The Underwater Noise Emission of Floating Hywind Tampen Wind Turbines : WindSYS project

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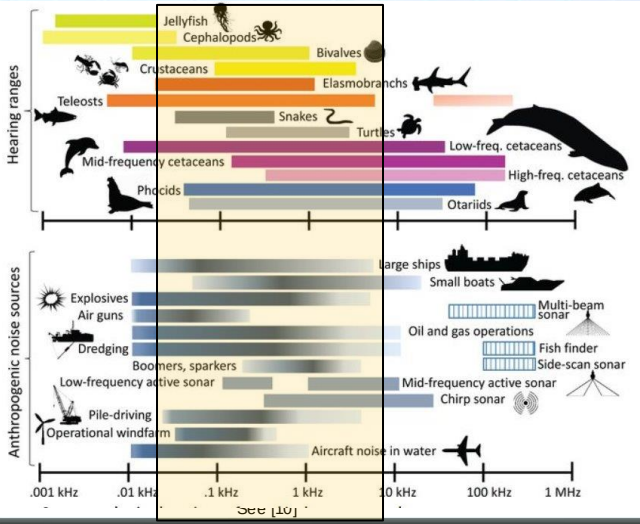
Motivation

Offshore wind turbines generate noise primarily in the low to mid-frequency range (10 Hz – several kHz), which overlaps with the auditory perception of many marine species.

the interconnection between **solid mechanics, fluid mechanics, and their environmental impacts**

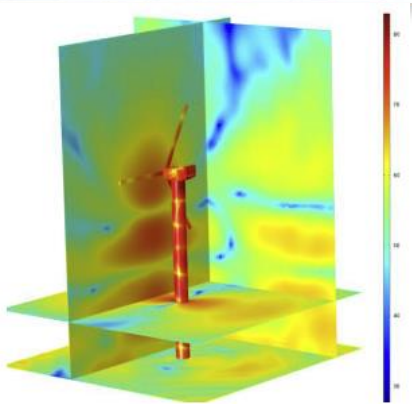
Urgent needs in **the noise mitigation** during turbine construction and operation,



https://c3polab.org/sounds-in-the-sea/

Outline

- how the turbine-induced noises during operation propagate in the ocean: **structure-noise modelling**.
- Introducing the WindSYS project: **noise measurements**.
- Noise measurements results in the close vicinity of **Hywind Tampen** wind park



The primary objective is to estimate the noise source levels at the turbine's towers in the water at different depths.

https://www.comsol.it/story/wind-turbine-noise-reduction-14479

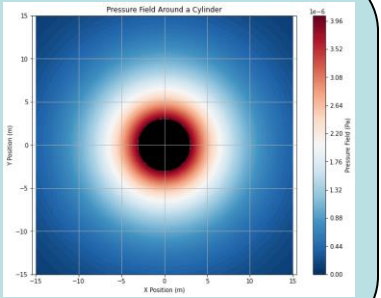
Noise generation through vibration

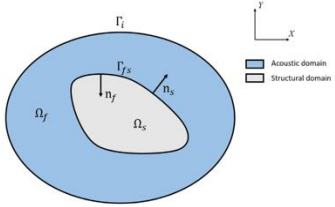
$$\nabla^2 p(x) + k^2 p(x) = 0,$$

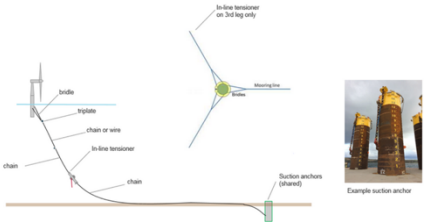
$$p(x) = \int_S \left(G(x,y) \frac{\partial p(y)}{\partial n} - \frac{\partial G(x,y)}{\partial n_y} p(y) \right) dS(y),$$

$$F(\mu) = \int_S \left[\rho_0 \omega^2 \mu(x) \mu(y) - \frac{\partial \mu(x)}{\partial n} \frac{\partial G(x,y)}{\partial n_y} \right] dS(x) dS(y$$

$$\mu(y) = p_1 - p_2$$

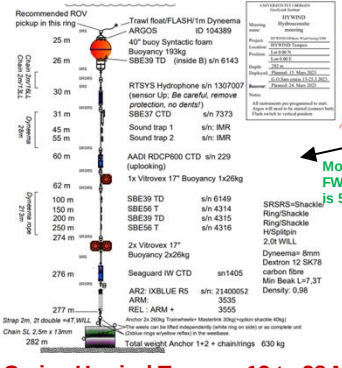


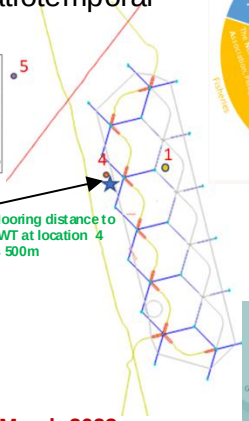




WindSys: Effects of OWF on the marine ecosystem with a focus on pelagic fish

Objectives: To understand the impact of FOWFs on marine life and a co-existing industry, and to measure the spatiotemporal patterns of underwater noise





Water depth: 300m

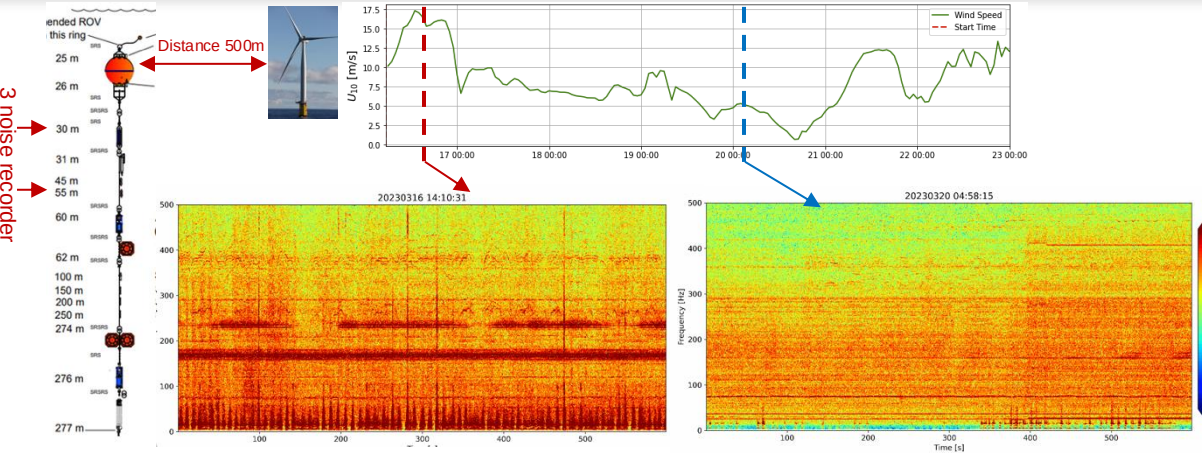
11 floating turbines

All 8MW turbines

Cruise Hywind Tampen 13 to 28 March 2023

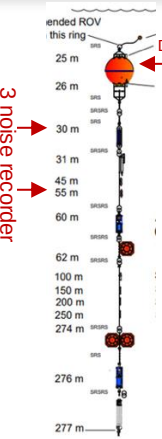
https://www.hi.no/hi/nettrapporter/toktrapport-en-2023-10

Underwater noise measurements



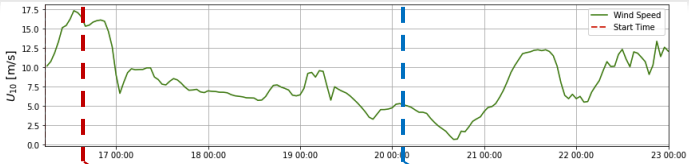
I use recorder at 45m

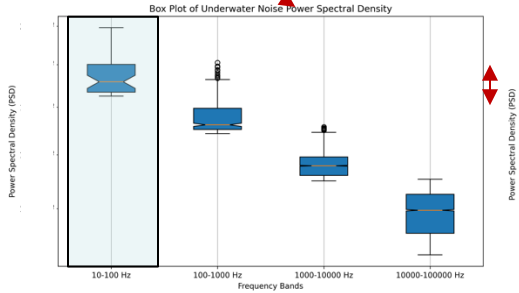
Underwater noise measurements



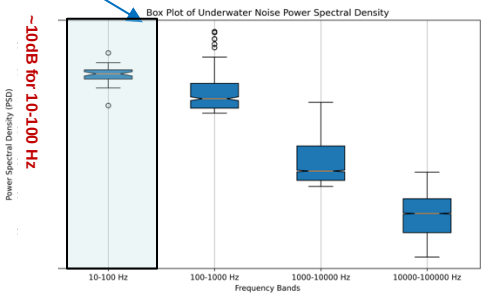
Distance 500m

3 noise recorder



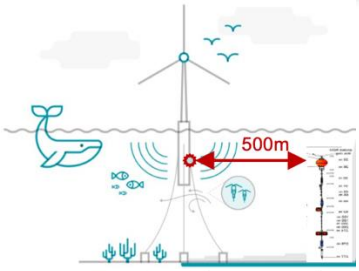


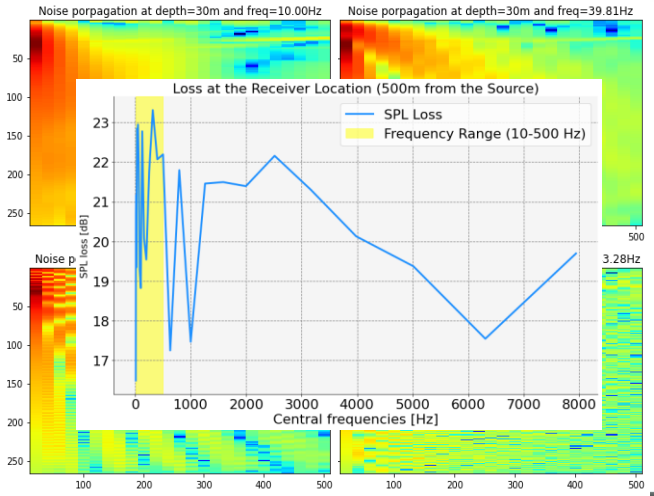
~10dB for 10-100 Hz



I use recorder at 45m

Turbine Source Level





Loss at time: 2023-03-16T12:00:00

Summary

- **Noise Generation**: The noise originates from the rotating rotor and moving components in the drivetrain. This sound propagates through the air and is transmitted via the tower to the ocean.
- **Wind Speed Impact**: As wind speed increases, the sound pressure level increases by more than 10 dB.
- **Floating Turbines**: Floating turbines produce significant tonal sounds during operation, which attenuate between 19 dB and 23 dB at a distance of 500 meters.
- **Effects on Marine Species**: The overlapping frequencies within the hearing ranges of marine species do not cause physical damage to their organs; however, they may lead to behavioral changes.

References

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