Reducing and Communicating Uncertainty in TL (Geo-acoustics)

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Capturing Uncertainty DRI
Providence RI, June 19 2003

- Alternate title:

Half an hour with the bottom half of OUR team

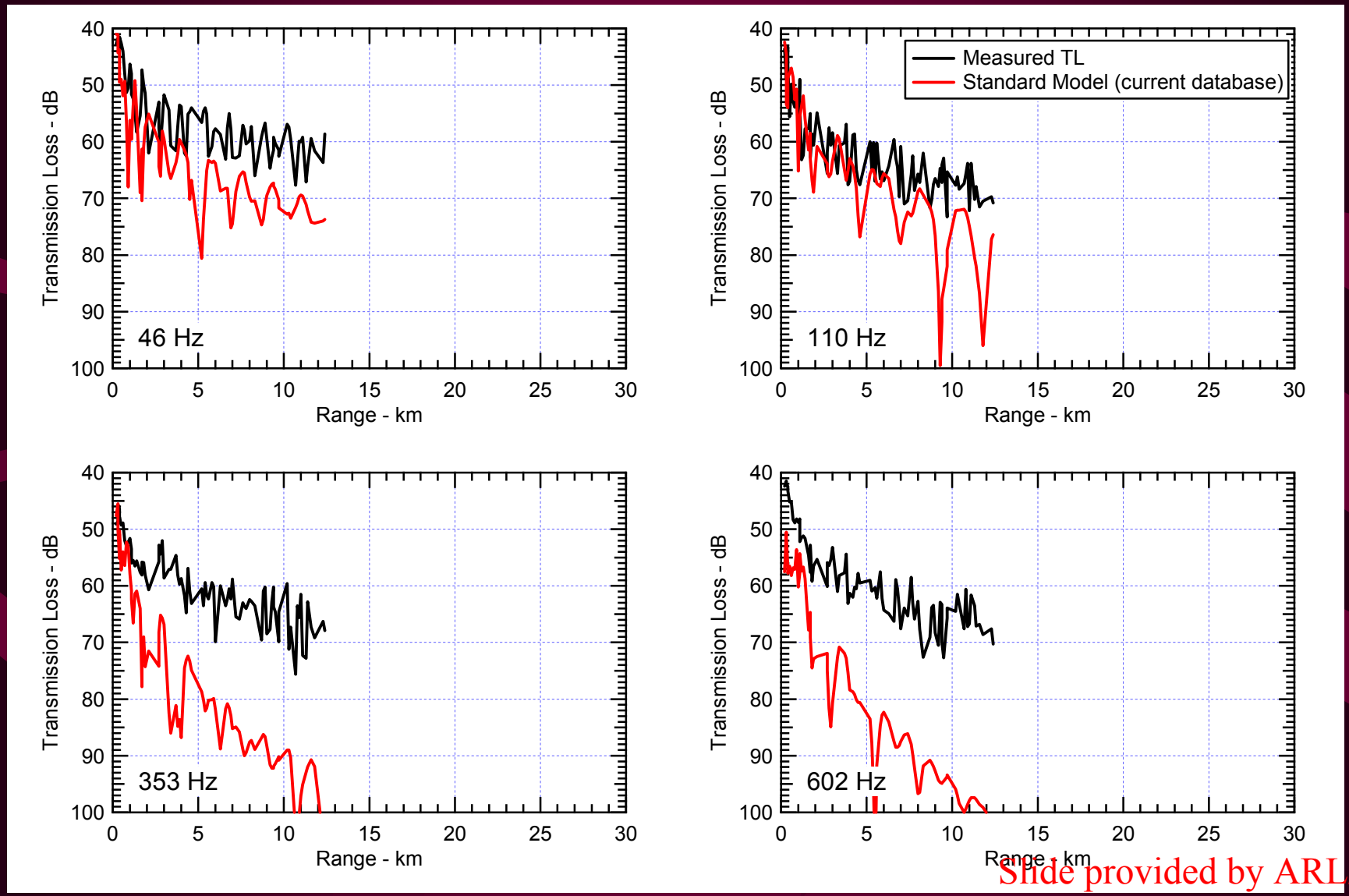
- Alternate TEAM NAME : MPLalUMS

Outline

- The Database Problem
  - Why worry about 3-5dB fluctuations (uncertainty) if you're off by 20 dB? (or worse)
- Database Alert Demo
- Rapid Geo-Acoustic Characterization
- Geo-acoustic Uncertainty measures for TL

Central Korean St
Measured TL Compared with Standard Model

Source for measured data: ACT III, Site 1A Coherent TL
Standard model based on current bottom loss database, measured SVP



Slide provided by ARL/UT

The Database Problem

1. (TL-BIAS) Current Geo-acoustic Databases are extrapolations of deep-water provinces to shallow water. They produce a significant error in mean TL estimates.
2. (TL-Mean Square Error) Current TDA's provide no estimate of variability, uncertainty or sensitivity to TL predictions.

Prototype “Database Alert”

- Simulated Example:
  - Towed Array
  - Sediment Parameters from Knobles Inversion of ACT III Data.
  - 10 Surface ships, broadband, time-domain simulation
  - Automated Tracker and Database Alert

Run MATLAB Demo

Warning : Current database does not predict the acoustics of this environment well.

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Recommend running RGC Algorithm

Rapid Geo-acoustic Characterization (RGC)

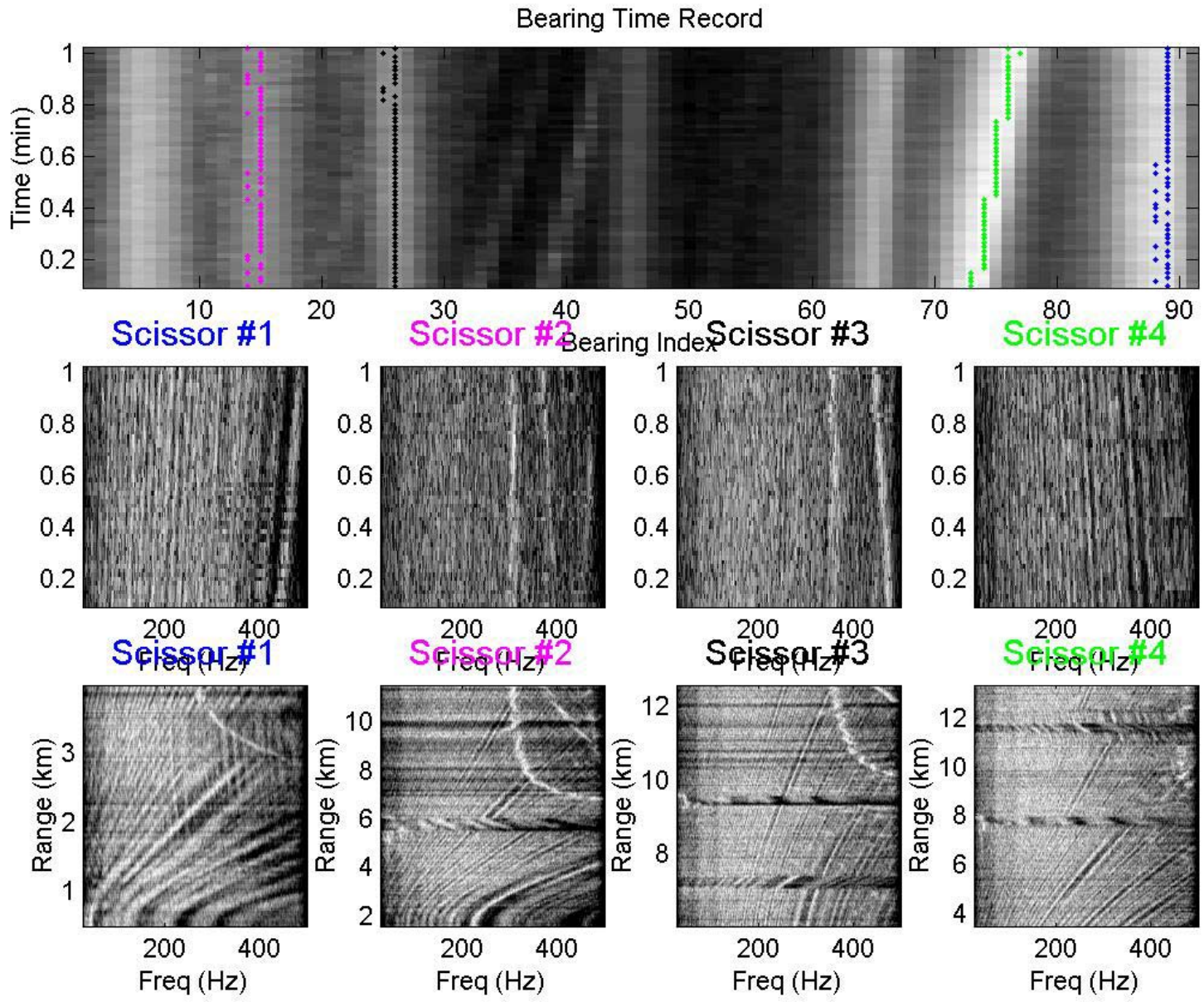
1. Estimate acoustic observables from the data in multiple bands where available:
   1. Time-spread (spacing of the striations)
   2. Wave-guide Invariant (Slope of the striations)
   3. Slope of the band averaged TL vs Range.
2. Compute acoustic observables for sediment parameters
3. Determine effective sediment from weighted mean-square error between the data and the predictions.

Hierarchy of Sediment Parameterizations

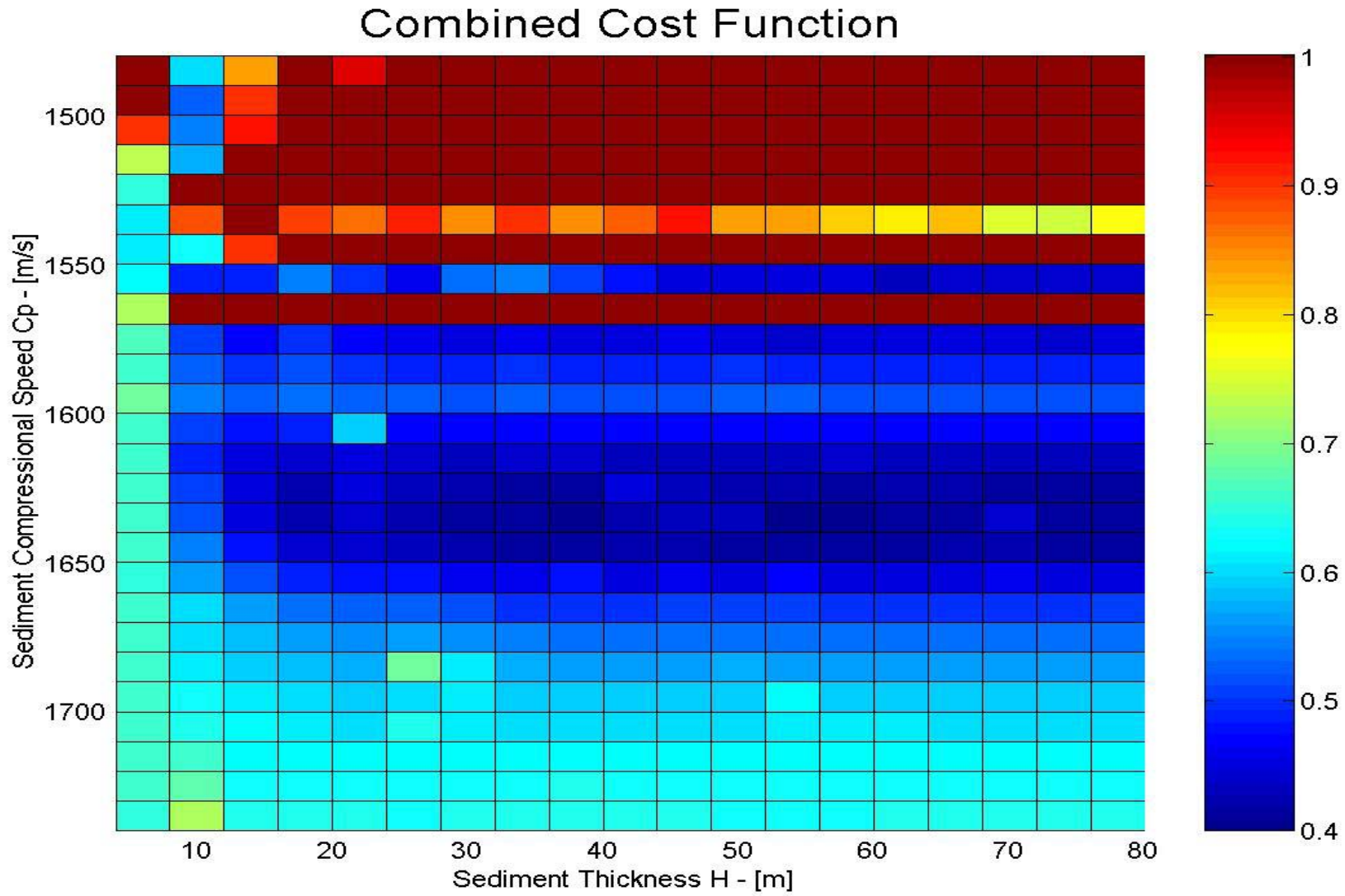
- Half-Space
- Single Homogenous Sediment (ϕ, H)
  1. Single homogenous sediment (single grain size) over a basement.
  2. Use Hamilton-Bachman empirical formulas to relate speed, attenuation, density to mean grain size
  3. Search over sediment type (ϕ) and sediment thickness (H)
- N-Layer Model
  - Compressional & shear speed, density, attenuations, per layer.

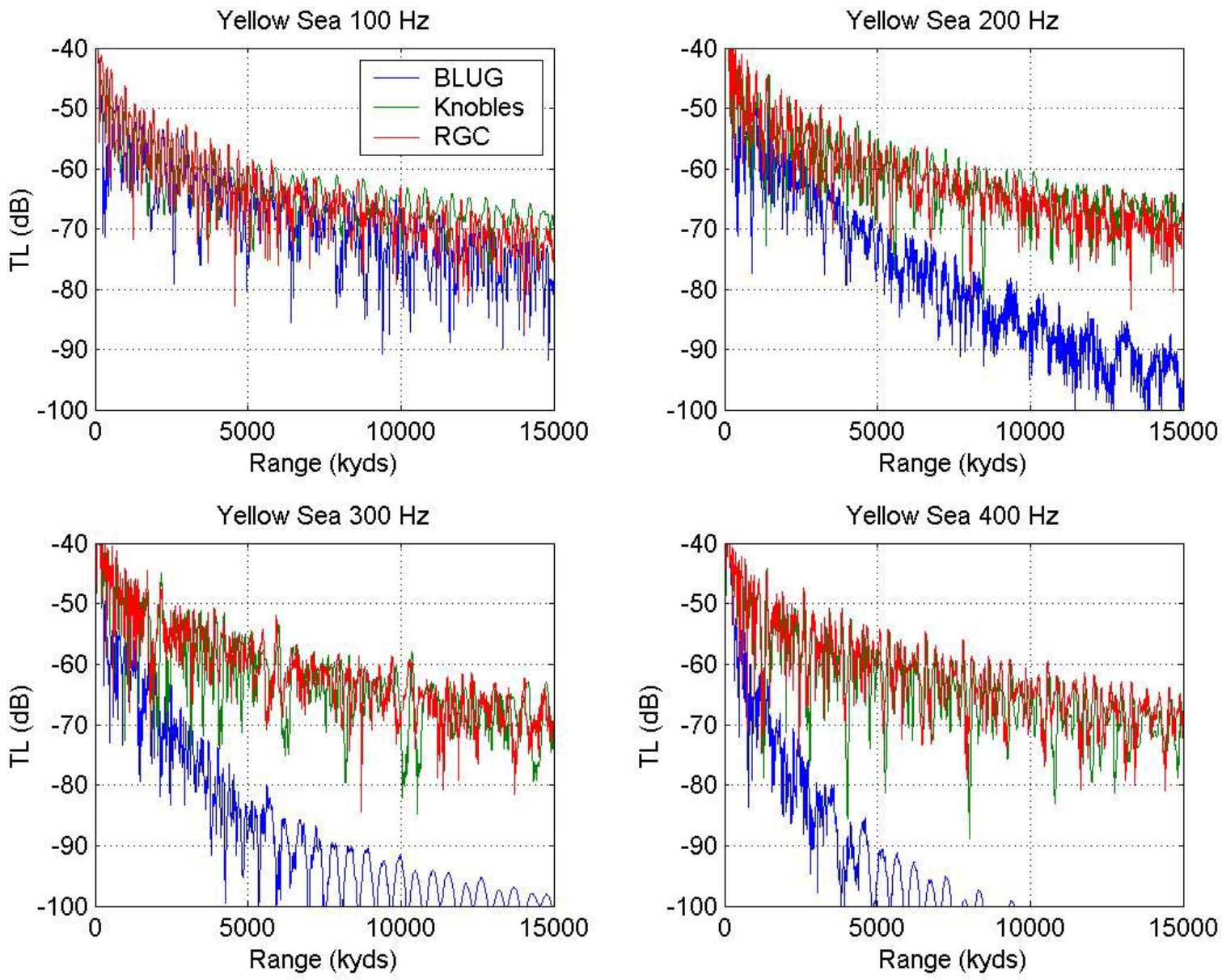
Procedure - RECAP

1. Simulated broadband array data using Knobles Geo-acoustic Inversion Results
   - 2 sediment layers over a basement. Linear sediment parameters.
   - Frequency exponent of 1.8
2. Beamformed, computed tracked spectra of 4 interferers
3. Estimated the acoustic observables at set of ranges/frequencies
4. Computed the acoustic observables for a set of H-B Sediments.
5. Computed the combined (weighted average) cost function.


Bearing Time Record
Time (min)
Bearing Index
Scissor #1
Scissor #2
Scissor #3
Scissor #4
Freq (Hz)
Range (km)

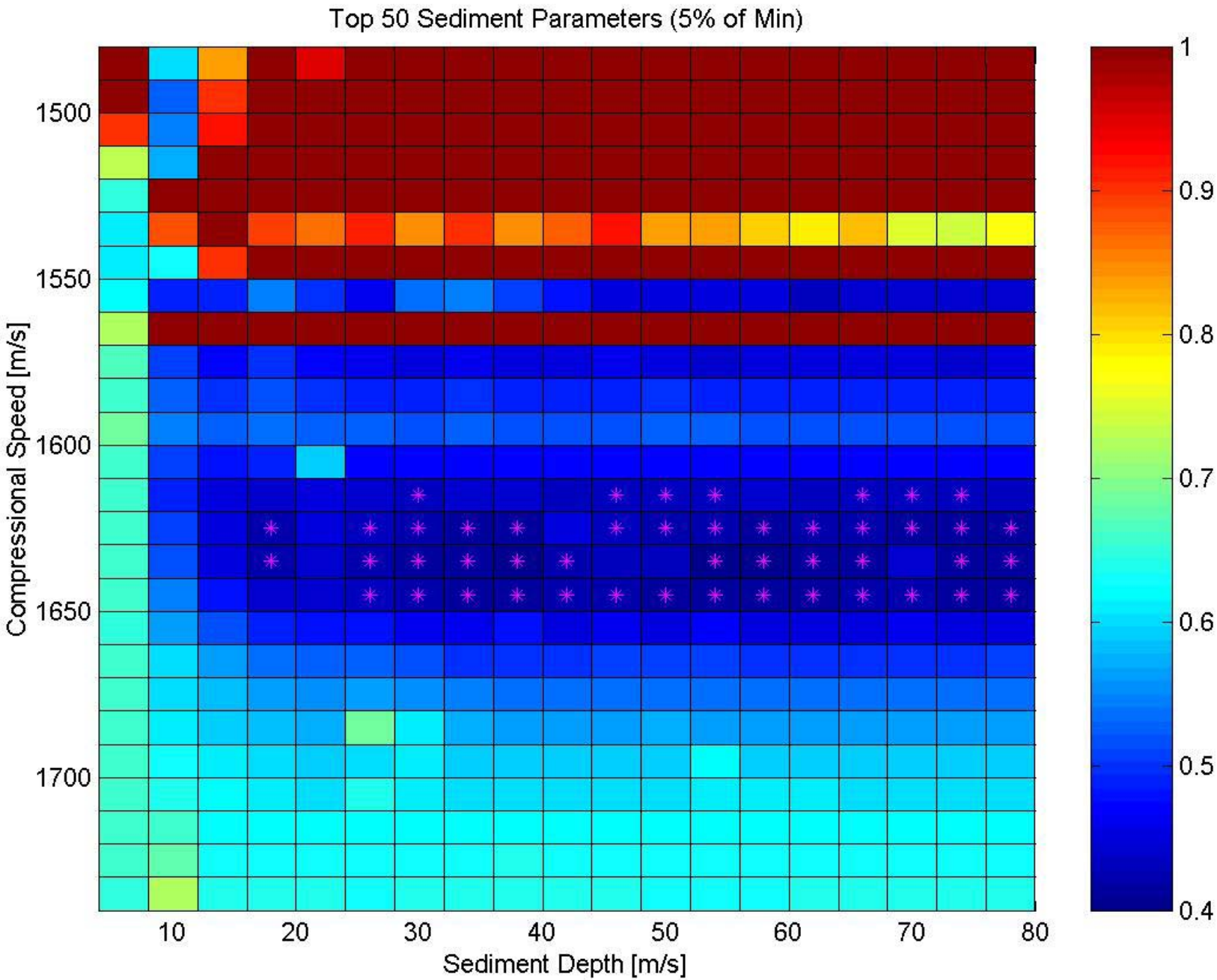
Combined (τ,β,α) Cost Function (H-B Sediment)

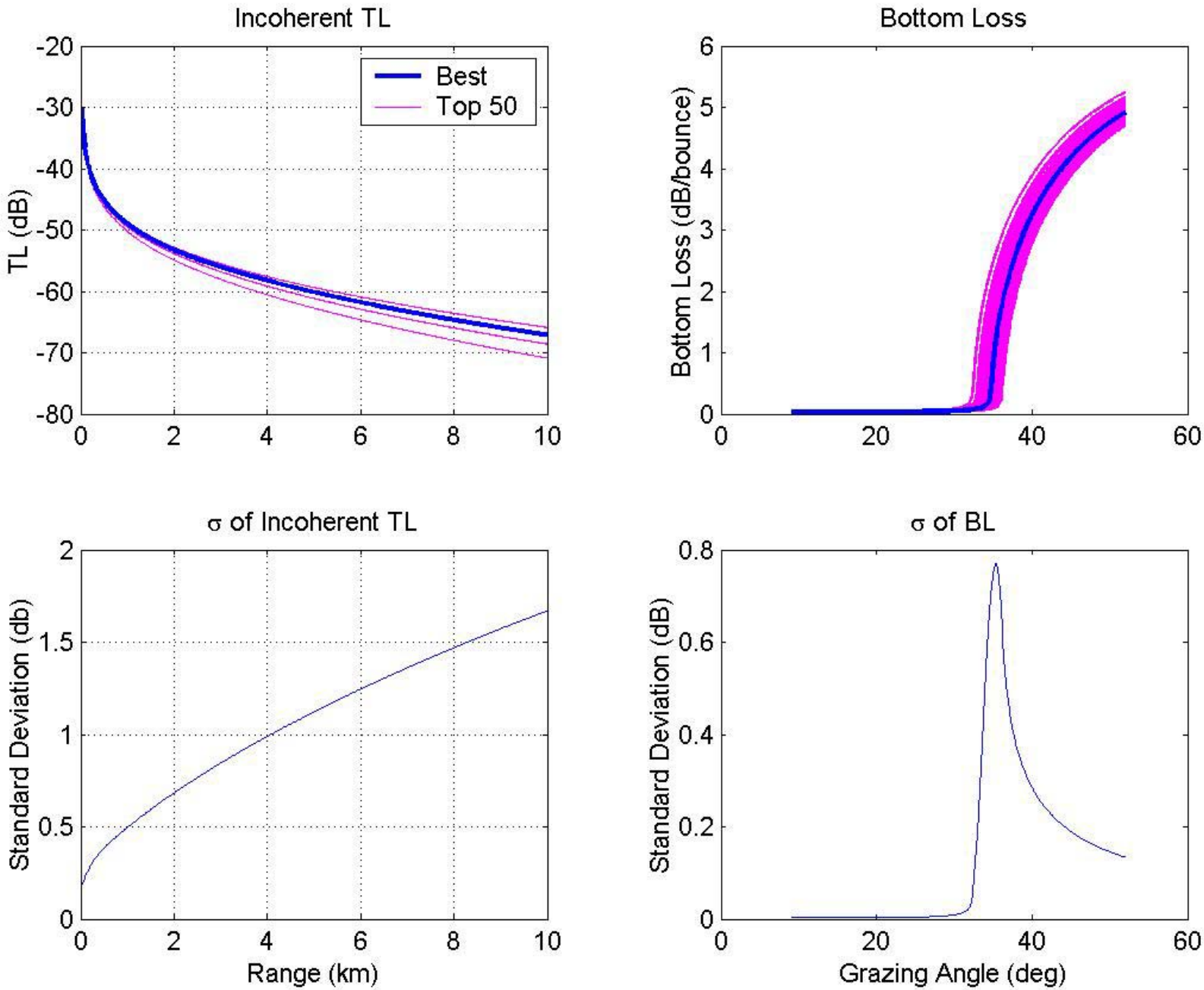



Yellow Sea 100 Hz
Yellow Sea 200 Hz
Yellow Sea 300 Hz
Yellow Sea 400 Hz
BLUG
Knobles
RGC
TL (dB)
Range (kyds)
-40
-50
-60
-70
-80
-90
-100
0
5000
10000
15000

Uncertainty Measures

- TL is unknown
- We can now compute the uncertainty in the TL predictions induced by the uncertainty in the RGC estimates of the geoacoustics.
  - Measures:
    - Incoherent TL (variance at 5 km)
  - Use the RGC Cost function results:
    - Top 5% of solutions: $E<1.05*E^0$


Top 50 Sediment Parameters (5% of Min)
Compressional Speed [m/s]
1500
1550
1600
1650
1700
Sediment Depth [m/s]
10
20
30
40
50
60
70
80
1
0.9
0.8
0.7
0.6
0.5
0.4


Incoherent TL
Best
Top 50
TL (dB)
-20
-30
-40
-50
-60
-70
-80
0
2
4
6
8
10
Bottom Loss
Bottom Loss (dB/bounce)
6
5
4
3
2
1
0
0
20
40
60
σ of Incoherent TL
Standard Deviation (db)
2
1.5
1
0.5
0
0
2
4
6
8
10
Range (km)
σ of BL
Standard Deviation (dB)
0.8
0.6
0.4
0.2
0
0
20
40
60
Grazing Angle (deg)

Warning : TL predictions from the archival database are lower than the RGC estimate by 25 dB at 5 km. (200 Hz)

TL estimates (at 5 km)are expected to be good to within:
1.2 dB Incoherent TL