Progress in NET-VISA Infrasound analysis

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Major Improvements since early 2015

- Static prior using a whole year's worth of data
- Clutter model to avoid building events from gas flares, for example
- Disentangling seismo-acoustic versus pure infra associations
- Identified minimal set of infrasound detection features
  - azimuth, celerity, trace velocity, energy, frequency
  - *dropped* -- consistency, family size, and duration
- Reducing spurious seismo-acoustic associations
- Highlights:
  - LEB overlap from 24.7% to 42% (2013 infrasound events)
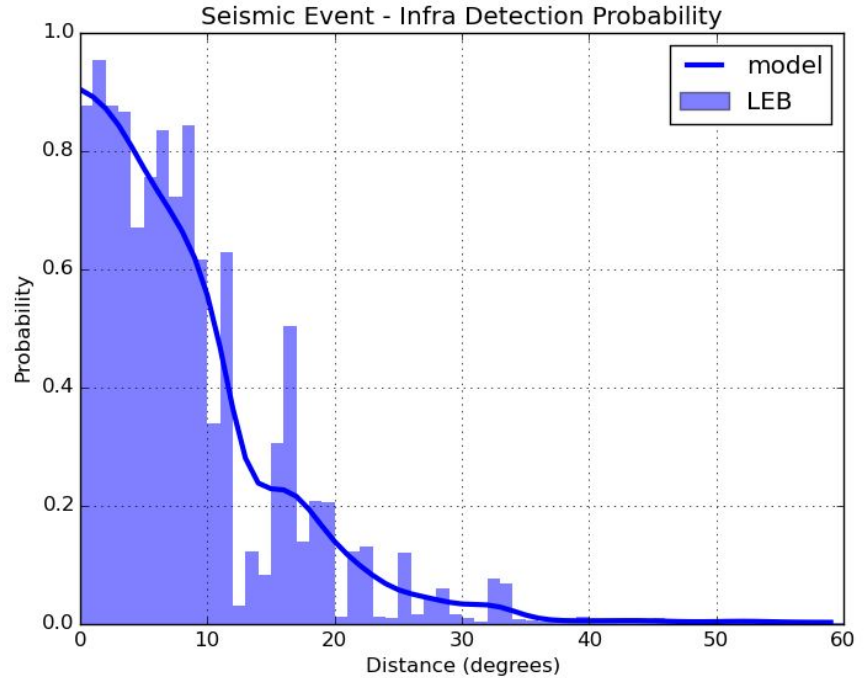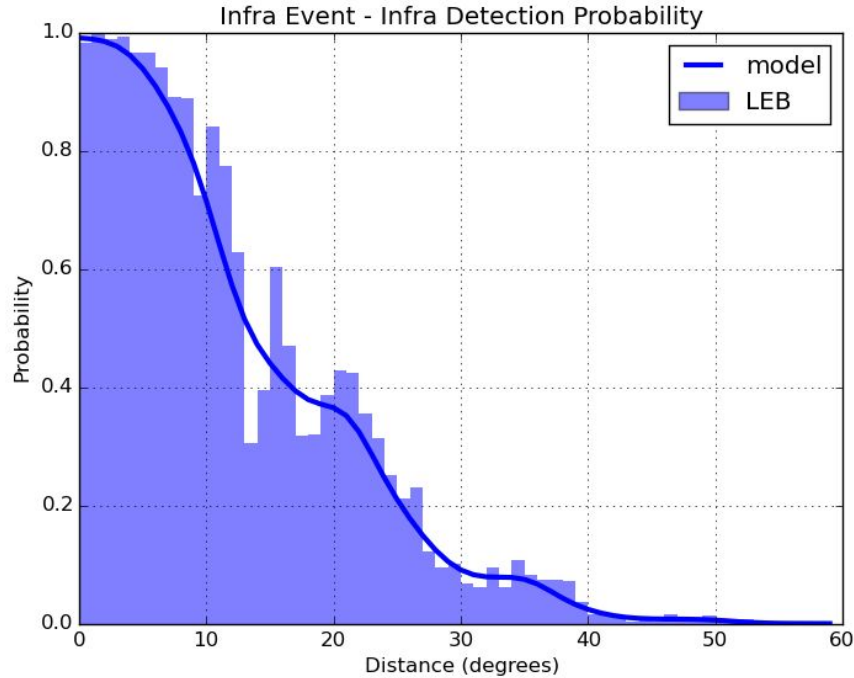 - 90% reduction in spurious seismo-acoustic associations (2013 SHI)
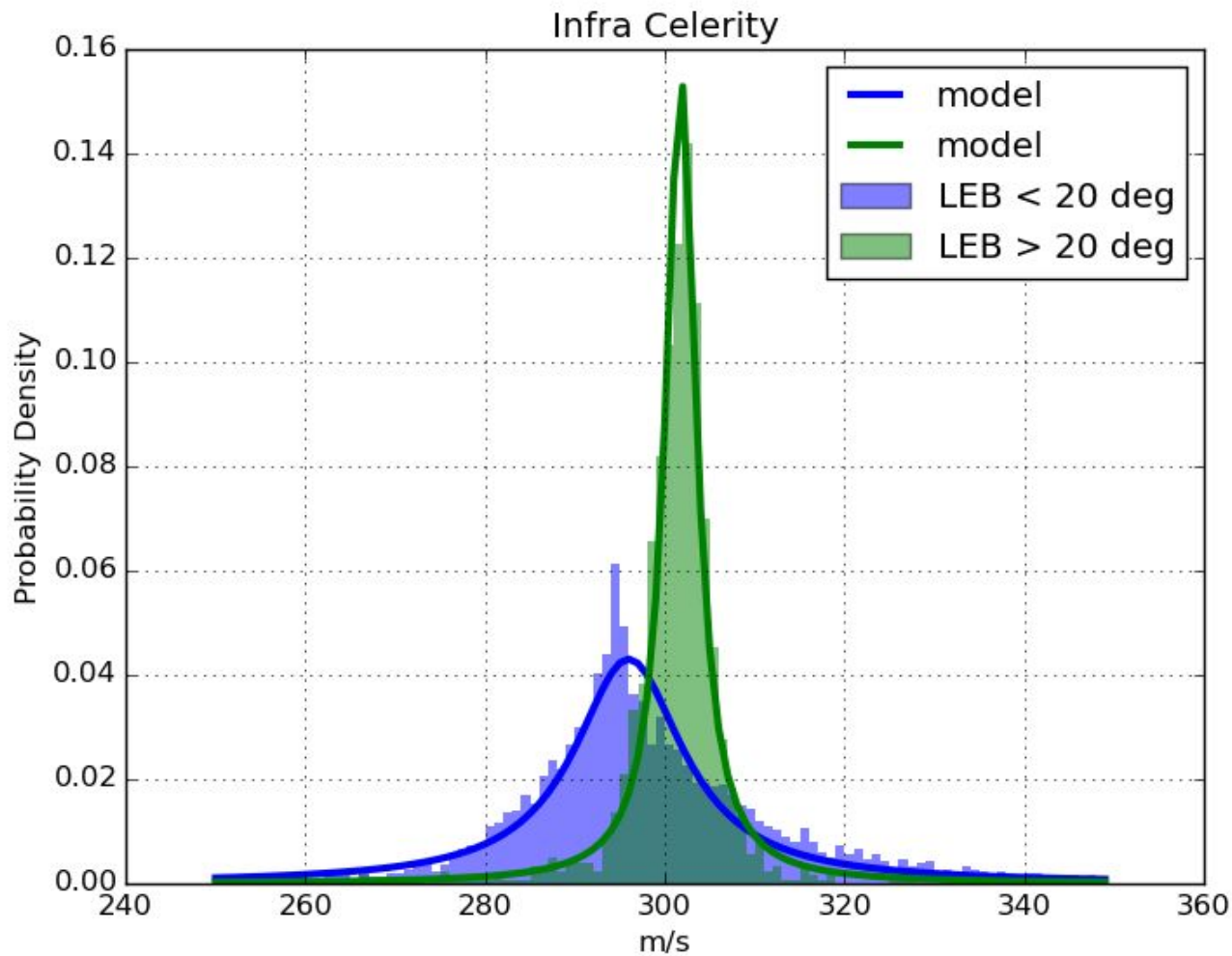
Overview

- Key Elements of the Infrasound Model
- Event Formation Criteria
- Inference
- Results

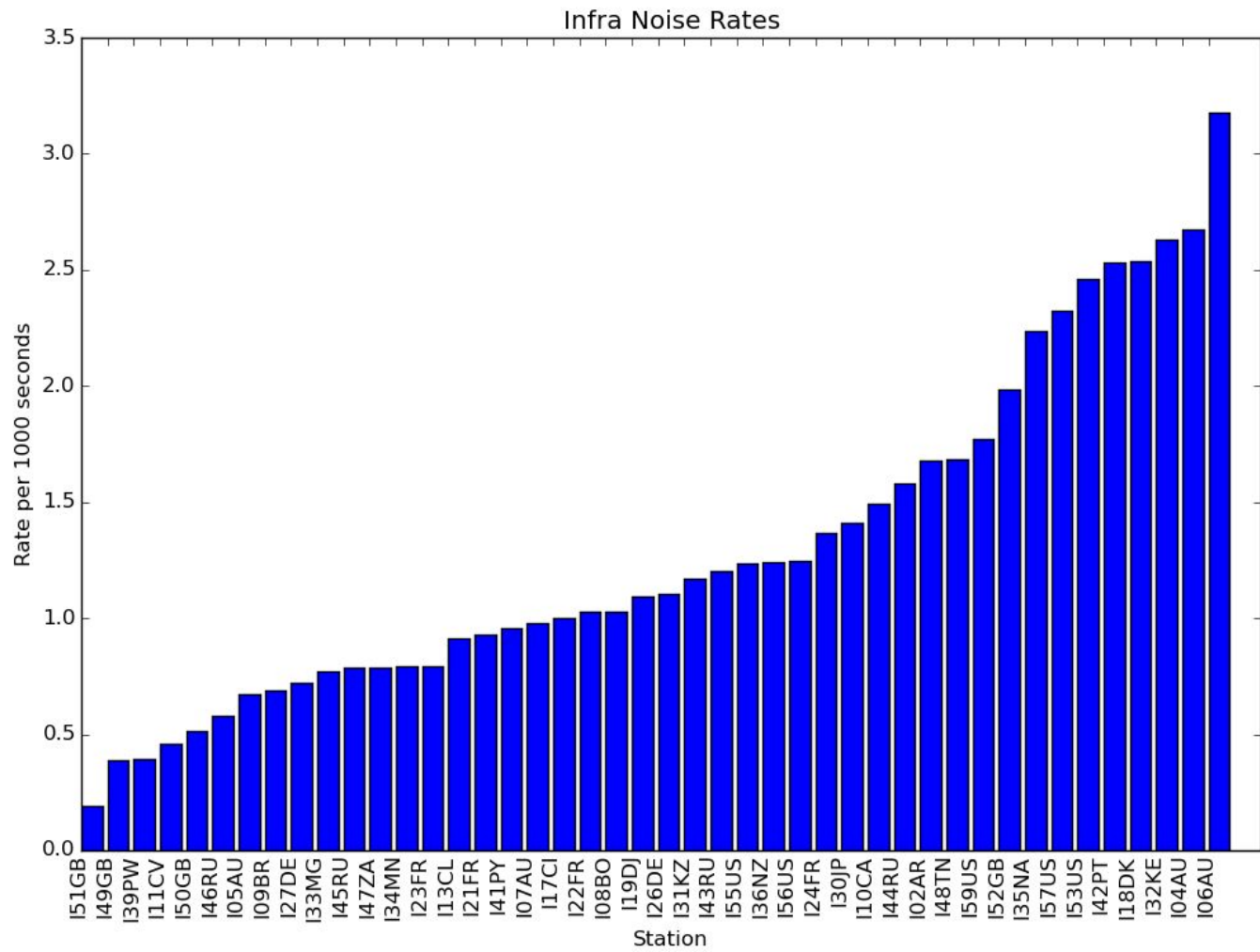# Detection Probability -- The First Element Of The Model

Detection Probability learned empirically.

Infra Celerity

Celerity (horizontal distance projected on the ground between source and receiver divided by the travel time)

Small uncertainty in celerity can lead to large uncertainty in arrival time.
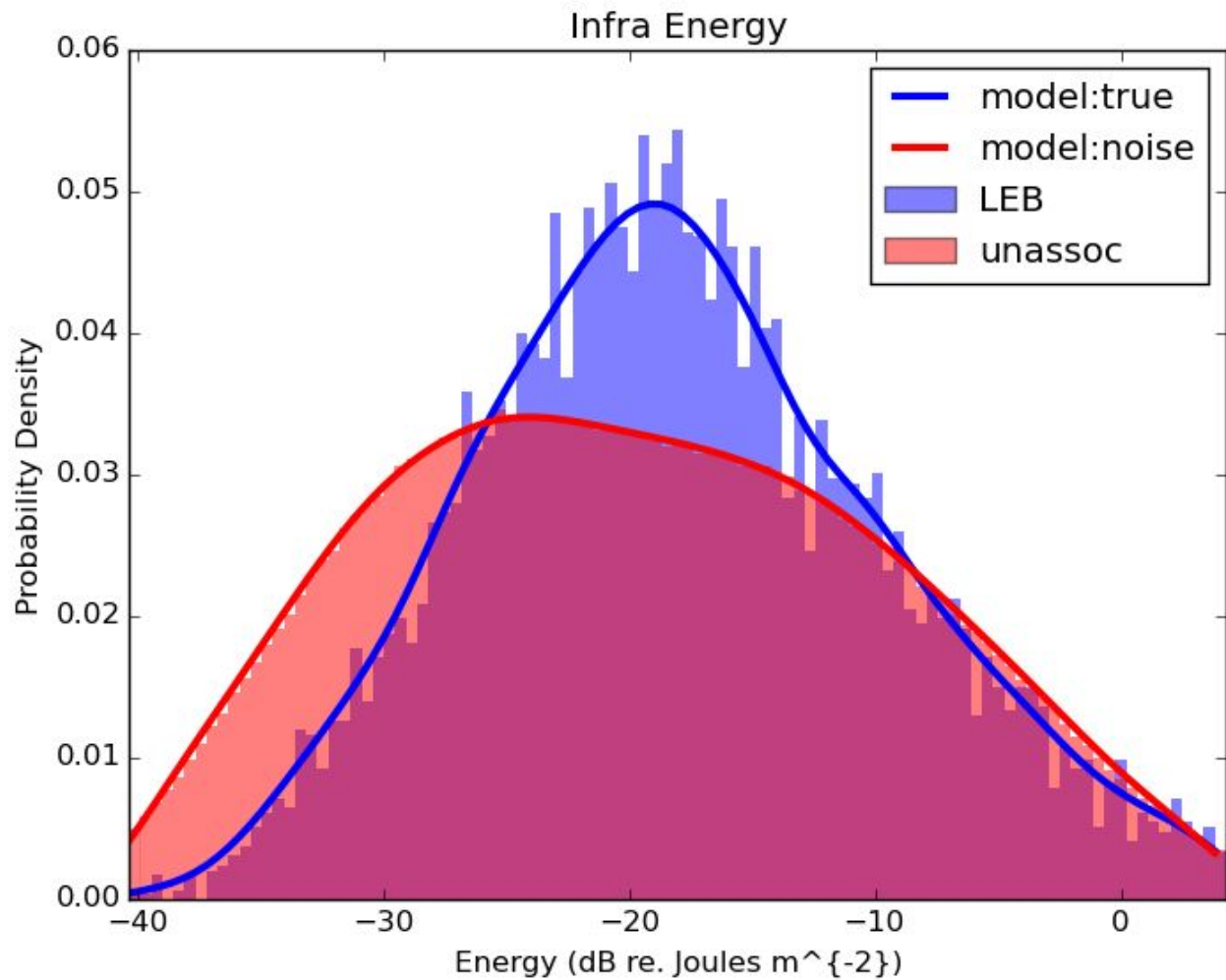
Infra Noise Rates

Noise rate at each station (the expected number of unassociated arrivals), some of them may actually be real
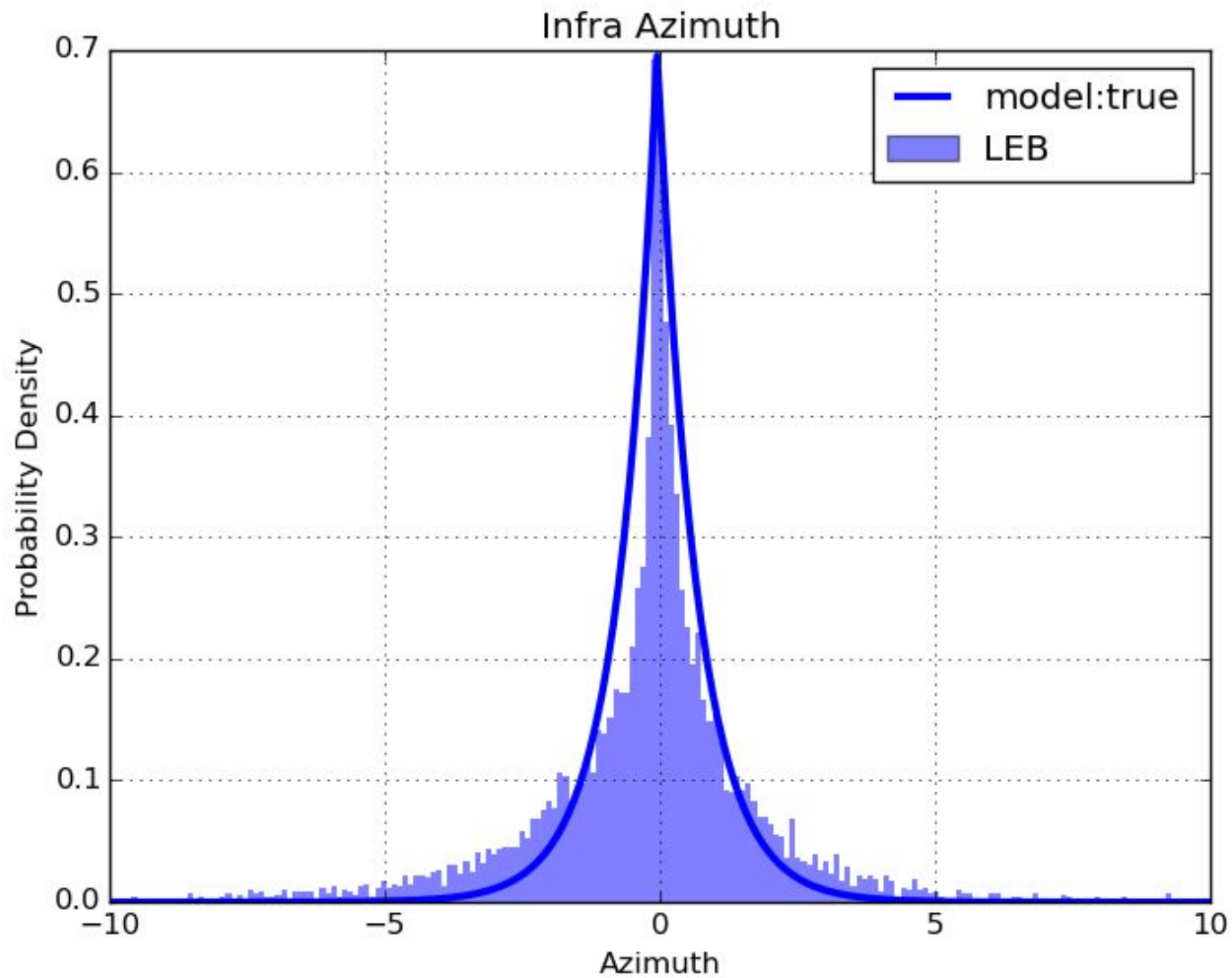
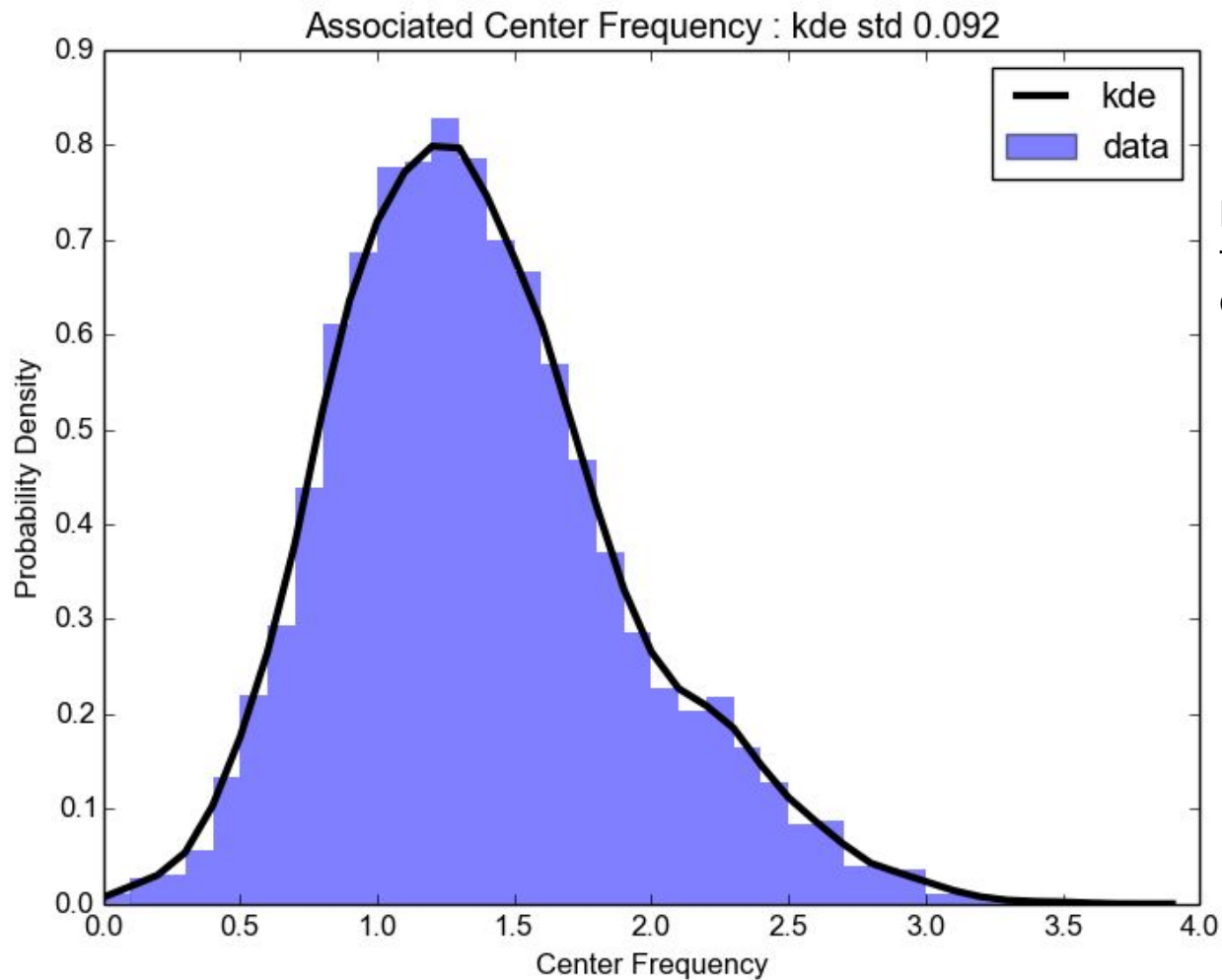Infra Trace Velocity
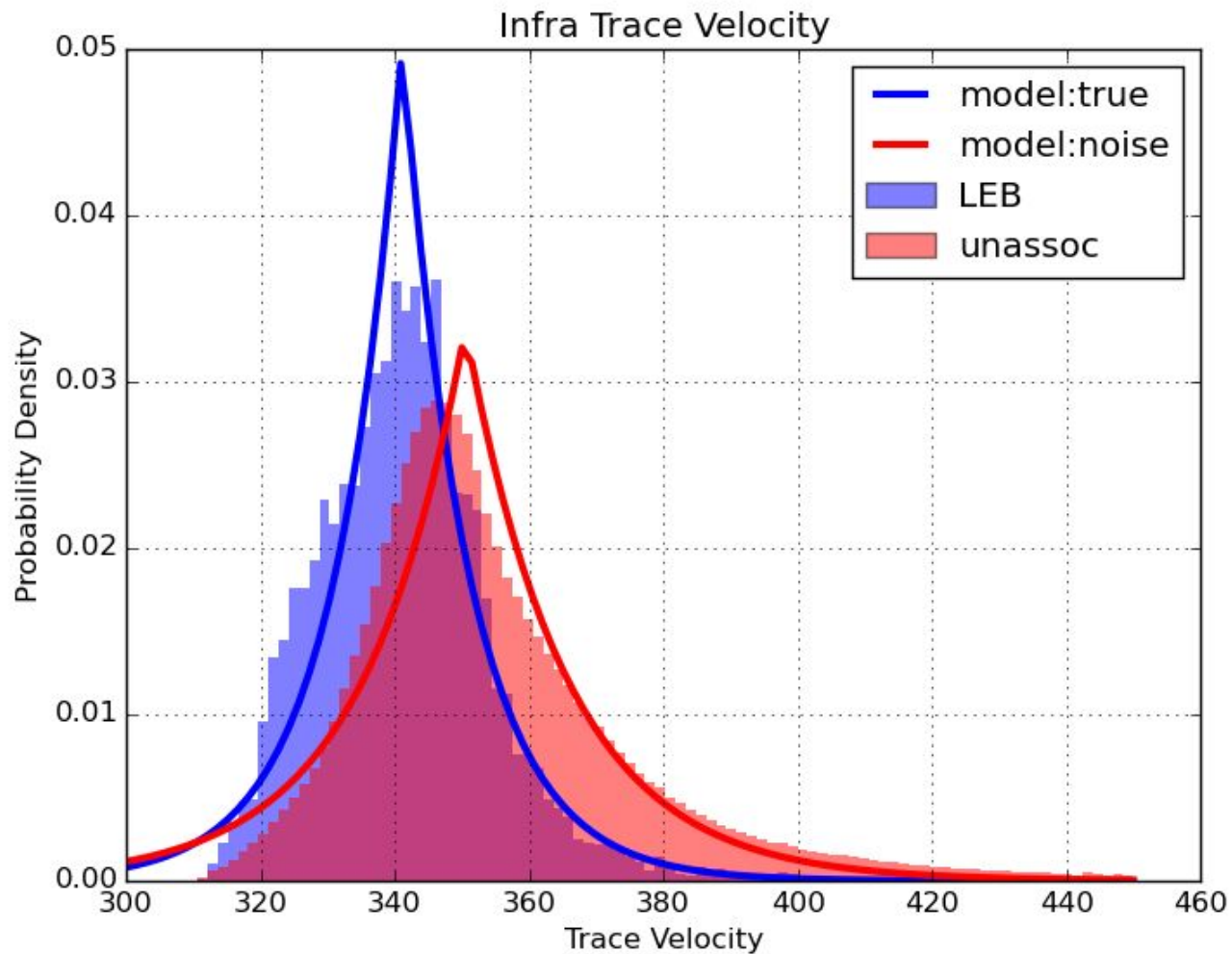
Trace Velocity (metres per second).

Equivalent to slowness.

Energy Model

Infra Azimuth

Azimuth is very tightly peaked and is the best attribute for infrasound.
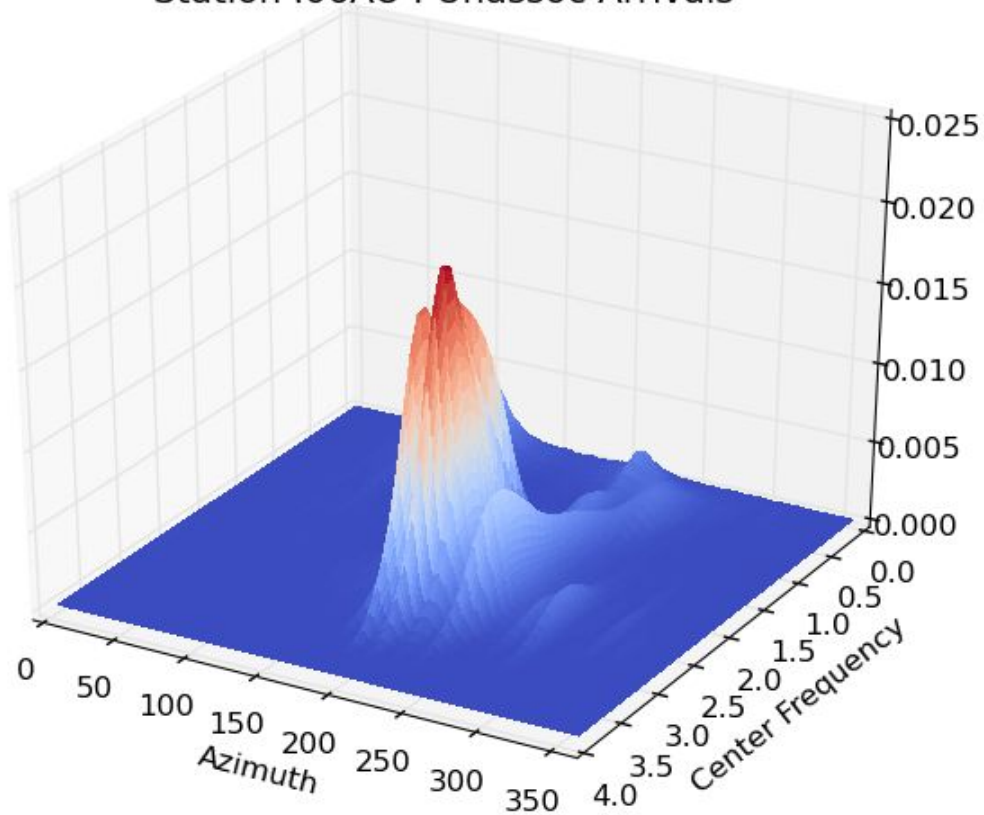
Associated Center Frequency : kde std 0.092

Kernel density estimate for estimating frequency distribution of real events

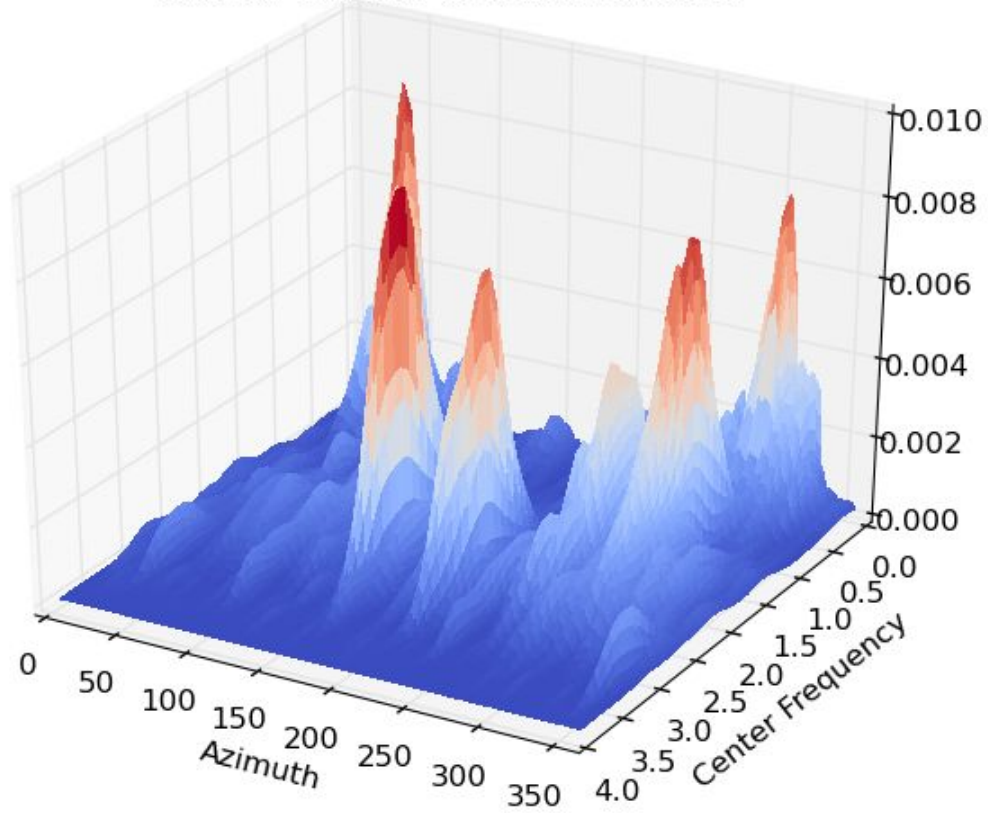**The station with the most number of unassociated arrivals!**

Station I06AU : Unassoc Arrivals

Clutter
Model

The station with the least number of unassociated arrivals.
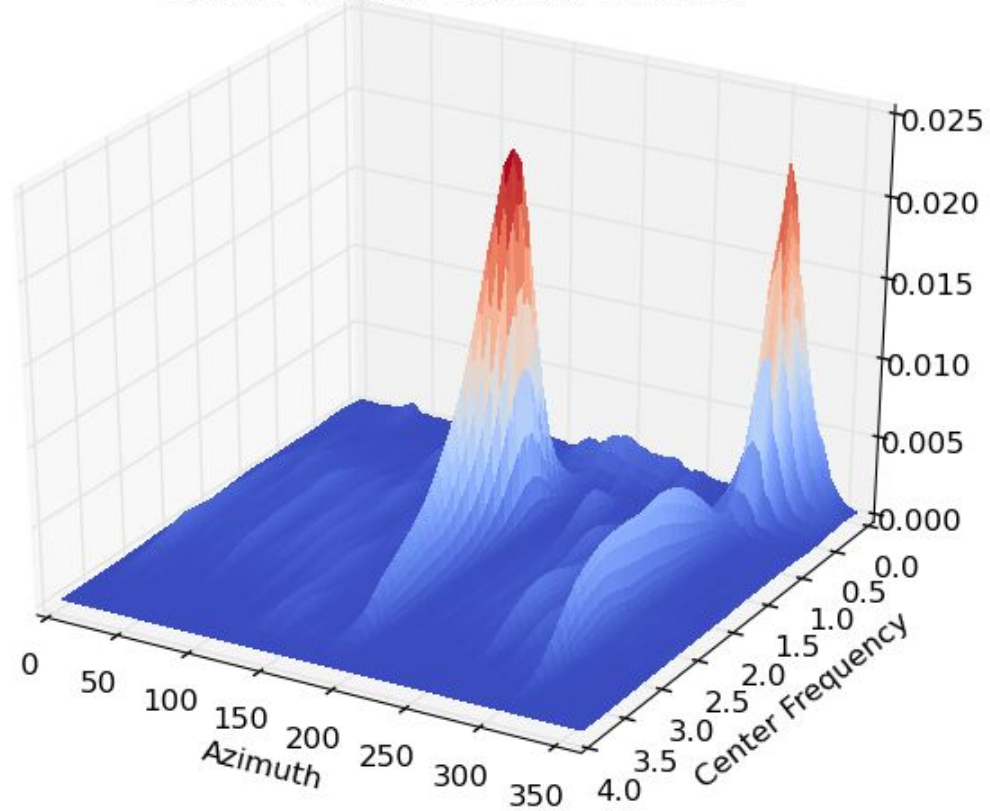

Clutter Model

A typical station (median number of unassociated arrivals)

Station I31KZ : Unassoc Arrivals

Clutter
Model

NET-VISA Event Formation Criteria

An event is real if the probability of the event occurring and generating its associated detections and mis-detections is higher than the probability of those same detections being generated by noise (including repetitive clutter) sources.

Inference -- main idea

- Propose events along backazimuth of detection at 0.5 degree interval up to 60 degrees away. Plus additional events with 2 degree perturbation of backazimuth
- Existing algorithm (from seismic) for associating proposed events to detections.
  - Reassociation i.e. find the best event for a detection.
  - Relocation i.e. changing location of an event to best explain associated detections.
  - Kill events not justified by model
- **Infra events have preference for associating with an infra detection (i.e. at an infrasound station)**
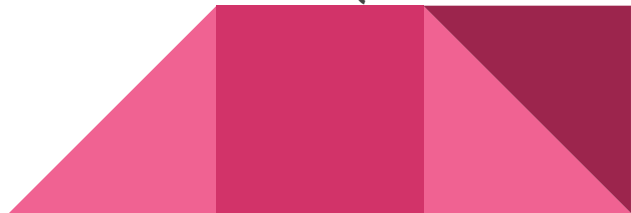
Infrasound Evaluation

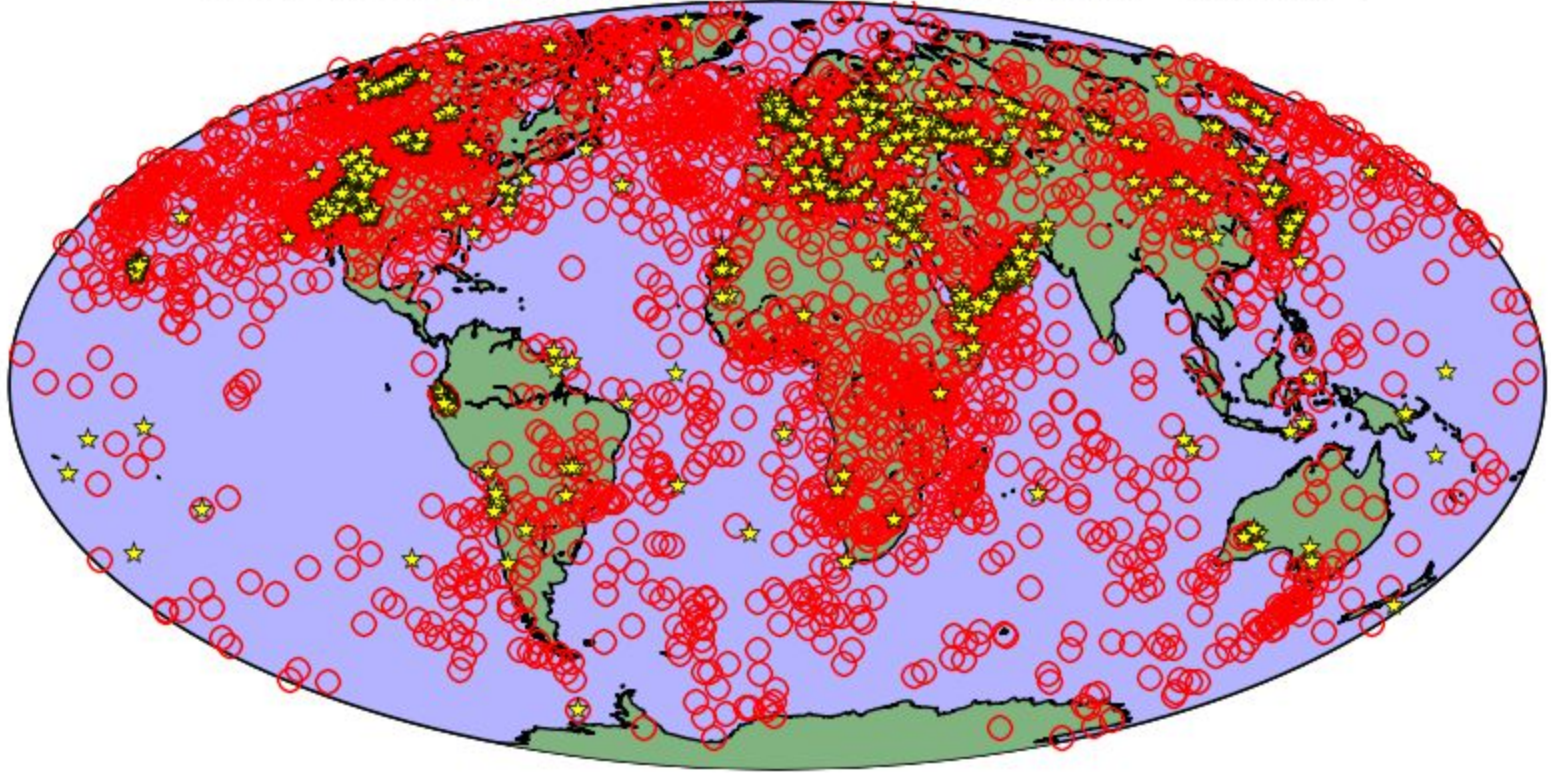Two events in two different bulletins are identical if they share two **similar** arrivals where the arrivals are

- are detected at the same station
- within 500 seconds in time of each other
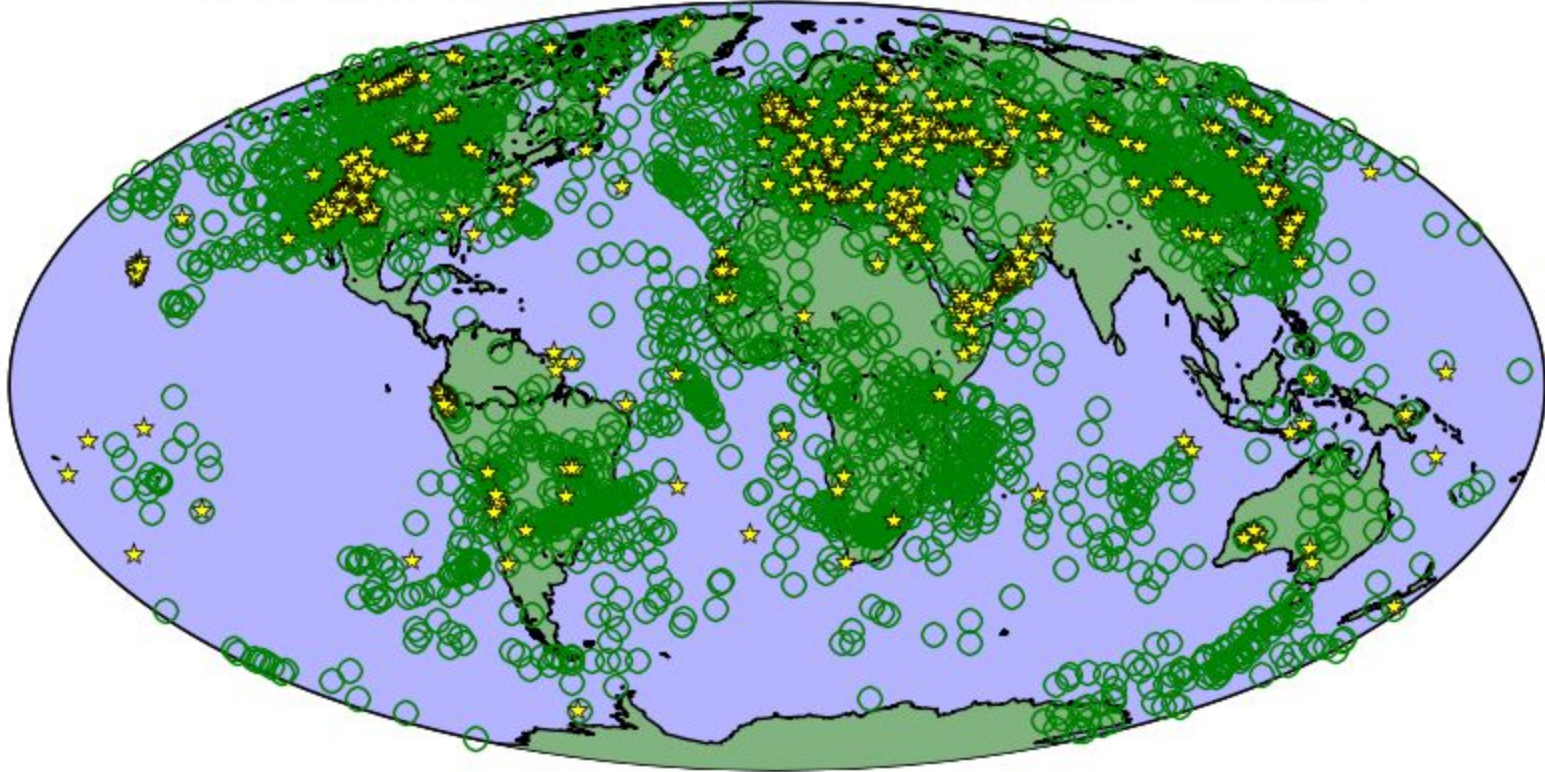- point to a back azimuth within 5 degrees of each other

SEL3

Reference Bulletin: LEB. Time Range: 2013/1/1 - 2014/1/1

Infrasound only

NET-VISA without clutter model
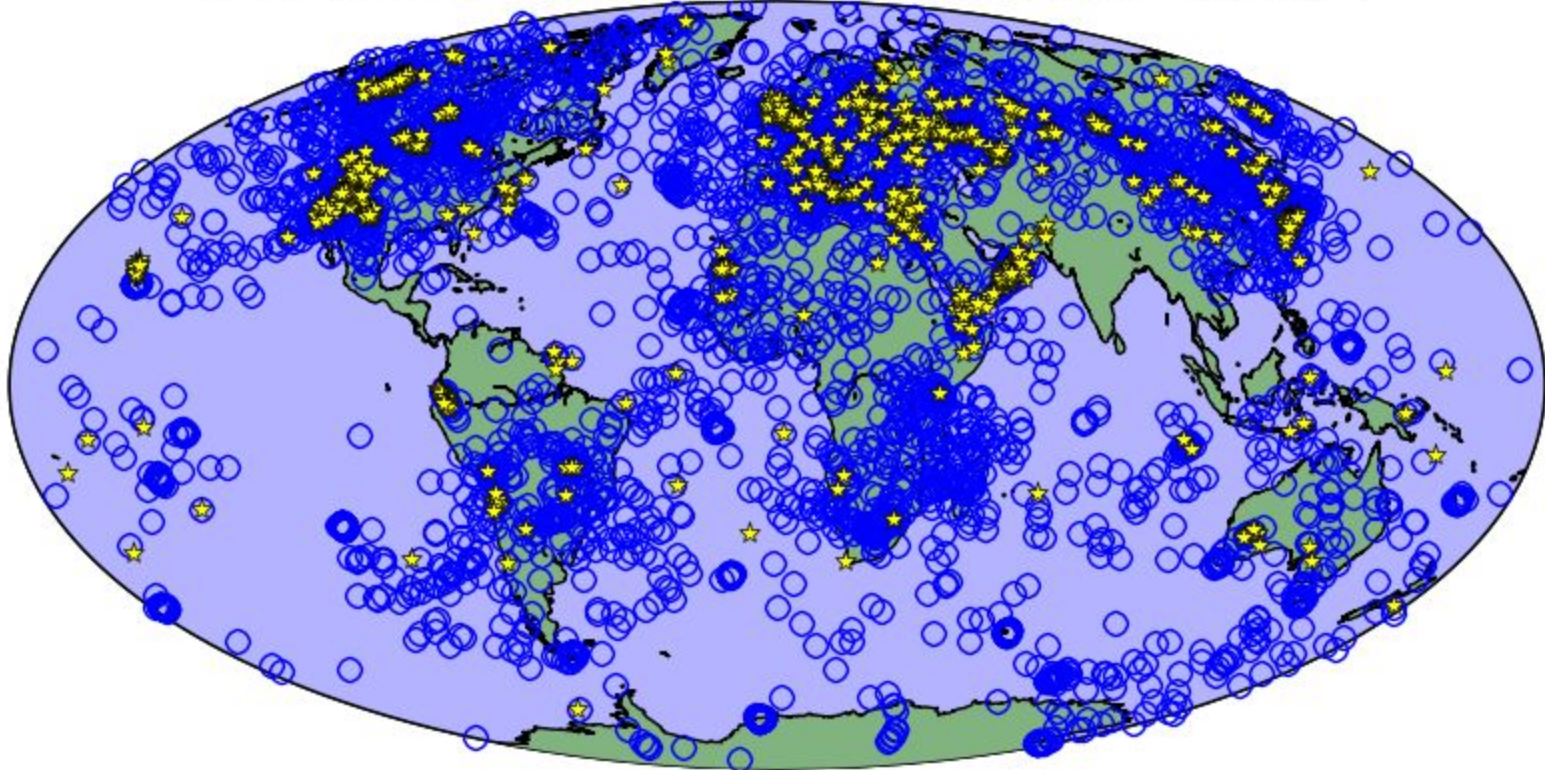
Reference Bulletin: LEB. Time Range: 2013/1/1 - 2014/1/1

Infrasound only
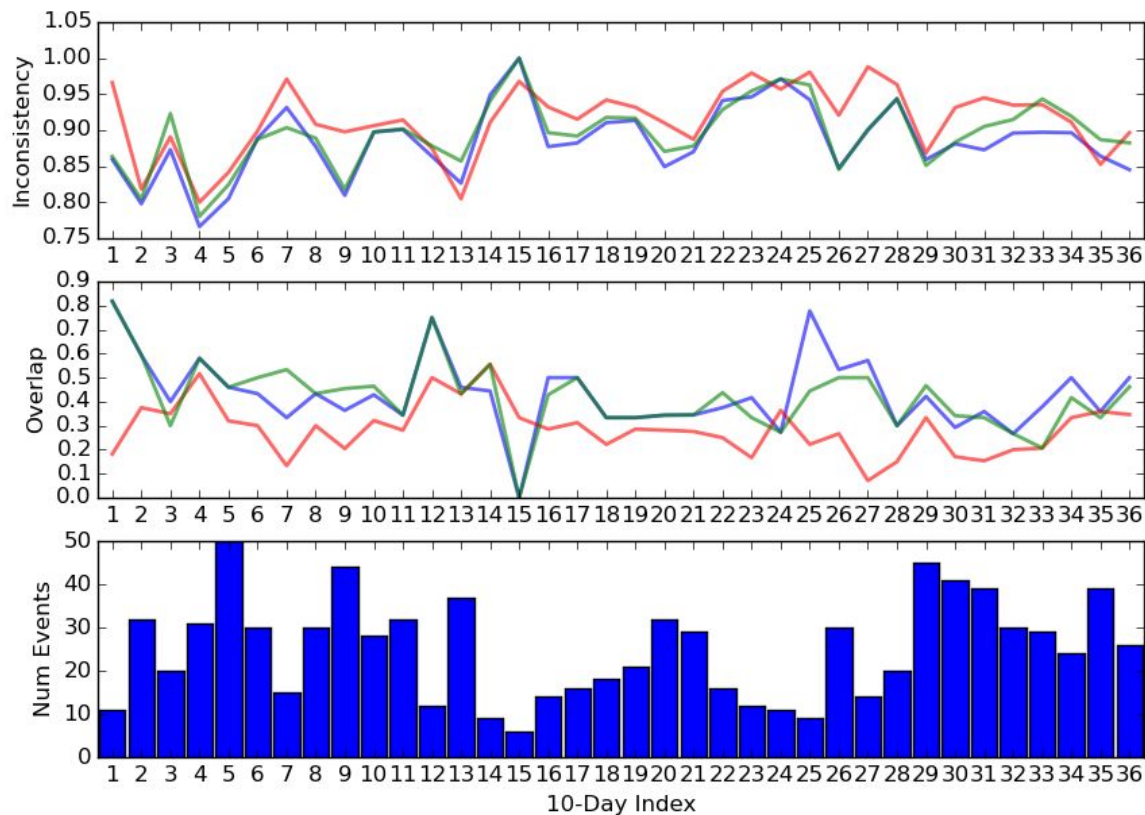
NET-VISA
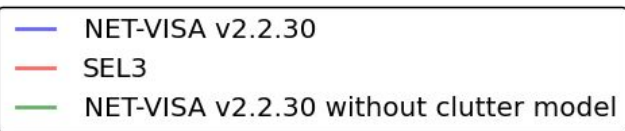
Reference Bulletin: LEB. Time Range: 2013/1/1 - 2014/1/1

Infrasound only

Reference Bulletin: LEB. Time Range: 2013/1/1 - 2014/1/1

Infrasound only

NET-VISA v2.2.30
SEL3
NET-VISA v2.2.30 without clutter model

Overall Overlap and Inconsistency for Infrasound events in 2013 vs LEB

	Overlap	Inconsistency
NET-VISA	42.1 %	88.5 %
NET-VISA without clutter model	41.4 %	89.5 %
SEL3	31.2%	91.4 %

Without the clutter model NET-VISA generates about 10% more events.

Overall Overlap and Inconsistency for all SHI events in 2013 Jan-Feb vs LEB

	Overlap	Inconsistency
NET-VISA	86.4 %	39.9%
SEL3	70.8%	44.4 %

Future Work

- Incorporate features from new PMCC processing
- Incorporate better travel time predictions with real time weather models