TL Uncertainty Characterization and Reduction

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NPS Accomplishments

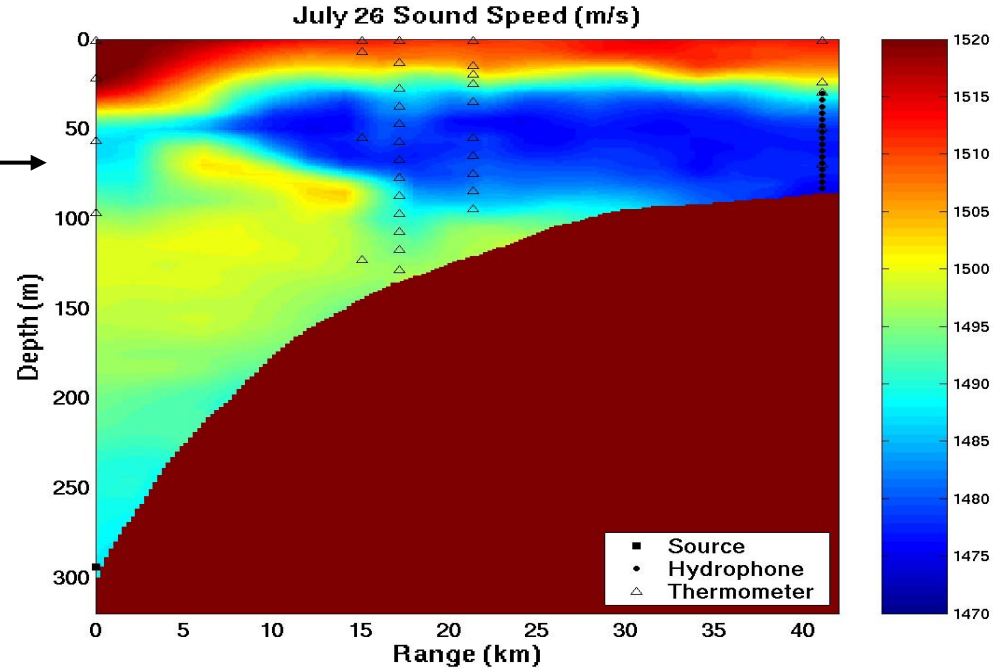
(1) TL Uncertainty Characterization (short scales)

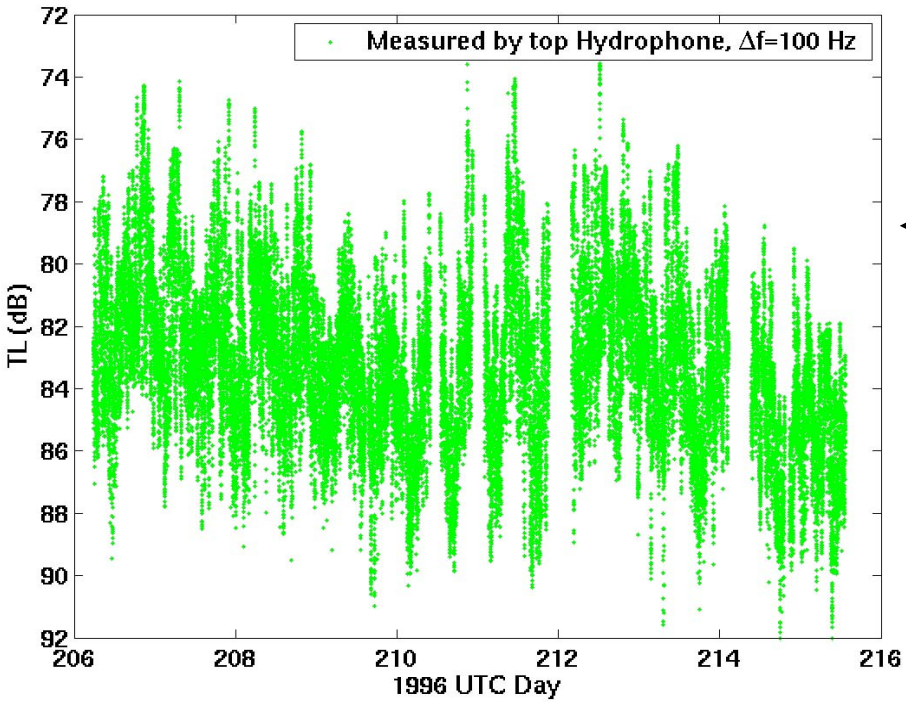
- Analyzed the dependence of TL fluctuation statistics on signal bandwidth using both (Shelfbreak) PRIMER and ASIAEX (SCS) data.
- Performed model simulation of ASIAEX TL fluctuation statistics, compared modeled statistics to measured statistics, and began studying uncertainty in the mean TL prediction.

(2) TL Uncertainty Reduction (long scales)

- Combined PRIMER SeaSoar and moored data (data integration) to upgrade daily SSP and TL estimates.
- Examined the sensitivity of the TL estimate to the resolution of the sound speed estimate.

Shelfbreak PRIMER Experimental Configuration - Western Track

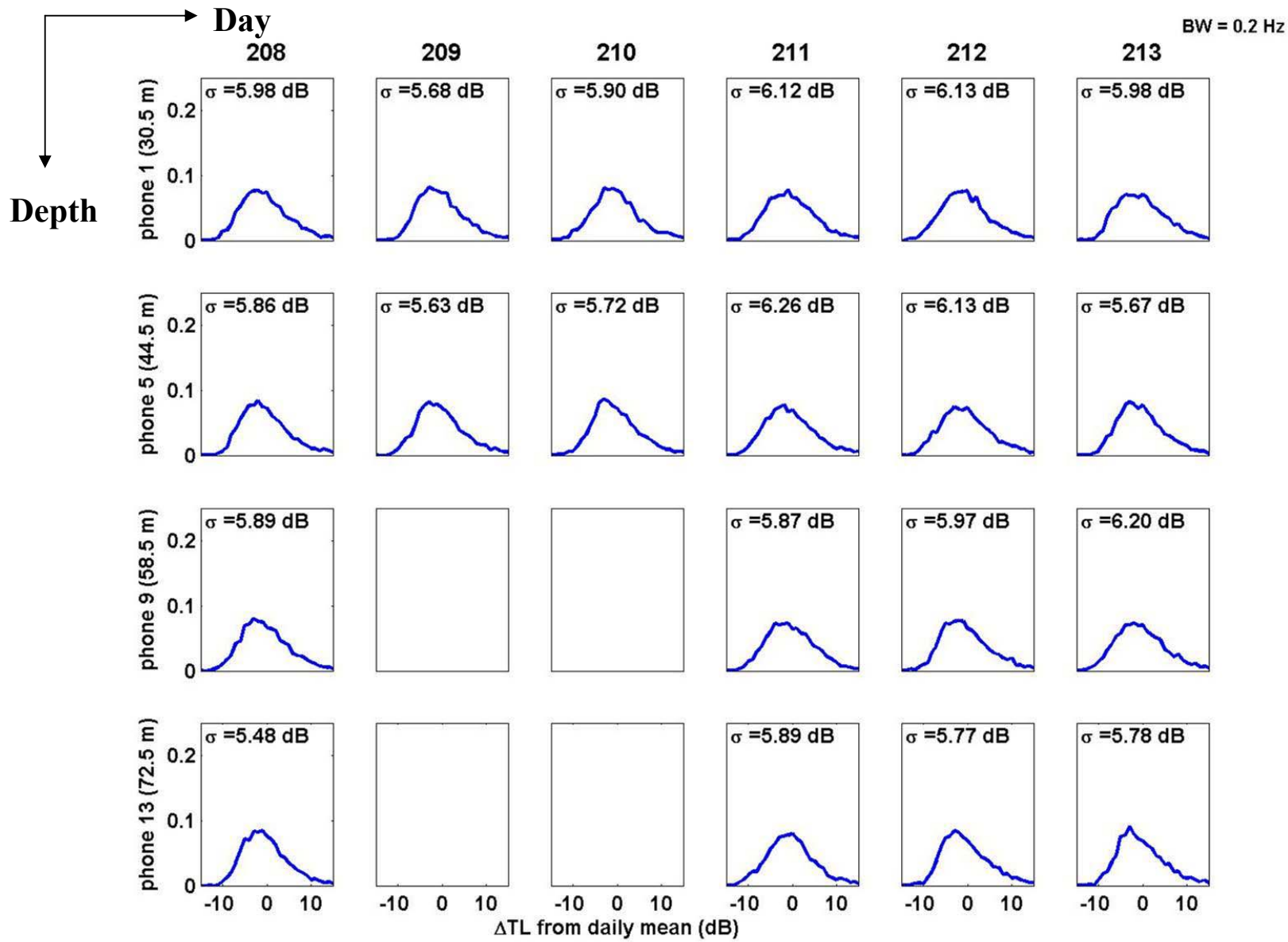




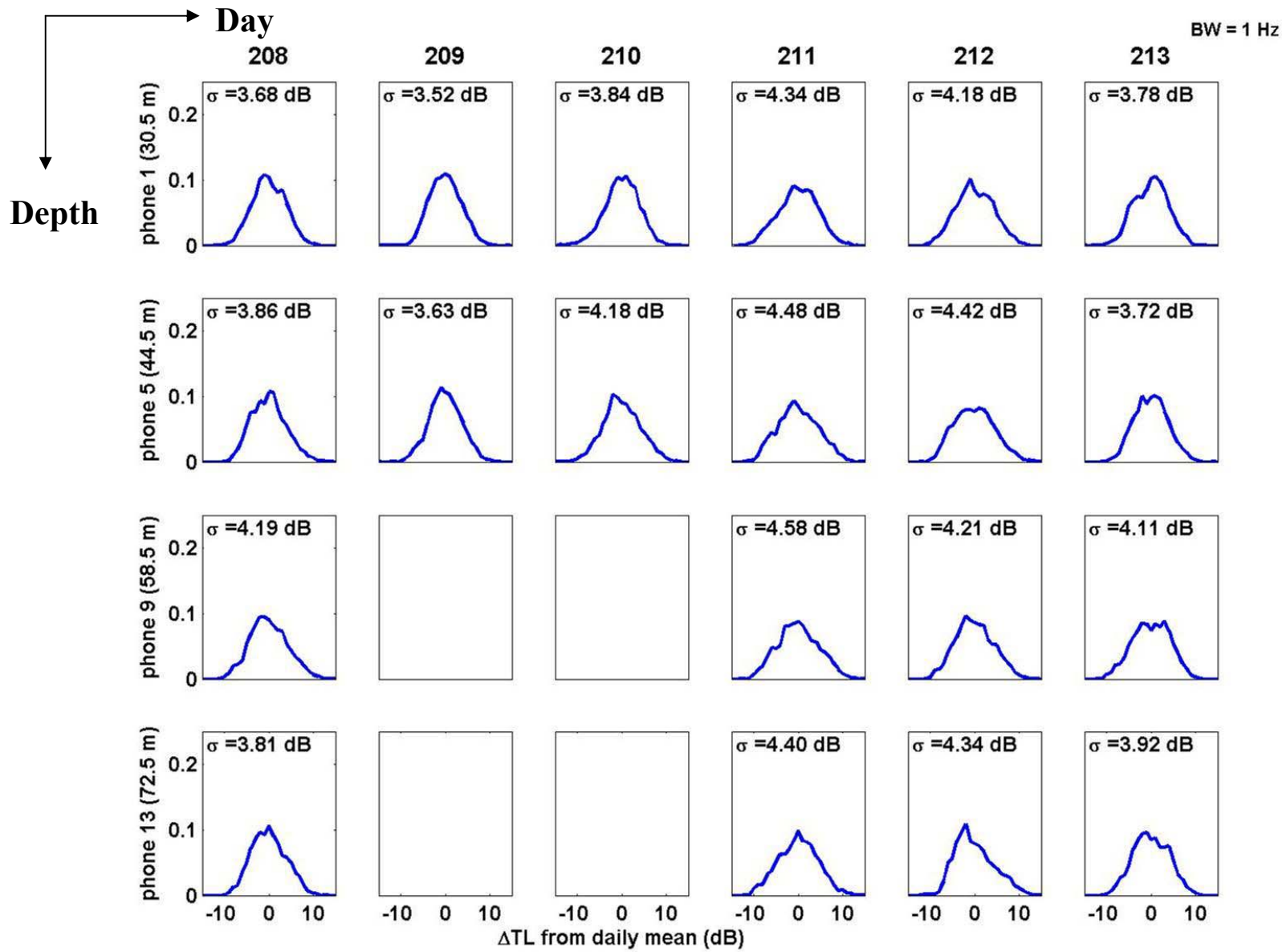
$$TL(\Delta f) = -10\log\frac{\int_T r^2(t;\Delta f)\,dt}{\int_T s^2(t;\Delta f)\,dt}$$

$$= -10\log\frac{\int_{\Delta f}|R(f)|^2\,df}{\int_{\Delta f}|S(f)|^2\,df}$$

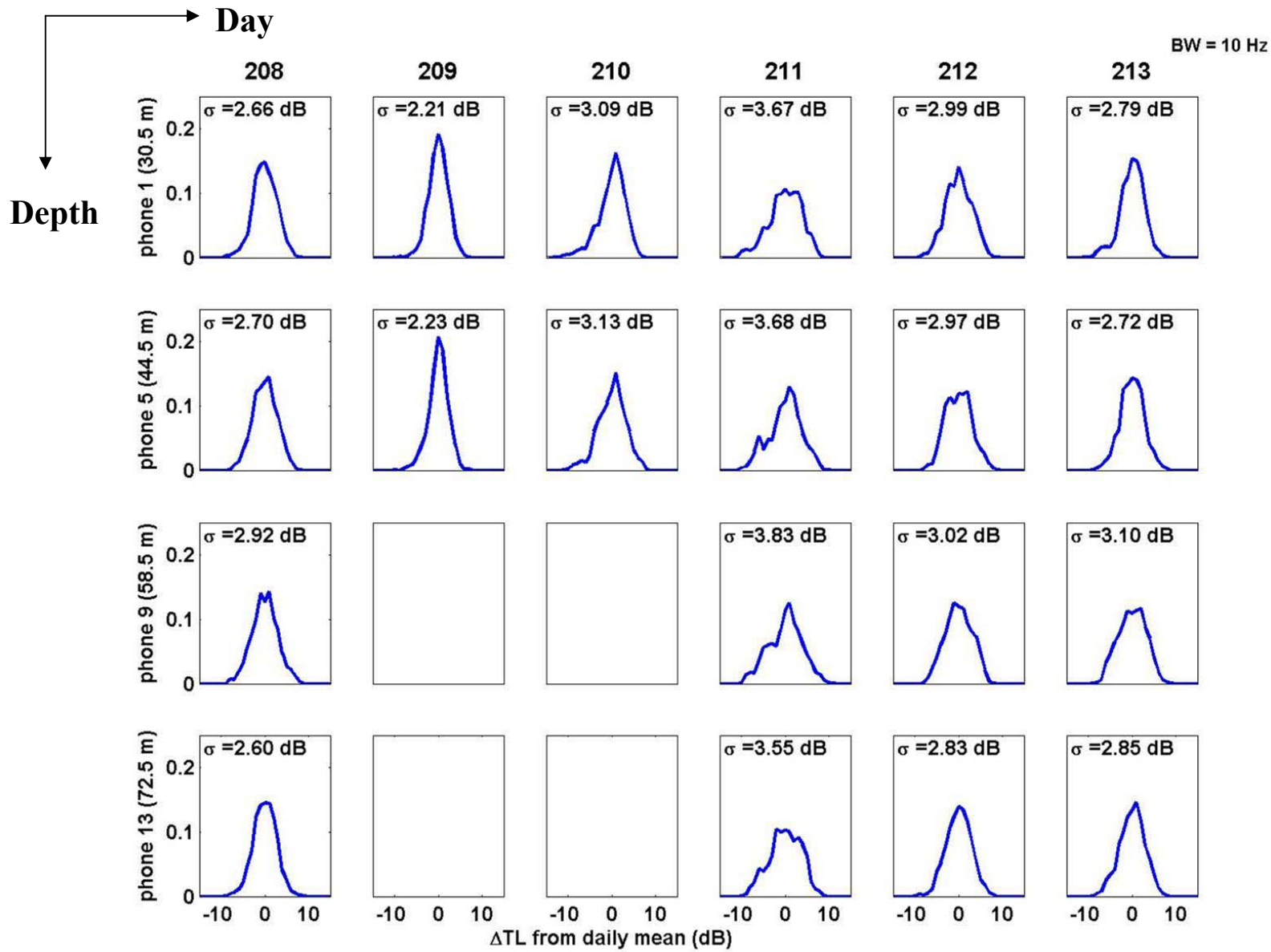
Measured PRIMER "Narrowband" ΔTL Histograms

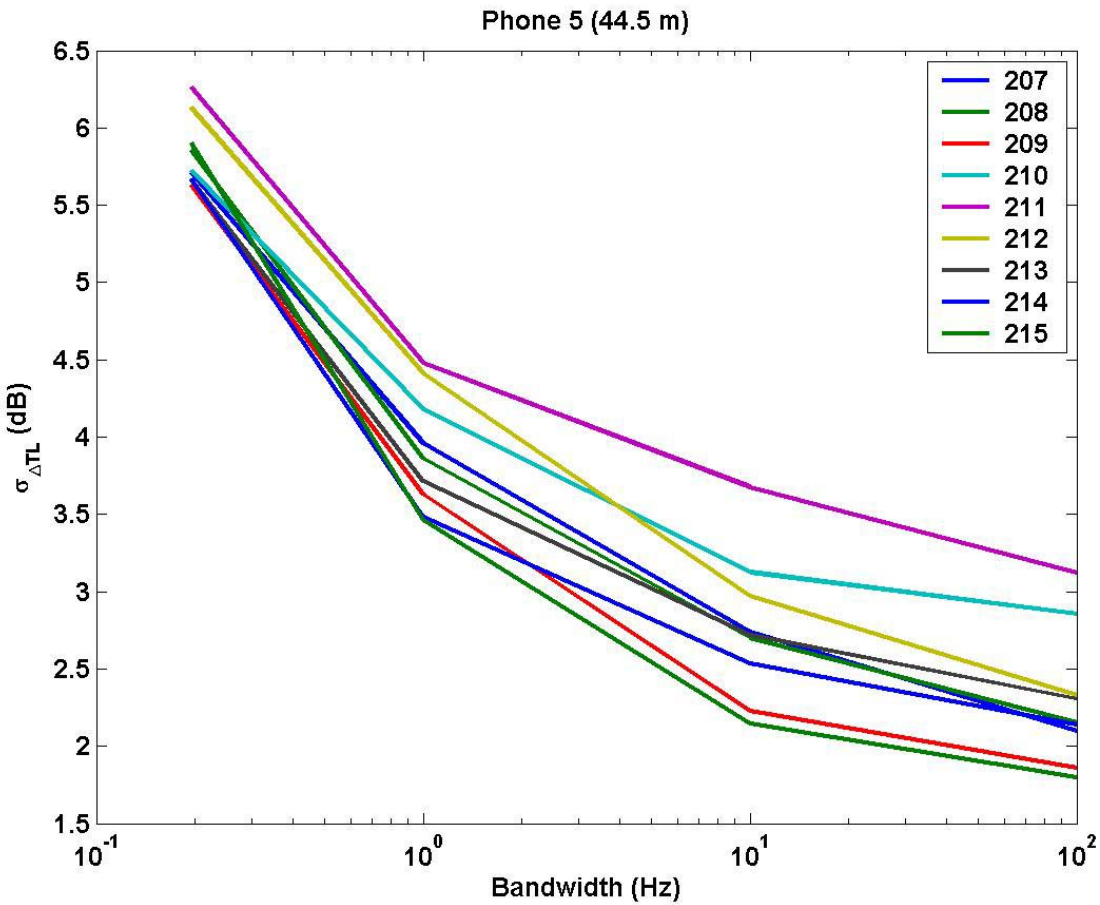


Measured PRIMER "1-Hz Bandwidth" ΔTL Histograms

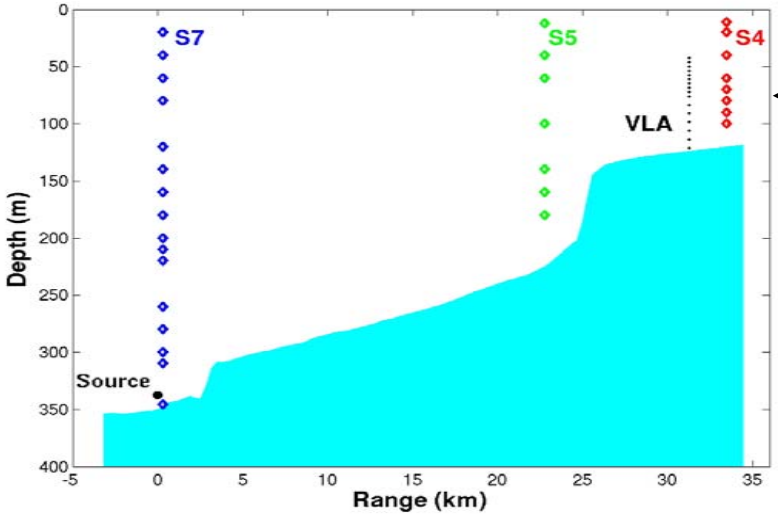


Measured PRIMER "10-Hz Bandwidth" ΔTL Histograms



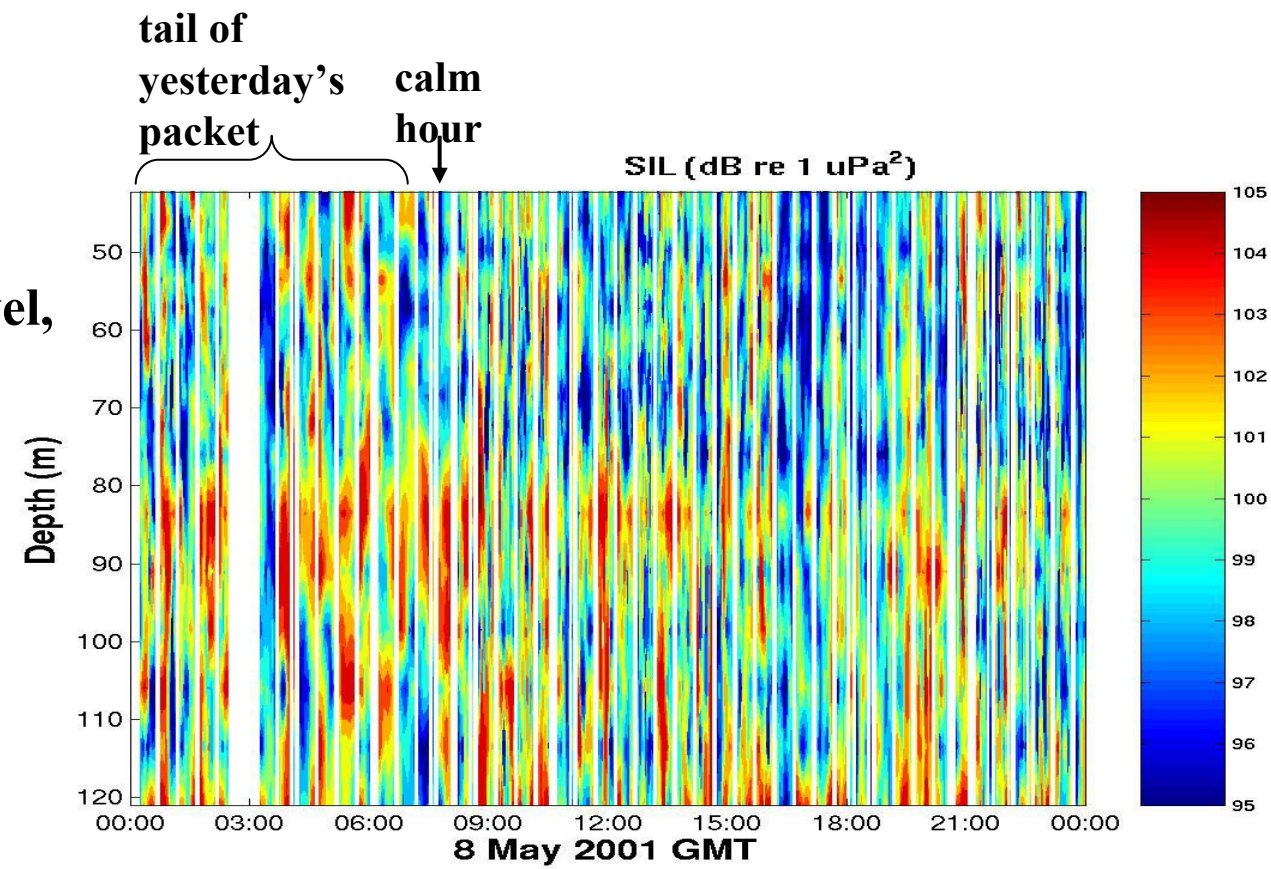


Measured standard deviation of PRIMER daily TL fluctuations versus bandwidth.

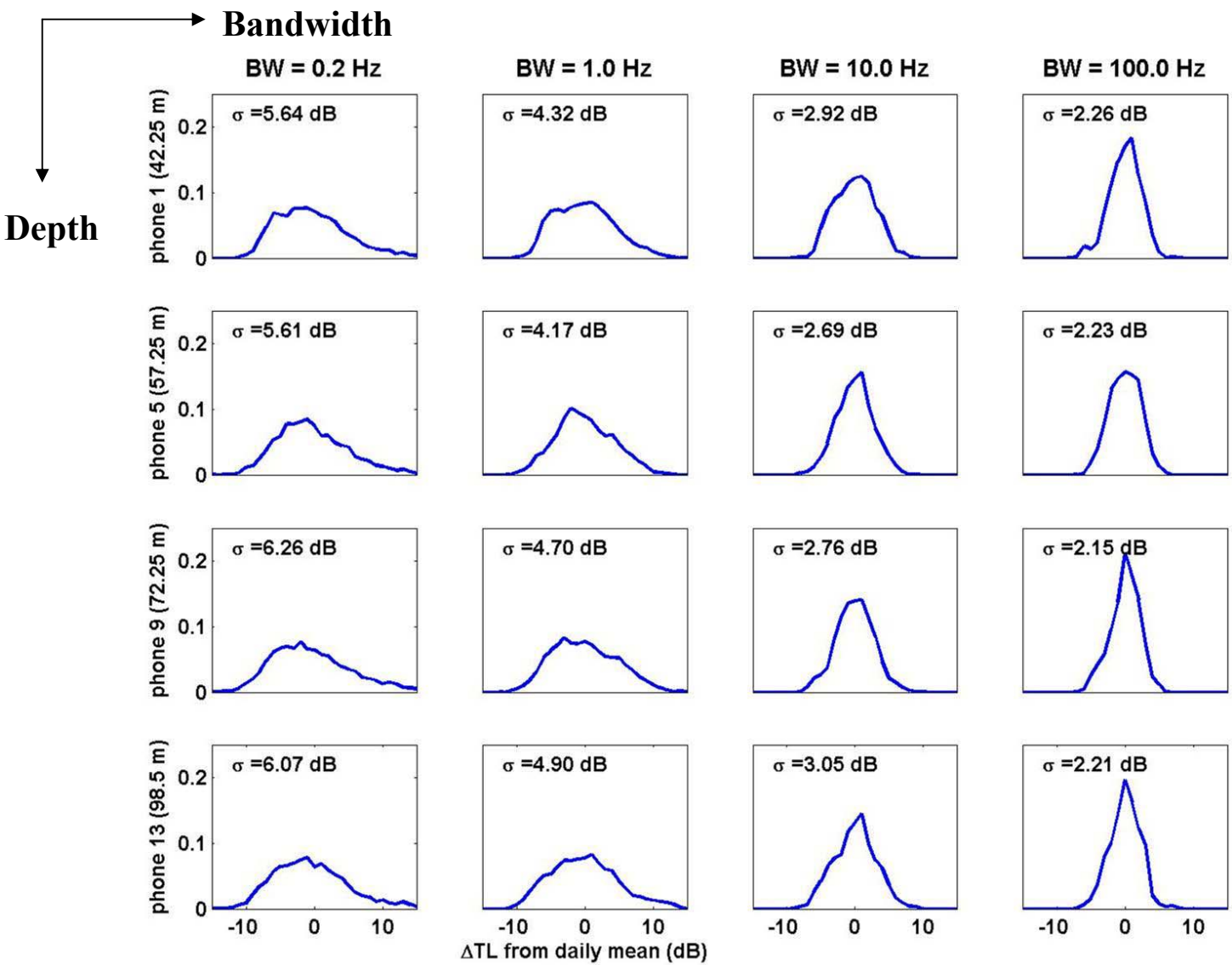


ASIAEX cross-shelf transmission experimental configuration

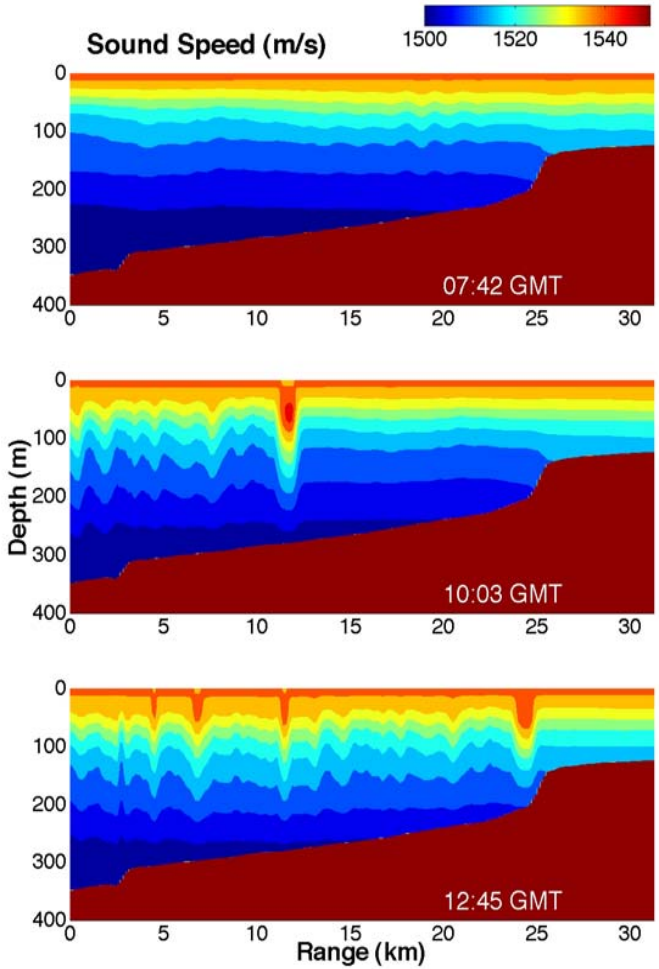
Measured sound intensity level, Δf=100 Hz



ASIAEX: Measured ΔTL Histograms versus Bandwidth

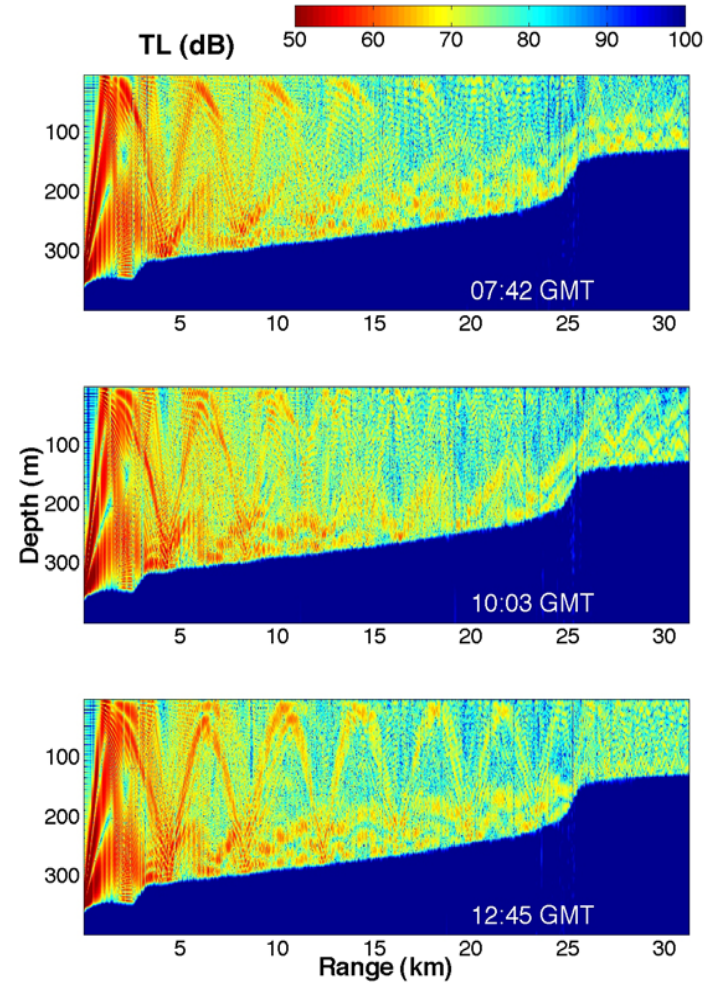


ASIAEX 2001: May 8 400-Hz Acoustic Modeling Snapshots/Realizations



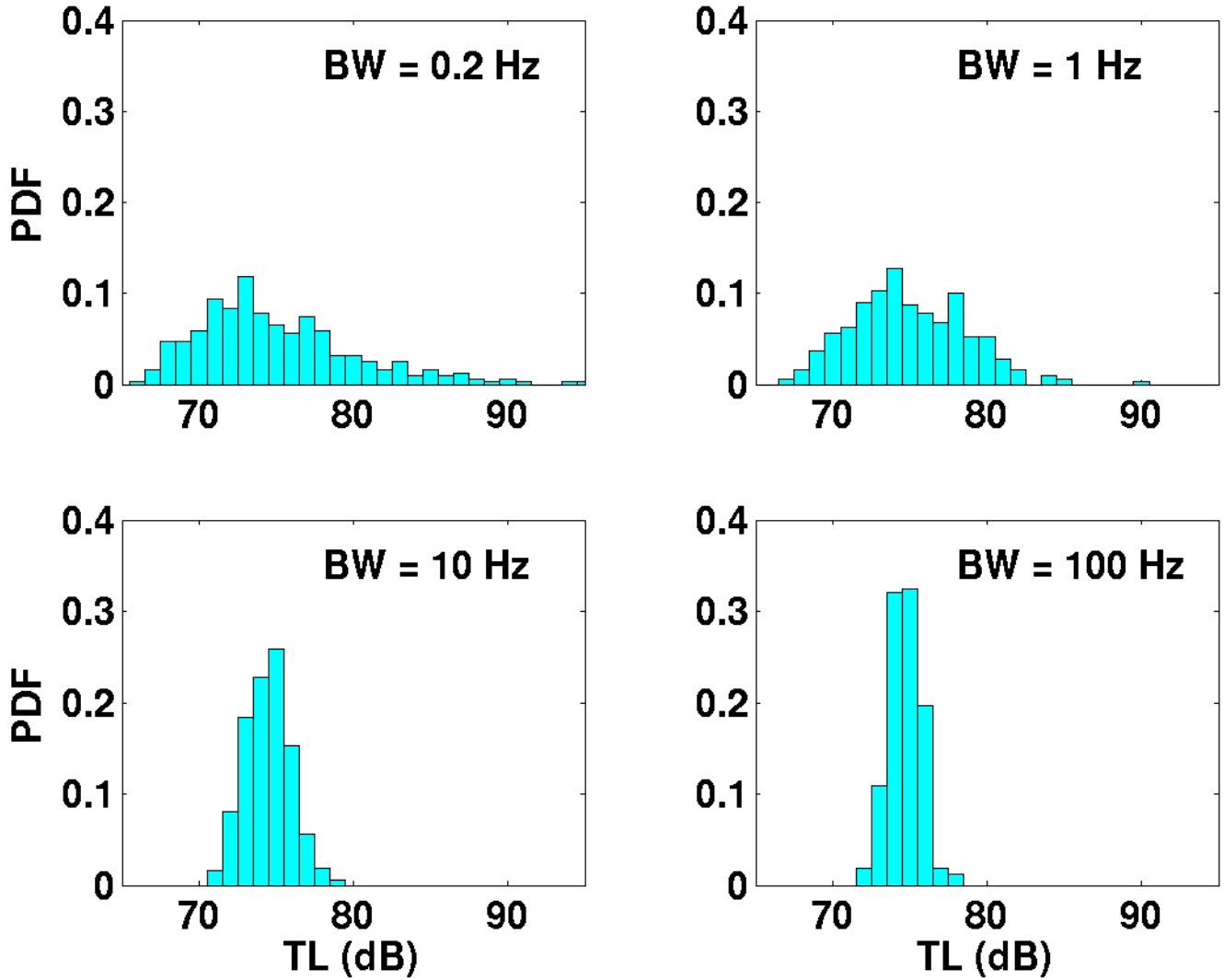
Sound Speed

[Data-based empirical model]

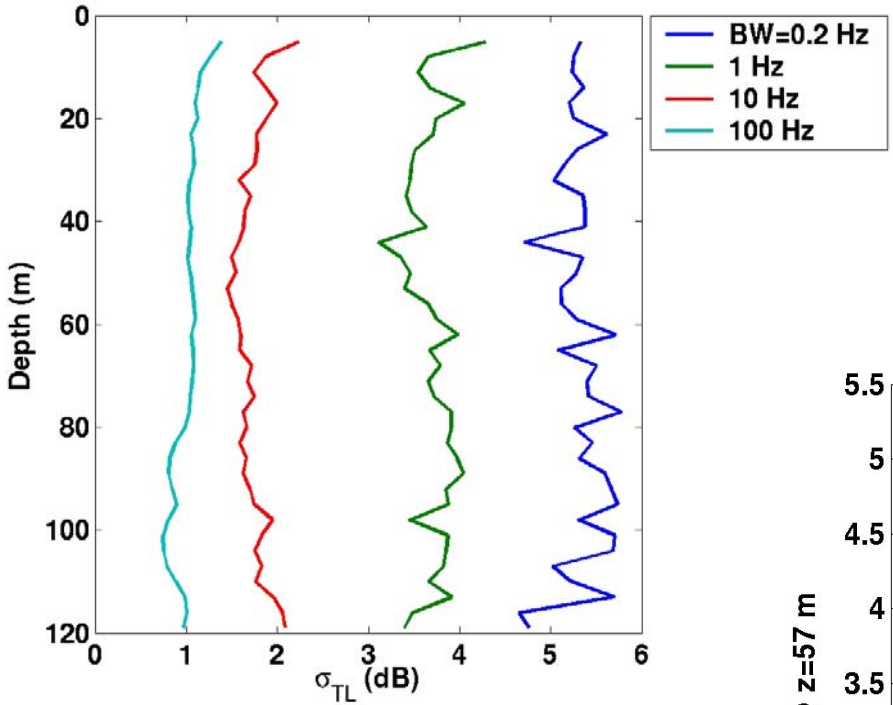


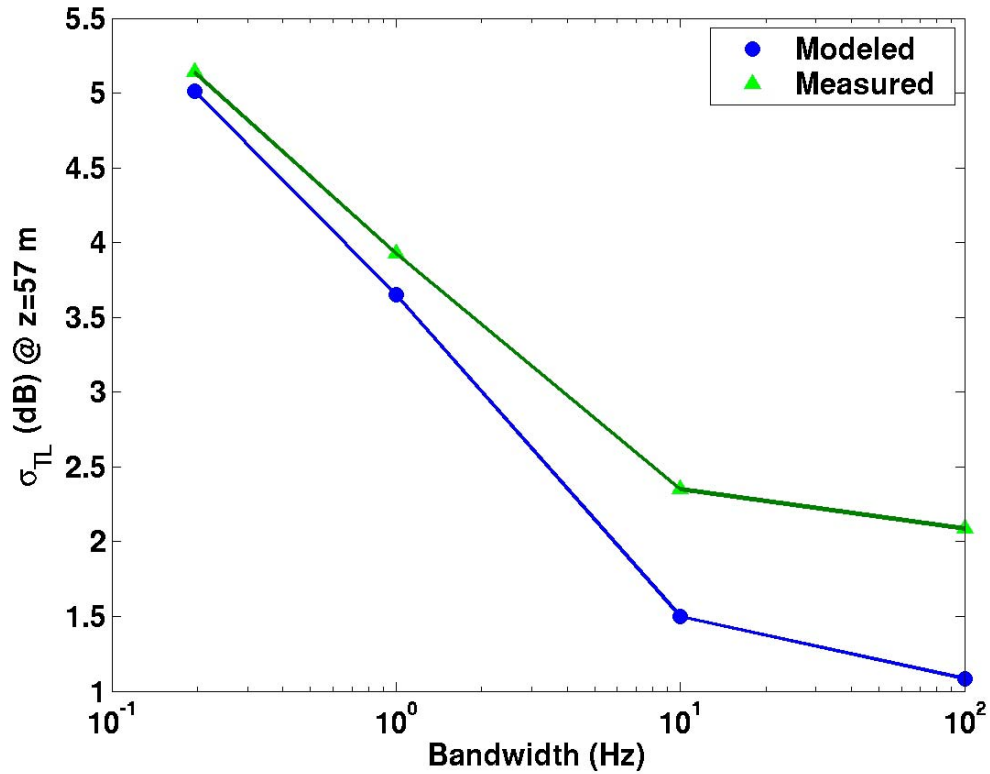
Transmission Loss

ASIAEX: Modeled ΔTL Histogram versus Bandwidth

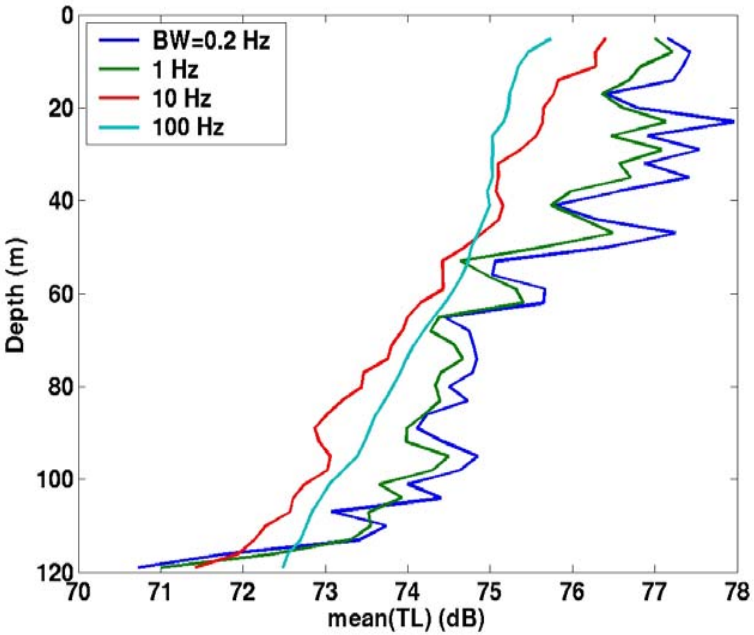


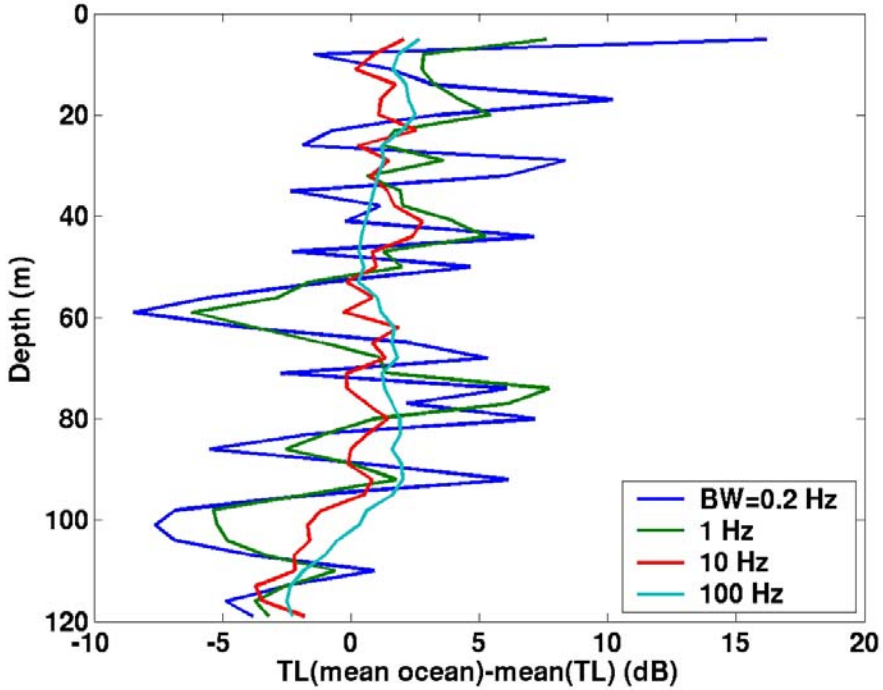
ASIAEX: Modeled σ_{TL} vs. Δf & Comparison to Data

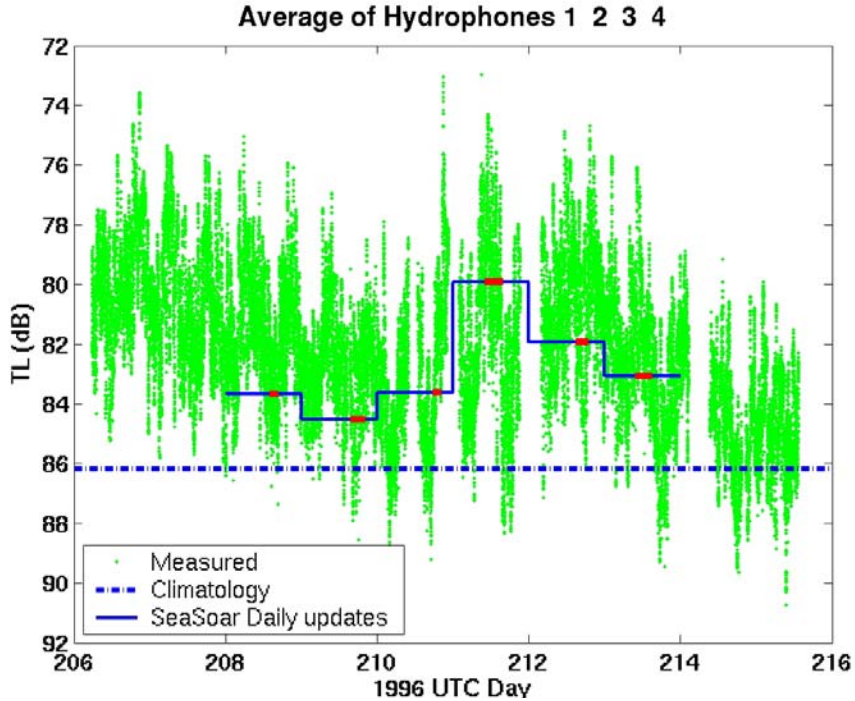


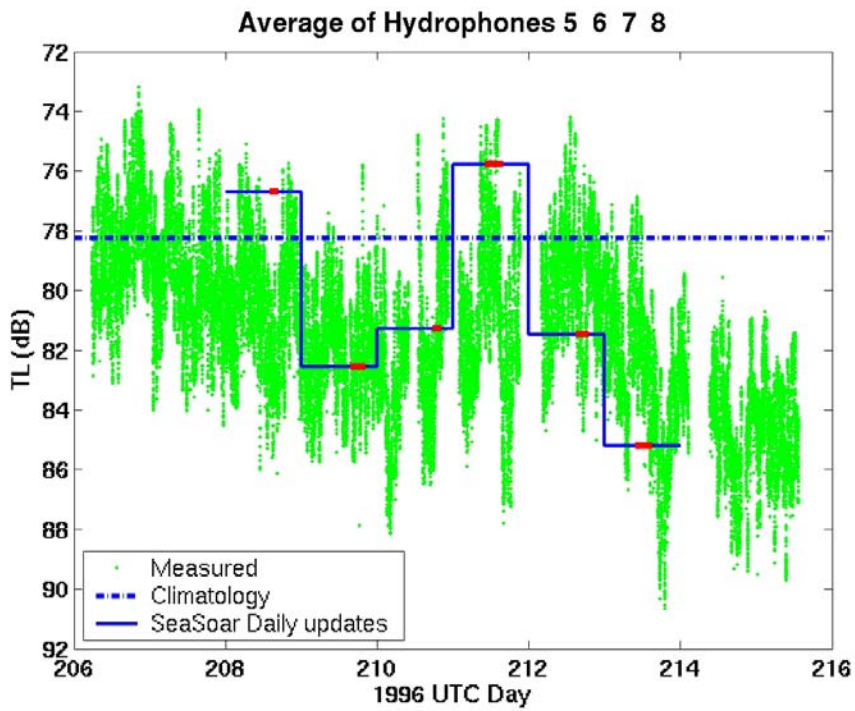


ASIAEX: Modeled Mean TL and Differences between TL in the Mean Ocean and Mean TL



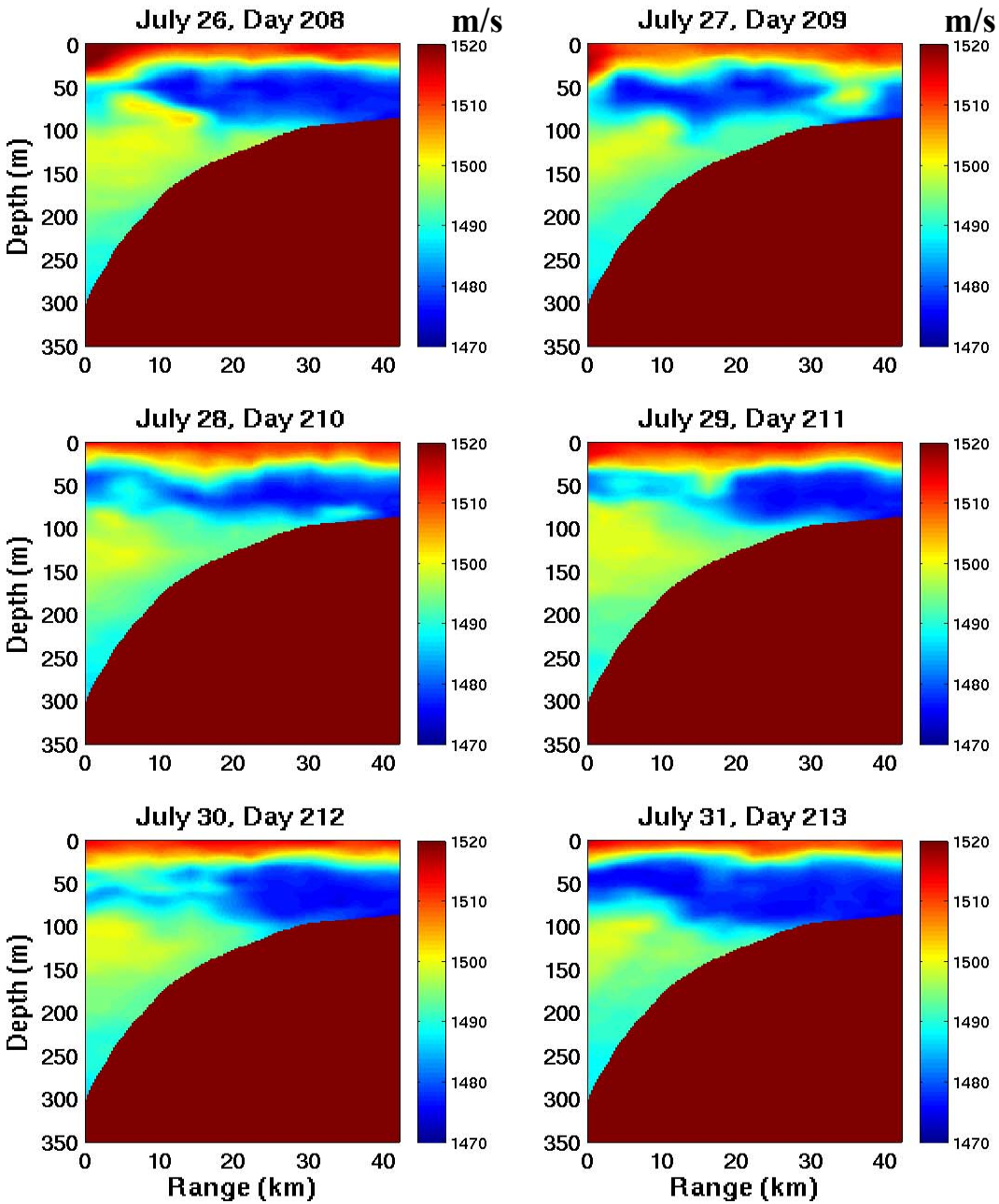






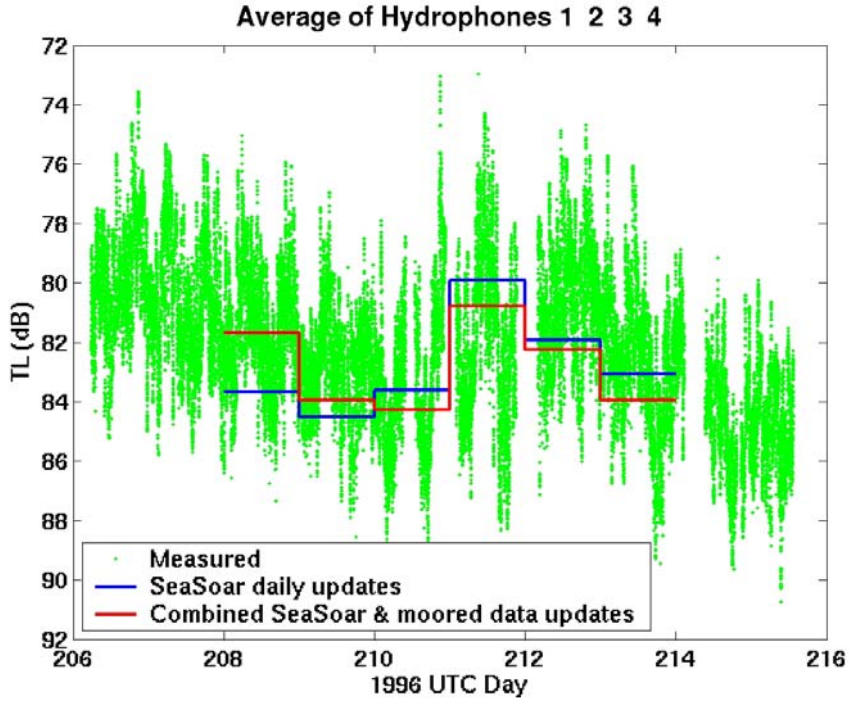
"Previous Results"

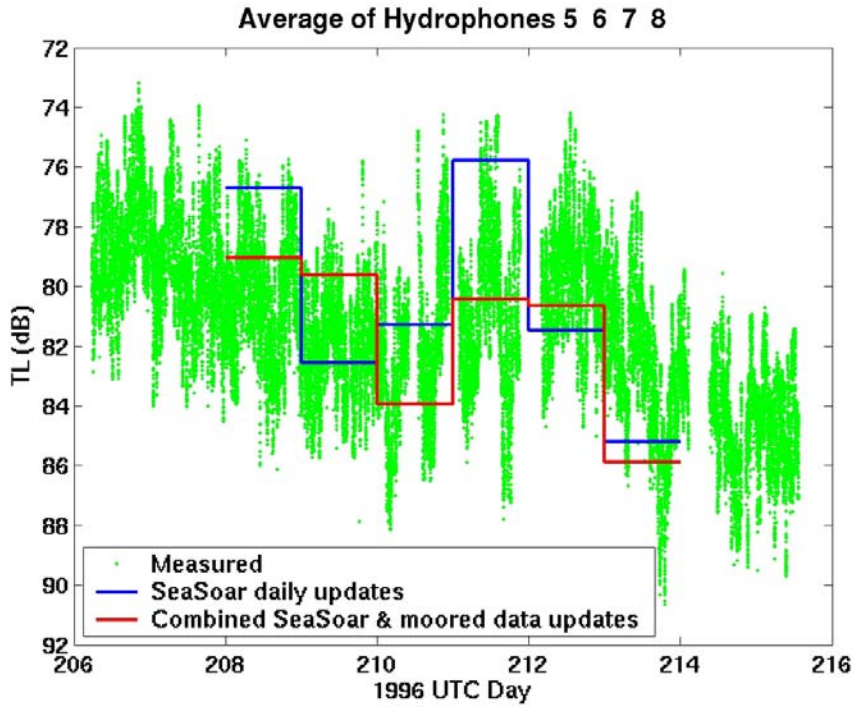
PRIMER TL predicted using seasonal climatology, updated using daily SeaSoar maps, and measured by the top half of the western VLA.



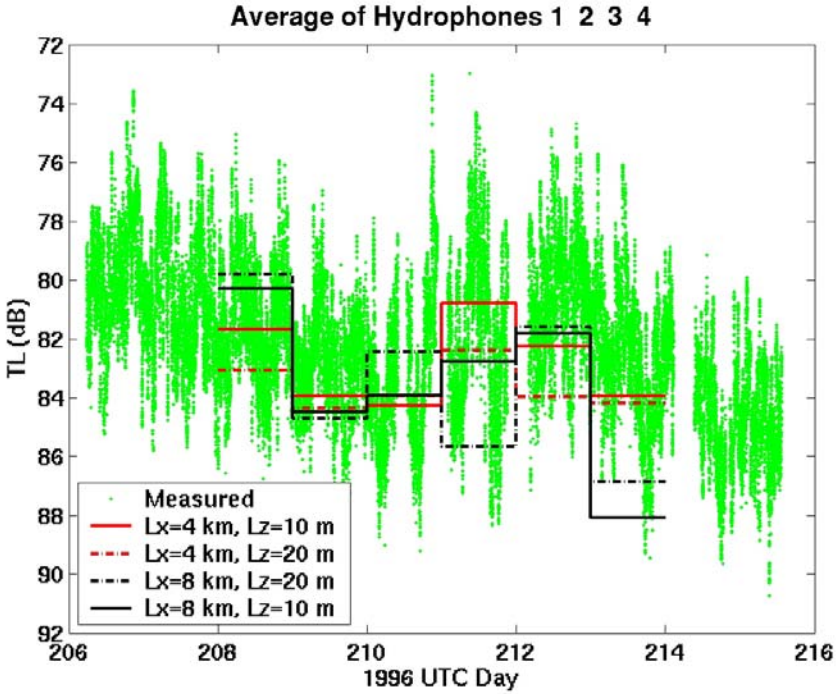
Data Integration:

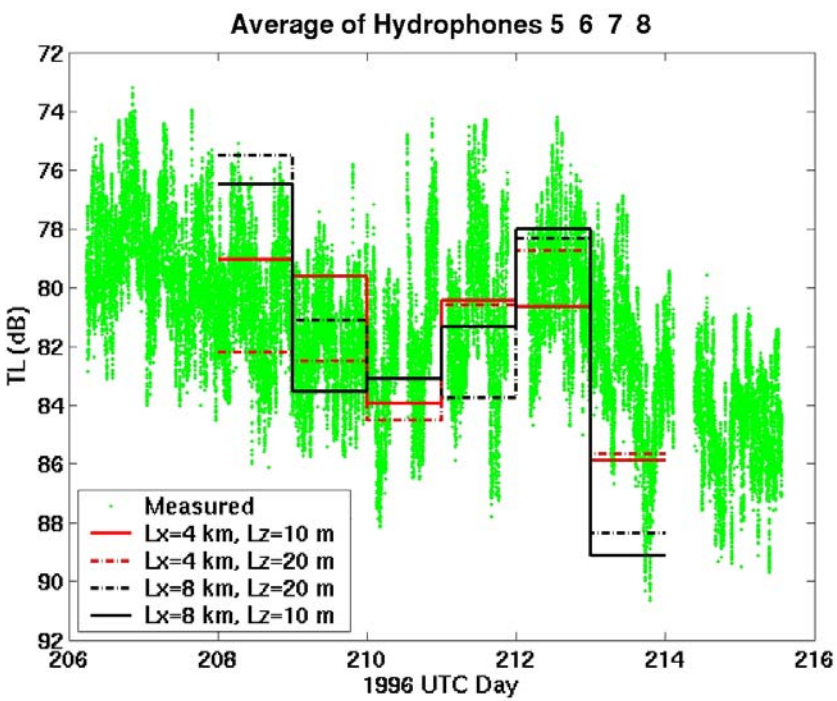
PRIMER daily sound-speed sections mapped by combining WHOI SeaSoar and moored data along the western transmission path.





PRIMER TL predicted using using SeaSoar-only daily maps, using SeaSoar-plus-moored data daily maps, and measured by the top half of the western VLA.





Sensitivity of the PRIMER TL prediction to the resolution of the sound speed field estimate (or mapping correlation lengths).

Summary of Findings

TL Uncertainty Characterization (short scales):

•Statistics of "narrowband" ΔTL is both depth and time invariant, with a skewed PDF (density of -10log of chi-square distribution) and $\sigma \cong 5.6$ dB, matching Dyer's theory (1970).
•As Δf is enlarged, PDF of ΔTL becomes more symmetric, σ reduces, vertical inhomogeneity is maintained, but stationarity is not.
•The differences between mean TL and TL in the mean ocean can be large, but the differences decreases as Δf increases.

TL Uncertainty Reduction (long scales):

•Data integration can improve TL prediction.
•However, TL prediction is somewhat sensitive to the mapping correlation lengths for the sound speed field. This has important implications on the resolution requirement of ocean models.

Future Work/Work in Progress

TL Uncertainty Characterization (short scales):

•Understand nonstationarity - its relation to ocean fluctuation.
•Characterize uncertainty in the mean TL estimates.

TL Uncertainty Reduction (long scales):

•Integration with ocean dynamical model and acoustic data.