*EERA DeepWind conference, Trondheim 15-17 January 2025*

# Acoustic and dynamic pressure comparison

## Investigating the interaction of structural vibration and noise in an offshore wind turbine using OpenFOAM

**Kaan Akkaş[1], Mostafa Bakhoday-Paskyabi[1]**
[1]Geophysical Institute, University of Bergen and Bergen Offshore Wind Centre
Contact:kaan.akkas@uib.no

EERA DeepWind CONFERENCE 2025

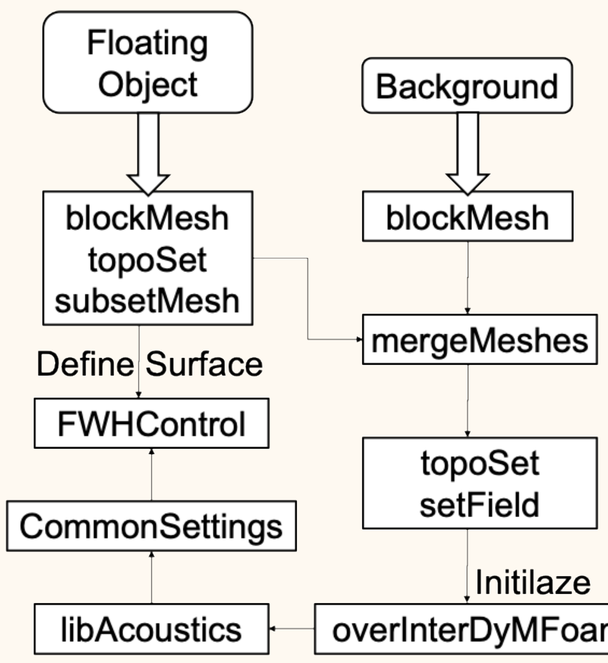
## INTRODUCTION

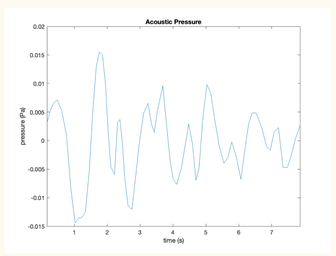
- Noise generation from a floating object is investigated using the open source CFD software OpenFOAM.
- Aerodynamic characteristics are obtained to analyze vibration-induced underwater noise.
- Noise generation is numerically solved using OpenFOAM's 6DOF motion solver *overInterDyMFoam* and acoustic library, which yields pressure fluctuations that link structural vibrations and underwater noise.

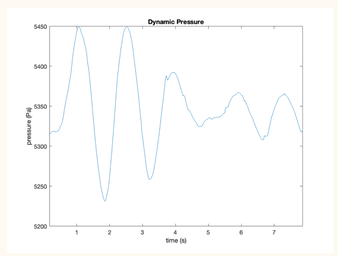


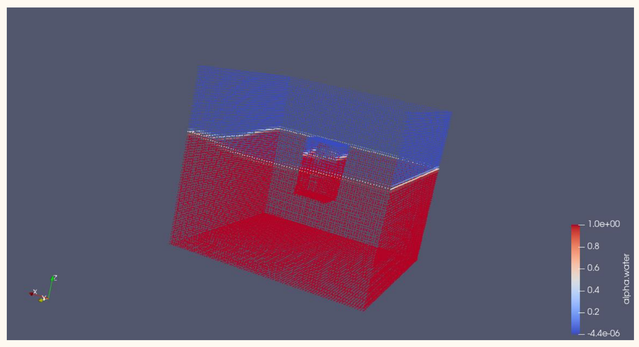







## OBJECTIVES

Reveal the connection between structural vibrations and underwater noise emissions in FOWTs, with a focus on vibrational modes.

### Identifying Vibrational Modes

Characterize the primary vibrational modes of the FOWT, including bending (Pitch, Roll, Yaw), lateral deflection (Surge, Sway, Heave), and combination modes, and identify those contributing significantly to underwater noise, particularly under resonance conditions. Specifically, analyze vibration characteristics of the tower's substructure underwater, including displacement and particle velocity at the structure-water boundary, to estimate the source level.

### Developing a Noise-Vibration Model

Formulate a mathematical model linking vibrational modes to acoustic source levels, incorporating acoustic analogy to understand the relationship between substructure vibration characteristics, and underwater noise.

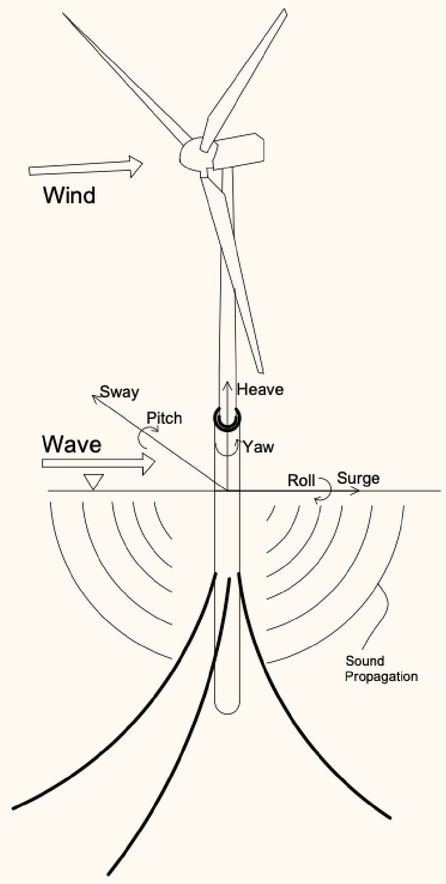
### Modeling Underwater Sound Propagation

Utilize the developed theoretical and modeling tools to analyze the coupling between tower vibrations,
including its mooring system, and sound generation and emission.

Simulate the structure-acoustic interaction to understand the relationship between the vibrating structure, including
its mooring system, and underwater noise generation and propagation under varying atmospheric,
oceanic, and sea-state conditions.

## POTENTIAL OUTCOMES

Support the development of floating offshore wind turbines (FOWTs) with reduced underwater noise impacts, promoting sustainable energy production in harmony with marine ecosystems.




## FUTURE WORK

- Model cylinder floating object in OpenFoam to represent the substructure of a spar-buoy floating wind turbine.
- Add tower, nacella, hub and blades to the cylinder floating object.
- Implement mooring lines and investigate the role of fairlead and anchor in noise generation.
- Extend the simulation time for better frequency analyses.

**ACKNOWLEDGEMENTS**
This work is a part of WindSYS project funded by Norwegian Research Council (NFR)

UNIVERSITY OF BERGEN

Bergen Offshore Wind Centre