The impact of ocean sound speed variability on the uncertainty of geoacoustic parameter estimates

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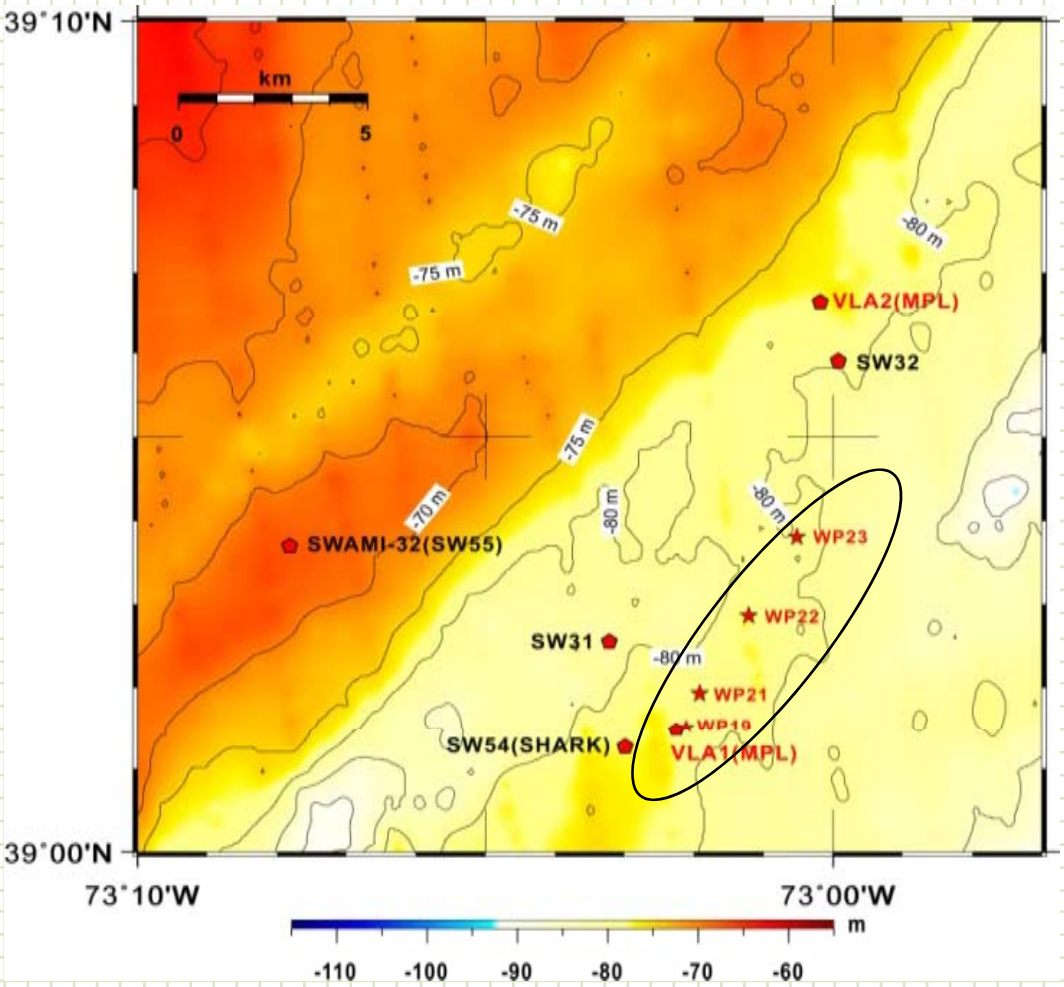
Objective:

- Describe a simple technique to account for unknown ocean sound speed profile in matched-field inversion
  - Invert for an effective SSP that creates a range independent propagation environment
- Method:
  - Use EOFs to parameterize the SSP
  - What information is necessary?
    - Large data set of SSP over extended space and time
    - Limited data set in vicinity of experiment in space and time
- Hypothesis is that limited set will be adequate if changes in SSP are not large

Experimental site:



Acoustic array (MPL):

- VLA1
- 16 sensors, 3.75 m separation
- the bottom one is 8.2 m from the sea floor

Source ship stations, distance to VLA1:

- WP21, 1 km
- WP22, 3 km
- Wp23, 5 km

Water depth:

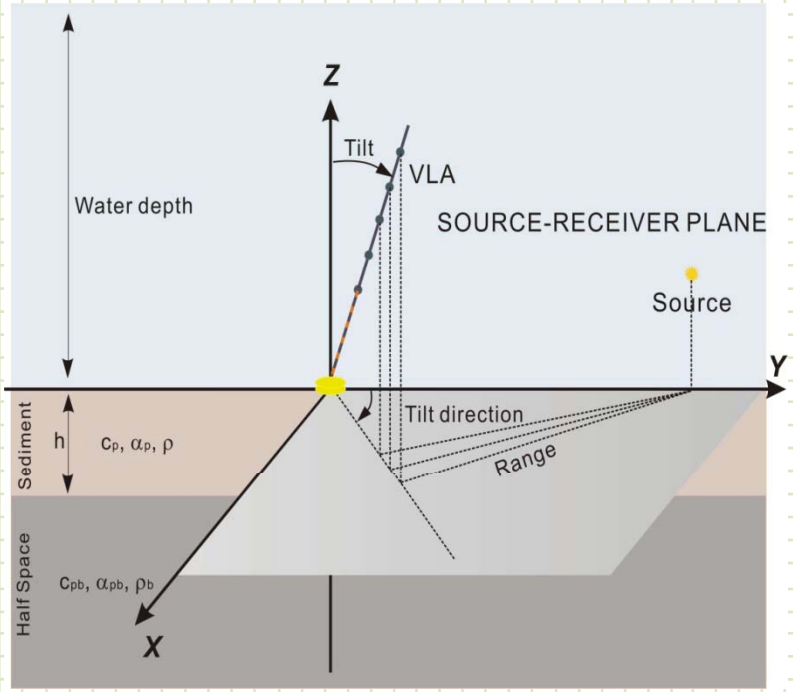
- ~79.0m

Signal frequencies (CW tonals):

- LF: 53, 103, 203, and 253 Hz
- MF: 303, 403 503, 703 and 953 Hz

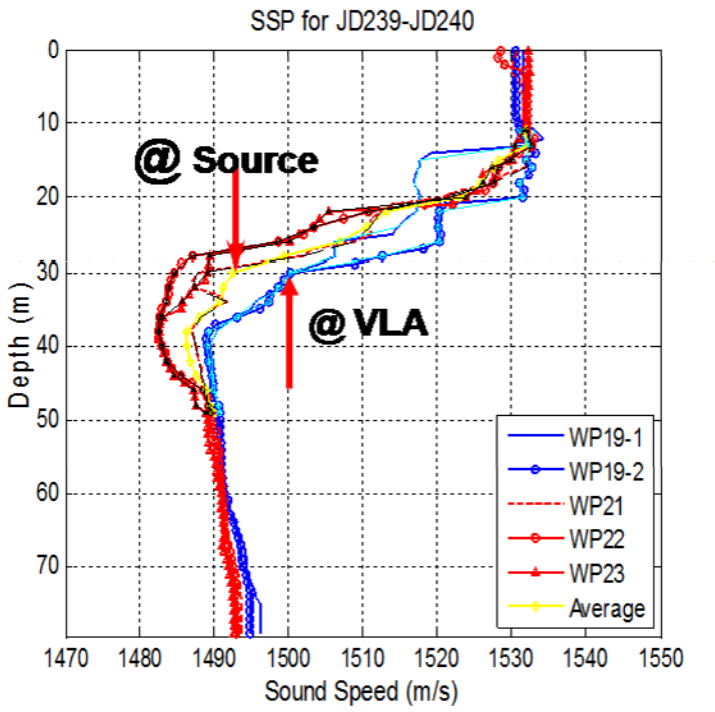
Geoacoustic model

- Invert for:
  - geometric parameters of the experiment, and
  - geoacoustic model parameters
- Approach:
  Bayesian Matched field inversion

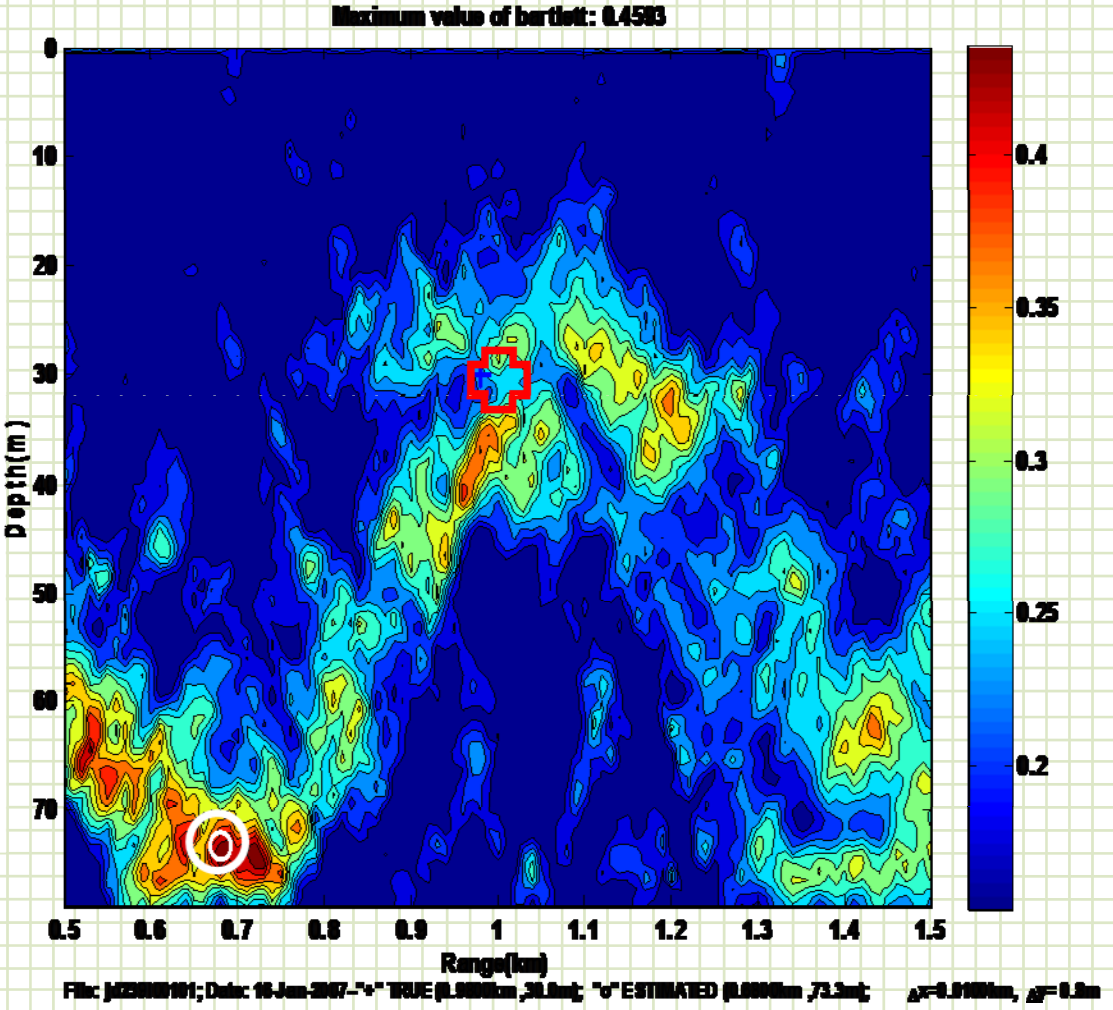


Geoacoustic model for the SW06 site

Recap: Is SSP at the source all we need?

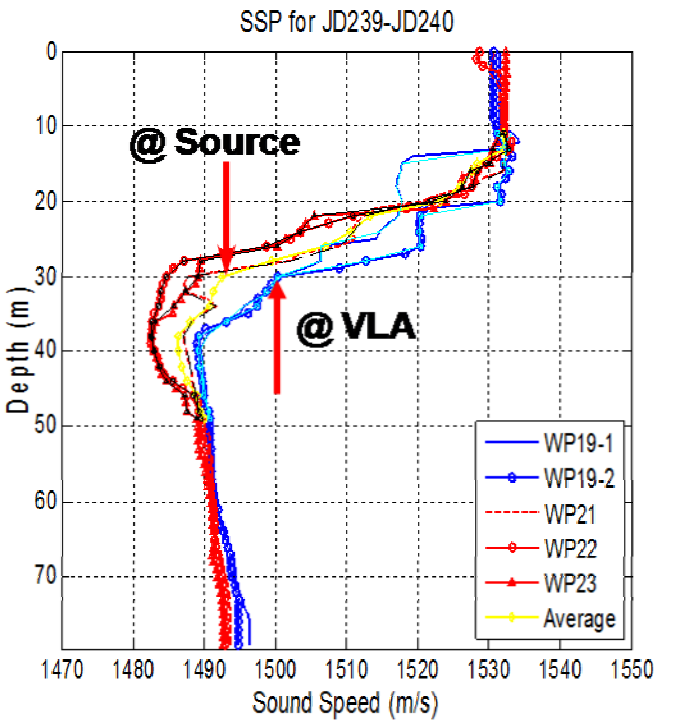


SSPs measured at source and VLA1

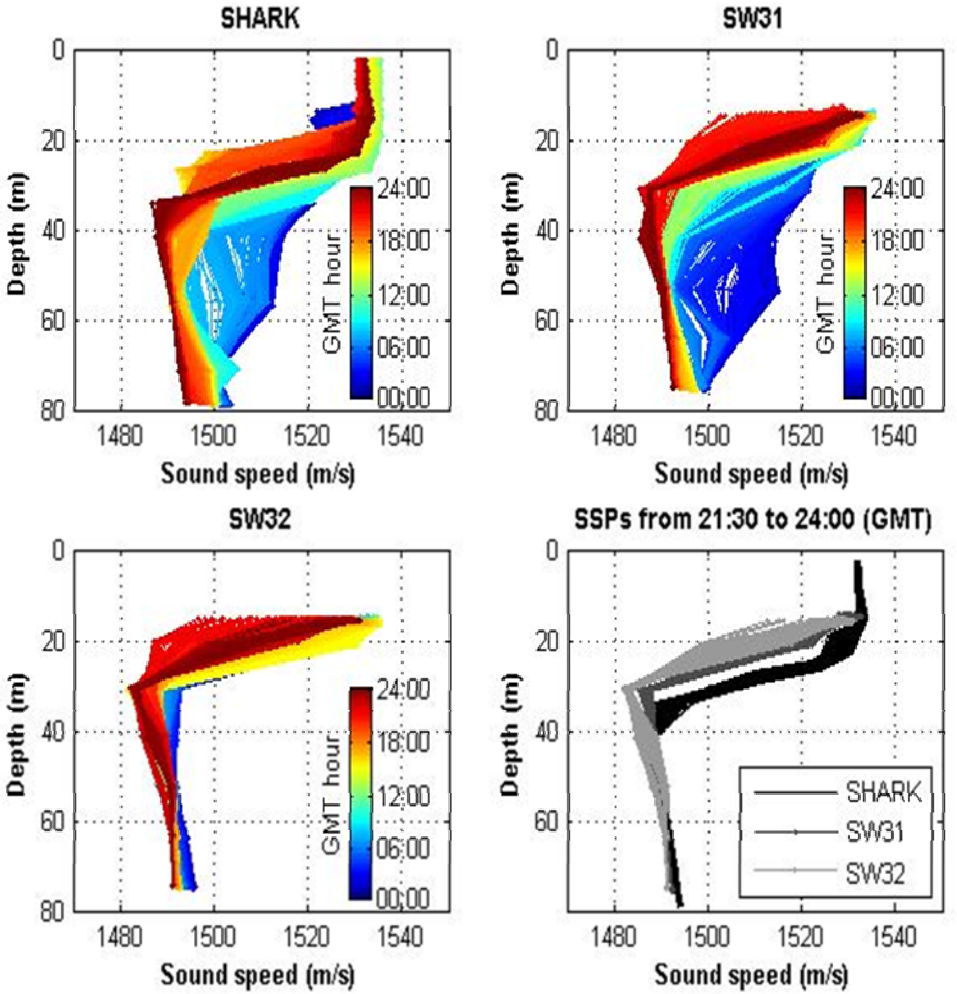


Ambiguity surface of MFP (source localization)

SSP data:



SSPs measured at source and VLA1 (derived from CTDs)



SSPs measured at SHARK, SW31 and SW32

Approaches:

- Limited set from CTDs measured at source ship stations
  - change only in the thermocline
  - requires fewer EOFs (only 4 EOFs)

- Full set from oceanographic moorings and CTDs from source ship stations
  - cover whole water column
  - need more EOFs
  - how to decide how many EOFs?

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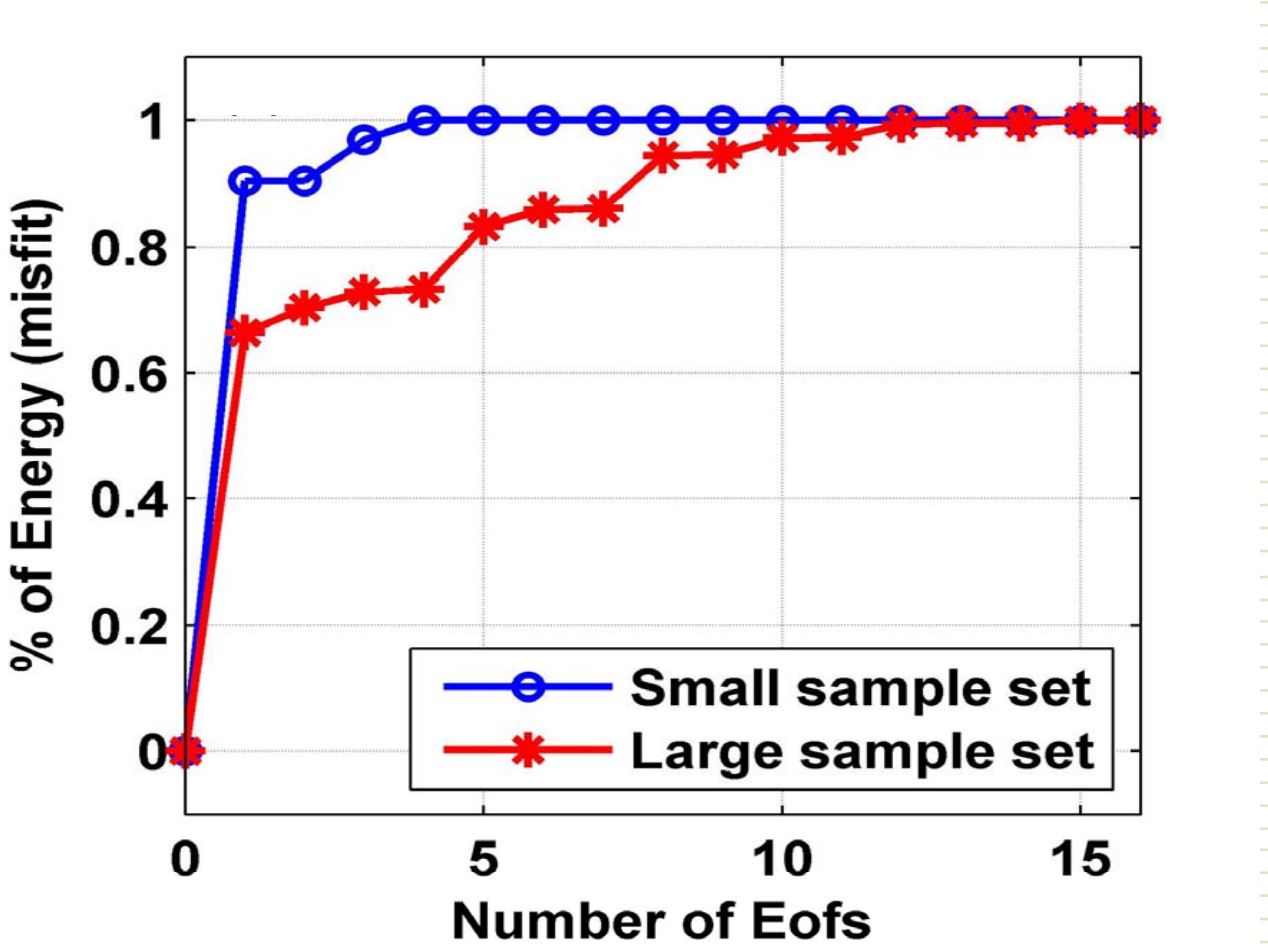
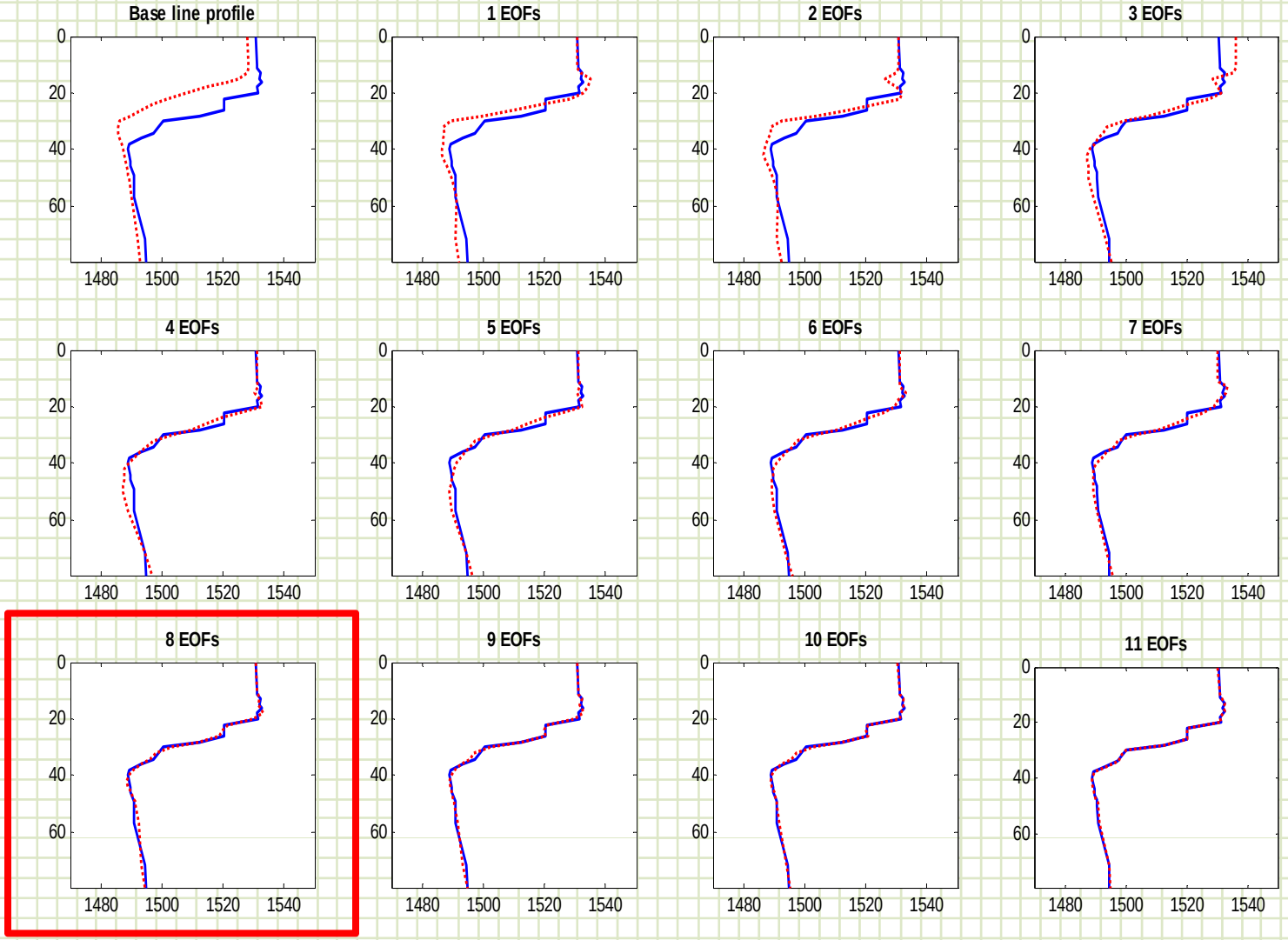
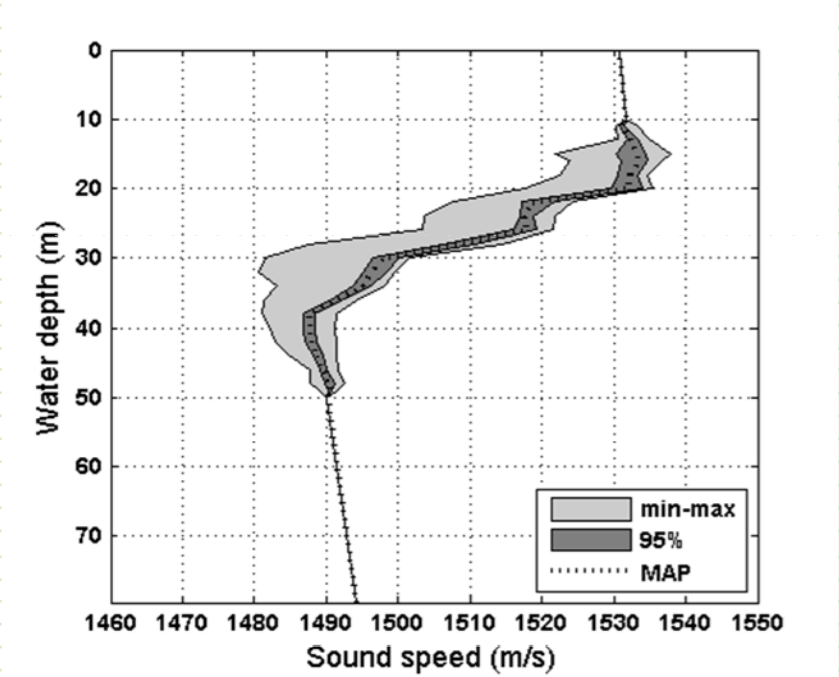
Comparison of the energy fit versus the number of EOFs used:

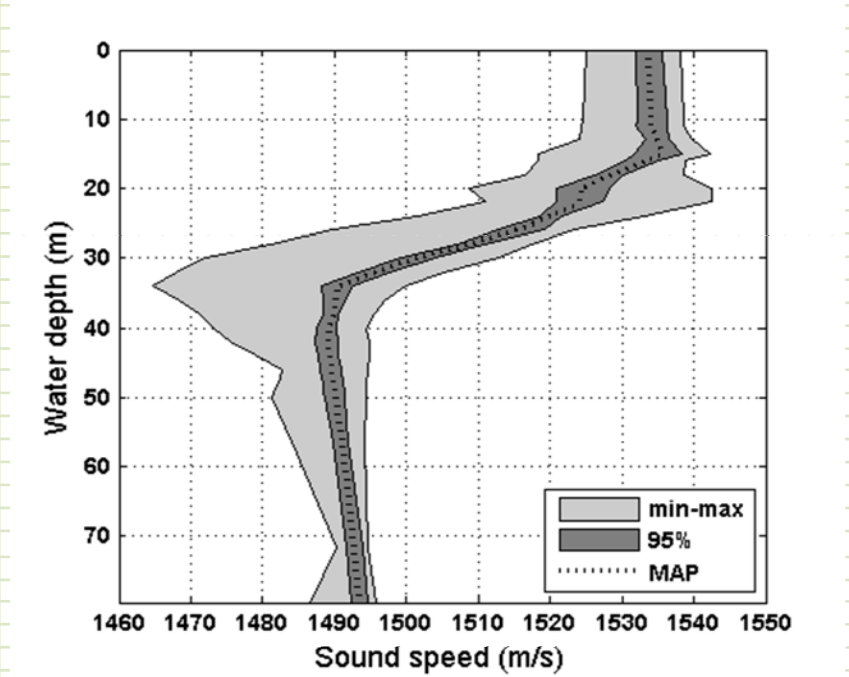


Example: 8EOFs for large SSP sample set:



Comparison of effective SSP for 1 km data



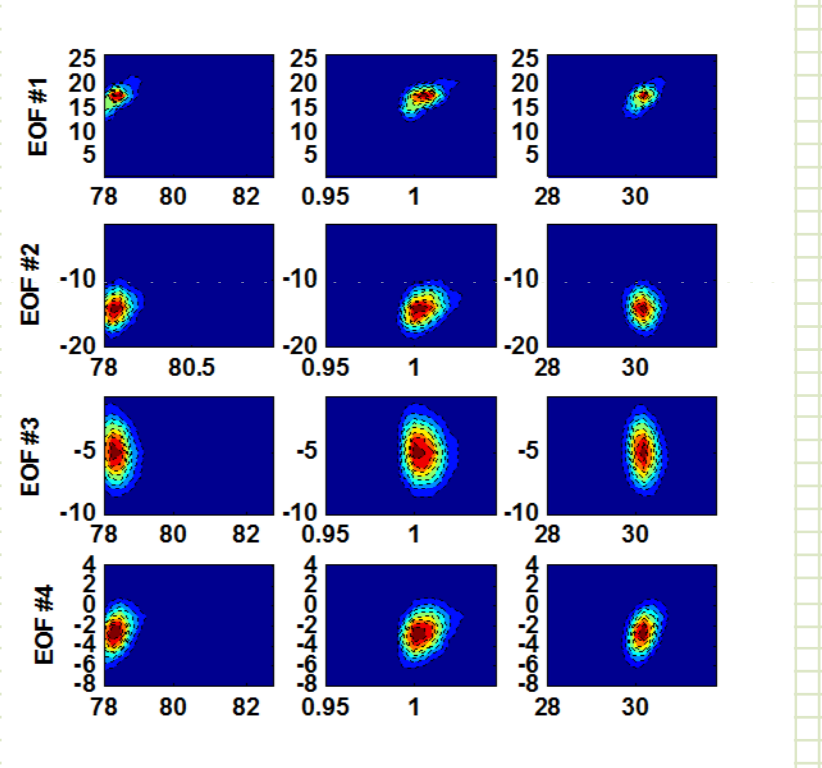


Small SSP data set

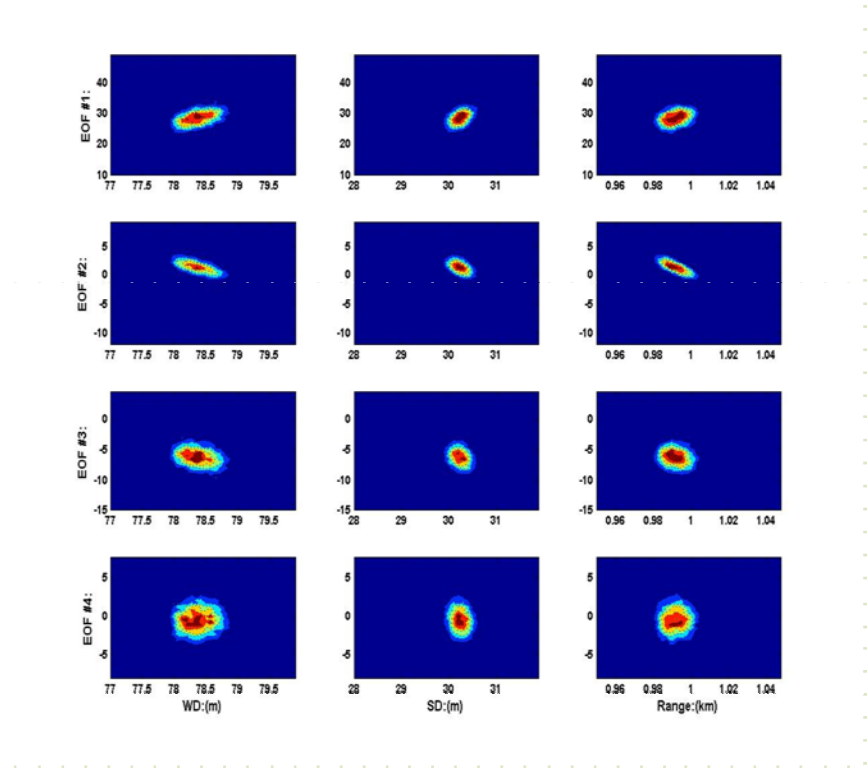
Large SSP data set

Marginal distributions of SSPs

Inter-parameter correlations for 1 km data – EOFs vs. geometric and geoacoustic parameters



Small SSP data set



Large SSP data set

2D Marginal distributions of EOFs

Results – comparison of Bayesian geoacoustic Inversion by using different SSP data set at 1 km

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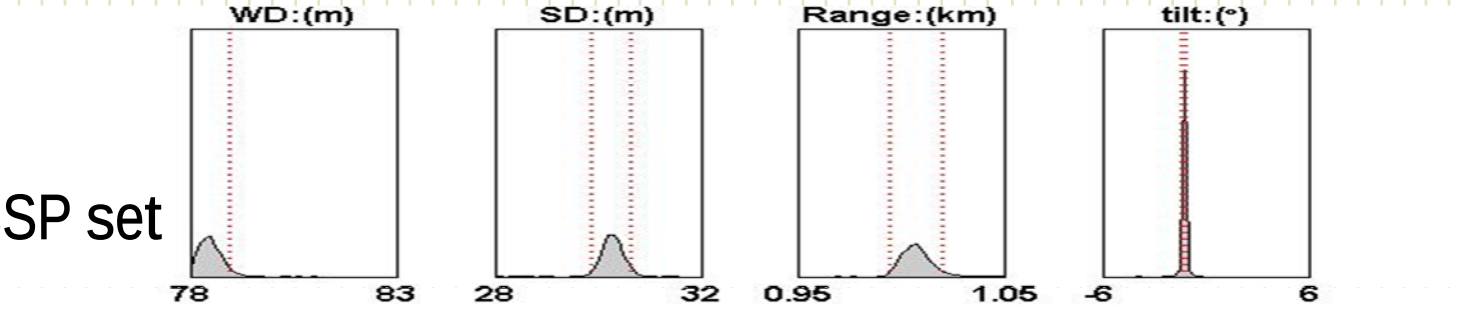
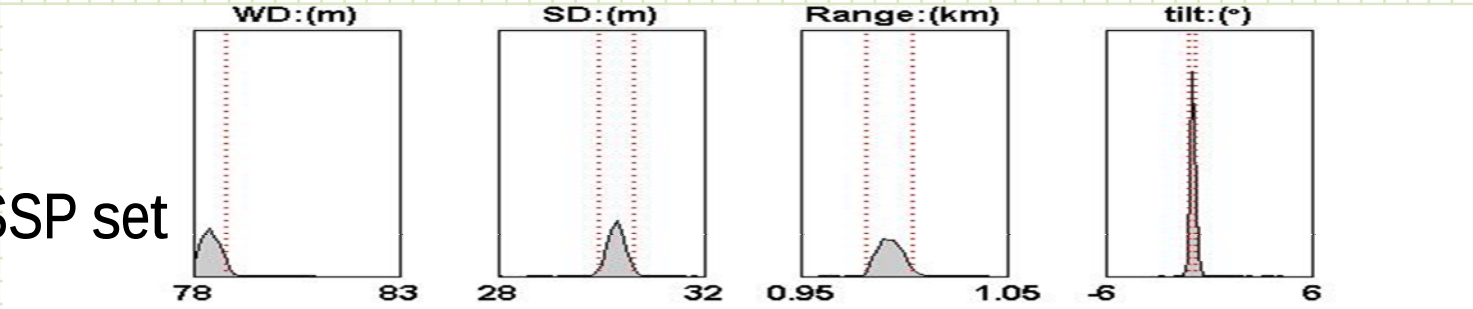
Small SSP set

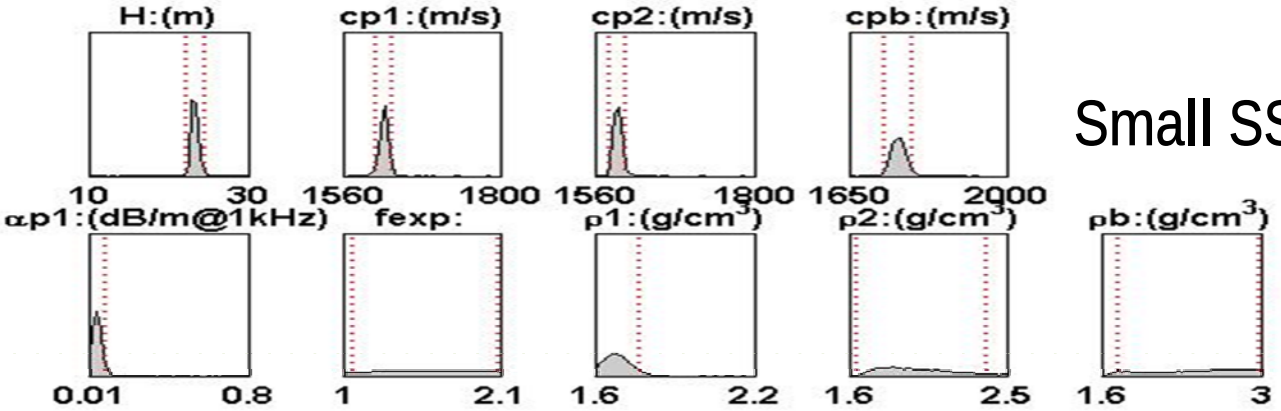


Large SSP set

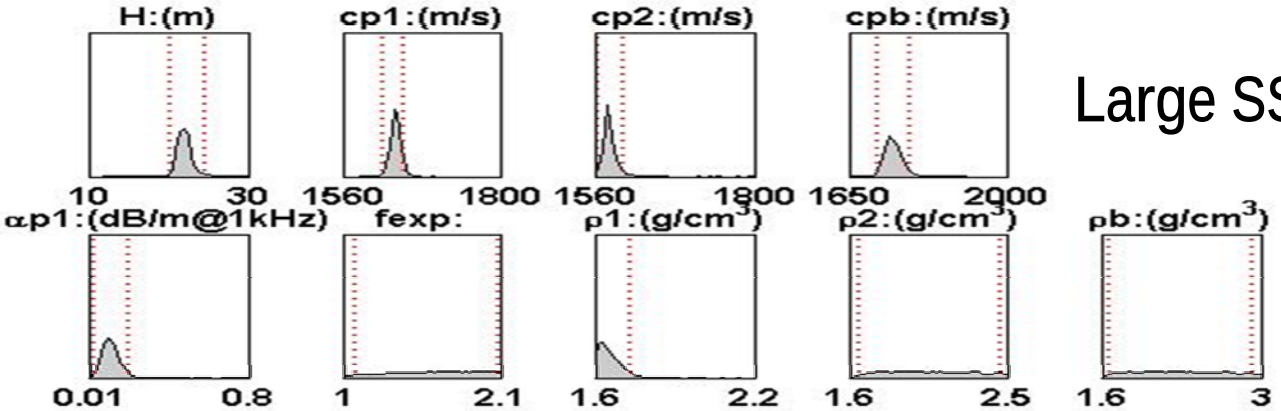


1D Marginal distributions of geometric parameters

Results – comparison of Bayesian geoacoustic Inversion by using different SSP data set at 1 km



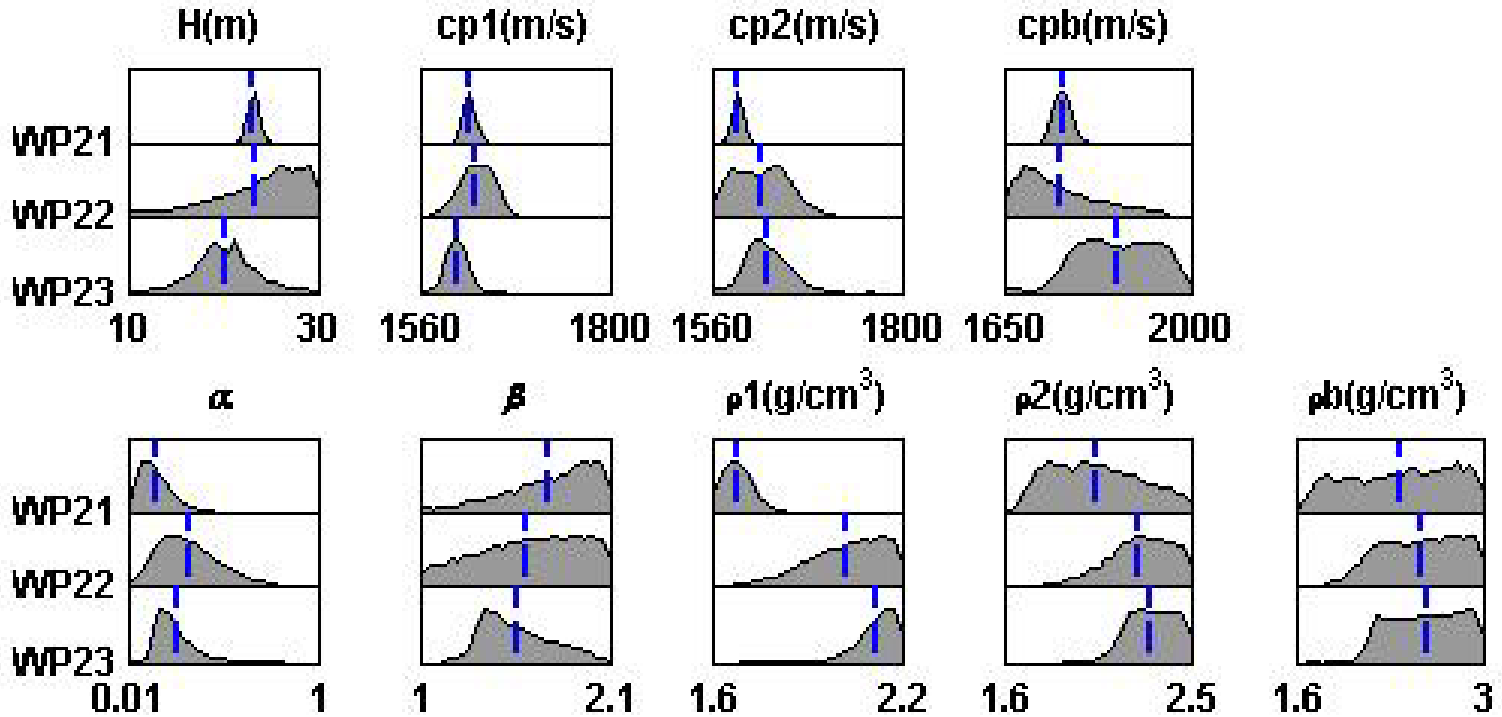
Small SSP set



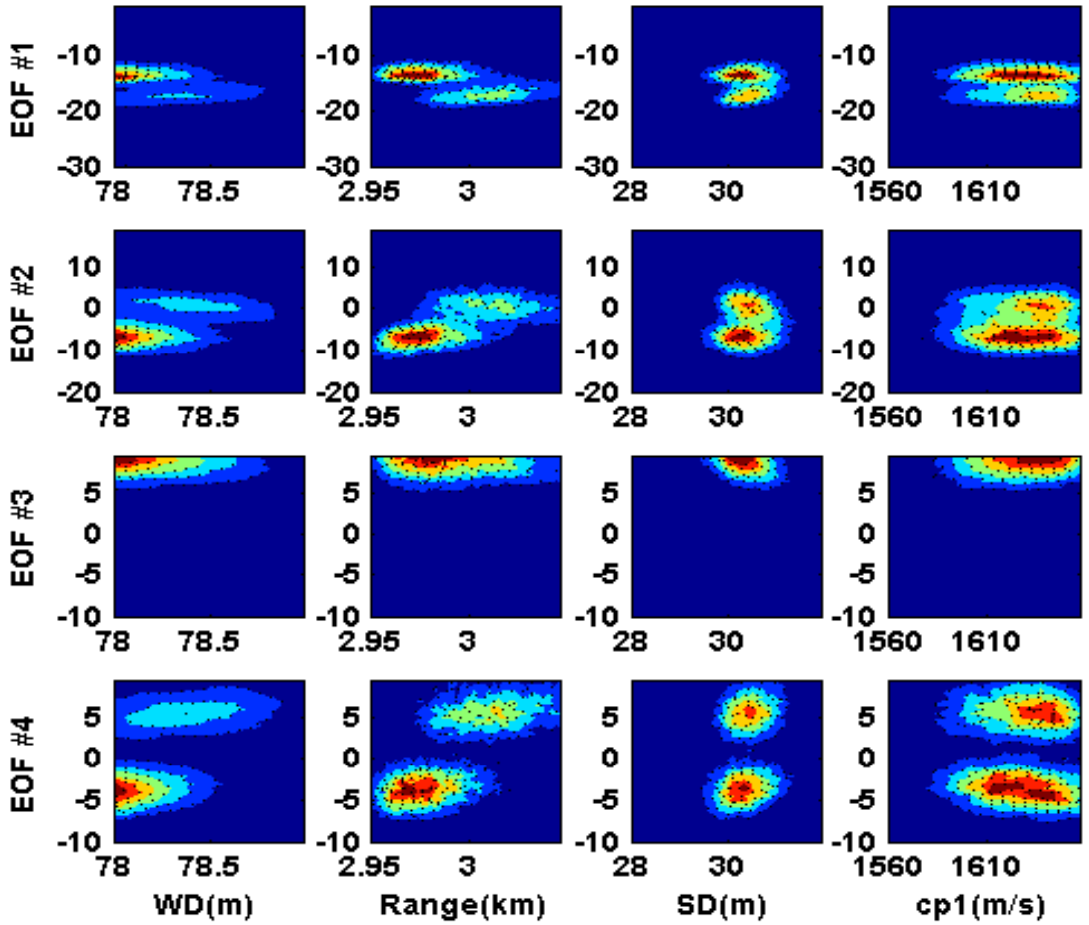
Large SSP set

1D Marginal distributions of geoacoustic parameters

Results – comparison of Bayesian geoacoustic Inversion using small SSP data set at 1, 3 and 5 km

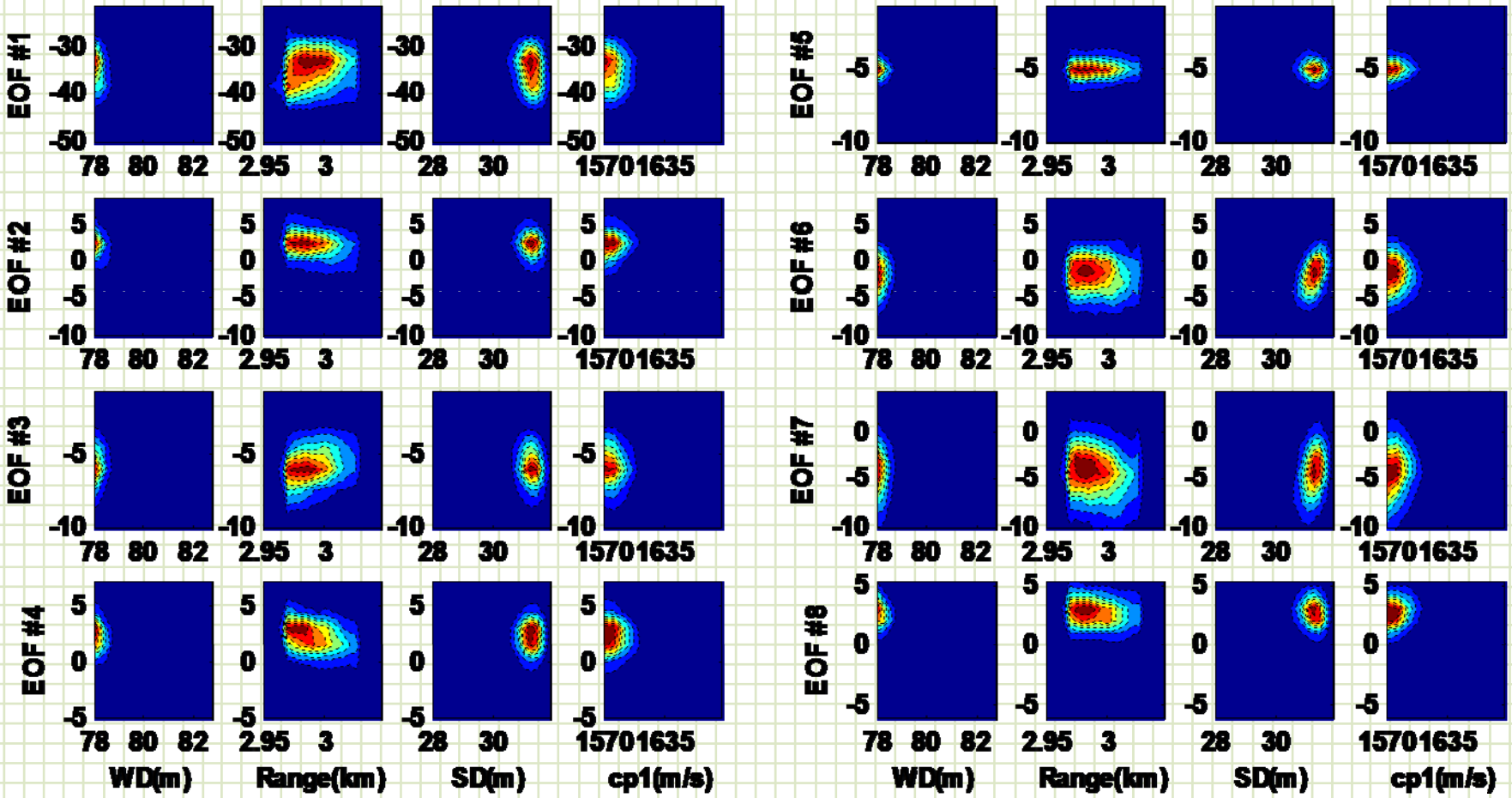


Breakdown – 3 km site, small SSP data set



2D Marginal distributions of EOFs with geometric parameters

Breakdown – 3 km site, large SSP data set



2D Marginal distributions of EOFs with geometric parameters

Conclusions:

- Water column sound speed profile has significant effect on geometric parameters and therefore
  - affects geoacoustic parameter estimates
  - has great impact on matched field processing based source localization

- Geoacoustic parameter estimates using different SSP observations are consistent with each other
  - for small SSP variations over the propagation path, the most relevant SSPs are more effective
  - for large SSP variations, single effective SSP may not be adequate

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