

Drifting Acoustic Instrumentation for Marine Energy

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Motivation

- Scientific Uncertainty** Sound produced by marine energy converters may affect marine animals, but the characteristics of these sounds are not well-understood.
- Risk Retirement** Accurate descriptions of acoustic emissions may allow regulators to "retire" some risks.
- Measurement Difficulty** Challenging to make accurate, but low-cost, acoustic measurements at marine energy sites.



Relation to Standards

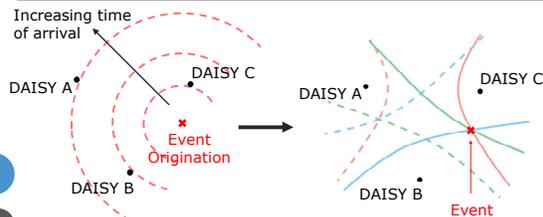
- IEC TC 114** Standards for measuring sound from marine energy converters have been under development since 2014 and are now in draft form.
- Current Energy & OTEC** Drifting measurements *required* for characterizing temporal and spatial variations in sound.
- Wave Energy** Drifting measurements allowable for basic characterization.



Sound Classification

Often, multiple sources of natural and anthropogenic sound at a marine energy site.
How do we objectively identify sounds originating from a marine energy converter?

Localize Received Sounds

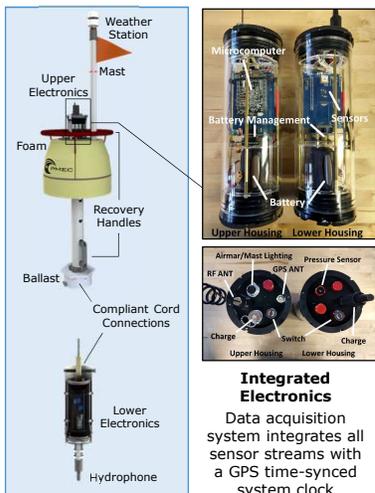


Use event location and characteristic frequencies to train machine learning classifiers for each event type

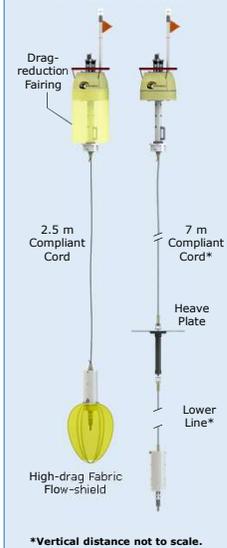
Drifting Acoustic Instrumentation System: DAISY

Design

Objective Reliable, cost-effective system for high-fidelity sound measurements at energetic sites



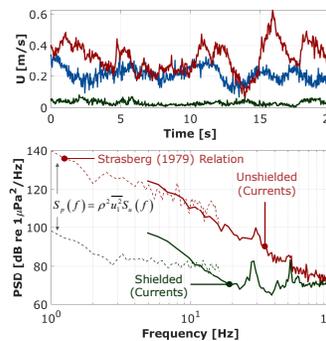
Currents Waves



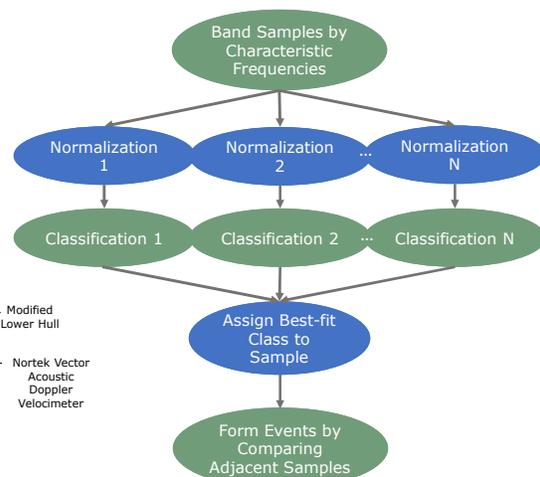
Flow-noise Mitigation

- Challenge** Pressure fluctuations from turbulence produce high-amplitude sound at "low" frequencies (e.g., < 100 Hz). Potential for measurement bias.
- Mitigation** Limit hydrophone exposure to advected turbulence and relative velocity.

Is drifting sufficient?



Machine Learning

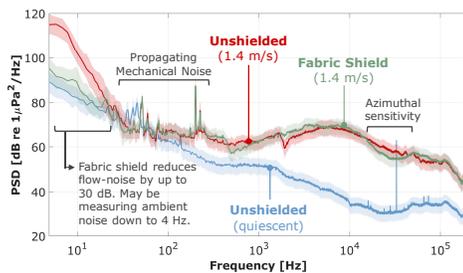
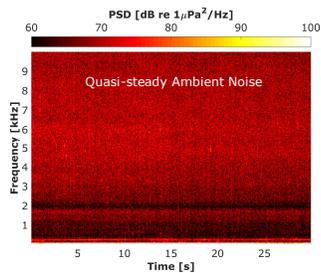


Performance in Currents

Pacific Northwest National Laboratory Marine Science Laboratory (US DOE)



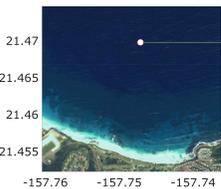
Current-Dominated: 1.5 m/s



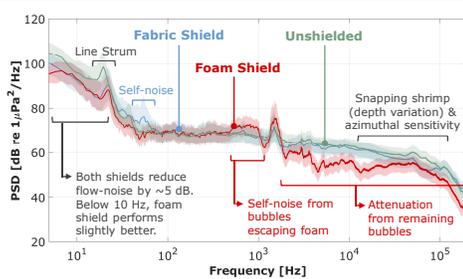
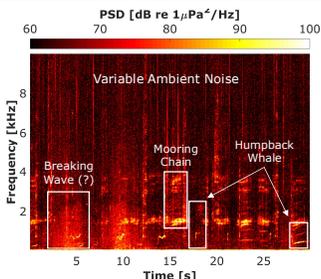
- Drifting Insufficient** Mismatch between size of drogue (Pacific Gyre Microstar) and size of hydrophone produces relative velocity and significant flow-noise.
- Flow-shield Effective** Substantial flow-noise reduction (may be resolving ambient noise down to 4 Hz). No significant self-noise. No significant attenuation at higher frequencies.

Performance in Waves

Wave Energy Test Site (WETS) (US Navy)



Wave-Dominated: 2.5 m, 7 s



- Flow-shield Partially Effective** With fabric shield, limited flow-noise reduction and some self-noise. With foam shield, better flow-noise reduction, but self-noise and attenuation at higher frequencies.
- Drifting Sufficient (?)** Suspension system may produce measurements that are "good enough" for decision-making.

Acknowledgements

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Next Steps

- Flow-shield durability improvement
- Design adjustments for stability
- Test localization and classification in waves and currents (Fall 2018)