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Title: Infrasound Overview

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# Infrasound Overview

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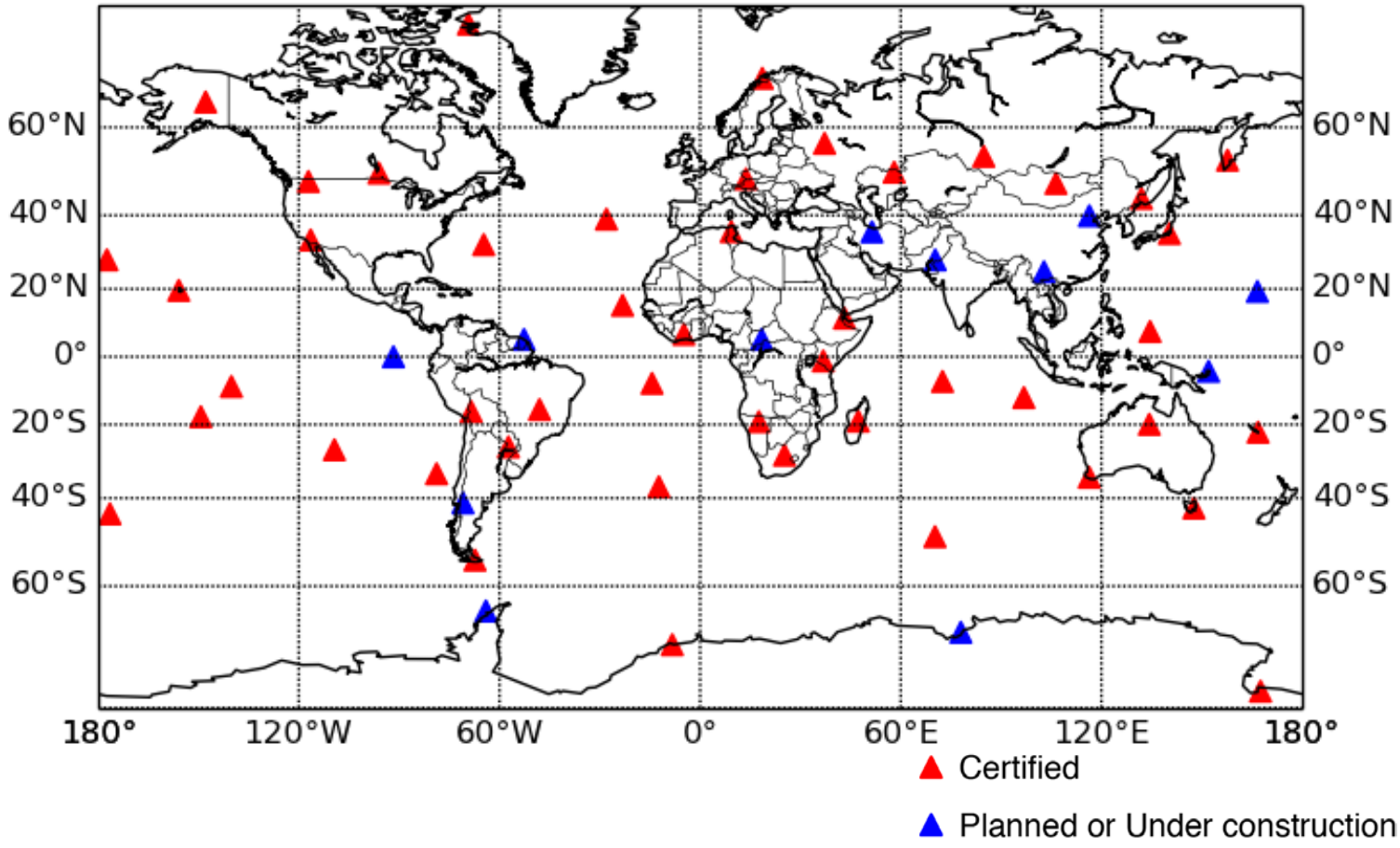
July 17, 2014

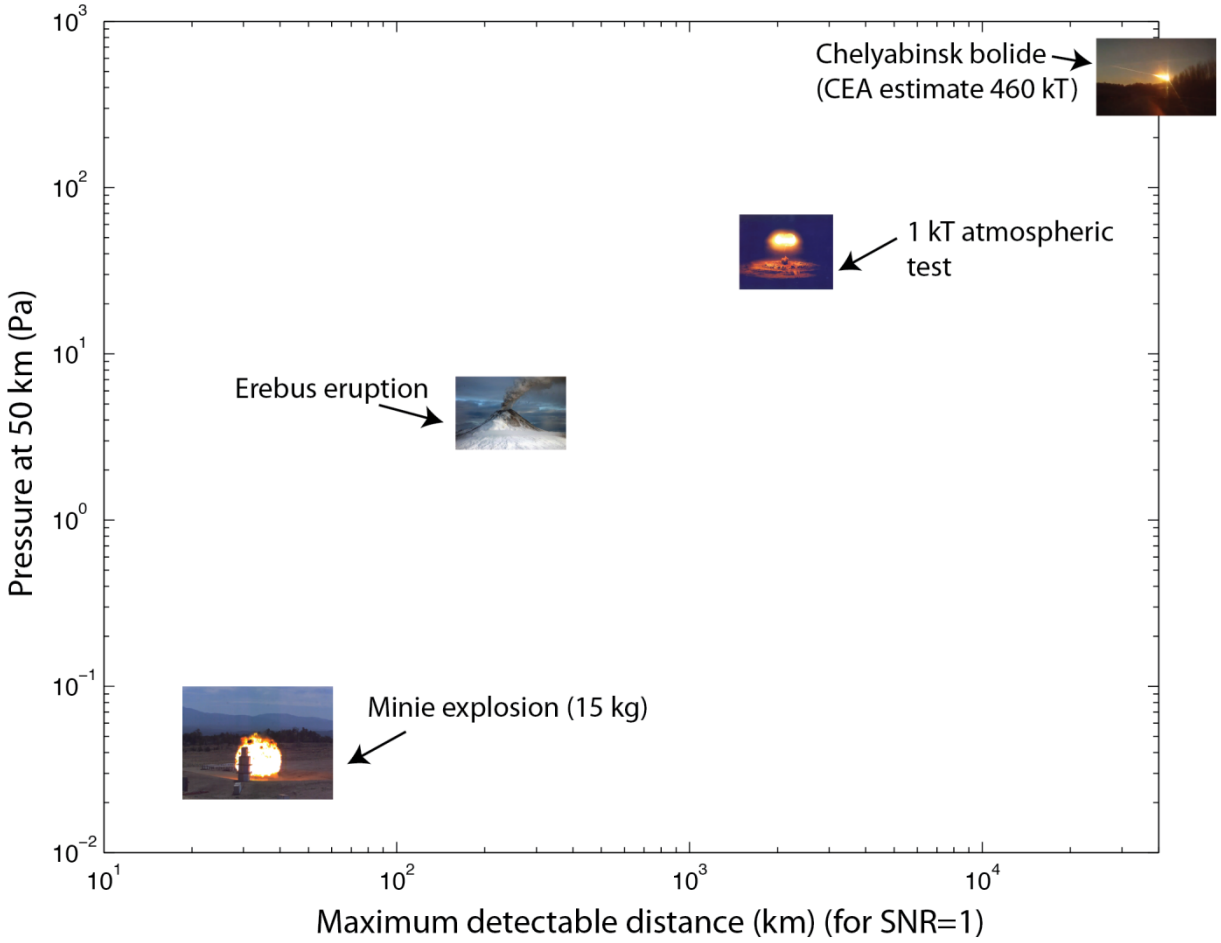
# Overview

- Existing capability with ground-based sensors
- Modeling solid earth/atmosphere coupling

# Infrasound: Global IMS Network

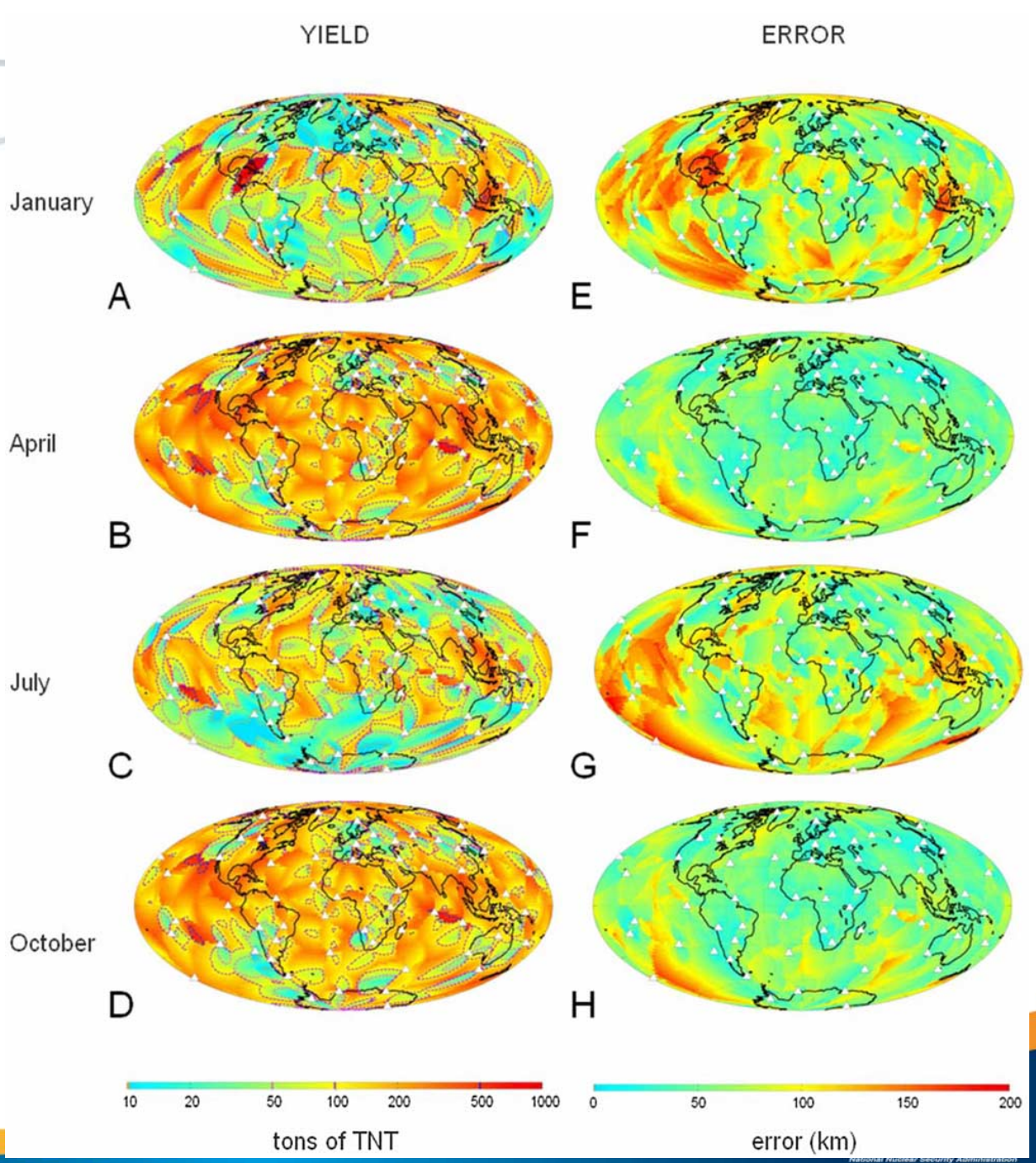


# Infrasound: Source Scales



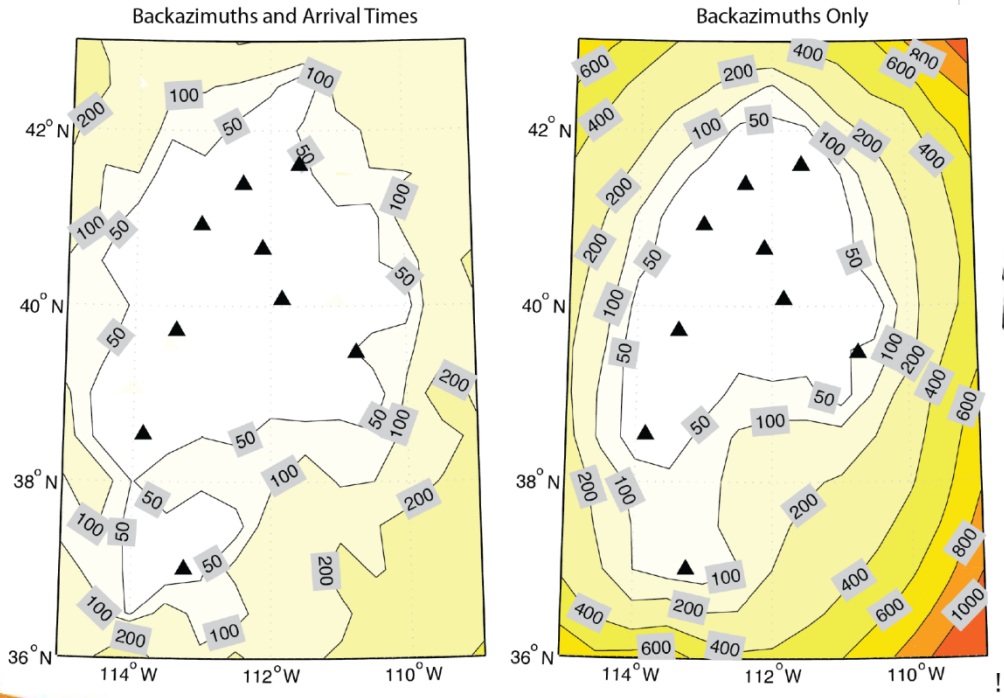
# Network performance: IMS Network

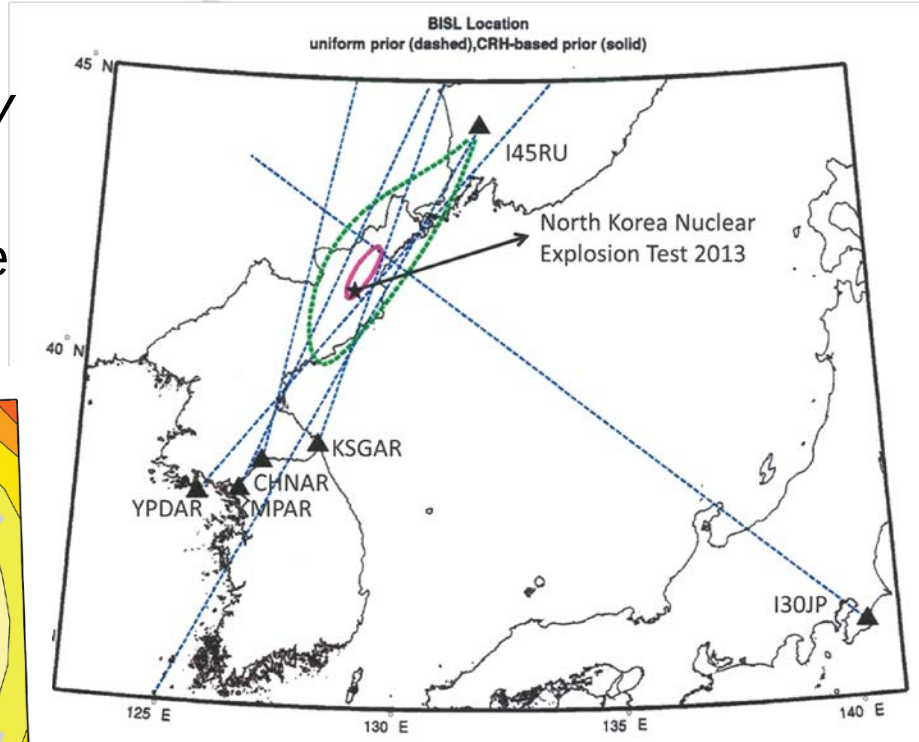
- Estimates of detection and location capability for above-ground tests using the IMS infrasound network.
- Yield precision is best during winter and summer, location precision is best at the equinox periods



# Network performance: Regional Location

- Can be quantified by both *accuracy* and *precision*.
- For any real or notional network we can simulate these parameters.




*Locations for the 2013 DPRK test*

*Location precision for Utah network with (a) azimuth and time, (b) time information.*

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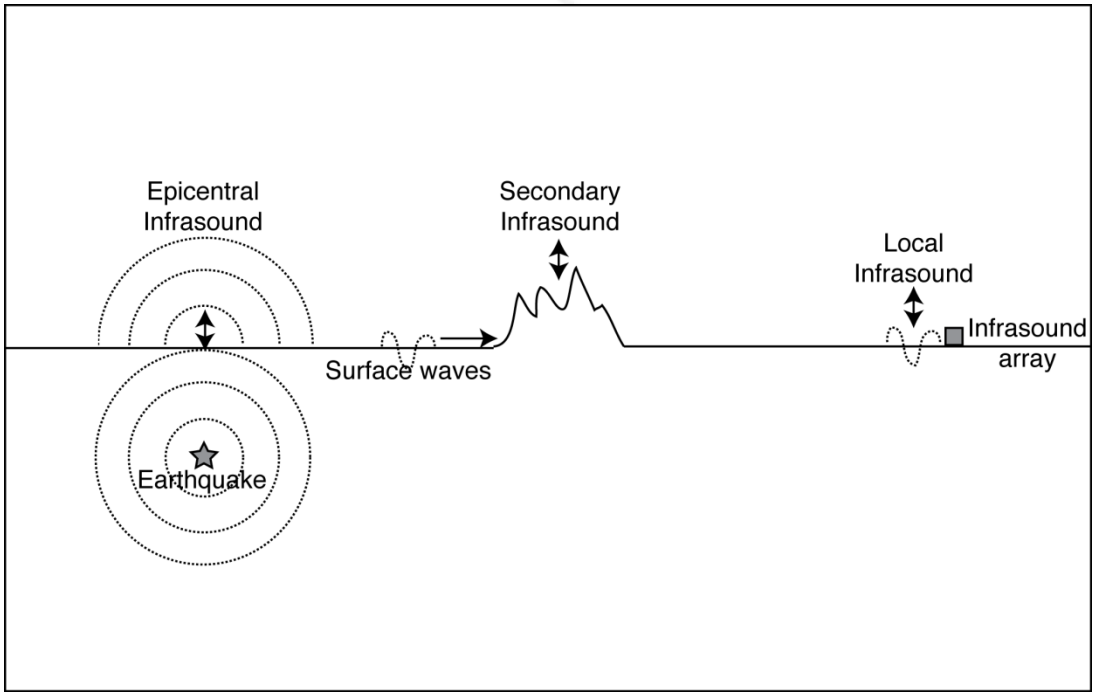
# Coupling Processes

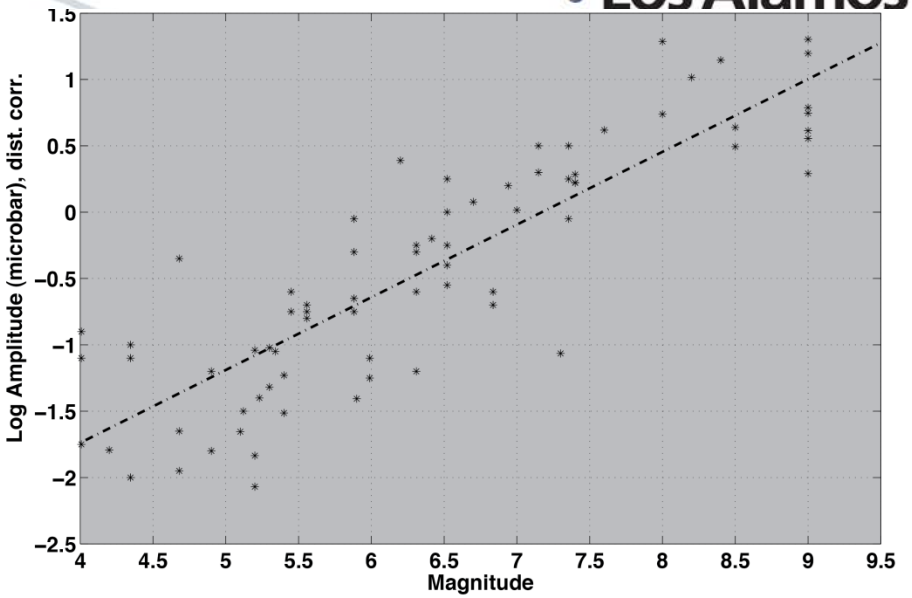
- Epicentral infrasound
  - ‘Baffled piston’ model. Observations have not been supported by modeling.
- Secondary infrasound
  - Passage of surface waves through areas of extreme topography (mountains, cliffs). Good agreement with modeling in recent studies.
- Local infrasound
  - Associated with the generation of infrasound from vertical motion at the receiver.

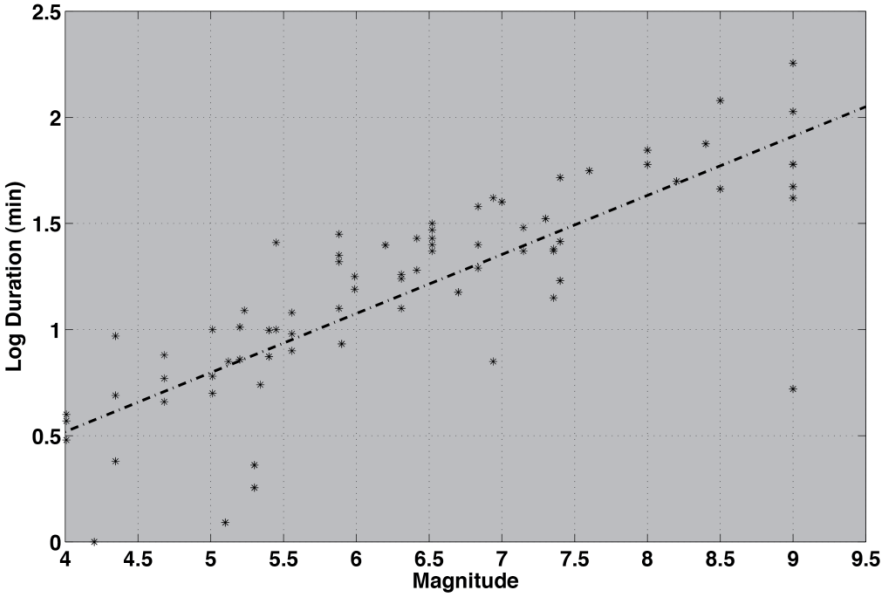



*A schematic diagram illustrating different mechanisms of infrasound generation from earthquakes.*

# Earthquake Infrasound

- The earthquake infrasound observational record is limited to MB 4 and above
- Thus, infrasound shows promise as a potential discriminant at low magnitudes (e.g., for separating EQ's and mine blasts)
- We can explore the physics behind this using modeling…

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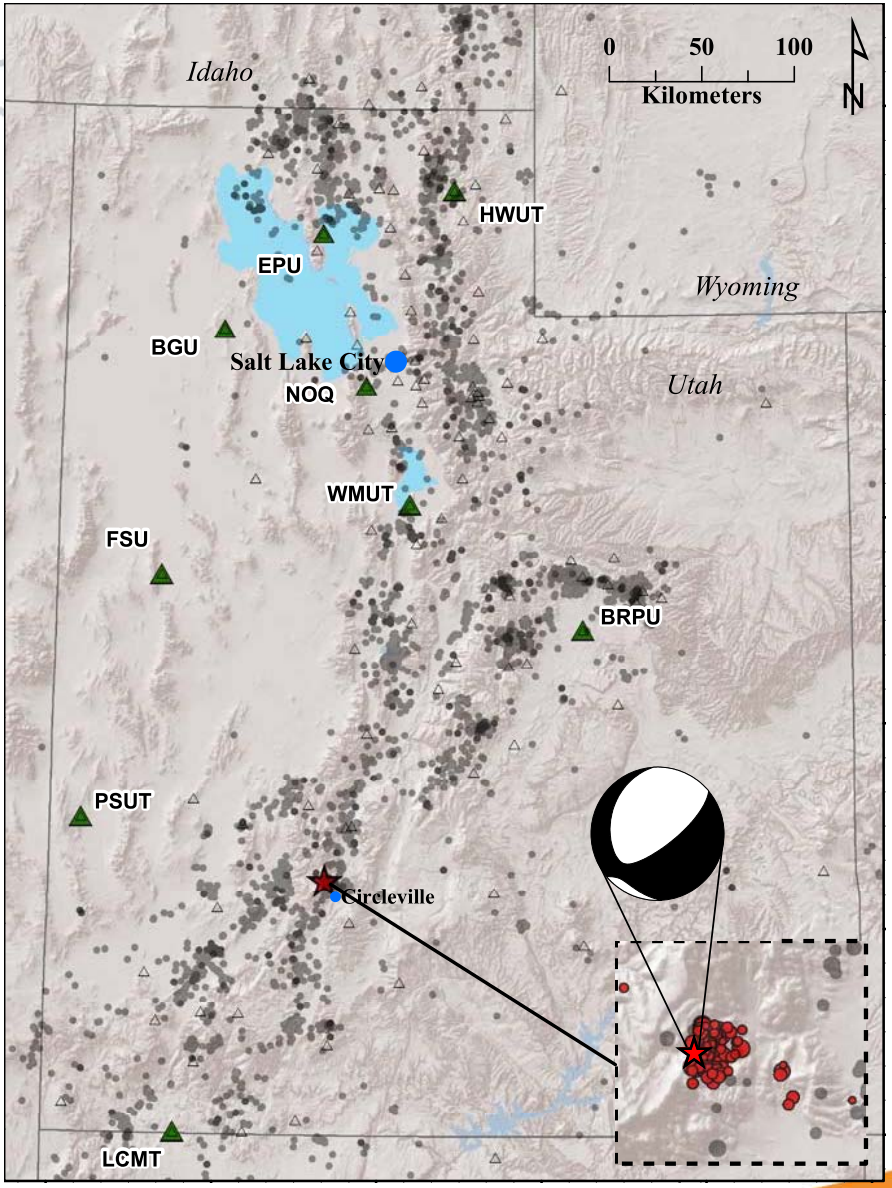
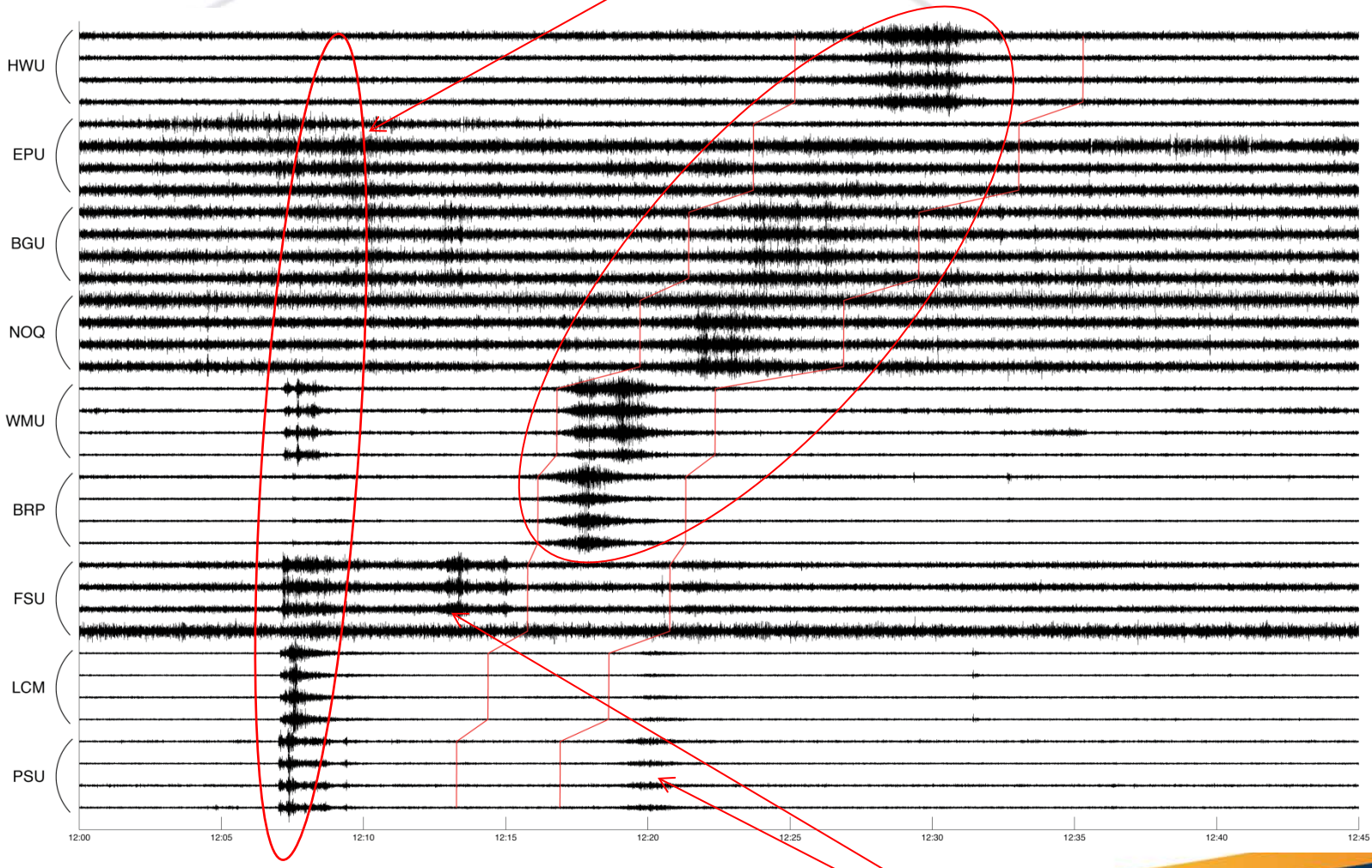
# The Utah infrasound network & Circleville, UT

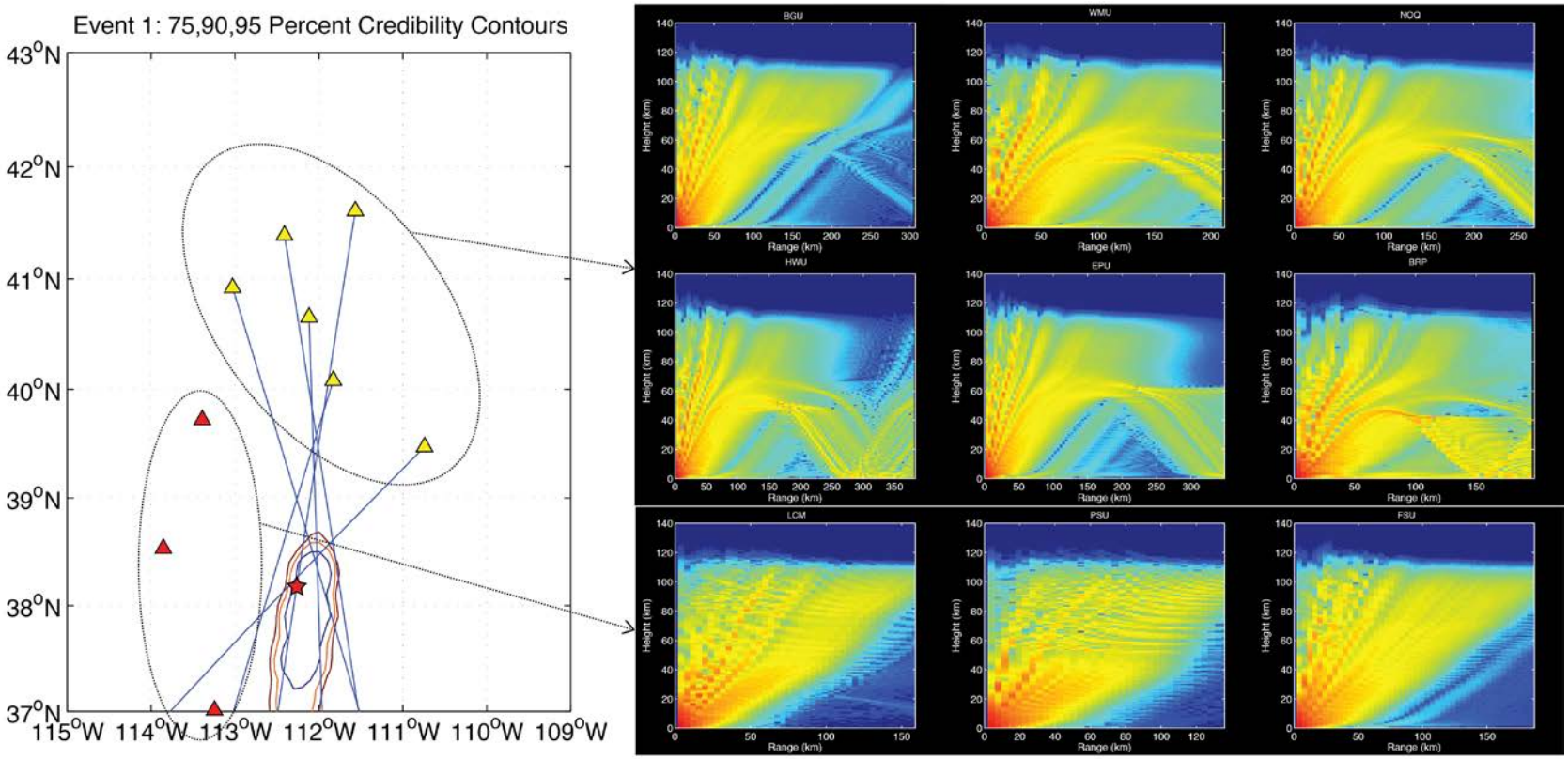
- Nine infrasound arrays, co-located with 3C seismometers, spanning the Utah intermountain seismic belt
- Each array has 4 elements (Chaparral 2, 2.5, and IML models)
- Circleville was a normal faulting Mw 4.7 earthquake in southern Utah
- Depth was constrained at 8 km from moment tensor inversions



# Infrasound waveforms

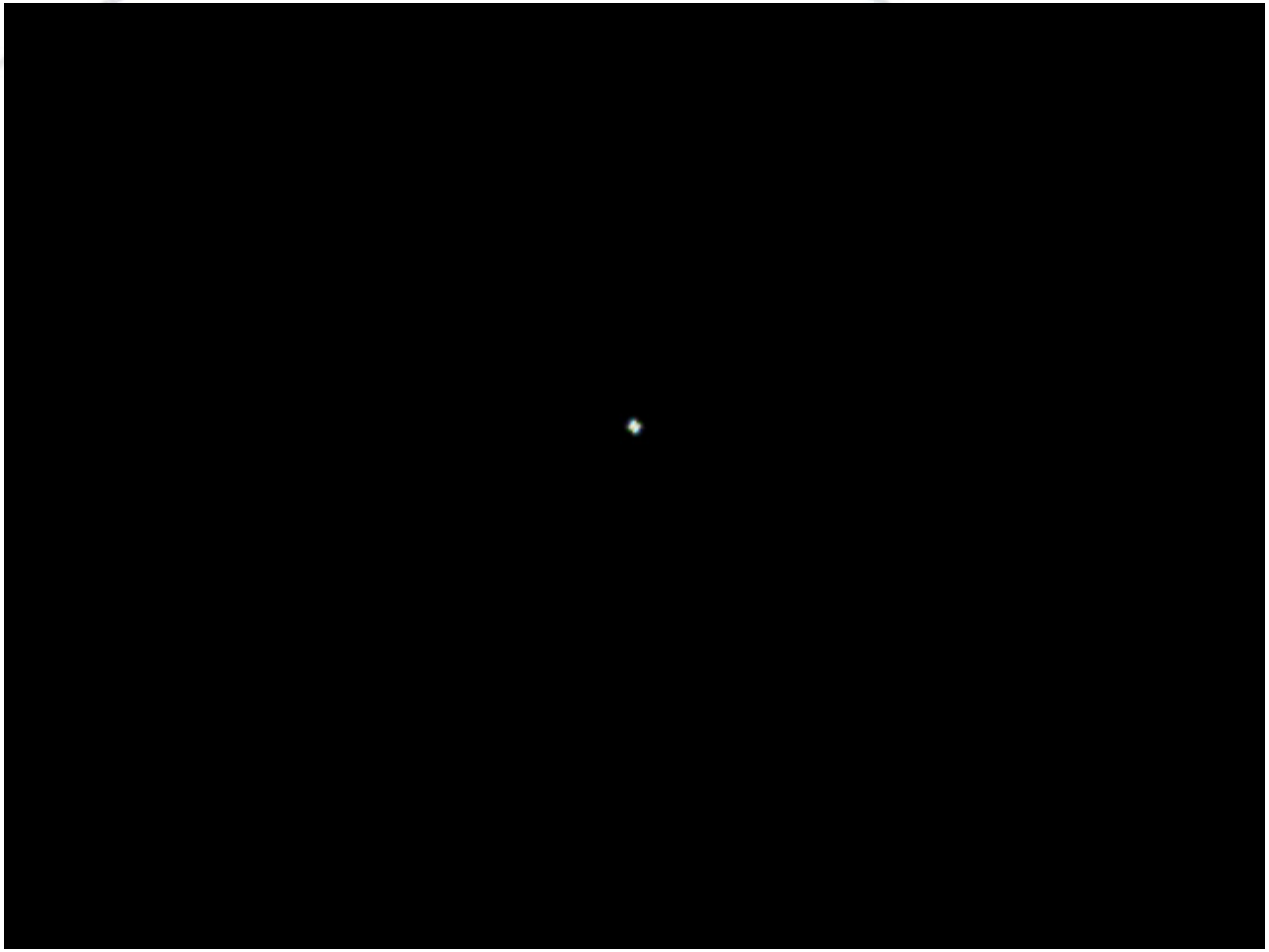


# Detection, location suggests epicentral source



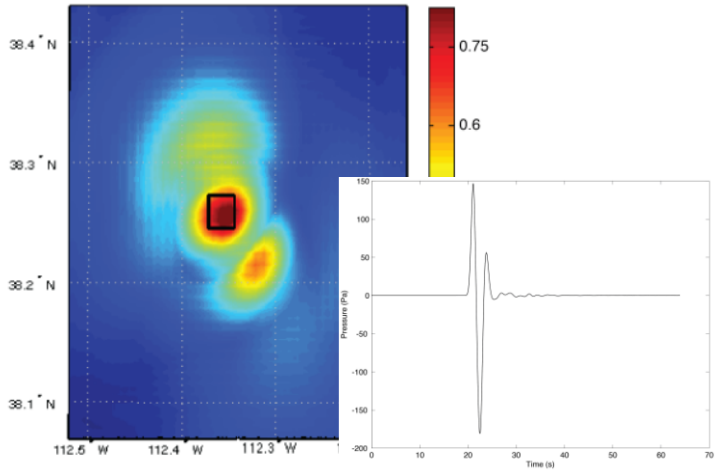

Red triangles & bottom panel: No detections
Yellow triangles & top 2 panels: Detections

# Modeling the seismic source (movie)



# Modeling the acoustic source

Seismoacoustic source modeling

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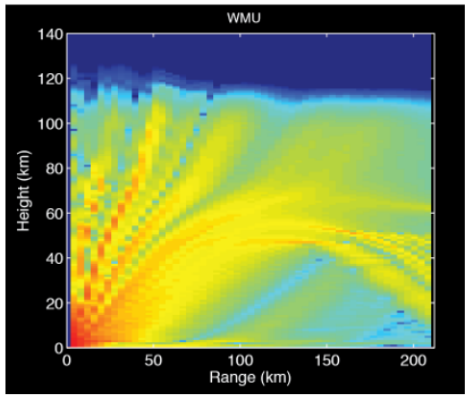
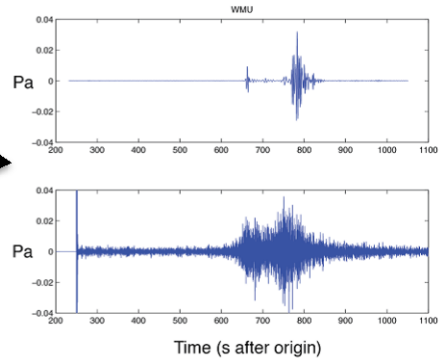
Propagation in atmosphere



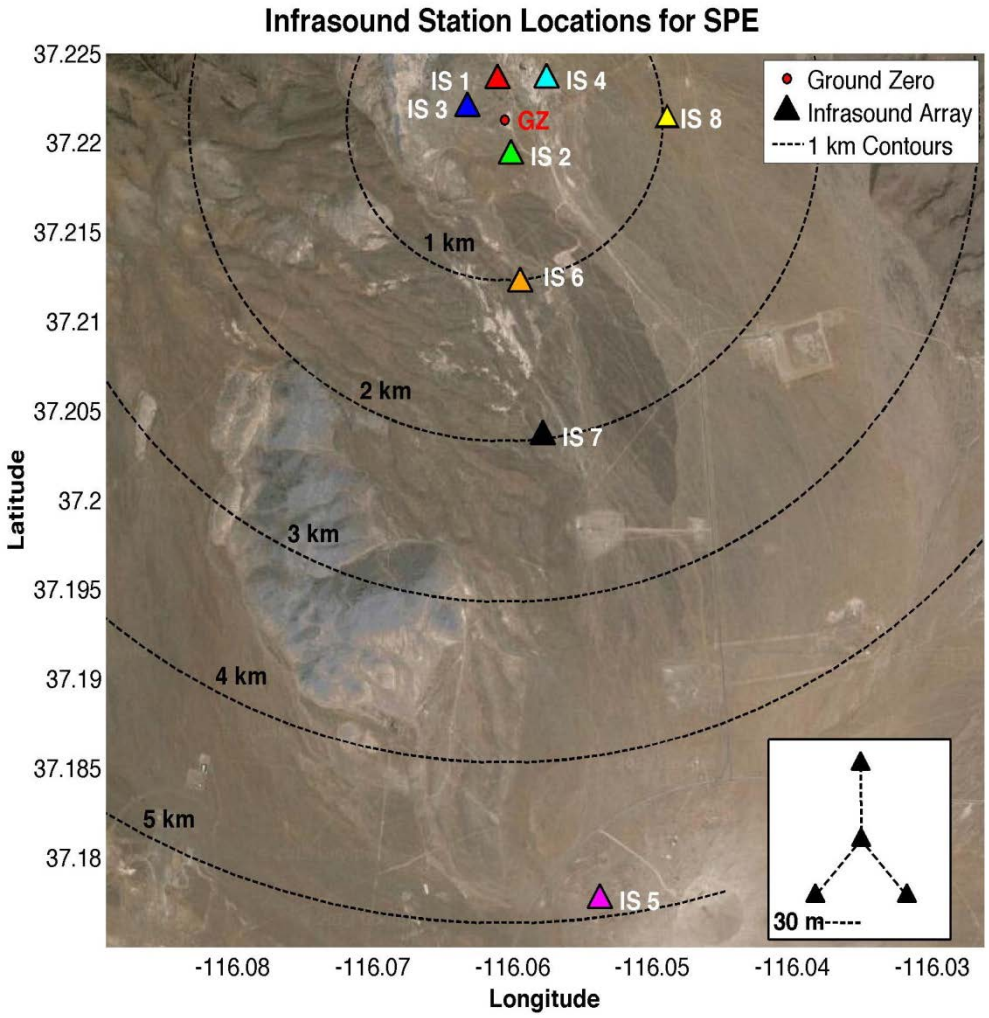

Predictions & observations

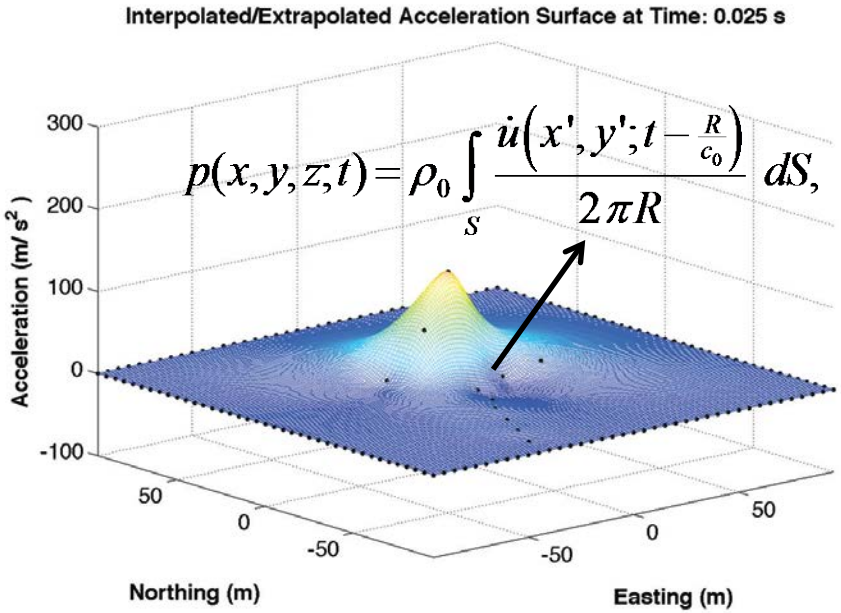



$$p(x,y,z;t) = \rho_0 \int_S \frac{\dot{u}\left(x',y';t-\frac{R}{c_0}\right)}{2\pi R}\, dS,$$

*The Rayleigh Integral is an approximation to the Kirchoff-Helmholtz integral in the far field.*

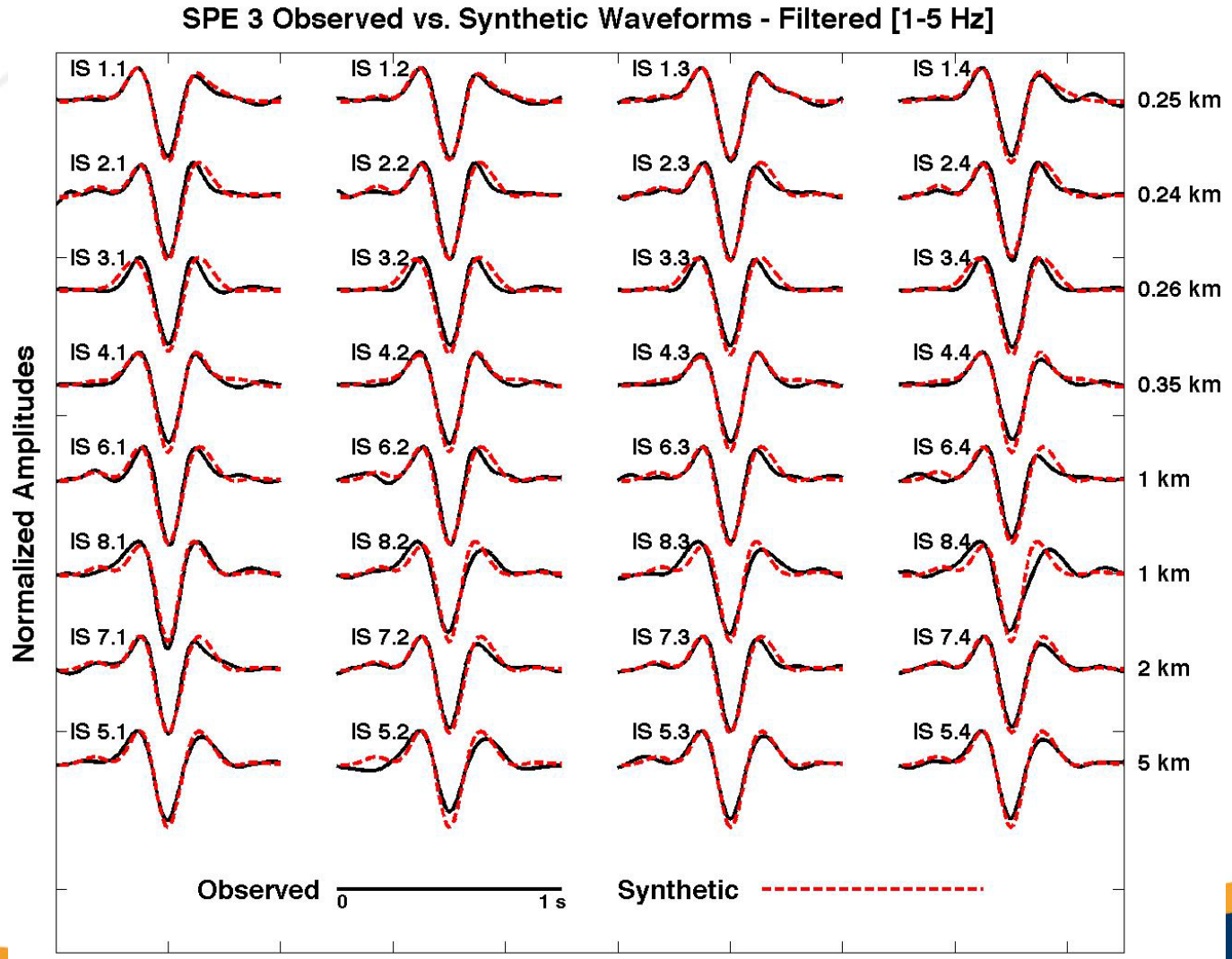
# Modeling small buried explosions




- The Source Physics Experiment has provided an excellent opportunity to test coupling models in the near-field.
- R&D on modeling larger shots, shots in different media, and extending the modeling to higher frequencies is needed

# Modeling small buried explosions



# Summary

- We can quantify the current capability of infrasound detection, location thresholds for above-ground tests.
- Recent research could in principle be extended to produce similar maps for below-ground tests.
- These simulations should be considered when evaluating GPS-TEC techniques.
- The modeling techniques developed for underground events (EQ, EX) can be coupled with plasma codes to simulate GPS-TEC.