Characteristics of Underwater Ambient Noise at a Proposed Tidal Energy Site in Puget Sound

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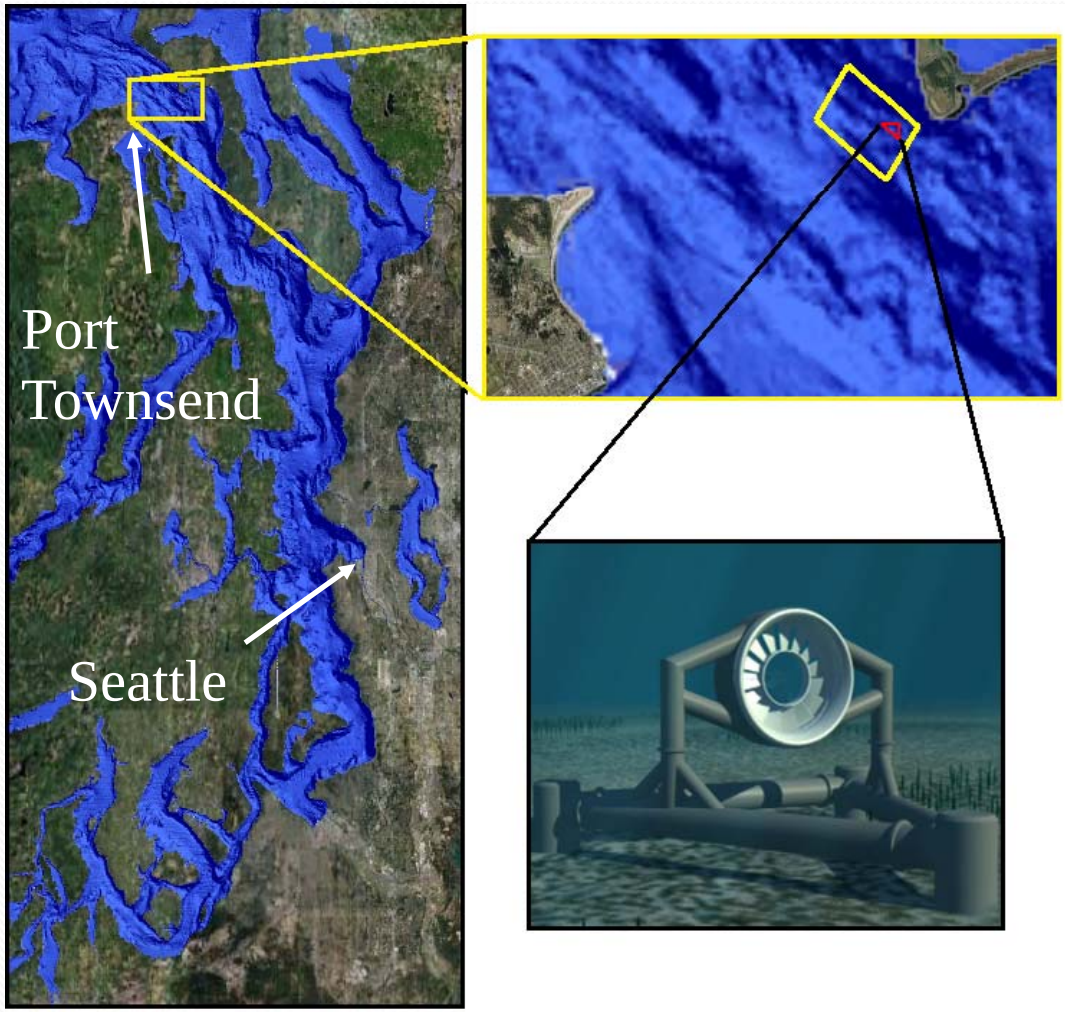
Motivation and Objectives

- Little is known about the potential environmental impacts on tidal energy extraction
- Quantify existing underwater ambient noise at the site and identify important noise sources
- Results provide a baseline for determining the impact of tidal energy development

Site Information

- Proposed site located in Admiralty Inlet, Puget Sound
  - 5 km wide
  - Water depth ~ 60 m
  - Currents exceed 3 m/s



Ambient Noise Sources

Marine Mammals

Shipping & Ferries

Surface agitation:

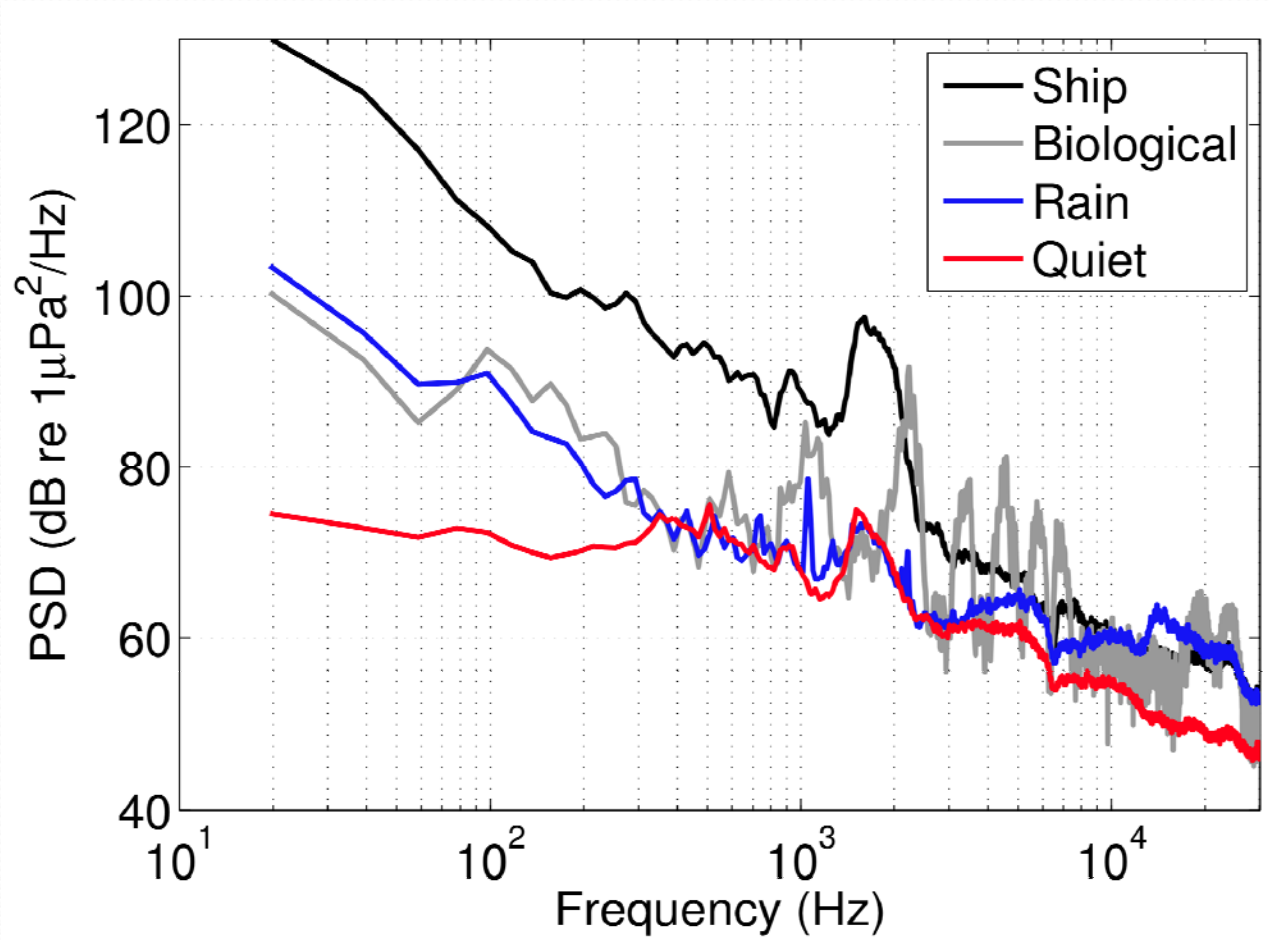
- Breaking waves
- Surf noise
- Rain

Instrument Tripod

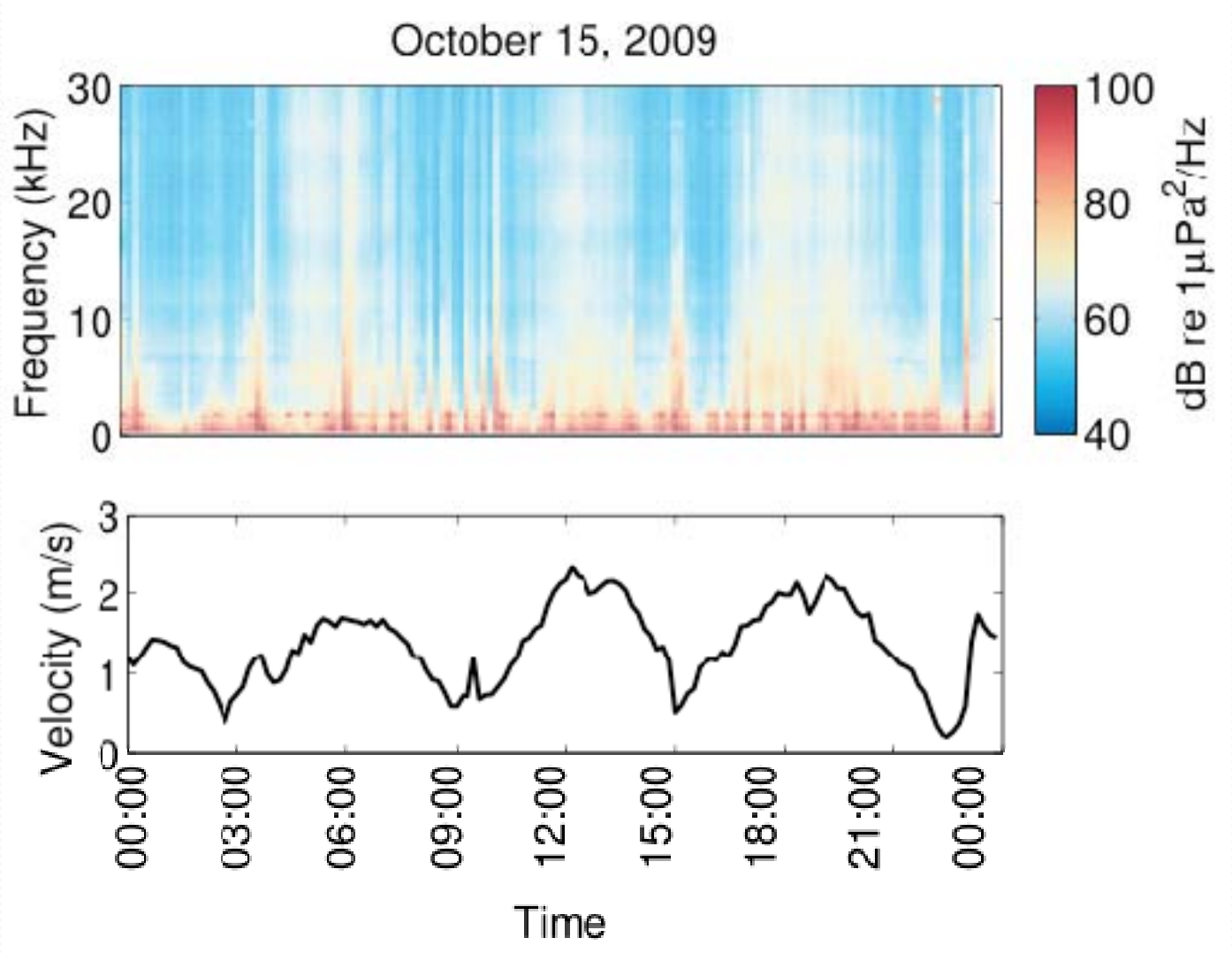
- Hydrophone:
  - Samples at 80 kHz
  - 1% duty cycle with samples every 10 minutes
- ADCP:
  - Surveys velocities throughout water column.
- Instruments operate on different duty cycles to avoid contaminating acoustic data

Acoustic Spectra

- Spectra are attributed to unique sources using ancillary data sets

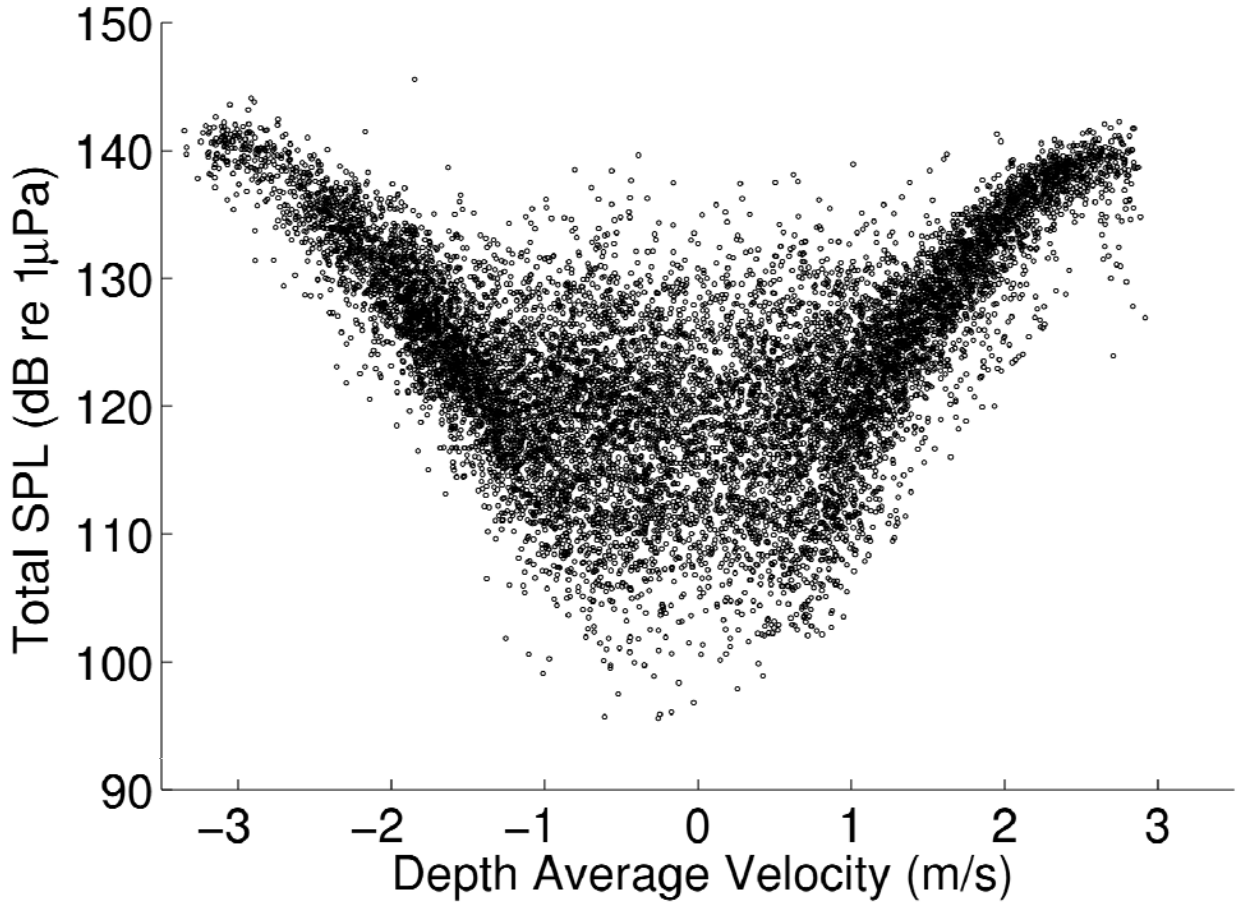


Spectrogram



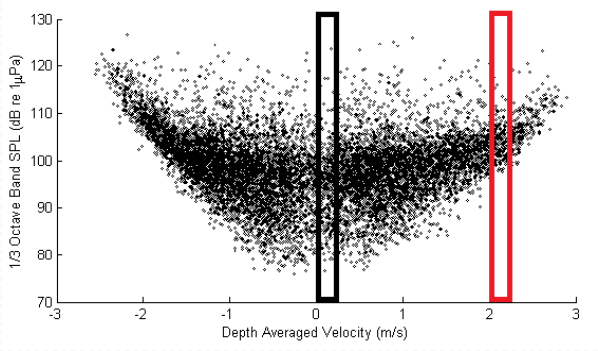
Velocity Dependence

- Hypothesis for velocity dependence:
  - Turbulence
    - Oceanic
    - Boundary layer
  - Bedload transport
  - Self-noise

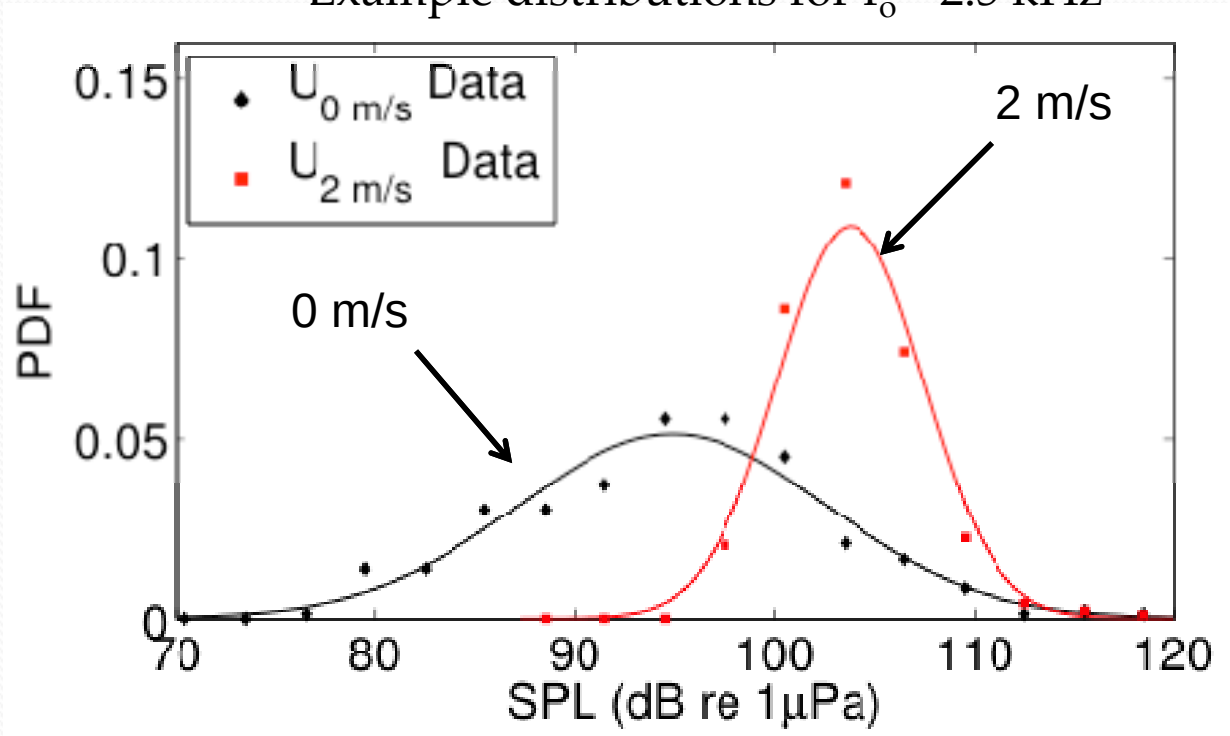


Velocity Dependence

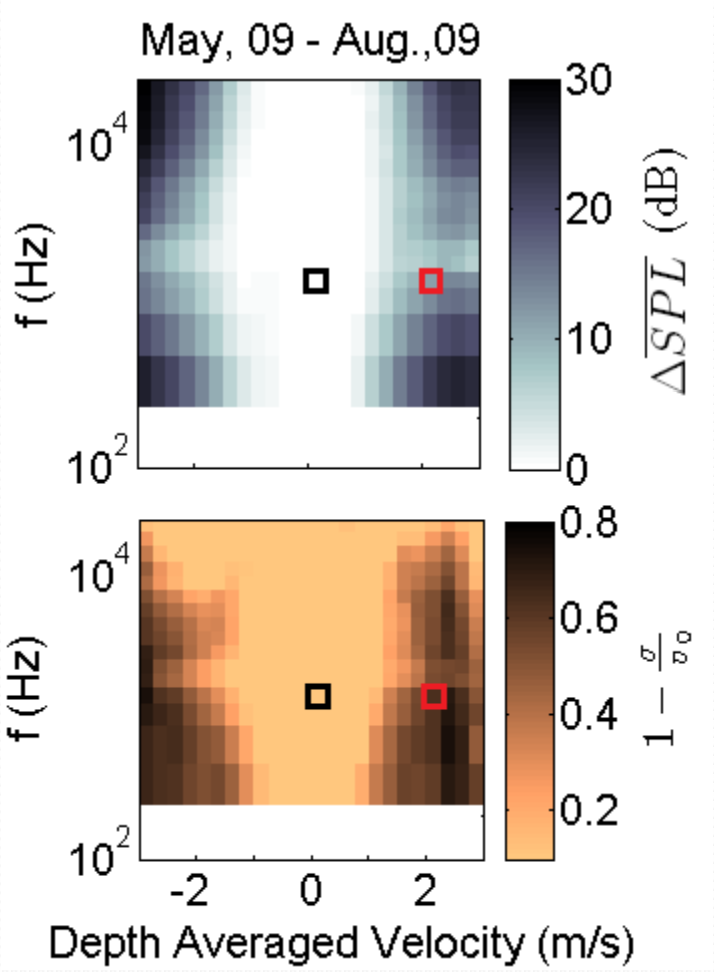
- Data from each deployment is divided into
  - One-third octave band SPLs
  - Velocity bins (0.25 m/s)



Example distributions for f_o = 2.5 kHz



Velocity Dependence



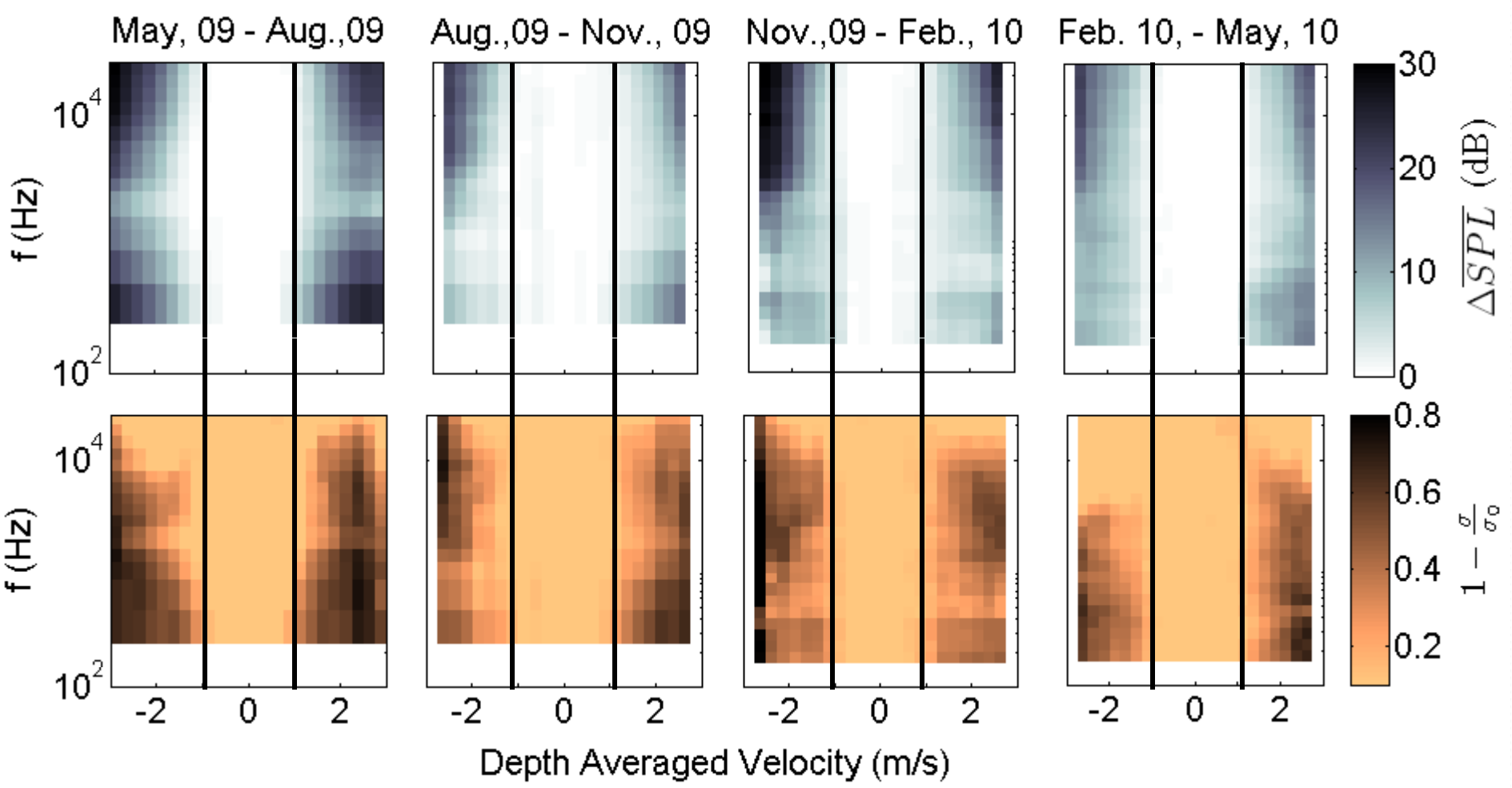
How much louder?

$$\Delta\overline{SPL} = \overline{SPL}_{f,v} - \overline{SPL}_{f,0}$$

How much narrower?

$$1 - \sigma_{normalized} = 1 - \frac{\sigma_{f,v}}{\sigma_{f,0}}$$

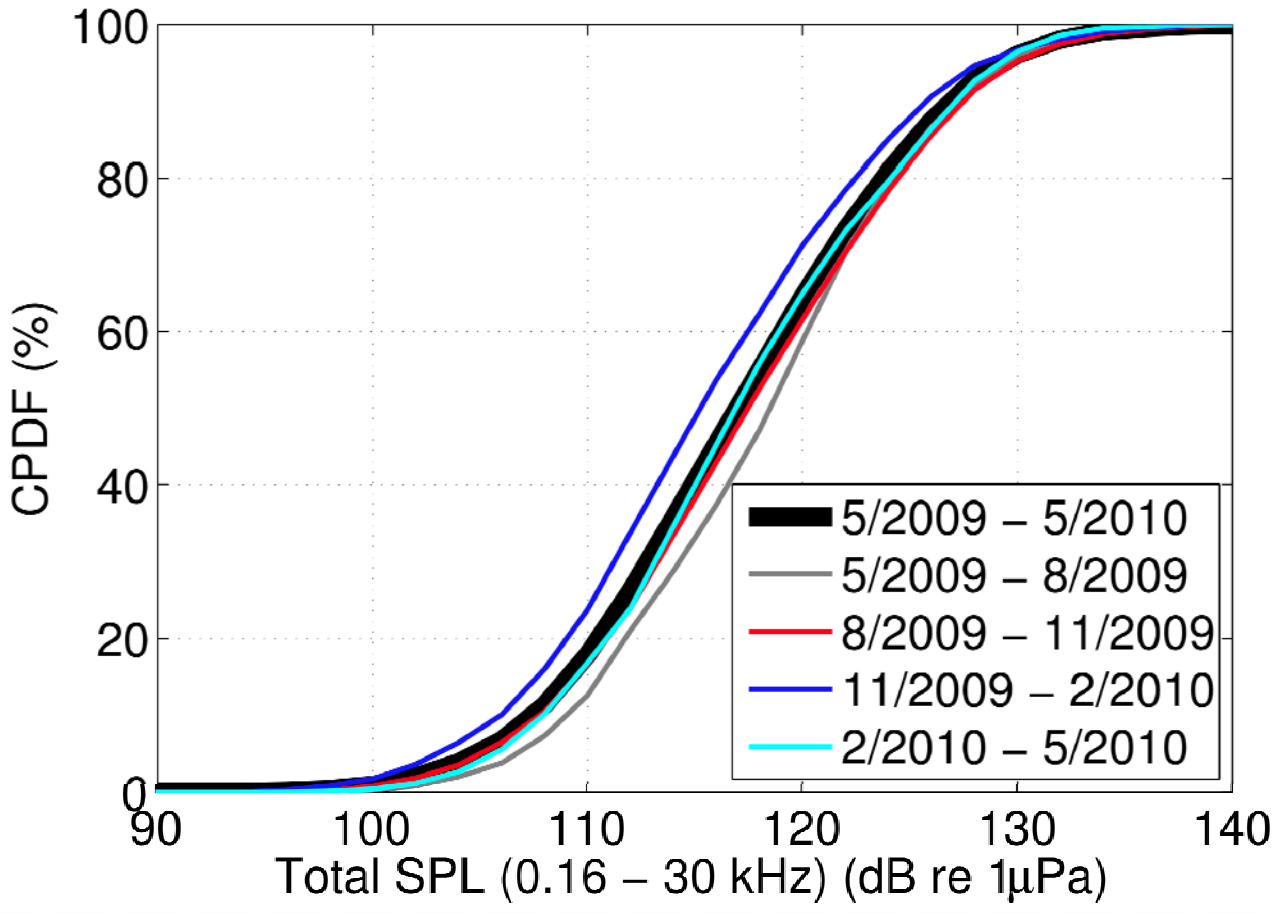
Velocity Dependence



On average, 42% of data (20266 files) are kept for ambient noise analysis

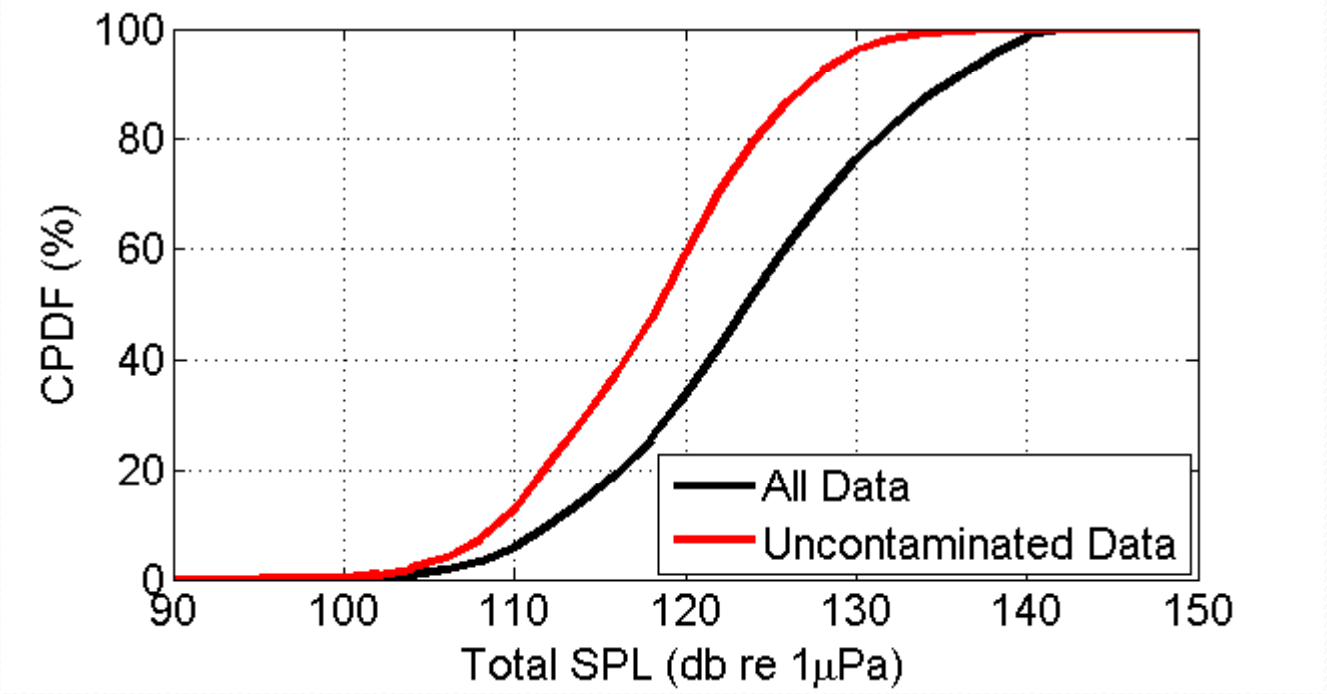
Cumulative Probability Distribution Functions

- Mean total SPL by deployment for currents under 1m/s:
  - 1: 118 dB
  - 2: 118 dB
  - 3: 116 dB
  - 4: 117 dB



Conclusion and Future Work

- The sources of increased sound pressure levels need to be indentified to explain ambient noise at the site.



- Co-deployed hydrophones to study coherence
- Tripod deployment in eddy field (max currents < 1 m/s)
- Drifters for acoustic measurements during high currents

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Questions?