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Seismo-acoustic Data Fusion: Determining the Best Acquisition Designs for Multi-Phenomenological Monitoring Campaigns

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ORAL PRESENTATION

National Nuclear Security Administration

SAND2021 – 3025 C

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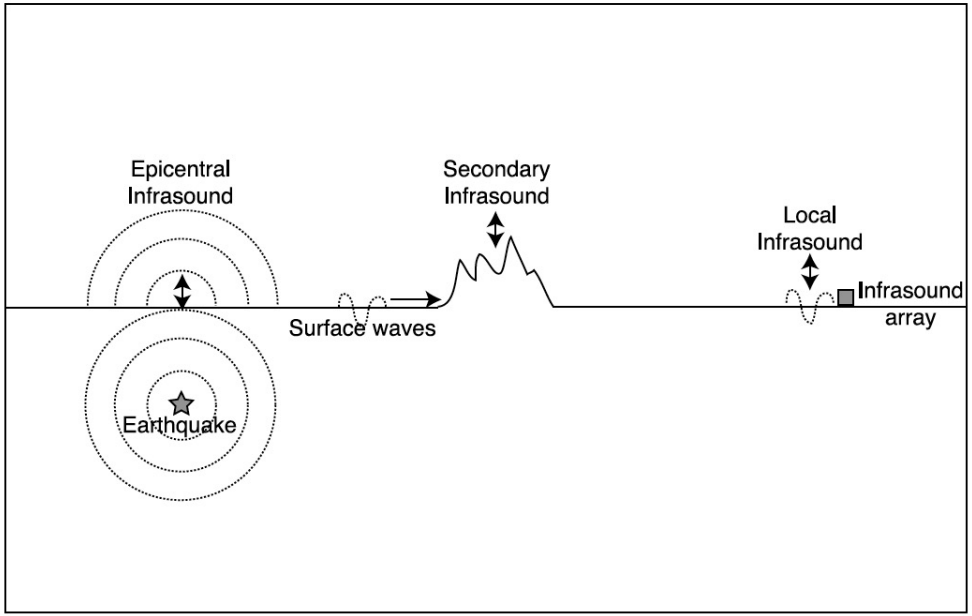
SEISMOACOUSTICS PRIMER

"[The] **solid-gas boundary** between the lithosphere and atmosphere has thus acted as an **intellectual boundary** between [seismology and infrasound]."
(Arrowsmith et al., 2010)



Arrowsmith et al., 2010

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SOURCES OF SEISMOACOUSTIC SIGNALS

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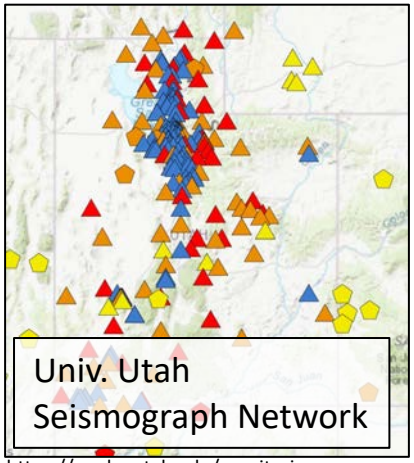
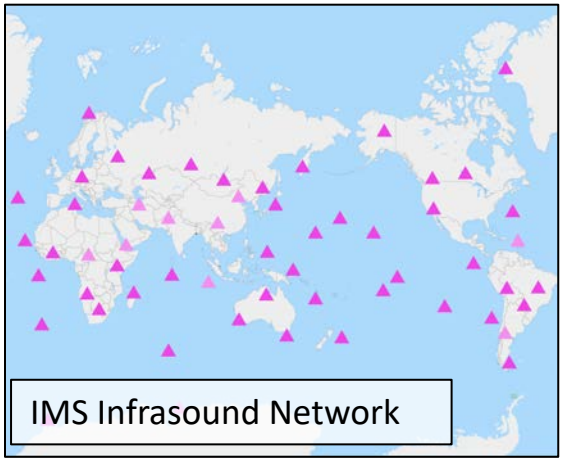
SEISMOACOUSTIC DATA COLLECTION

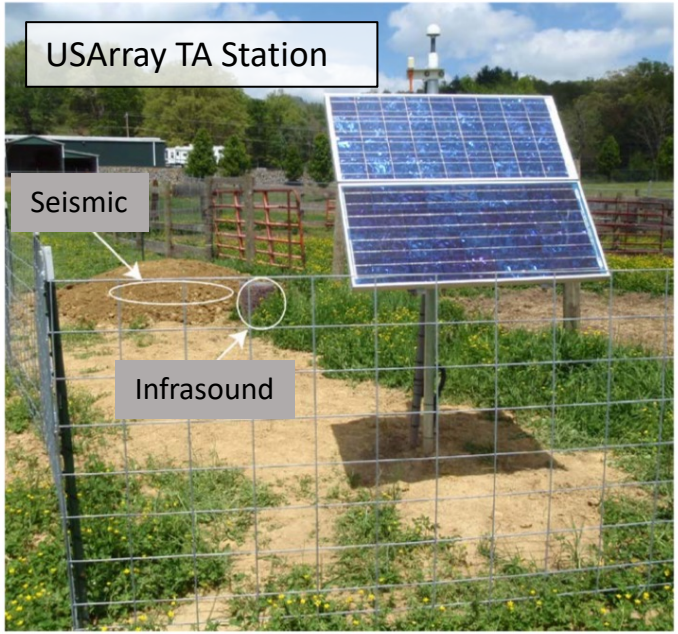
- USArray Transportable Array (TA) Stations
- Infrasound array networks, seismic networks
- Seismic and infrasound arrays not typically co-located



https://quake.utah.edu/monitoring-research/station-map



Modified from https://www.ctbto.org/map/



http://www.usarray.org/files/docs/pubs/L48_TA_Report/TA_L48.pdf

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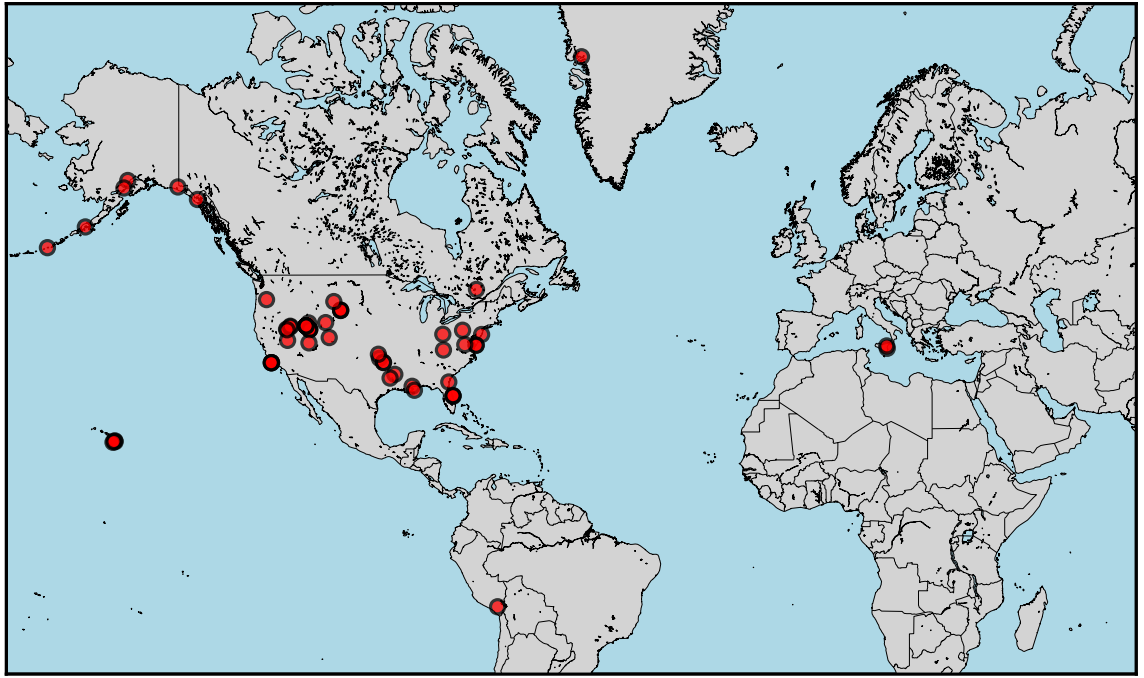
SEISMOACOUSTIC EVENT CATALOG

65 Events

- Recorded both seismic and infrasound arrivals
- Within 5 degrees of source
- Variety of source and station locations
- Covering 5 countries across the globe



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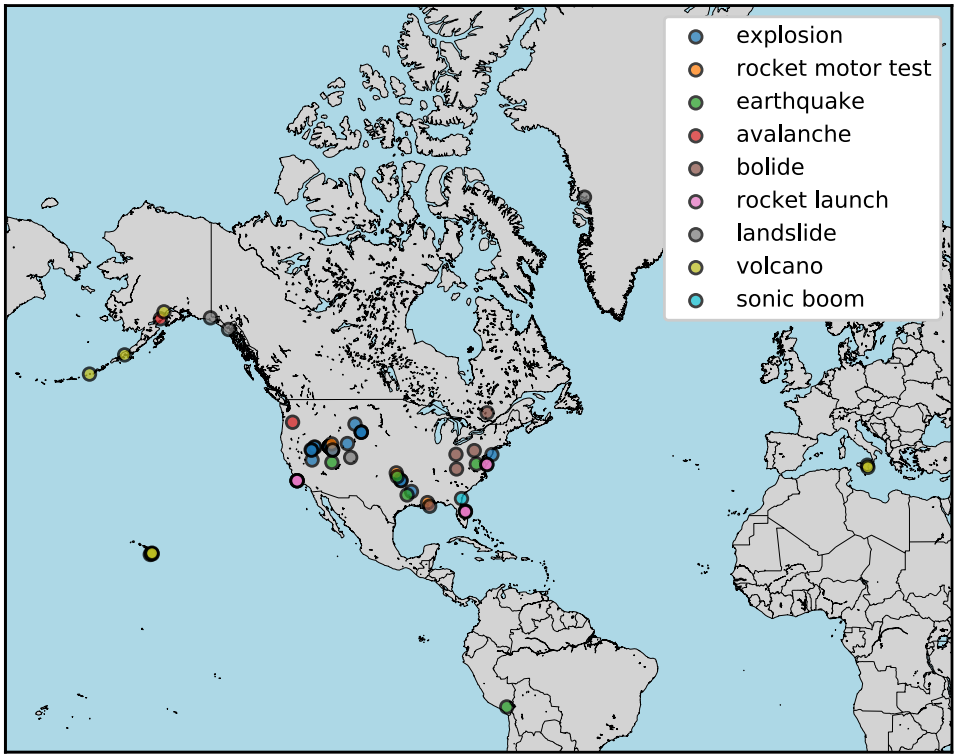
SOURCE TYPE VARIATION

Source Type	Number of Events
Explosion	27
Rocket Launch	9
Volcano	9
Landslide/Avalanche	6
Bolide	5
Earthquake	5
Rocket Motor Test	3
Sonic Boom	1
Total	**65**



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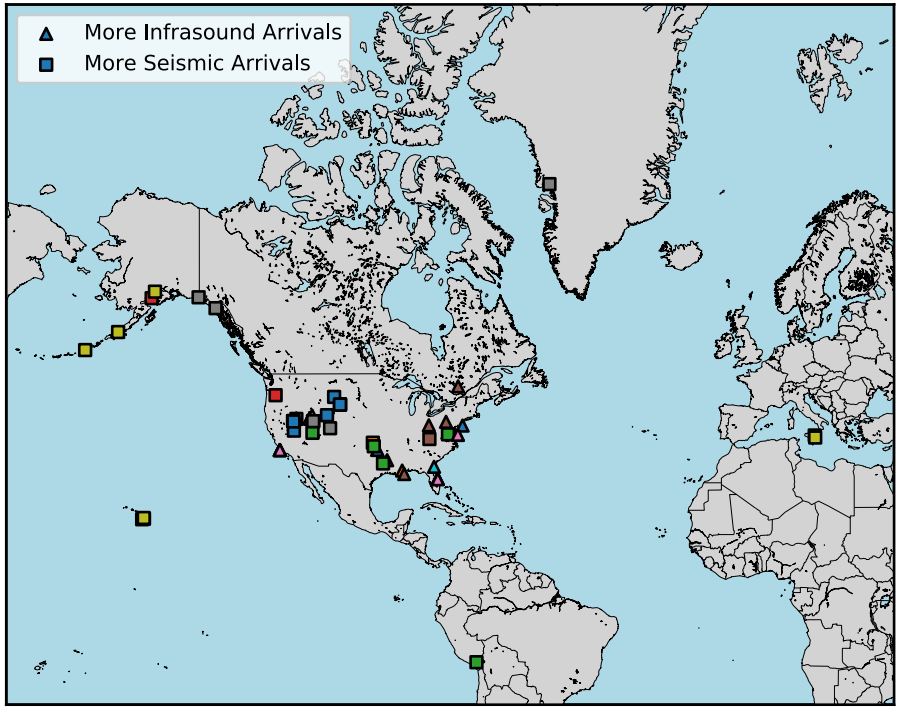
EVENTS BY MAJORITY OF ARRIVALS

Source Type	Events with More Infrasound Arrivals	Events with More Seismic Arrivals
Explosion	16	11
Rocket Launch	9	0
Volcano	0	9
Landslide/Avalanche	0	6
Bolide	4	1
Earthquake	0	5
Rocket Motor Test	2	1
Sonic Boom	1	0
Total	**32**	**33**



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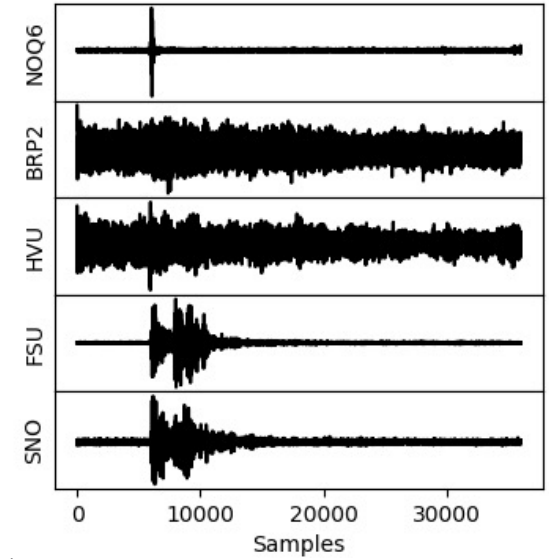
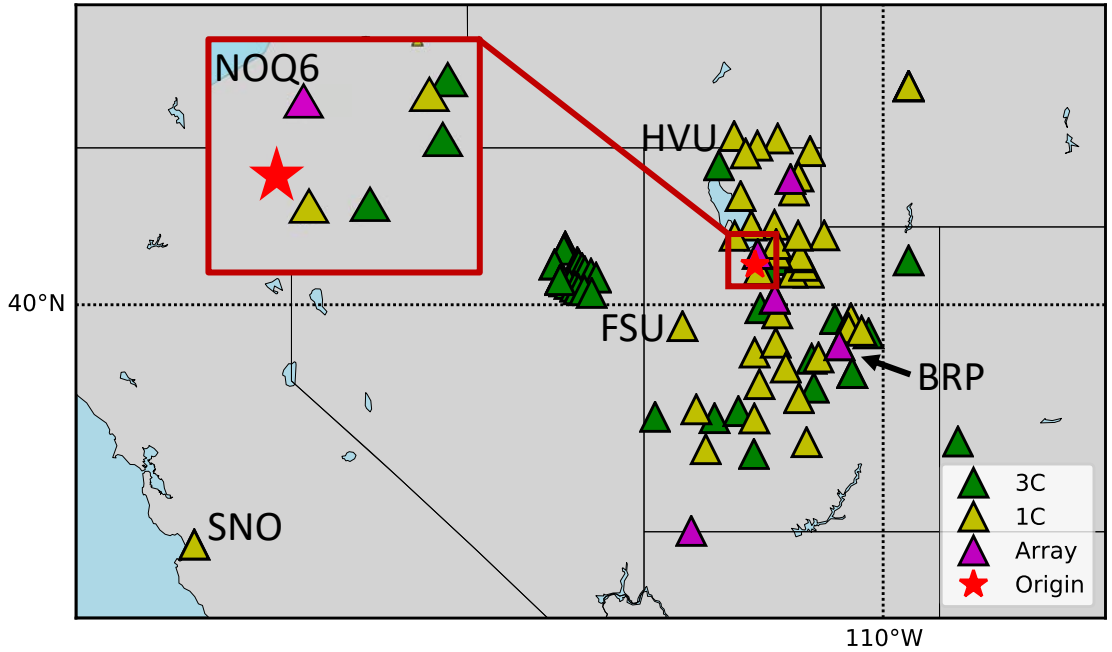
SEISMOACOUSTIC EVENT EXAMPLES

Bingham Canyon Mining Blast

Nov 11, 2011 23:11 UTC

1- 10 Hz bandpass





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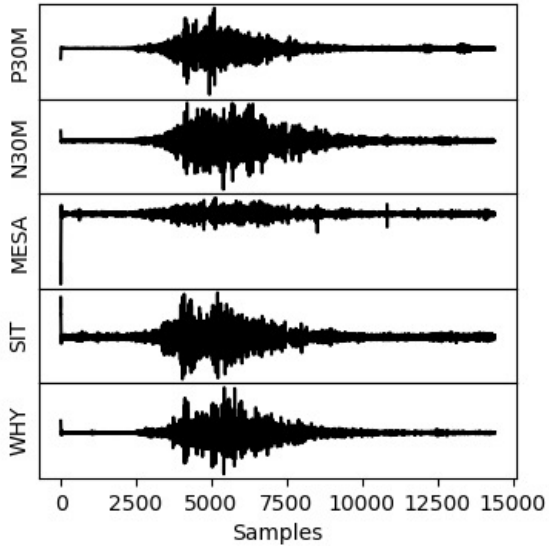
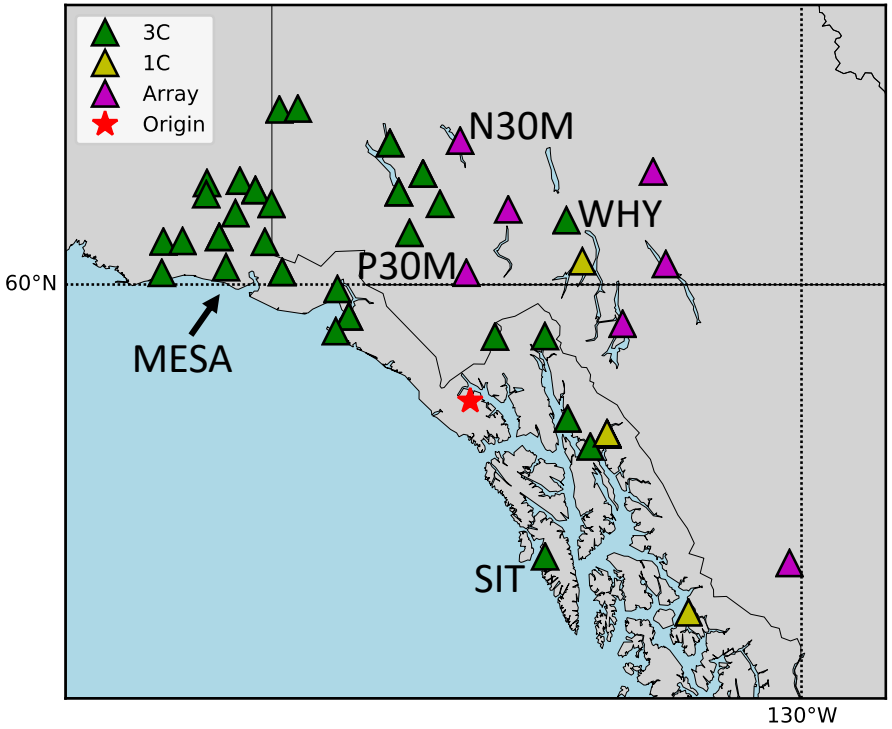
SEISMOACOUSTIC EVENT EXAMPLES

Lamplugh Glacier Rock Avalanche
June 28, 2016 16:20 UTC
1- 10 Hz bandpass





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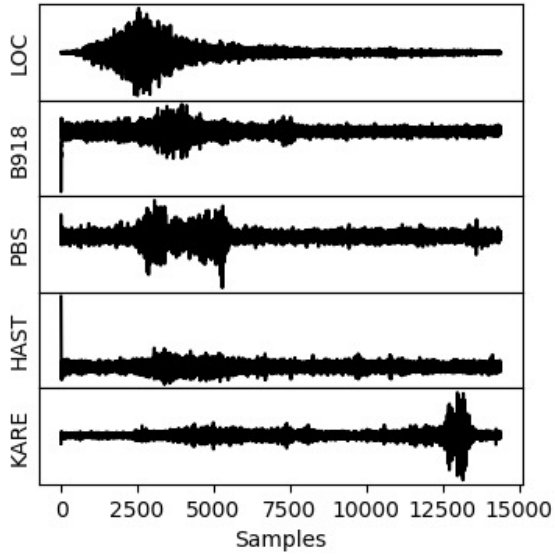
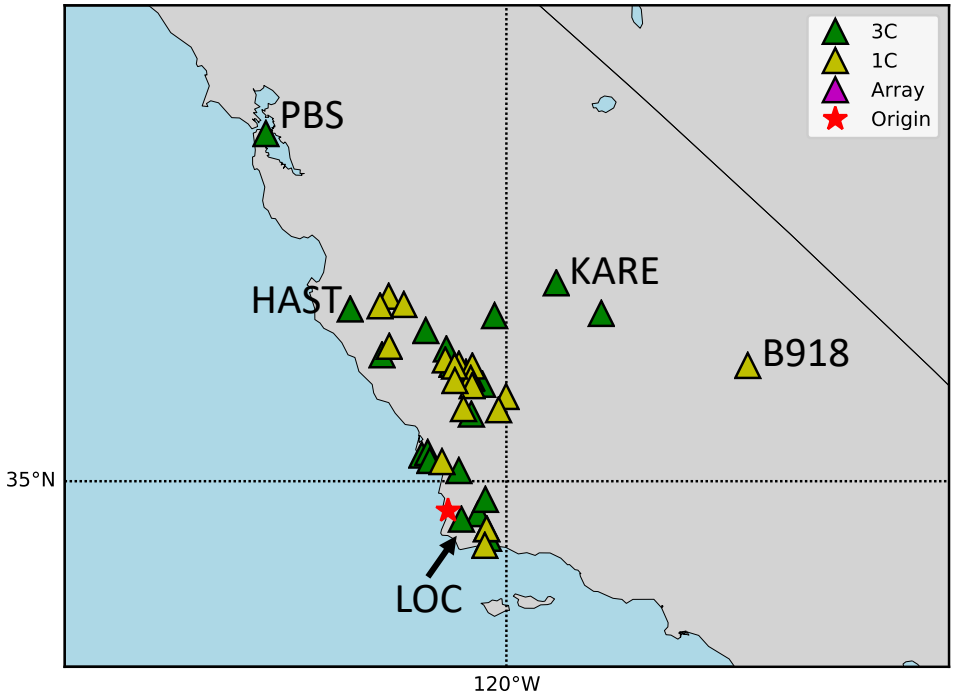
SEISMOACOUSTIC EVENT EXAMPLES

SpaceX Falcon 9 Launch
Jan 11, 2019 15:33 UTC
1- 10 Hz bandpass





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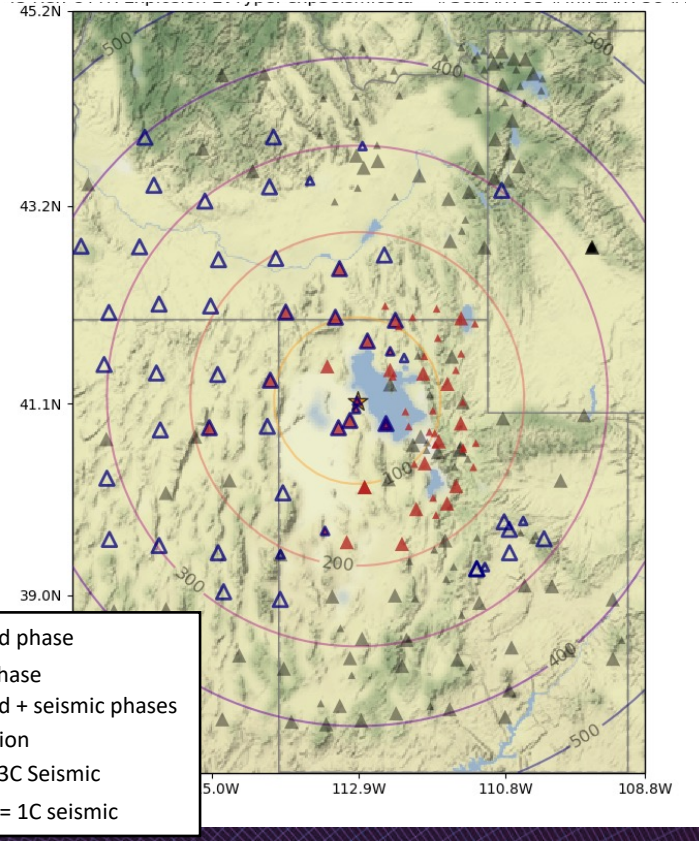
EVENT DEEP DIVE

Aug 1, 2007 20:01 UTC – Surface Explosion in Utah

Arrivals on seismic stations:

- Infrasound arrivals directed to the NW
  - Small cluster to SE
  - Likely related to atmospheric conditions
- Stations with both seismic and infrasound arrivals
  - Useful for joint inversion
- Majority of arrivals on 3C seismic sensors



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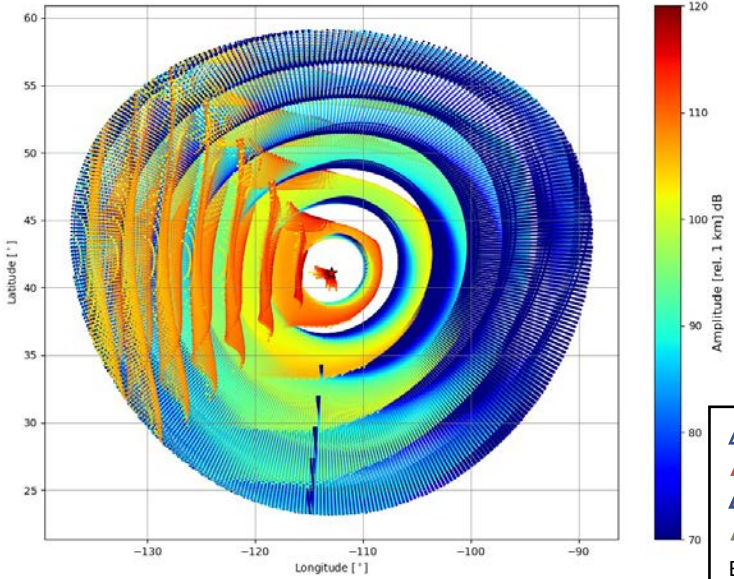
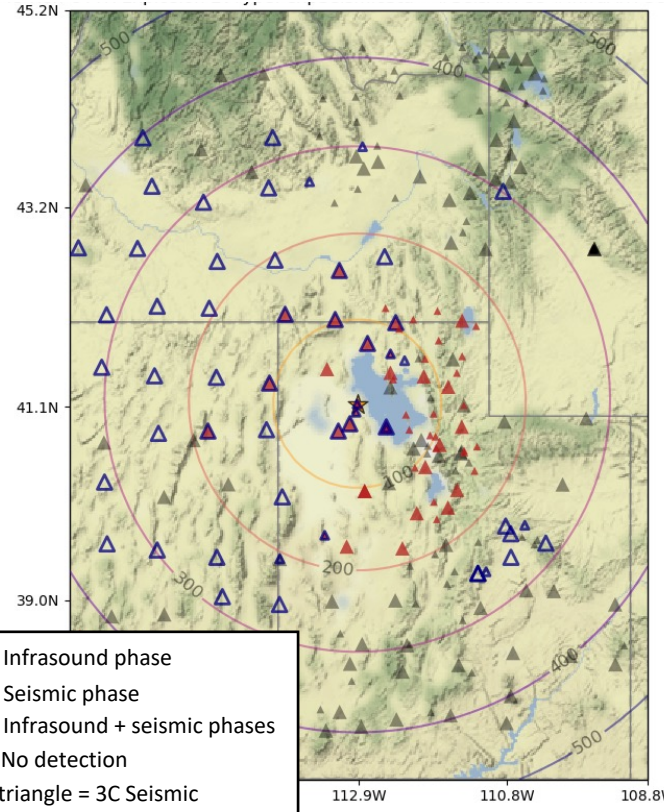
EVENT DEEP DIVE

Aug 1, 2007 20:01 UTC – Surface Explosion in Utah

Propagation modeling

- Shows clear acoustic duct to the West
- Correlated with infrasound detections





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CONCLUSIONS AND FUTURE WORK

Conclusions

1. Improved geographical and source diversity over other seismoacoustic catalogs
2. Atmospheric events are generally associated with more infrasound arrivals
3. Seismoacoustic waveform characteristics may provide insight into source type
4. Propagation modeling provides explanation for directed infrasound arrivals in example event

Future work

1. Seismoacoustic review paper expected August 2021
2. Seismoacoustic source location
3. Exploration of source processes and the advantages of using seismoacoustic monitoring

REFERENCES

1. Arrowsmith, S. J., Johnson, J. B., Drob, D. P., and Hedlin, M. A. H. (2010), The seismoacoustic wavefield: A new paradigm in studying geophysical phenomena, *Rev. Geophys.*, 48, RG4003, doi:10.1029/2010RG000335.