Applying the data nullspace projection method to the SW06 experiment data for bottom inversions

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- We have applied the data nullspace projection method to

  – bottom inversion using the sound of an ADCP battery pack explosion in the SW06 experiment,
  – Bayesian geoacoustic inversion using modal wavenumbers
  – bottom inversion using the J15-3 source signals (cooperate with Kyle Becker and Megan Ballard)

Introduction

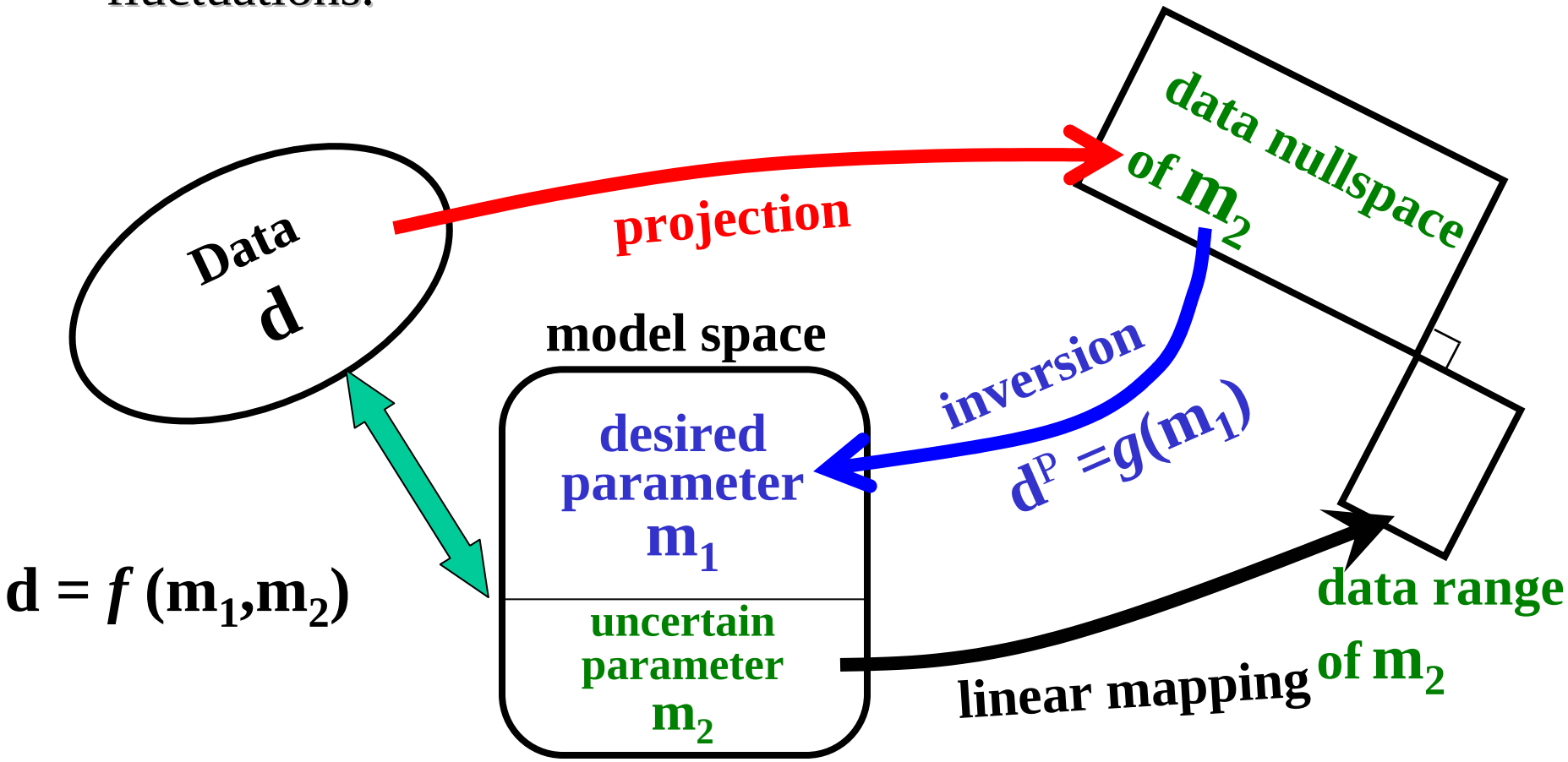
- Environmental model mismatch caused by uncertain/random water-column fluctuations can degrade the performance bottom inversions.

- The data nullspace projection method has been developed to reduce the bottom inversion errors caused by uncertain water-column fluctuations.

- EOF statistics of water-column fluctuations are used to determine the data nullspace.

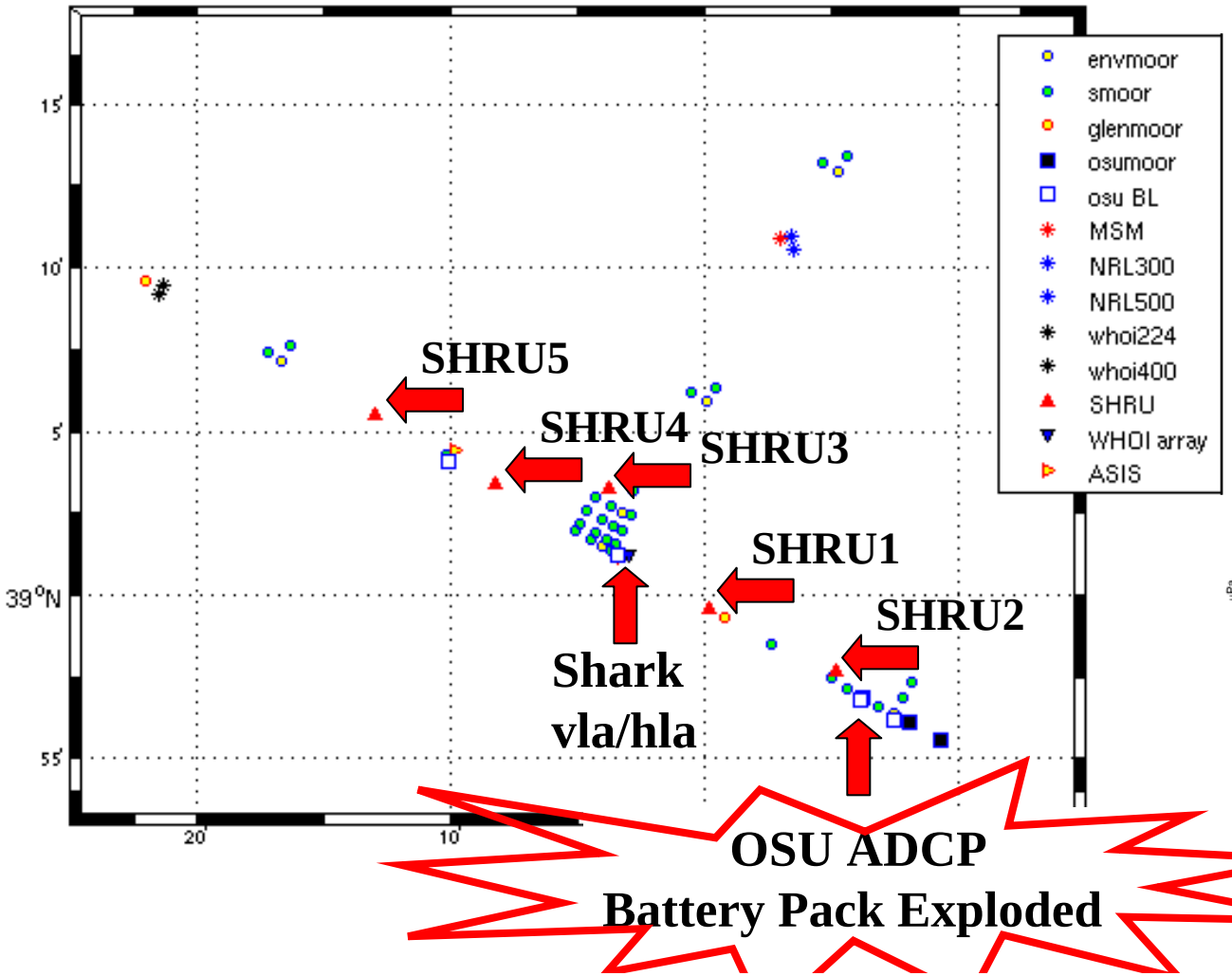
What is data nullspace projection?

- This method is designed to expose the desired information (bottom properties) by projecting the acoustic signal onto a subspace that is insensitive to uncertain/random water-column fluctuations.

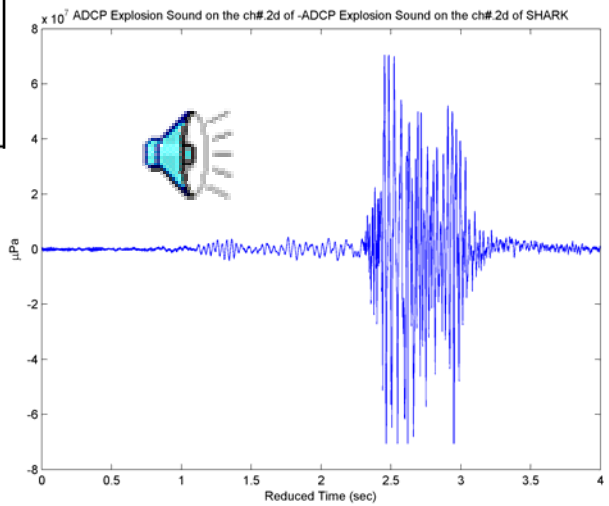


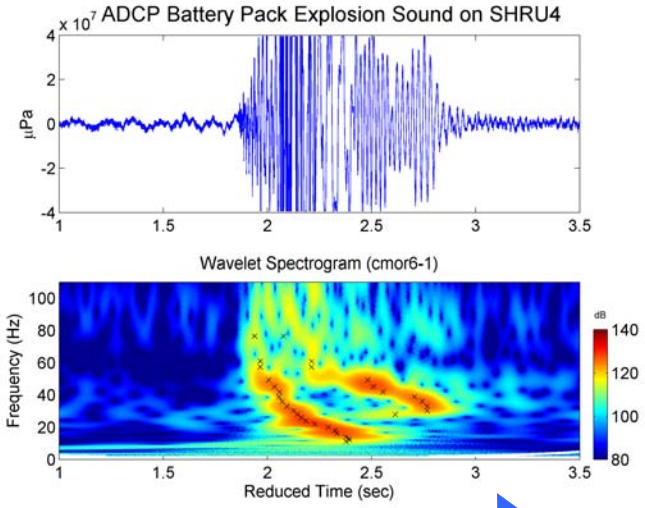
Bottom Inversion from the Sound of an ADCP Battery Pack Explosion* in the SW06 Experiment

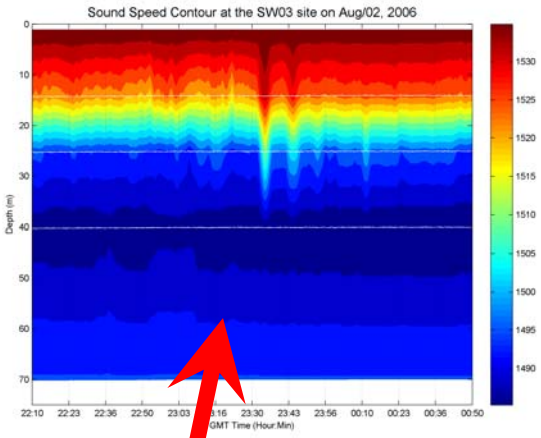
* J. Moum, J. Nash and M. Levine, OSU

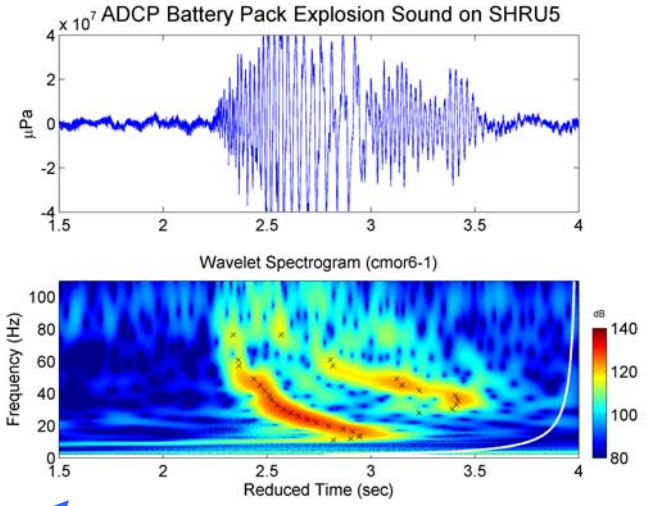


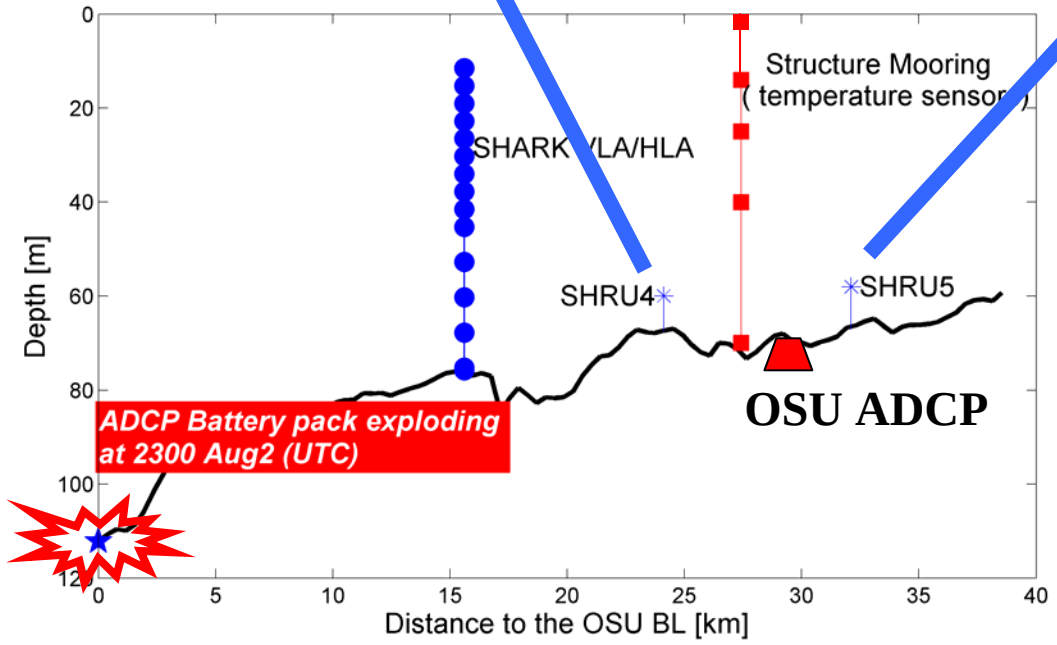
Sound recorded on one of hydrophones on SHARK HLA




x 10^7 ADCP Battery Pack Explosion Sound on SHRU4
μPa
Wavelet Spectrogram (cmor6-1)
Frequency (Hz)
Reduced Time (sec)
dB


Sound Speed Contour at the SW03 site on Aug/02, 2006
Depth (m)
GMT Time (Hour:Min)


x 10^7 ADCP Battery Pack Explosion Sound on SHRU5
μPa
Wavelet Spectrogram (cmor6-1)
Frequency (Hz)
Reduced Time (sec)
dB

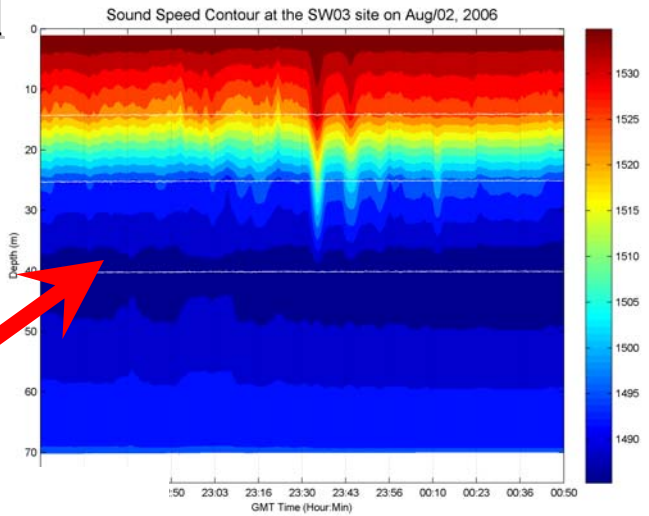

Structure Mooring
(temperature sensor)
SHARK /LA/HLA
SHRU4
SHRU5
OSU ADCP
ADCP Battery pack exploding
at 2300 Aug2 (UTC)
Depth [m]
Distance to the OSU BL [km]

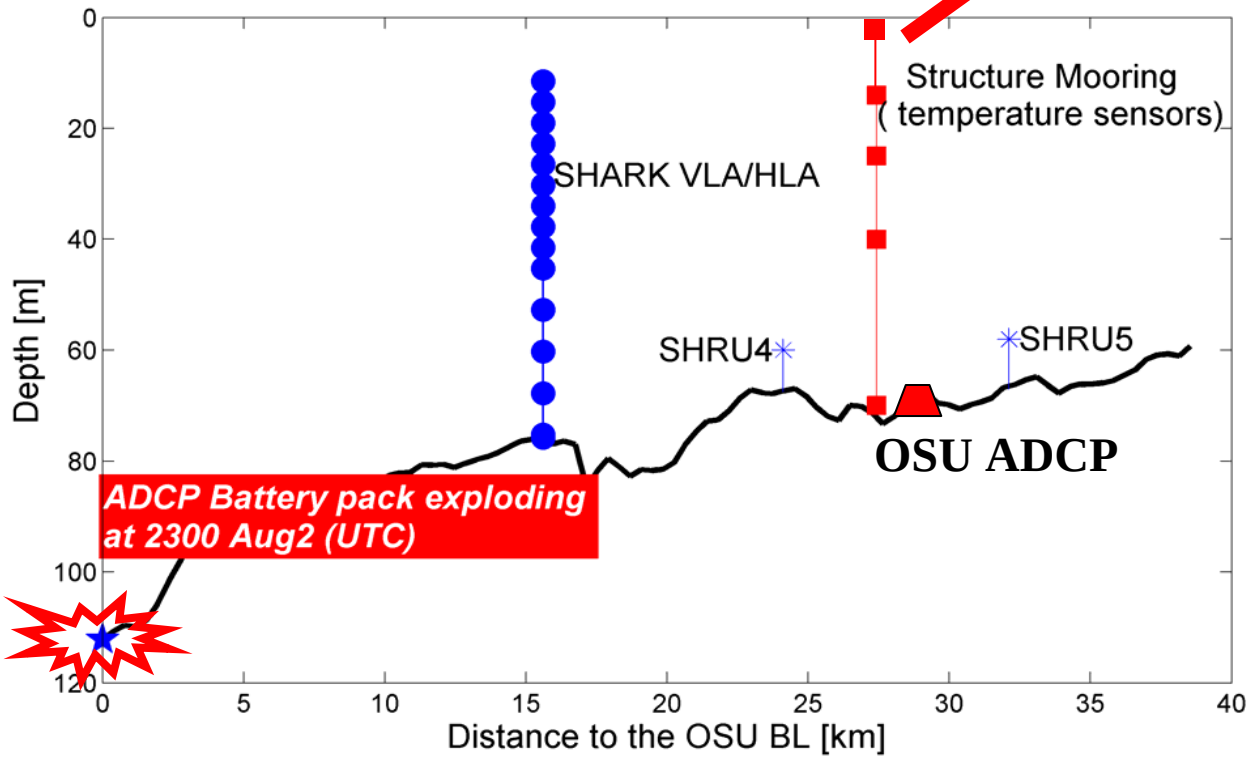
Bottom Inversion using an "Exact" Reconstructed Water Column Sound-speed Field

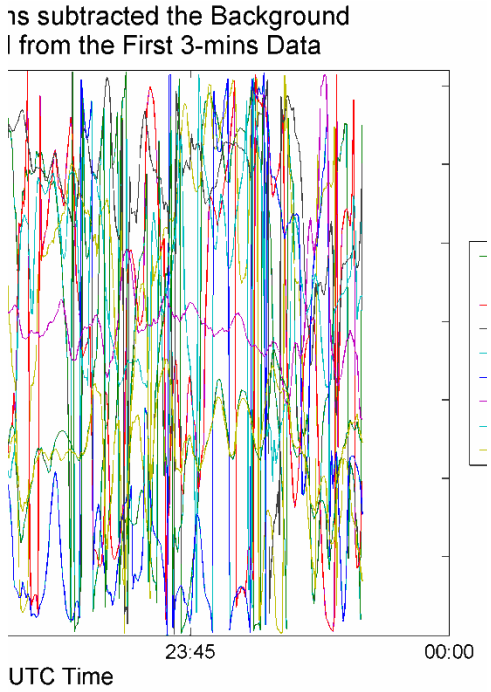
— Sound-speed field reconstruction

OSU ADCP Data

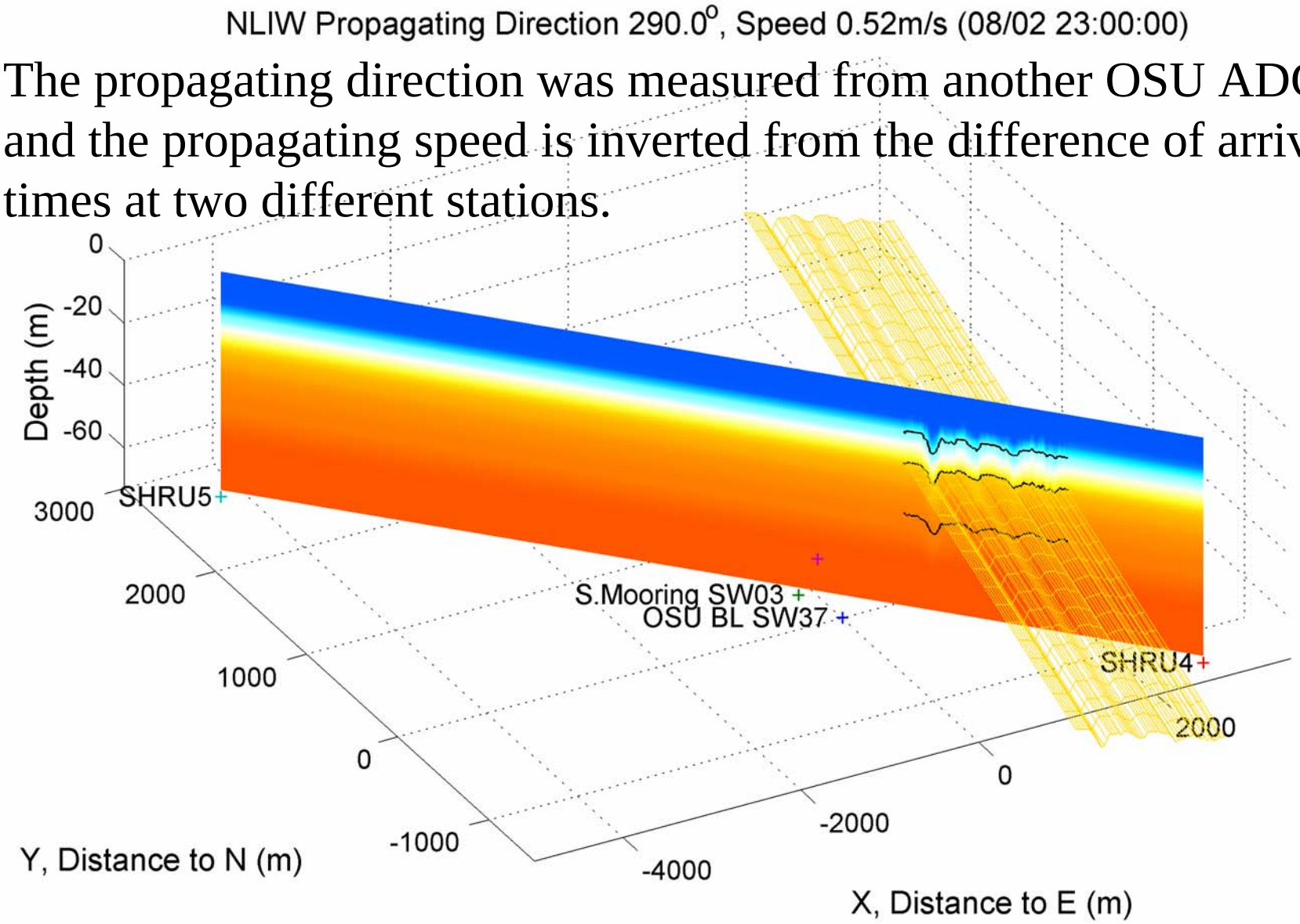
*** Courtesy of J. Moum and J. Nash, OSU**







Reconstructed Water Column Sound-speed Field

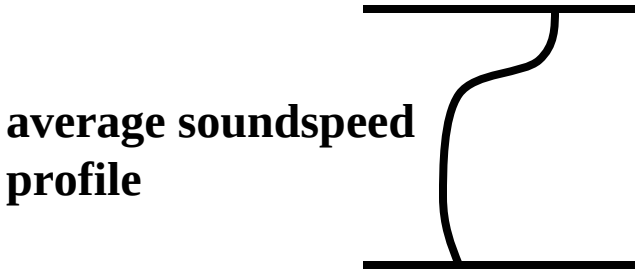


The propagating direction was measured from another OSU ADCP, and the propagating speed is inverted from the difference of arrival times at two different stations.

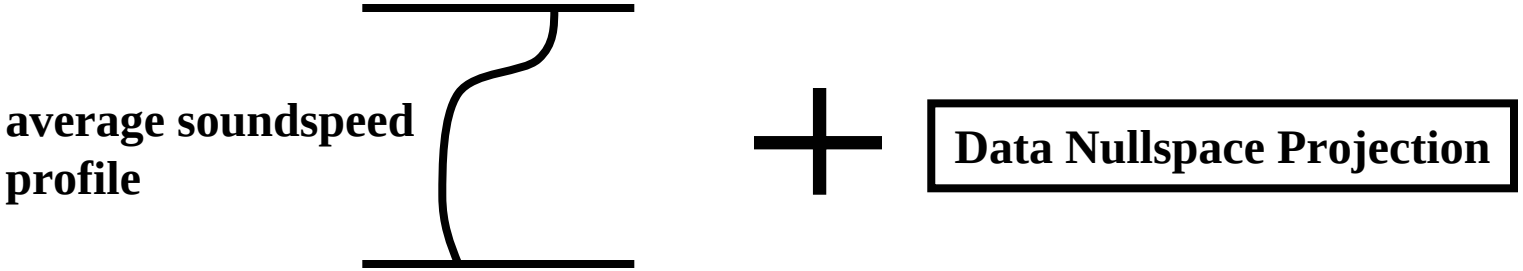
Geoacoustic Perturbative Inversion

Three inversion schemes are taken.

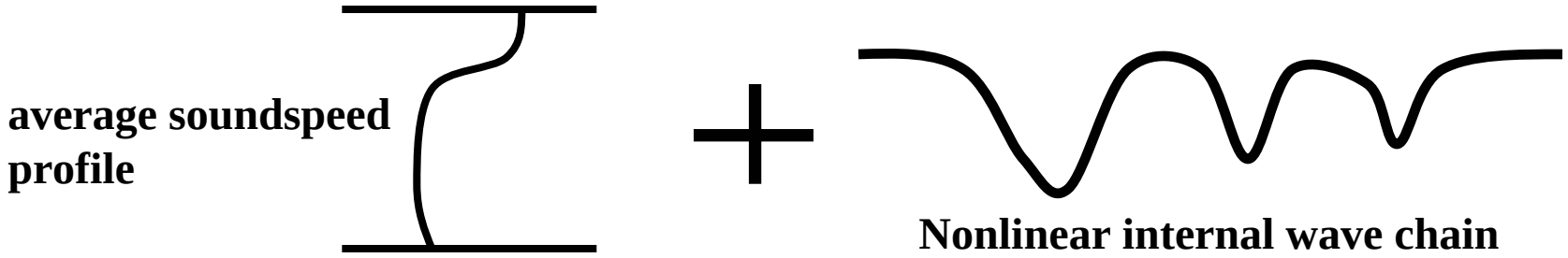
(1) *Inversion with Average Water-column Sound Speed Profile*



(2) *Inversion with Data Nullspace Projection*

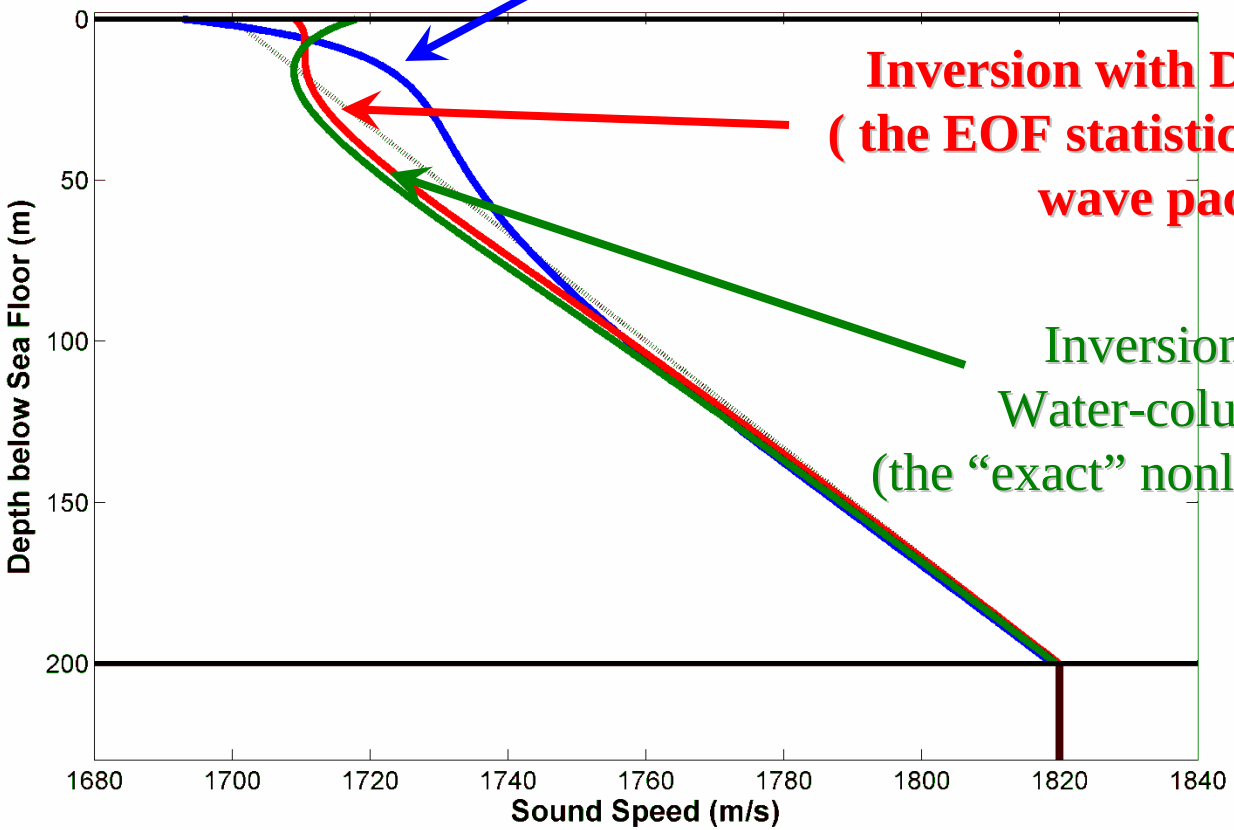


(3) *Inversion with Reconstructed Water-column Sound-speed Field*



Range-Averaged Bottom Sound Speed Inversion using Modal Group Velocity

Inversion with Average Water-column Sound Speed Profile
(the nonlinear internal wave packet is neglected)



Inversion with Data Nullspace Projection (the EOF statistics of the nonlinear internal wave packet are utilized)

Inversion with Reconstructed Water-column Sound-speed Field (the “exact” nonlinear internal wave packet is considered)

Summary

- The data nullspace projection method is applied to a bottom inversion using an explosive sound in the SW06. A comparison with an inversion using an “exact” reconstructed water-column sound-speed field confirms the validity of this method.

Work in Progress

- Applying the projection method to Bayesian geoacoustic inversion using modal wavenumbers.
- Bottom inversion using the J15-3 source signals of Modal Inverse Method Experiment in the SW06 ,cooperate with Kyle Becker and Megan Ballard.
- Applying the projection method to other inverse problems and acoustic signal processing in the dynamic ocean.