

SAND2019-10705PE

Comparison of pick-based and waveform-based event detectors for local to near-regional distance data from Utah



PRESENTED BY

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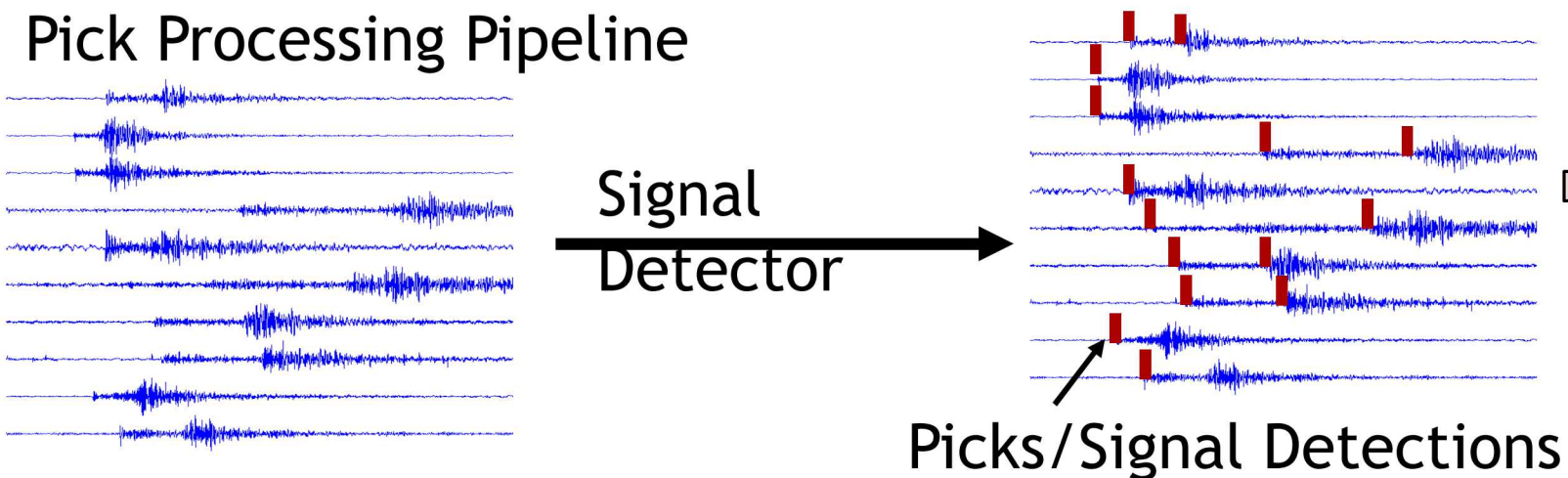


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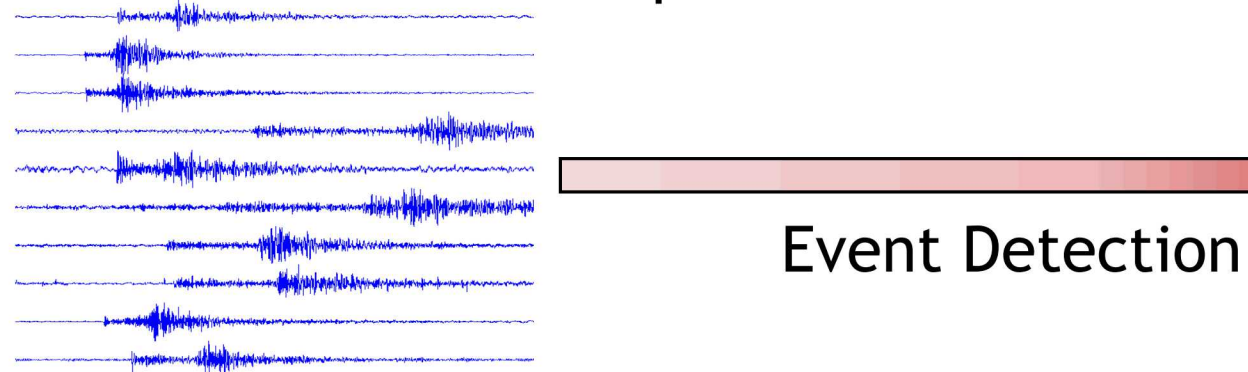
Pick vs Waveform Event Processing Pipeline

Seismic Waveforms

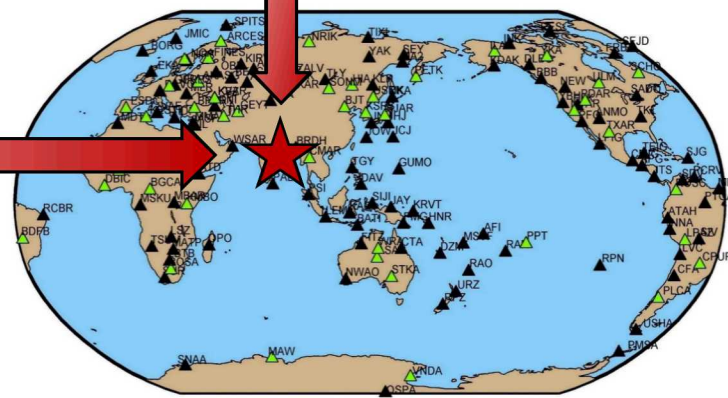
Pick Processing Pipeline



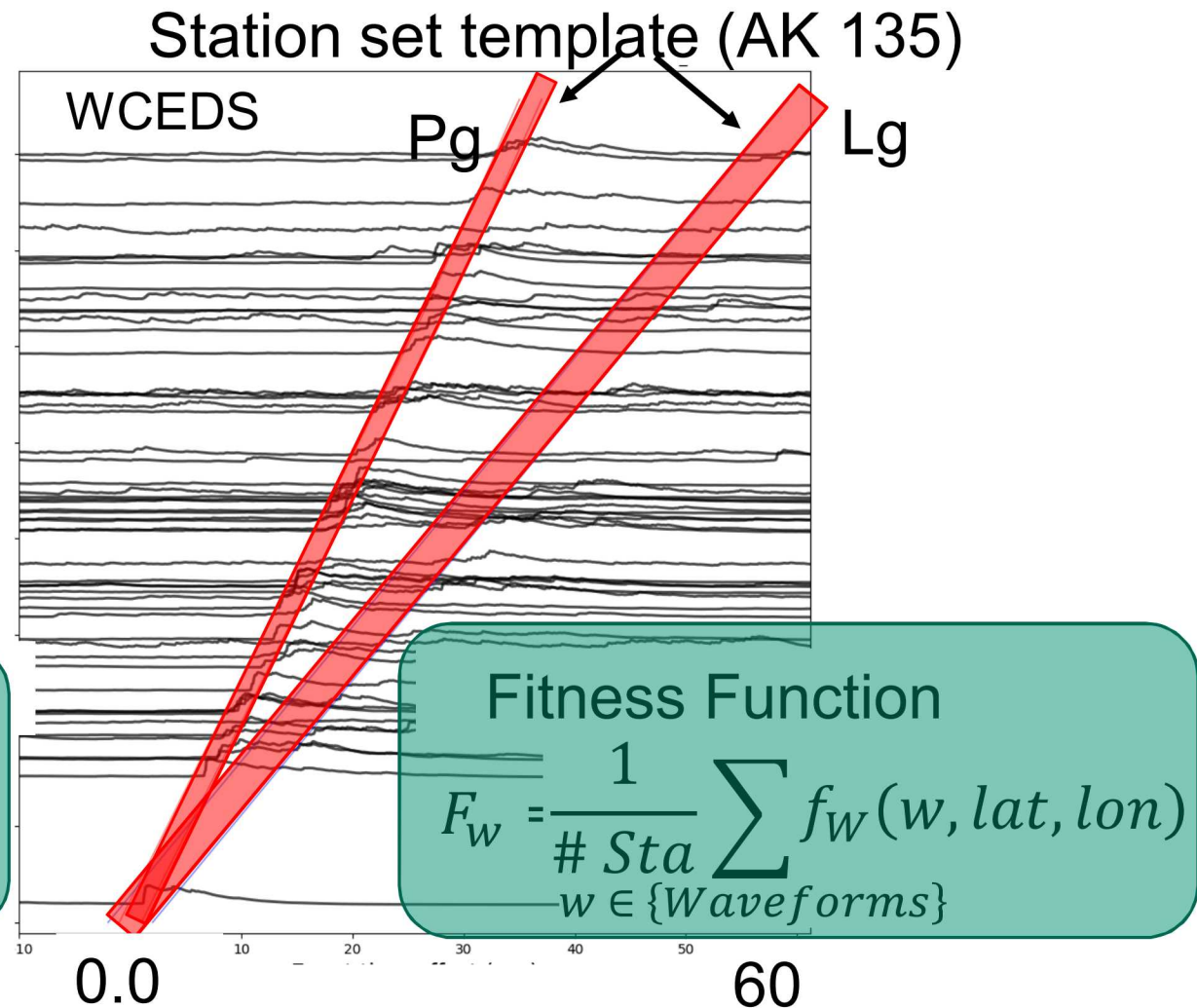
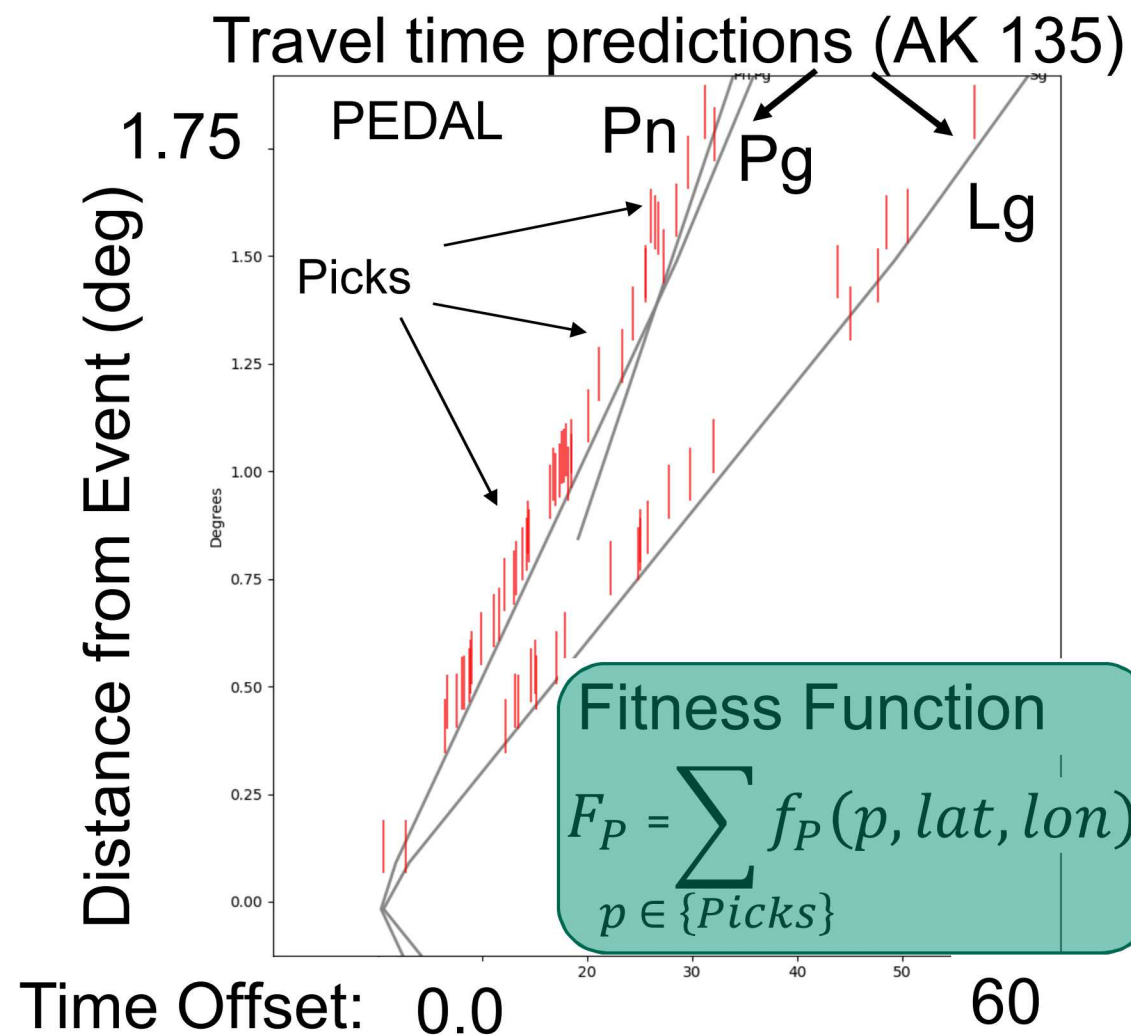
Pick-less/Waveform Pipeline



Event Detection
and
Association



Same Event as viewed by PEDAL and WCEDS



PEDAL and WCEDS are grid search algorithms

For each grid location:

- 1) Compute Event Fitness Score
- 2) If Event Fitness at grid location “i” > Threshold

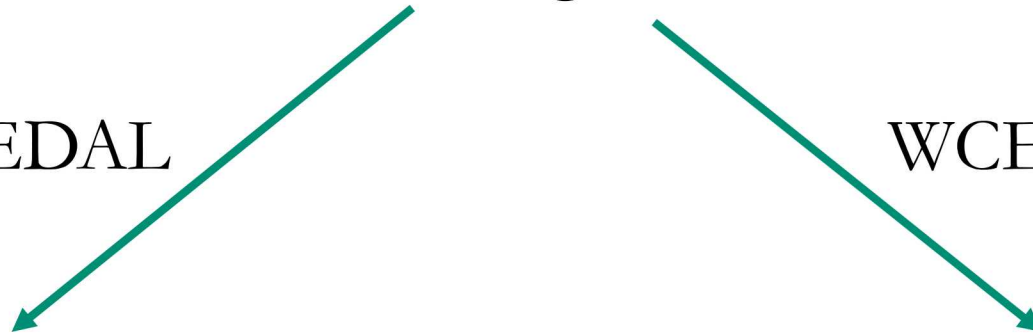
Create Event at grid location “i”

PEDAL

WCEDS

Associate Signal Detections

Iterate



Processing Recipes: PEDAL

For each grid location:

- 6 closest stations contribute to the initial event formation.

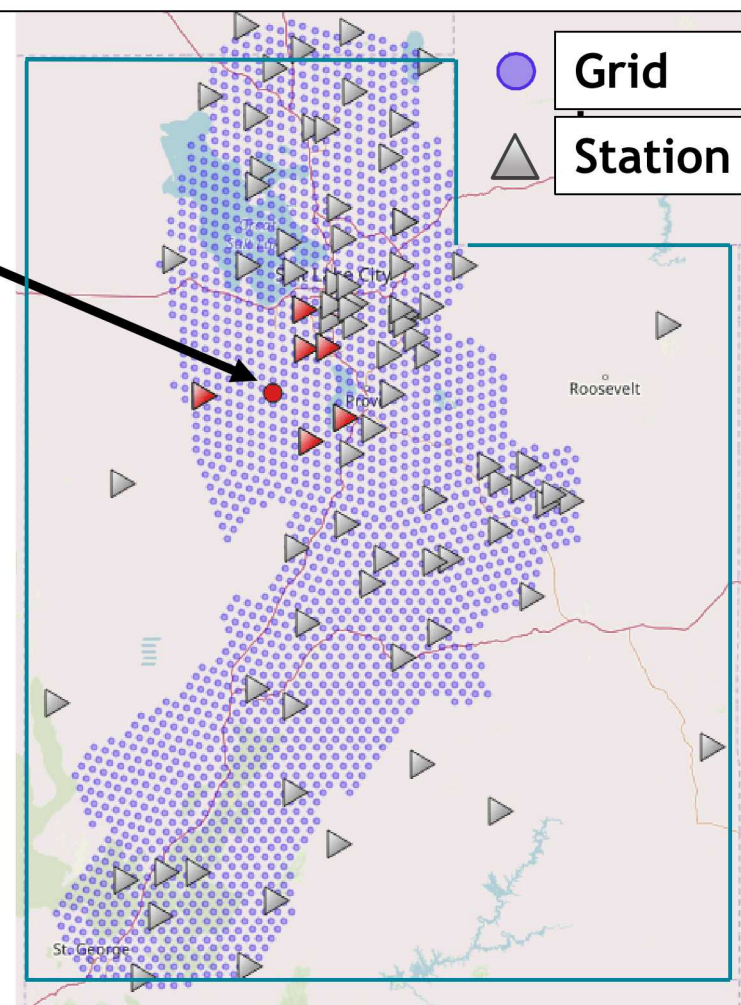
(helped reduce false positives)

- All stations can have their signal detections associated with any event/grid location.

(leftover picks can create more events)

Uniform Grid Spacing (.06 deg)

PEDAL Grid and Station Set

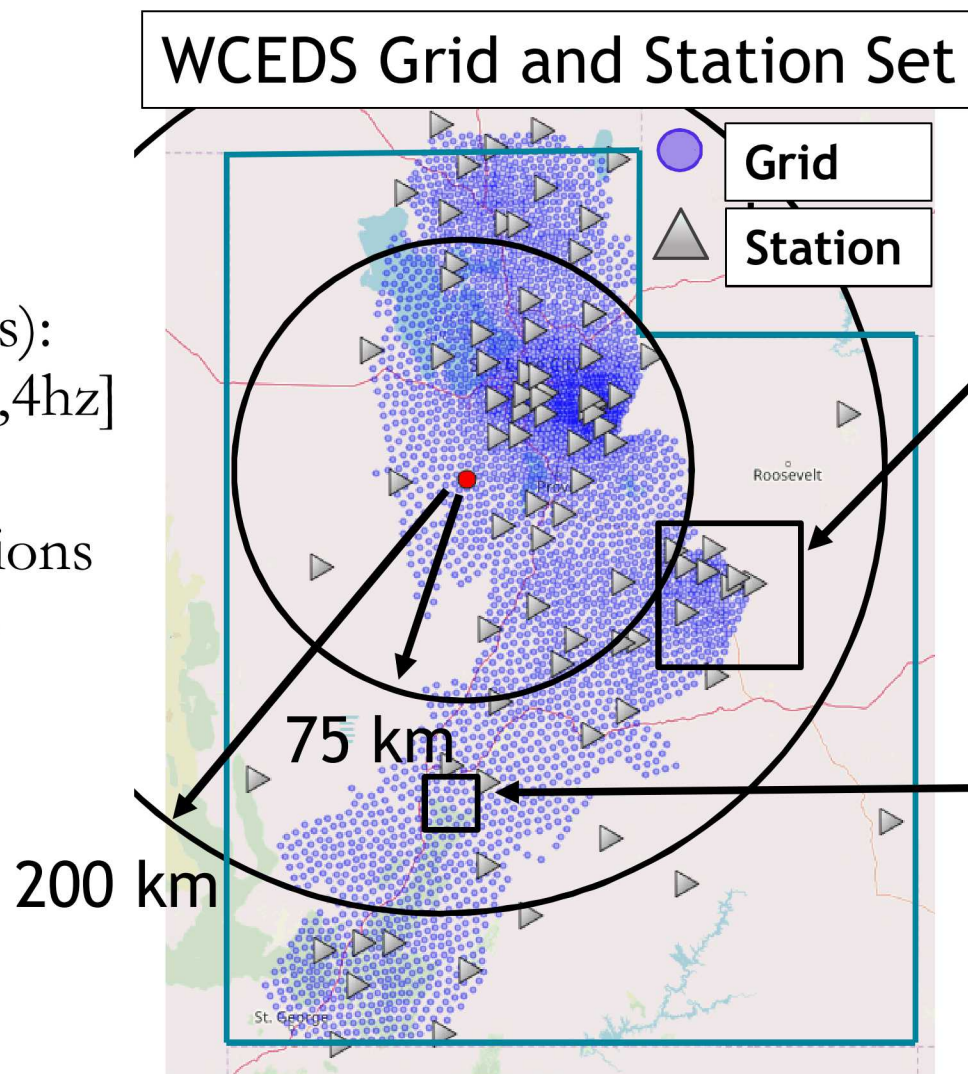


Processing Recipes: WCEDS

For each grid location:

Utah Iteration

- 1st Pass (Network wide events): stations within 200 km [.5hz, 4hz]
- 2nd Pass (Smaller events): stations within 75 km for second pass [.5hz, 4hz]



- Mining grid iteration - for each grid point
 - Filter [4hz, 8hz]
 - Only stations in mining grid
- Circleville iteration
 - stations within 75 km
 - Filter [4hz, 8hz]

The **UUEB** was developed to evaluate signal detection and event association algorithms.

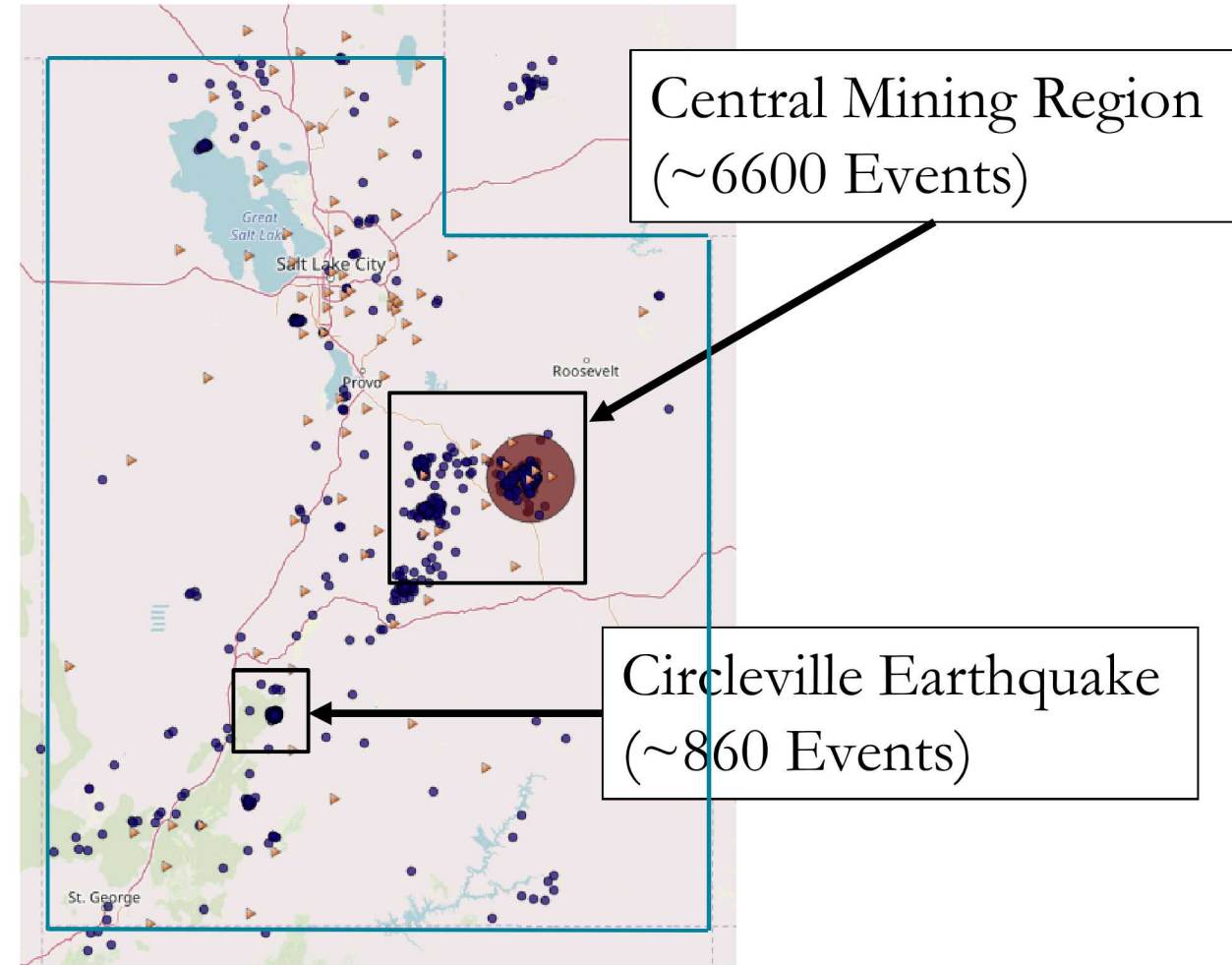
UUSS network for the Jan 1-14, 2011 time-period. Both anthropogenic and natural seismic sources.

Overview:

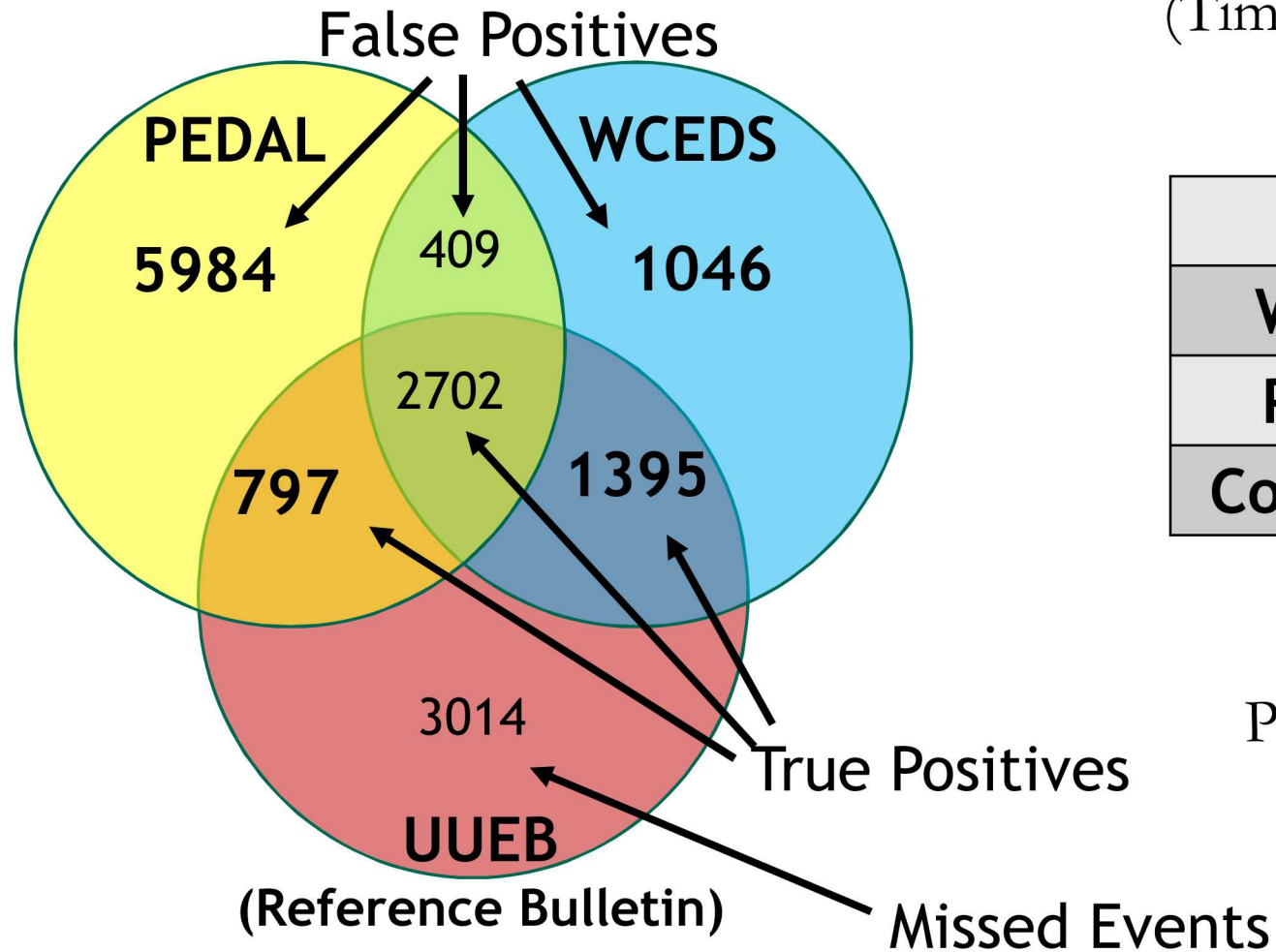
- ~7,800 events

- All events ≥ 3 associations

- ~3/4 of events have 5-9 defining stations



Results: Clustering Events by Time and Location



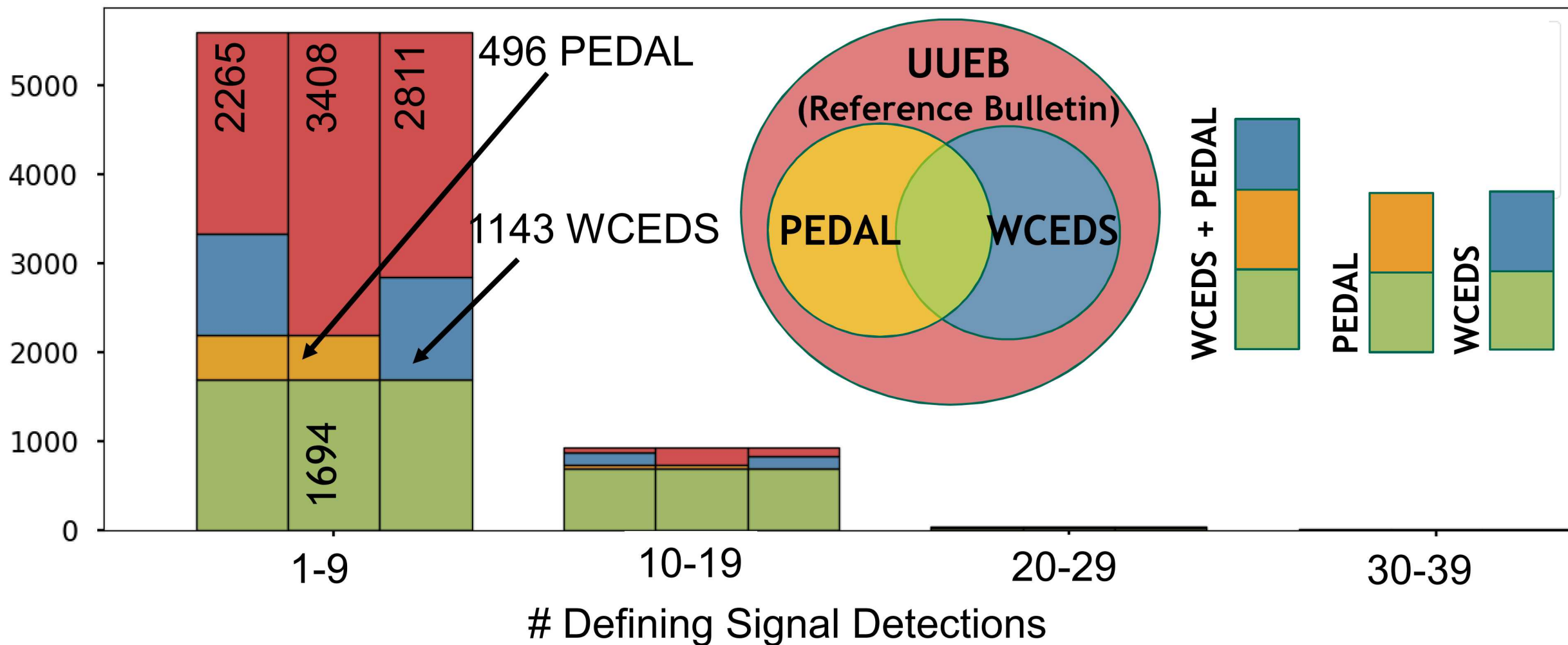
(Time delta ≤ 10 sec) (Dist delta ≤ 45 km)

	Precision	Recall
WCEDS	74%	52%
PEDAL	35%	44%
Combined	39%	62%

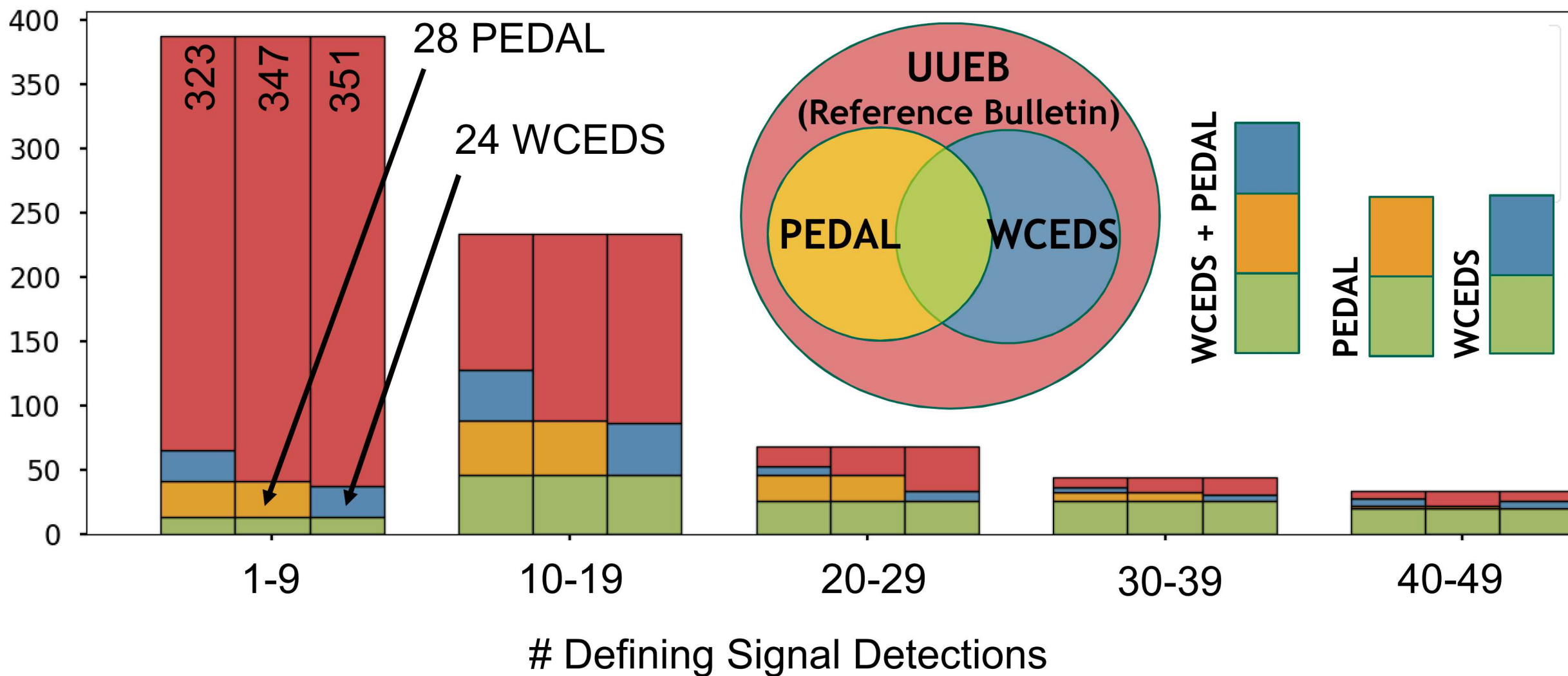
Precision = # True Pos. / # Events Found

Recall = # True Pos. / # UUEB Events

9 True Positives by Event Size: Mining Region



True Positives by Event Size: Circleville Earthquake



Analysts rejecting false alarms is better than analysts building missed events

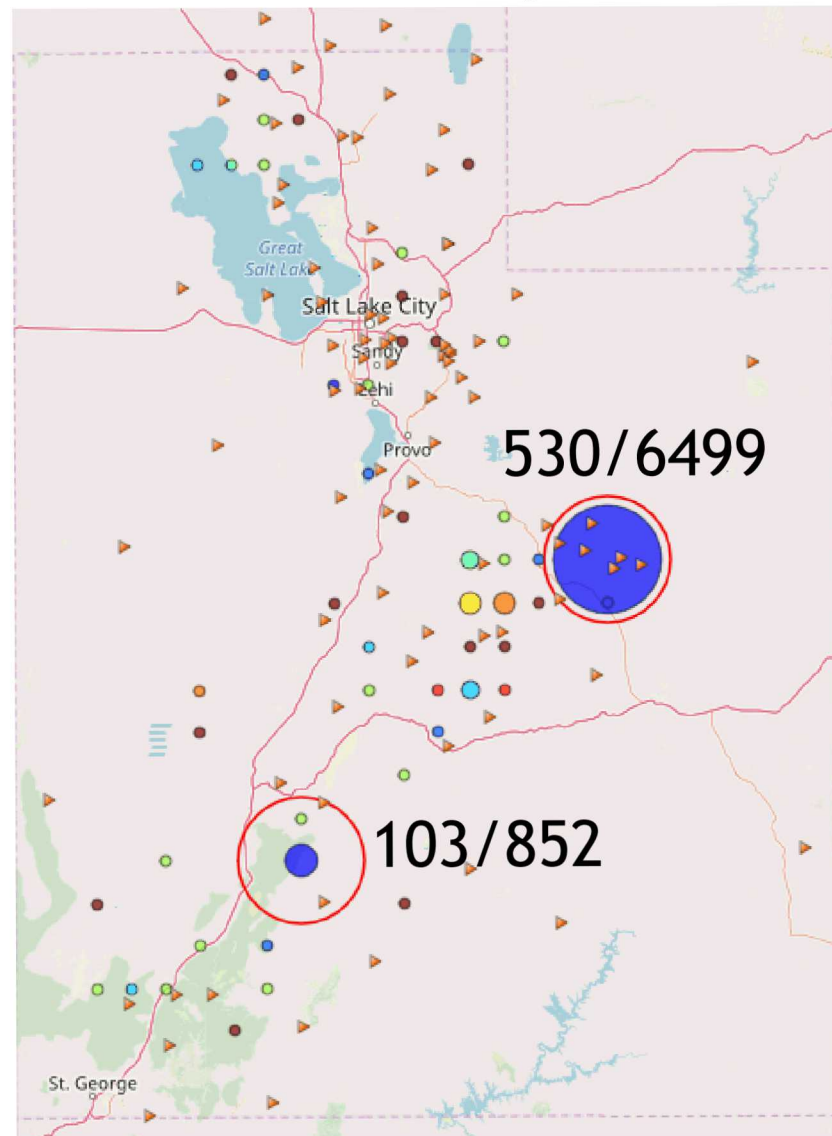
	Precision	Recall	False Pos/True Pos
WCEDS	74%	52%	.36
PEDAL	35%	44%	1.8
Combined	39%	62%	1.5

Future Work:

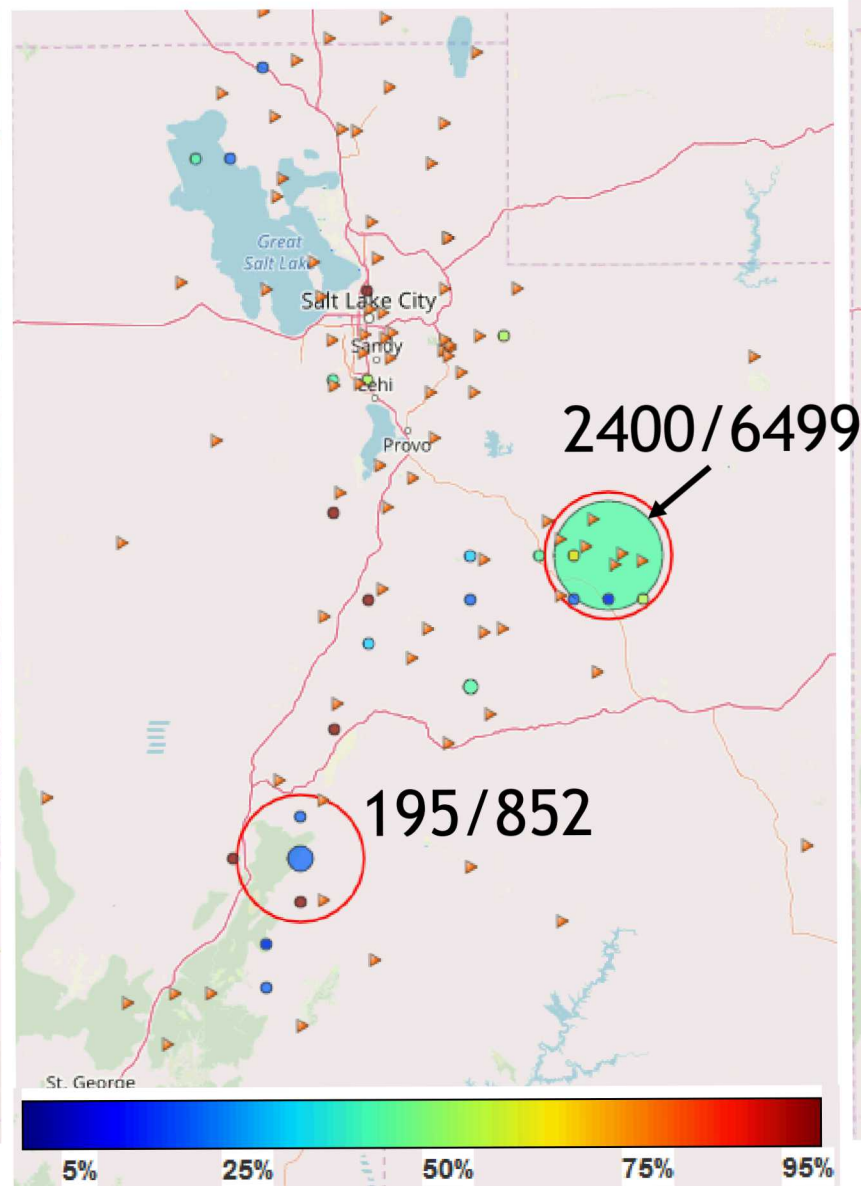
- Tuning to find more of the smaller events
- WCEDS only True Positives vs PEDAL only True Positives
- Better Signal Detection => PEDAL will perform better

True Positive Locations

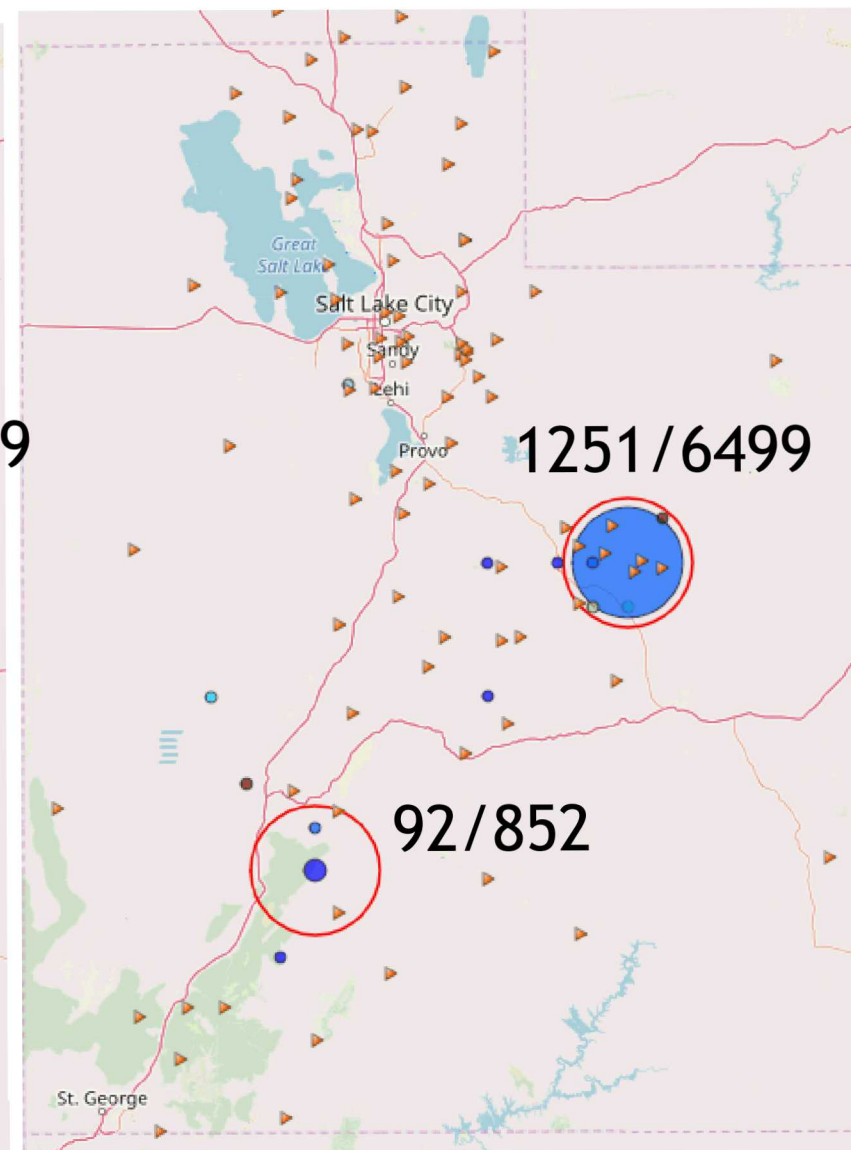
PEDAL Only



PEDAL and WCEDS

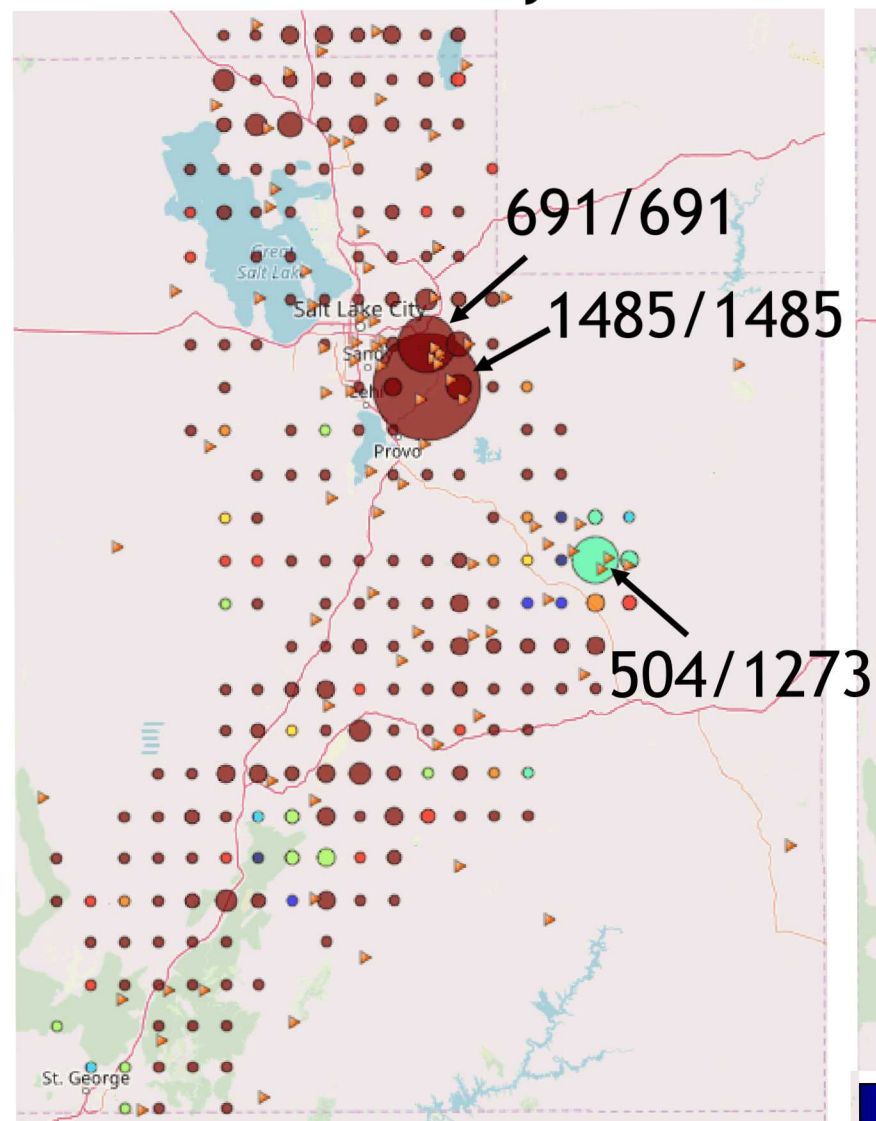


WCEDS Only

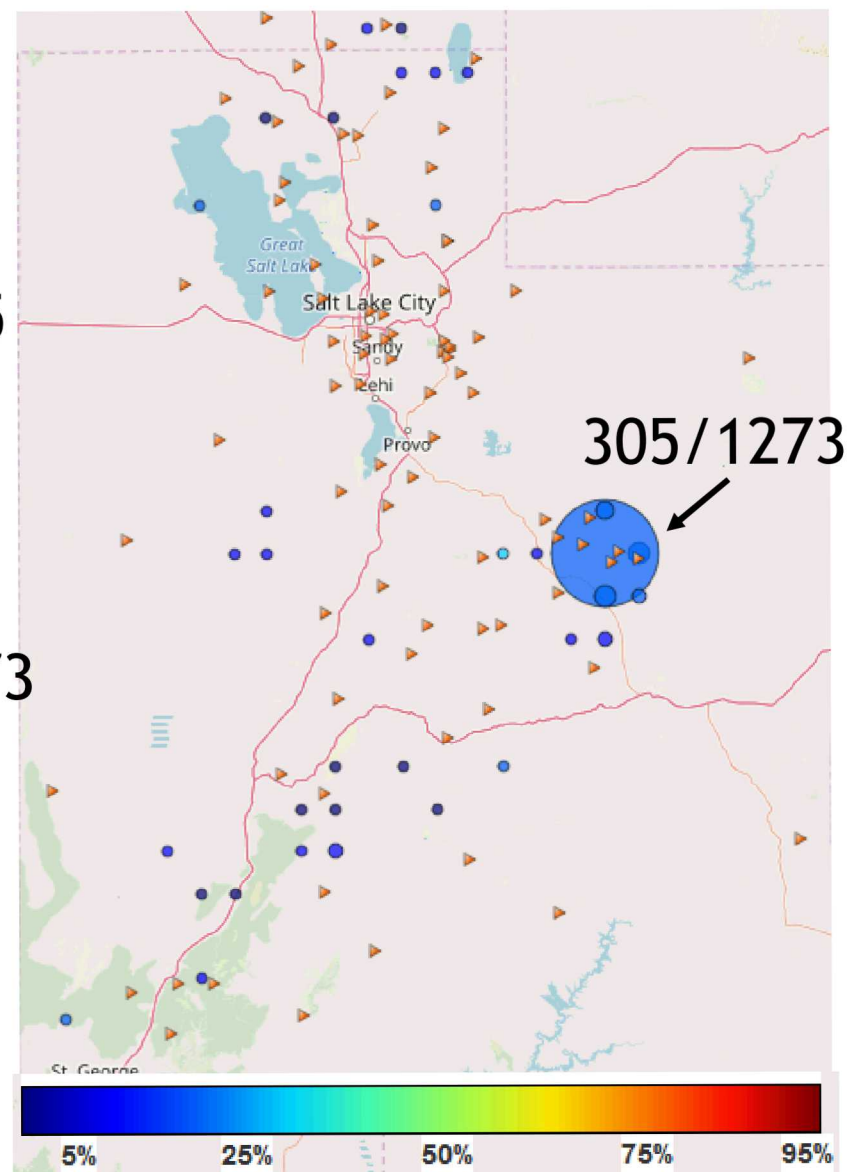


False Positive Locations

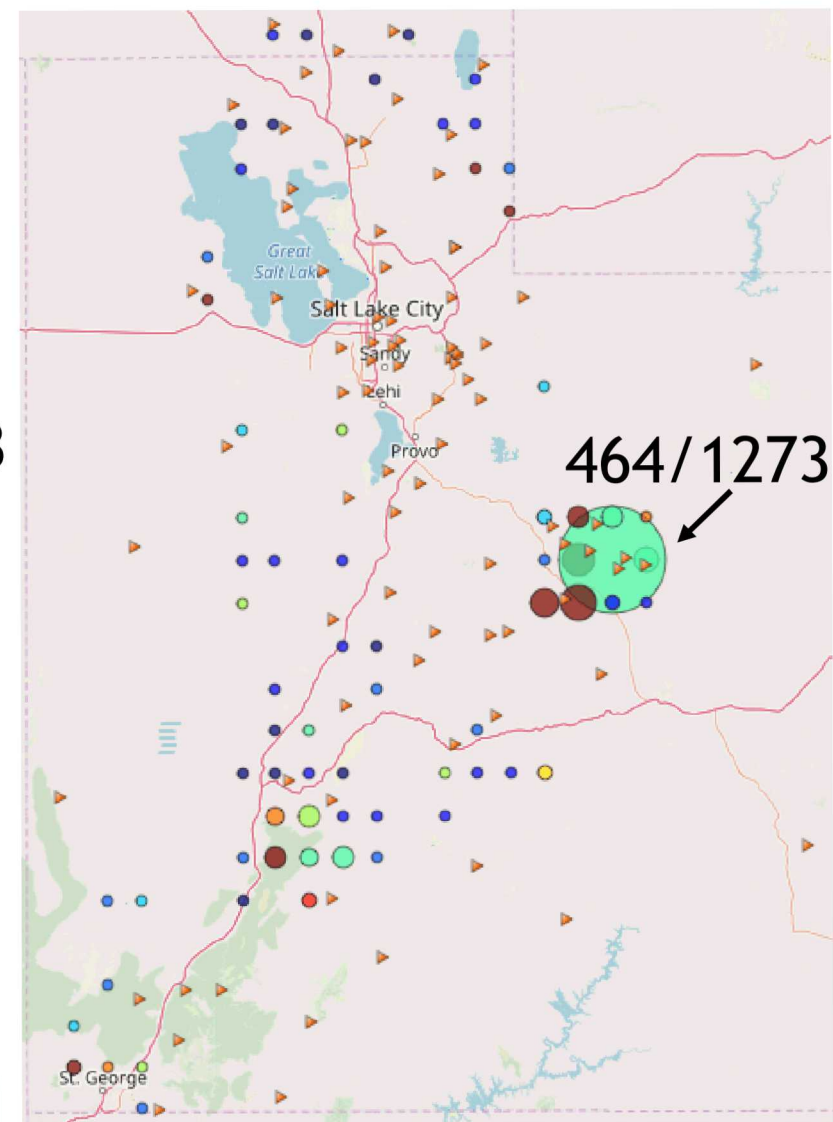
PEDAL Only



PEDAL and WCEDS



WCEDS Only

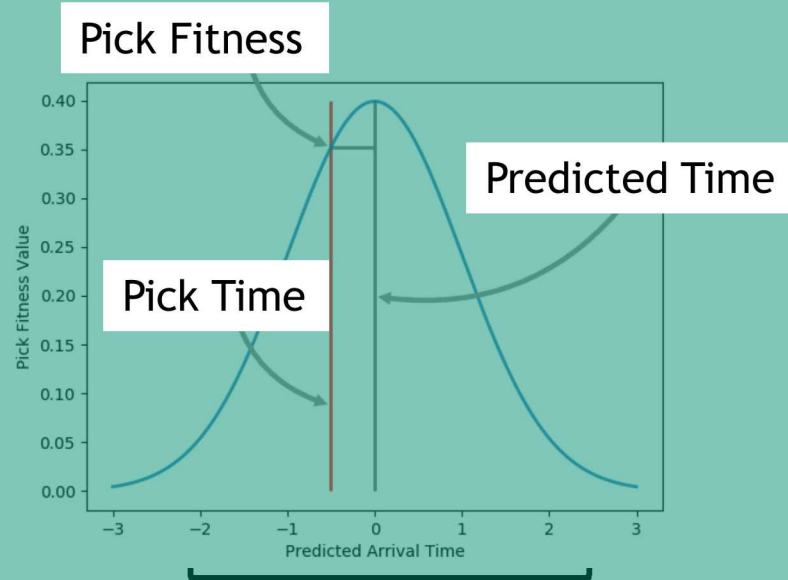


Event fitness at grid location (lat, lon)

PEDAL

$$F_P(lat, lon) = \sum_{p \in \{Picks\}} f_P(p, lat, lon)$$

$$f_P(p, lat, lon) = e^{-\left(\frac{\Delta t}{\sigma}\right)^2}$$



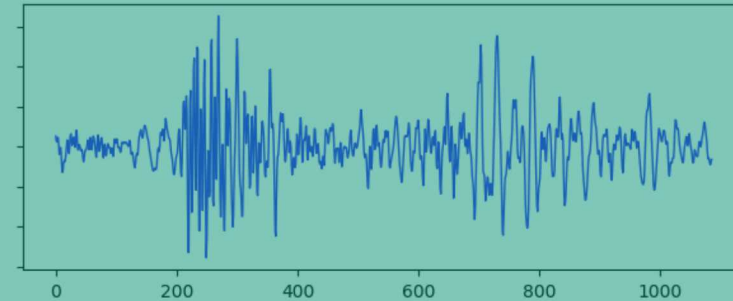
Uncertainty controlled by data:

$$\sigma^2 = \sigma_{predicted}^2 + \sigma_{pick}^2 + \sigma_{grid}^2$$

WCEDS

$$F_w(lat, lon) = \frac{1}{\# Sta} \sum_{w \in \{Waveforms\}} f_w(w, lat, lon)$$

Waveform given event hypothesis at (lat, lon)

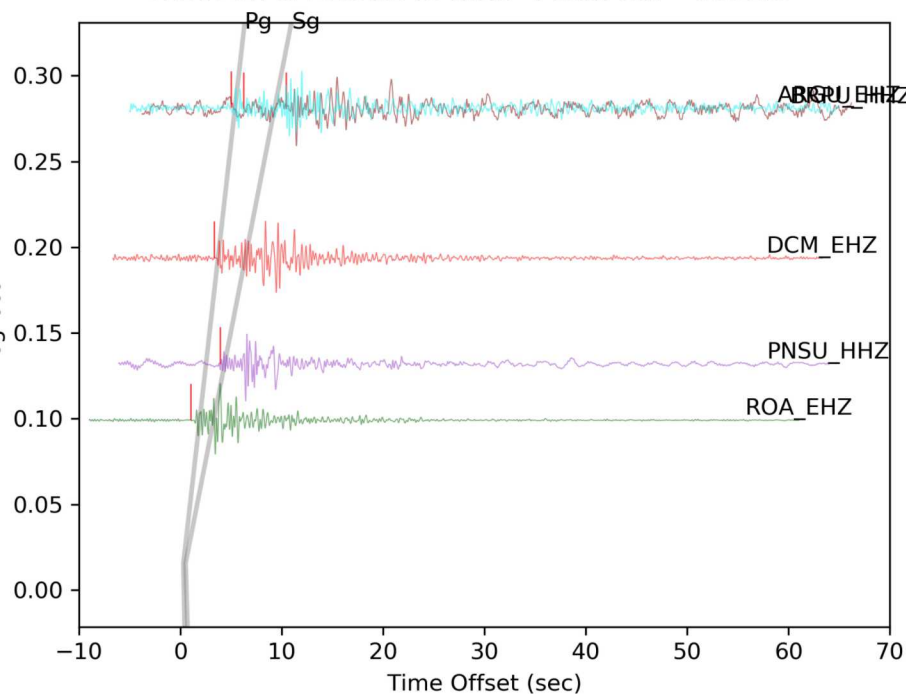


Uncertainty is fixed.

Small Magnitude Event Example

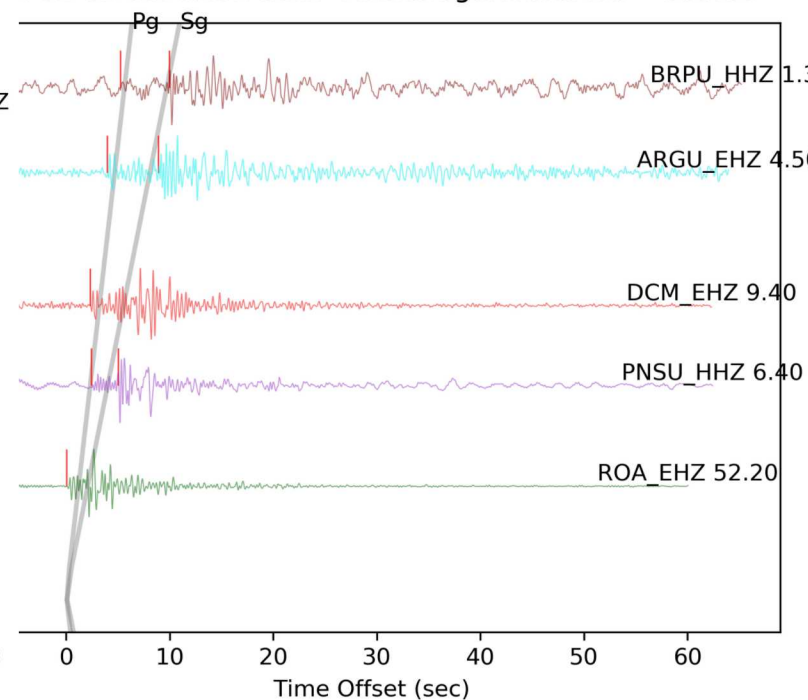
PEDAL

Match Id=272 pedal_orid=412
2011-01-01 03:49:49 auth=Pedal mb=-999.00



UUEB

Match Id=272 uueb_orid=988
l-01-01 03:49:51 auth=ARS:brogan.rona mb=-999.00



WCEDS

Match Id=272 wceds_orid=68
2011-01-01 03:49:52 auth=bc_1 mb=1.21

