Seabed Characterization Workshop

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Scientific Objectives

- Surface generated noise and other noises as ensonifying source, environmentally friendly
- Impact of water column and sea surface variability
- Impact of source motion and seafloor variability
- Sloping seafloor
- Careful comparison to other methods (accuracy, efficiency)

Ambient Noise Seabed Profiling Experiments

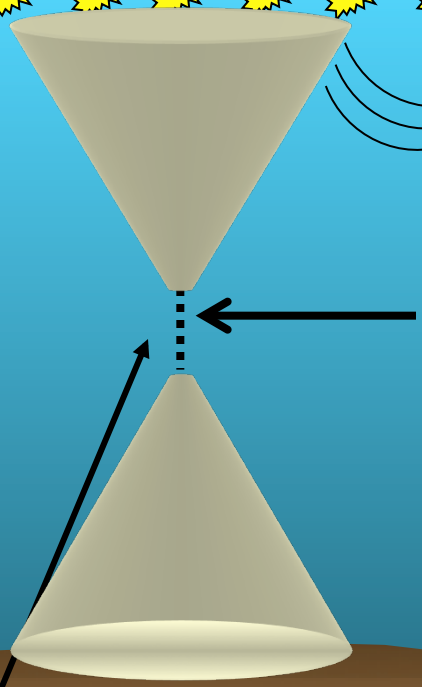
Perform seismic profiling survey along drift track.

We have done this experiment but only one good data set with chirp-type data and a sediment with significant penetration.

Can also use two arrays (different bands).

Could also think about simultaneous source transmissions

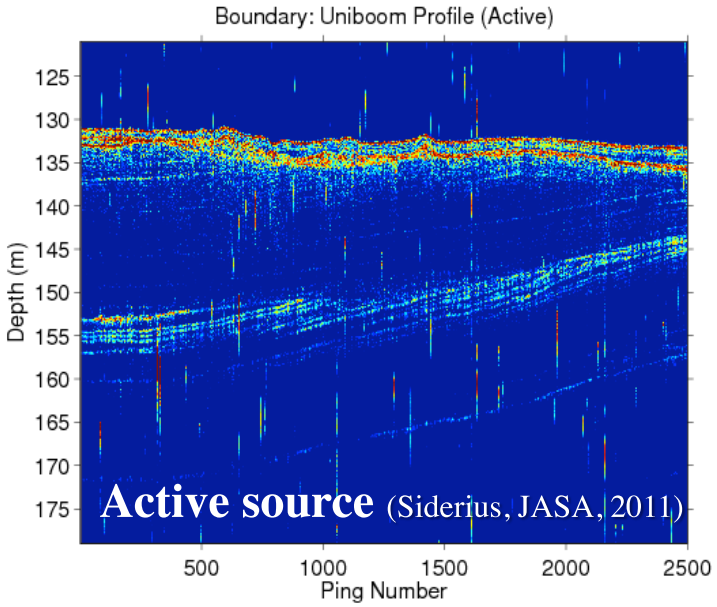
Requirements: Diverse sediments, places not too calm, not a lot of competing noise sources (R/V not in area), broadband drifting/moored vertical array (low noise, good sensitivity), chirp sonar system.

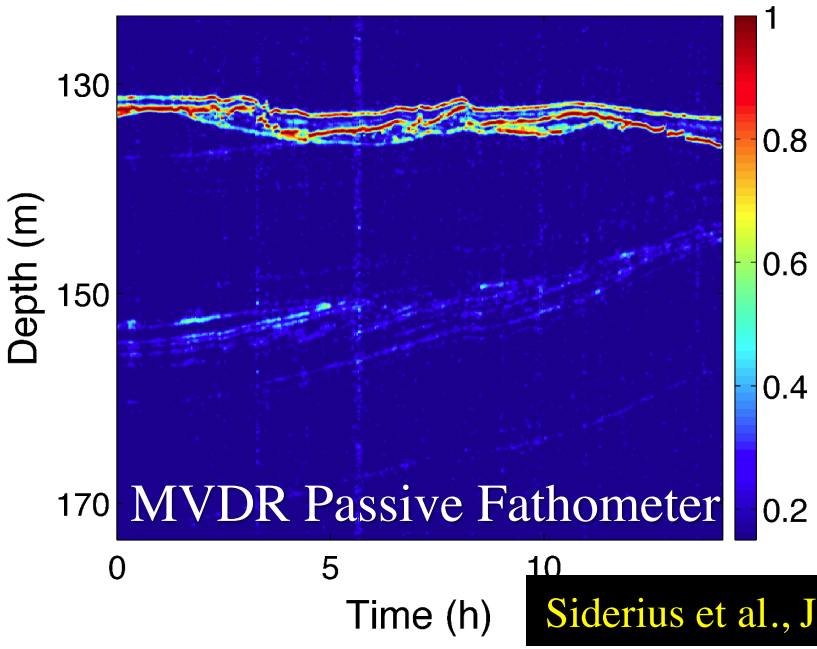


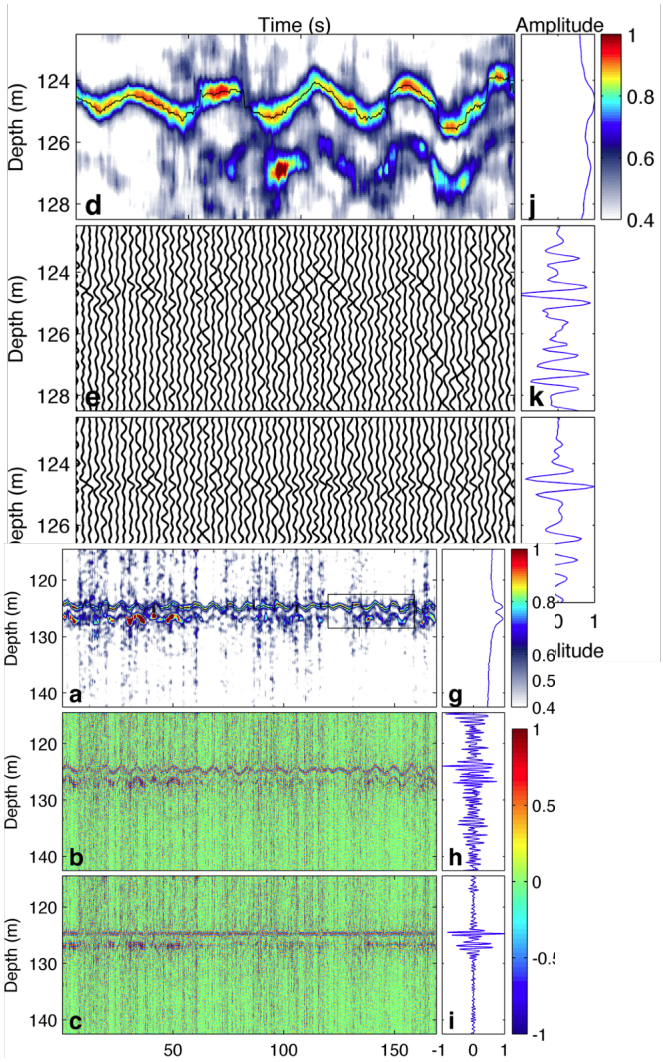
Drifting Vertical array

Fathometer results

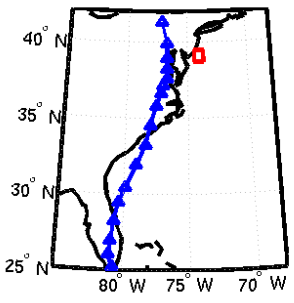
Boundary2004 data: had strong wave motions





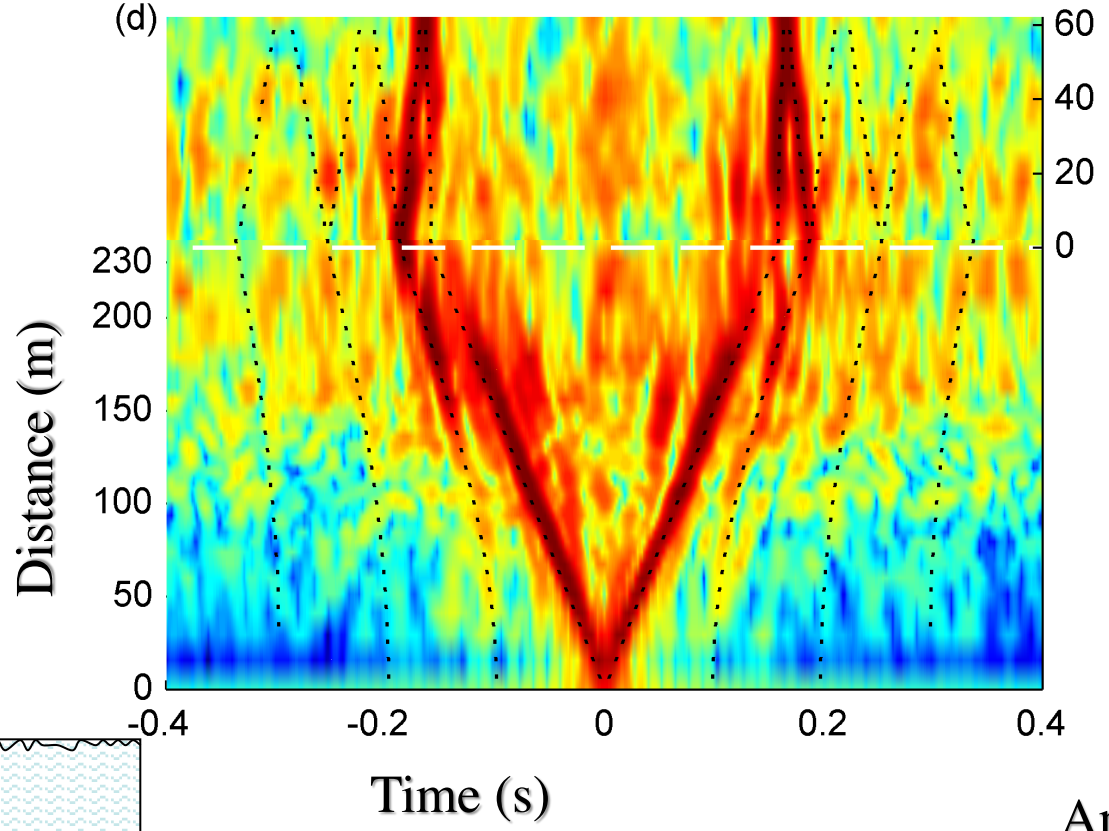


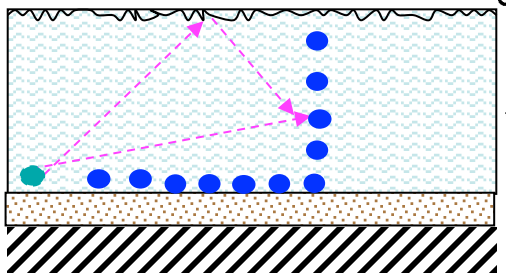
Siderius et al., JASA, 2006; Gerstoft et al., JASA, 2008; Traer 2011a,b



Ambient noise EGFs (20-100 Hz)

EGF envelopes (dB) with modeled travel times (dotted) between hydrophones





Wd=80 m

Amplitude (dB)

-40 -20 0

230 m long array

Brooks and Gerstoft (JASA 2009a 2009b); Fried at al (JASAEL 2008)

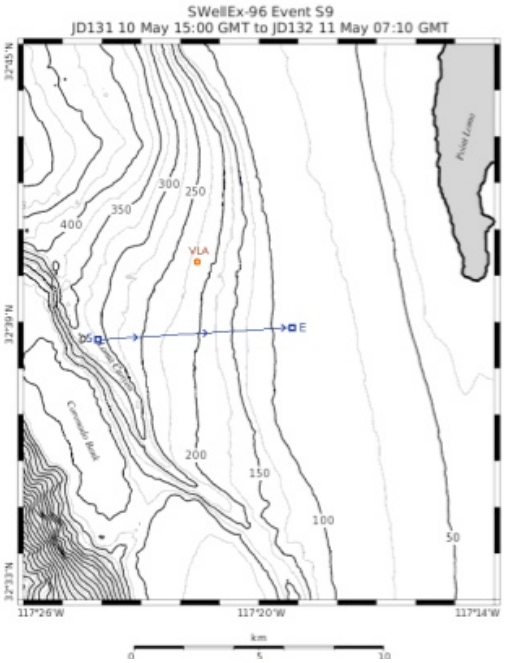
Fathometer and noise science questions

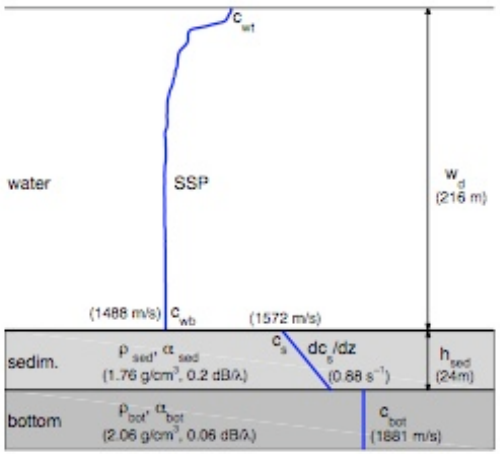
- Fathometer
  - Demonstration on a new dataset
  - Classical geoacoustic data is needed for verification
  - Convergence times, is noise 1D, 2D or 3D?
  - Phone spacing
  - Get geoacoustic parameters

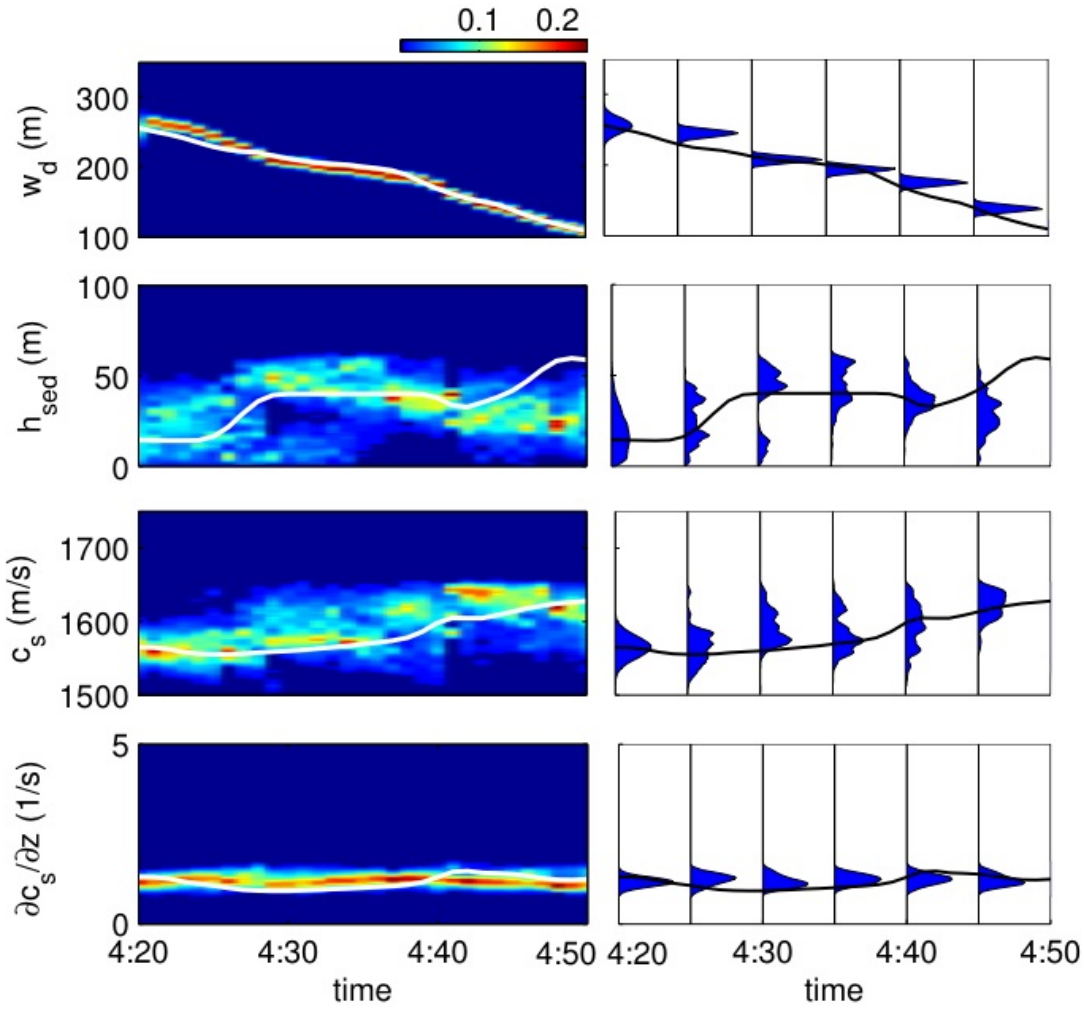
- Noise CC
  - longer ranges
  - Get geoacoustic parameters
  - Temporal Variation in noise CC

Geoacoustic Tracking

Seafloor Parameters - SWellEx-96







Geoacoustic tracking

Geoacoustic tracking can provide more stable estimates than geoacoustic inversion

Data would be used for

- Tracking of water column variability
- Tracking of source and seabed variability, sloping seafloor
- Fathometer tracking

Algorithmic developments: Faster, more stable, better environmental models, better forward models, better tracking methods.

Data Requirements

Data Requirements

- Surface generated noise as ensonifying source
  - Noise fathometry and geoacoustic inversion (passive)
  - Drifting vertical line arrays (e.g. 4 VLAs with 16-32 elements/each)
  - Horizontal line arrays (hydrophones/geophones)
  - Frequency band ~10 Hz – 2 kHz
- Impact of water column and sea surface variability
  - Fixed source (preferably moored) – multiple fixed vertical receiving array geometry (e.g. 4 VLAs)
  - Short and long range (e.g. 1, 2, 4, and 8 km)
  - Frequency band ~0.1–10 kHz (including the 5kHz active band)
- Impact of source motion and seafloor variability
  - Towed source – multiple fixed vertical receiving array geometry (e.g. 4 VLAs)
  - Source tows from fixed source position across location of VLAs
  - Frequency band ~0.1–10 kHz

Data Requirements

- Sloping seafloor
  - Towed source – multiple fixed vertical receiving array geometry (e.g. 4 VLAs)
  - Source tows cross-shelf
  - Frequency band ~0.1–10 kHz
- Supporting environmental data
  - Seafloor bathymetry and subbottom layering
  - Cores and seafloor surficial grain size [maybe too expensive—just a point sample].
  - Spatially separated water column measurements (thermistor strings [MPL])
  - Wind speed and direction
  - Sea surface directional wave spectrum (waverider buoy)

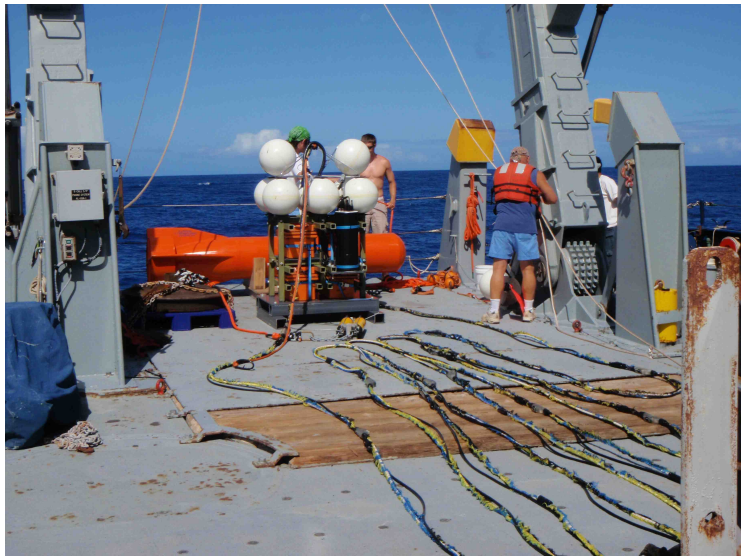
Experiment Hardware

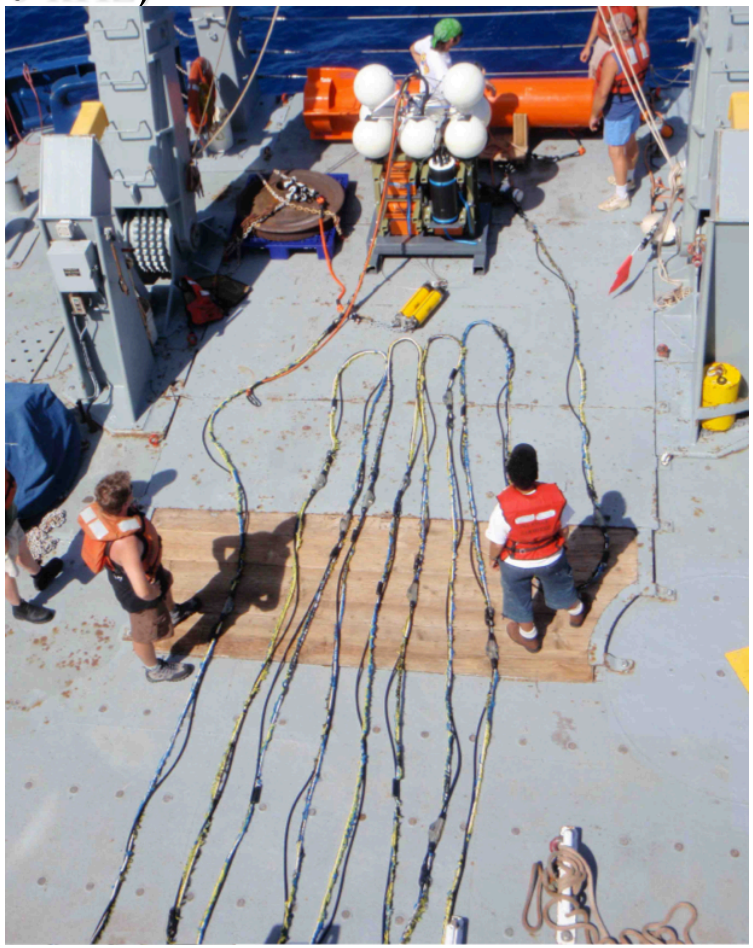
MPL Receive Arrays, Source/Receive Arrays, and Towed Sources

Autonomous Seafloor Receive Arrays

Autonomous Seafloor Receive Arrays (4) - Each Array

- 16/32-element seafloor VLA with 3.75 m element separation (56.25 m aperture)
    - Other separations easily obtained with new array cables
- Bandwidth 20/500 Hz – 10/20/30 kHz (fs = 25/50/100 kHz)
- Record duration ~96 hours
- Oven based FEI-Zyfer GPS clocks
- Autonomous or buoy deployed (fixed or drifting)
- Radiobouy

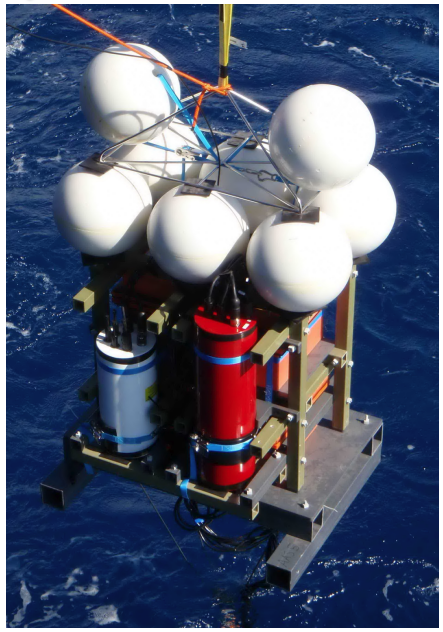


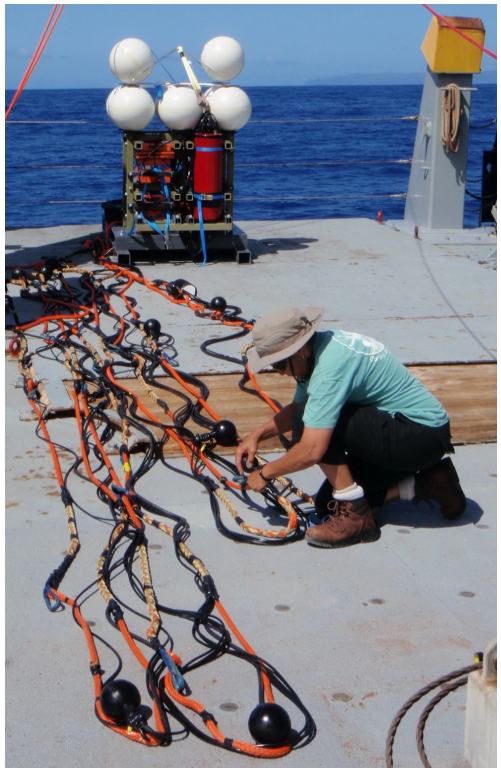


Autonomous SRA

Autonomous or Ship–Deployed Source/Receive Arrays (2) – Each Array

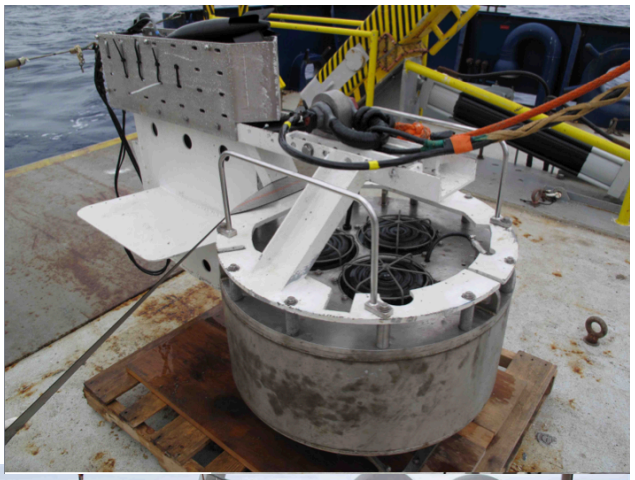
- 8-element VLA with 7.5 m element separation (52.5 m aperture)
    - Separations easily can be modified
- Bandwidth 10-32 kHz (fs = 100 kHz)
    - Modifications for operation 2.5-10 kHz feasible (DURIP?)
- Source level 185 dB +/- 4 dB across band
- Arbitrary waveform transmissions from any/all elements

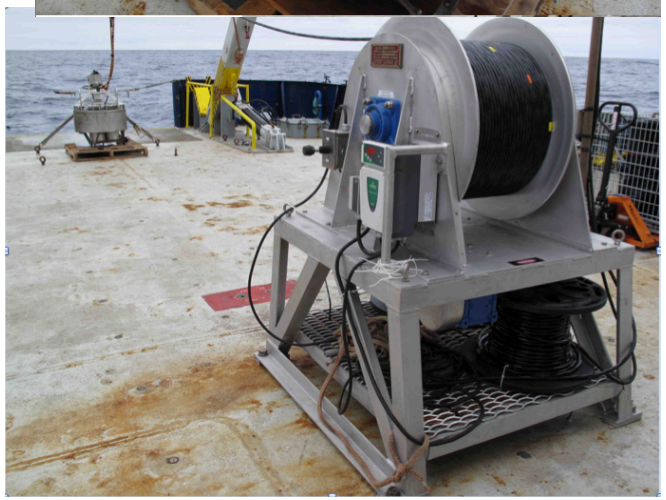




Here with ITC sources used in comm exp,
NURC TRM exp sources are in DURIP proposal

Sources/Source Tow System





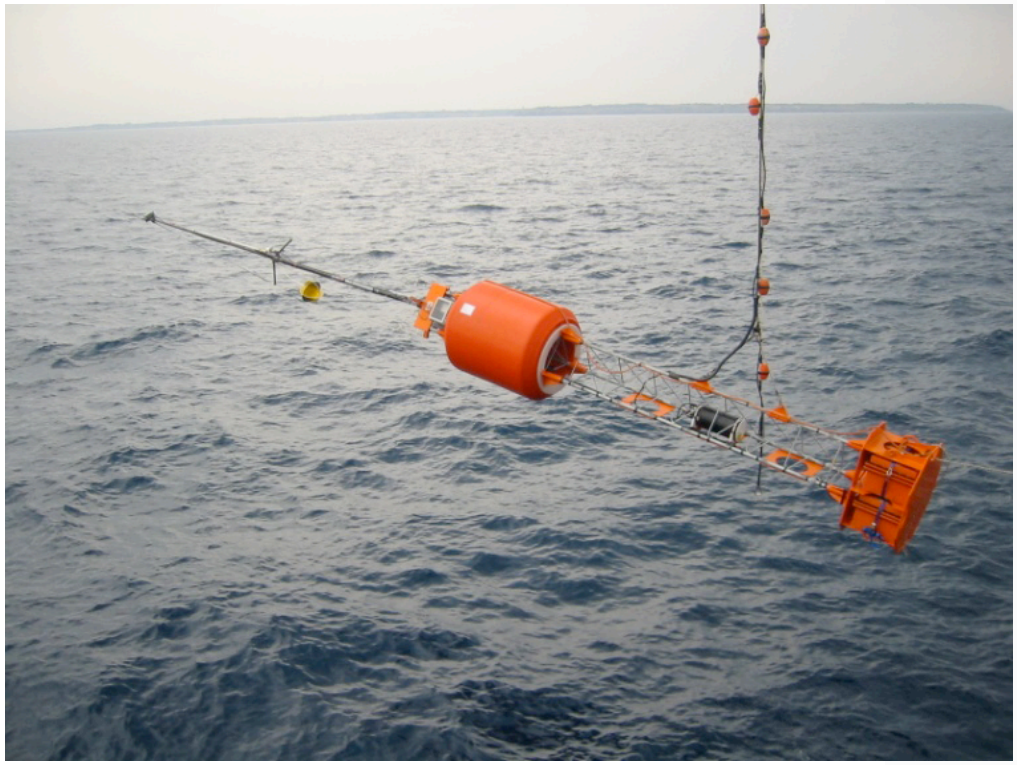
- Towed Sources
  - ITC-2040X in a tow body (3-10 kHz)
  - ITC-2015 mounted under tow body (1.5-4 kHz)
  - J-15-1 / J-15-3 (rental)

- Source Tow System
  - Winch
  - Monitor phone and depth sensor (both recorded)
  - Arbitrary waveform synthesis (fs = 100 kHz)
  - Transmit from two sources simultaneously (separate power amplifiers)

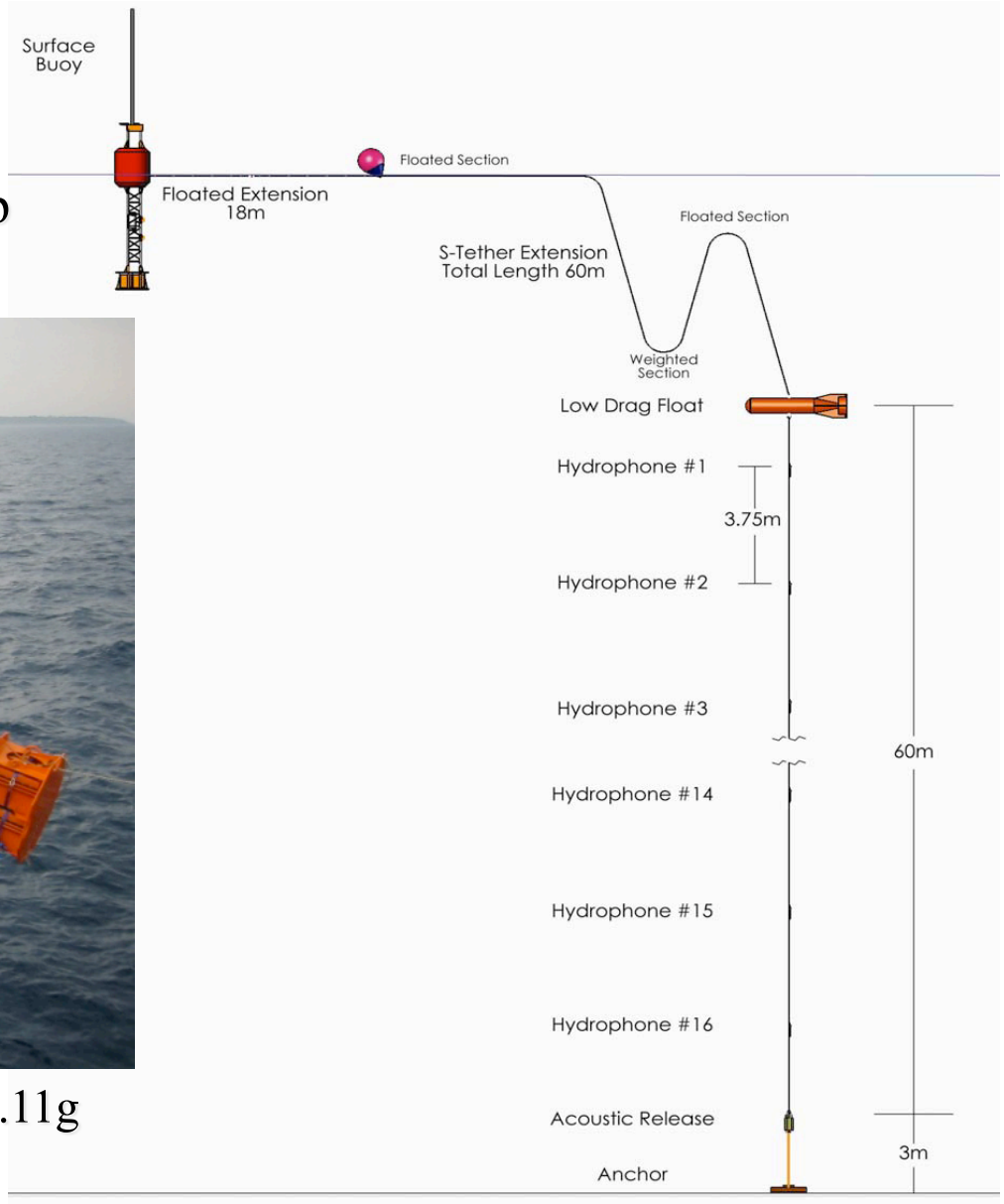
Networked Deployment with Communications Buoy

Radio Buoys (2)

- DSPL batteries (4)
- 802.11 WLAN connectivity to ship



Recording electronics in tower section. 802.11g antenna on top of mast.



Portland State Equipment:

- Webb Slocum Glider: Allows us to get oceanographic information in area using on board CTD.
- Recently integrated a WHOI DMON sensor (on loan from WHOI for testing). Allows us to collect low and mid frequency acoustic data from glider platform.

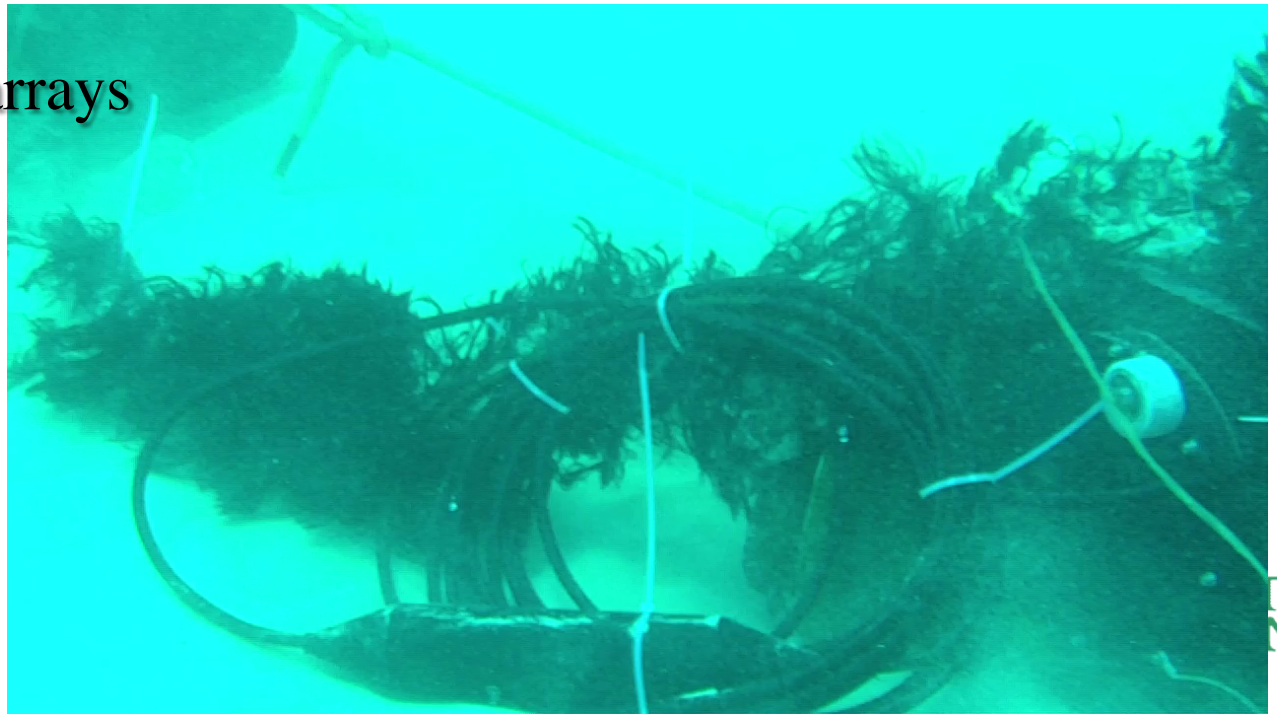
NEAR-Lab
Northwest Electromagnetics & Acoustics Research

PORTLAND STATE UNIVERSITY

Portland State Equipment: Vertical Arrays

- Vertical array, 24 element, 0.5 m records up to 50 kHz (identical 0.25 m spacing array may be available from UHawaii)
- Can be deployed together (e.g. as L shape) or independently.
- Suggest here to deploy fixed and drifting.

Movie of arrays in water



TLAND STATE
NIVERSITY

Questions: Extraction information from noise

- PIs Peter Gerstoft, Bill Hodgkiss, Martin Siderius, and Eliza Michalopoulou
- Noise processing requires dedicated ship time/ No other experiments

1) Ambient noise processing, Fathometer Fixed and drifting arrays, Controlled sources to simulate noise.

2) Noise

3) Fluid, and sometimes elastic

4) Range dependent bottom, Sequential processing

5) PIs

1. What are the measurements you wish to make or to make in collaboration with others to determine directly or from inferred analysis fundamental physics of acoustic propagation and scattering in the seabed?
2. What is new about these measurements and what is the latest expected technology to be employed?
3. What is the representation of the seabed in your model; fluid, elastic, Biot-like, etc?

For your model how do you include surface roughness at layer interfaces, volume inhomogeneities within layers, degree of depth inhomogeneities of physical parameters within the layers?

4. To what resolution do you plan to measure and/or infer values for basic parameter values? What is your statistical inference model to analyze propagation and scattering data?
5. A number of these researchers have already indicated that they plan to collaborate and have formed preliminary scientific teams. I assume the nature of these collaborative teams will form in the usual manner; over coffee, dinner, off-line discussions, etc. In your presentations, it would be helpful to discuss your collaboration plans/desires.

Questions: Sequential type experiments

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