Studies of large- and fine-scale atmospheric structure using dense seismic networks

Michael A.H. Hedlin[1] and Doug Drob[2]
[1] Laboratory for Atmospheric Acoustics, U.C. San Diego
[2] Upper Atmospheric Physics Section, NRL

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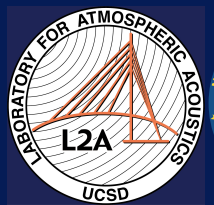
This talk

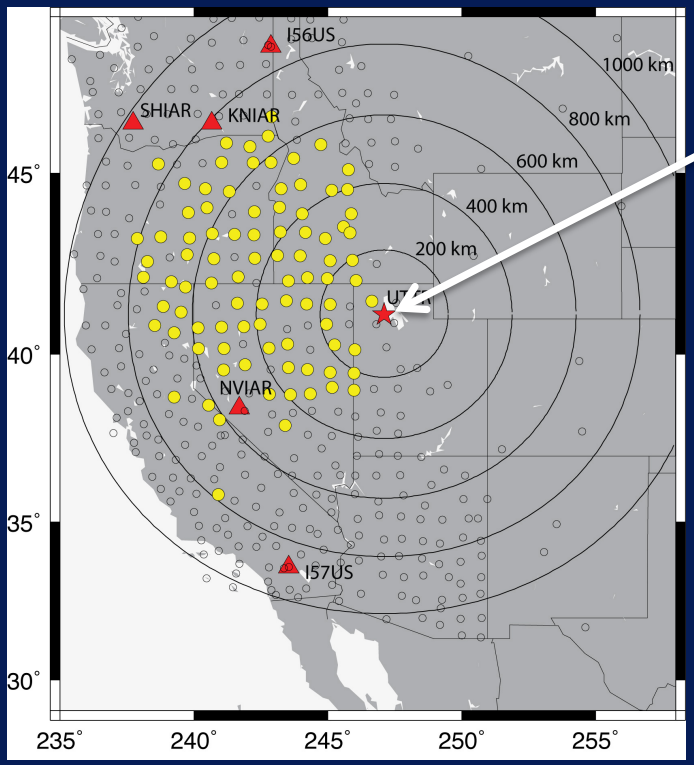
- Focus on four things:
  - ① Used dense seismic network data to study the spatial extent of infrasound branches and signal dispersion
  - ② Signals from ground-truthed explosions
  - ③ Model recordings using rays
  - ④ Consider two types of models
    - Ambient background model (G2S)
    - G2S with realizations of gravity waves



Spatial sampling

USArray TA in June, 2007

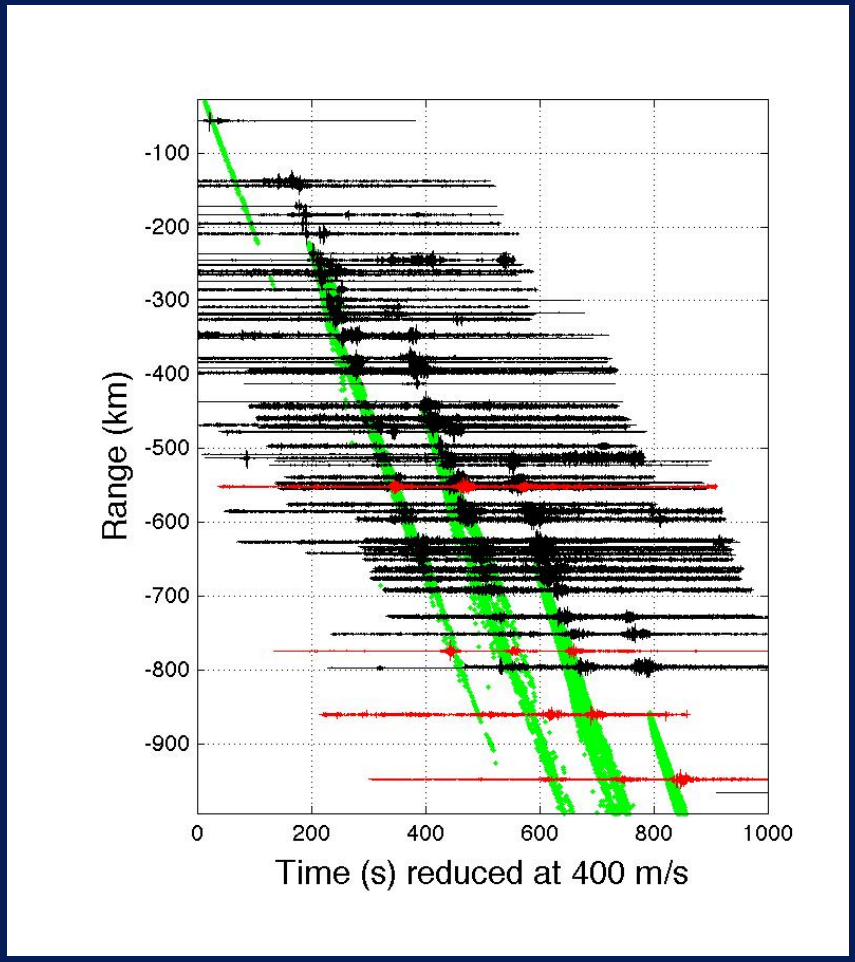
First event: Focus on spatial extent of wavefield

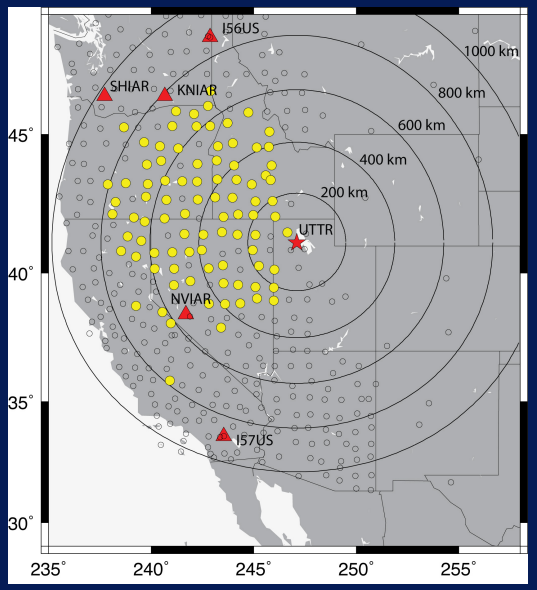


17,651 kg blast on June 11, 2007

UTTR explosion recorded by TA and four infrasound arrays

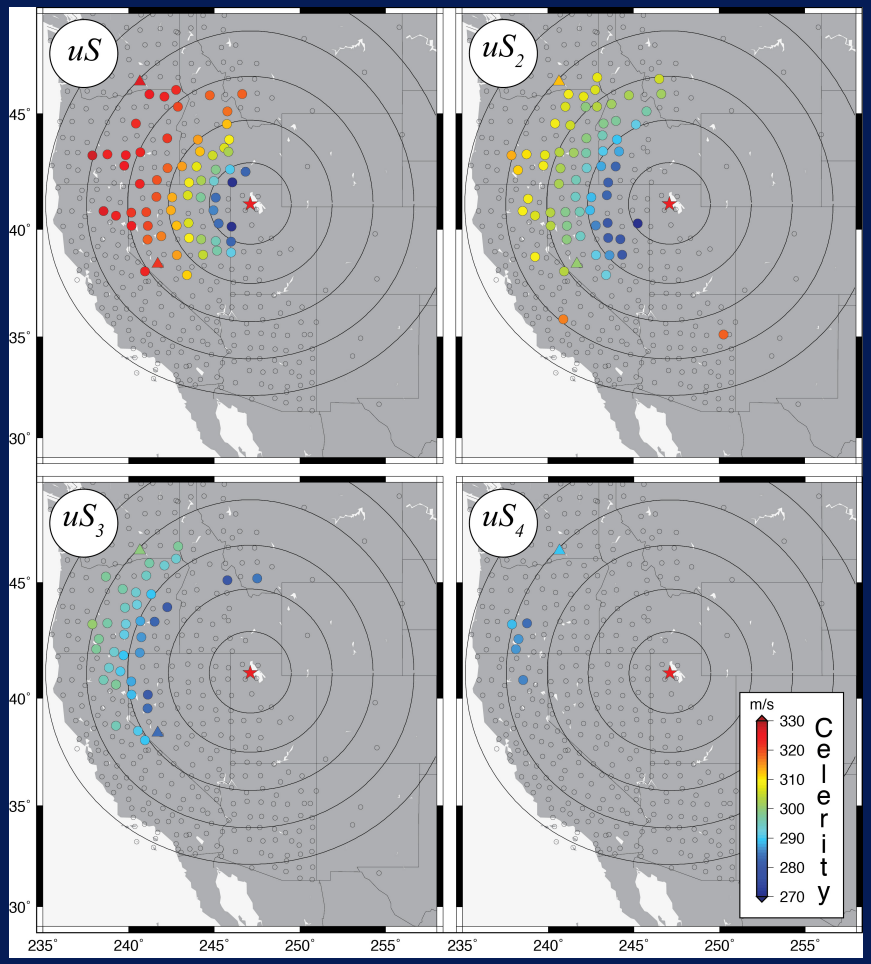
Sub thermospheric rays vs data



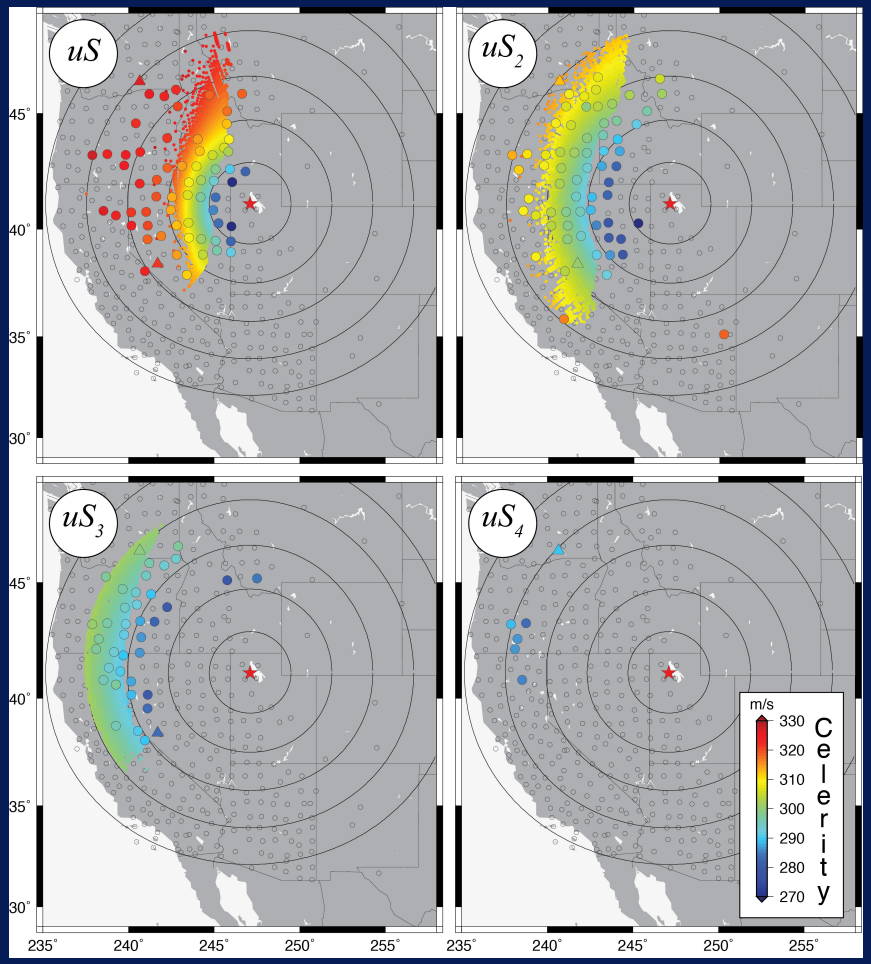


Vertical components 0.8 – 3.0 Hz BP

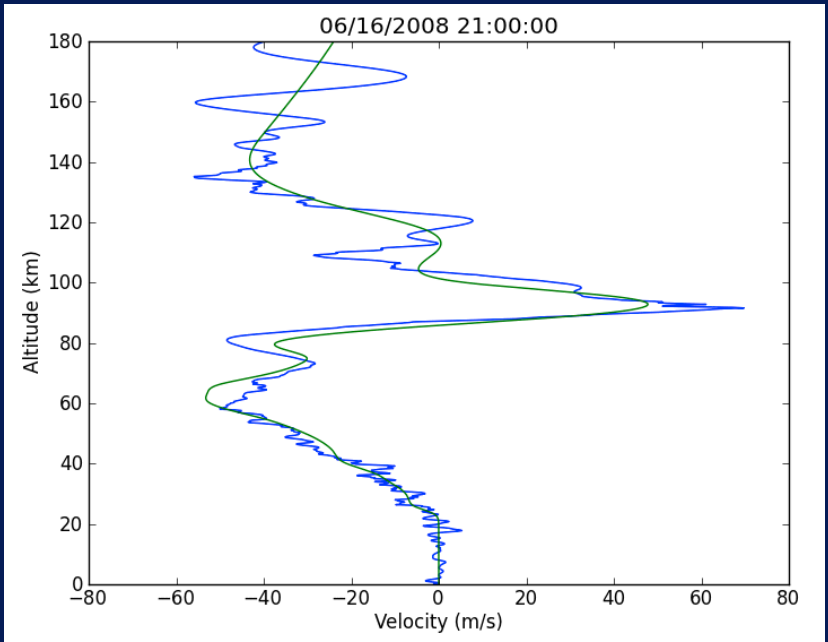
Maps of the four branches



Added rays through background G2S

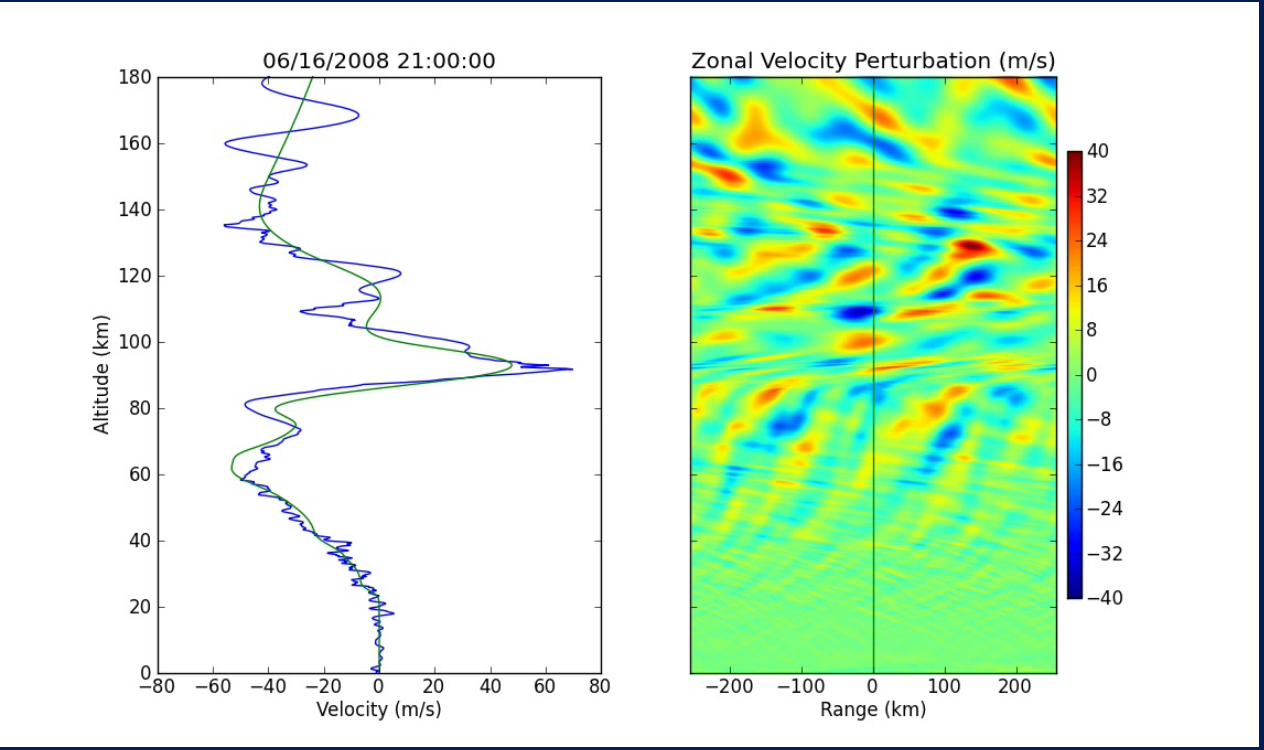


Drob et al. Gravity Wave Model



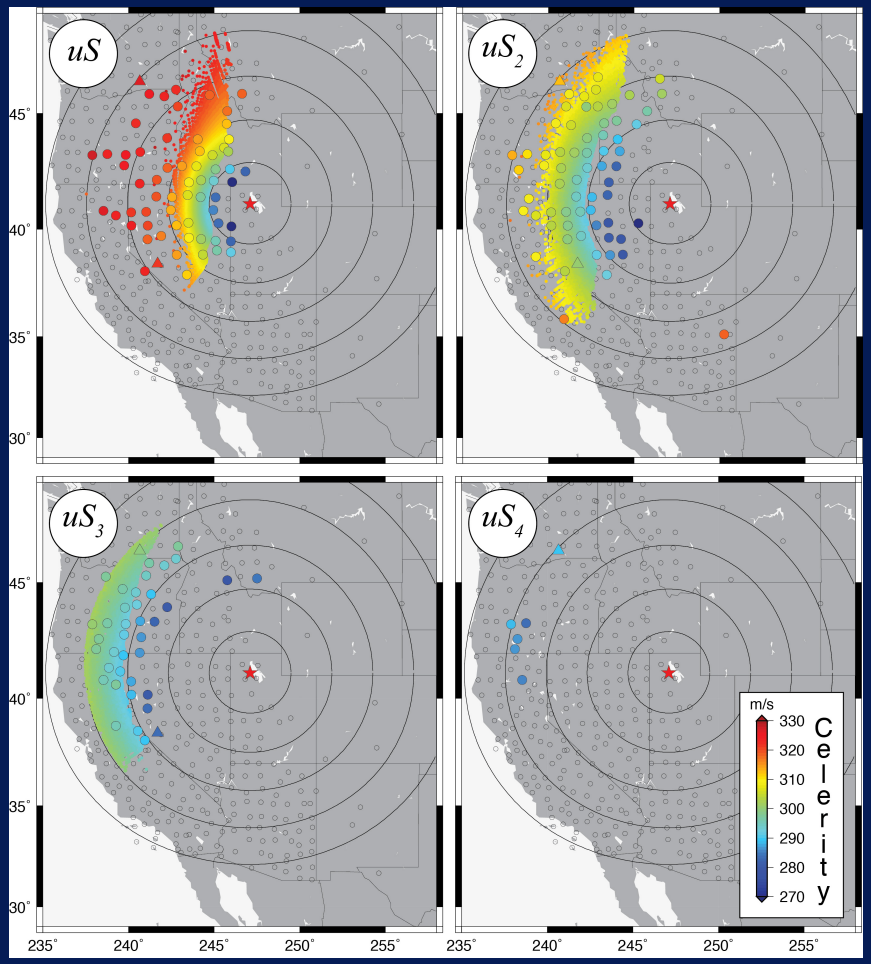
Drob and colleagues developed method to propagate gravity waves through atmosphere and add to background G2S

It is time dependent

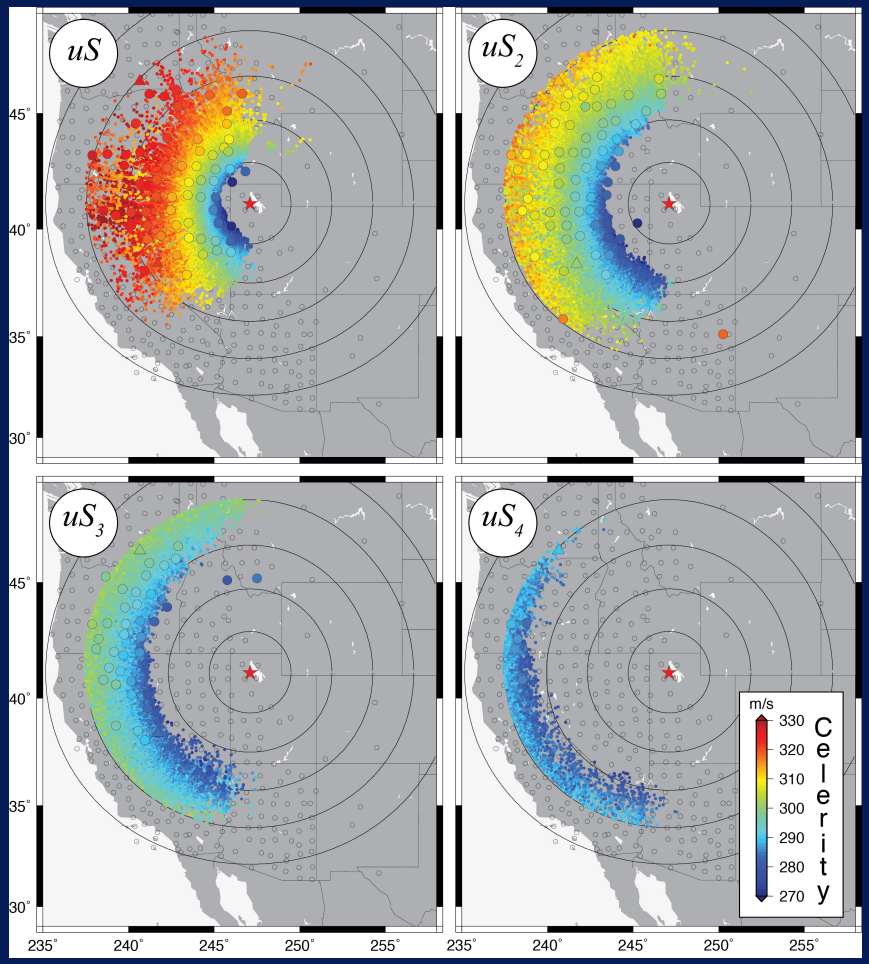


Zonal velocity perturbation

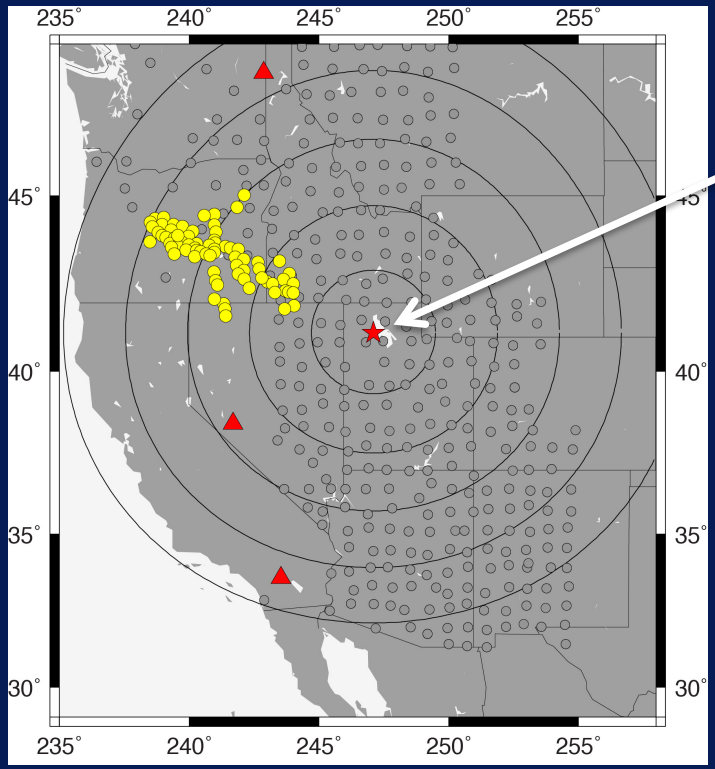
Before adding perturbations …



… and after (one realization of gravity waves)



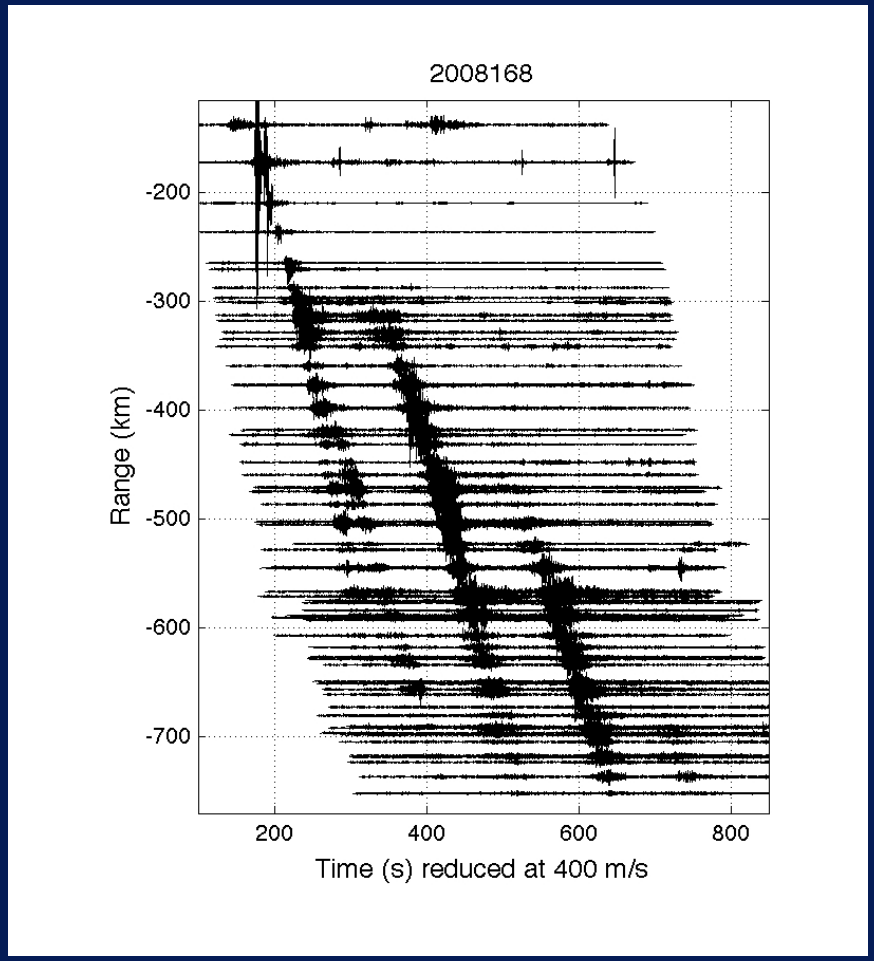
Second event: Focus on signal dispersion

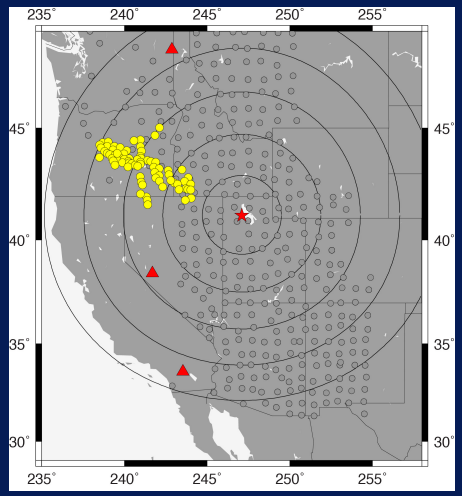


17,957 kg blast on June 16, 2008

Recorded in 2008 by dense network at 300° and part of TA

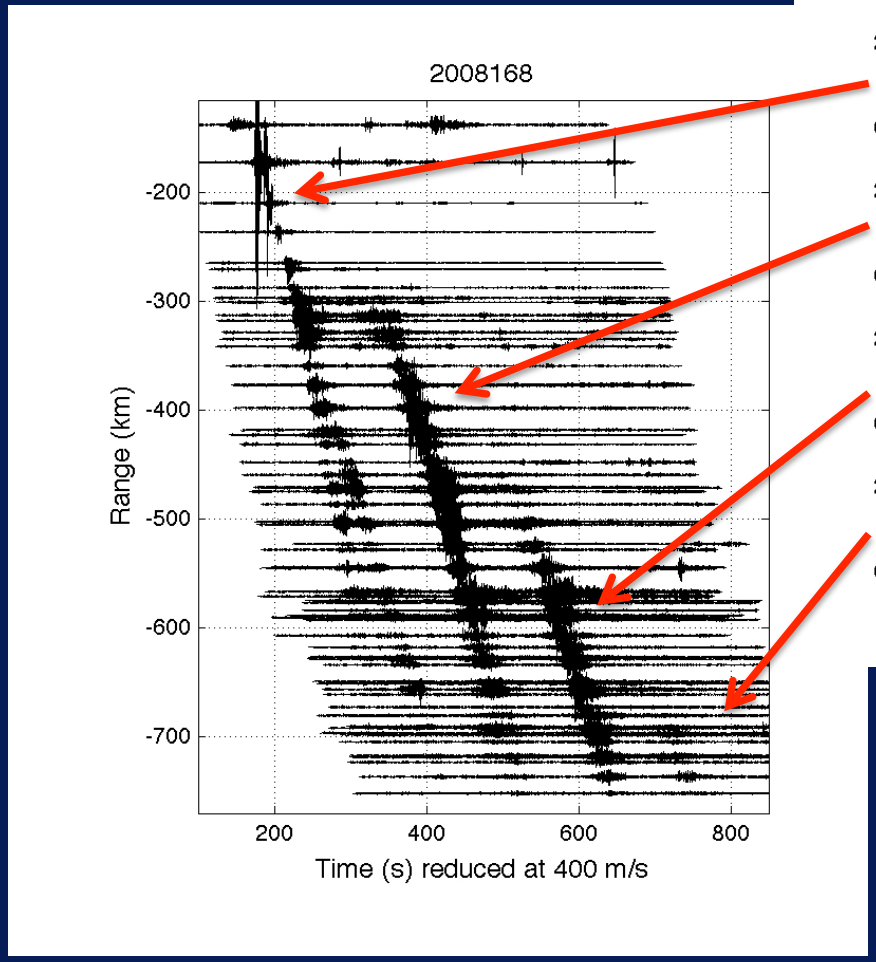
150-km wide corridor at 300°

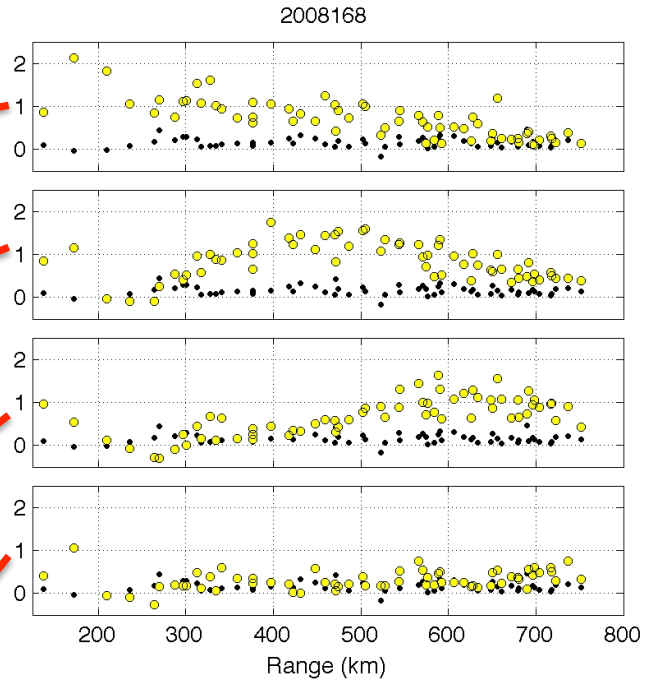




Vertical components 0.8 – 3.0 Hz BP

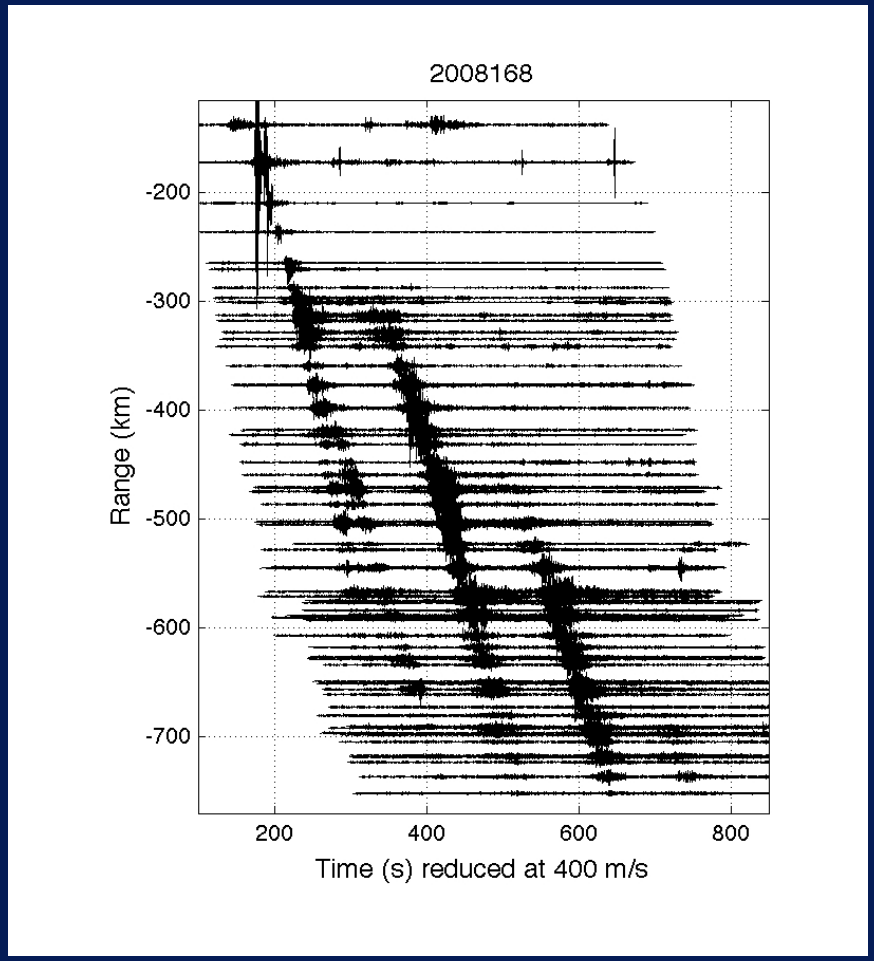
150-km wide corridor at 300°

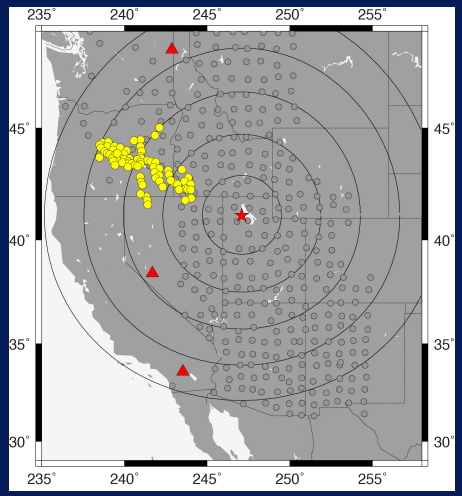




Vertical components 0.8 – 3.0 Hz BP

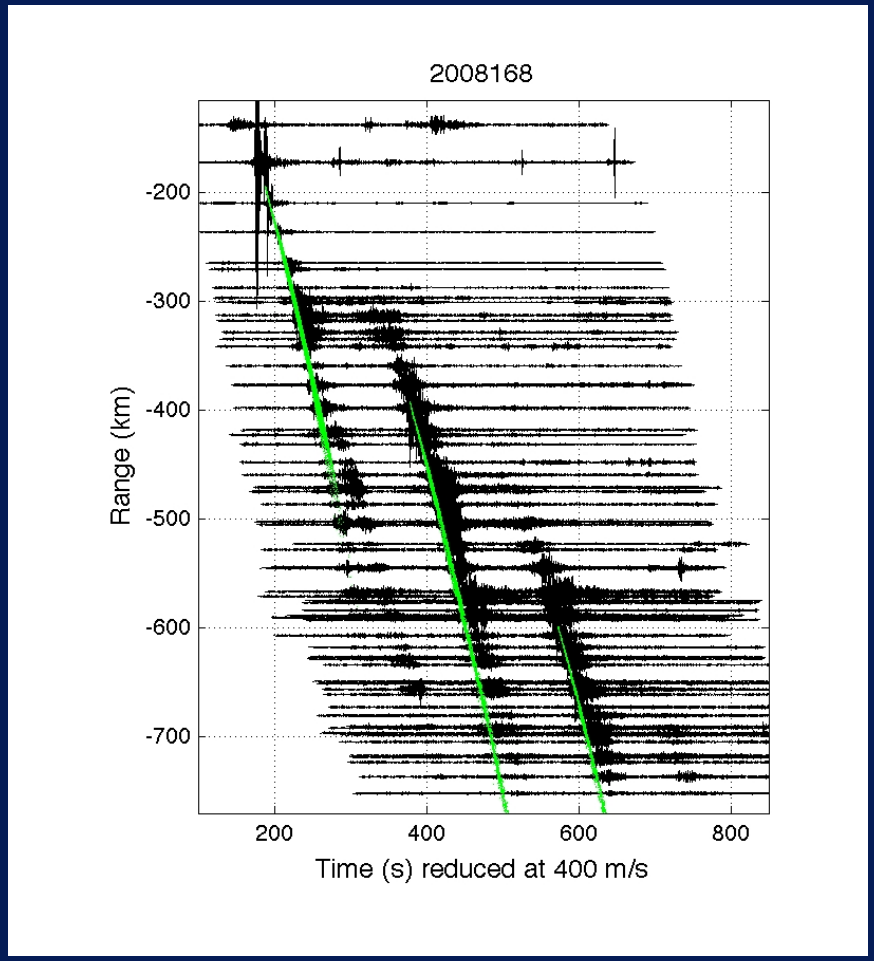
150-km wide corridor at 300°

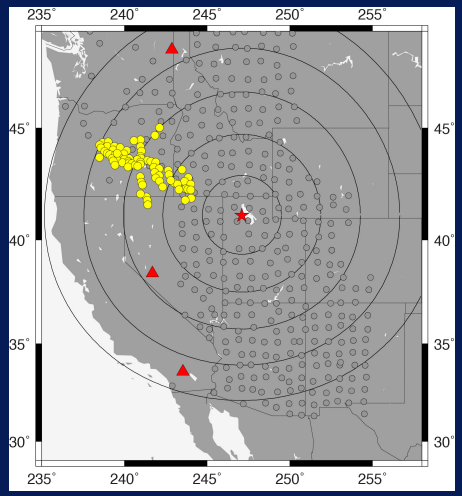




Vertical components 0.8 – 3.0 Hz BP

Added rays shot through background atmospheric specs.

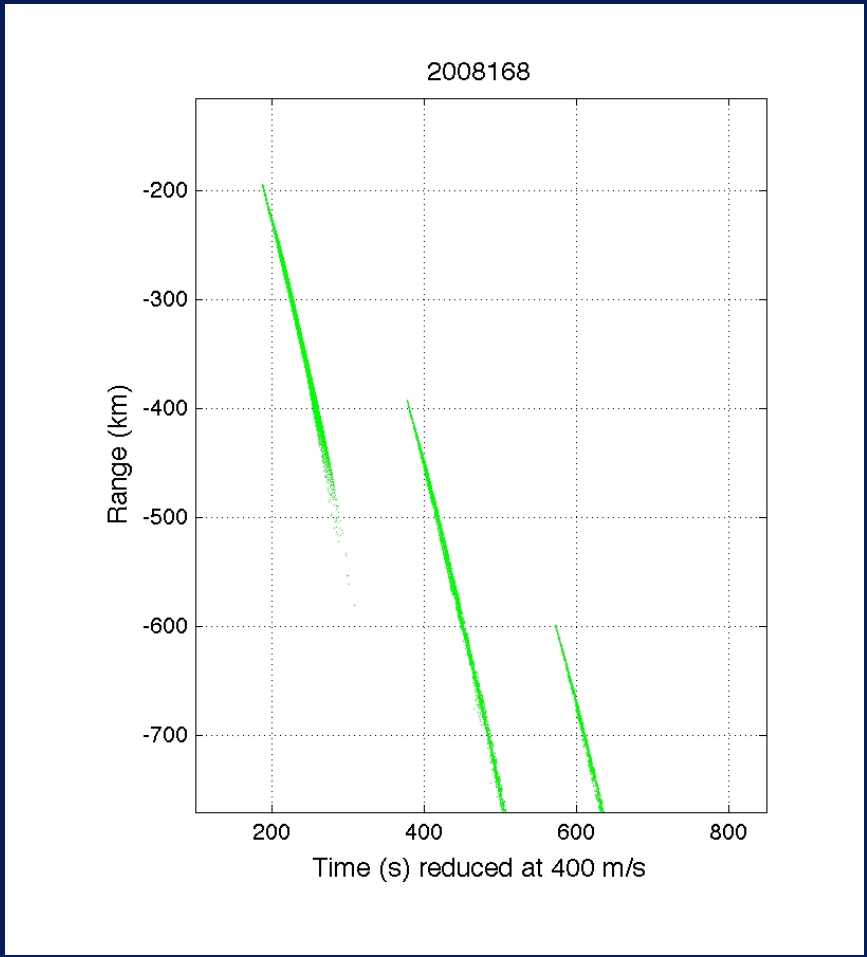


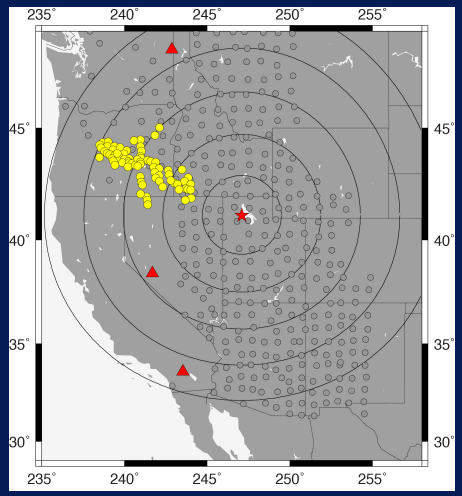


LABORATORY FOR ATMOSPHERIC ACOUSTICS
L2A
UCSD

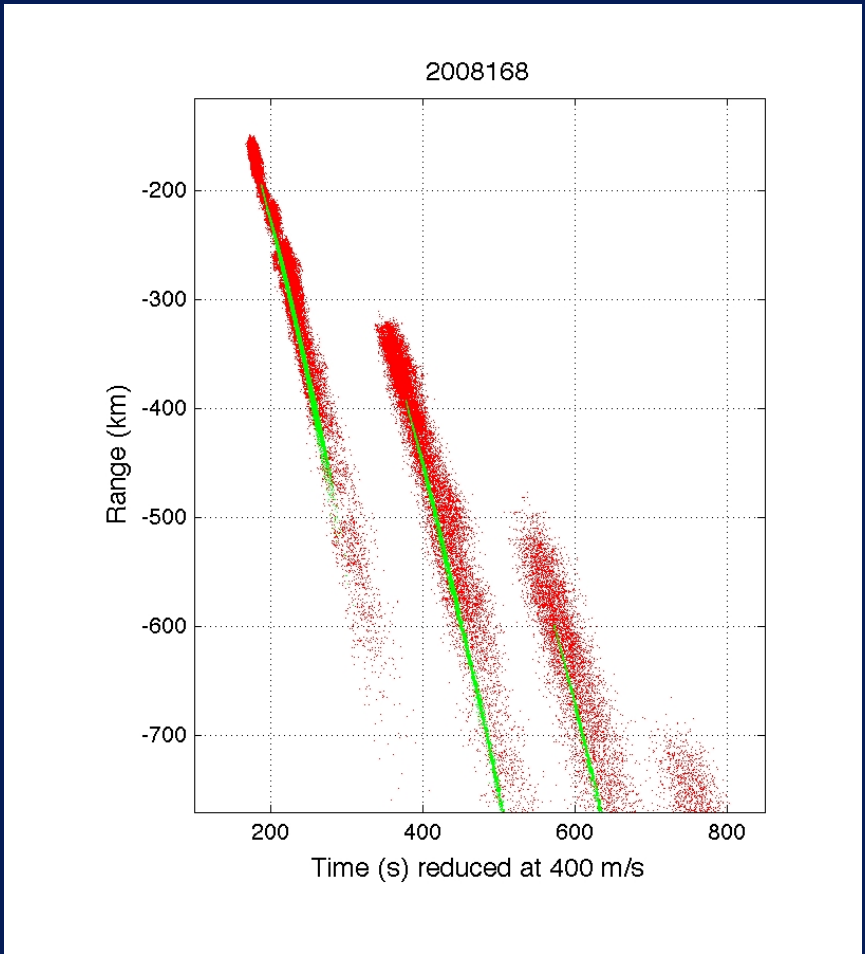
NAVAL RESEARCH LABORATORY
WASHINGTON, DC

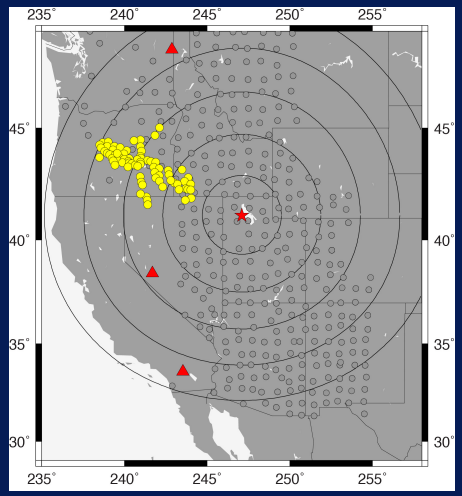
Rays through background model



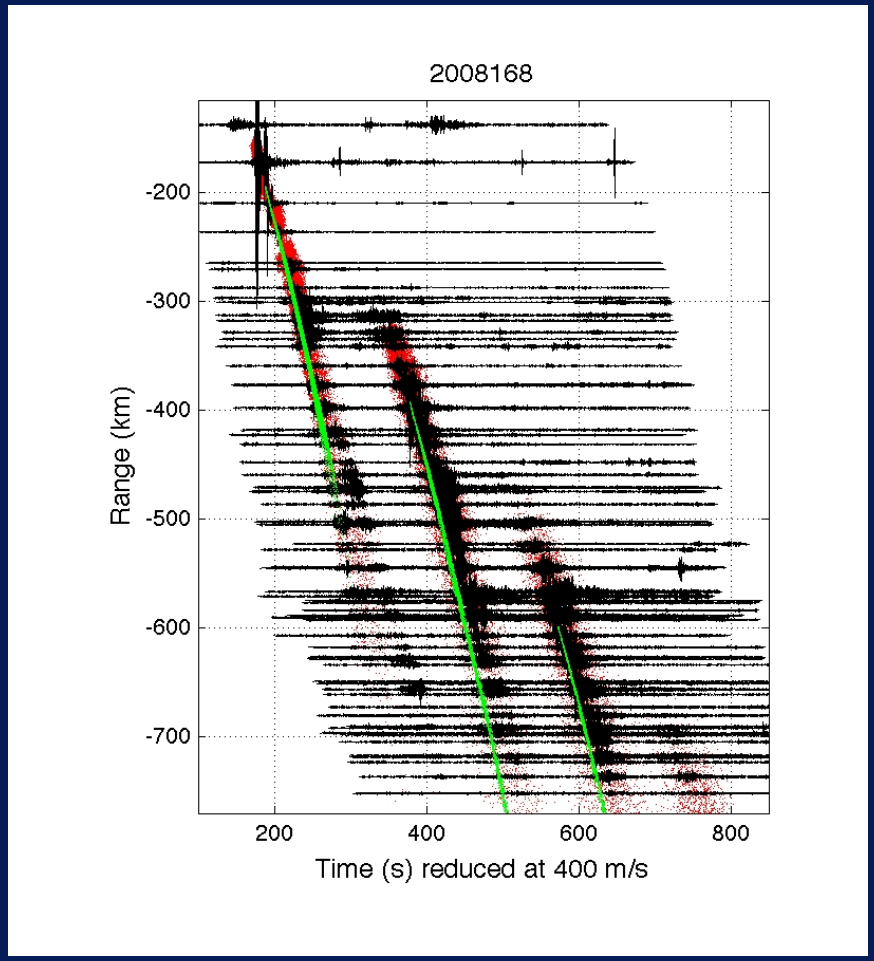


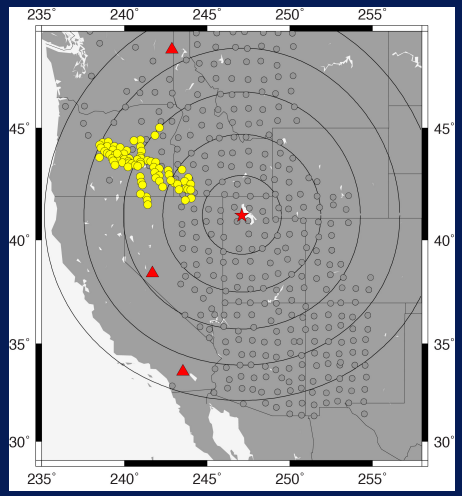
Rays through perturbed model added



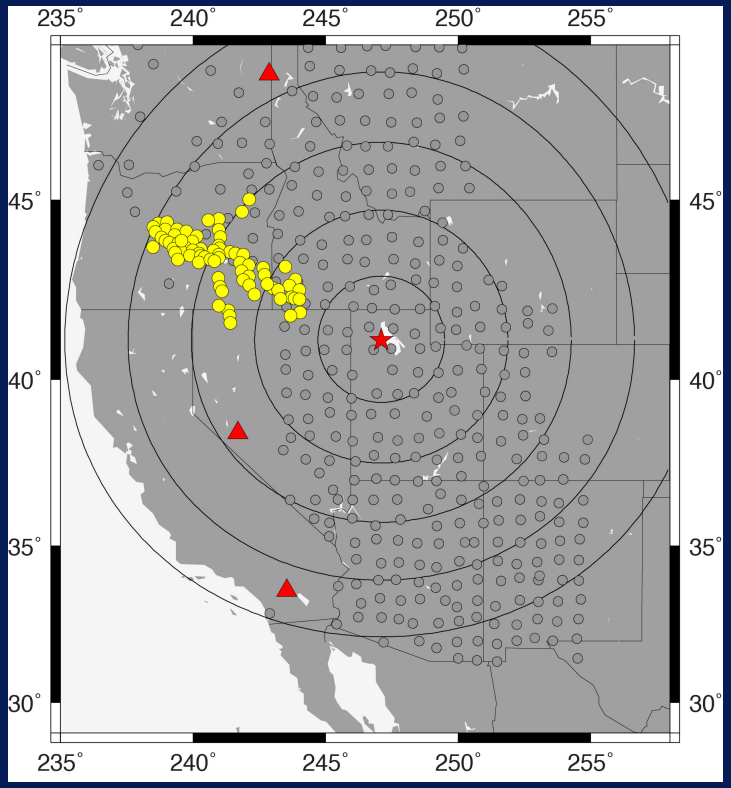


Rays and data



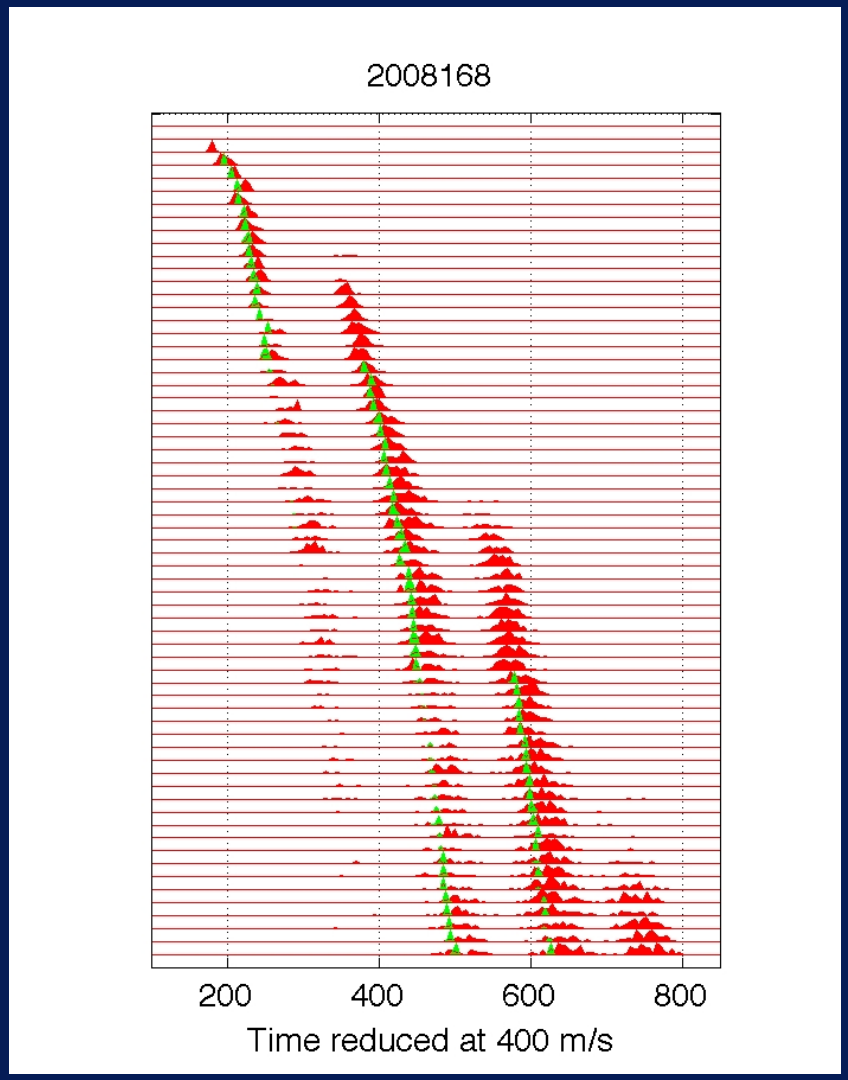


Ray statistics



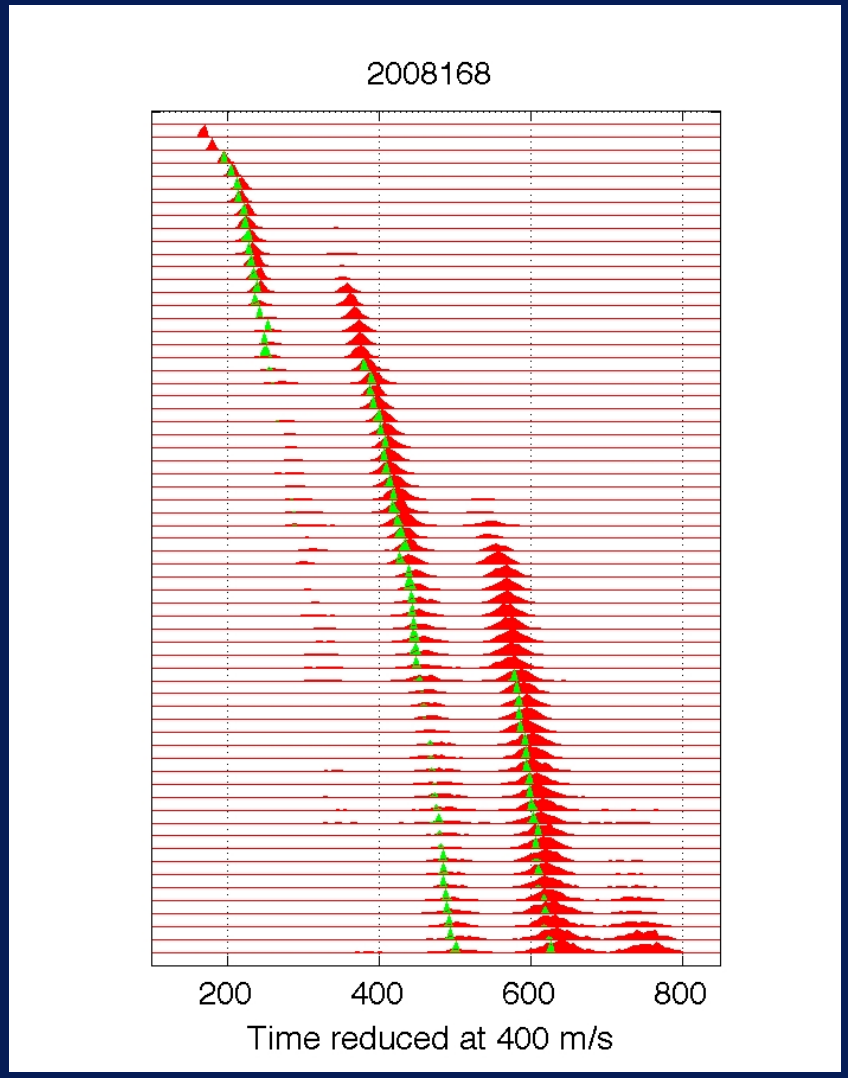
- Circular bin around each station
- Adjust travel time of each ray for range
- Compute histogram of ray arrival times for each realization

Ray statistics - one realization



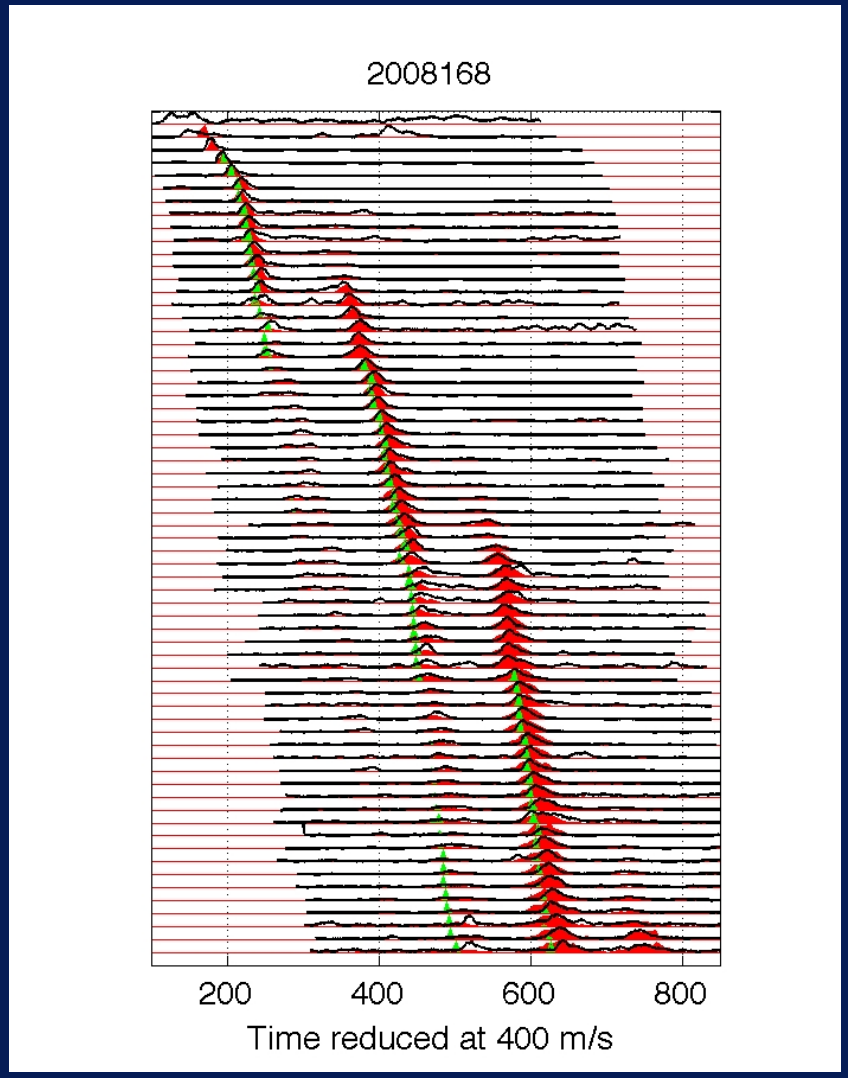
- Histograms of rays through background model (Green) vs rays through gravity wave perturbed model (Red)

Ray statistics



- Average of ten realizations

Ray statistics



- Rays vs envelopes of recorded data

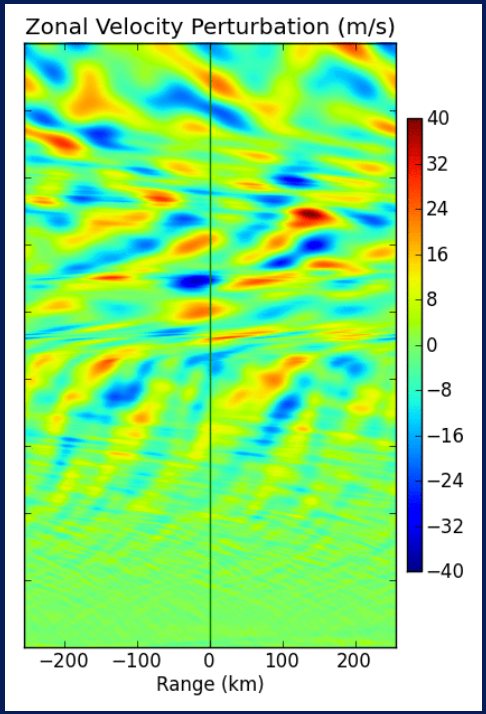
Key findings of study

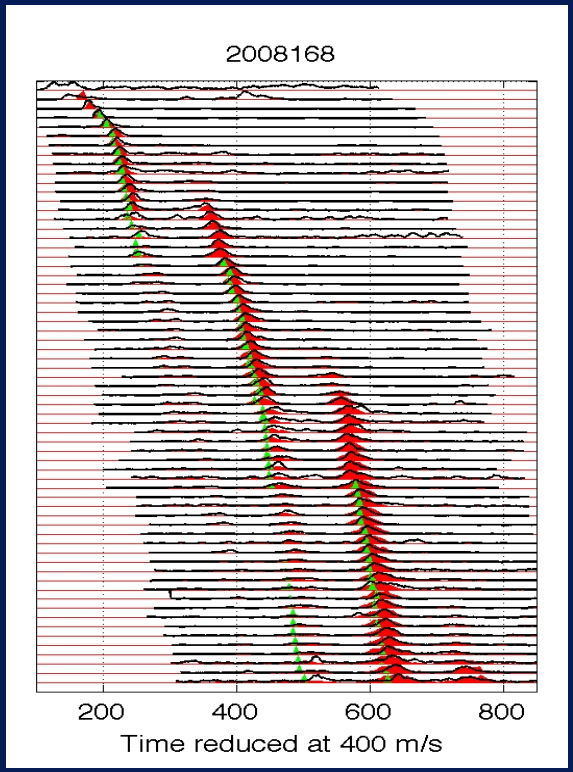
① Data validate large-scale background atmospheric specs

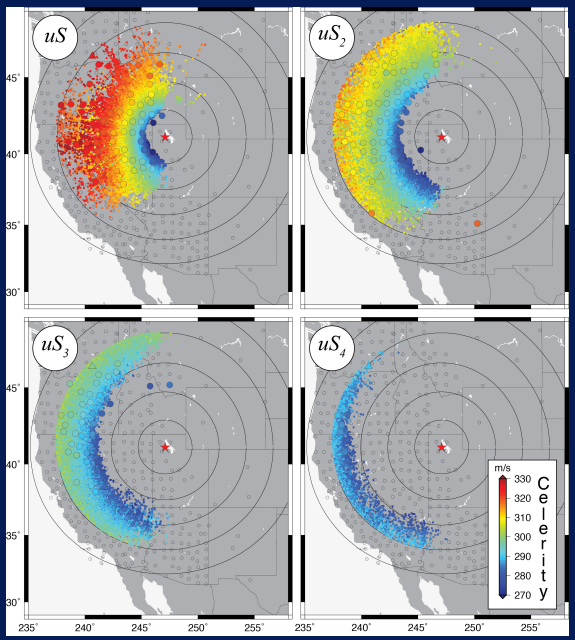
② Rays shot through background G2S do not match signal dispersion or spatial spread of any branch

③ Rays shot through perturbed background model accurately predict signal amplitude variation with time, sound penetration into shadow zones near source and away from source

One perturbed atmospheric model







Fits independent aspects of the data – dispersion in t, spread in x,y

Key findings of study

① Data validate large-scale background atmospheric specs

② Rays shot through background G2S do not match signal dispersion or spatial spread of any branch

③ Rays shot through perturbed background model accurately predict signal duration, amplitude variation with time, sound penetration into shadow zones near source and away from source

④ Duration of signals and spatial distribution from seismic data sensitive to amplitude and length scales of the gravity waves

Acknowledgements

- IRIS-DMC for USArray TA data and HLP data
- Matt Fouch (ASU) and David James (Carnegie) for access to HLP data
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- NOAA's GFS