

Matched Field Inversion of Explosive Signals from the ASIAEX ECS Experiment

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Report Documentation Page

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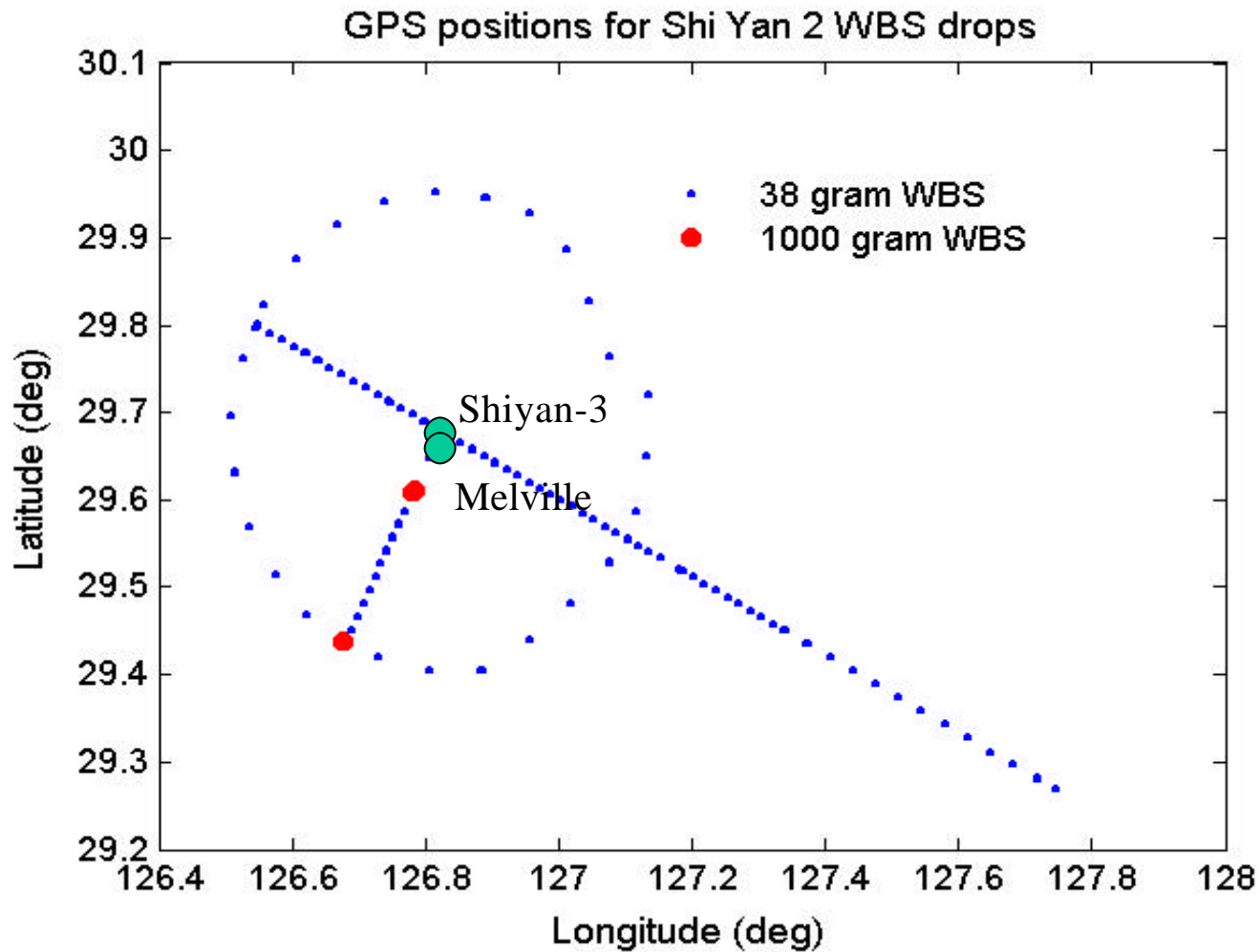
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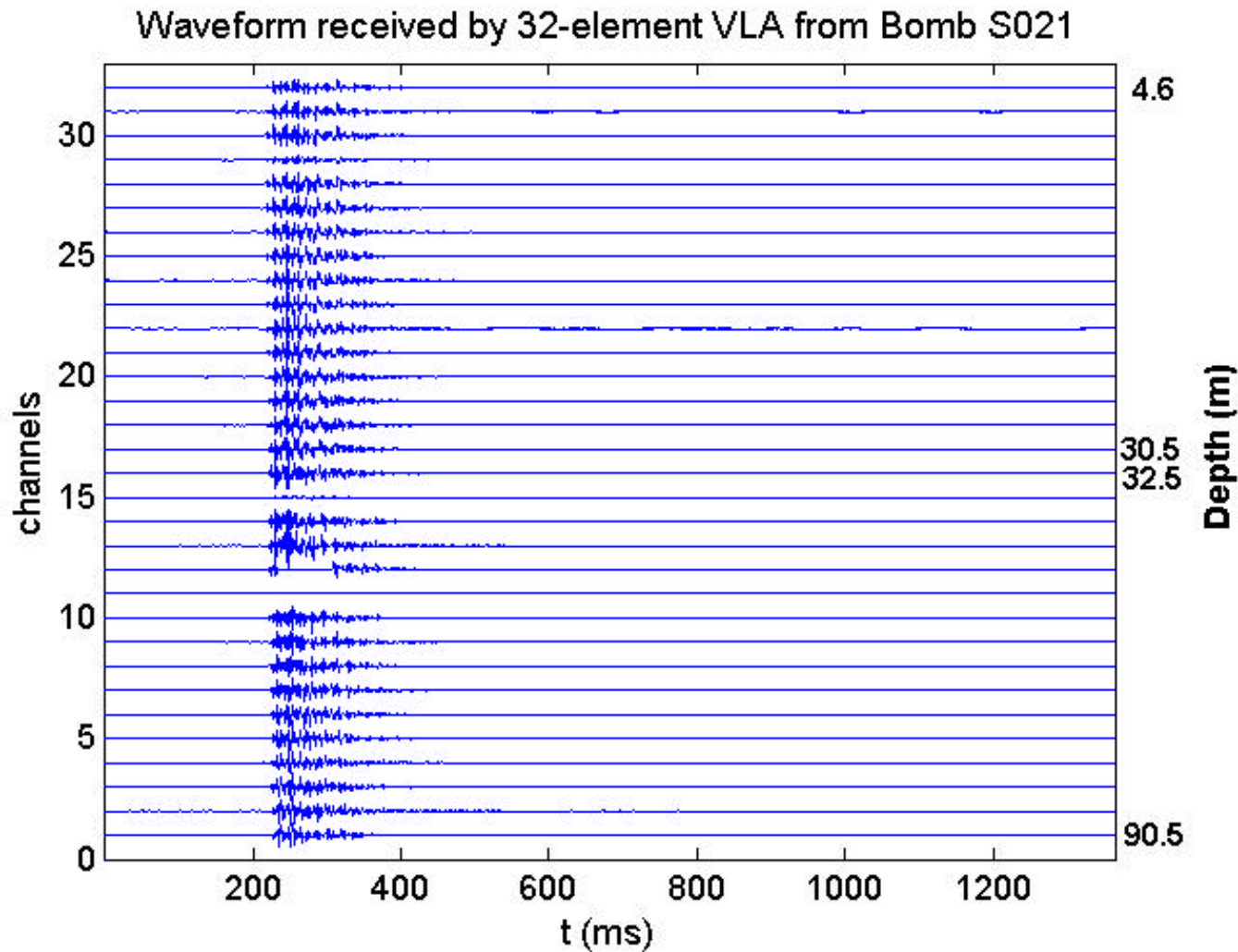
Outline

- Introduction
- Matched Field Inversion
- TL Calculations and TL measurements
- Conclusion

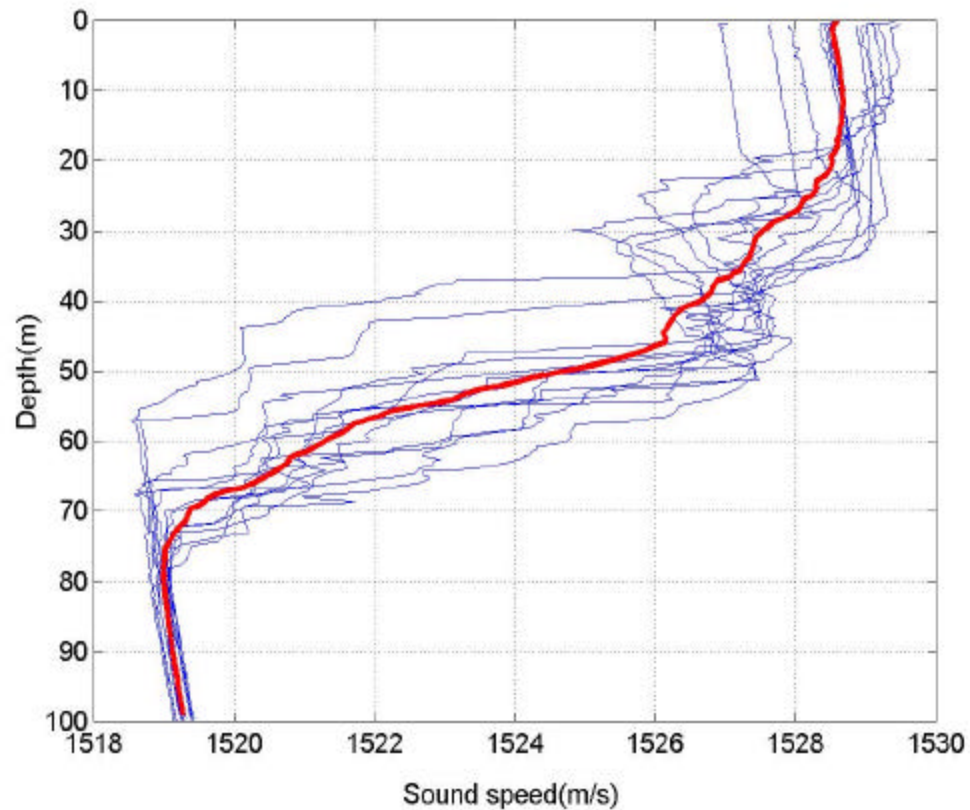
WBS Propagation Measurements



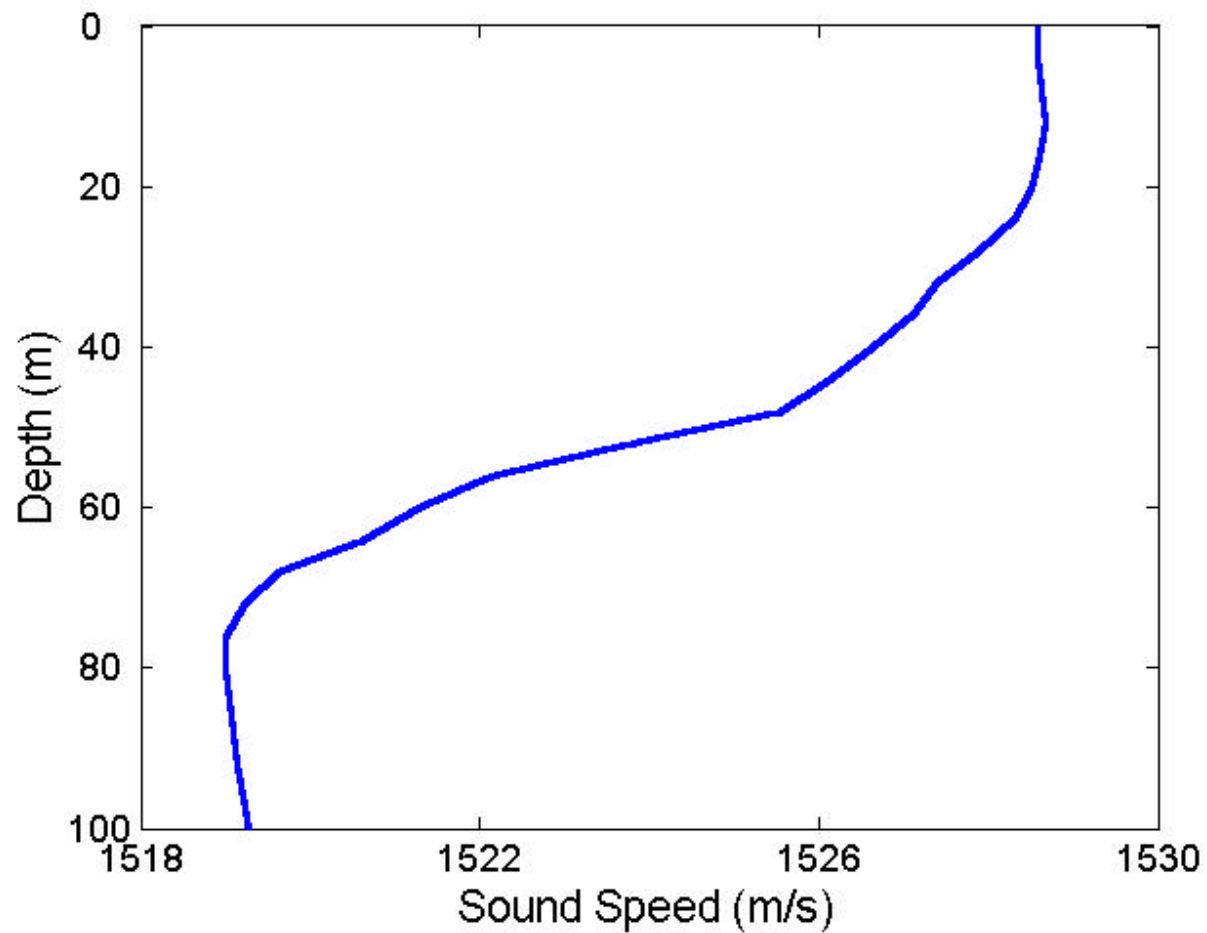
The Bomb Signal Received by the VLA



Sound Speed Profiles from Shiyan-3 CTD Casts during bomb signal propagation



Sound Speed Profile used for Replica Field Computation



The Matched Field Inversion using Multi-tone Signal

$$E(\mathbf{m}) = 1 - \prod_{j=1}^{N_f} \frac{\left| \sum_{i=1}^{N_D} p_{ij} q_{ij}^*(\mathbf{m}) \right|}{\sqrt{\sum_{i=1}^{N_D} |p_{ij}|^2 \sum_{i=1}^{N_D} |q_{ij}(\mathbf{m})|^2}}$$

p_{ij} — Complex sound pressure measured by the i 'th hydrophone at frequency f_j

q_{ij} — Complex sound pressure calculated

Frequency range 120 - 360Hz, and NF = 6

The Genetic Algorithms for Inversion

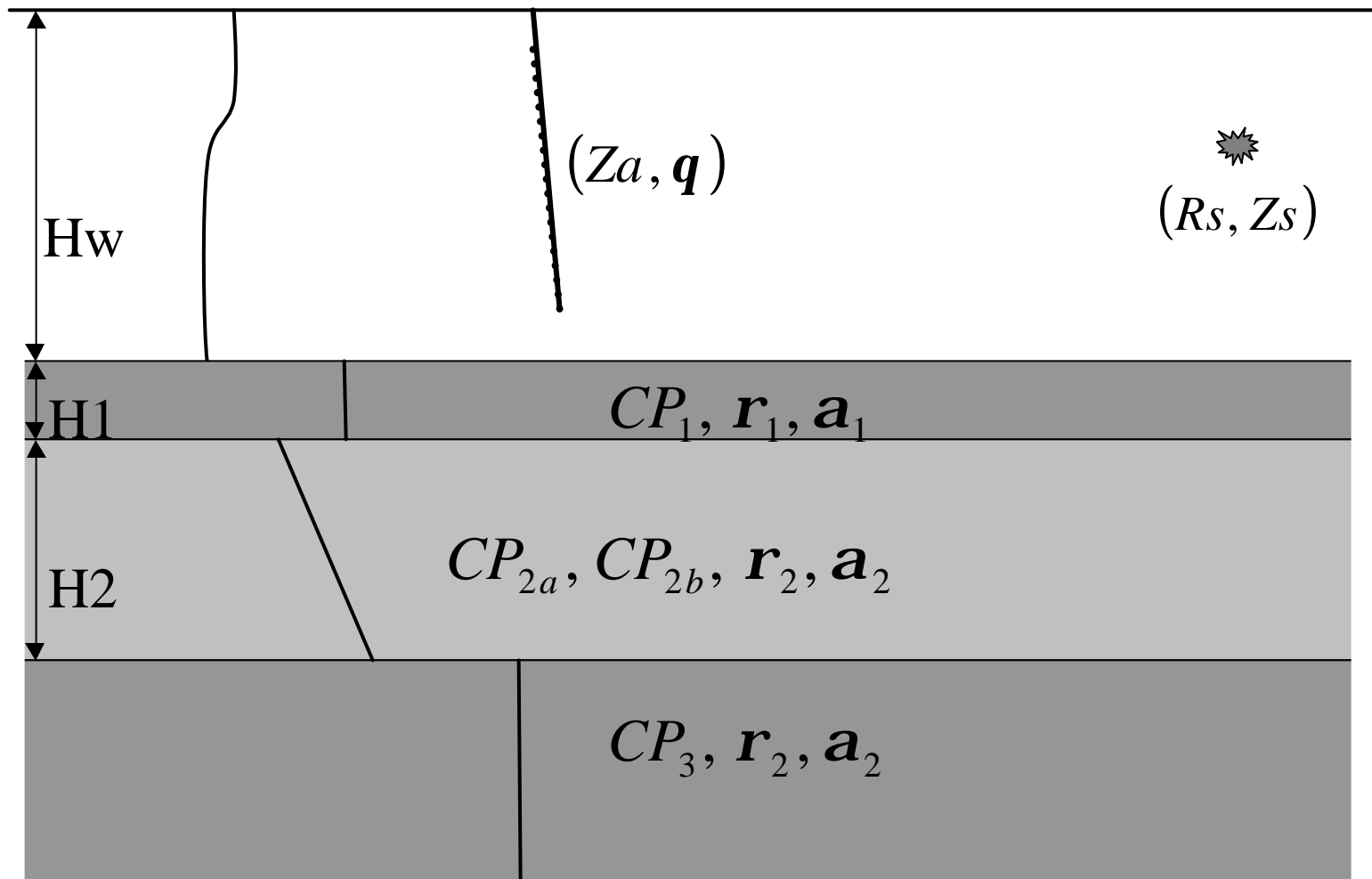
- Population size -- 80
- Reproduction size -- 0.5
- Crossover probability -- 0.8
- Mutation probability -- 0.05
- Number of generations for a GA run -- 150

- 6 independent GA runs for every bomb signal

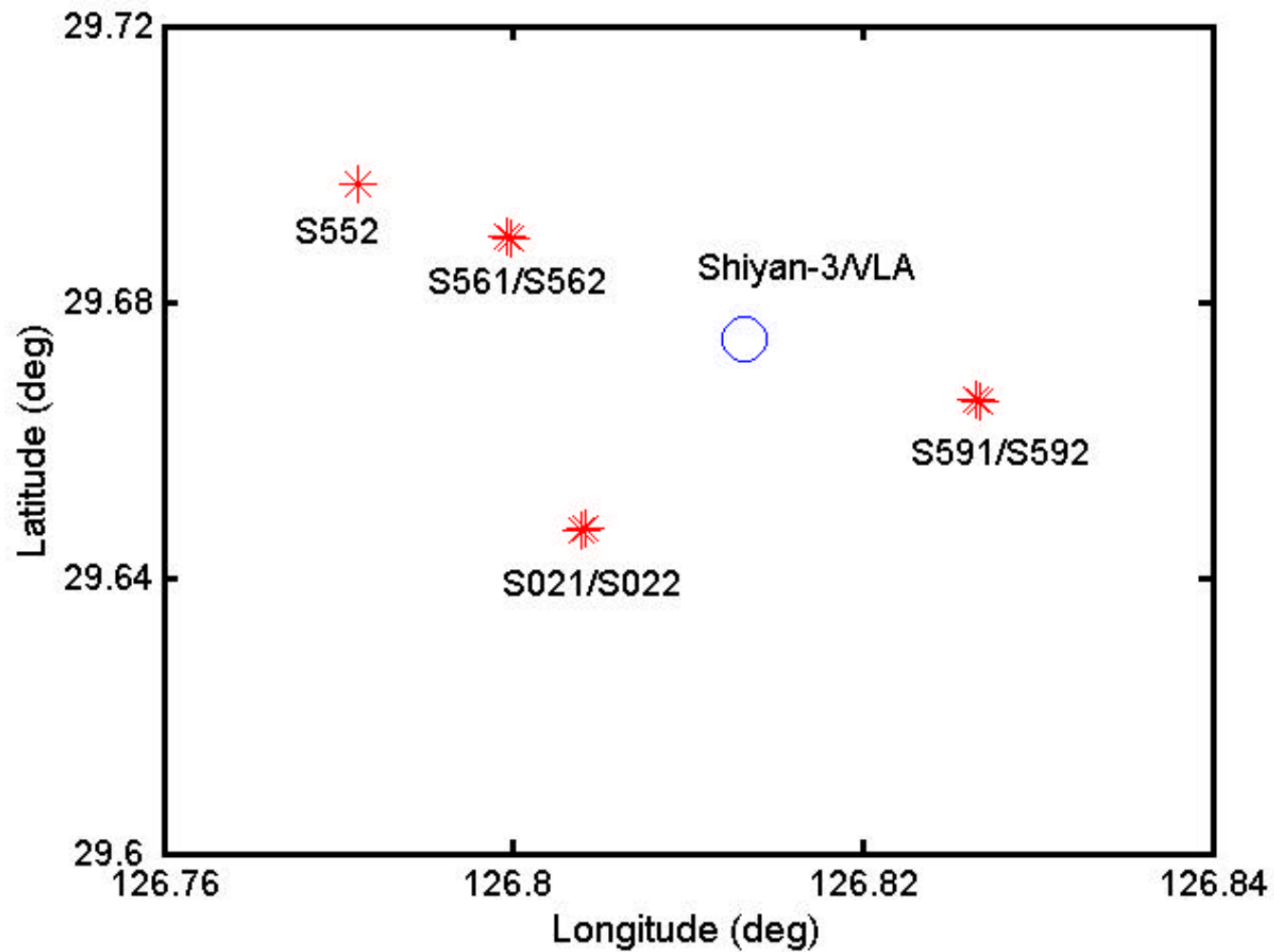
- The best-fit parameter set is taken as inversion result

Parameters to be Estimated

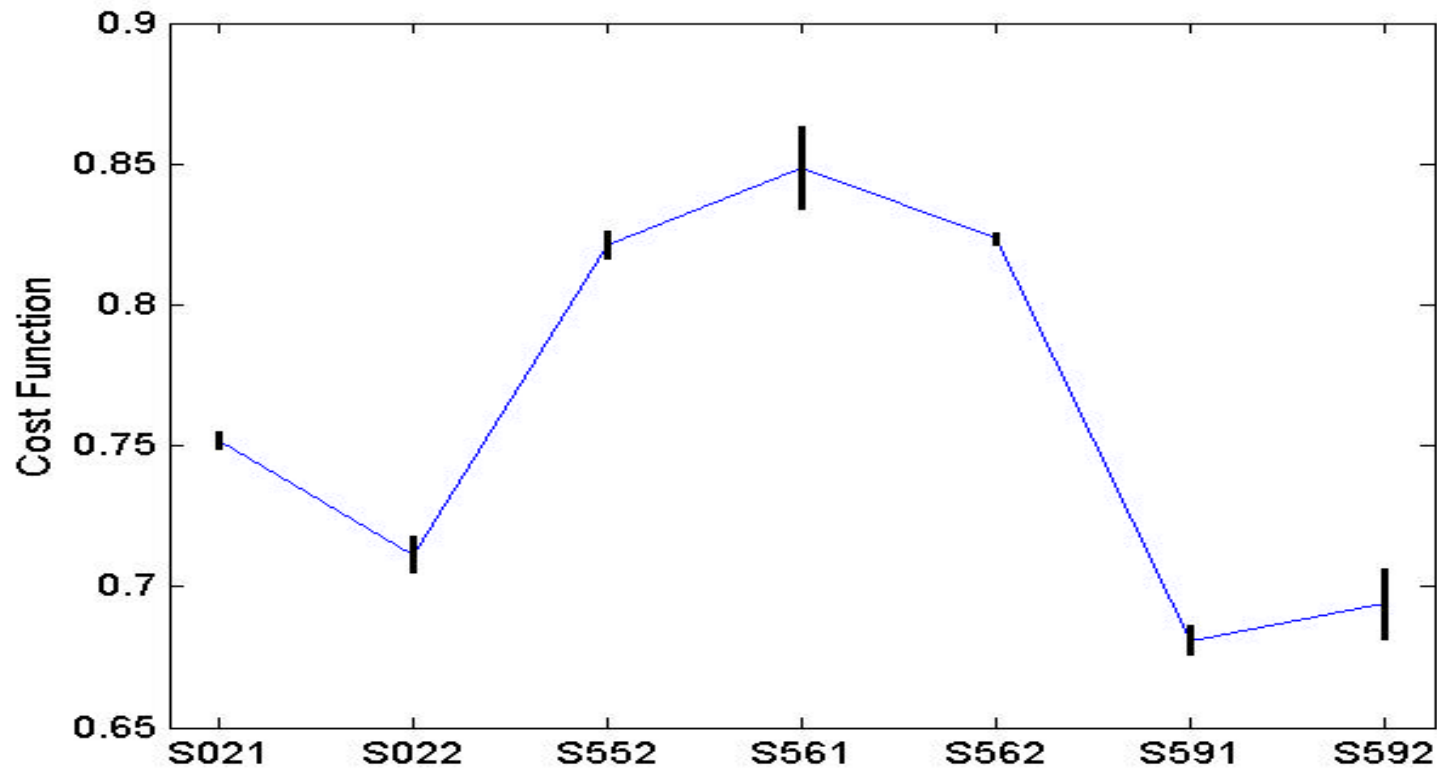
-- Range-independent Model



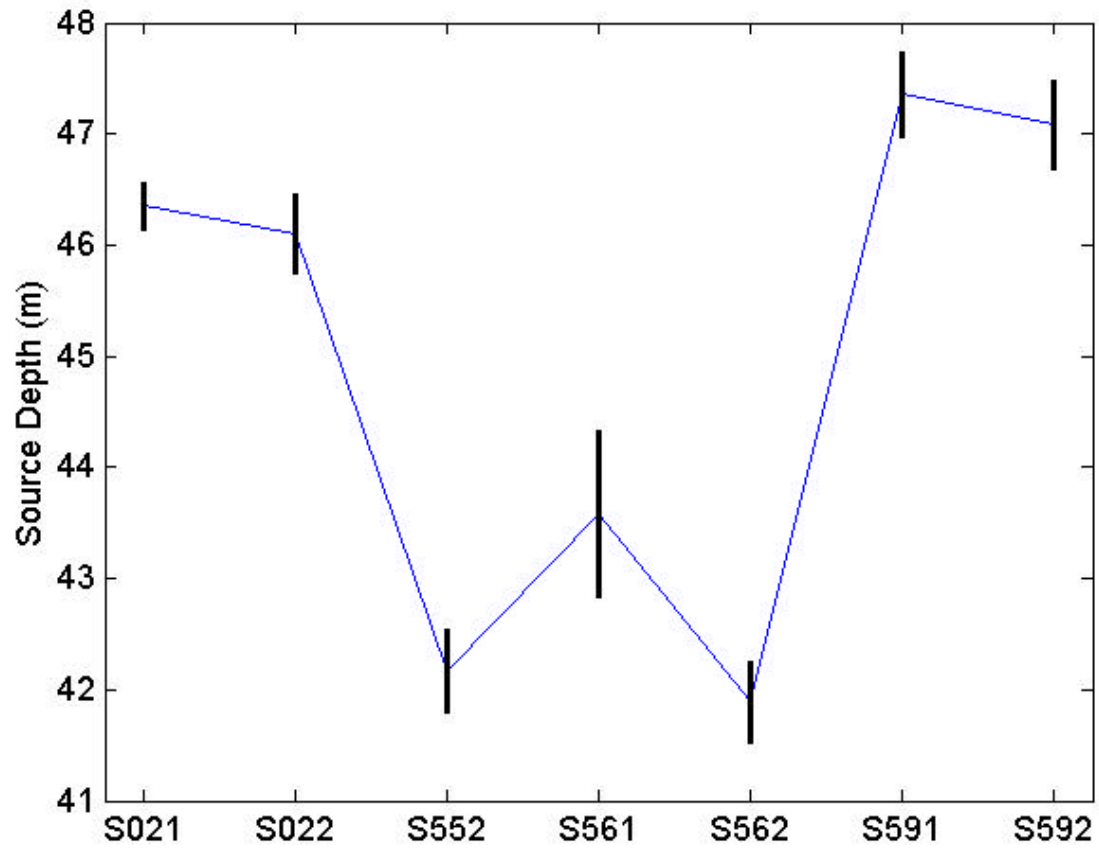
The Bomb Signals used for Inversion



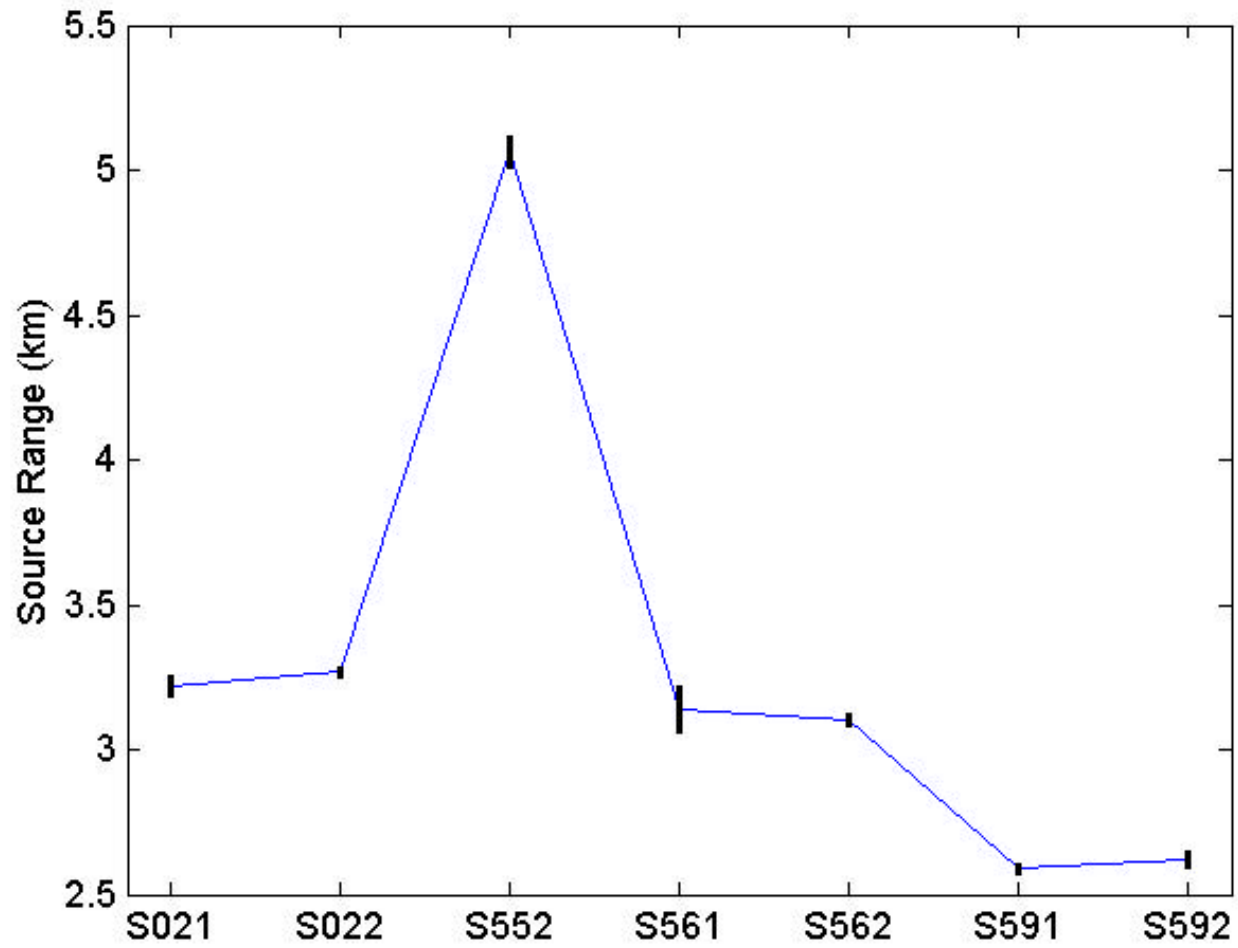
Inversion Results – Cost Function



Inversion Results – Source Depth

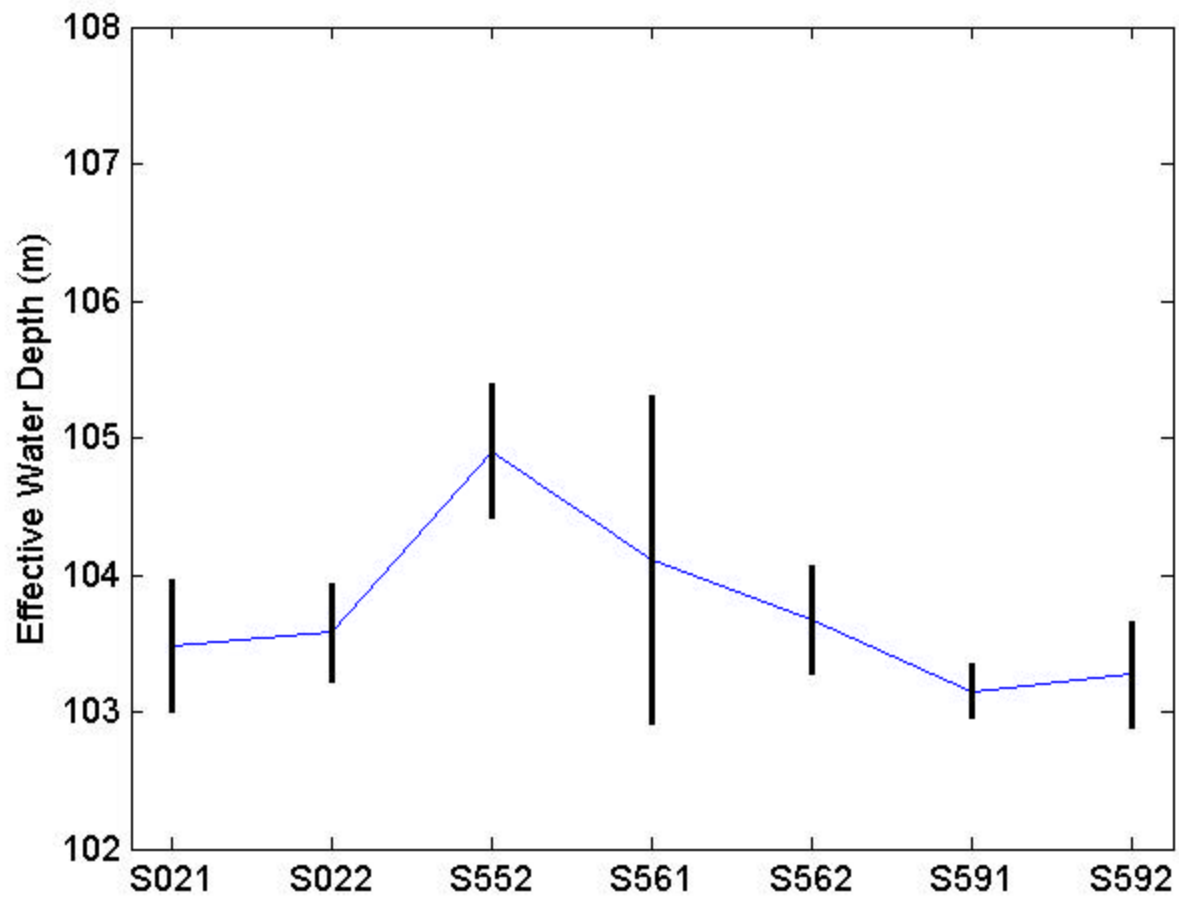


Inversion Results – Source Range



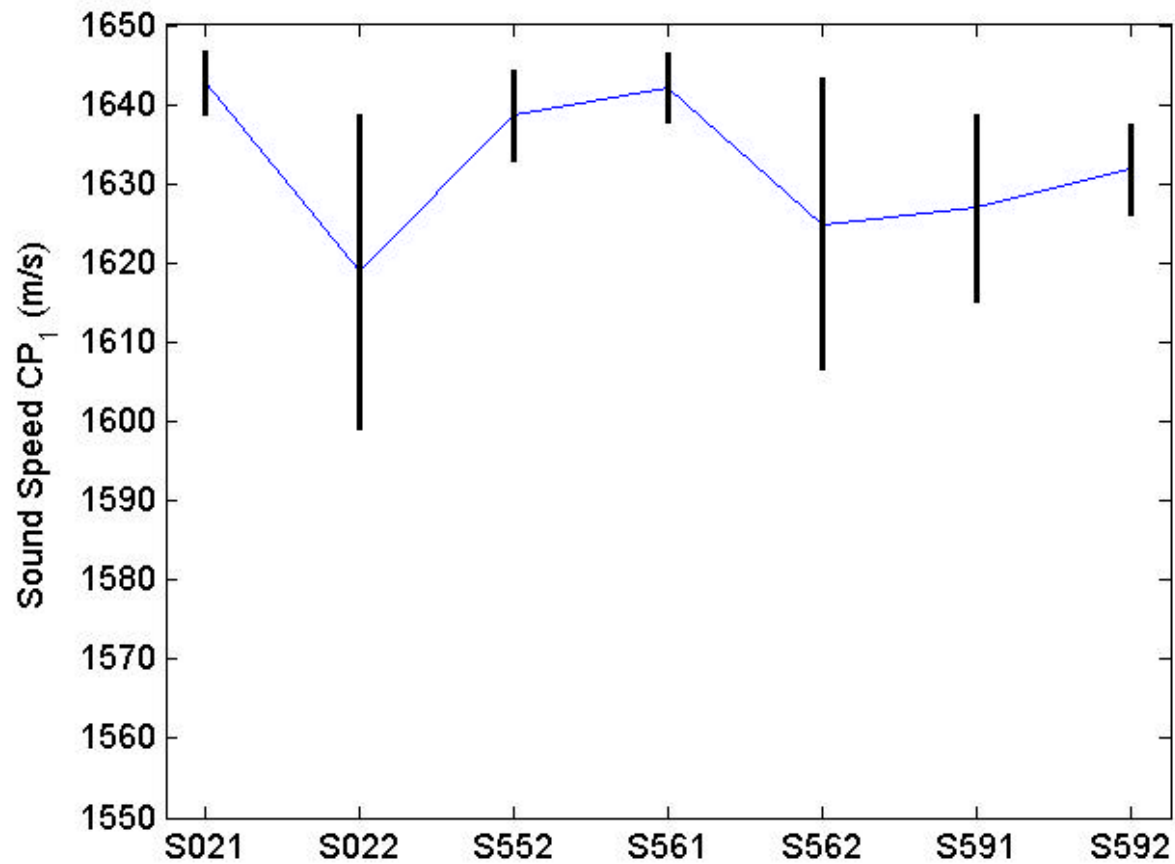
Inversion Results

– Effective Water Depth



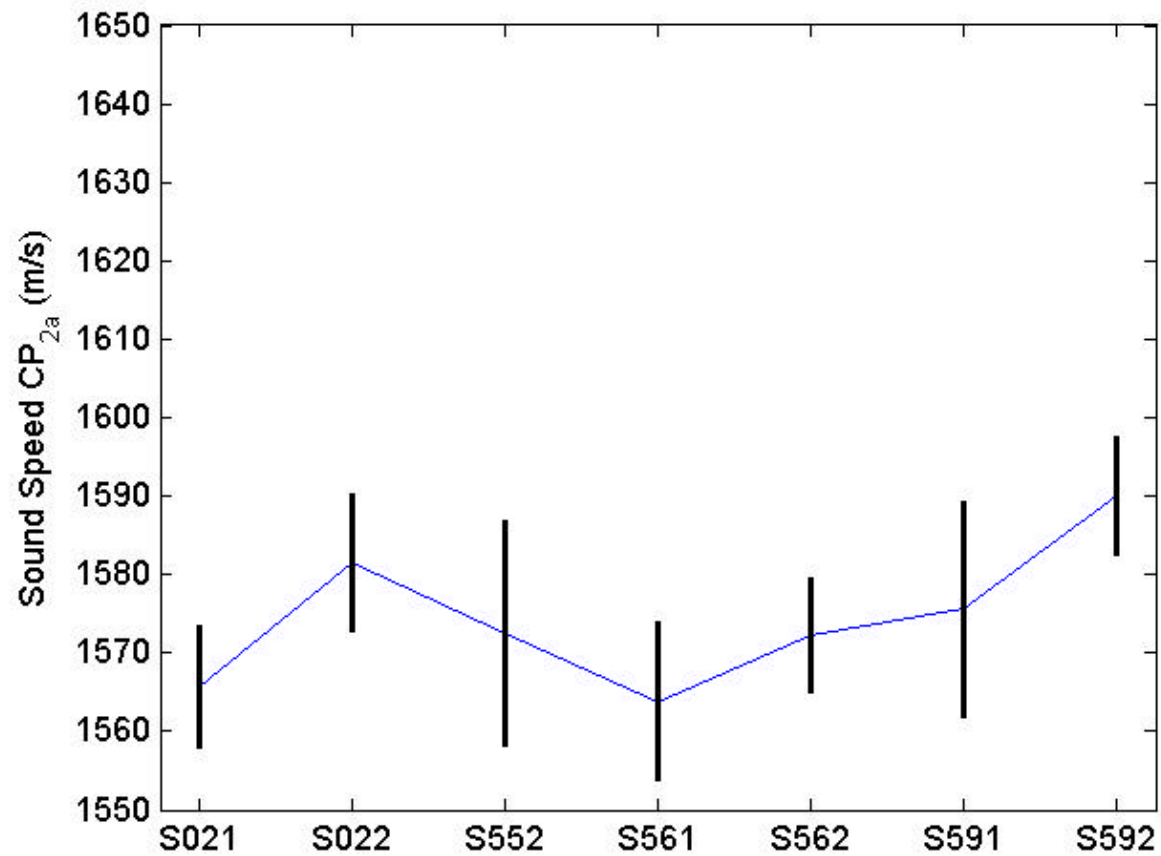
Inversion Results

– Surface Layer Sound Speed



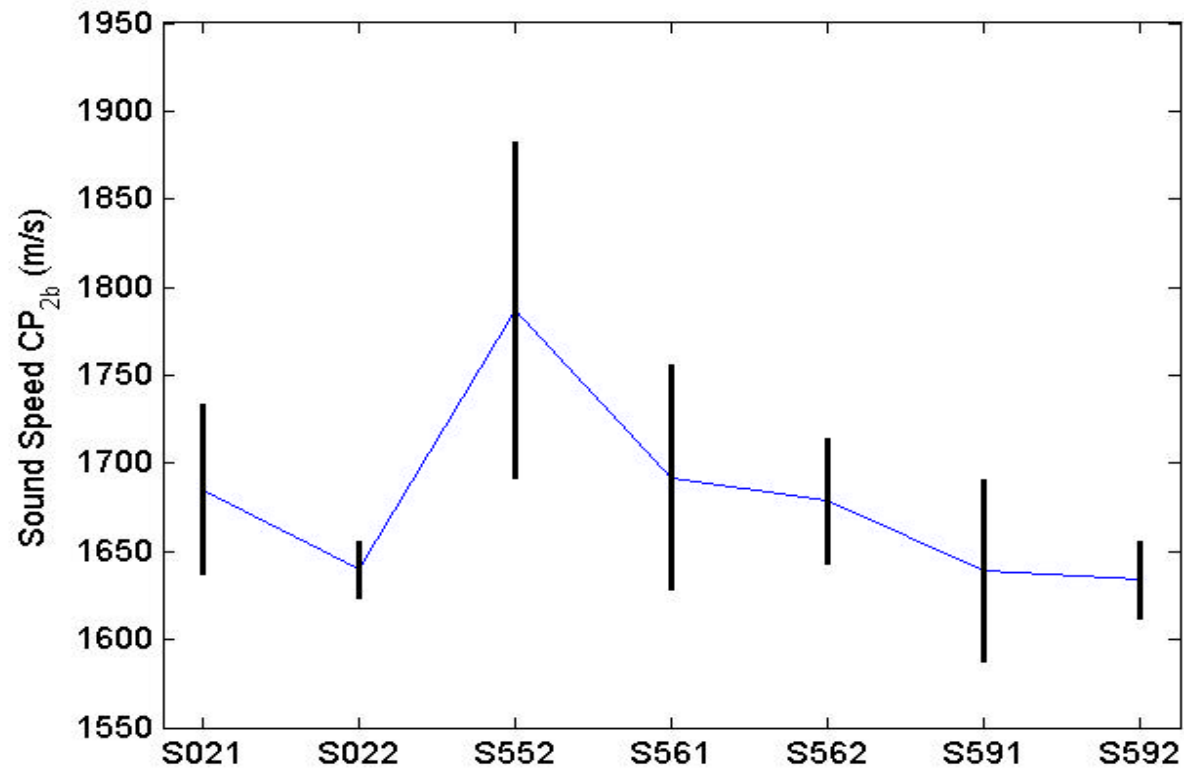
Inversion Results

– Medium Layer Sound Speed



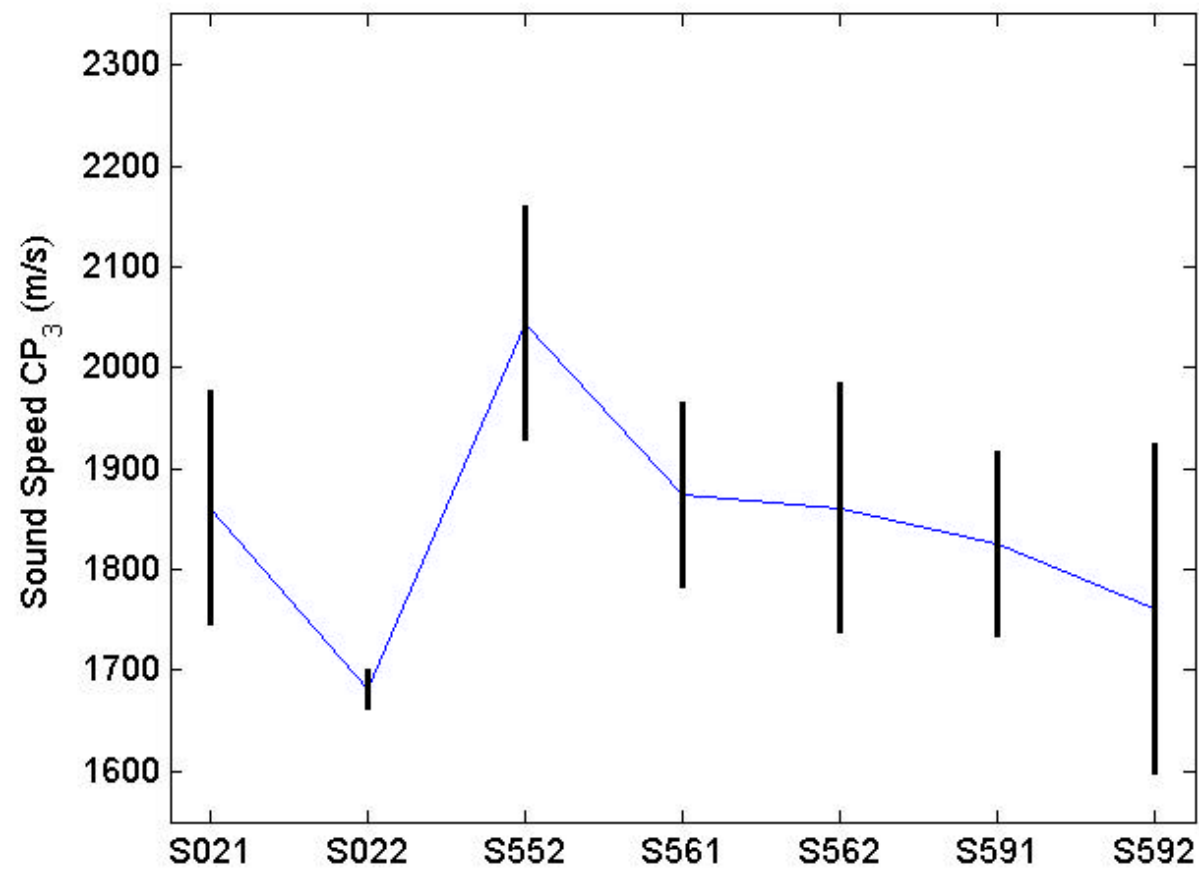
Inversion Results

– Medium Layer Sound Speed



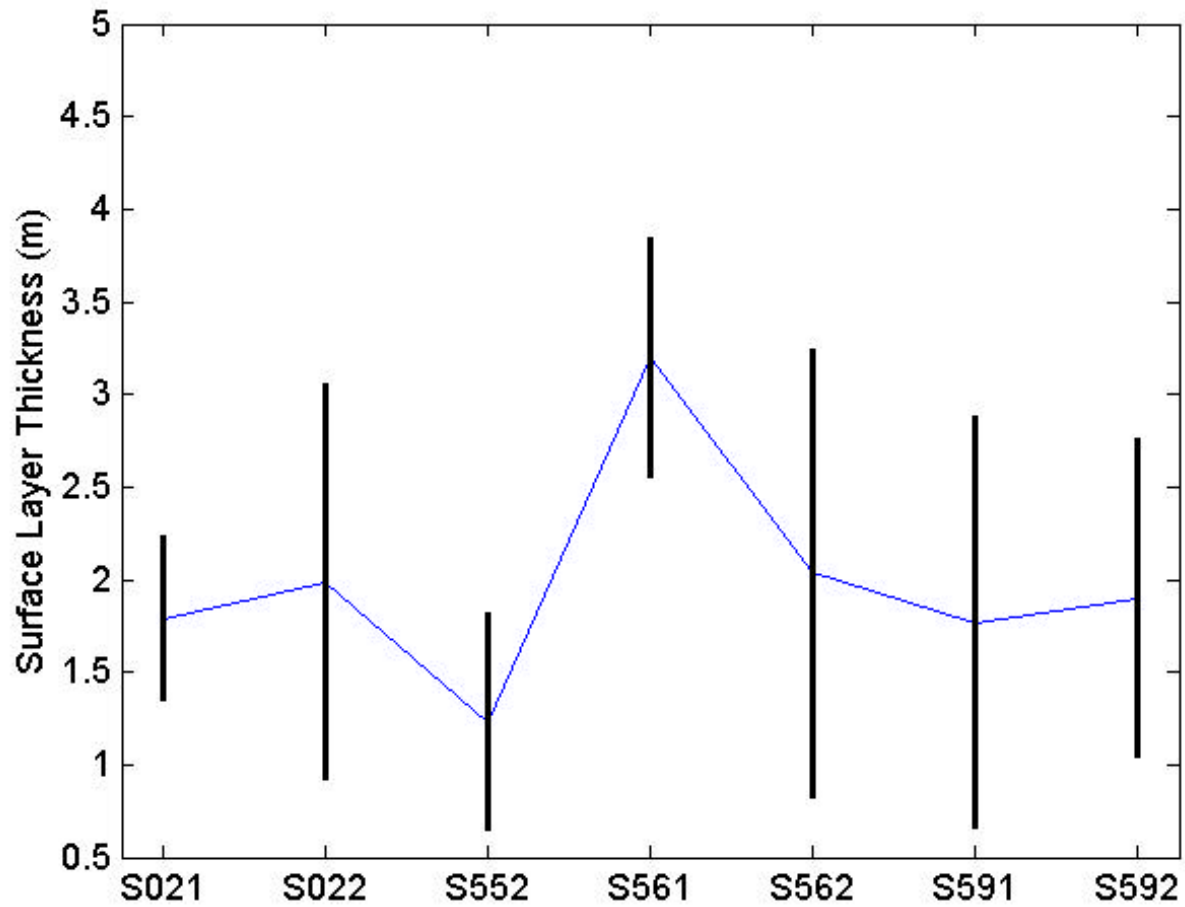
Inversion Results

– Basement Sound Speed



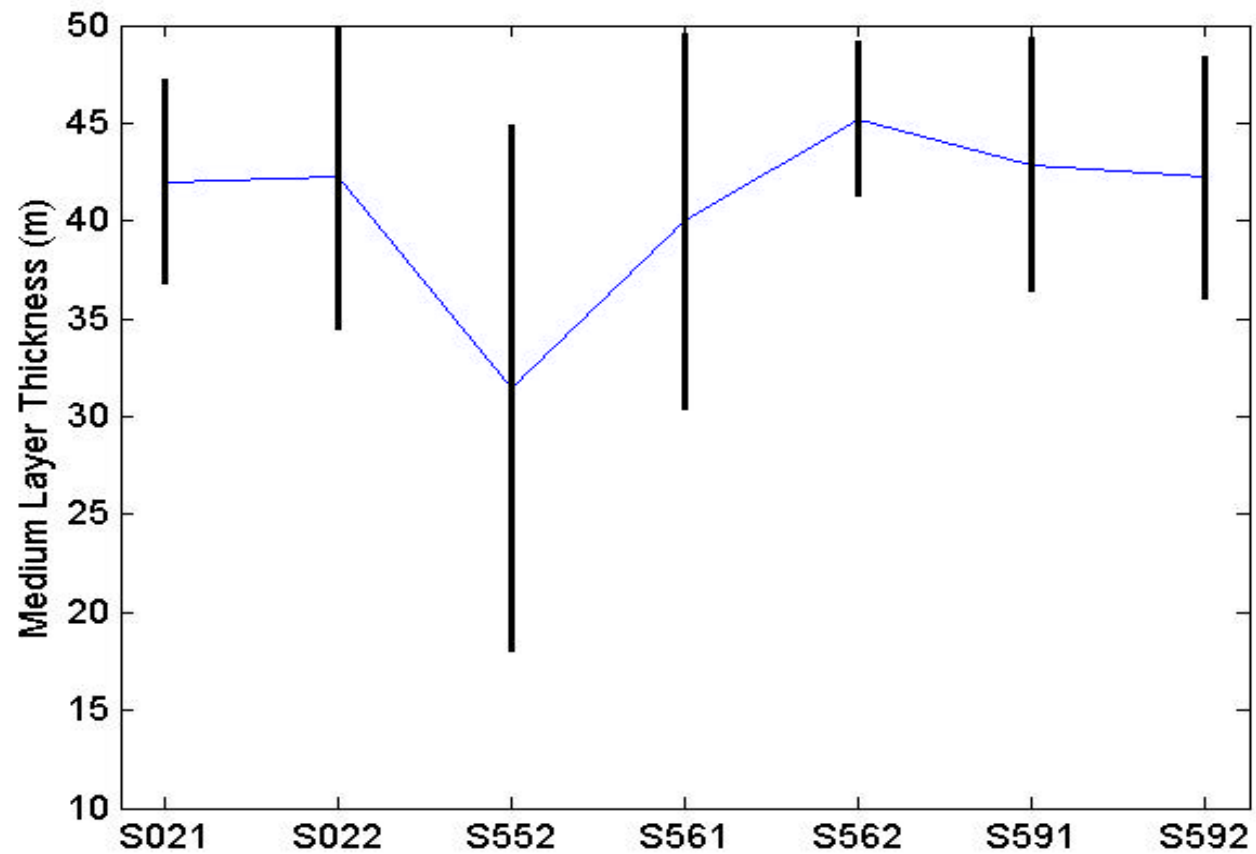
Inversion Results

– Surface Layer Thickness



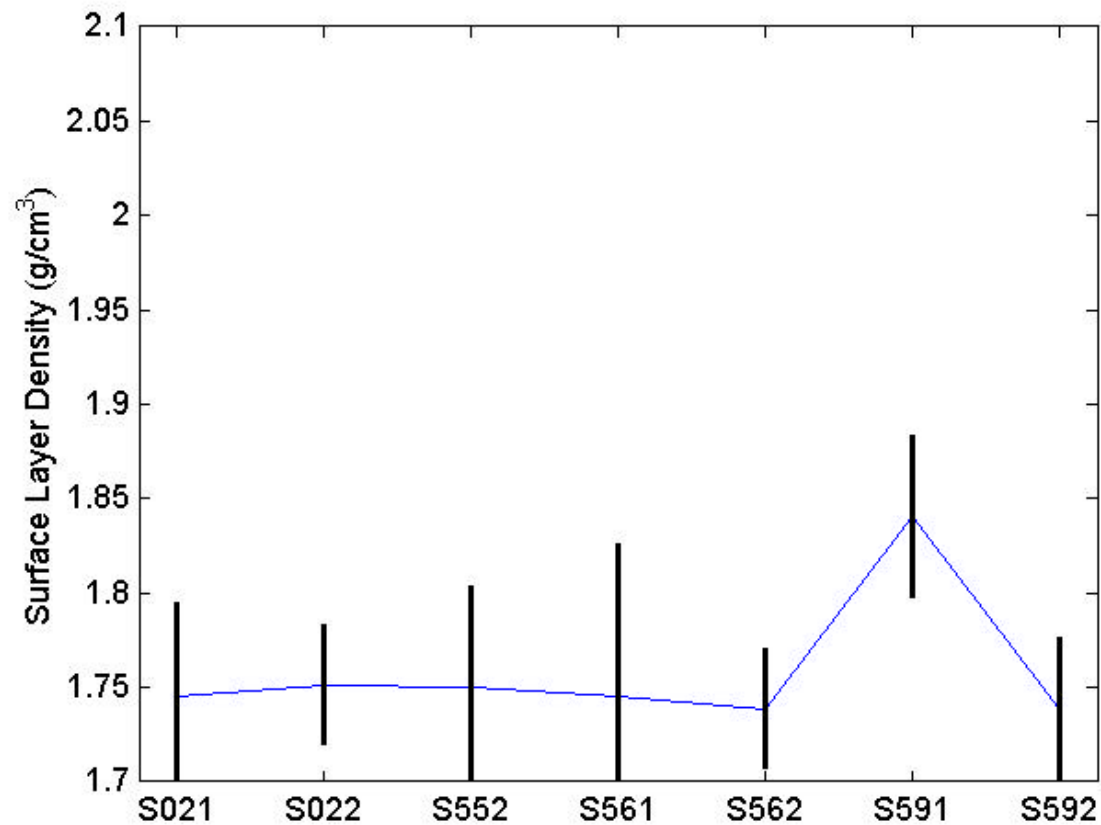
Inversion Results

– Medium Layer Thickness



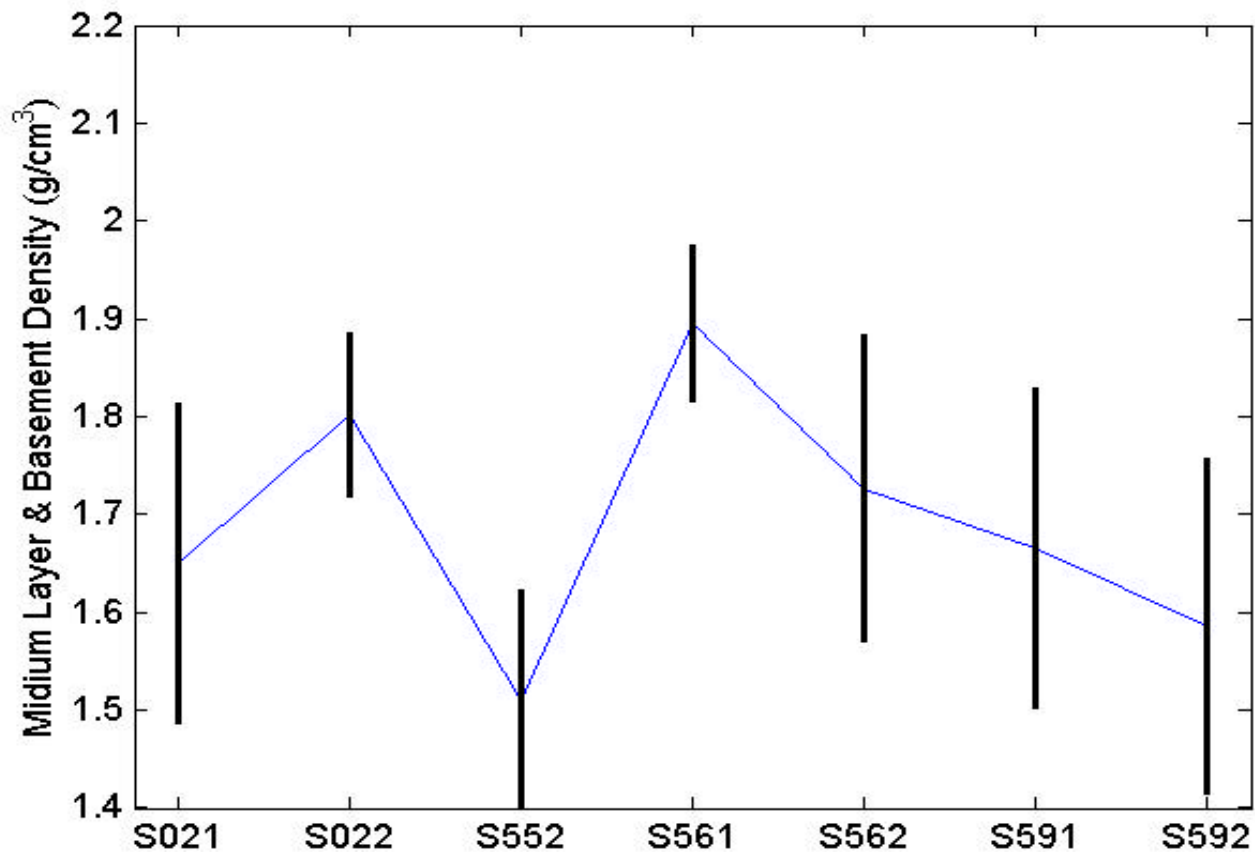
Inversion Results

– Surface Layer Density



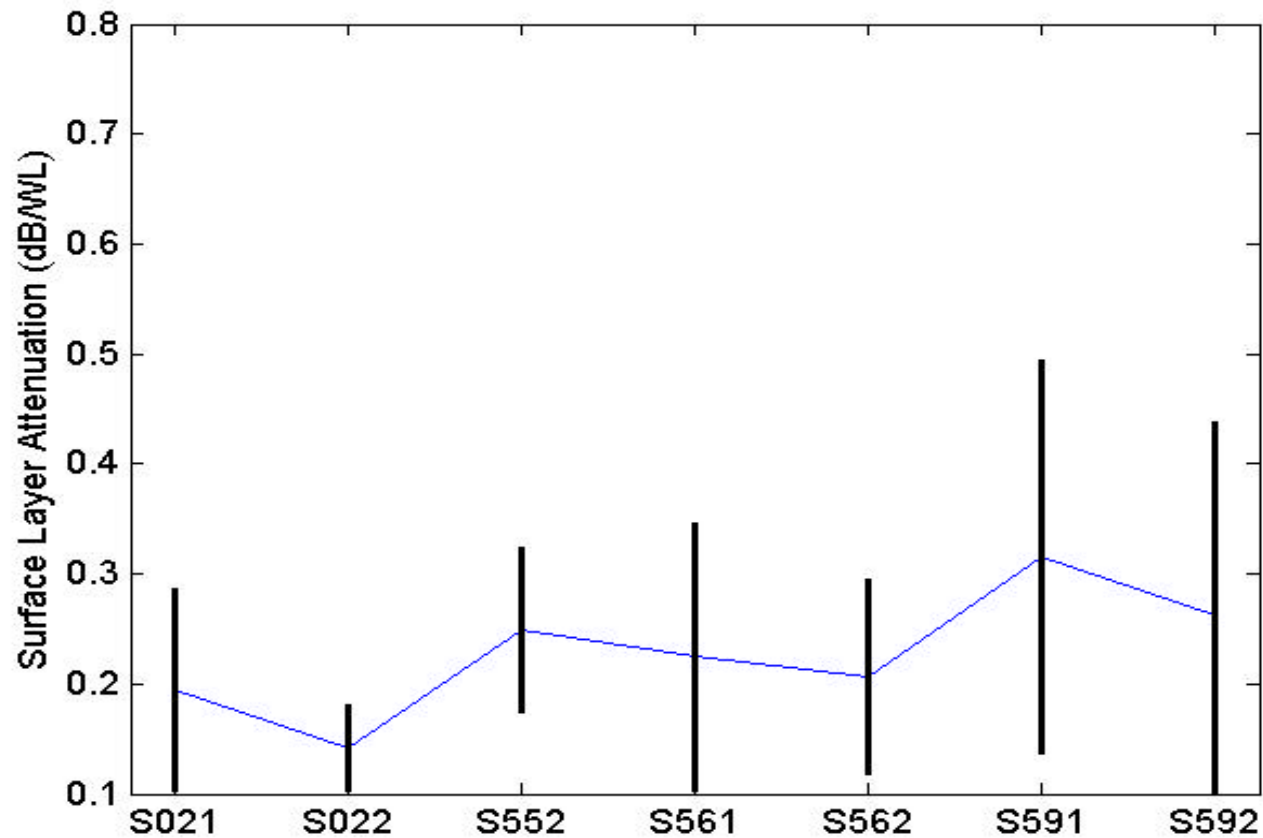
Inversion Results

– Medium Layer & Basement Density



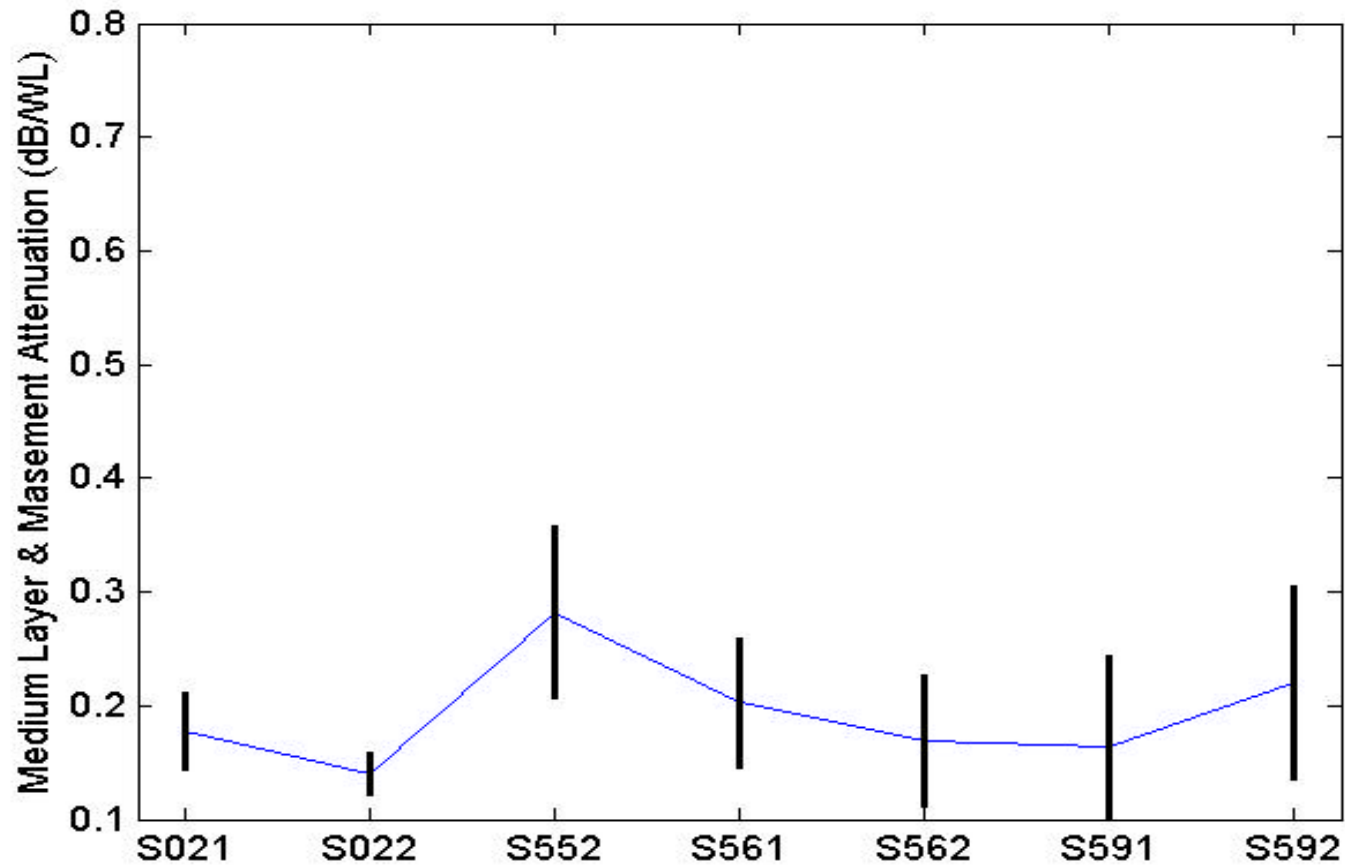
Inversion Results

– Surface Layer Attenuation



Inversion Results

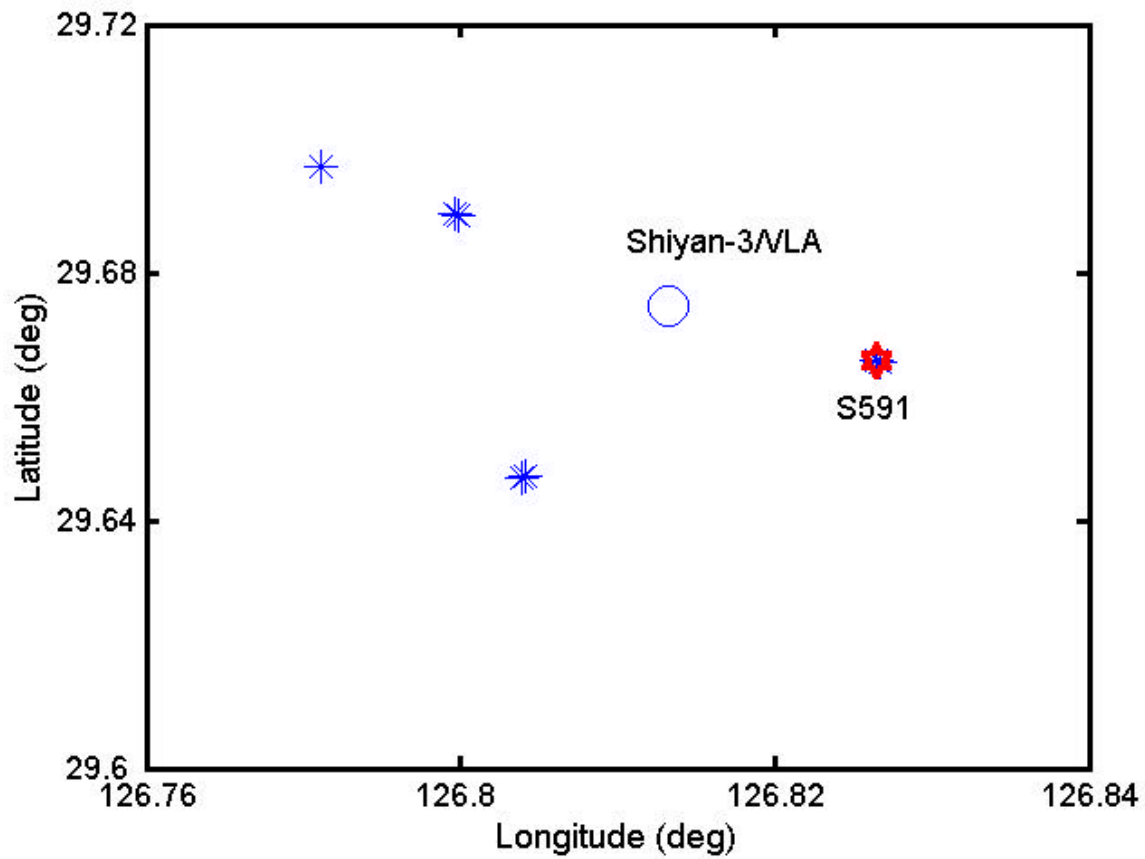
– Medium Layer & Basement Attenuation



Inversion Results of the Geo-acoustic Parameters

Parameter	Search Bounds	Step 1 results	
		Mean	STD
CP_1 (m/s)	[1550 1650]	1634	11.
CP_{2a} (m/s)	[1550 1650]	1574	13.
CP_{2b} (m/s)	+ [0 300]	1681	71
CP_3 (m/s)	+ [0 400]	1853	144
r_1 (g/cm ³)	[1.7 2.1]	1.76	0.05
r_2 (g/cm ³)	[1.4 2.2]	1.69	0.17
a_1 (dB / I)	[0.1 0.8]	0.21	0.08
a_2 (dB / I)	[0.1 0.8]	0.19	0.07
$H1$ (m)	[0.5 5.0]	2.0	1.0
$H2$ (m)	[10 50]	40.9	9.5

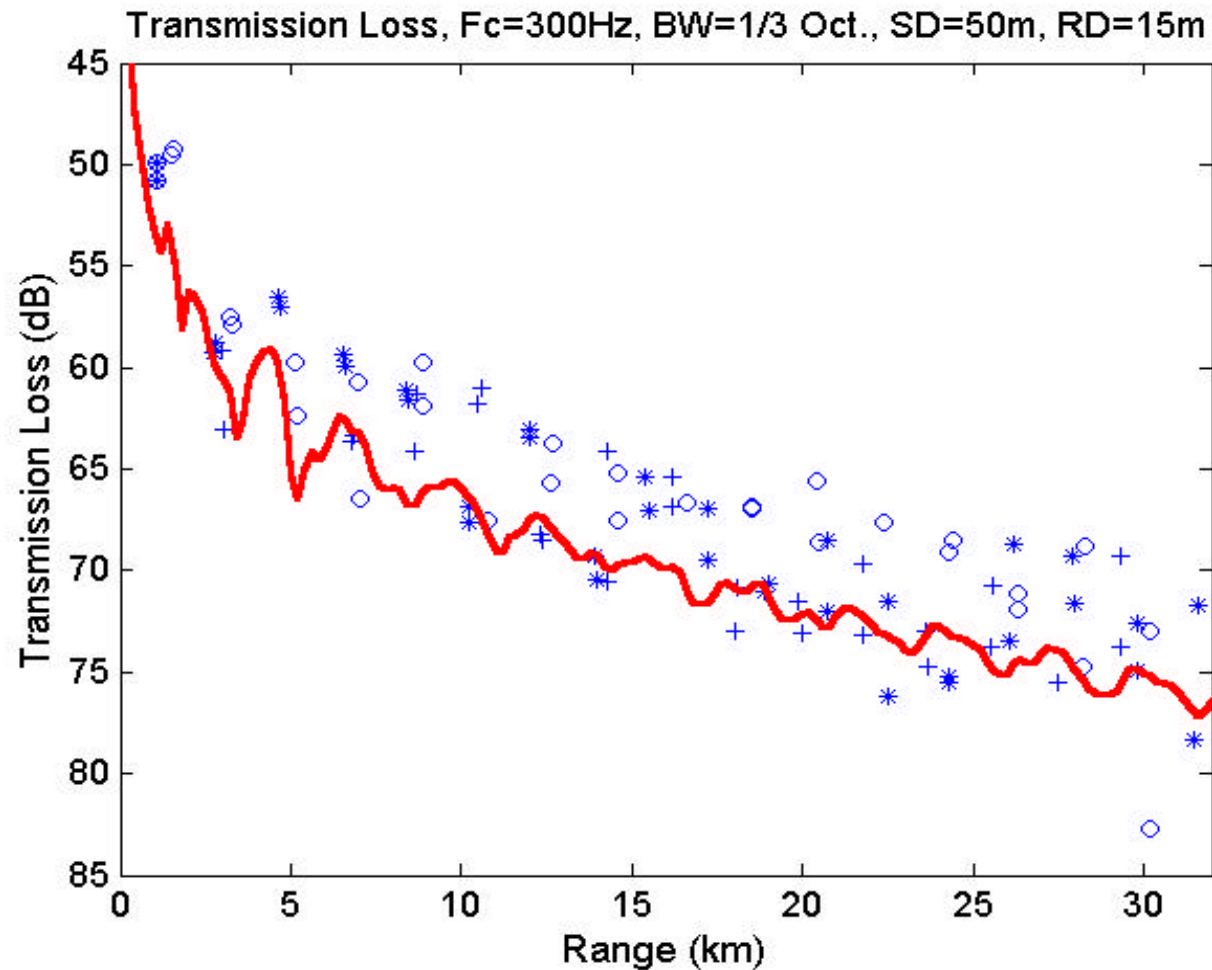
The Bomb Signals from the Closet Range



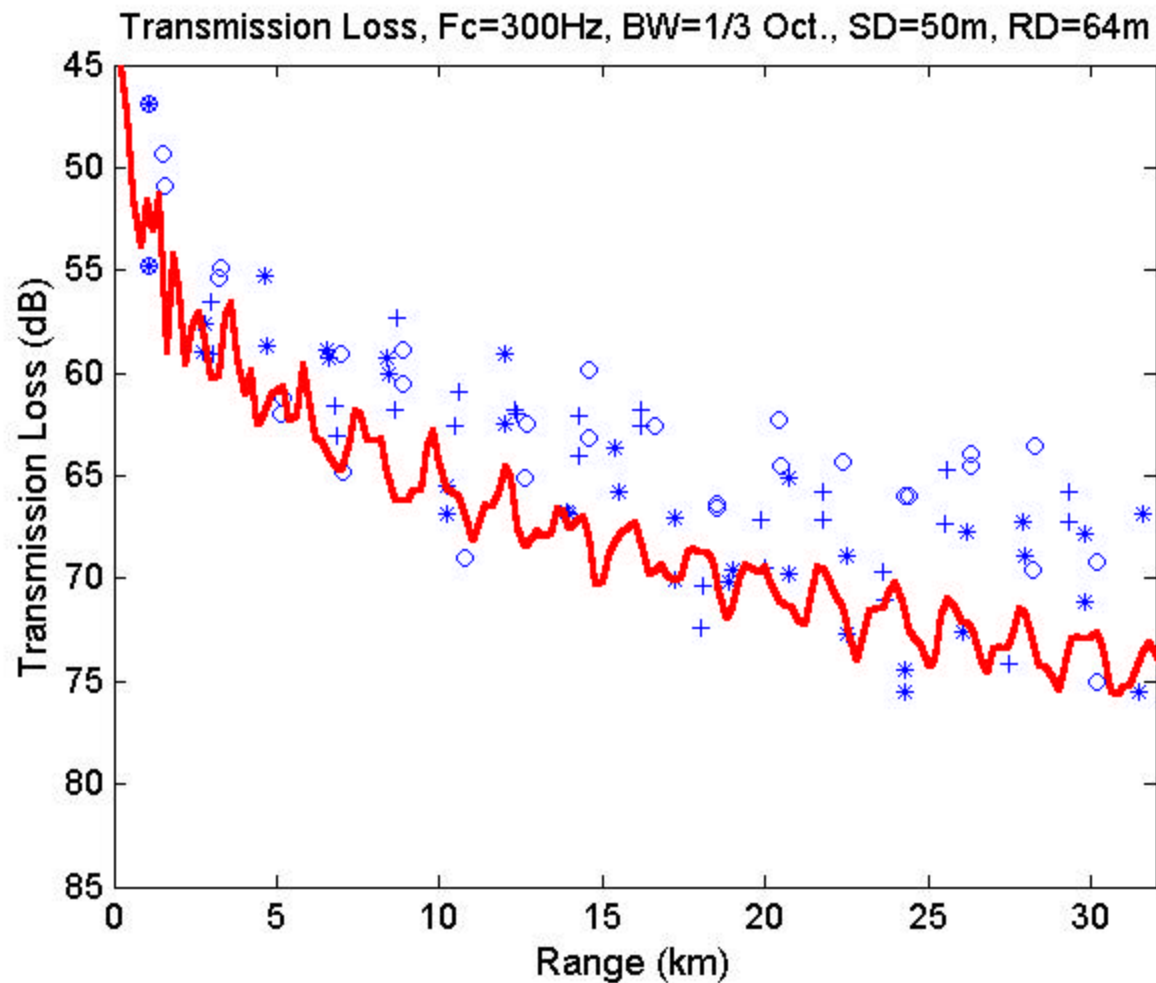
Inversion Results of the Geo-acoustic Parameters

Parameter	Search Bounds	Step 1 results		Step 2 results	
		Mean	STD	Mean	STD
CP_1 (m/s)	[1550 1650]	1634	11.	-	-
CP_{2a} (m/s)	[1550 1650]	1574	13.	-	-
CP_{2b} (m/s)	+ [0 300]	1681	71	1648	22
CP_3 (m/s)	+ [0 400]	1853	144	1845	112
\mathbf{r}_1 (g/cm ³)	[1.7 2.1]	1.76	0.05	-	-
\mathbf{r}_2 (g/cm ³)	[1.4 2.2]	1.69	0.17	1.50	0.12
\mathbf{a}_1 (dB/ I)	[0.1 0.8]	0.21	0.08	-	-
\mathbf{a}_2 (dB/ I)	[0.1 0.8]	0.19	0.07	-	-
$H1$ (m)	[0.5 5.0]	2.0	1.0	1.5	0.4
$H2$ (m)	[10 50]	40.9	9.5	37.1	9.1

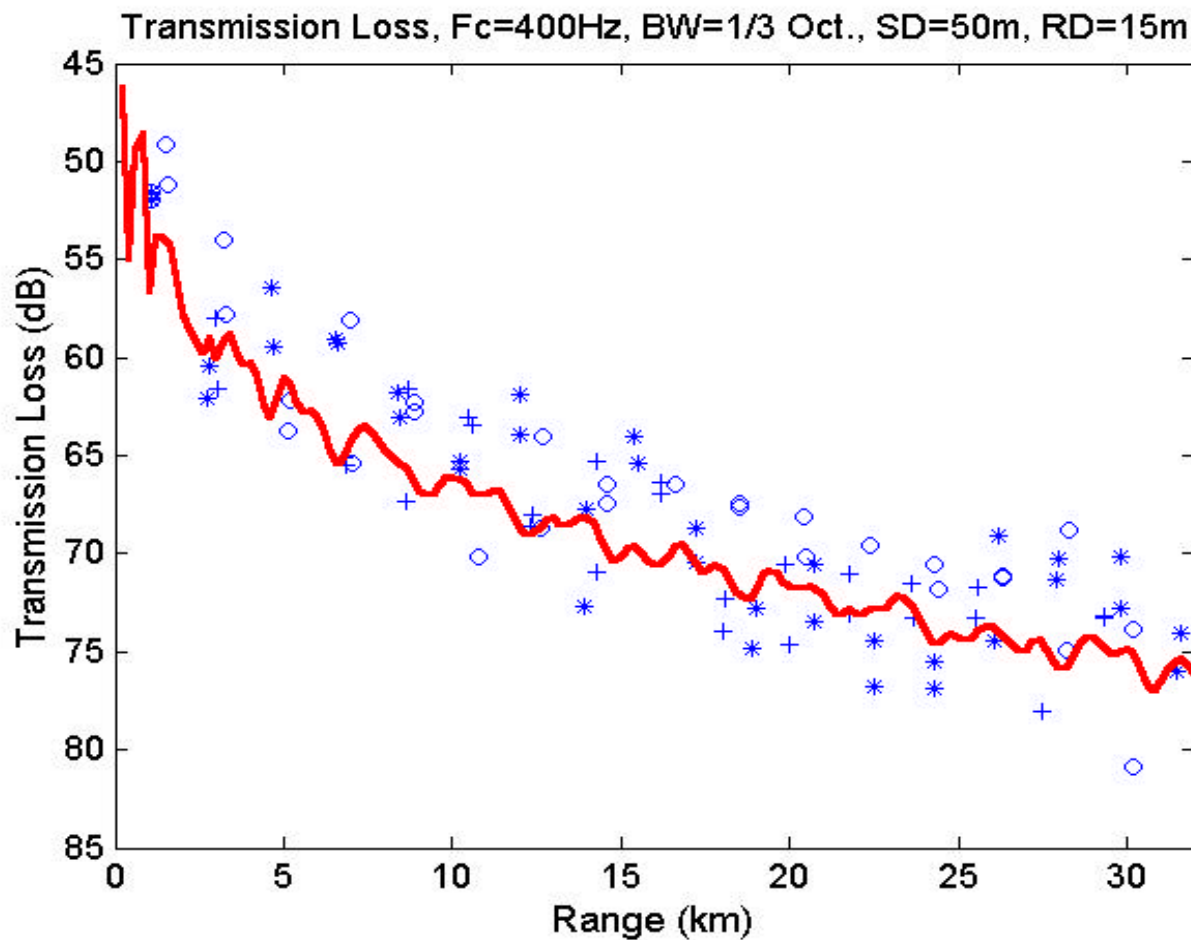
Transmission Losses Calculated from the Inversion Results



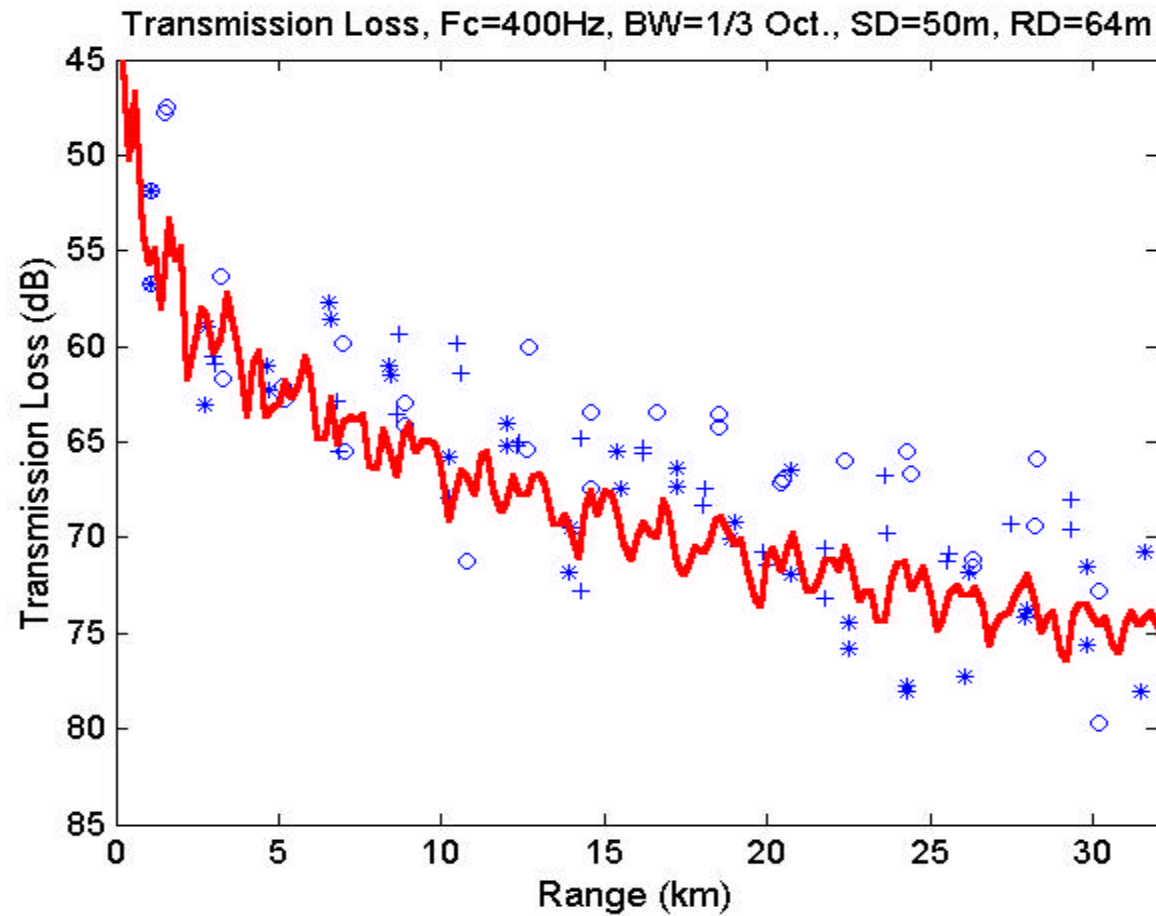
Transmission Losses Calculated from the Inversion Results



Transmission Losses Calculated from the Inversion Results



Transmission Losses Calculated from the Inversion Results



Conclusions

- 3-layer bottom model
- Sound speed, density and attenuation for the surface layer are about 1634m/s, 1.76g/cm³ and 0.21 dB/WL, respectively. The thickness is about 1.5m.
- For the medium layer, the sound speed changes from 1574m/s to 1648m/s, and the thickness is about 37m.

Thanks!