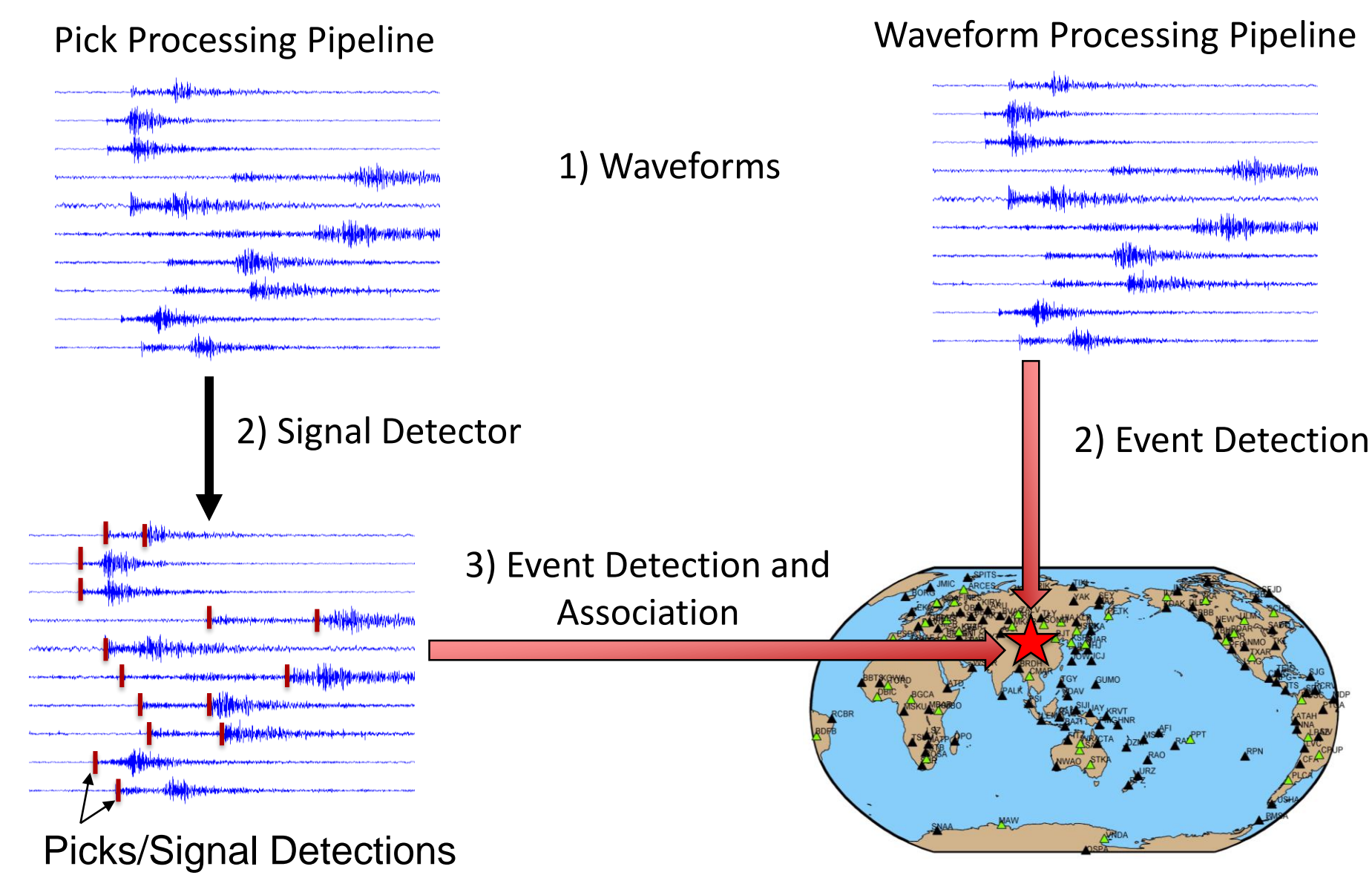




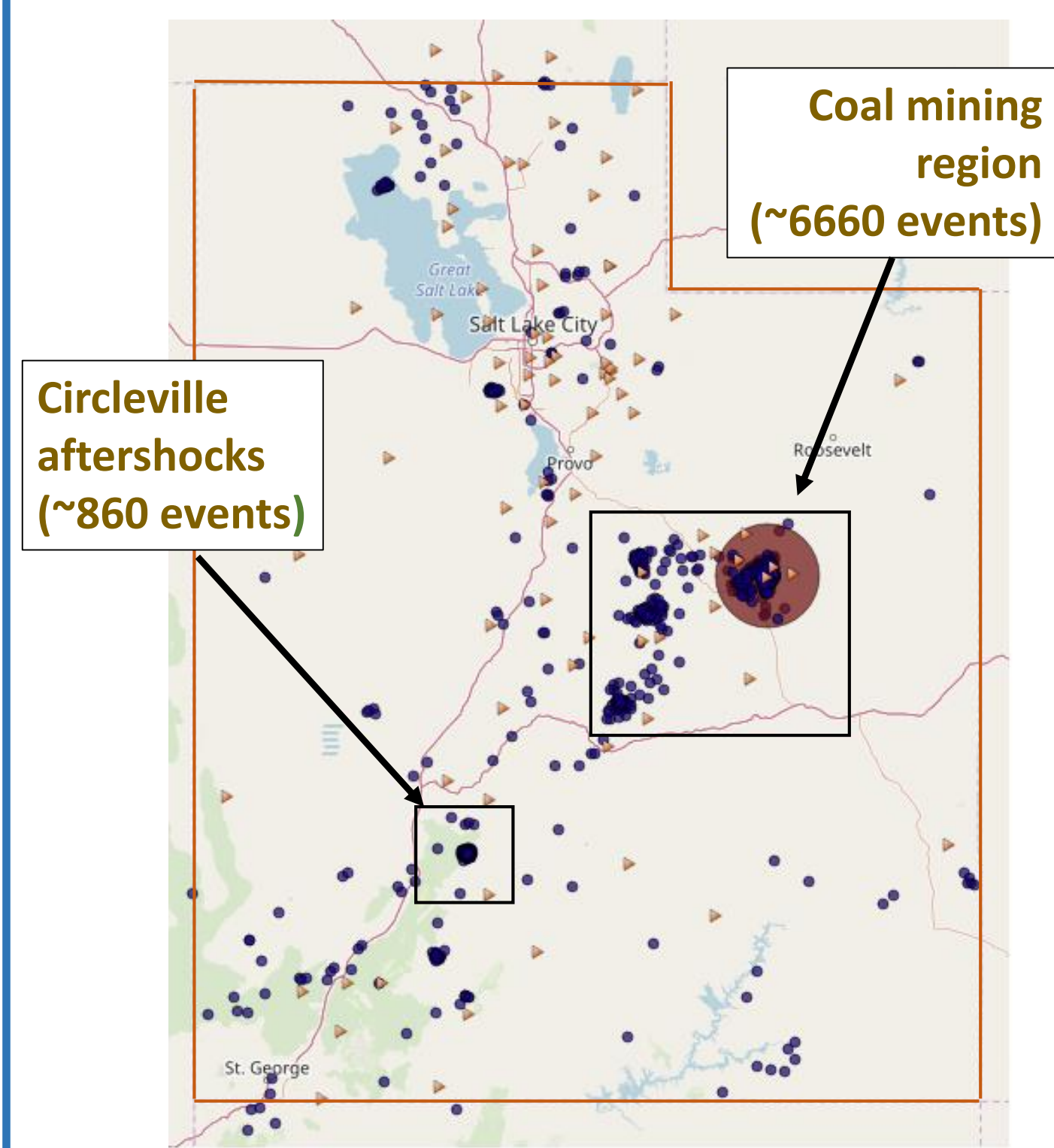
Pick-Based vs. Waveform Based Event Detection

Pick-based associators (e.g. GA, GLASS) are more commonly used, but other methods have been developed that skip the signal detection step and back-project waveform data directly into time/space to detect events.



Assessing which approach is better is difficult because different methods are not evaluated using the same test data sets. In this study, we facilitate a direct comparison by processing the same data set using the PEDAL pick-based signal associator and with the WCEDS waveform back-projection method. Both software packages were developed by Sandia National Laboratories (see References).

Utah Data Set

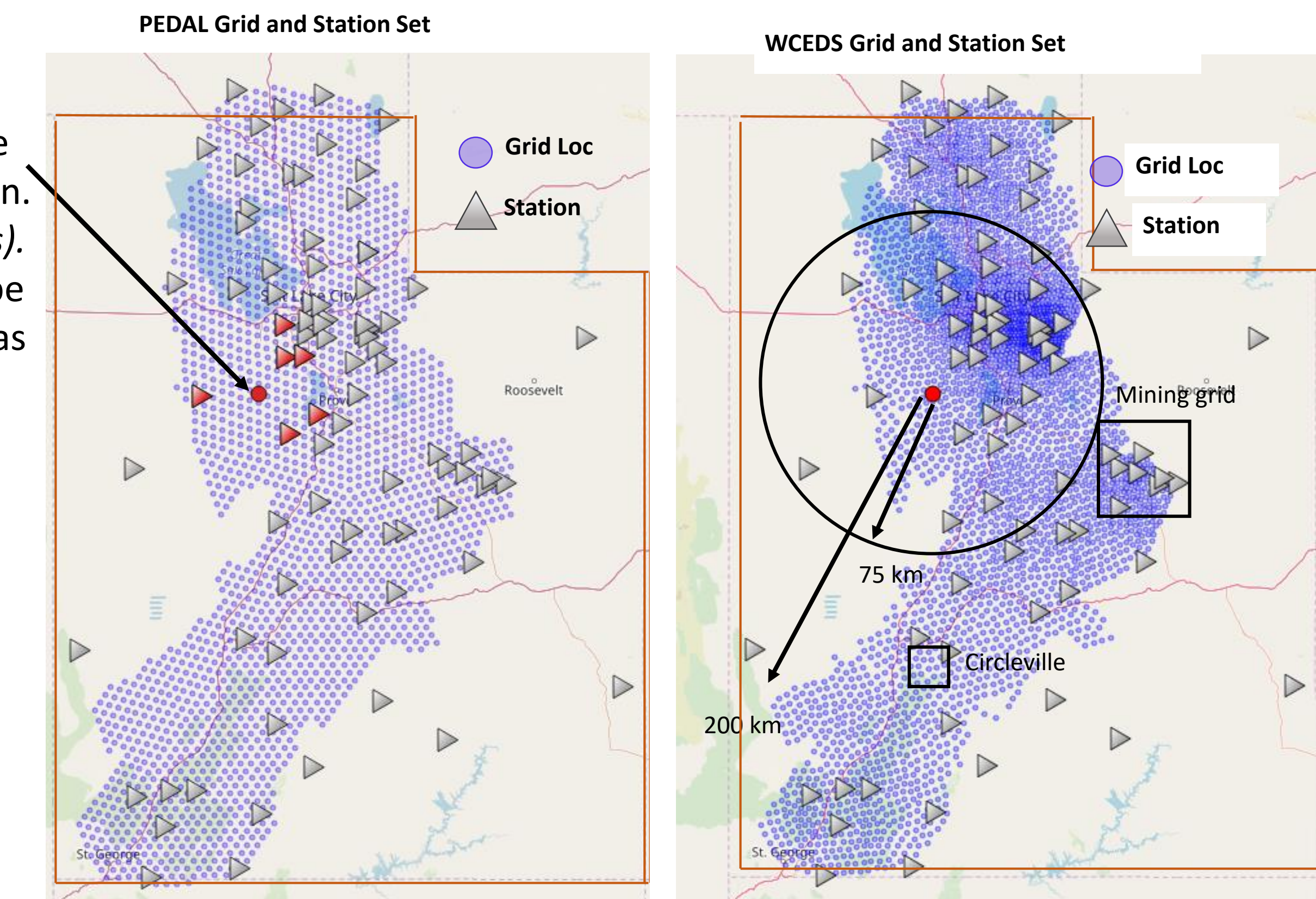


- UUSS network; Jan 1-14, 2011.
- 7,889 events; nsta>=3; all analyst reviewed

PEDAL vs. WCEDS Grids and Processing Recipes

For each grid location:

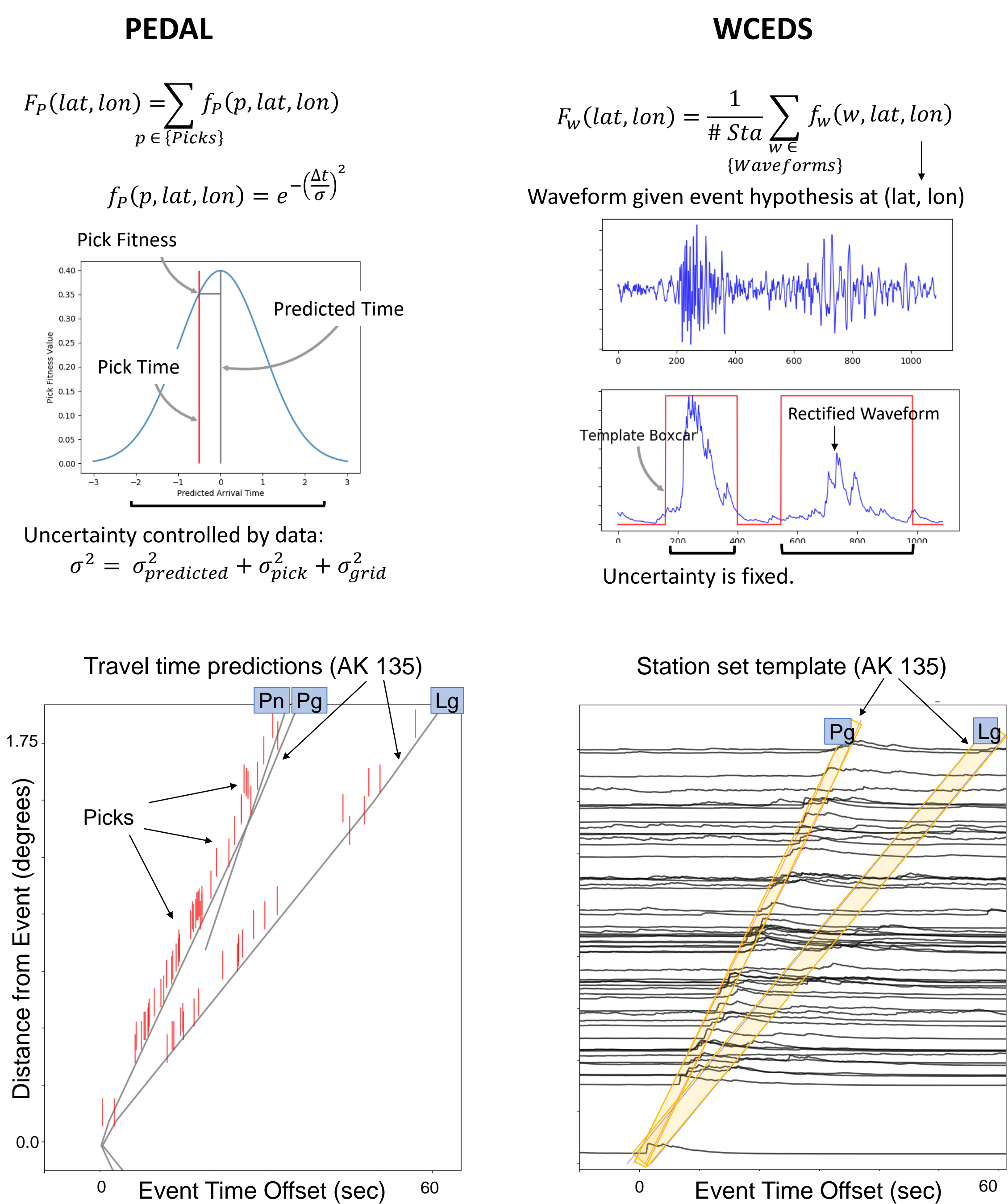
- 6 closest stations contribute to the initial event formation. (*helps reduce false positives*).
- Picks from any station can be associated once an event has been formed (*unassociated secondary phases can lead to false events*).
- Uniform grid spacing (.06 deg)
- Using a finer grid did not improve performance.



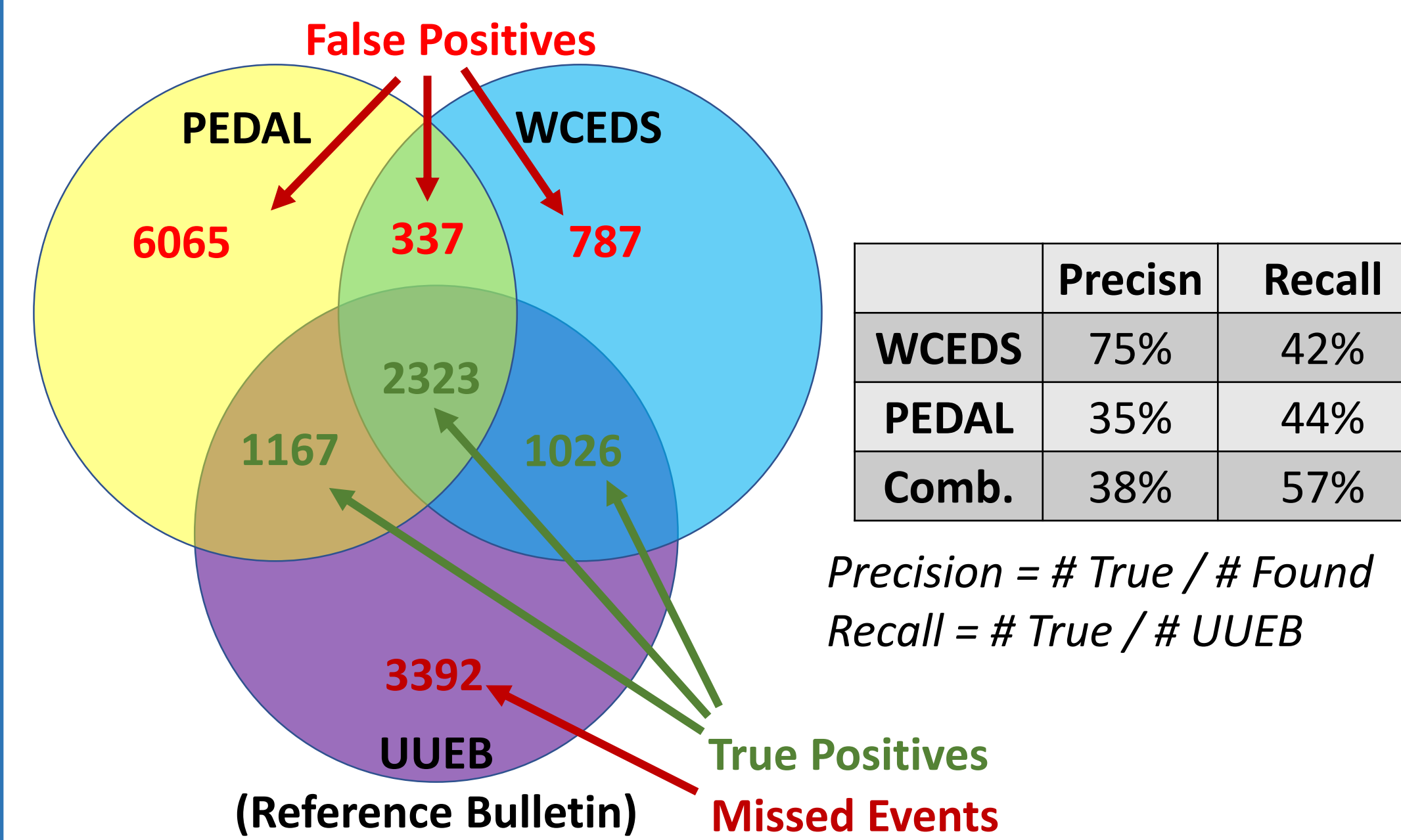
For each grid location:

- Utah Iteration [.5hz, .4hz]
- 1st Pass (Network wide events): stations within 200 km
- 2nd Pass (Smaller events): stations within 75 km
- Mining grid iteration [4hz, 8hz]
- Only stations in mining grid
- Circleville iteration [4hz, 8hz]
- stations within 75 km

PEDAL vs. WCEDS Event Detection

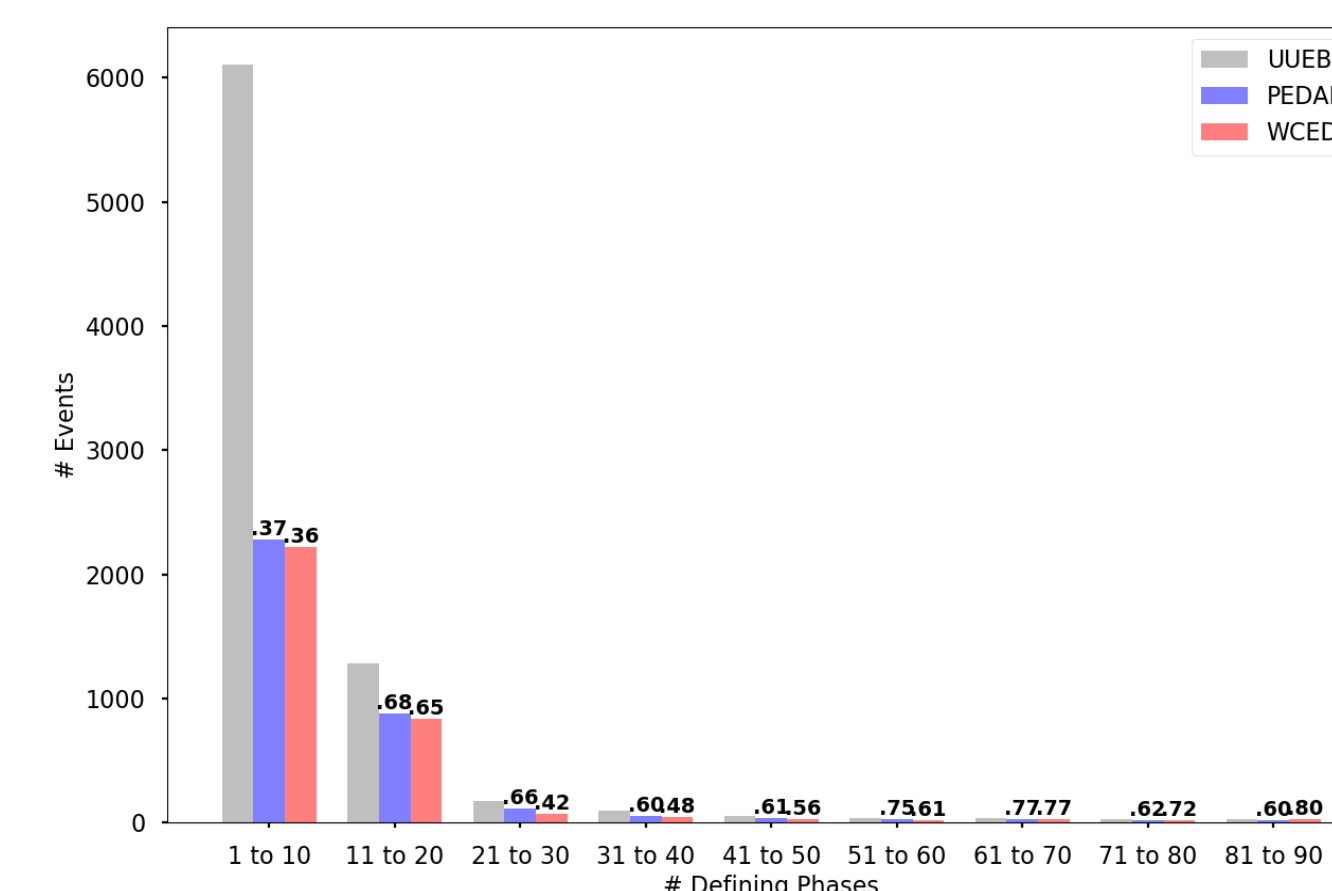


PEDAL vs. WCEDS Data Processing Results

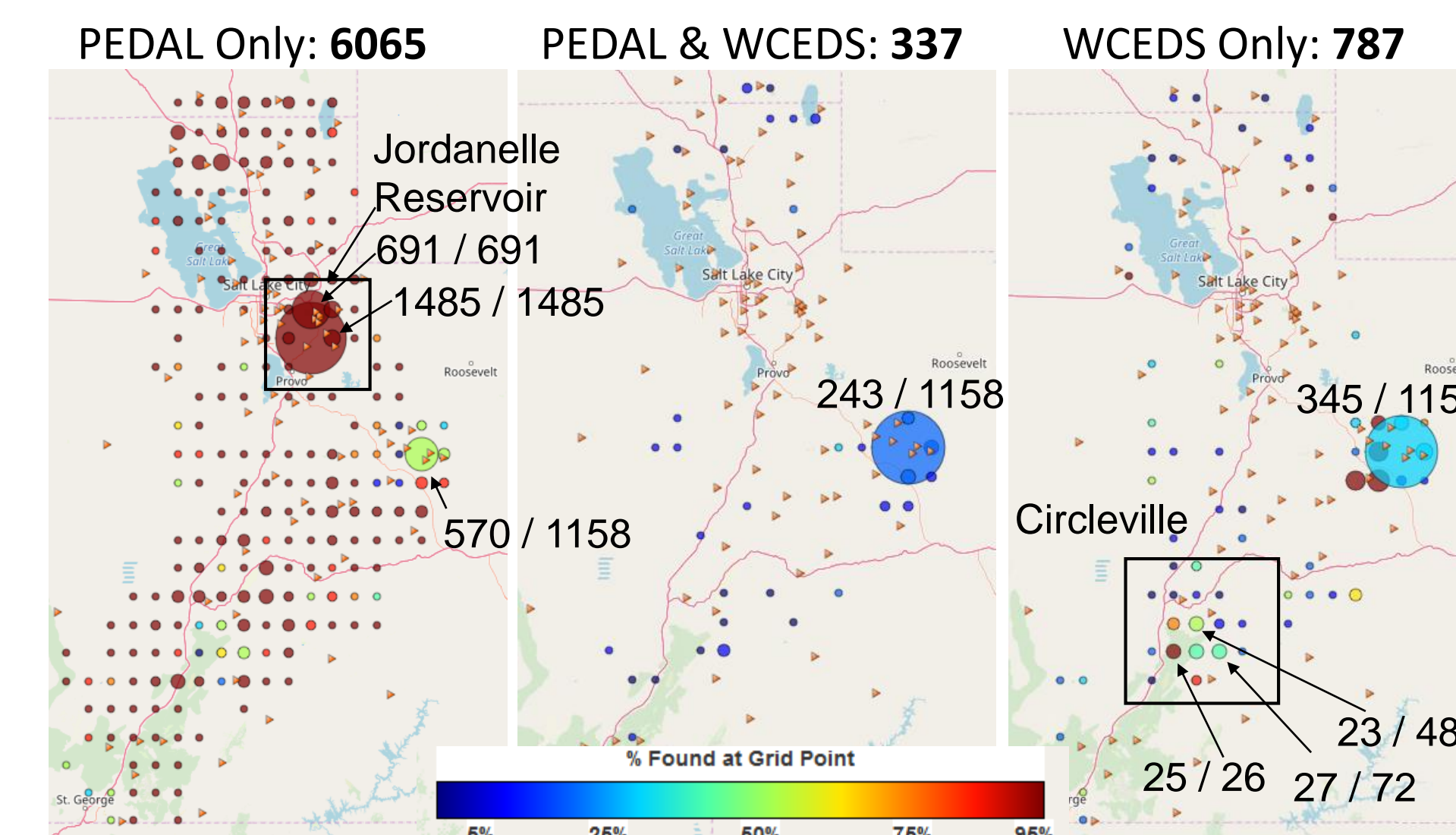


- Our comprehensive analyst-reviewed bulletin (UUEB) is treated as truth.
- Both methods achieve similar recall.
- WCEDS has *much* better precision (far fewer false events).
- Big surprise is the modest amount of overlap → suggests that combining methods could make sense.

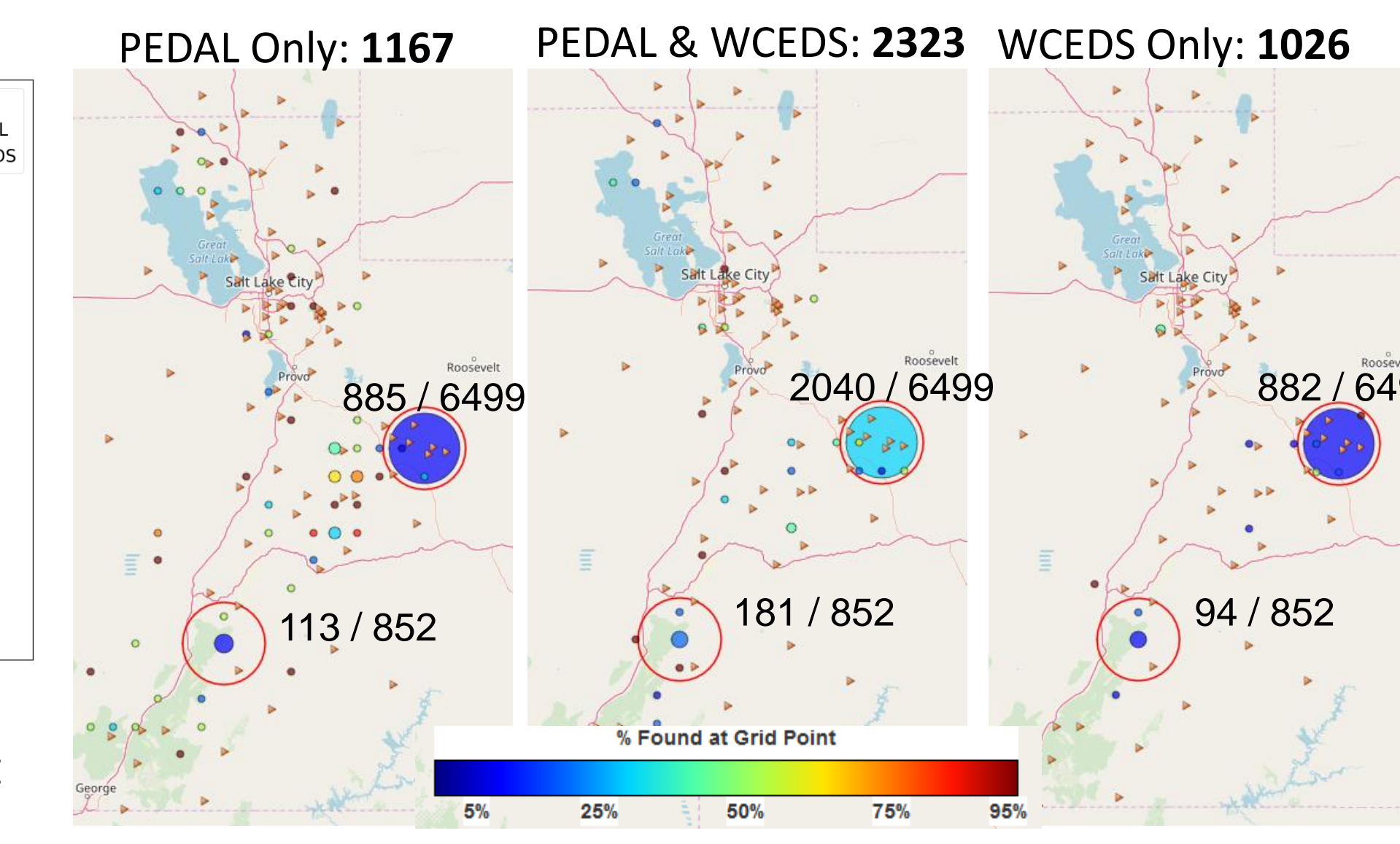
True Positives By Event Size



False Positive Locations



True Positive Locations



Conclusions & Future Work

PEDAL	WCEDS
Recall (44%)	Recall (42%)
Precision (35%)	Precision (75%) (Processing Recipe, Averaging in fitness function)
Harder to tune: signal picker, fitness function	Easier/more intuitive to tune
Data QC <i>absolutely</i> necessary	QC "for free" (Averaging in fitness function)
Full signal association	Only "associates" phases in template

Possible Next Steps

- Tuning to find more of the smaller events (# def <=10)
- Investigate WCEDS Only True Positives vs PEDAL Only True Positives
- Combine the algorithms – Event formation with WCEDS and PEDAL, Association with PEDAL (Early Results: Precision=40%, Recall=52%)
- Better Signal Detector for PEDAL – Deep Learning?

References

PEDAL: Draelos, T.J., Ballard, S., Young, C.J. and Brogan, R., 2015. A new method for producing automated seismic bulletins: Probabilistic event detection, association, and location. BSSA, 105(5).
WCEDS: Arrowsmith, S., Young, C., Ballard, S., Slinkard, M. and Pankow, K., 2016. Pickless event detection and location: The Waveform Correlation Event-Detection System (WCEDS) revisited. BSSA, 106(5).
UUEB: Linville, L., R. Brogan, C. Young, & K. Aur., 2019. Global and local scale high-resolution event catalogs for algorithm testing. Accepted for publication in Seismological Research Letters.