SAND2017-5433PE

SPE/UNESE Day at AFTAC

Infrasound Modeling using SPE Overburied Explosions

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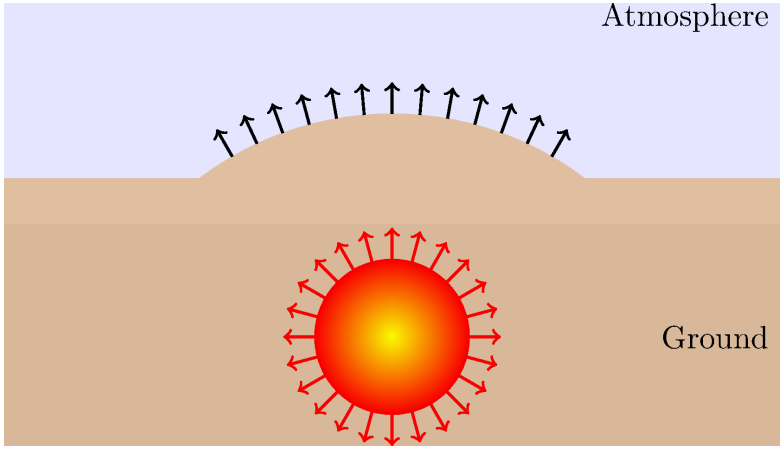
Sandia National Laboratories / Los Alamos National Laboratory

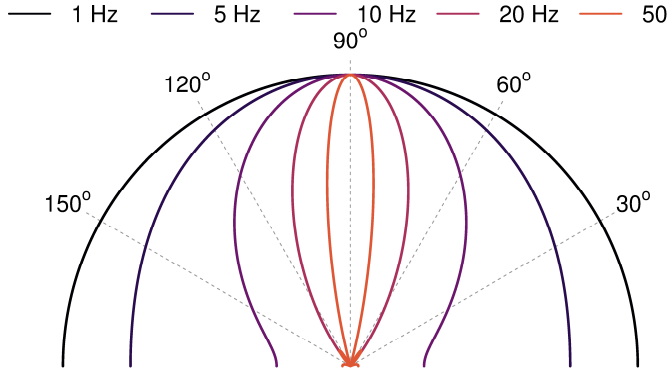
April 26, 2017

Sound from Underground Blasts

Ground Motion Source

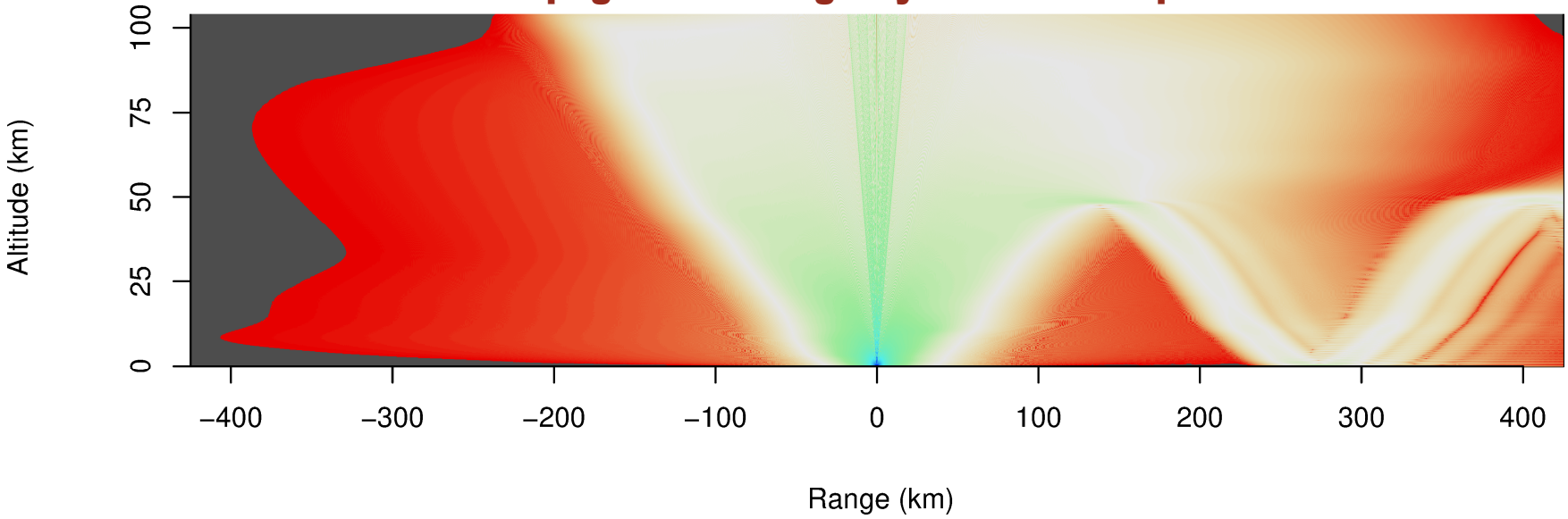


Frequency-Dependent Radiation Pattern



Piston Radius: 100 m, Sound Speed: 343 m/s

Propagation through Dynamic Atmosphere



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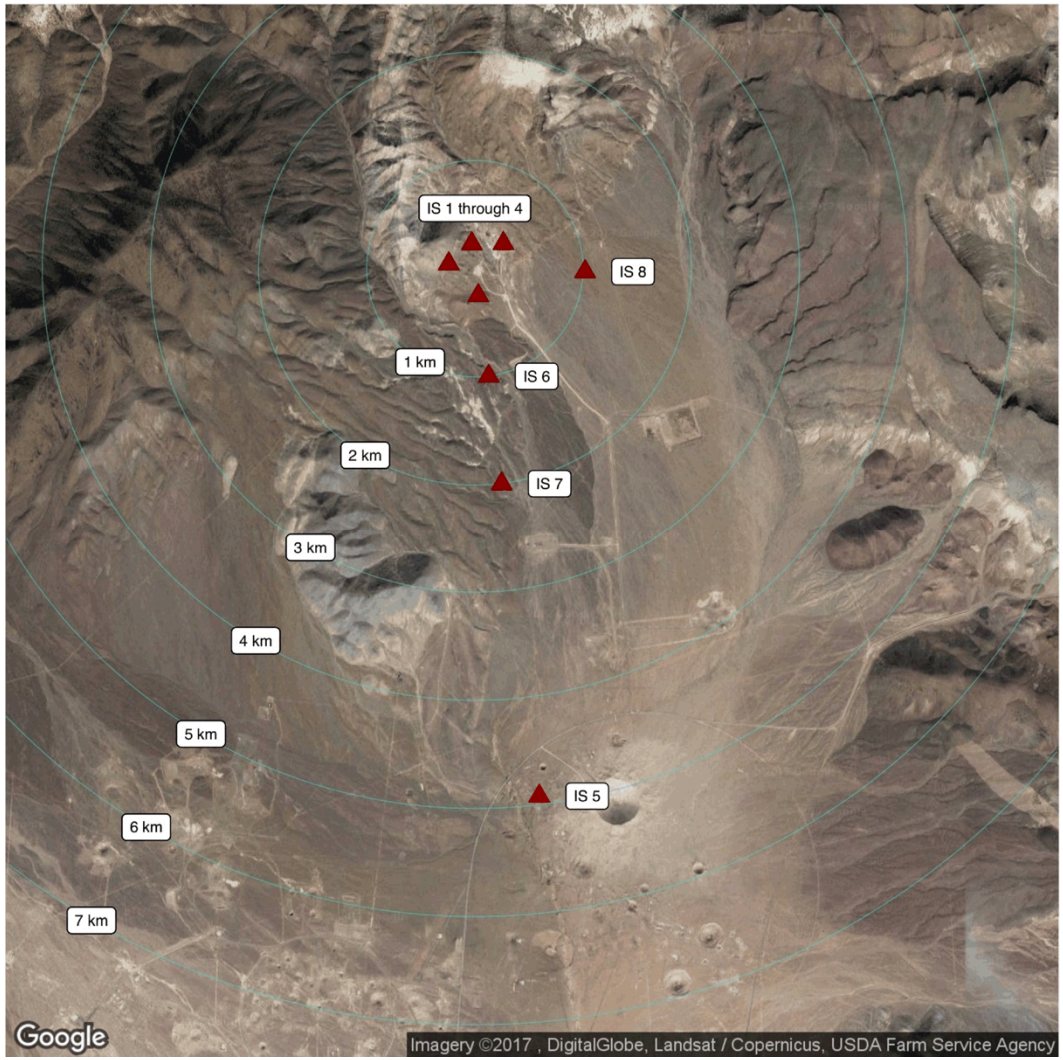
SPE Phase 1 – Far View

National Nuclear Security Administration
Defense Nuclear Nonproliferation



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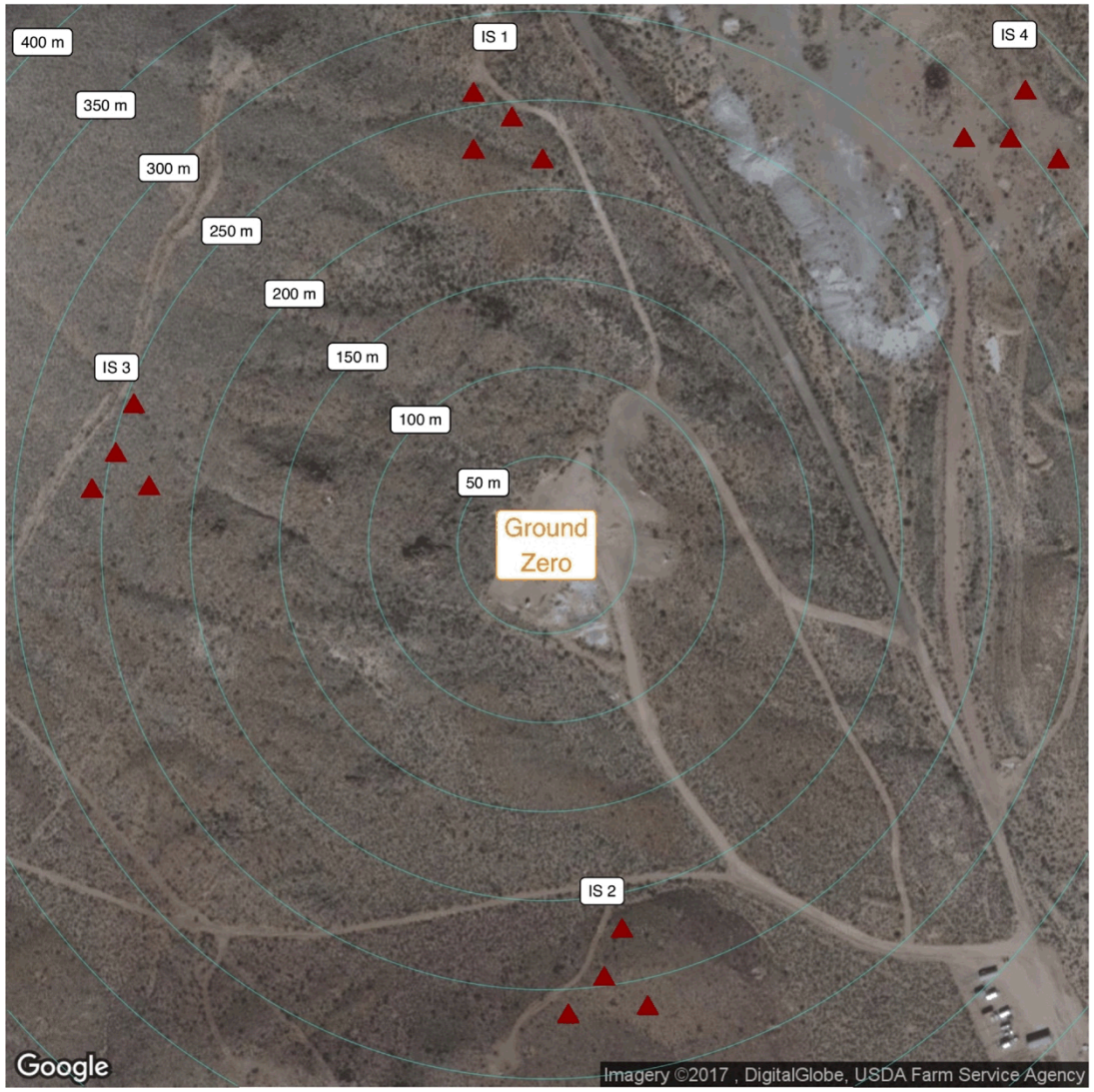
SPE Phase 1 – Close View

National Nuclear Security Administration
Defense Nuclear Nonproliferation



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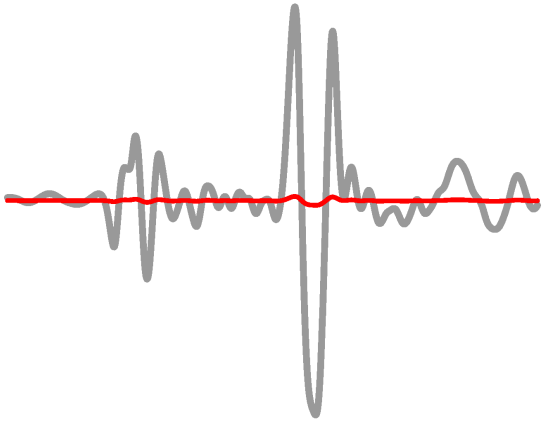
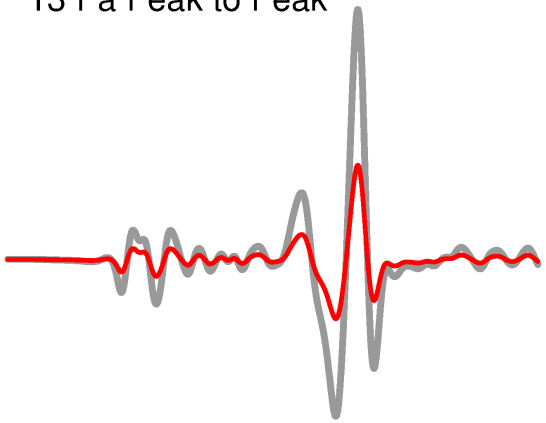
SPE Phase I

National Nuclear Security Administration
Defense Nuclear Nonproliferation

SPE–1: 90 kg @ 55 m
0.77 Pa Peak to Peak

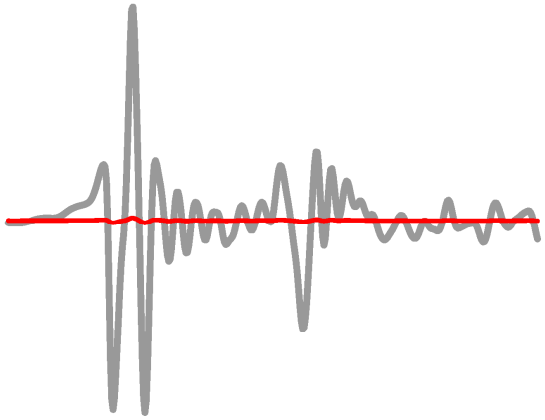


SPE–2: 1000 kg @ 46 m
13 Pa Peak to Peak



SPE–3: 900 kg @ 47 m
19 Pa Peak to Peak

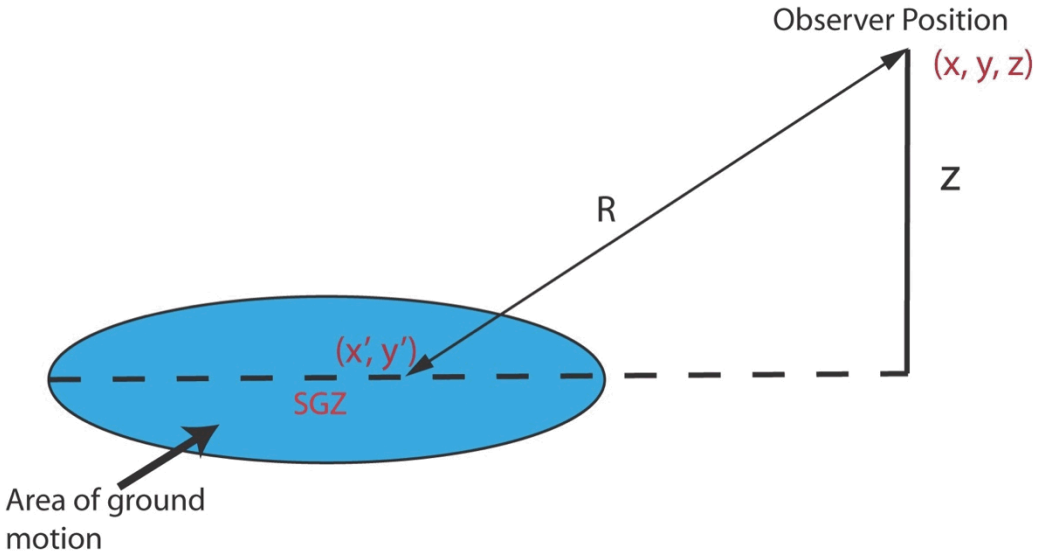
SPE–4P: 89 kg @ 87 m
0.19 Pa Peak to Peak

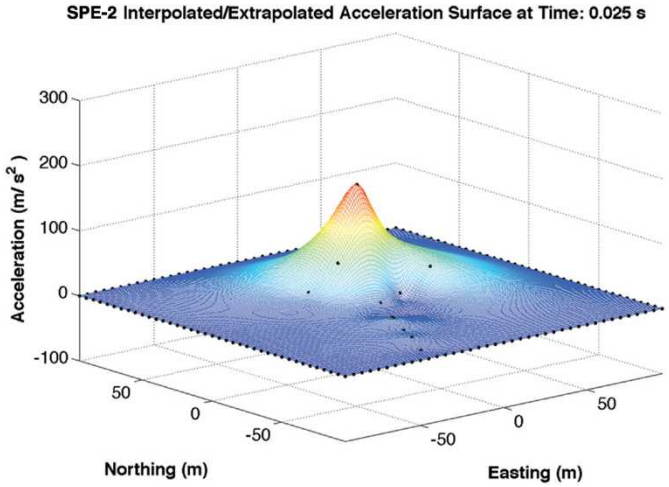


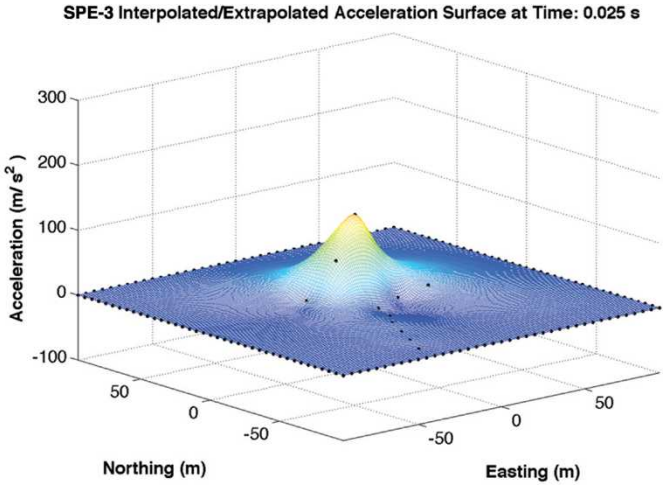
SPE–5: 5000 kg @ 77 m
16 Pa Peak to Peak

SPE–6: 2200 kg @ 31 m
36 Pa Peak to Peak

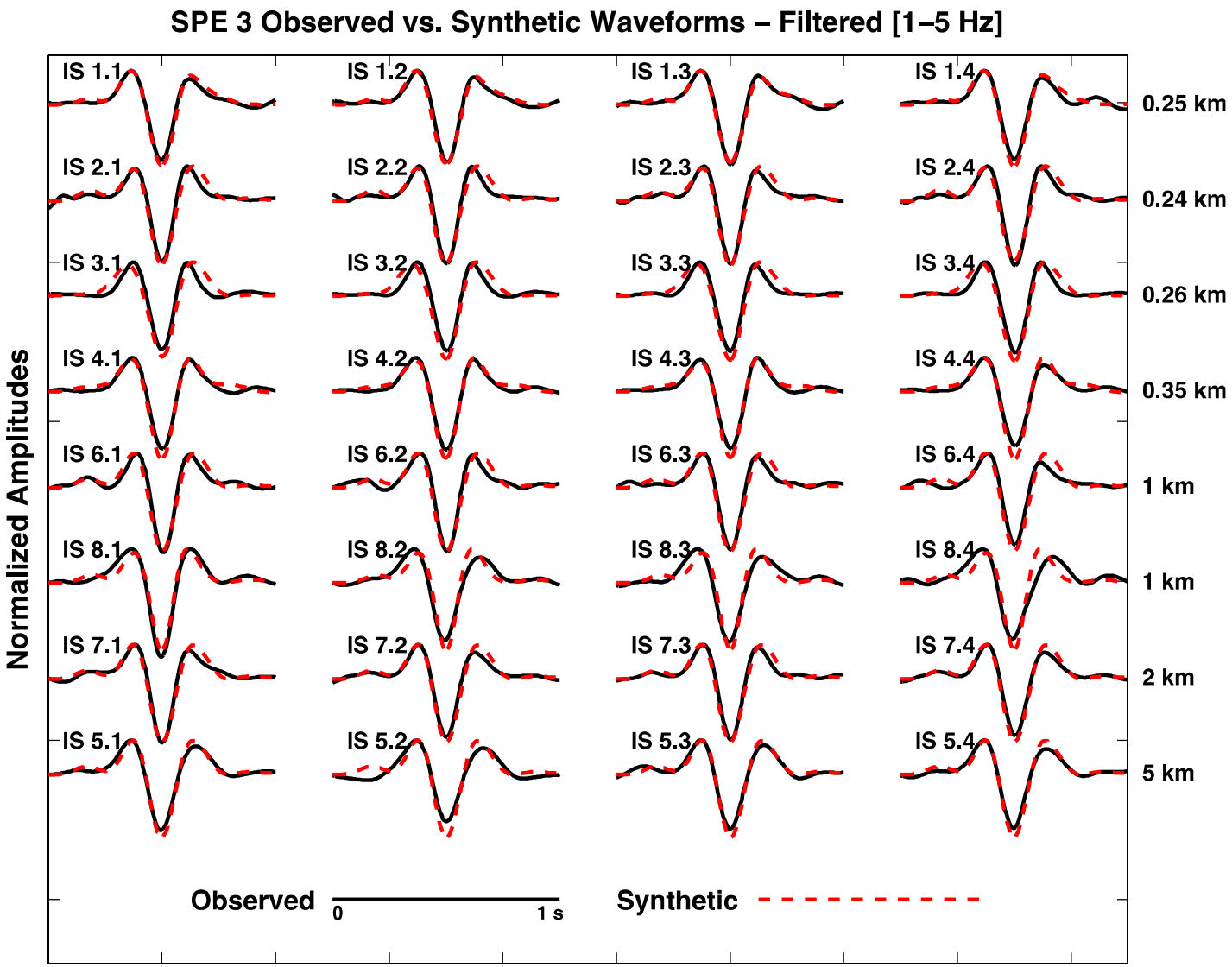
Source Modeling-Rayleigh Integral







Source Modeling-Rayleigh Integral



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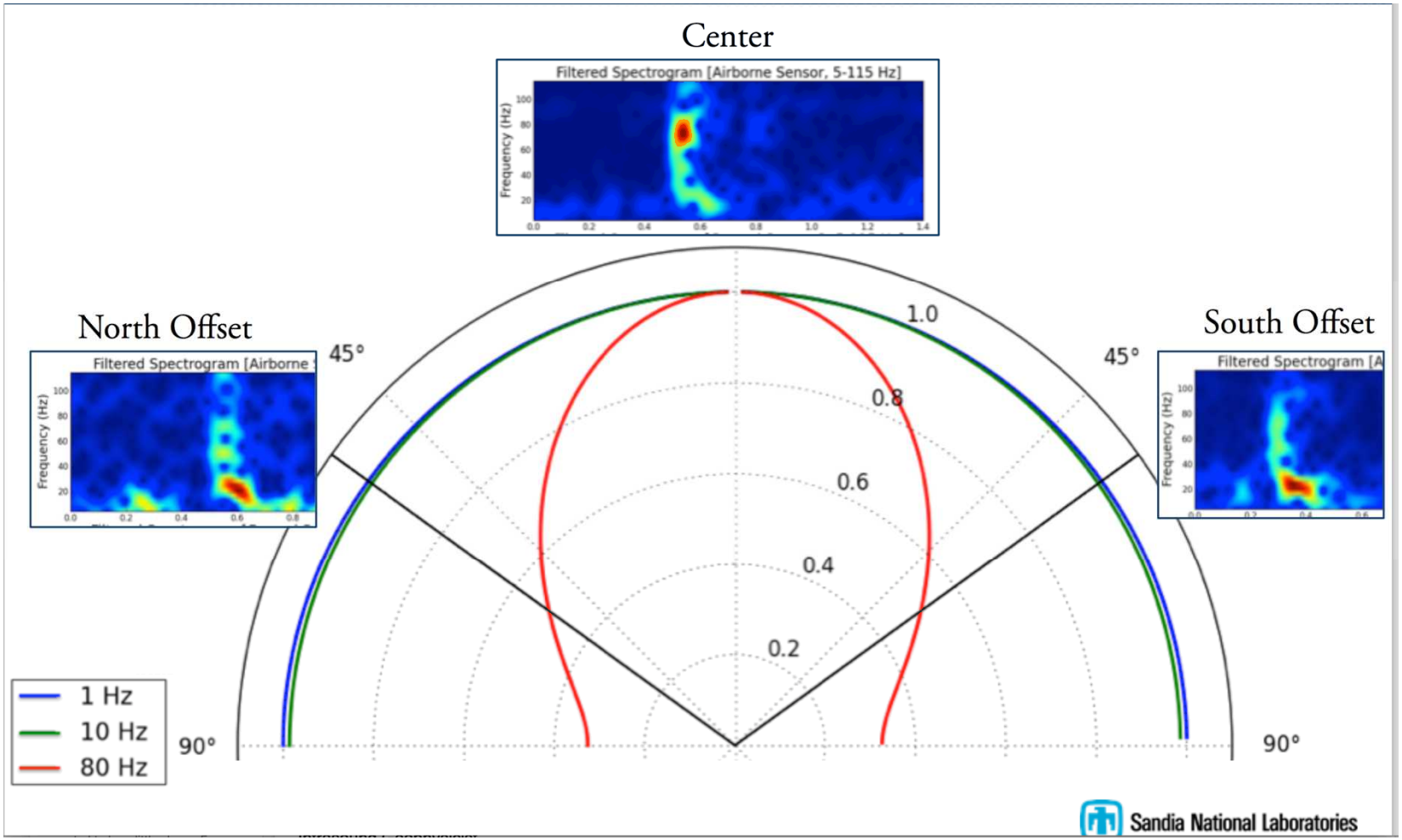
Radiation Pattern Modeling

National Nuclear Security Administration
Defense Nuclear Nonproliferation

Radiation Pattern Modeling



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Empirical Model: Overpressure

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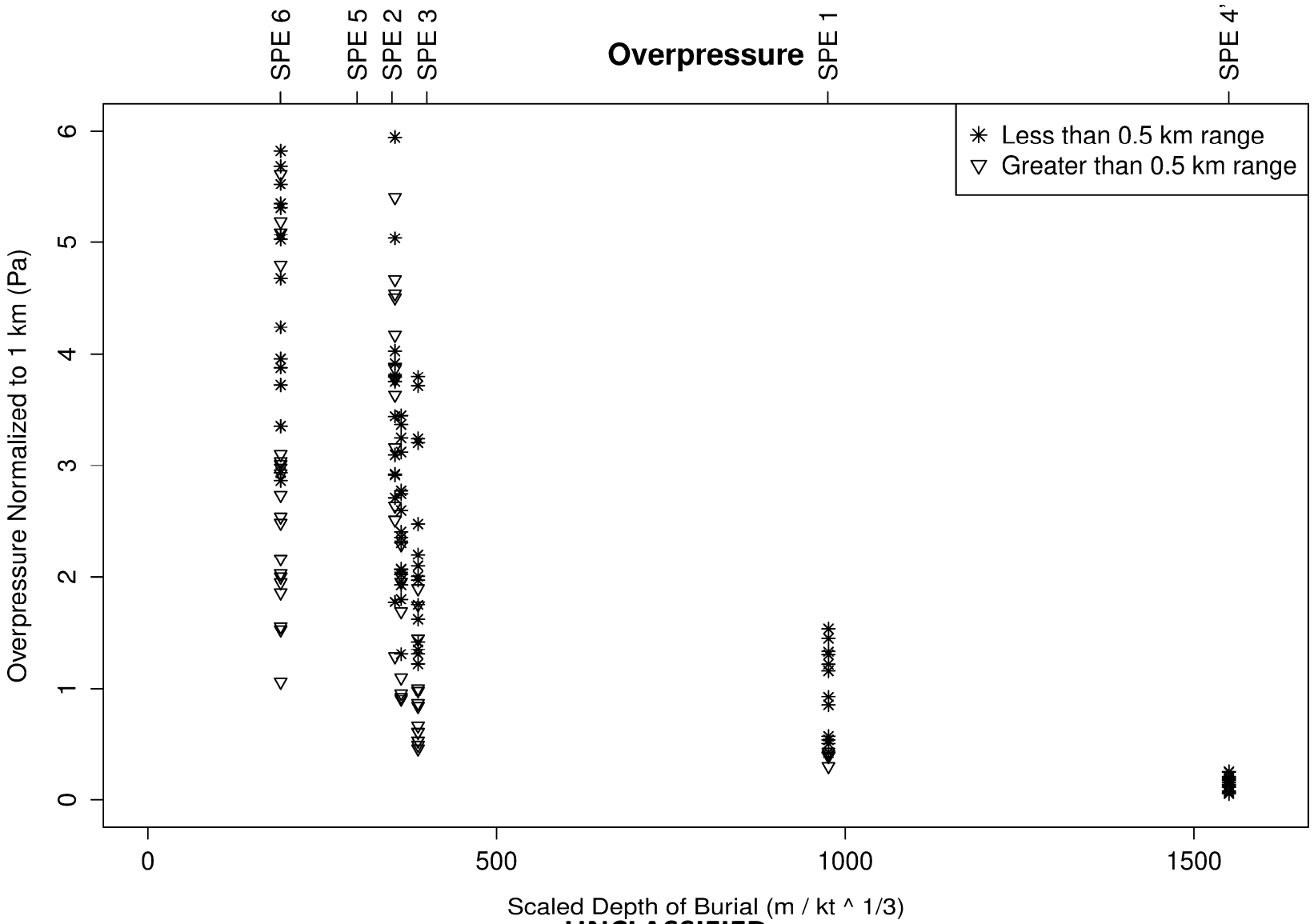
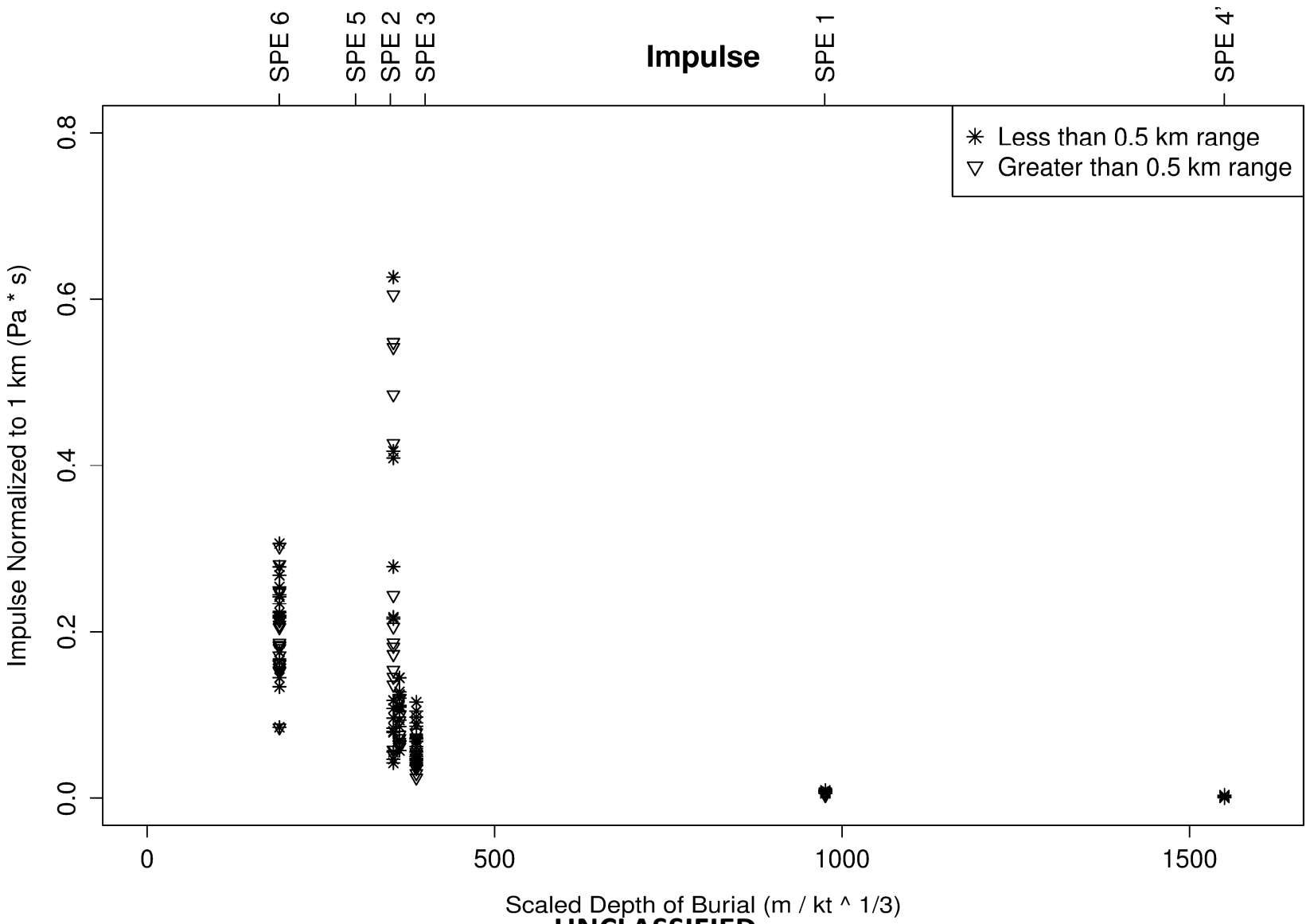
Defense Nuclear Nonproliferation



Empirical Model: Impulse



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Empirical Model: Frequency

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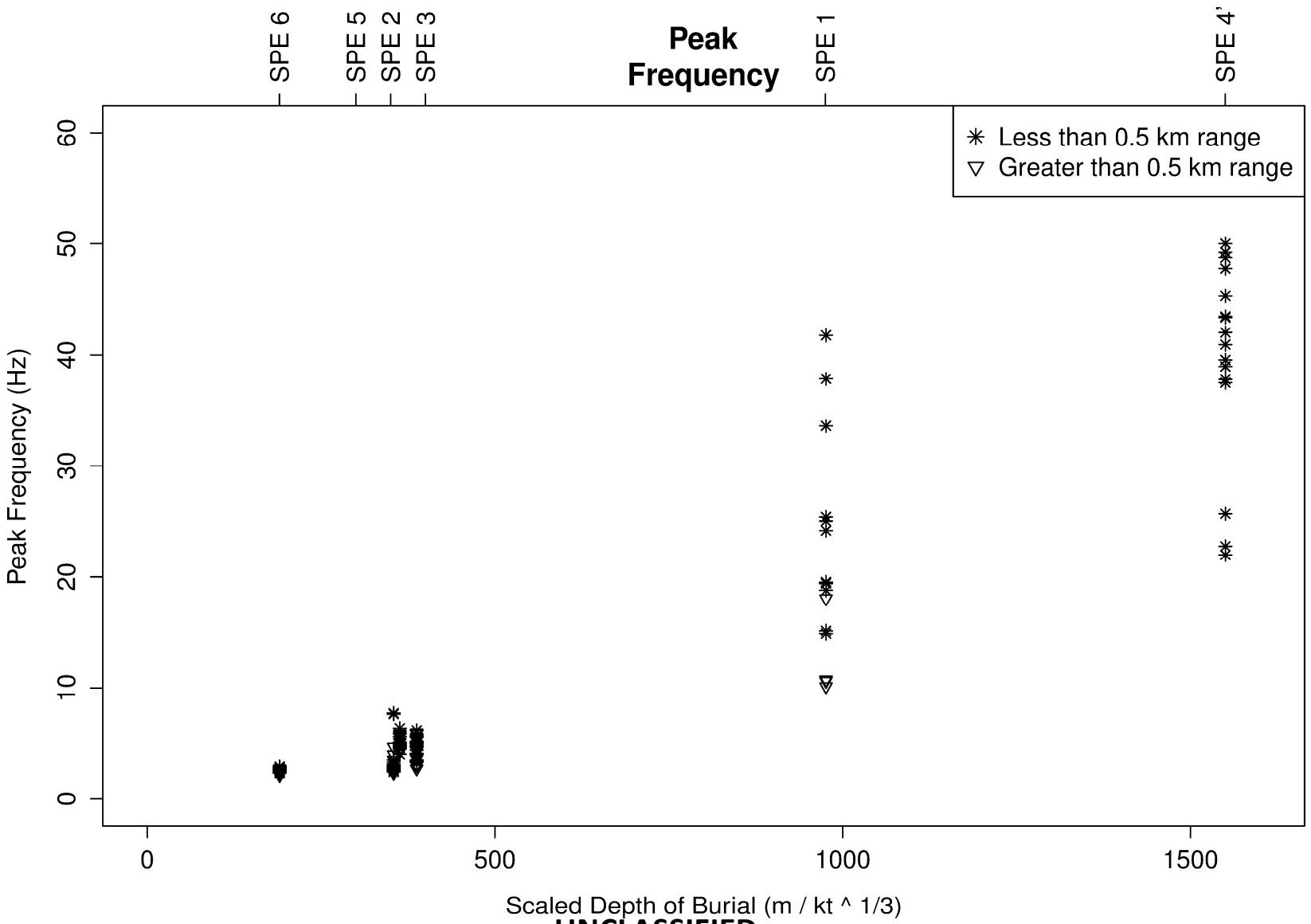
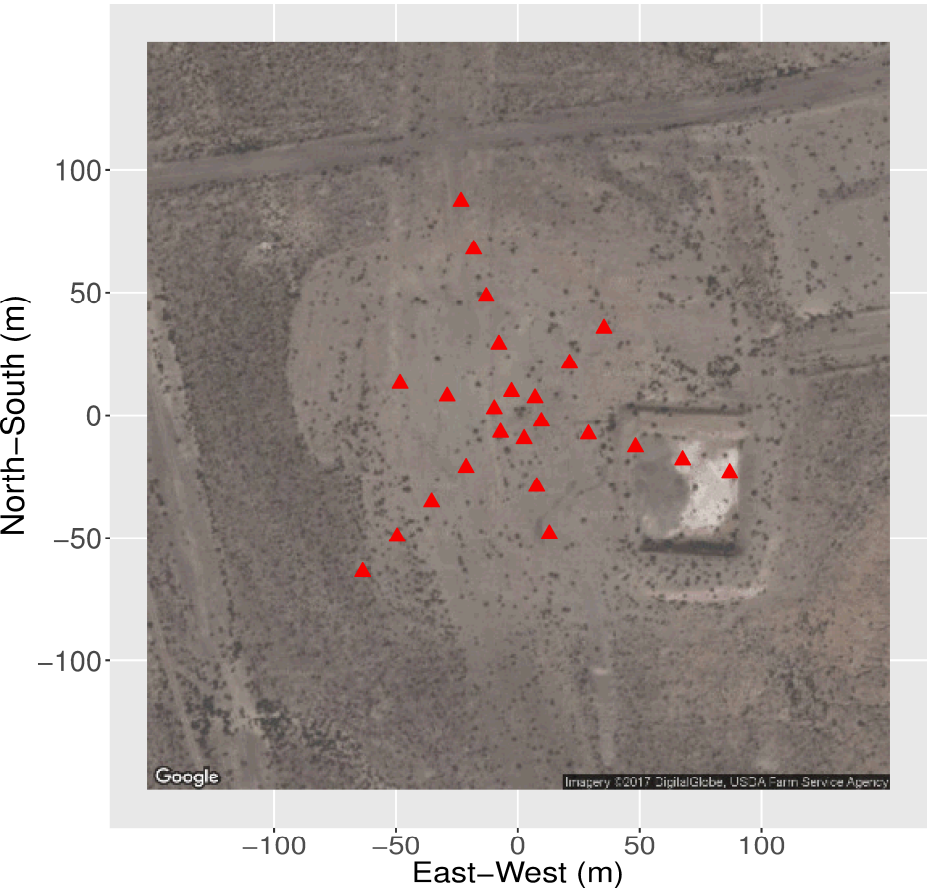
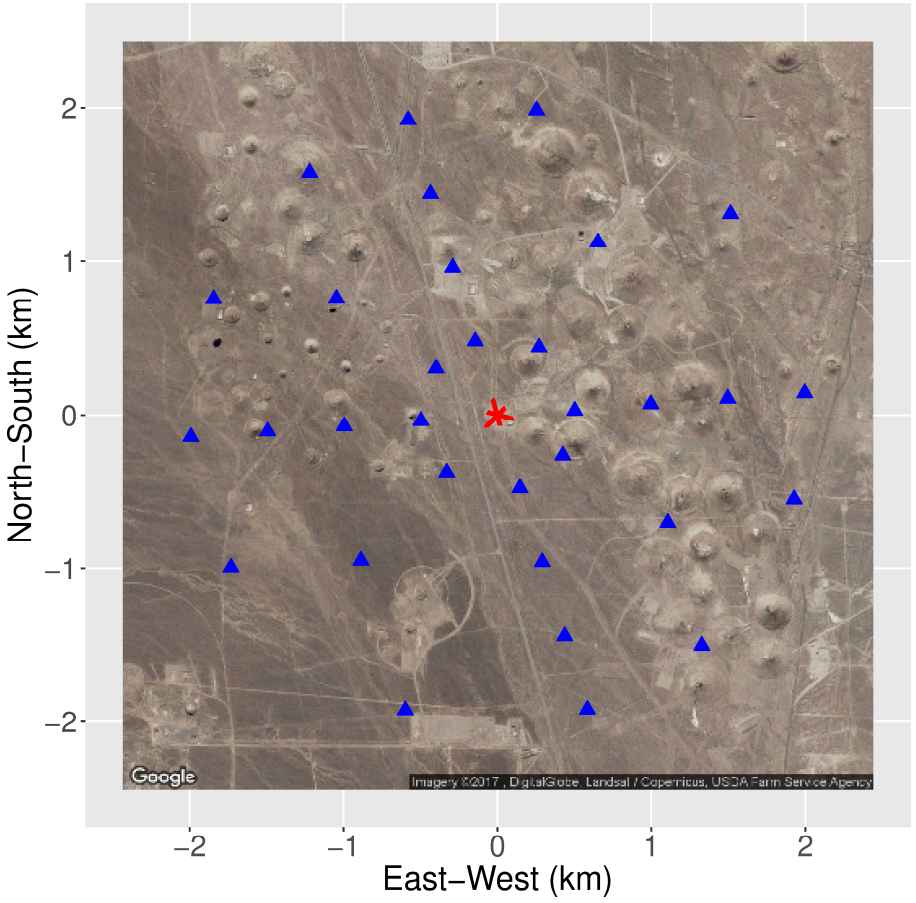


The DAG Geoacoustic Network

Surface Accelerometers



Surface Microphones



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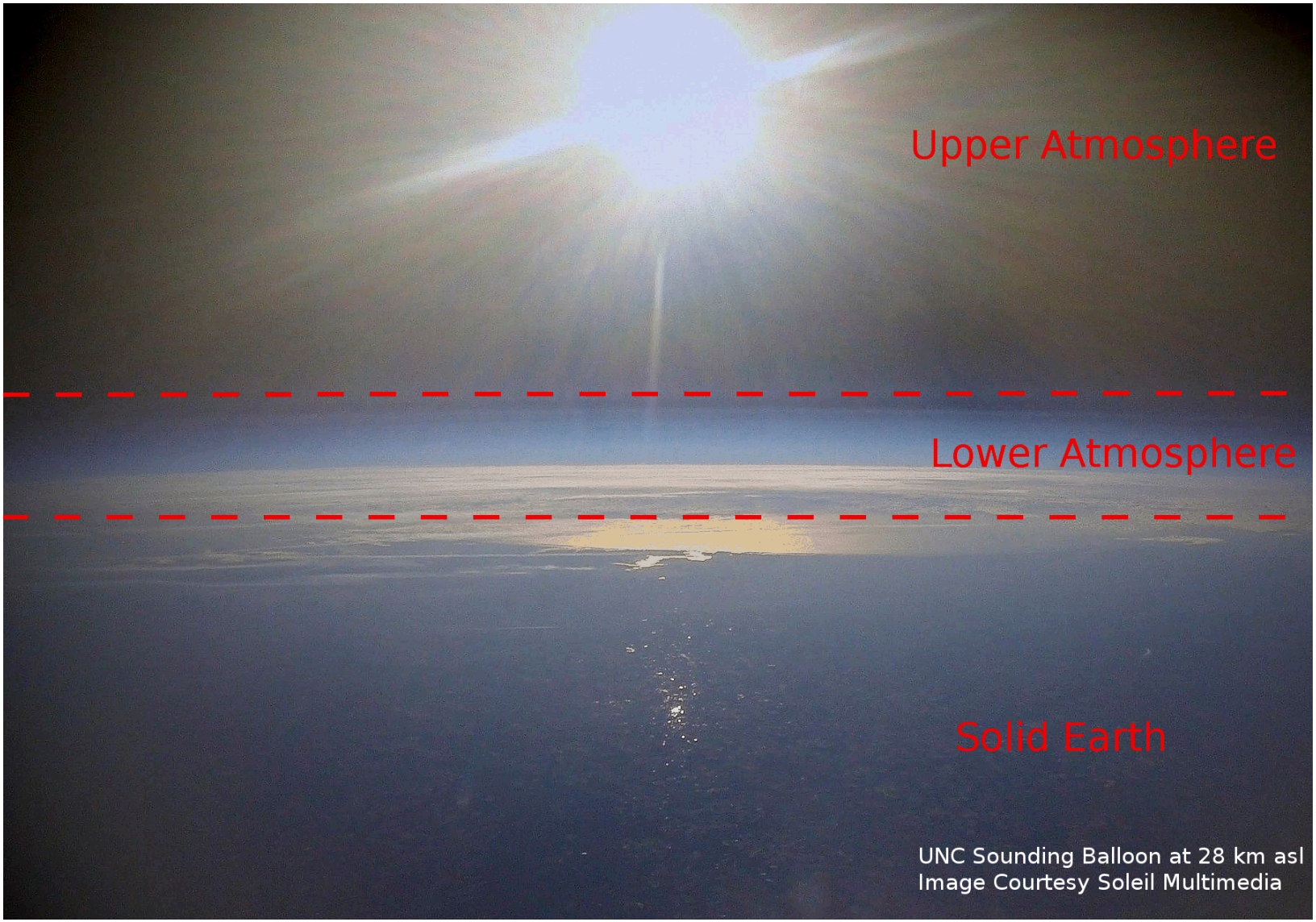
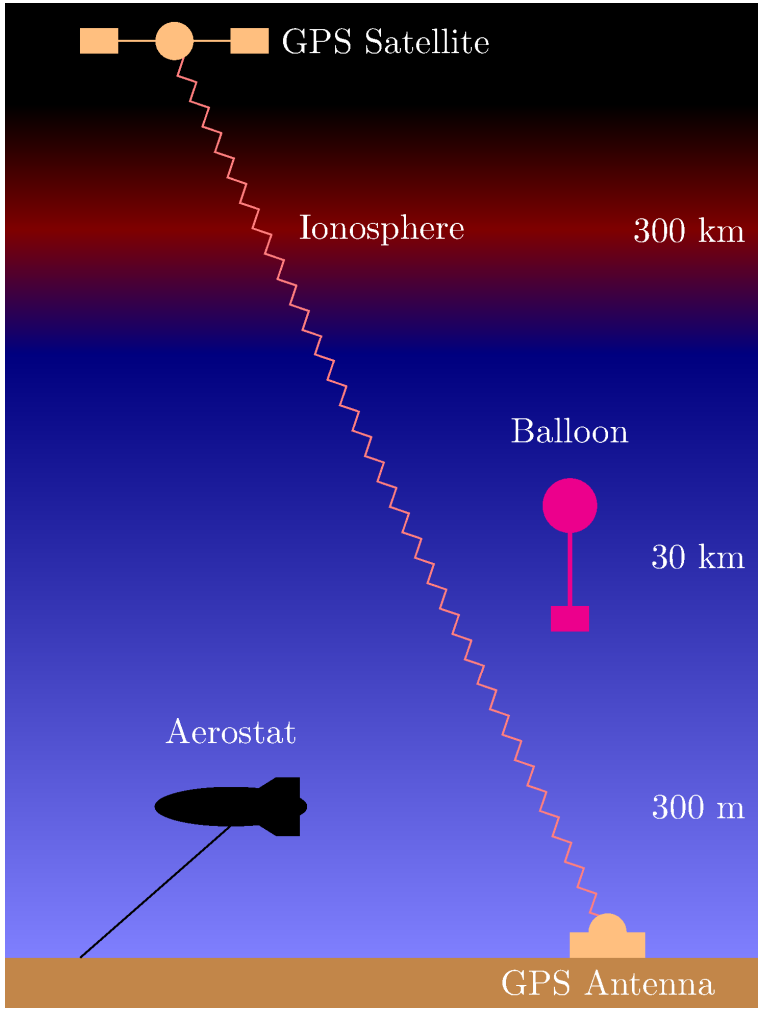
New Horizons

National Nuclear Security Administration
Defense Nuclear Nonproliferation

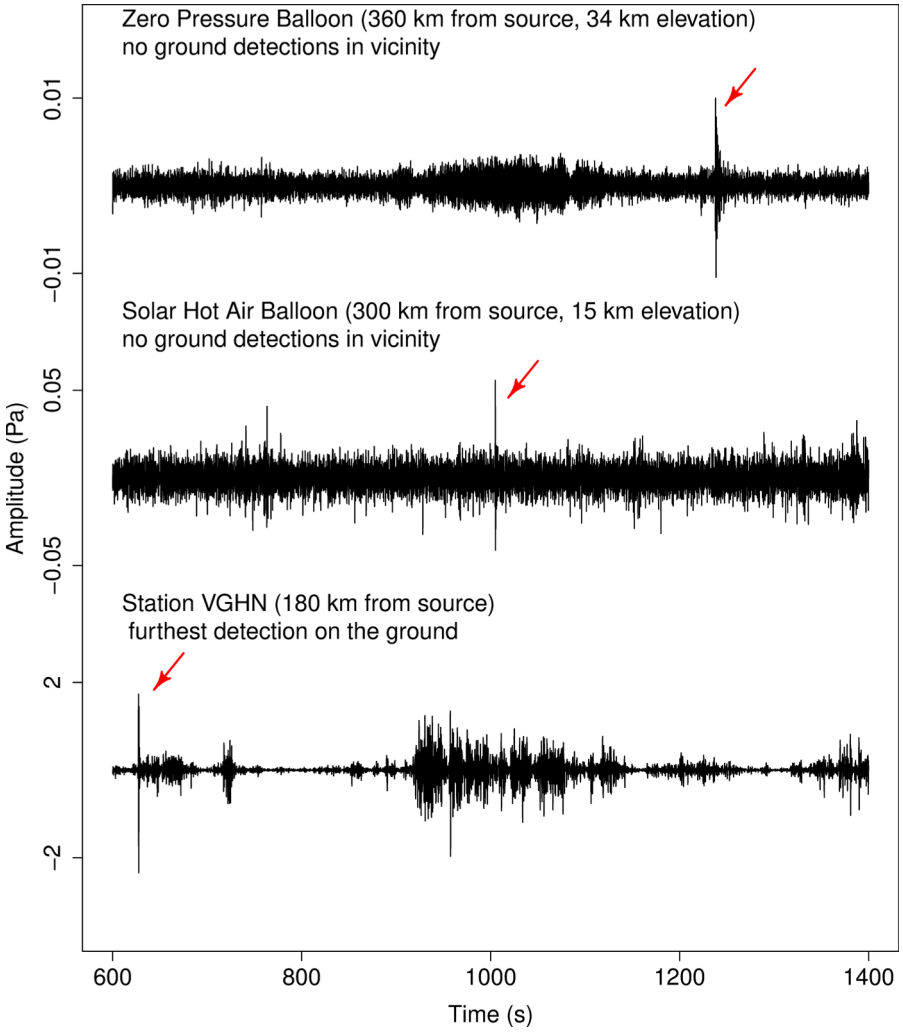


Geoacoustics Takes to the Sky

Airborne Detector Platforms



SISE/USIE 2016



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Conclusions

National Nuclear Security Administration
Defense Nuclear Nonproliferation

Achievements

- 100% data recovered from 6 underground explosions in granite (SPE Phase I)
- Wave form modeled via the Rayleigh Integral (Jones et. al., 2015*)
- 3-D acoustic radiation pattern measured from seismic hammer using octocopter
- Integrated acoustic and acceleration sensor network developed for DAG

Next Steps

- Execute DAG series
- Investigate relationship between burial depth, explosive yield, and acoustic signal
- Determine feasibility of acoustic source inversion using ground and airborne data
- Investigate other detection prospects (boundary layer, stratosphere, ionosphere)

Advance buried explosion acoustic theory with ground truth data.

*Jones, K. R., Whitaker, R. and Arrowsmith, S. J. (2015) Modeling infrasound signal generation from two underground explosions at the Source Physics Experiment. Geophysical Journal International 200, p. 779-790