

Data needs and motivation

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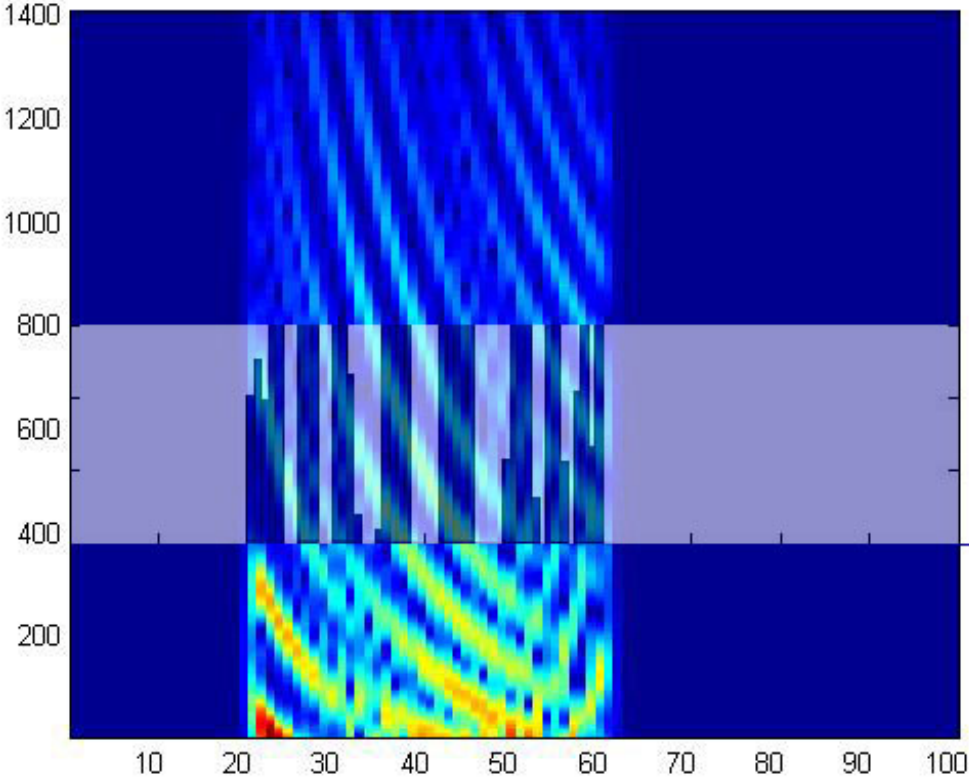
Department of Mathematical Sciences

New Jersey Institute of Technology

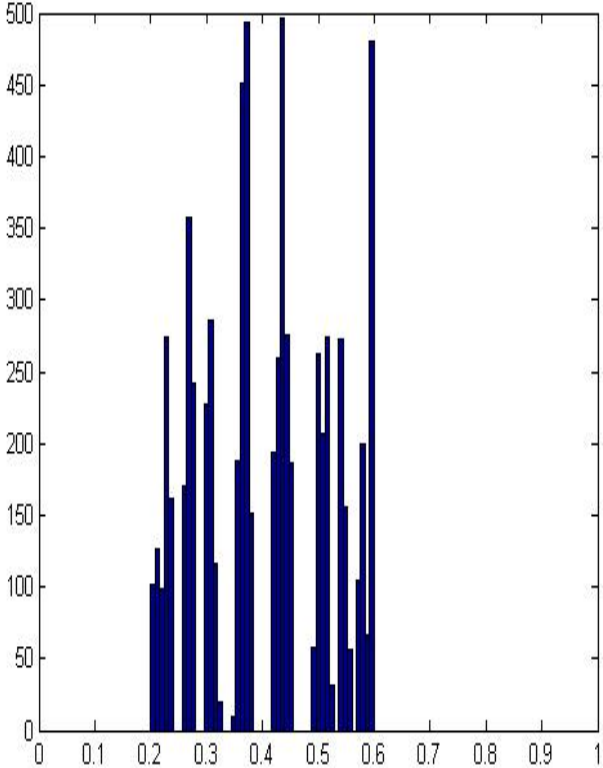
Data Needs

- Wide range of frequencies: 10 Hz to 4 kHz.
(Combustive source with power in low frequencies? Chirps, time domain signals are important.)
- Low frequency CW (J15?)

Dispersion Analysis - Time-Frequency

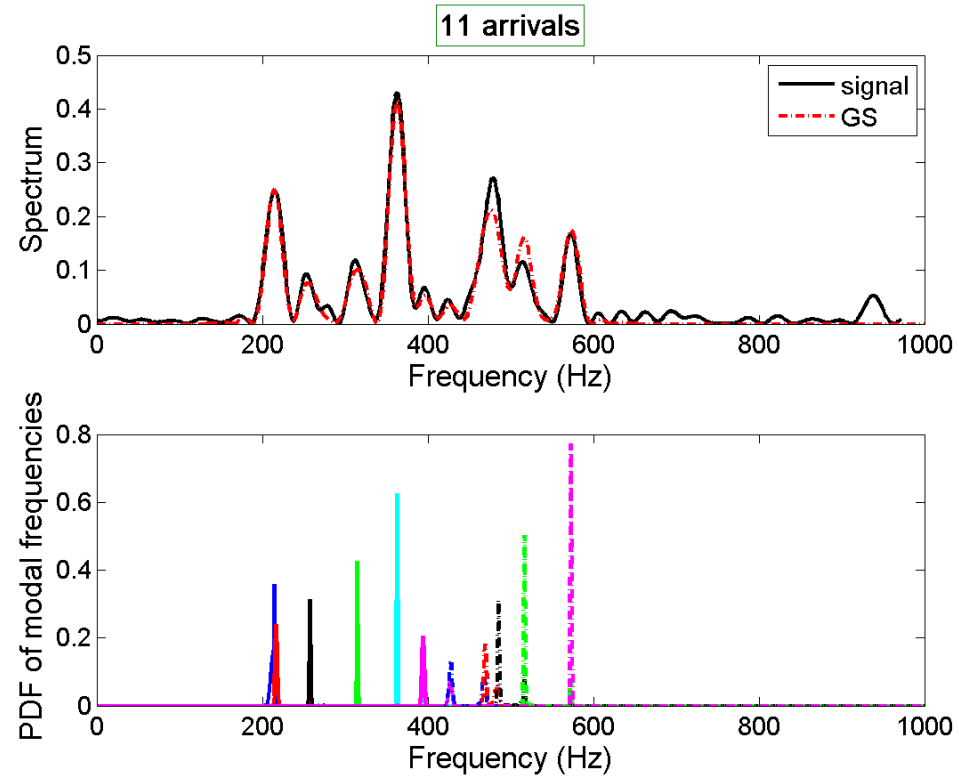
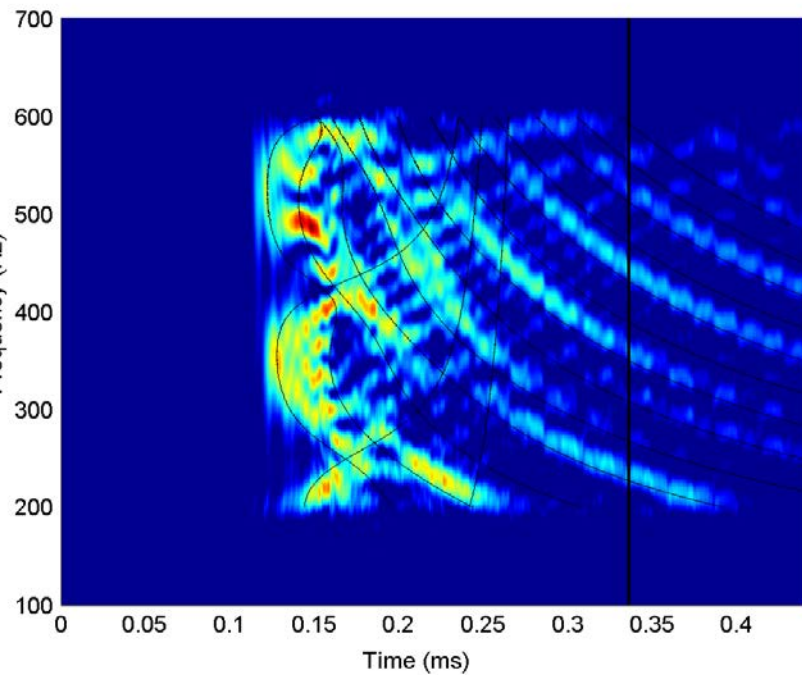


Time-frequency analysis

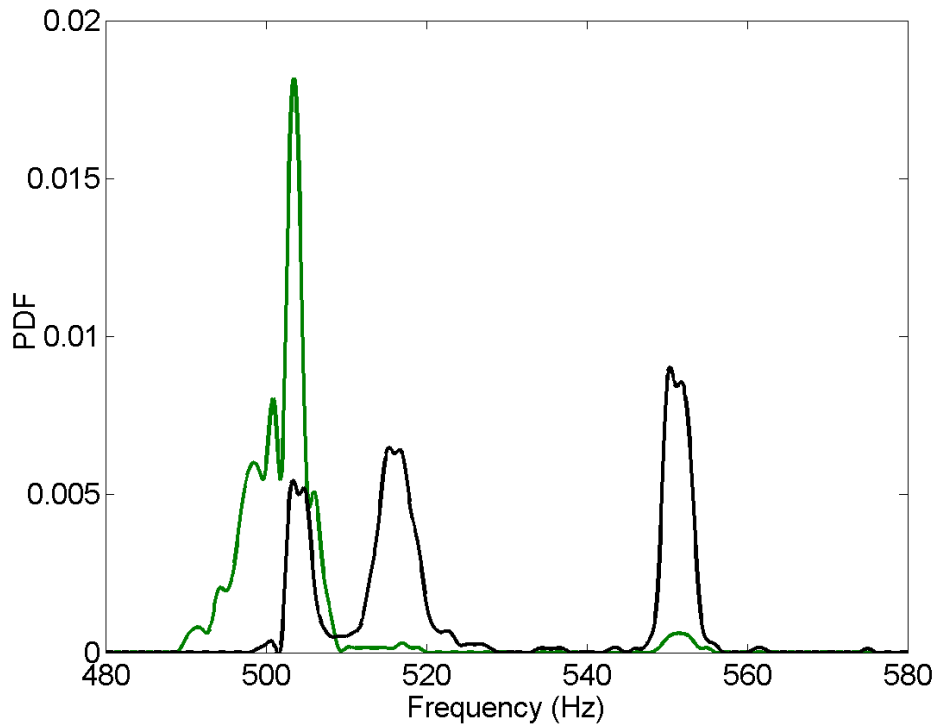


Which modes are identified?

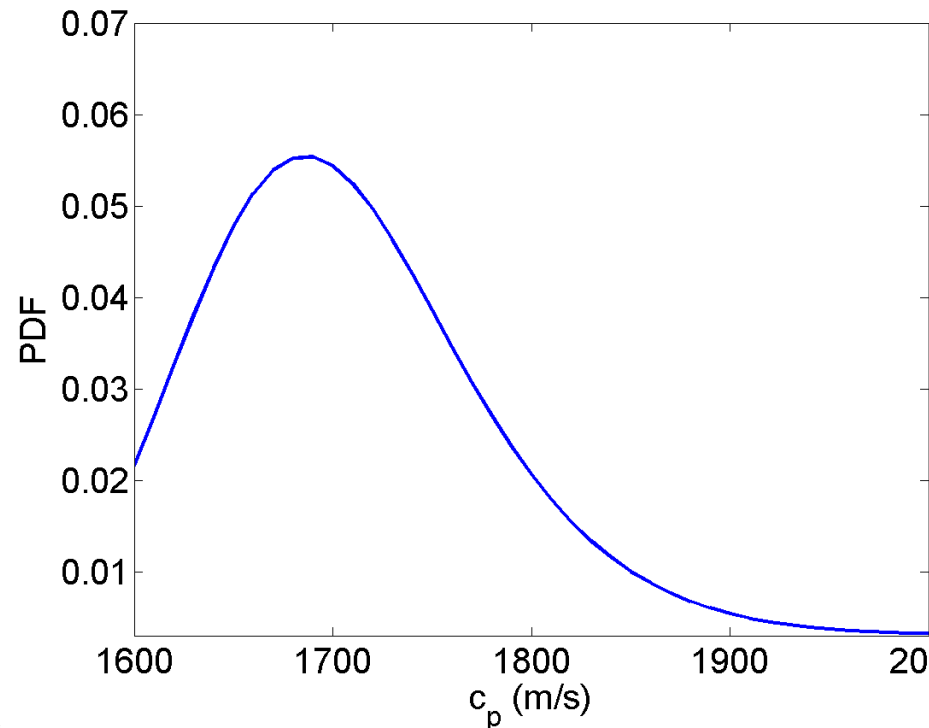
Dispersion Analysis



Dispersion - Uncertainty

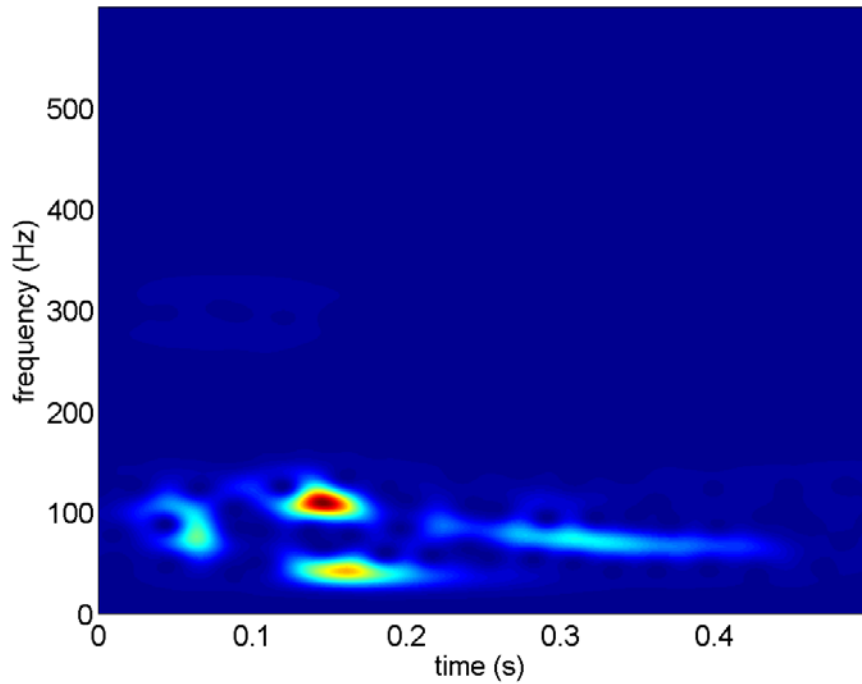


Modal frequency PDFs for two modes



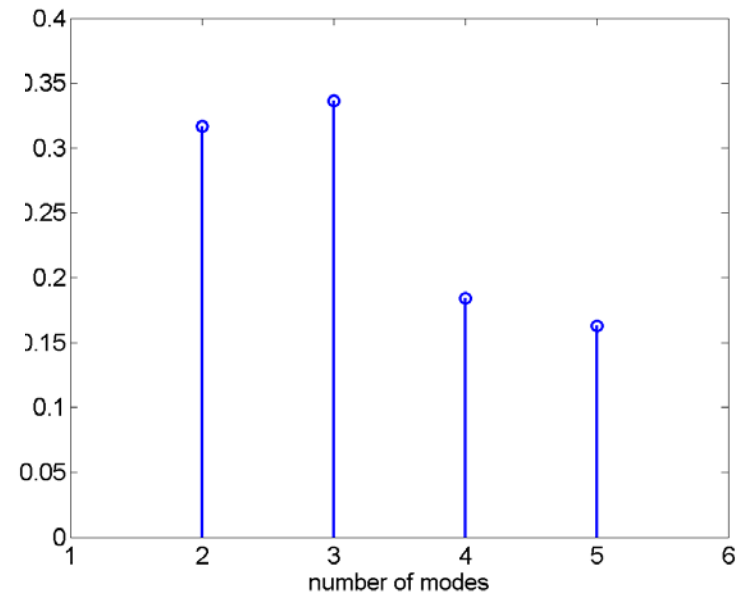
Sediment sound speed – first layer
True value: 1674 m/s

Shallow Water-06



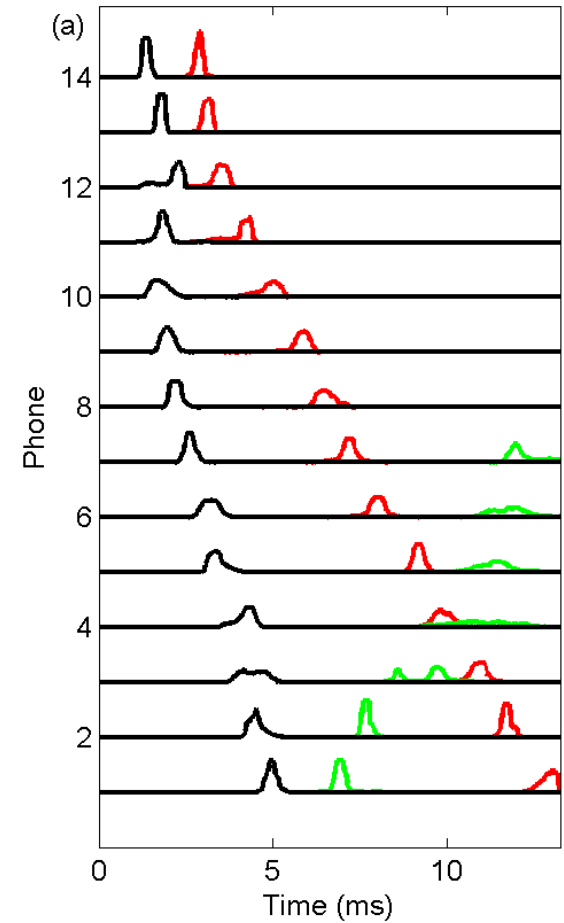
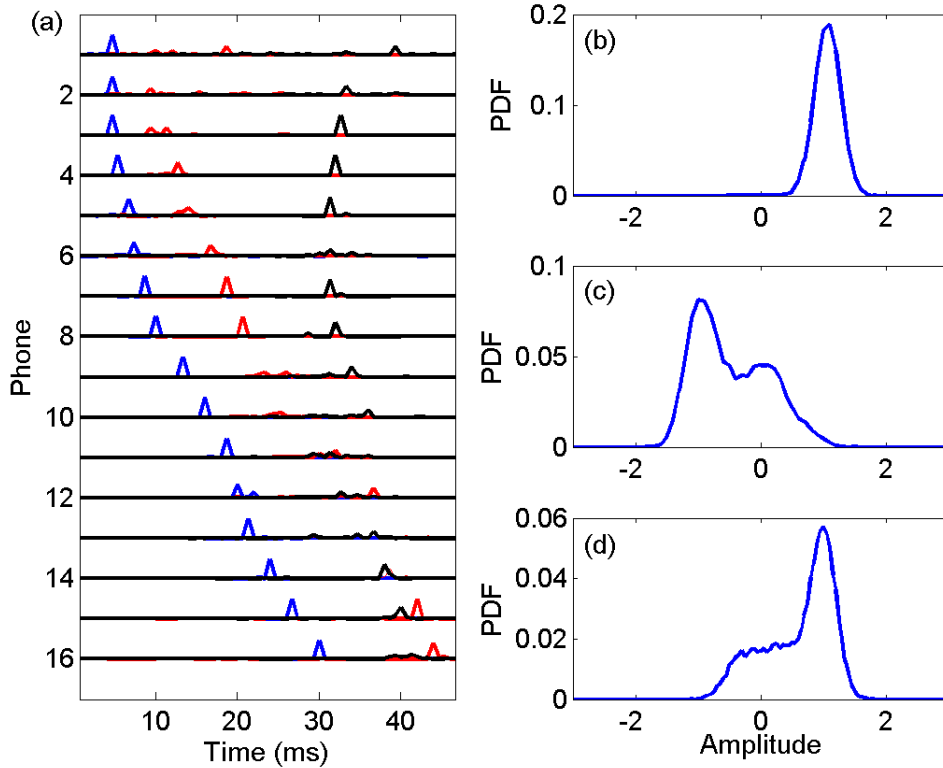
Schwartz-Rissanen criterion
(Time delay estimation
Michalopoulou and Picarelli JASA 2006)

Dispersion (combustive source)

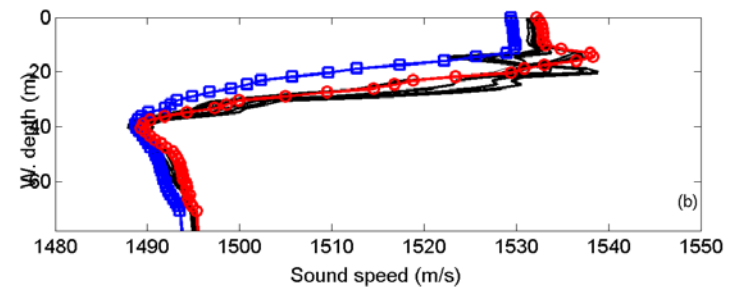
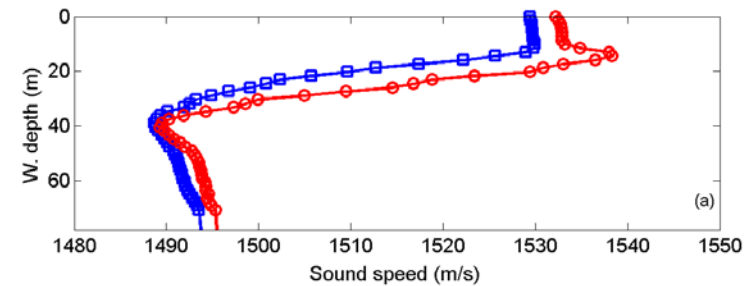
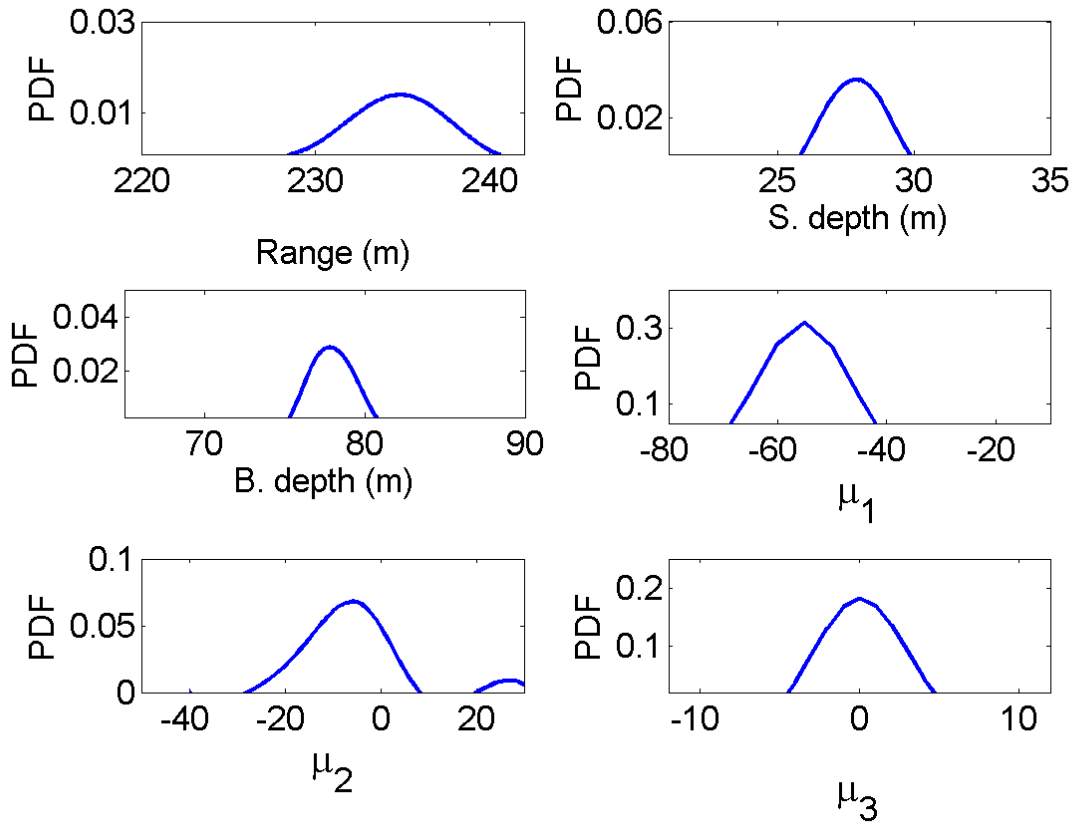


Arrival time inversion

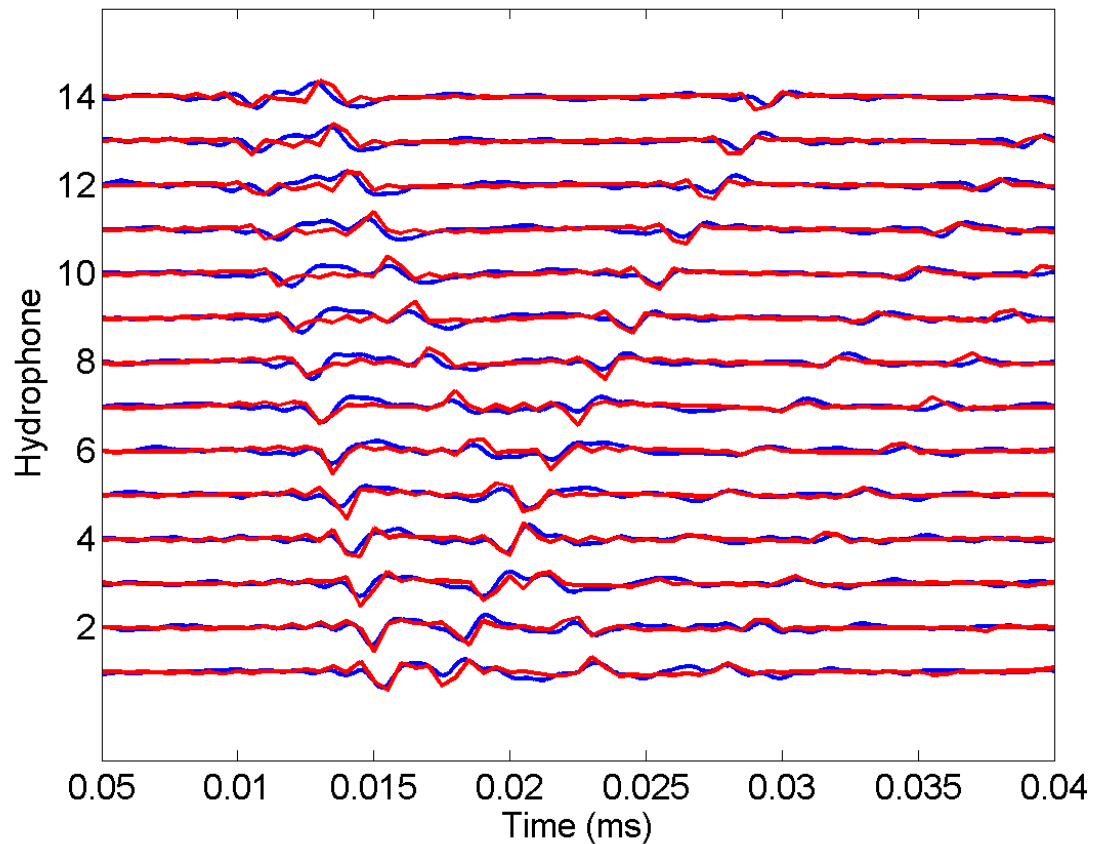
SWo6



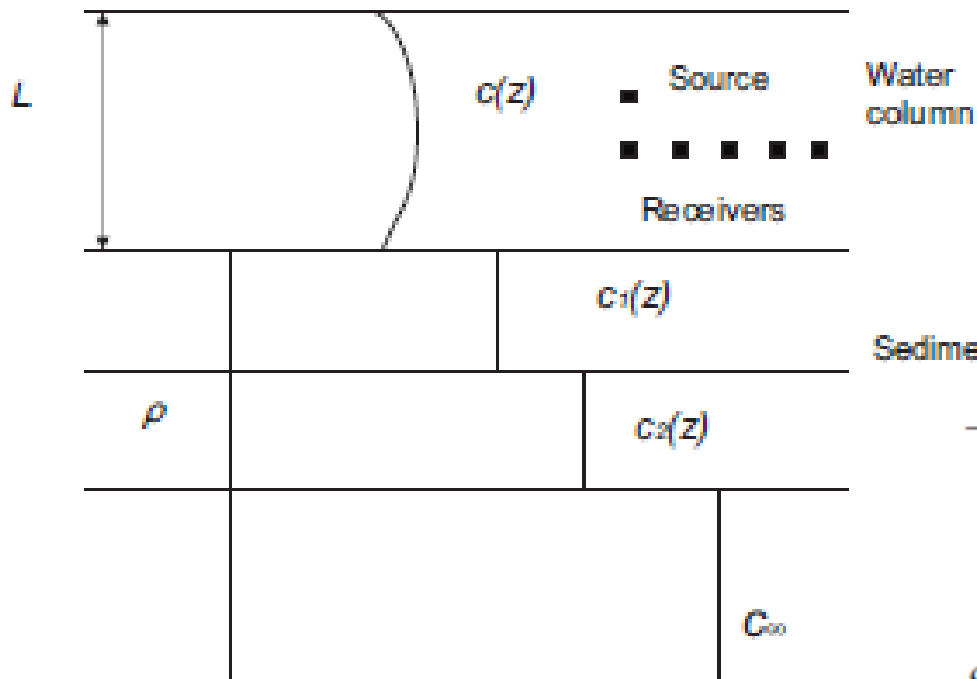
Inversion for sound speed using arrival times – SW06



Inversion for attenuation



Direct Method for Inversion



$$\frac{d^2 v}{dz^2} + [k^2(z) - \beta^2]v = \delta(z - z_0),$$

$$v(\beta, 0) = 0, \quad 0 \leq \beta,$$

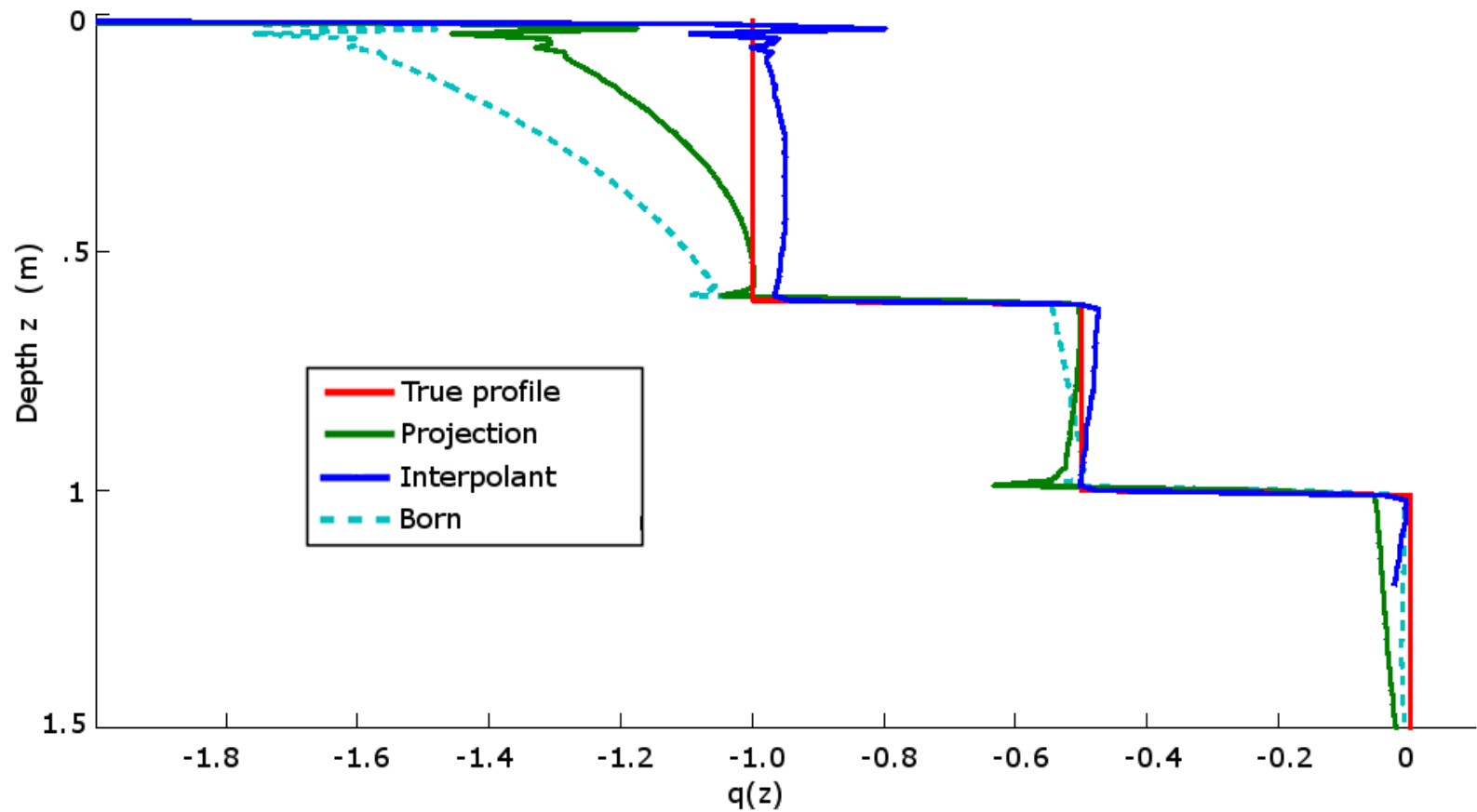
$$v(\beta, z), \quad \text{outward going as } \beta, z \rightarrow \infty.$$

$$-f''(z, \mu) + q(z)f(z, \mu) = \mu^2 f(z, \mu),$$

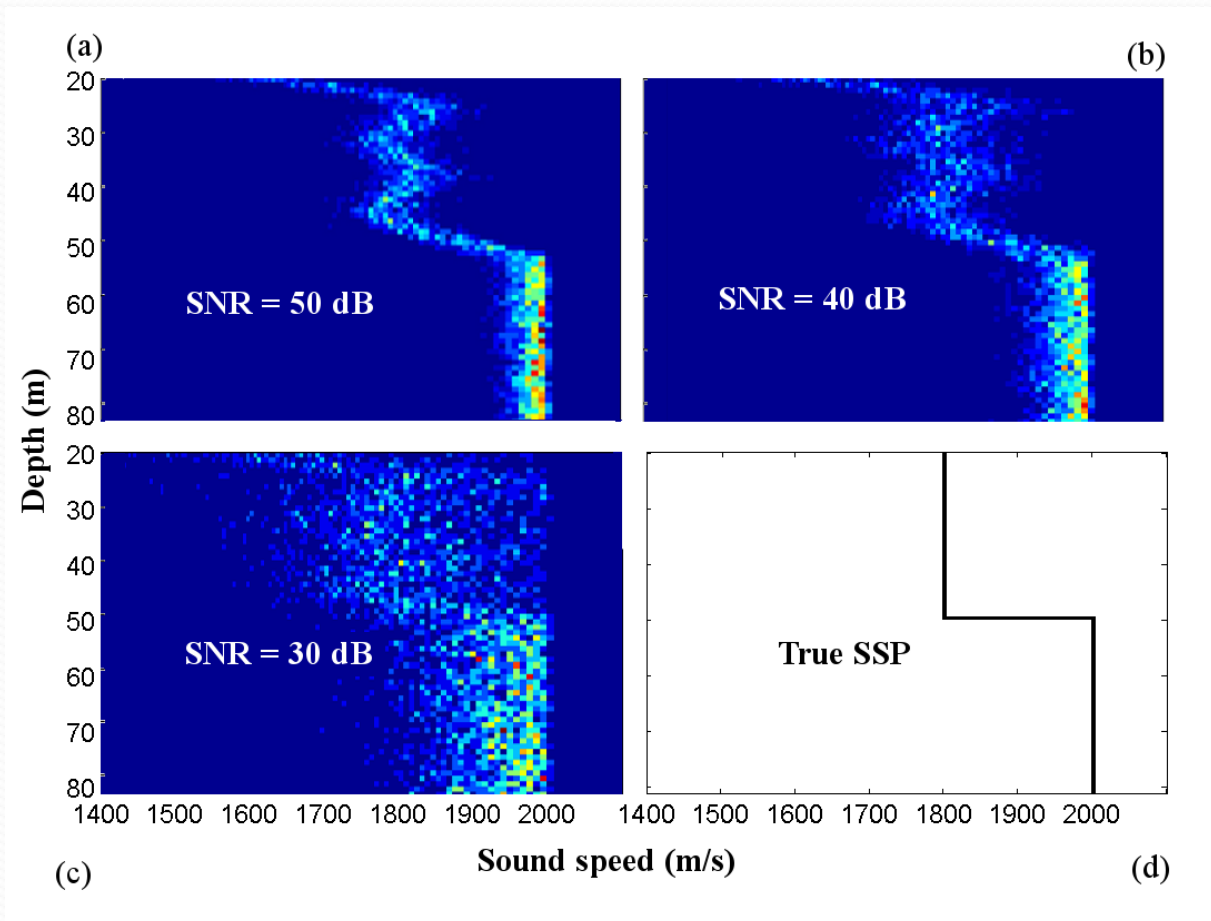
$$f(z, \mu) \sim e^{i\mu z}, \text{ as } z \rightarrow \infty,$$

$$S(\mu) = \frac{f(0, -\mu)}{f(0, \mu)} = \frac{e^{-i\theta(\mu)}}{e^{i\theta(\mu)}} = e^{-2i\theta(\mu)}.$$

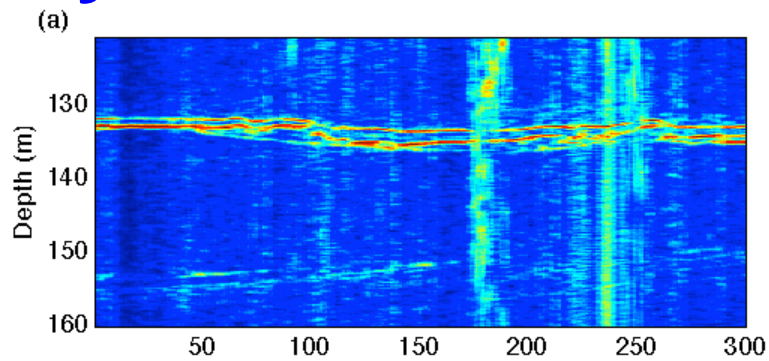
Direct method for inversion



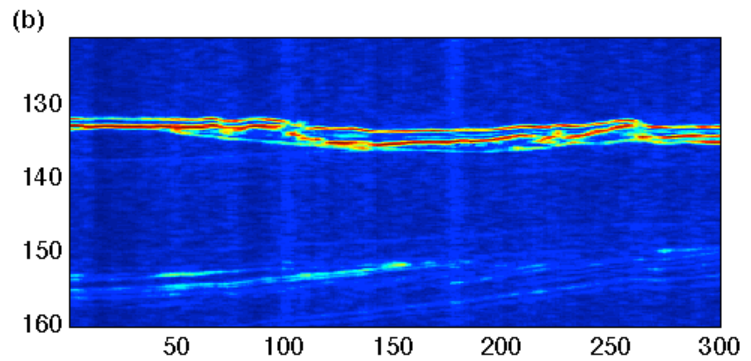
Direct method for inversion



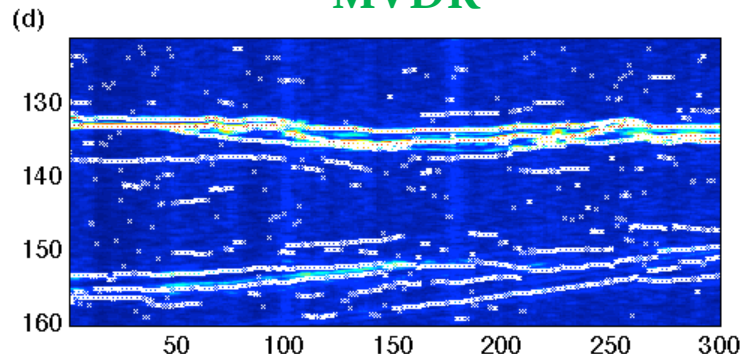
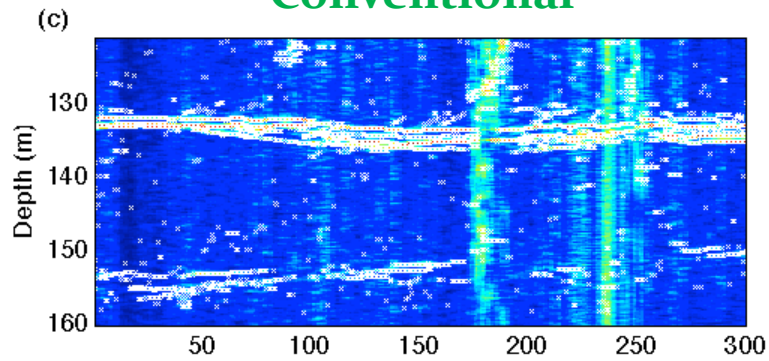
N-layer model - Passive fathometer tracking



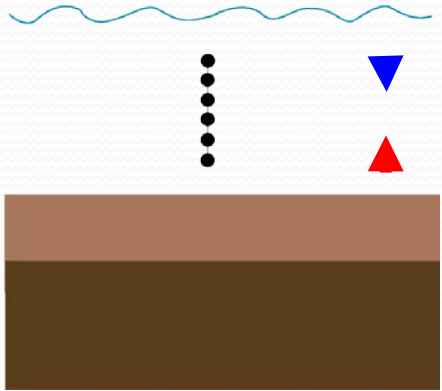
Conventional



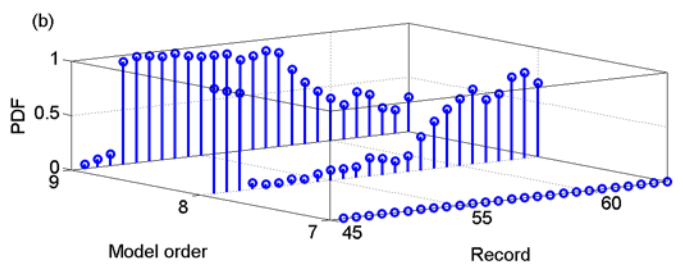
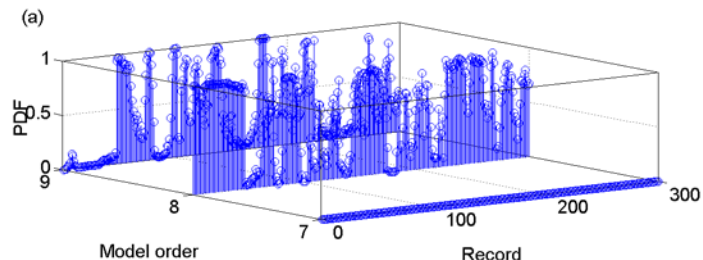
MVDR



Record (as the array drifts)

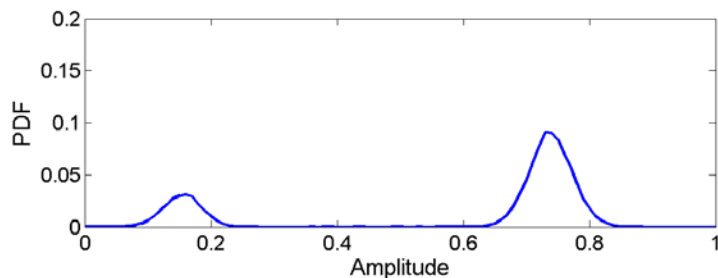
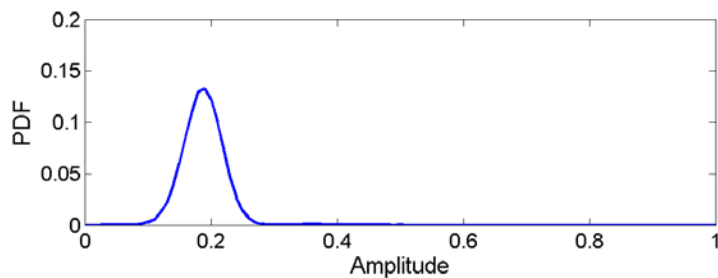
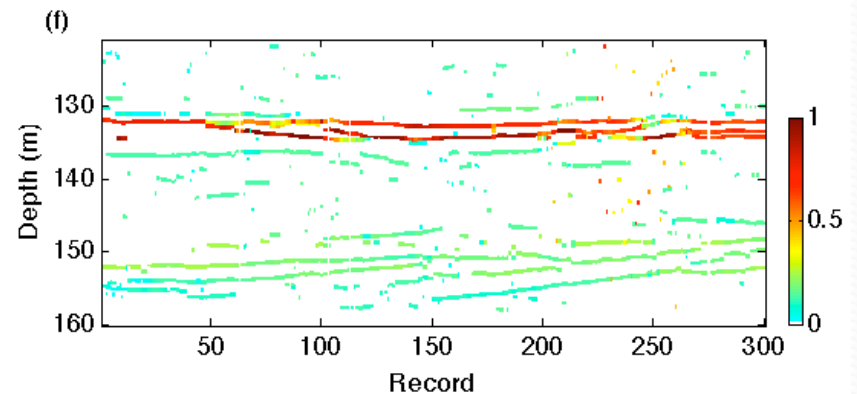
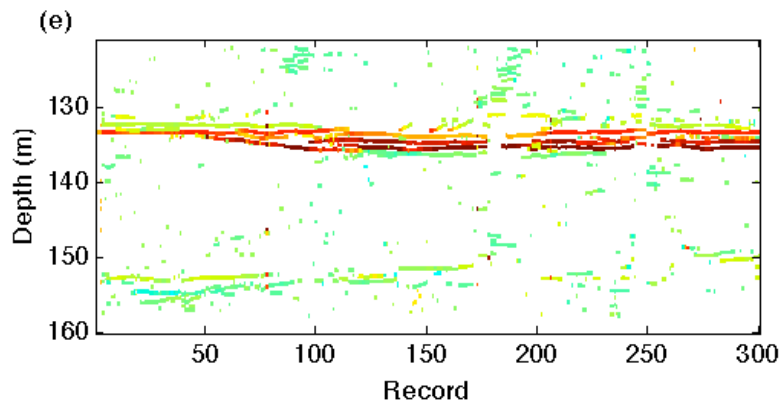


Model order estimation (number of reflectors) using a multiple model particle filter.



N-layer model – Passive fathometer tracking – amplitude estimation

Amplitude MAP estimates of reflections vs. record



Amplitudes of reflections are related to physical properties of the sea-bottom sediments. Posterior PDFs exhibit interesting multi-modal behavior.