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# SANDIA INFRASOUND GROUND-TRUTH SIGNALS DATABASE (SINGS)

## *Developing a catalogue of infrasound events and arrivals for model calibration and validation*

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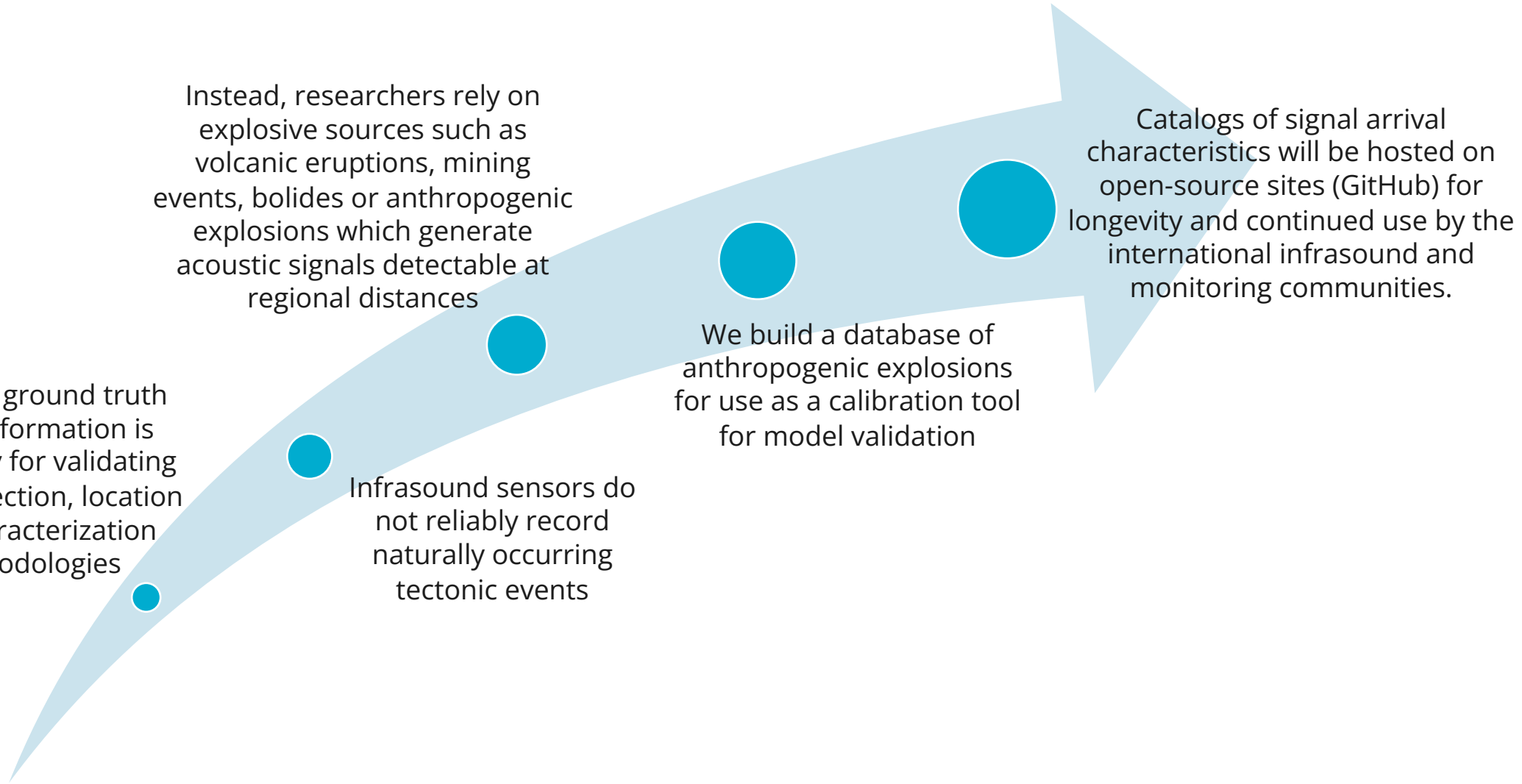
# BACKGROUND AND MOTIVATION

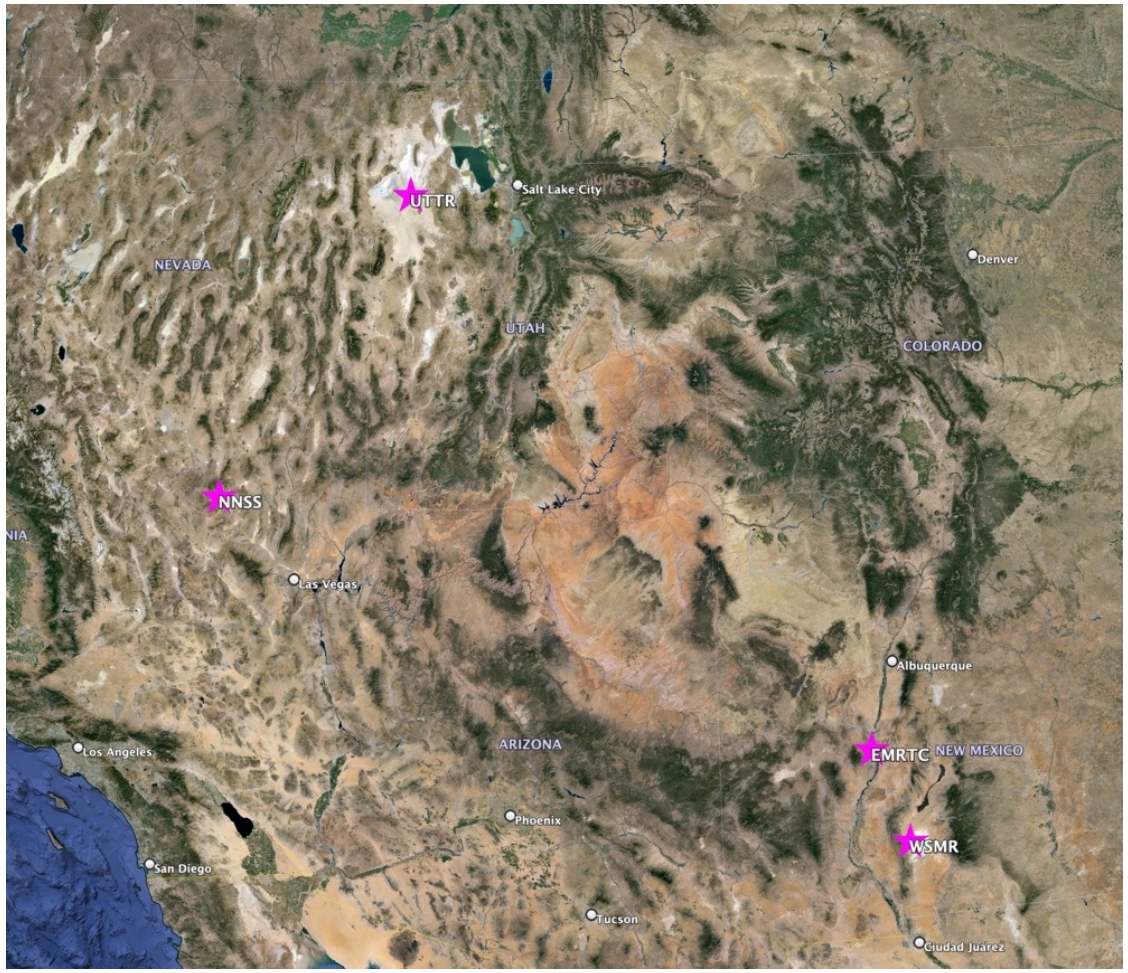


# BACKGROUND AND MOTIVATION

- Seismoacoustic waveform model development improves precision and accuracy in event characterization estimates by refining travel time models for infrasound signal propagation
- The SINGS database offers empirical infrasound arrival data from ground truth explosive tests in the Southwestern U.S.
  - This data can be used to refine transmission loss models, improving travel time estimates
- The SINGS database will aggregate arrival information in a standardized format so it can be used as inputs for network-level analysis including location and characterization, including yield estimation
- Consistent input information, i.e. arrival times, amplitudes, peak frequencies, signal duration, across events reduces uncertainties in network-level estimation
- **Key improvement = ability to hone in on improvements related to algorithms rather than inputs**

# THE DATASET

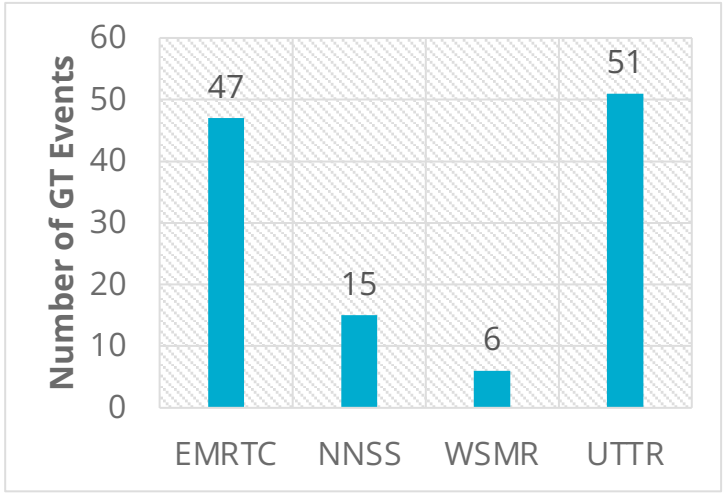
- Curated source information for 119 explosive events which generated regional infrasound signals in the American Southwest
- Data sources include:
  - Publicly available literature
  - Reports available from the U.S. Department of Energy Office of Scientific and Technical Information
  - Conversations with network operators and campaign managers
- Some events in the GT dataset have signal arrival data documented in scientific literature, but arrivals are not identified in a consistent and reproducible manner

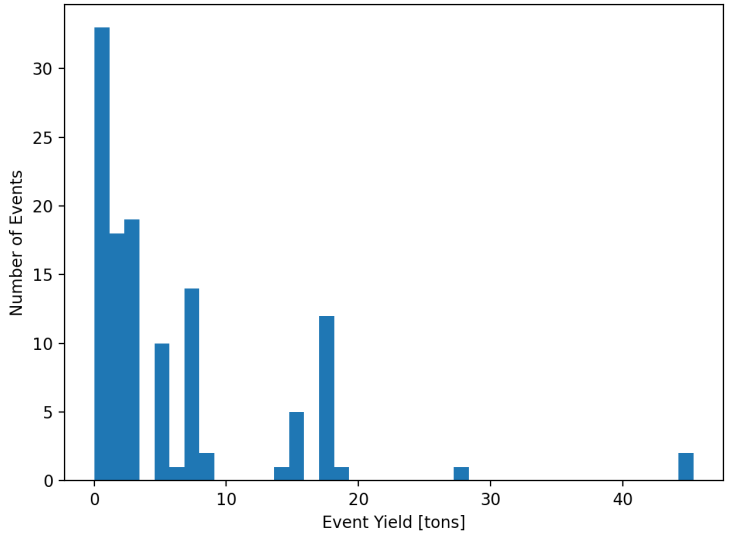



Data from Utah Testing and Training Range, Energetic Materials Testing Center, Nevada National Security Site, and White Sands Missile Range

# GROUND TRUTH EVENT TABLE

- Included explosions took place from 2002–2023
- Yield ranges from 0.1–45 tons
- All included explosions were conducted at the surface
- Some events at UTTR are rocket motor tests. In these entries, the number of motors is listed in the GT table
- This GT table is separate from the SINGS arrival tables, and was completed prior to building the main database




| EVENT ID | Date | Time (UTC) | Latitude | Longitude | Elevation | Weight | Weight | Weight | No. Motors | Depth | Product /Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm/dd/yyyy | hh:mm:ss | degrees | degrees | meters | lbs | kg | tons | | meters | |

# DATABASE TABLES

- SINGS is structured after CSS3.0 (Anderson et al., 1990), with new tables specifically designed to record infrasound arrival information
- The new tables are tied in each other and back to the existing CSS3.0 tables via common variables

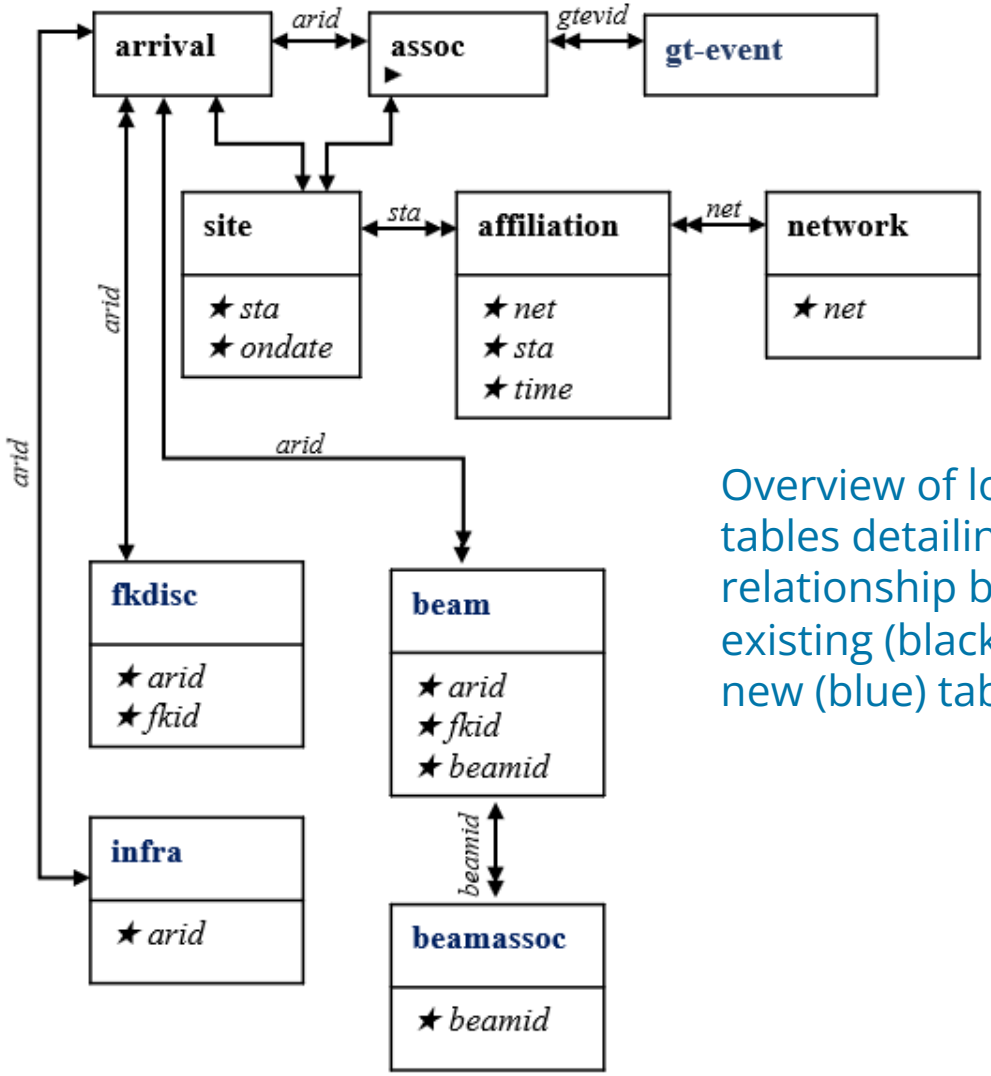
## SINGS TABLES

- fkdisk – table focused on frequency-wavenumber (fk) information
- infra – table focusing on infrasound information
- beam – describes beams from accompanying data
- beamassoc – connects beams to the station, channel, and instrument that were used to generate it

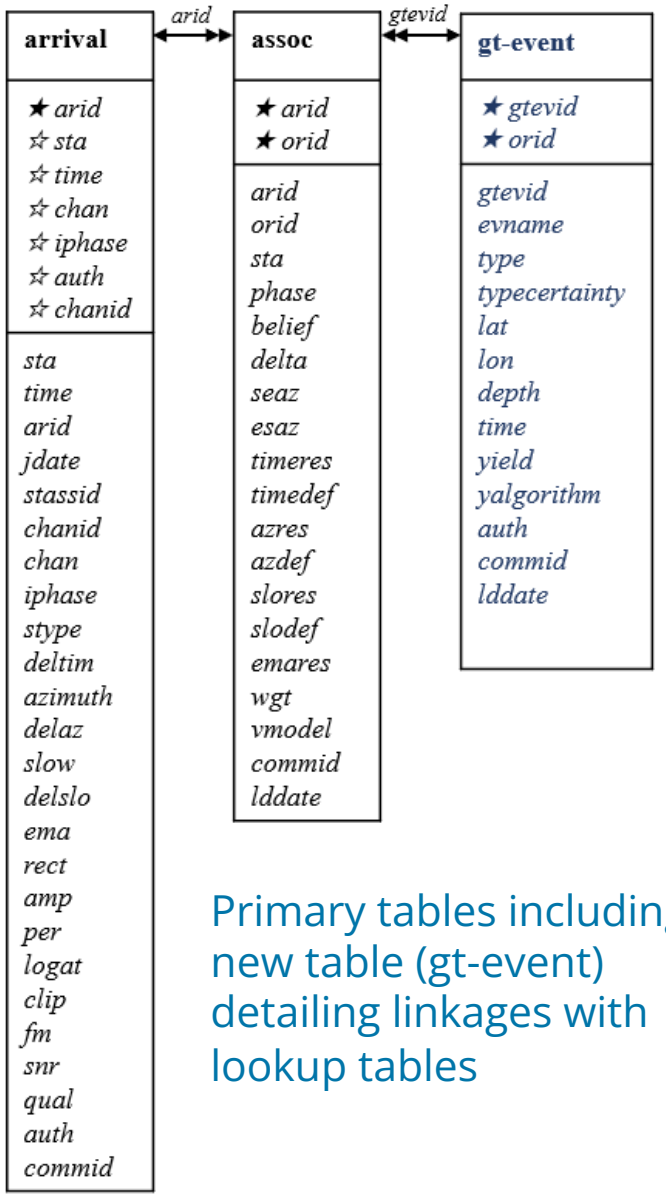
## CSS3.0 TABLES

- **Note:** seismic-specific variables in CSS3.0 tables are excluded from the SINGS data tables
- arrival – summary information on arrivals
- assoc – table that connects arrivals to GT events
- affiliation – network station affiliations
- network – description and ID
- site – station location and on/off dates

# TABLE CONNECTION AND INTEGRATION




Overview of lookup tables detailing relationship between existing (black) and new (blue) tables



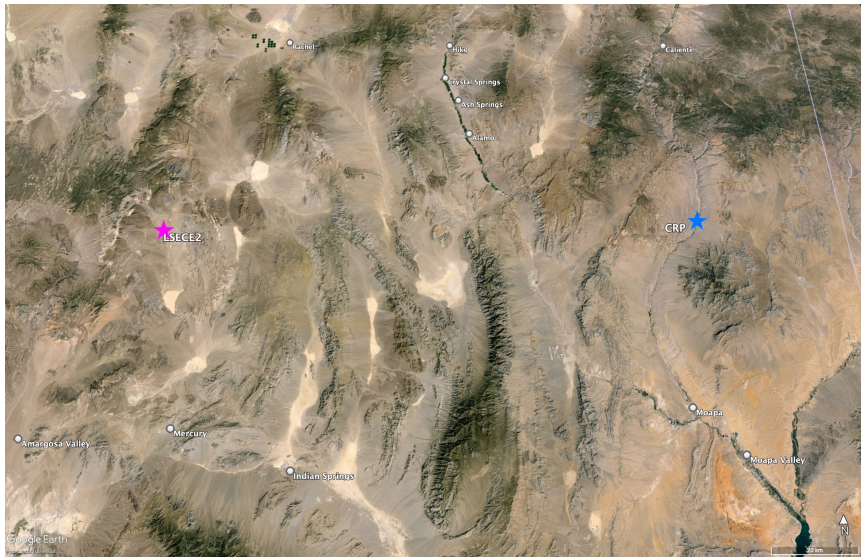

Primary tables including new table (gt-event) detailing linkages with lookup tables

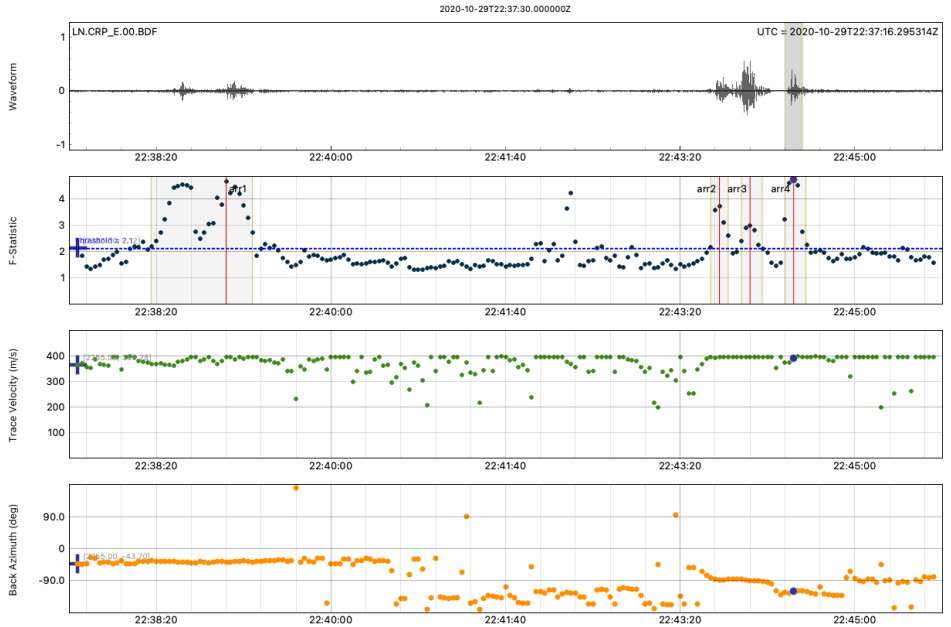
# SIGNAL ARRIVALS – SINGLE STATION PICKING AND PROCESSING

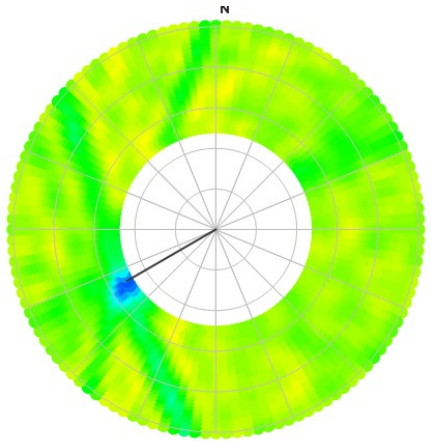
- Infrasound time series and frequency data at regional distances from events in the GT table was pulled from publications, Sandia datasets available on OSTI.gov, and openly available EarthScope data.
- Data was trimmed to fast (0.4 km/s) and slow (0.2 km/s) acoustic travel times based on source to receiver distance
  - Waveform data in these windows for each infrasound station was inspected for possible arrivals
- Waveforms were demeaned, detrended, and bandpass filtered from 1-20 Hz
- Arrival onset times, peak amplitude times, and coda length were manually picked and recorded using Pyrocko's Snuffler tool

# SIGNAL ARRIVALS – ARRAY PICKING AND PROCESSING

- The same initial process for identifying waveforms was use as in single station cases
- Los Alamos National Laboratory's InfraPy array processing tool suite was used
  - 10 second windows with 50% overlap, bandpass filtered at 1-20 Hz




**Calculated Back Azimuth:** -121.05
**Calculated Trace Vel:** 391.36 m/s

# CONCLUSIONS AND CONTINUING WORK

- An evolving version of this dataset will be available in coming weeks via a Sandia hosted, open-source data sharing platform
- This database is an ongoing effort, and we aim to add new events as data becomes available
- Feedback is welcome– the dataset is meant as a useful and useable resource

THANK YOU!

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