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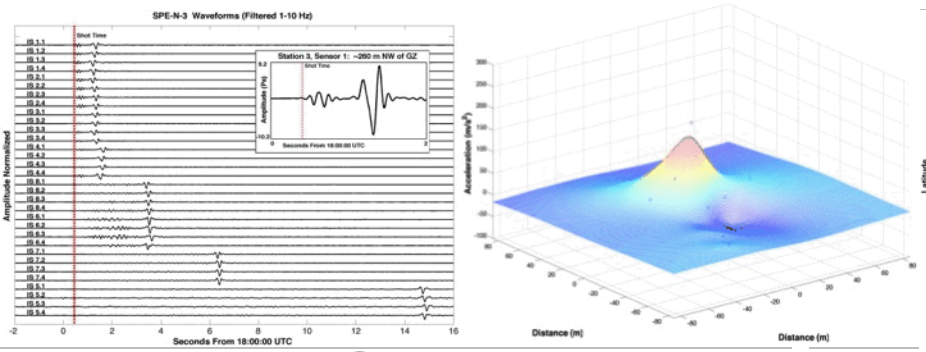

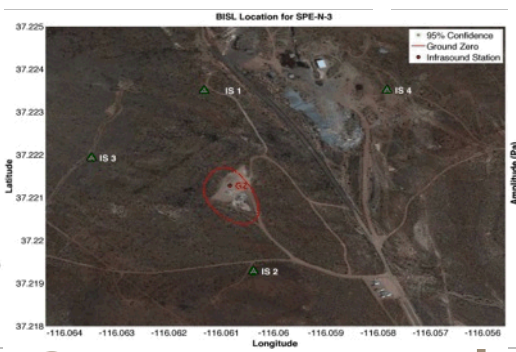

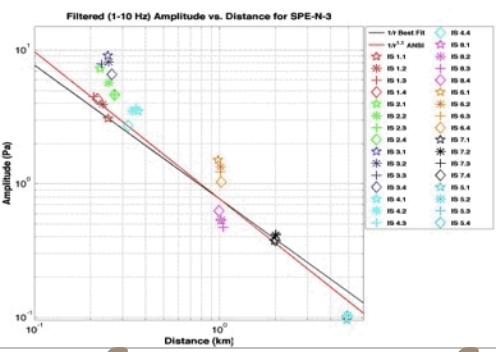

New Sensors, New Sources: The future of infrasound monitoring

Kyle R. Jones – Sandia National Labs

RMR: June 19, 2014

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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Roadmap

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- Near-Source Infrasound is an important part of understanding signals detected at greater distances
- Several current projects related to source physics
  - The Source Physics Experiment
  - Humming Wombat
- Limitations and Challenges
- What does this mean for our science and what are the next steps

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Near-Source Infrasound is an important part of understanding signals detected at greater distances

Motivation

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- The ability to detect and monitor for various sources both man-made and natural
  - Nuclear and chemical explosions
  - Artillery
  - Aircraft and rockets
  - Bolides
  - Tornadoes
  - Hurricanes
  - Wind Farms
- Not always able to deploy within the “near-source” region
- Must be able to make determinations about the source after propagation

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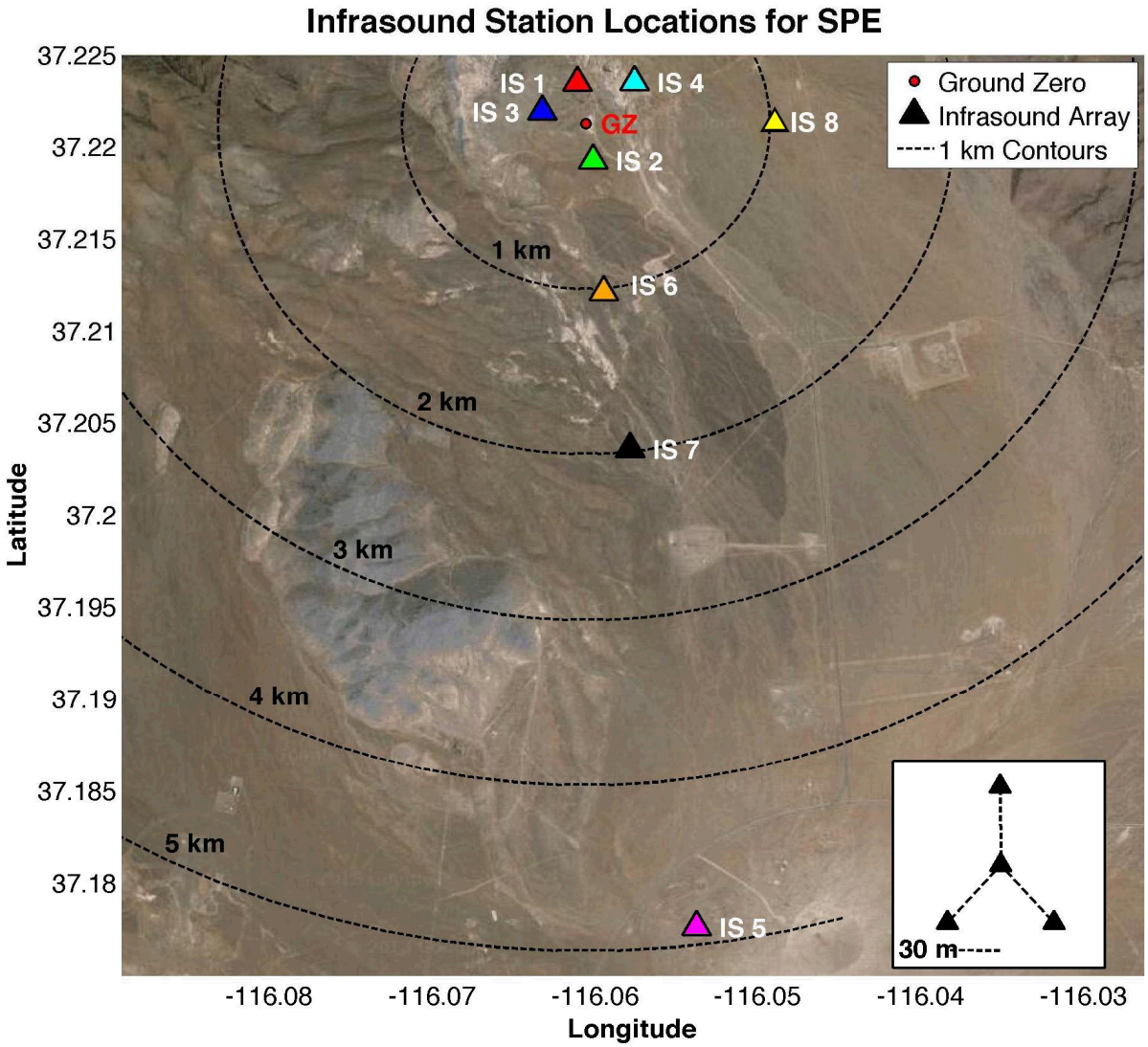
Several current projects related to source physics:

The Source Physics Experiment

Humming Wombat

The Source Physics Experiment

- Northeast corner of the Nevada National Security Site (NNSS)
- Various underground explosions in the same source hole
- Network of 8 infrasound arrays consisting of 32 Hyperion sensors
- Additionally, surface and borehole accelerometers, geophones, and broad-band seismometers



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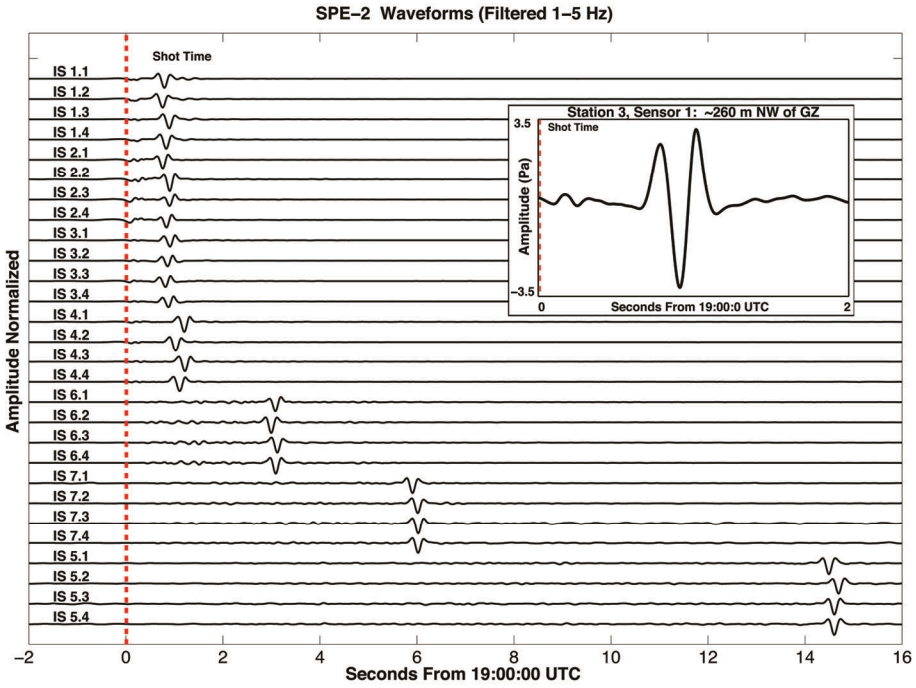
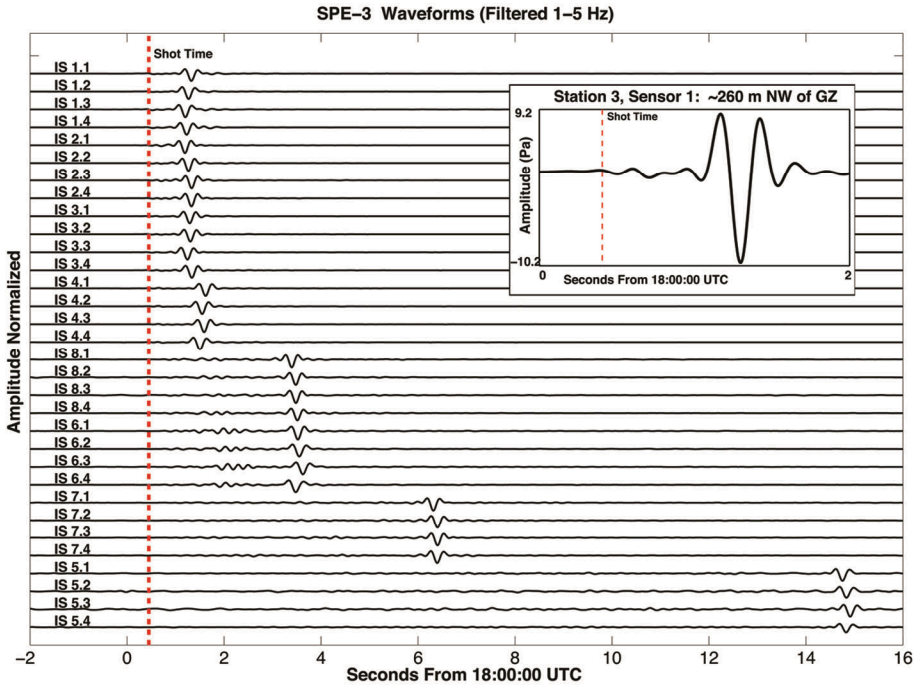
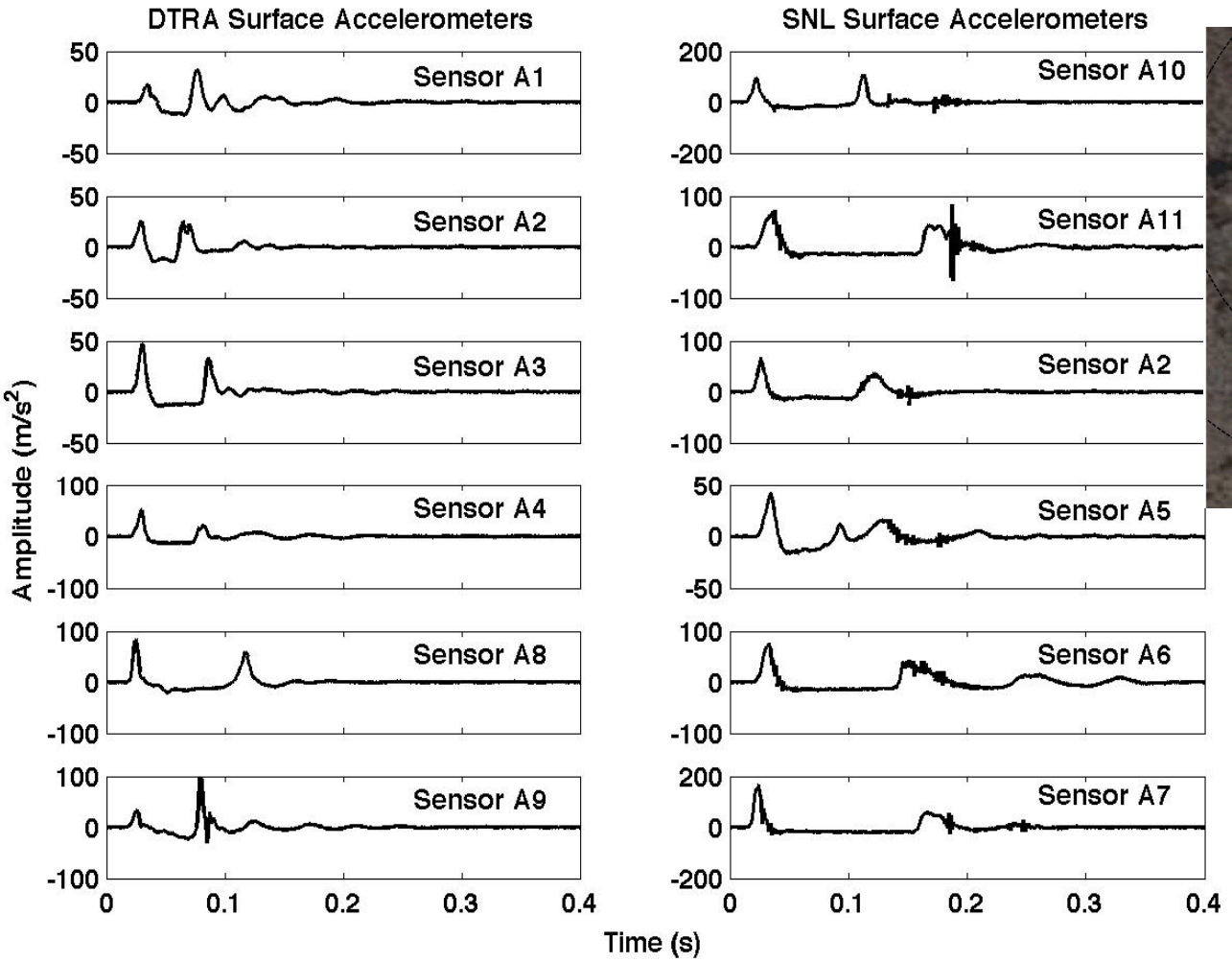
The Source Physics Experiment

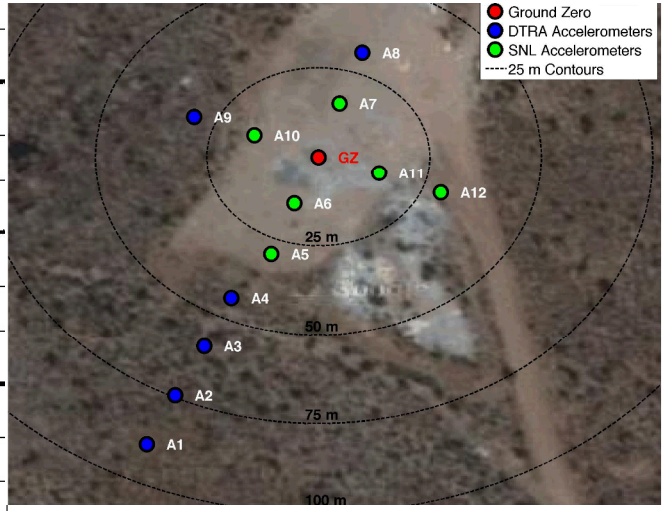




The Source Physics Experiment

- Use data from surface accelerometers to get ground motion





DTRA Accelerometers
A1, A2, A3, A4, A8, A9

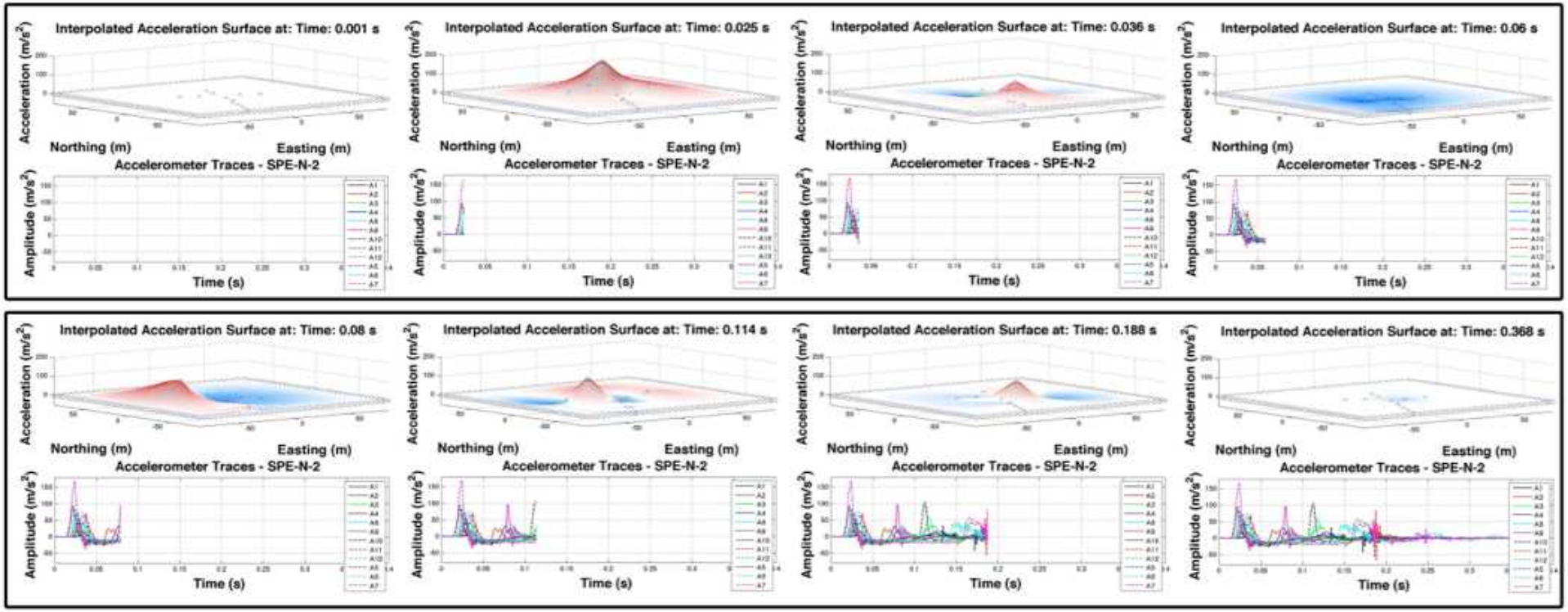
Endevco 500g

SNL Accelerometers
A5, A6, A7, A10, A11, A12

Endevco 500g

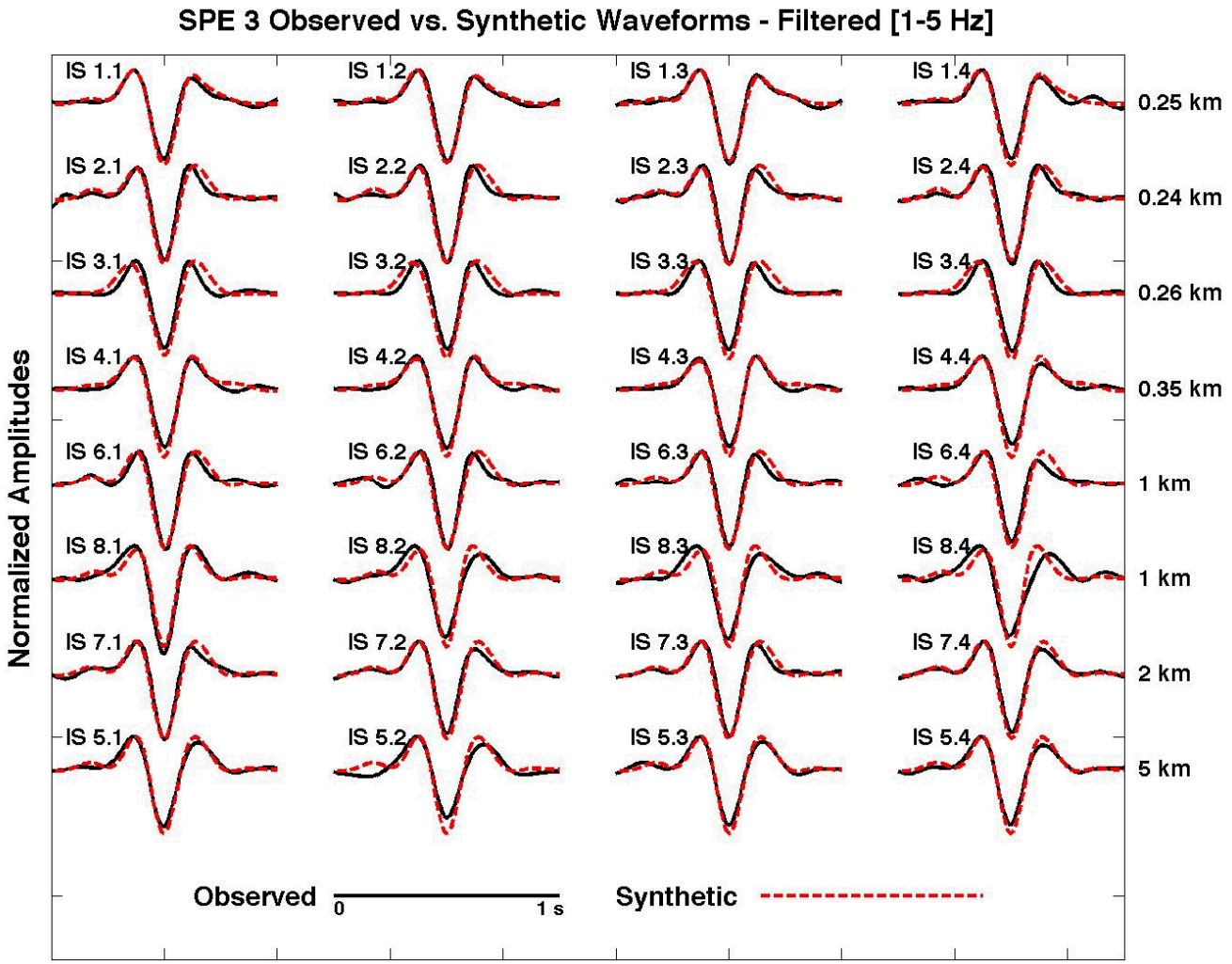
The Source Physics Experiment

- Set up a grid and interpolate/extrapolate the accelerometer data



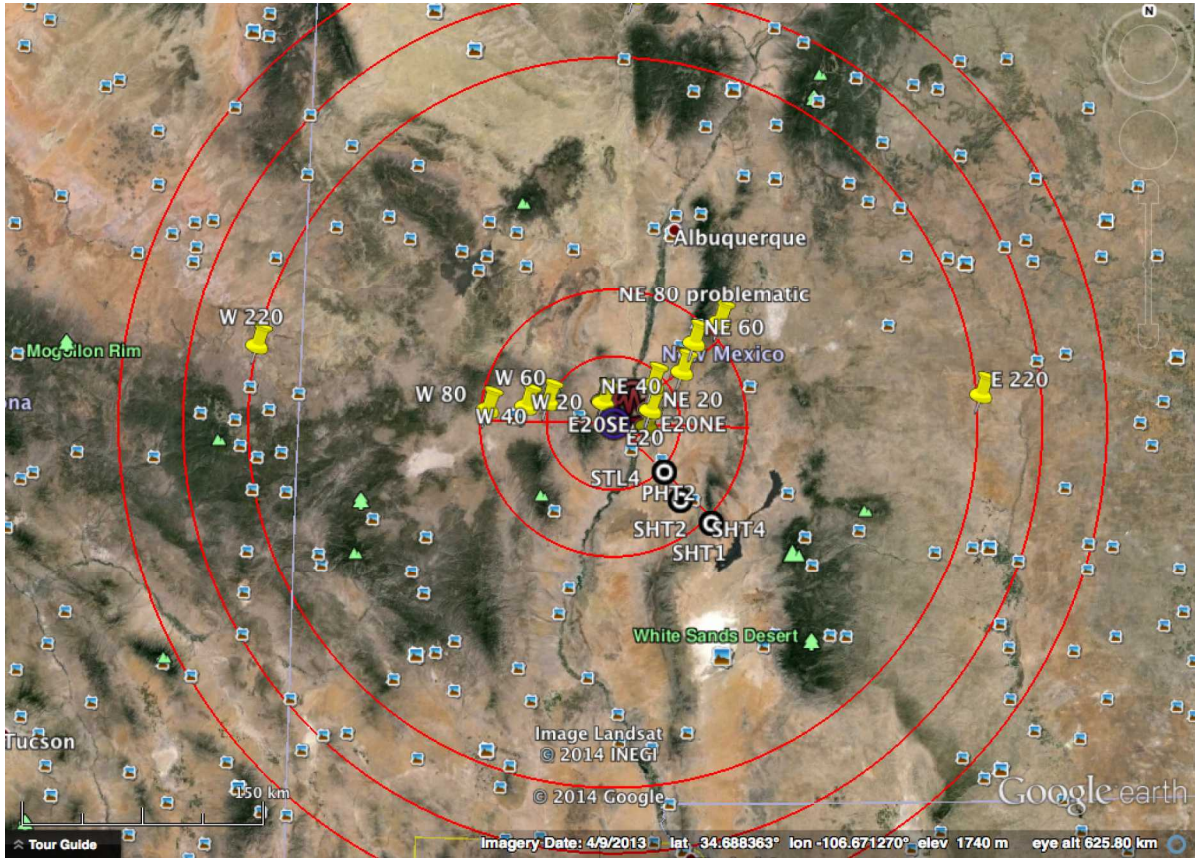
The Source Physics Experiment

- Integrate the pressures at each grid point over both area and time to produce synthetic waveform
  - The final summation step takes into account the constructive and destructive interference inherent in such a large source area.
  - Can be thought of a baffled piston in an infinite plane



Humming Wombat

- Central New Mexico at the Energetic Materials Research and Testing Center at New Mexico Tech
- Similar surface explosions over several seasons
- Large network of infrasound blast sensors, near-field and far-field arrays
- Additionally, broadband seismometers and other equipment



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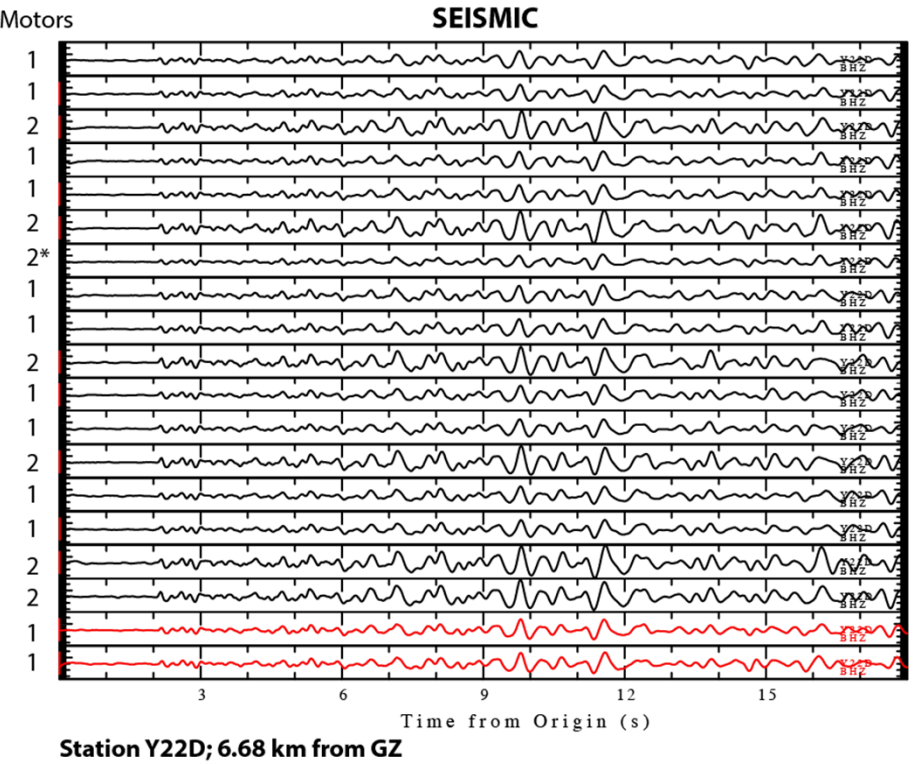
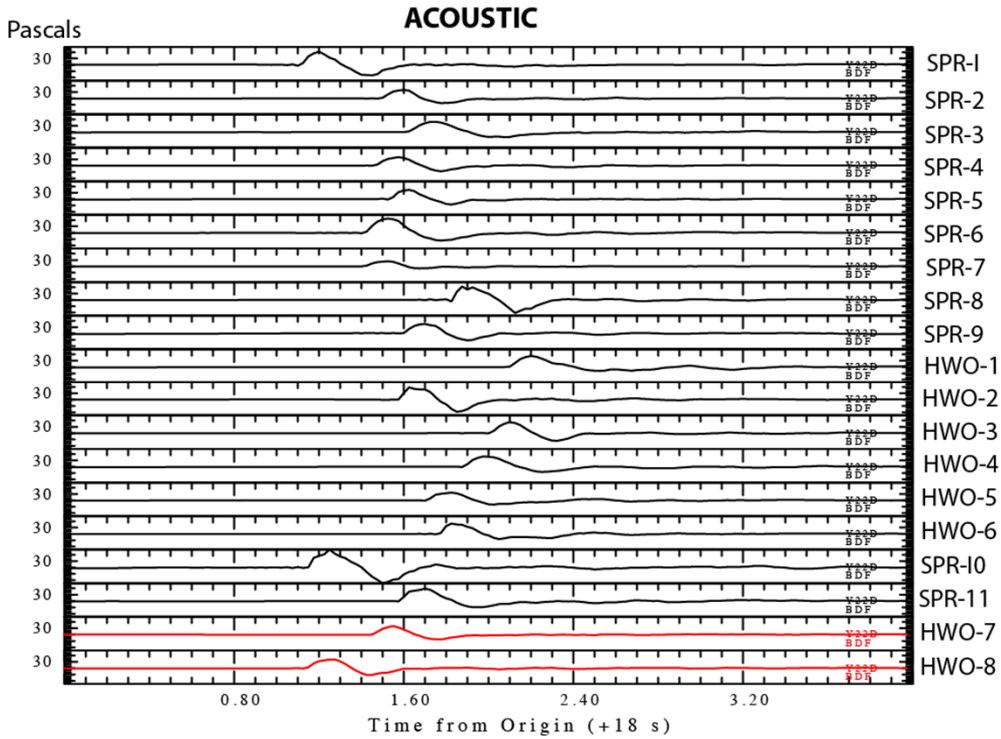
Humming Wombat





- Sensor network includes:
  - Infrasound
  - Seismic
  - Blast Sensors
- Close in measurements out to hundreds of km
- Surface Shots

http://d3vvl31cy8gagb.cloudfront.net/282_ear/approximatenoiselevels.jpg

Humming Wombat

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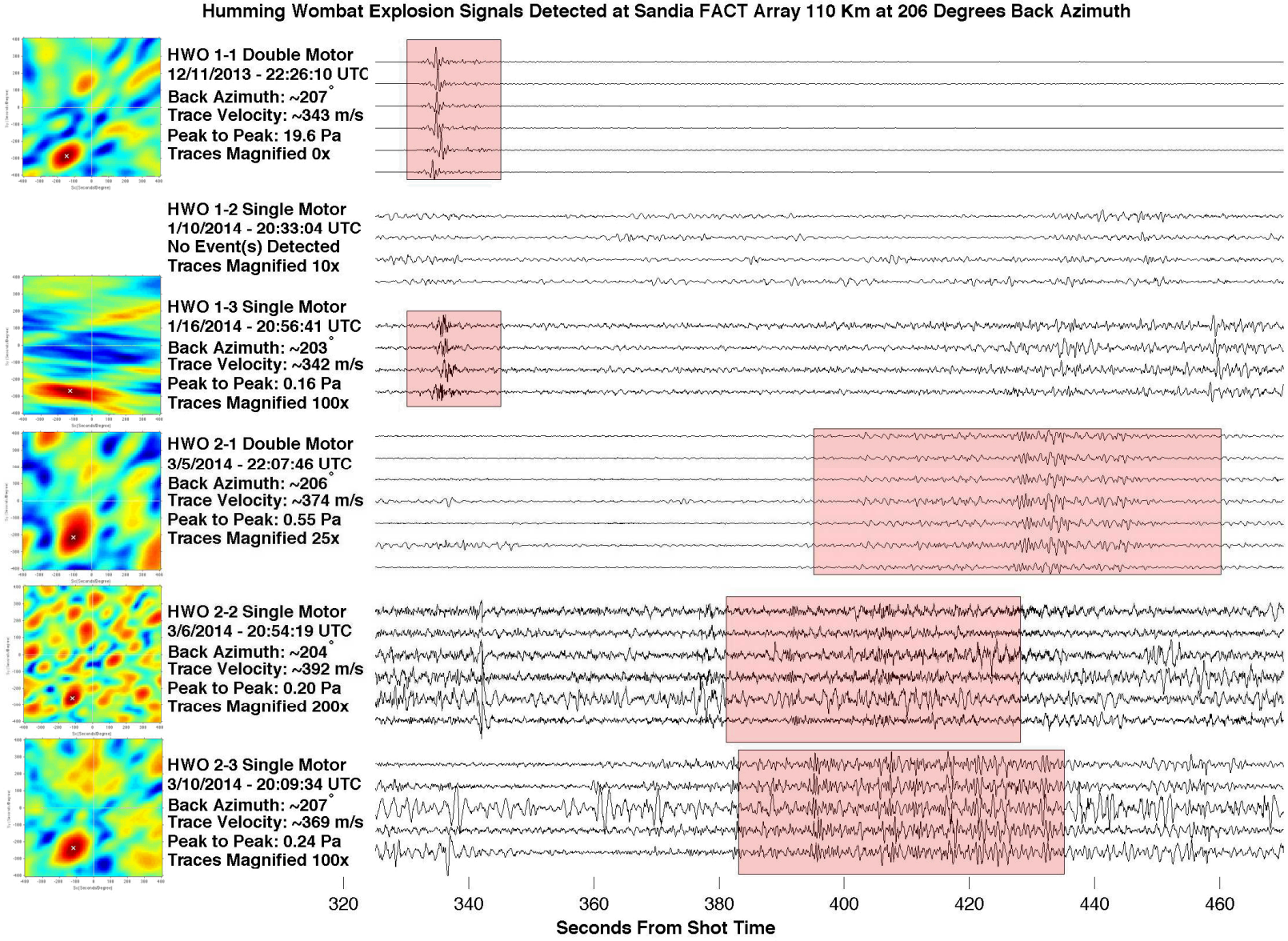

Sensor Tech

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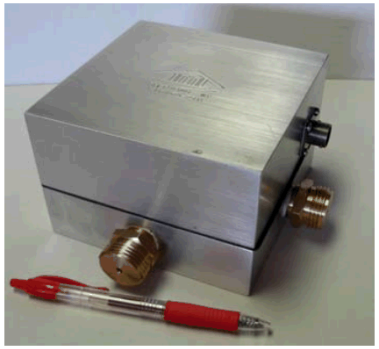
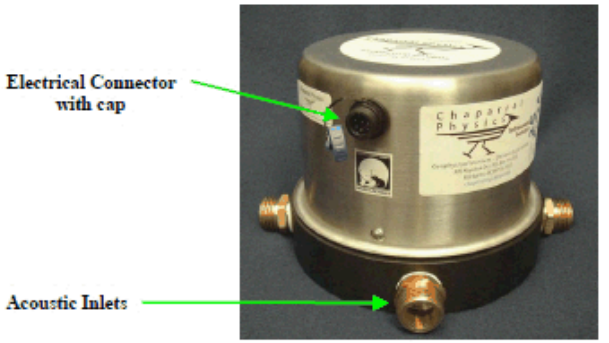
Inter-Mountain Labs (IML-ST)



Inter-mountain Labs. 555 Abraska, Sheridan, WY 82801
(307) 674-7506 http://www.intermountainlabs.com/

Chaparral (CP25)



http://bric.postech.ac.kr/upload/geditor/201010/0.15810600_1286701047.jpg

CEA - MB2000

http://www-dase.cea.fr/public/dossiers_thematiques/microbarometres/images/mubaro.gif

Seismically decoupled versions available or soon to be

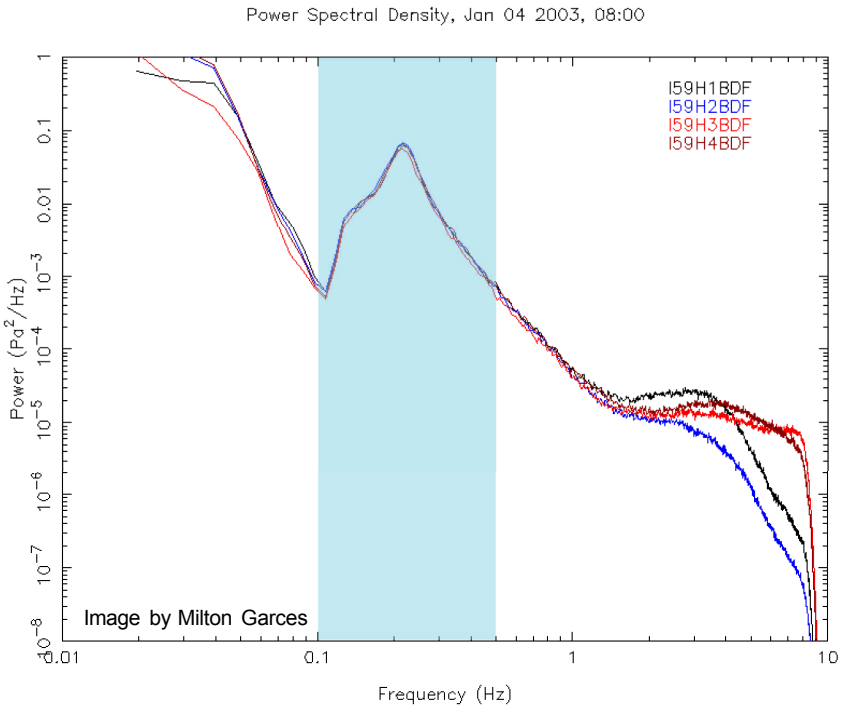
Very near-source overpressure sensors

Hyperion (IFS3000)

Hyperion Technology Group, Inc., 3248 West Jackson Street, Tupelo, Mississippi 38801
662.823.0600 http://www.hyperiontechgroup.com

Detectability Issues

- Detectability depends on many factors
  - Yield/Size of the event
  - Above vs. below ground
  - Frequency range
  - Microbaroms (0.1 – 0.5 Hz)
- WIND!!!!
  - Wind reduction systems



Detectability Issues

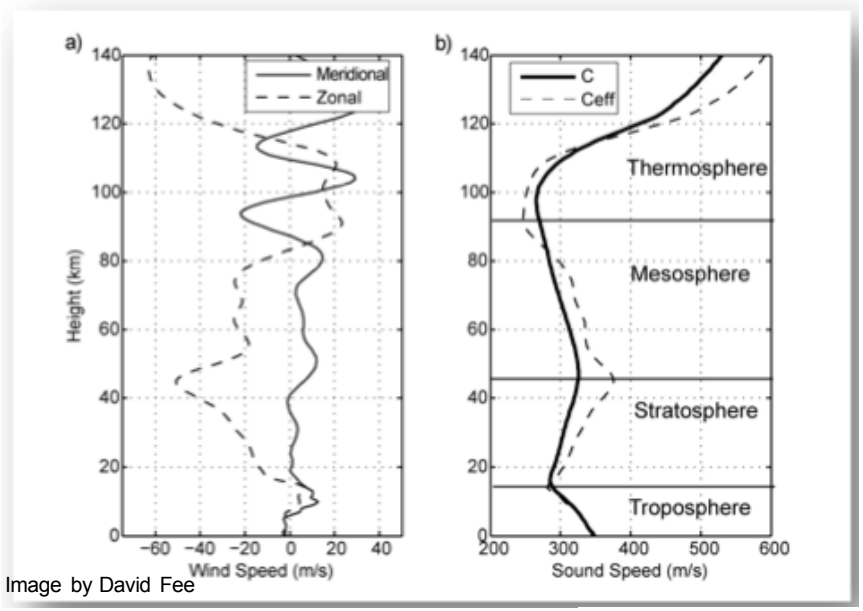


Image by David Fee

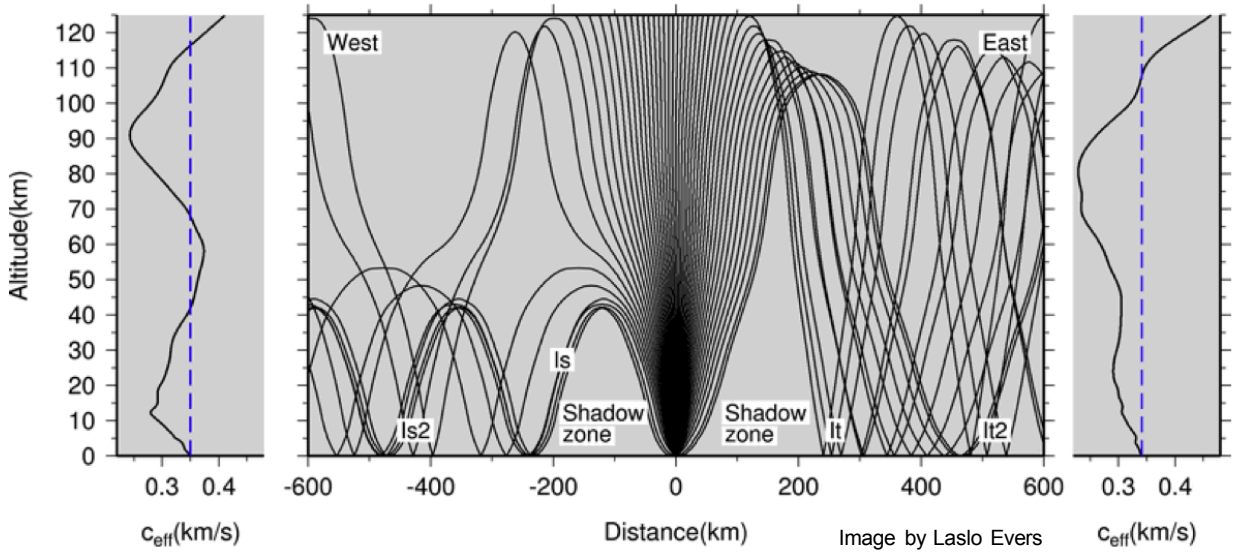


Image by Laslo Evers

Detectability Issues

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Raytracing Northern Hemisphere winter

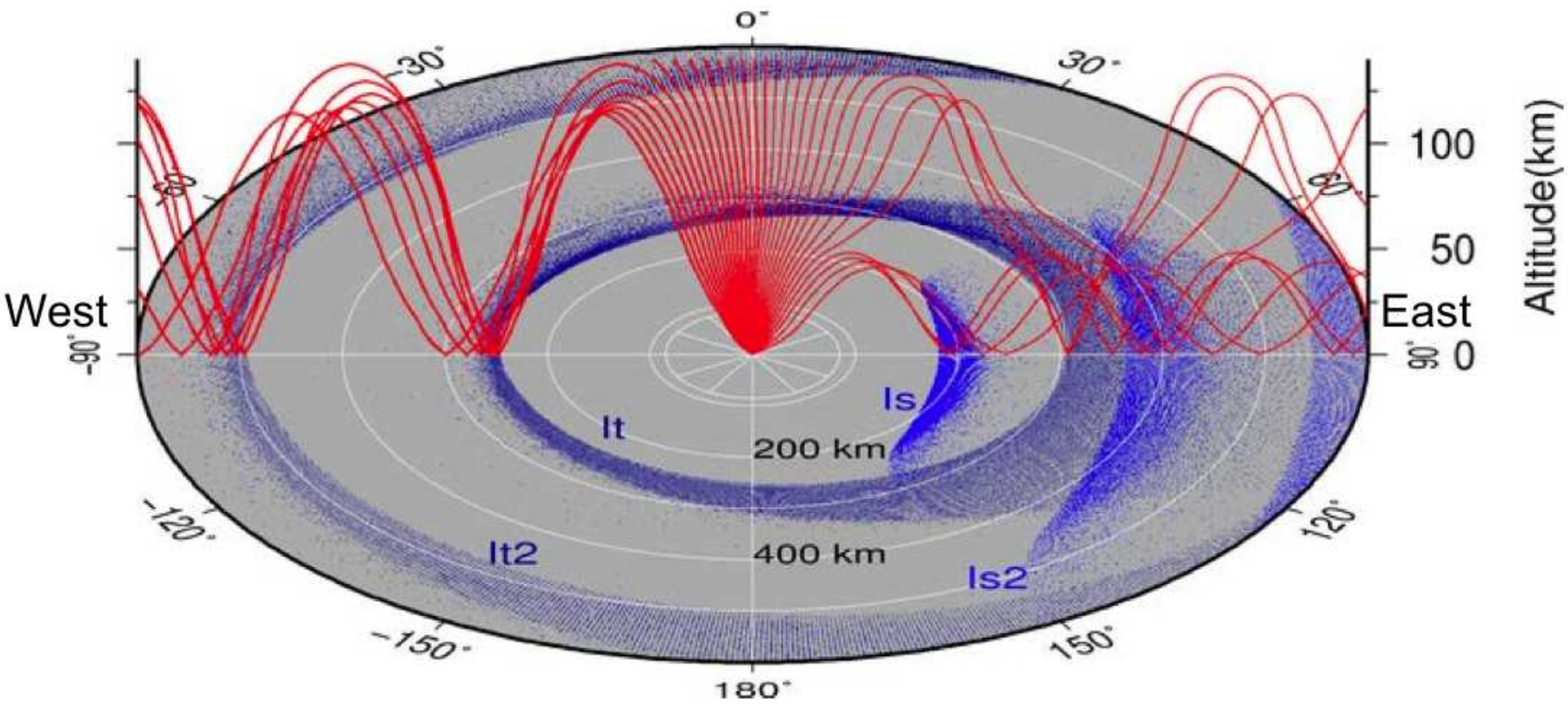


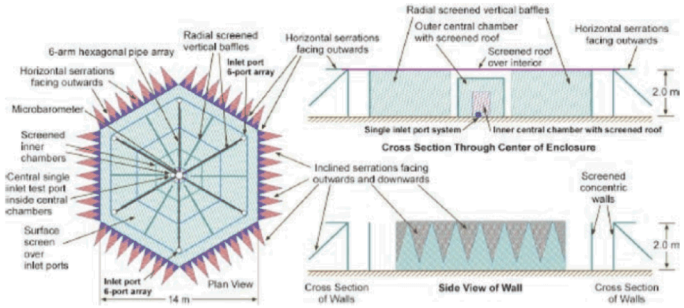
Image by Laslo Evers

Wind Reduction

Current State of Windscreens

- IMS Pipe Rosette
- Porous Hoses
- IRIS “Puck” in Gravel
- Wind Fences

Infrasound Monitoring for Atmospheric Studies (2.18) pg 59



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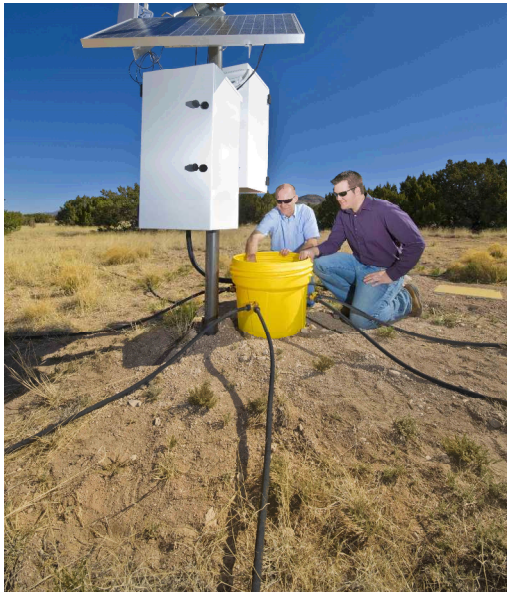
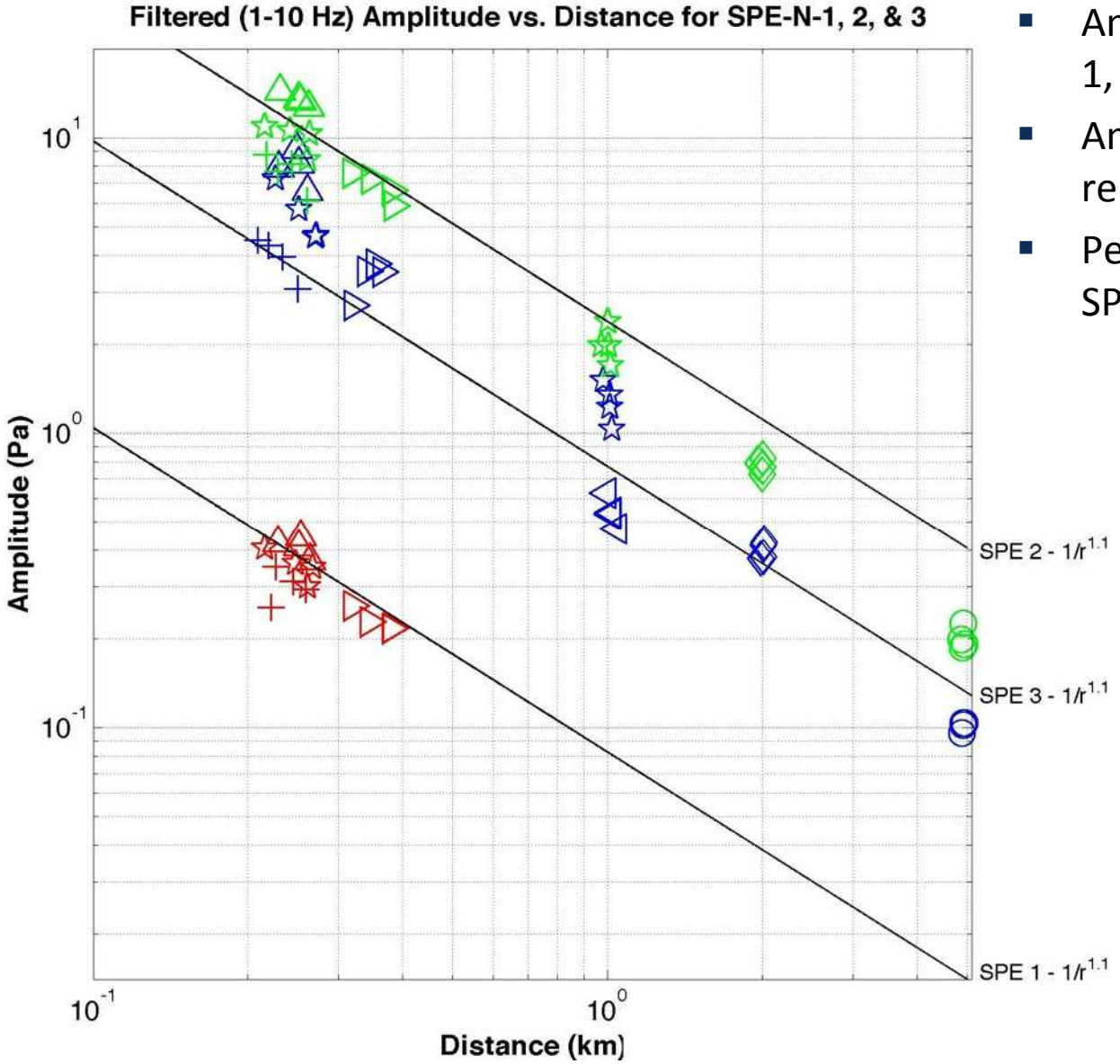
FACT SITE



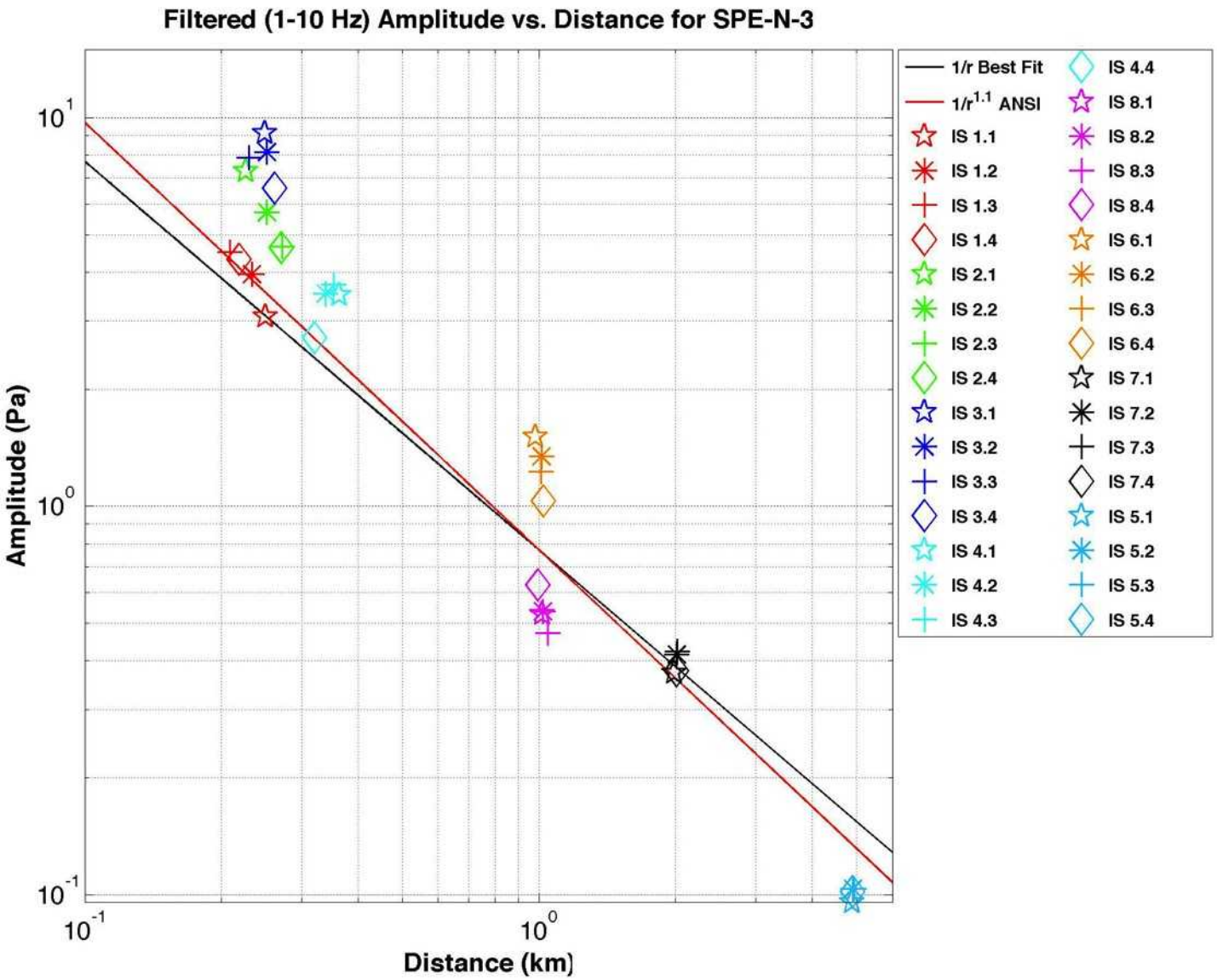
FACT SITE

Amplitude vs. Distance



- Amplitudes vary between SPE 1, 2, and 3
- Amplitude variations are yield related
- Peak vertical acceleration for SPE 3 are 2/3 that of SPE 2

Amplitude vs. Distance



- Amplitude decays linearly
- Reasons for amplitude differences:
  - Off-axis vs. On-axis pressures observations
  - Line of sight
  - Wind reduction issues

Path Forward

- Investigate whether or not porous hoses are necessary at these distances
  - Porous hoses attenuate amplitude and add a level of complication to analysis
  - Deteriorate in the sun, leading to porosity changes

- Account for wind in the short propagation to determine if it improves solution
  - This should be investigated but may prove not to matter

- Continue to model the source using infrasound to better match the shape of the observed wave

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Questions?