Geoacoustic Inversion Results from SW06 Data
– long range vs. short range

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Objectives:

- Synthesize comprehensive geoacoustic model for well surveyed common site: experimental ‘Benchmark’
  - geophysically realistic
  - capture essential features for TL prediction
- determine limitations/advantages of present day inversion approaches
- MPL Data inversions
  - Long range vs short range geometry
  - Inversions in variable ocean environment
  - MF and travel time inversions
Data sets used (MPL VLA1):

- **Long range:**
  - Low and mid-frequency tonals
    - 53, 103, 203, 253, 303, 403 and 503 Hz
  - 3 ranges along ‘DJ’ track
    - ~ 1, 3, and 5 km away from MPL VLA1

- **Short range:**
  - Low and mid-frequency chirp
    - 100 – 900 Hz and 1500 - 4500 Hz
  - For both frequency bands
    - ~ 230 m away from MPL VLA1
Long range geoacoustic inversion:

- Matched field inversion
  - Bayesian inversion to estimate the sub-bottom properties and their uncertainties
  - Sea bottom model: one layer over half-space
- Challenge
  - Dynamic ocean environment
- Solution
  - Include water column SSP in the inversion in terms of EOFs
Inversion result for water column SSP

Marginal distribution of SSP (1 km)

Min - max 95% HPD 66% HPD

Map

Source

Depth (m)

Sound Speed (m/s)

Water depth (m)

Sound speed (m/s)
Example of geoacoustic inversion results (1 km):

- $H$: 21.1 m
- $c_p$: 1636.8 m/s
- $c_p$: 1572.8 m/s
- $c_p$: 1740.5 m/s

- $\alpha_p$: 0.532 (dB/m/kHz)
- $f_{exp}$: 2.109
- $\rho$: 1.739 (g/cm$^3$)
Geoacoustic inversion results:

Marginal distribution of estimates at 1 km

C1: [1621.6 1636.8 1654.7] m/s
C2: [1557.4 1572.8 1591.3] m/s
Cb: [1696.2 1740.5 1765.3] m/s
H: [19.7 21.1 23.0] m
Short range geoacoustic inversion:

- Reflectivity coefficient inversion
  - Complications arise from the water column SSP
  - The limitation of $R(\Theta)$ curve generation
- Waveform inversion
  - Full field inversion (computational intensive)
  - Parameterization (make use of both LF and MF data)
- Travel time inversion
  - Invert only for sound speed and layer thickness by ray tracing method
Waveform inversion (parameterization):

- **Lines in black:**
  - Low frequency chirp

- **Lines in red:**
  - Mid-frequency chirp
Travel time inversion (source depth = 65m):

- Direct arrival
- Surface reflection
- Bottom reflection
- Sub-bottom reflection
Travel time inversion (source depth = 55m):

- direct arrival
- surface reflection
- bottom reflection
- sub-bottom reflection
Travel time inversion results (1-layer model):

Source depth = 65 m

Source depth = 55 m
Travel time inversion results (2-layer model):

\[ cp_1: 1578.8590 \text{ (m/s)} \]

\[ H: 14.4574 \text{ (m)} \]

\[ cp_2: 1606.1780 \text{ (m/s)} \]

\[ H: 6.5300 \text{ (m)} \]

SD = 65 m
Travel time inversion results (3-layer model):

SD = 65 m
Sub-bottom layering profile:
Summary:

- Focus on ‘benchmark’ site

- MF inversions:
  - Long range geometry
  - Inversion includes water sound speed uncertainty
  - Sound speed decrease to R-reflector

-Future/current work:
  - Short range geometry at VLA (MORAY) site
  - Travel time inversions of sub-bottom signals
  - Consistent with long range data inversions