

Towards More Accurate Sound Source Verification for Offshore Wind

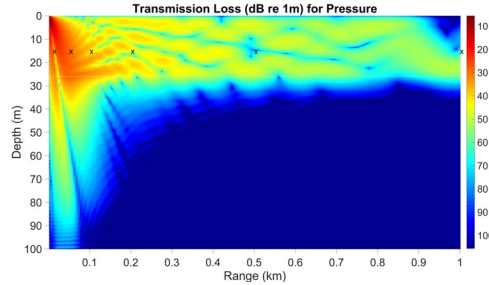
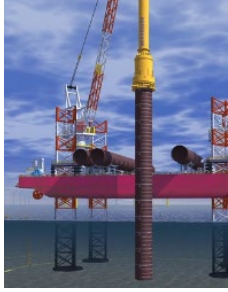
Kaus Raghukumar

November 18, 2024

NetZero Atlantic Offshore Wind R&D Forum



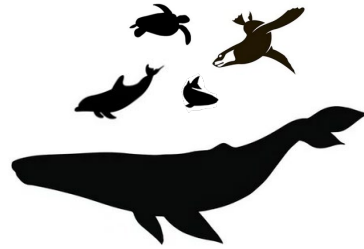
OSW Underwater Acoustic Impact Assessment - 101



Source of sound

Sound moves
through water

Numerical model



Marine life that
rely on sound

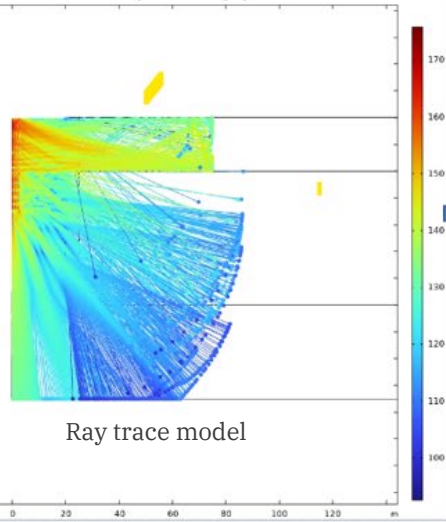
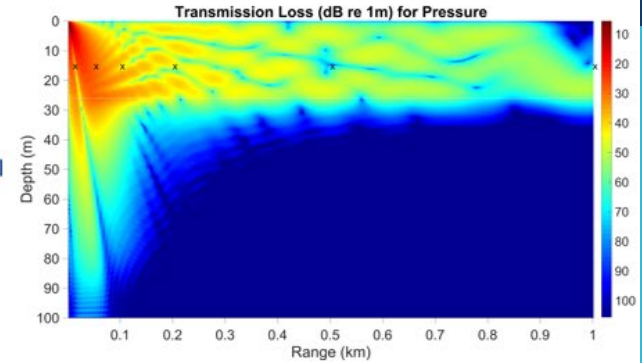
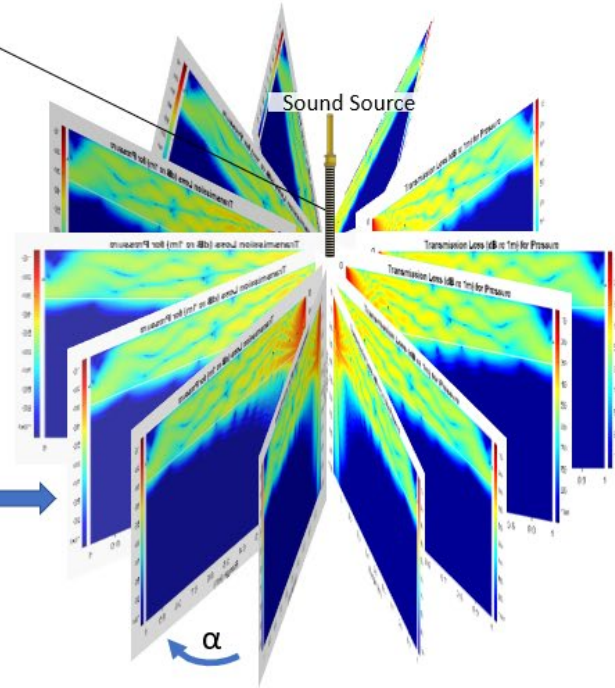


A portion of individuals may
encounter sound believed to
cause hearing injury and
changes in behavior



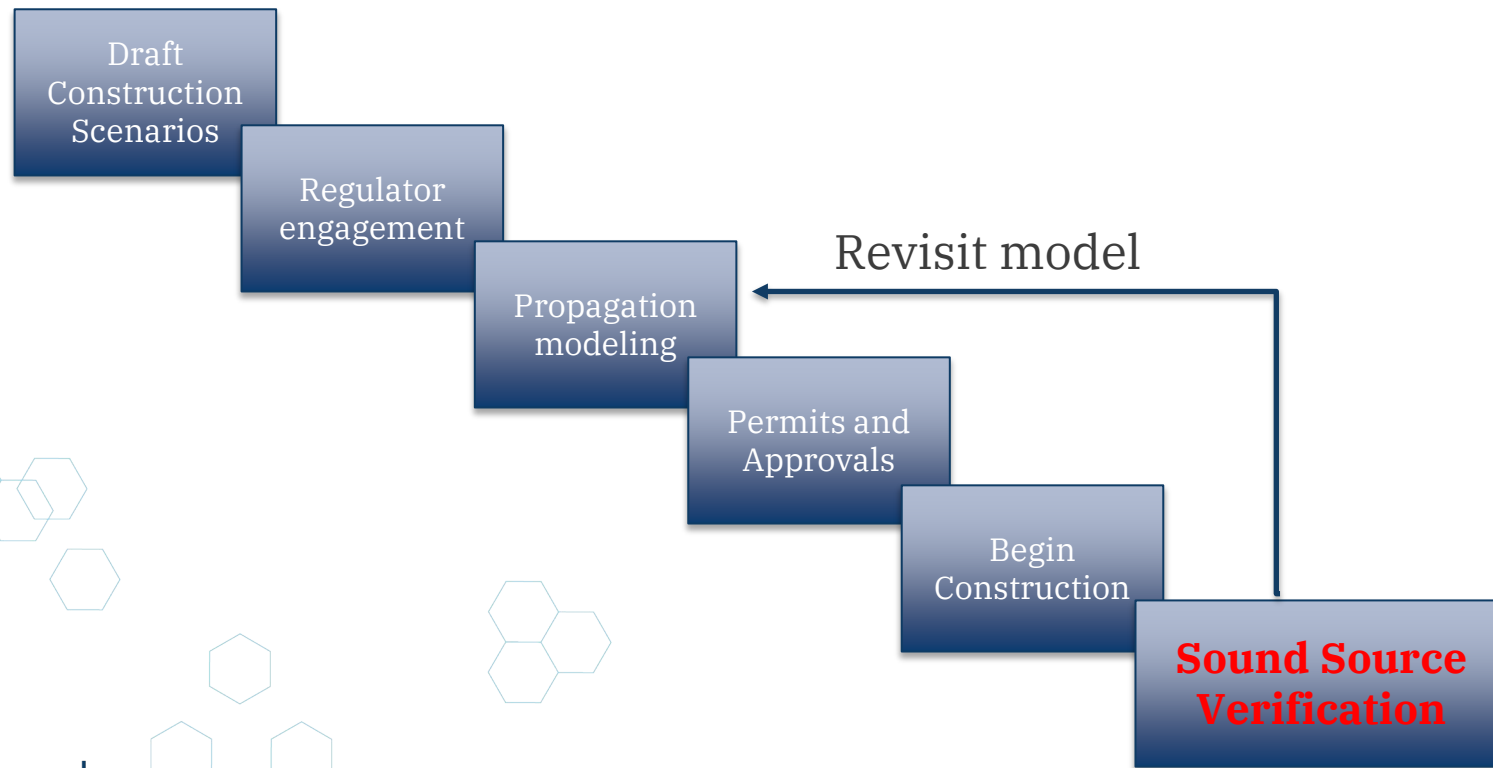
Sound Source

Conceptual Model of Sound Propagation from Pile Driving

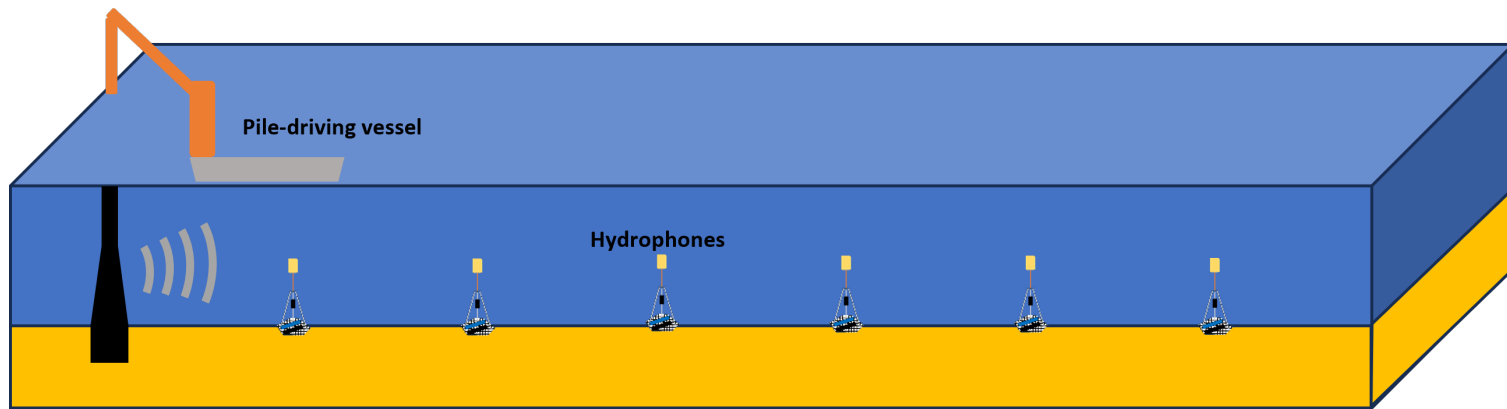


Ray trace model

Underwater Acoustic Assessment Activity Work Flow



Sound Source Verification



- › Conducted during pile installation
- › Hydrophones to measure acoustic pressure levels
- › Hydrophones deployed at multiple distances from pile
- › Measured acoustic pressure 'back propagated' to source location
- › Prior modeling can be corrected based on new measurements

But...

Sources of Sounds are Numerous and Varied

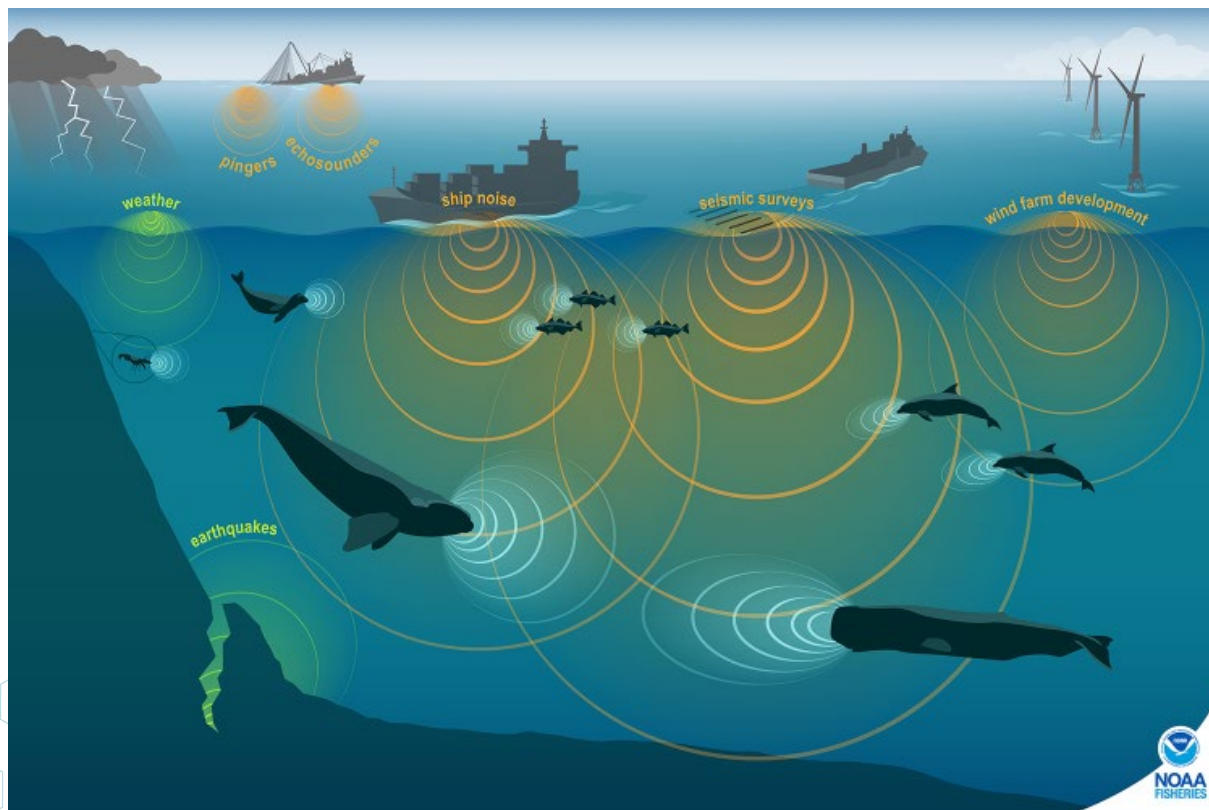
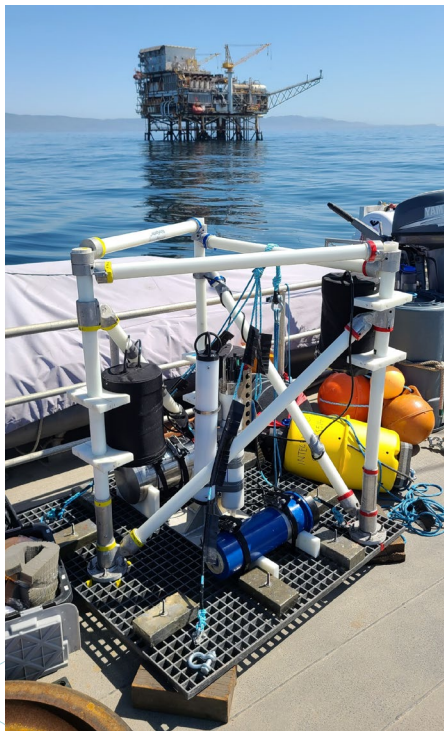


Illustration from NOAA Fisheries showing different sound sources in the sea.

Solution: Directional Acoustic Sensors



NoiseSpotter®, Integral Consulting Inc.



Credit: John Joseph, Naval Postgraduate School

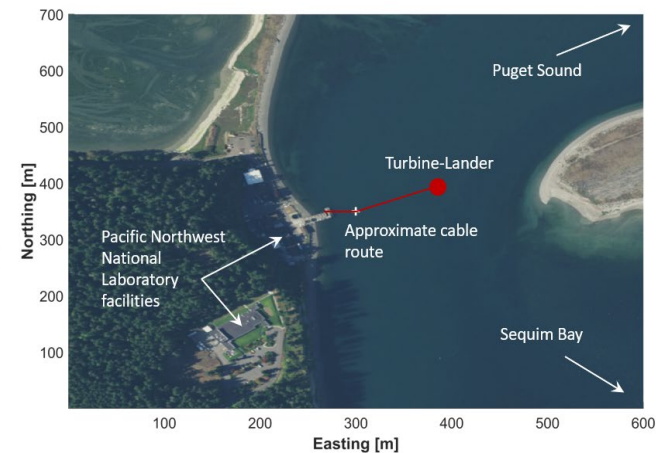
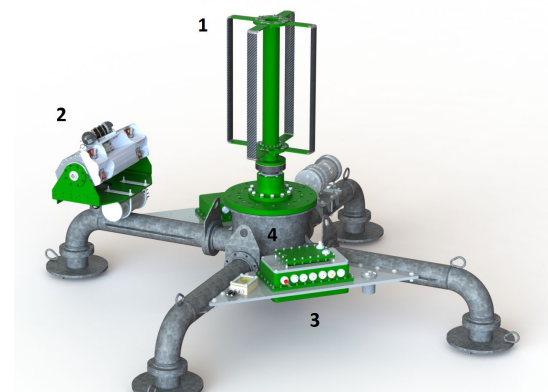


Credit: BioWaves Inc.

Case Studies



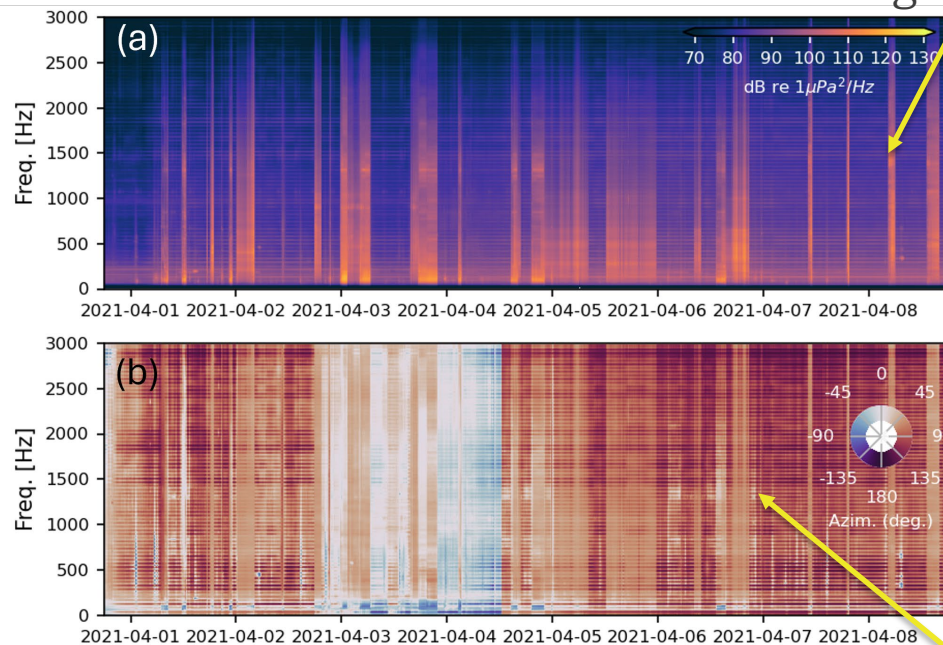
Oil Platform Decommissioning



Tidal Energy Turbine

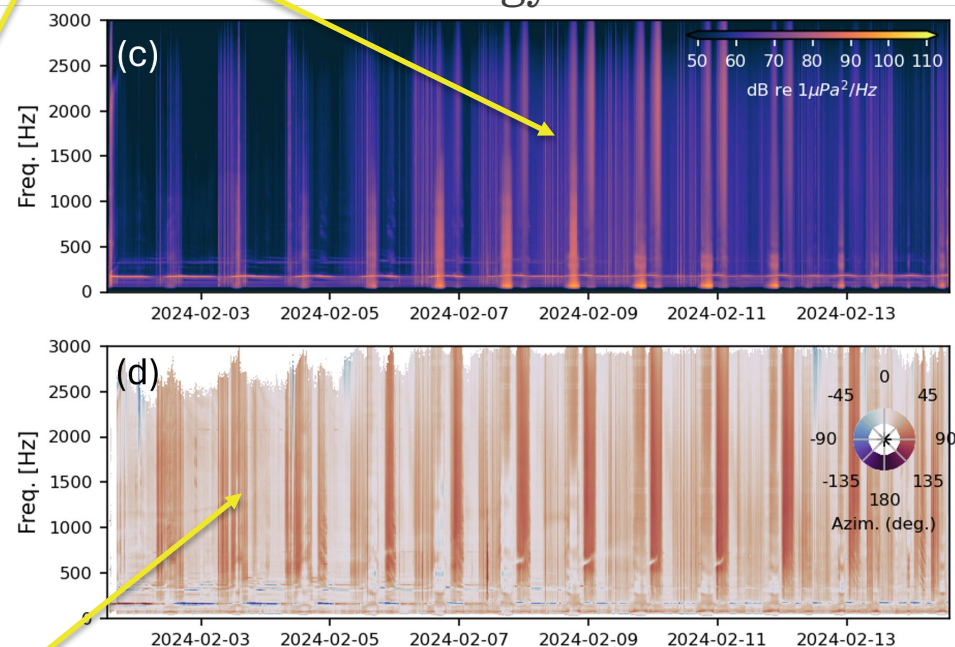
Example Data

Oil Platform Decommissioning

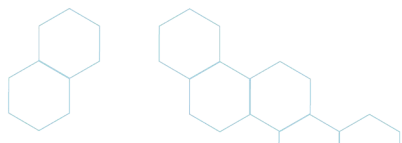


Hydrophone-only measurement

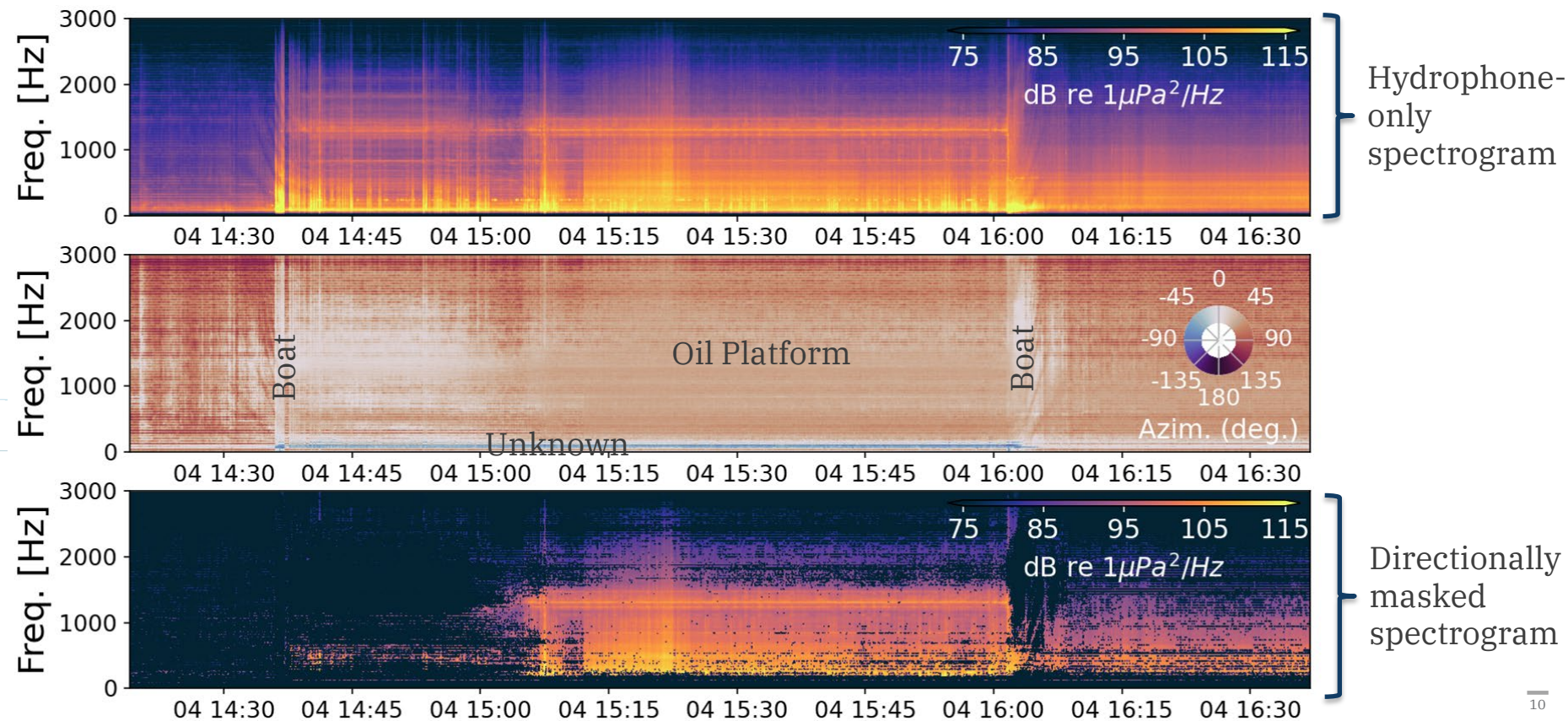
Tidal Energy Turbine



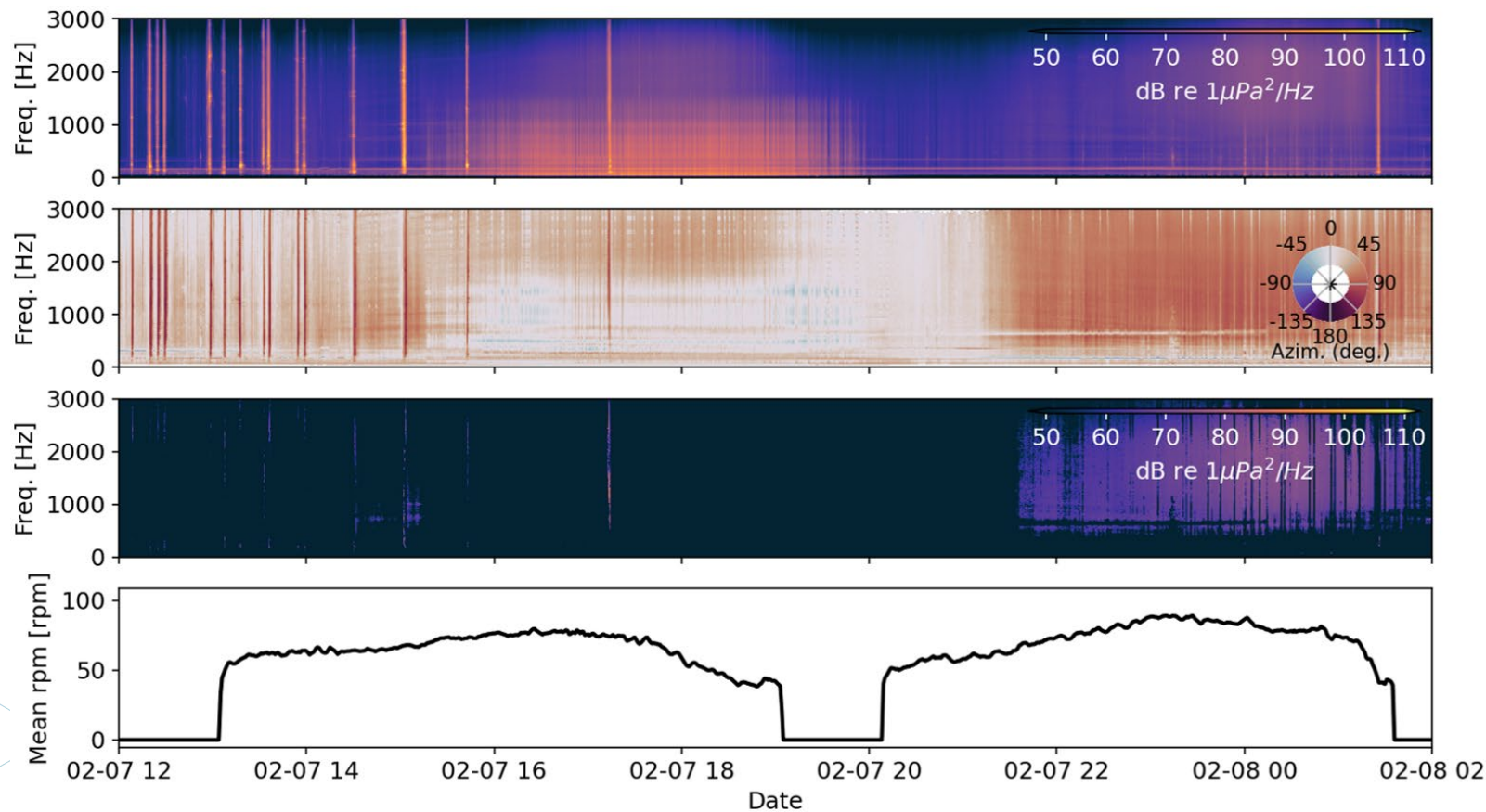
Directional acoustic measurement



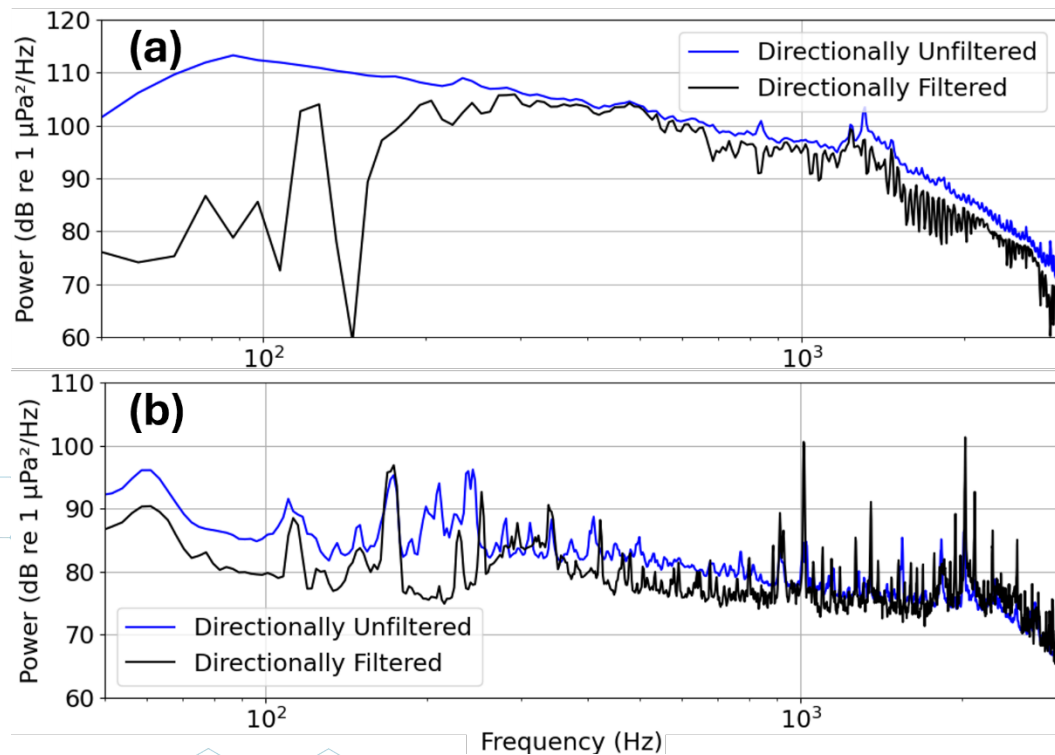
Directional Masking – Oil Platform Decommissioning



Directional Masking – Tidal Turbine



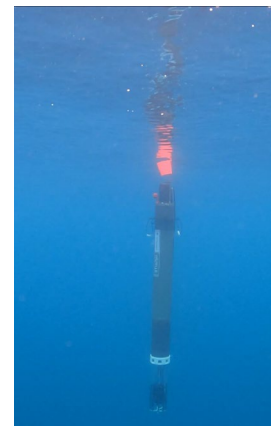
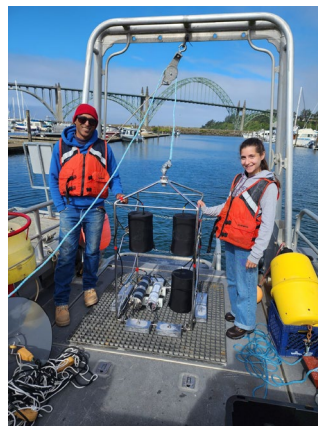
Frequency Spectra



- › Frequency spectra are generally used as 'source function' in propagation modeling
- › Directionally masked frequency spectra has different shape and energy

Conclusions

- › Sound Source Verification is a critical aspect of permitting for offshore wind
- › Traditional hydrophone measurements have no directional information
- › Sounds in the ocean are varied and often mixed
- › Directional acoustics can help isolate sounds of interest.



Contact



Kaus Raghukumar

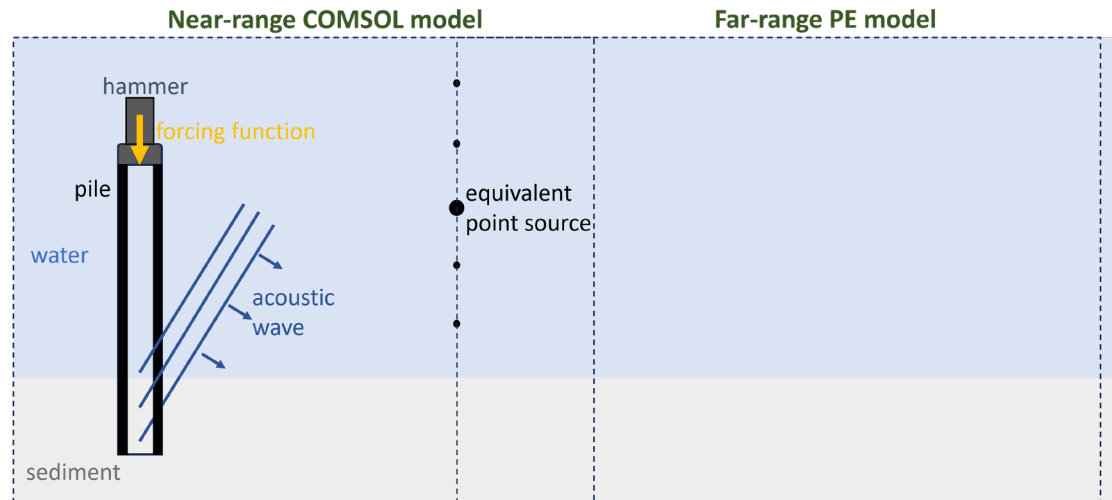
kraghukumar@integral-corp.com

Extra



Numerical Methods

- › An individual hammer strike is modeled as the sound source.
- › Three models:
 1. Forcing function at top of pile
 2. Near-range acoustic propagation model
 3. Far-range acoustic propagation model





integral