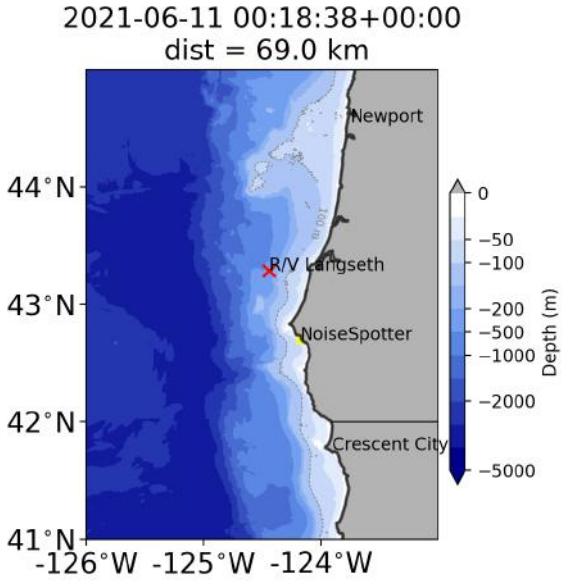
Source	$L_{E,60\ s}$ (dB re 1 µPa² s)
WEC	139 dB re 1 µPA
Boat	147
Helicopter	140
Gray Whale	138 dB

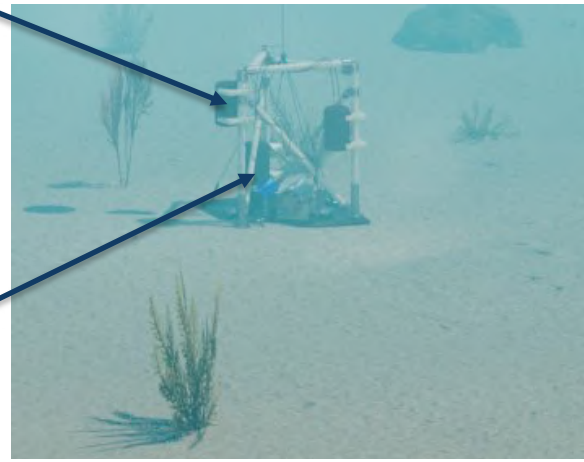
Humpback Whale



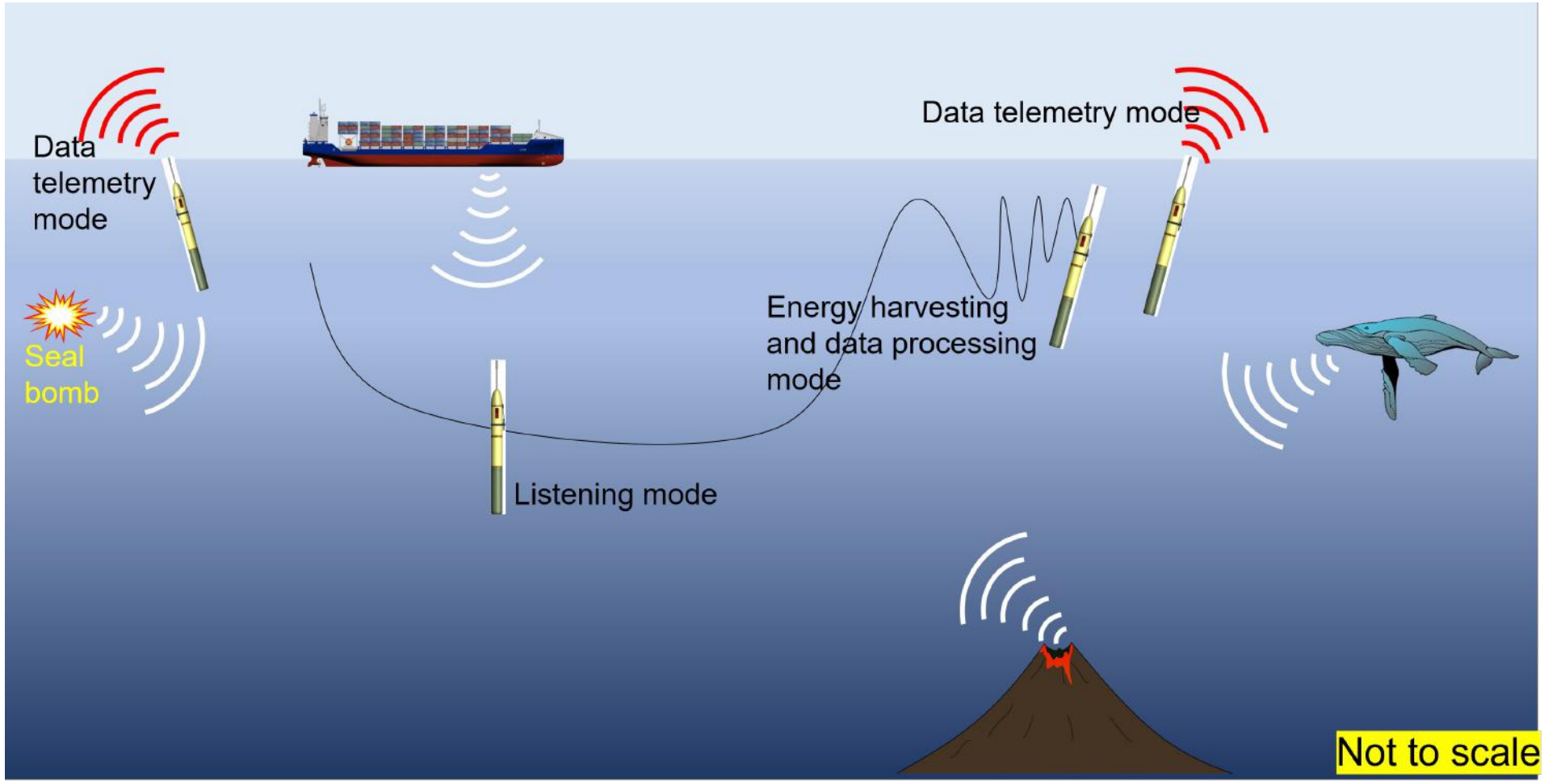
Directional Processing







Ongoing NOAA OER project



Conclusions

- WEC sounds at considerably lower levels than ambient sounds such as boats
- Directional processing helps isolate WEC sounds from background
- Some directional anisotropy, likely due to bathymetric variability around WEC

Acknowledgements

- Garrett Staines, Joe Haxel (PNNL)
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