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Modeling intensity fluctuations of acoustic transmissions from the R/V Sharp during SW06

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158th Acoustical Society of America meeting
San Antonio, Texas, October 2009

THINK BIG WE DO℠

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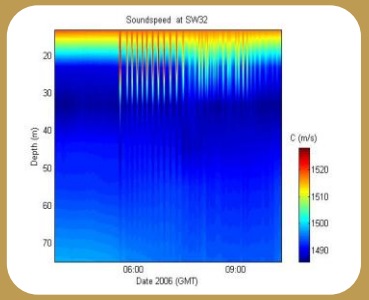
Outline

SW06 & R/V Sharp

- 50+ events
- Different locations



Specific internal wave events

- Event 44 (past work)
- Similar events (new work)

Modeling

- Simplified model
- Looking forward → Modeling real environment

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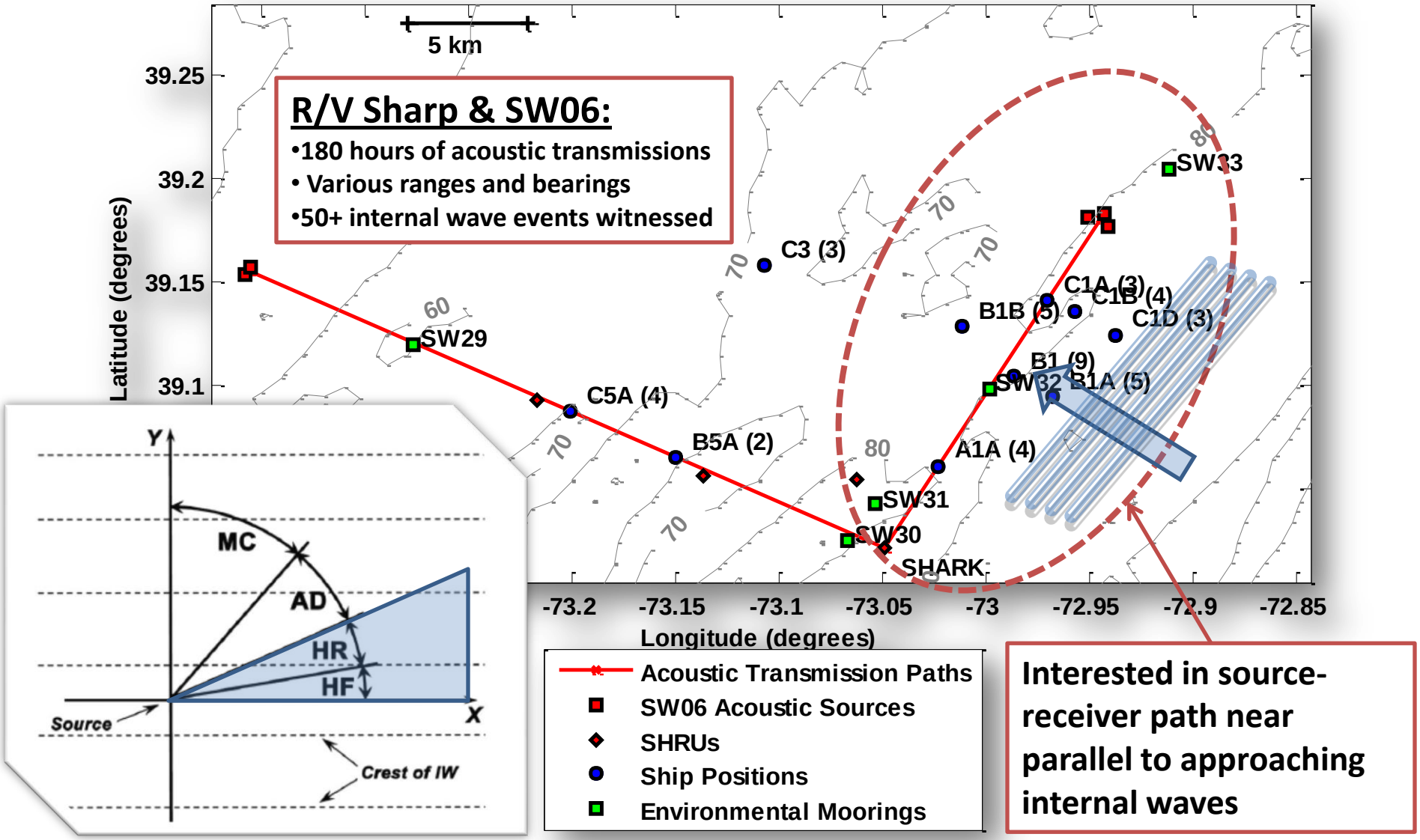
SW06 Test Site & R/V Sharp Locations



M. Badiey, B. G. Katsnel'son, J. Lynch, S. Pereselkov, "Frequency dependence and intensity fluctuations due to shallow water internal waves," J. Acoust. Soc. Am. **122**, 747-760 (2007)

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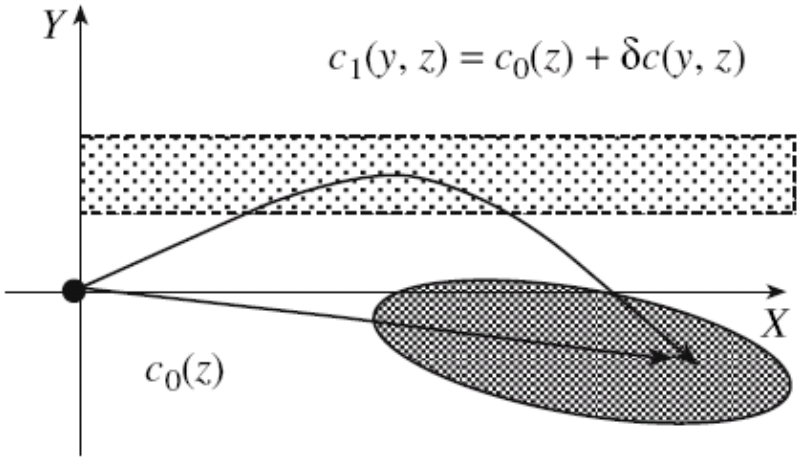
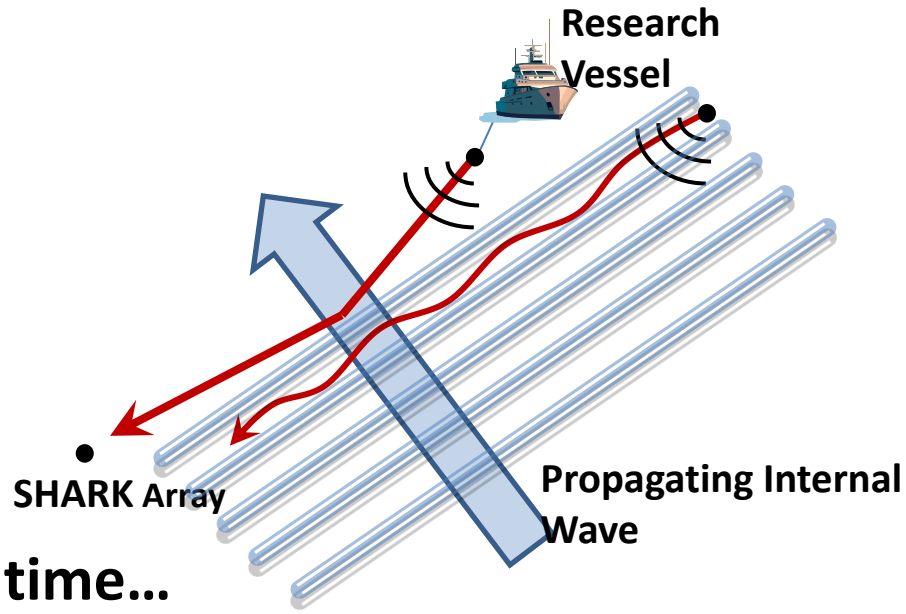
Objectives





Examine intensity fluctuations over time…

→ **before, during, and after internal wave events**

Examine intensity fluctuations over space…

→ **depth and modal dependence**

Statistically characterize intensity fluctuations…

$$I((z \parallel N), k, t, f)$$

$$(z = Depth, \text{ or } N = Mode\,Number)$$

$$k = Chirp\,arrival number \;\; t = Time \;\; f = Frequency$$

B. G. Katsnel'son, J. Lynch, A. V. Tshoidze, "Space-Frequency Distribution of Sound Field Intensity in the Vicinity of the Temperature Front in Shallow Water," Acoustical Physics **53**(5), 611-617 (2007)

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Intensity Measurements

Integrated Energy: $I_{z\tau}(k) = \int dz \int d\tau I(\tau, z, k)$

Temporally Integrated Energy: $I_{\tau}(z,k) = \int d\tau I(\tau, z, k)$

Point Observations of Broadband Intensity: $I_{\tau}(\tau, z, k)$

Observations of Point Scintillations: $SI = \frac{\langle I^2 \rangle}{\langle I \rangle^2} - 1$

Point Observations of Peak Intensity: $I_P(z,k) = \max_{\tau}[I(\tau, z, k)]$

Observations of Modal Amplitudes: $I(N, k, f)$

A. Fredericks, J. A. Colosi, J. Lynch, C. Chiu, and P. Abbot, “Analysis of multipath scintillation from long range acoustic transmissions on the New England continental slope and shelf,” J. Acoust. Soc. Am. **117**, 1038–1057 (2005)

Duda, T.F., Lynch, J.F., Newhall, A.E., Lixin Wu, Ching-Sang Chiu, “Fluctuation of 400-Hz sound intensity in the 2001 ASIAEX South China Sea experiment,” Oceanic Engineering, IEEE Journal of, **29**(4), 1264 – 1279 (2004)

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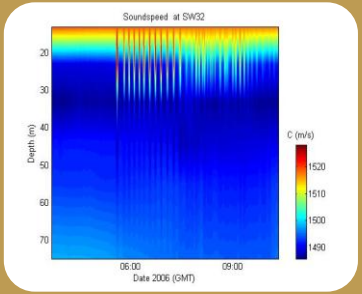

Specific events

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- Similar events (new work)

Modeling

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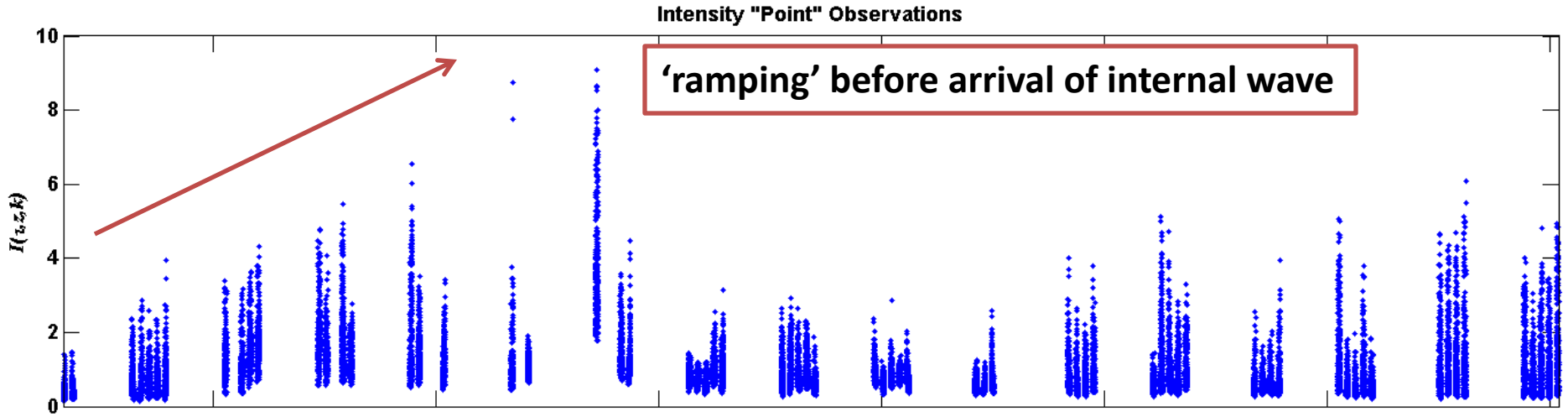
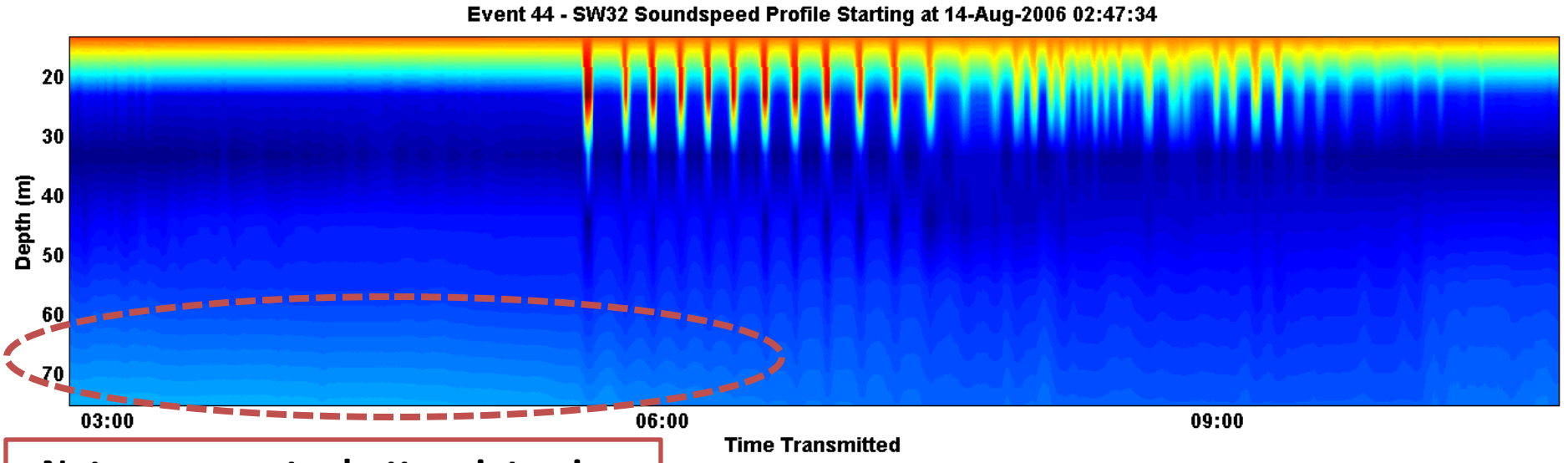
Event 44 “Point” Observations





Note warm water bottom intrusion

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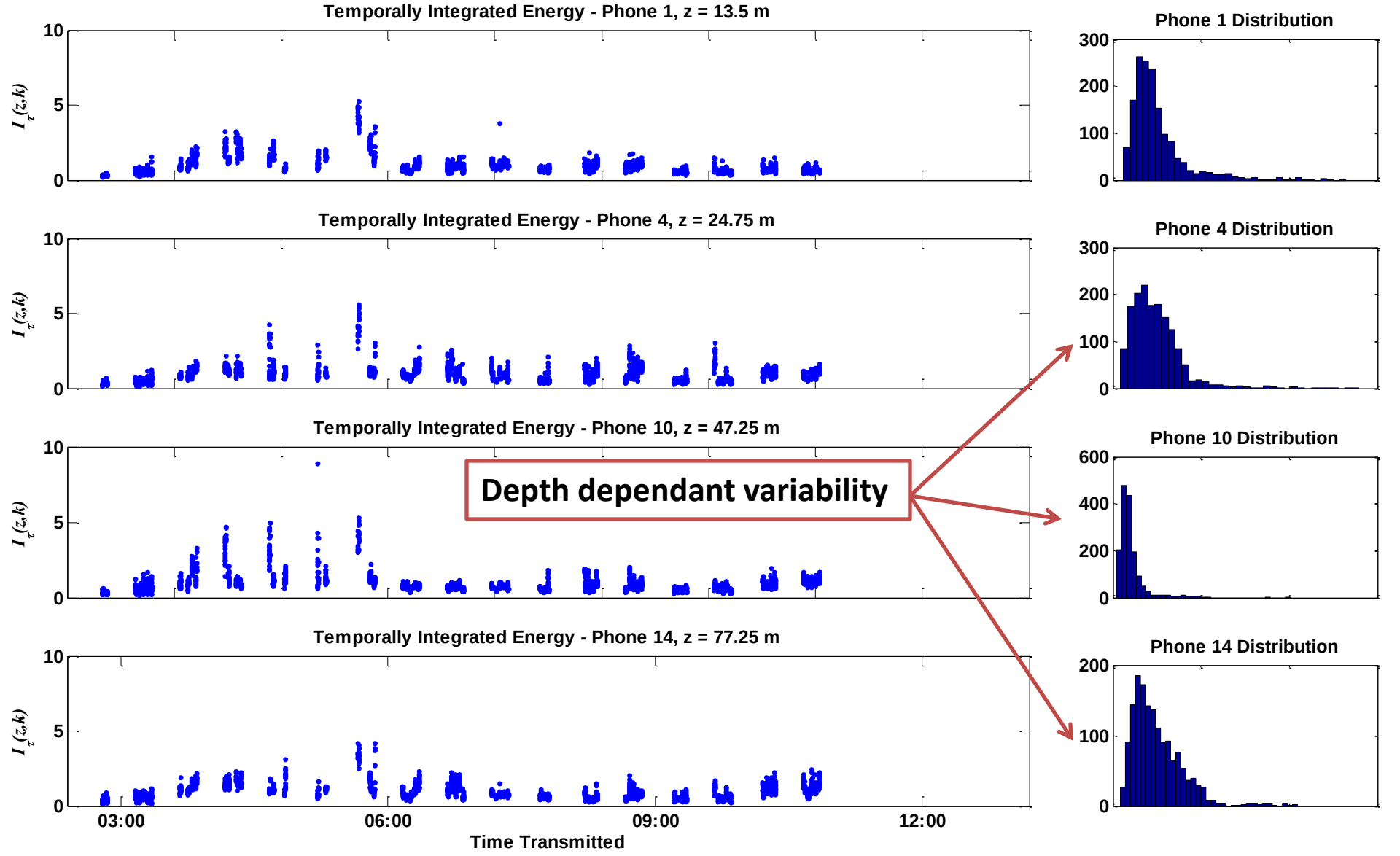
Event 44 depth dependance



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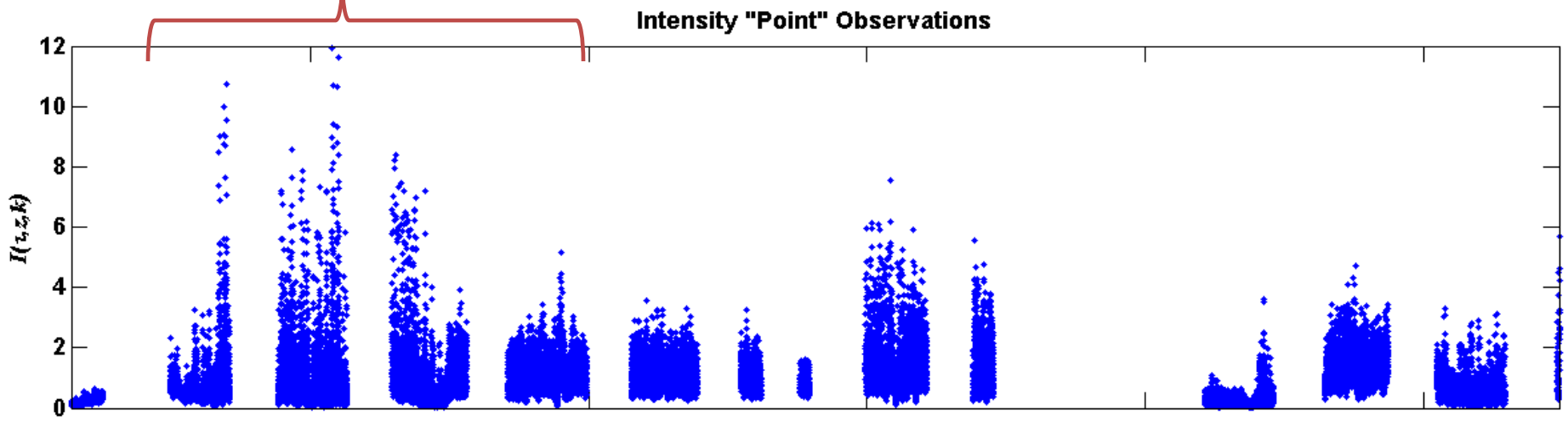
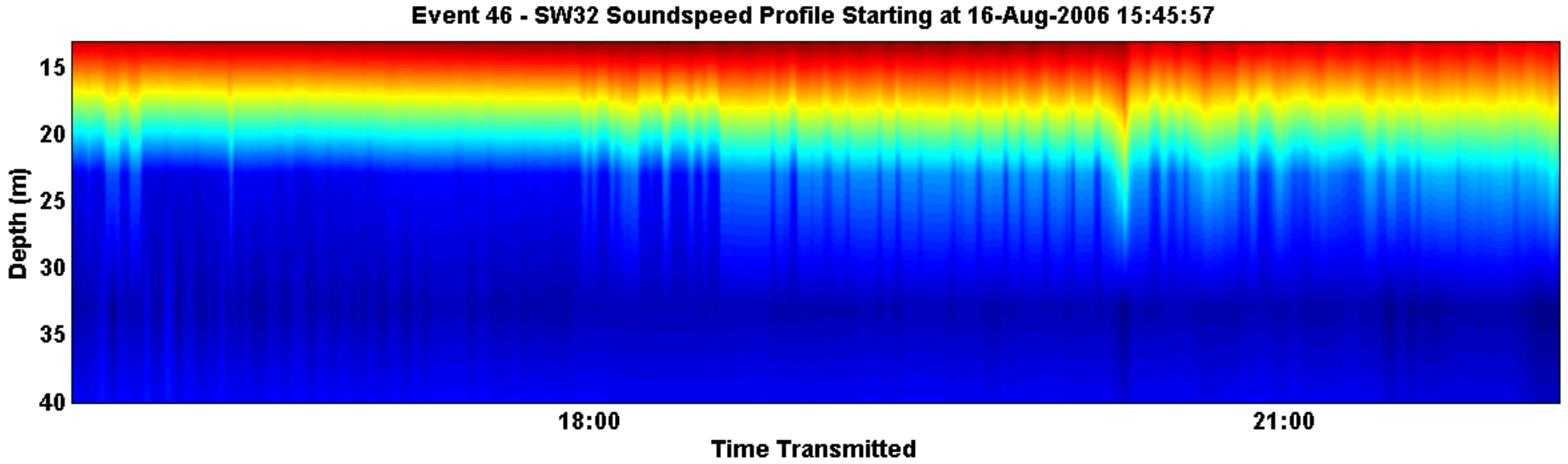
Event 46 (new)

Trapped sound between solitons?





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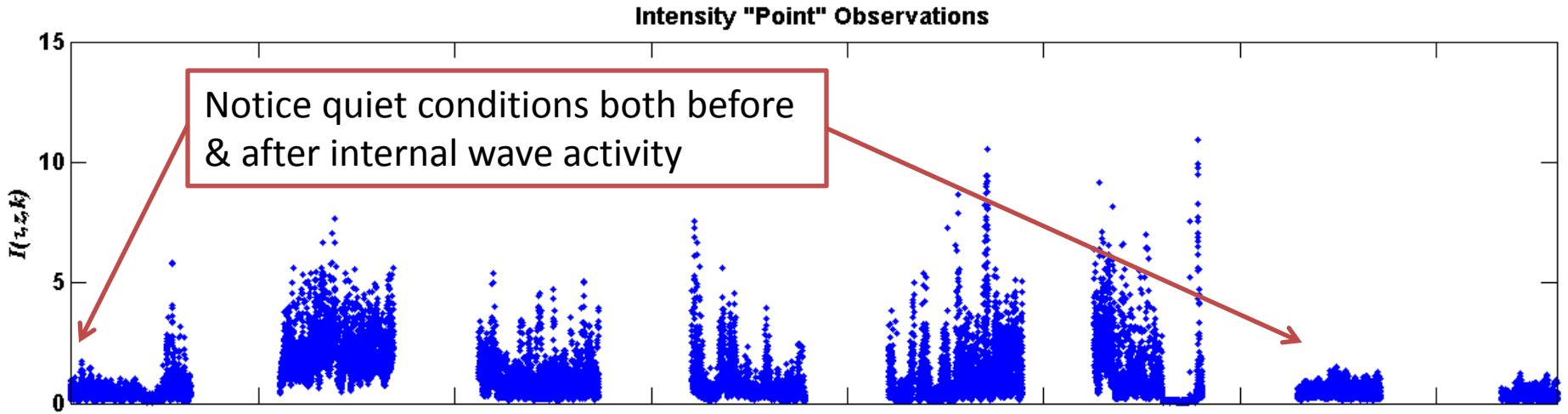
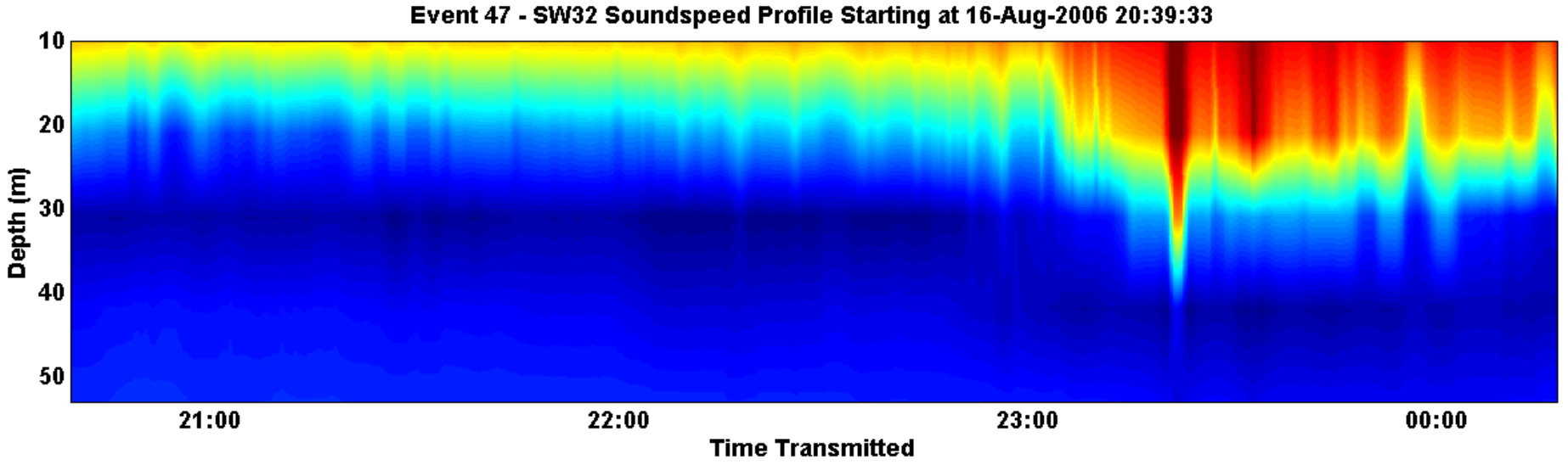
Event 47 (new)





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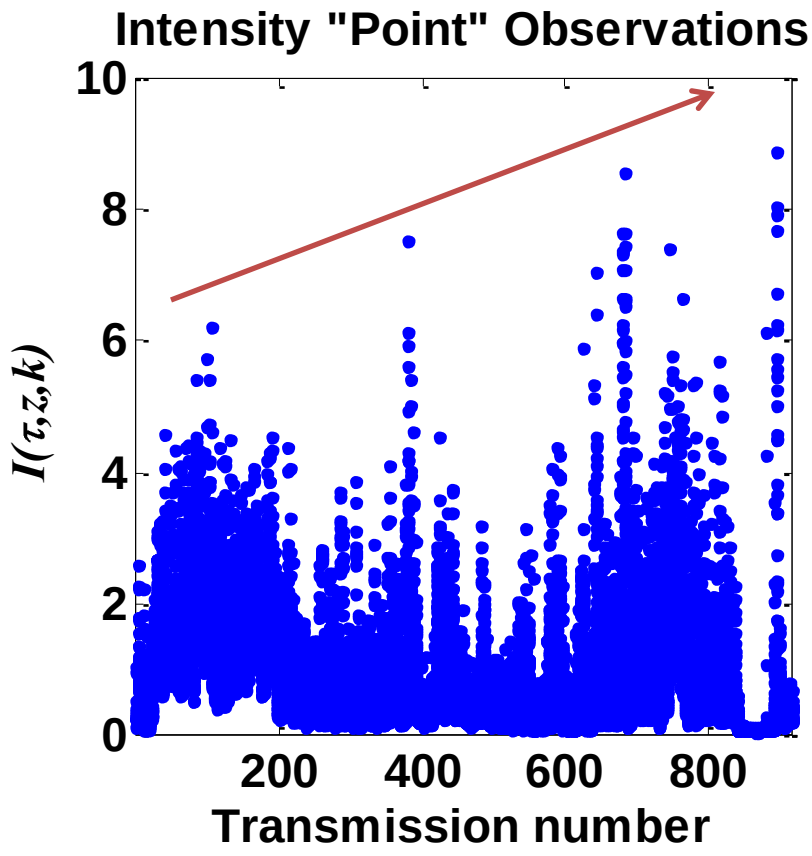
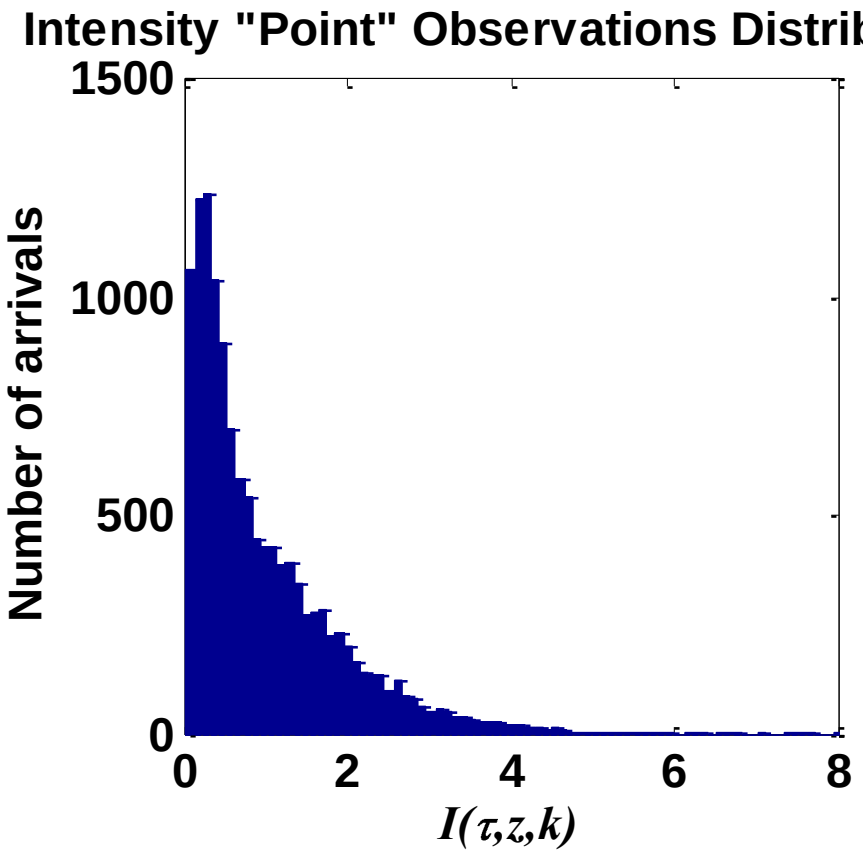
Event 47 (new)

Slight ‘ramping’ before arrival of internal wave





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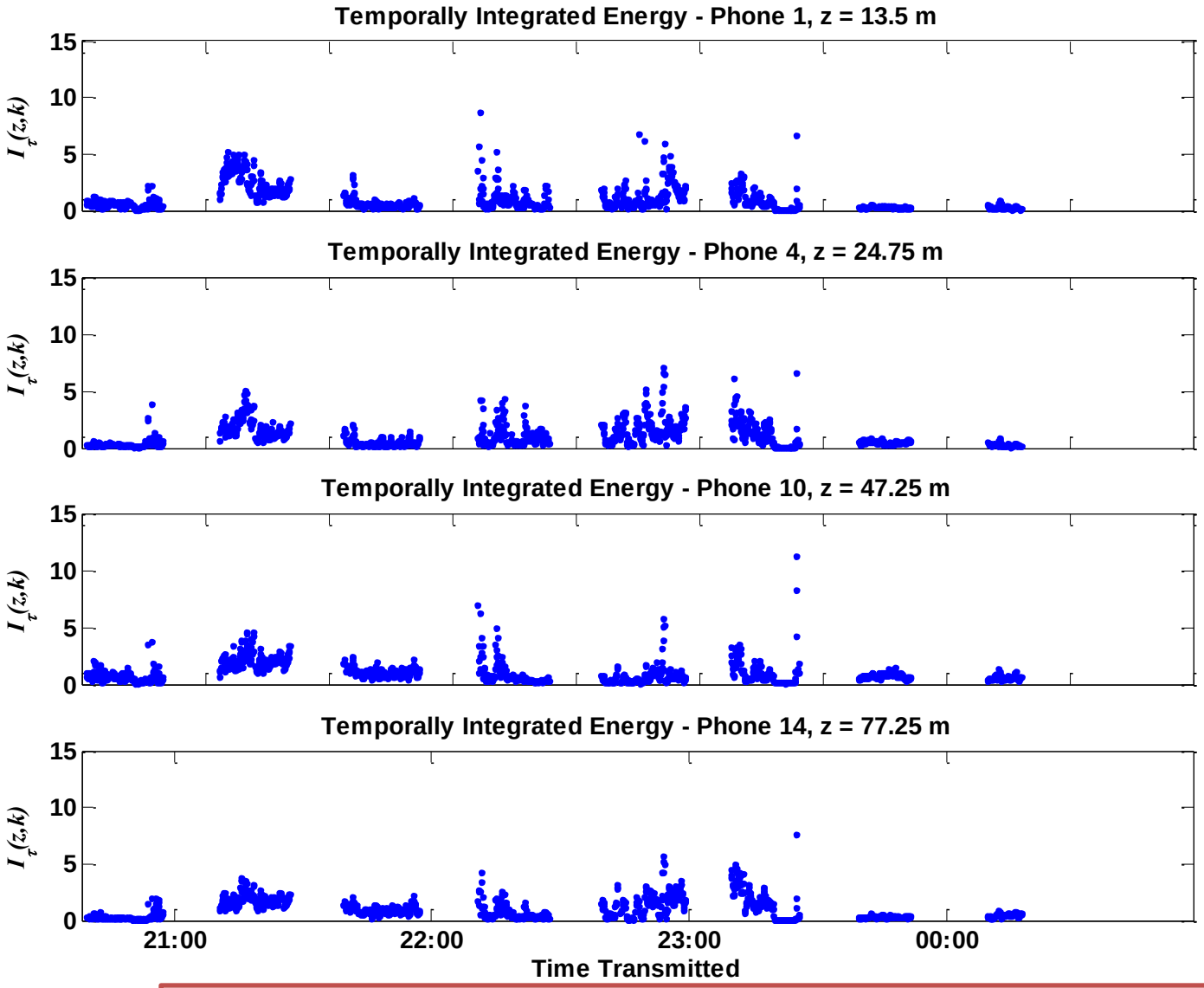
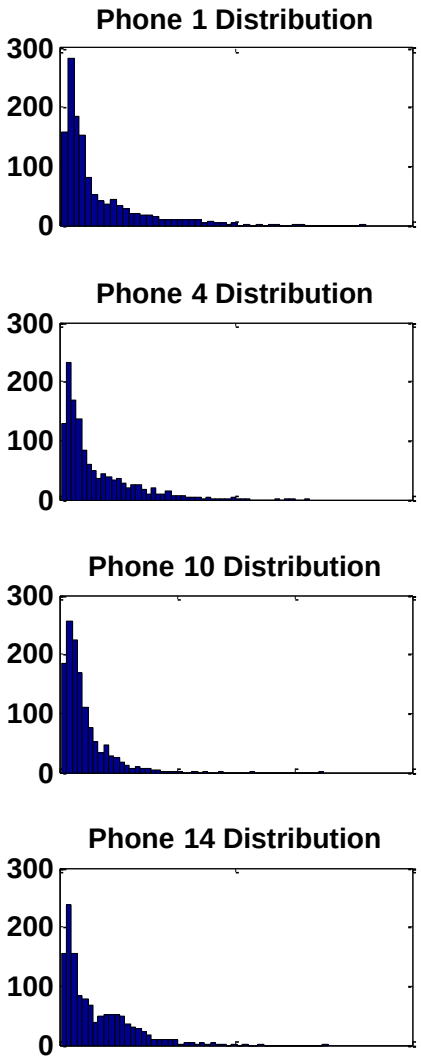
Event 47 (new)





Lack of warm water intrusion near bottom → less depth dependant variability

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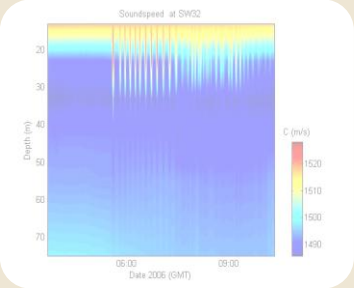

Specific events

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Modeling

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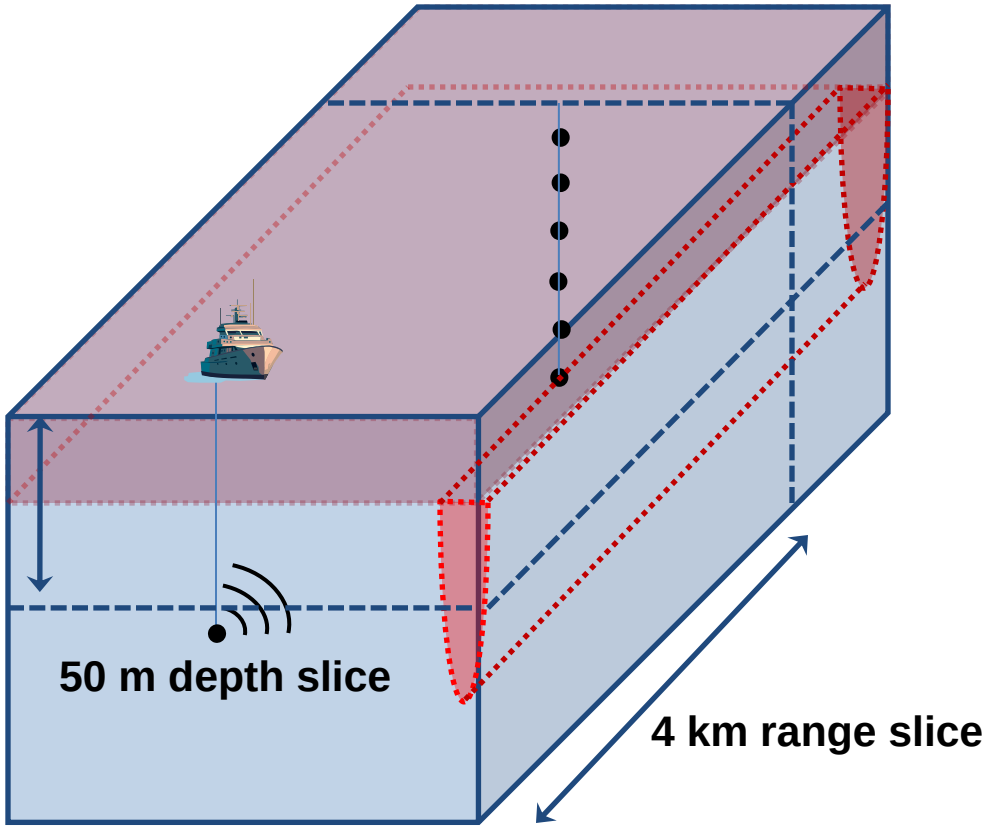
Modeling

Using 3D PE model provided by NPS, start with a simple scenario



Assumptions:

- 5km × 5km × 100m water column
- Flat bottom
- Single layer soundspeed properties for sediment
- Source at 75 m depth
- Single soliton marches eastward
- Same source-receiver angle as in Event 44
- Virtual VLA 4 km away from source

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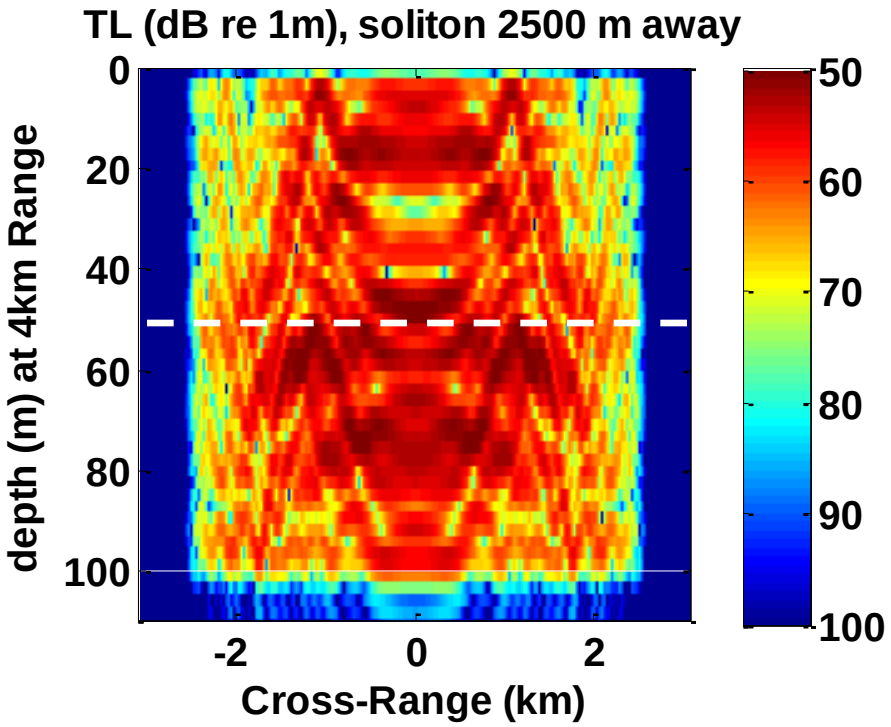
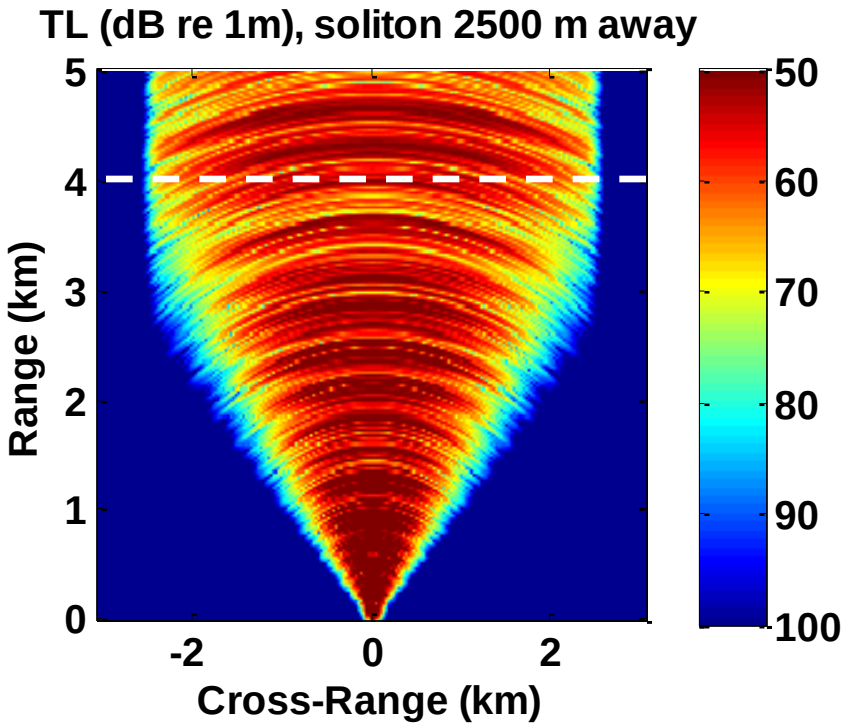
Modeling





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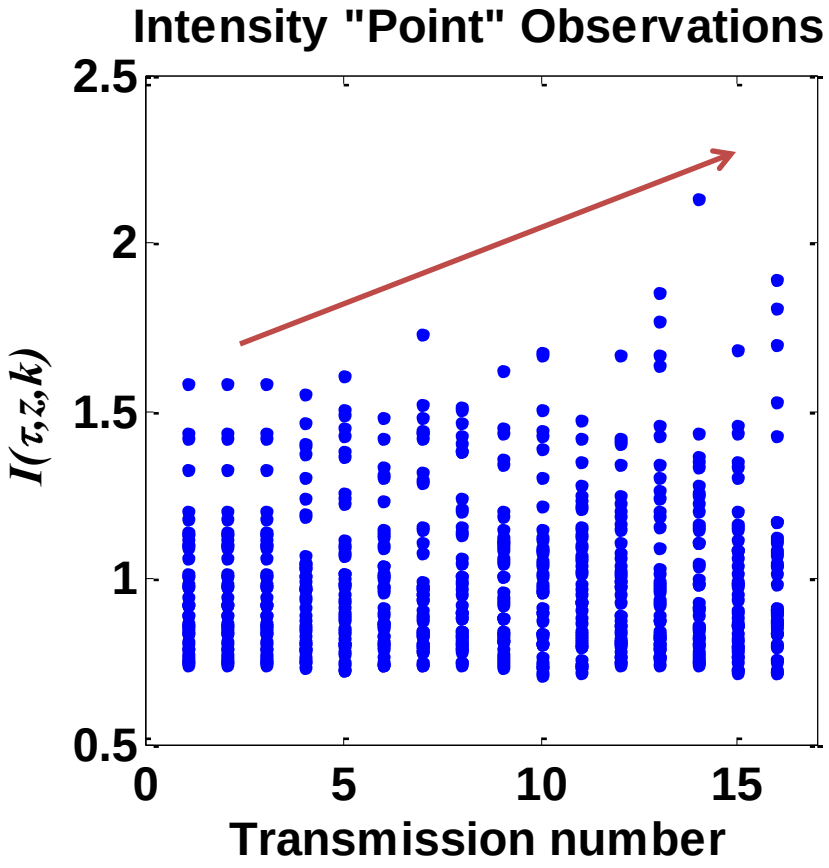
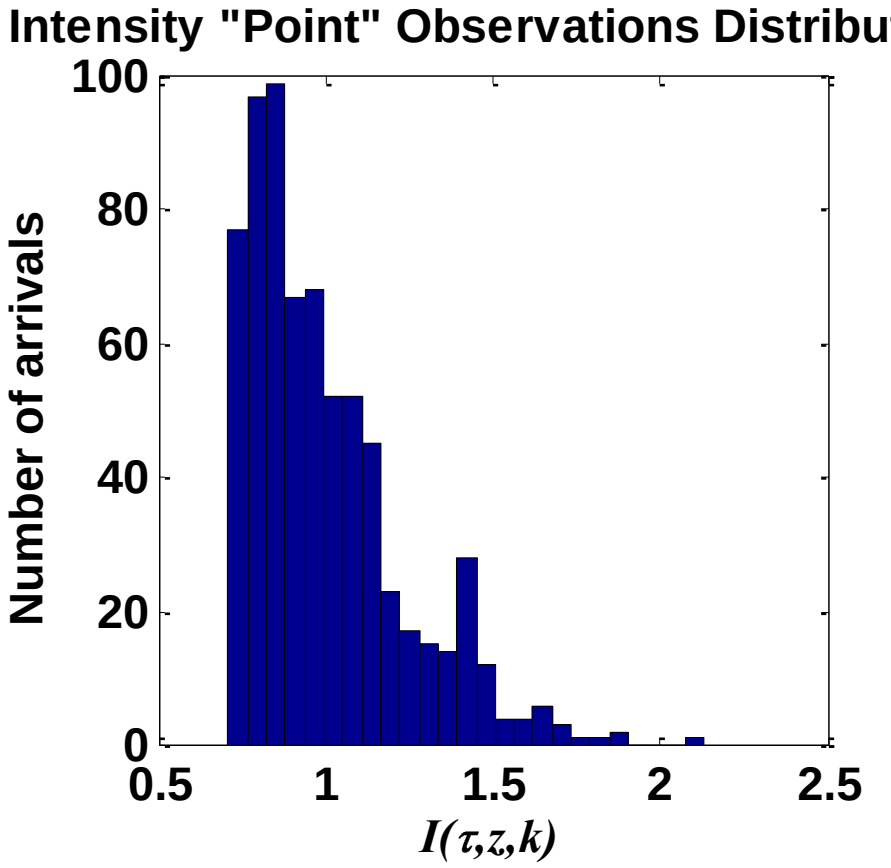
Modeling





Although not quite as dramatic, the same ramping trend is evident as soliton moves closer. Modeled distribution similar to that of measured data.

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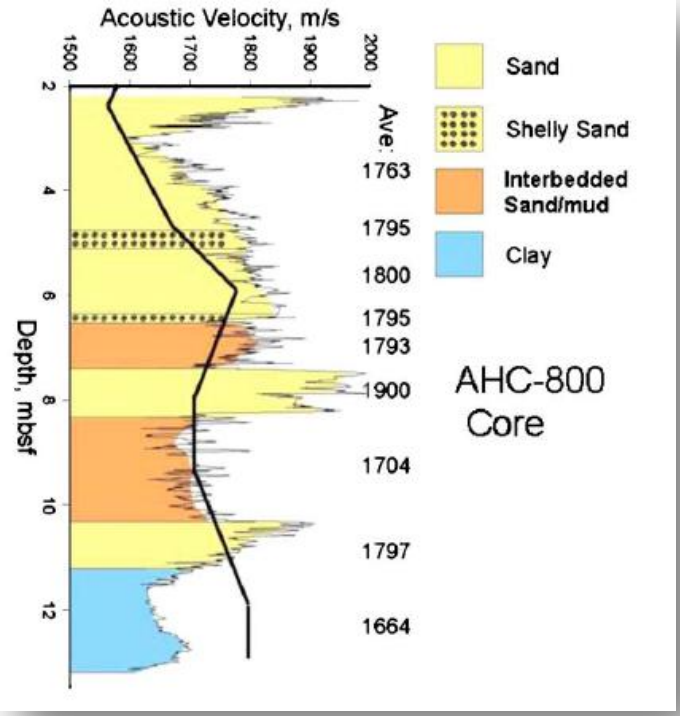
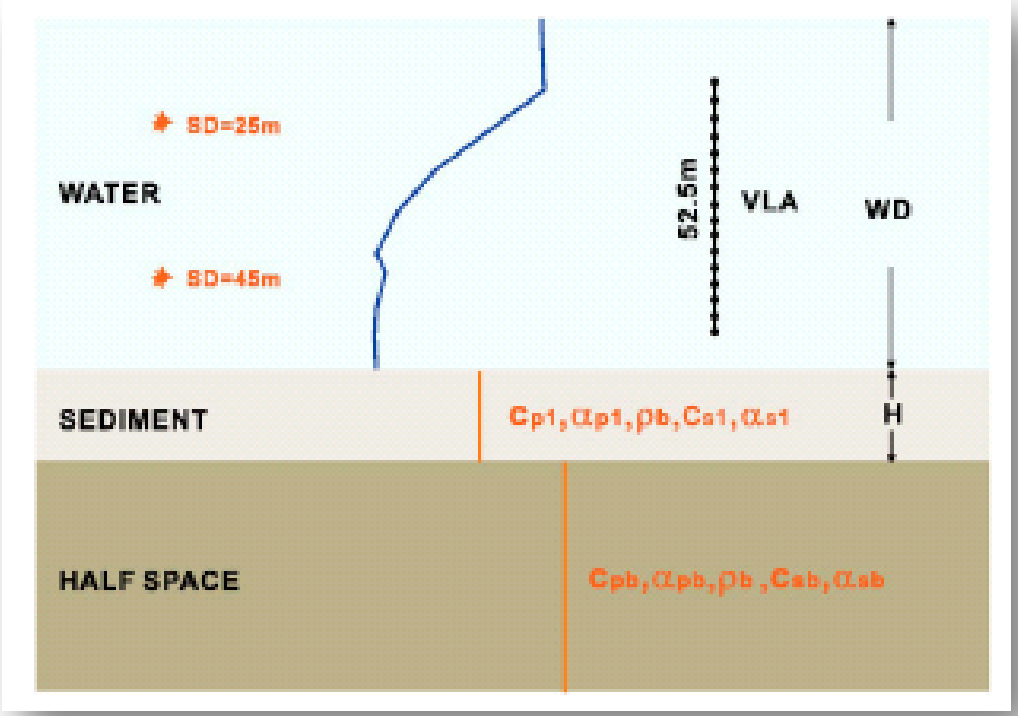
Modeling: Next steps

→ Modeling inputs for bathymetry and sediment properties to be taken from data and literature





G. R. Potty, J. H. Miller, P. S. Wilson, J. F. Lynch, A. Newhall, "Geoacoustic inversion using combustive sound source signals," J. Acoust. Soc. Am. **124**, EL150 (2008)

Y-M Jiang, N. R. Chapman, M. Badiey, " Quantifying the uncertainty of geoacoustic parameter estimates for the New Jersey shelf by inverting air gun data," J. Acoust. Soc. Am. **121**, 1879-1894 (2007)

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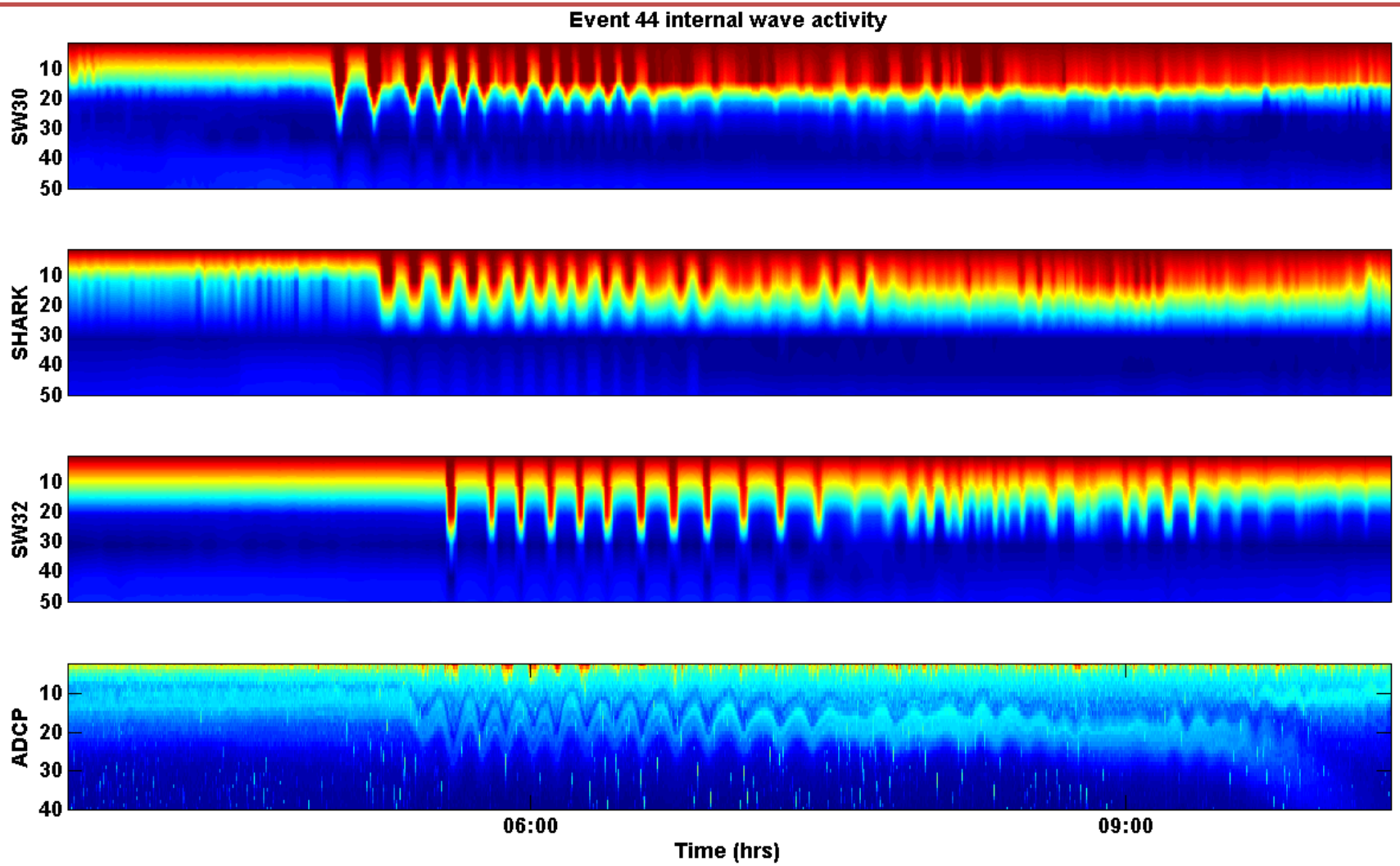
Modeling: Next steps

→ Creating 3D soundspeed profile requires interpolation from various moorings and sensors and code modification



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Conclusions & Future Work

R/V Sharp datasets

- Wealth of data from over 50 events across different bearings and ranges

Events 44, 46, 47

- Provide evidence of refraction – and 'ramping' of intensity measurements before arrival of IW
- Provide insight into depth dependence of intensity fluctuations associated with (or lack of) warm water bottom intrusions

Modeling

- Simple 3D model shows similar trends to measured data
- Next steps to include measured data to better portray actual environment

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Thank you