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Global and Local Scale High-Resolution Seismic Event Catalogs for Algorithm Development and Testing

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T3.5-P33

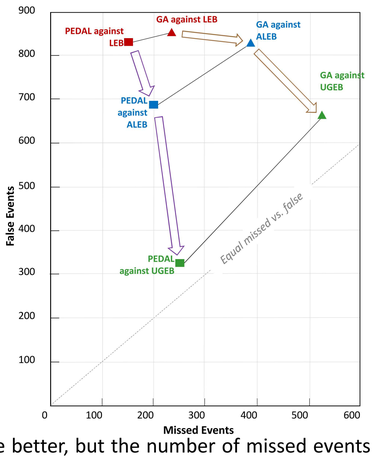
The Importance of High Quality Data for Algorithm Development & Testing

During the development of new seismic data processing methods, the verification of potential events and associated signals can present a non-trivial obstacle to the assessment of algorithm performance, especially as detection thresholds are lowered to include anthropogenic signals from surface and shallow underground sources. In particular, we note that without a complete and accurate catalog, it is not possible to accurately calculate either precision or recall.

Case Study: Development of the PEDAL Signal Associator

Sandia Labs developed the PEDAL signal association algorithm with the goal of producing a better catalog (fewer missed events, fewer false events) than the current Global Associator (GA) algorithm used by the International Data Centre (IDC) to process data from the International Monitoring System (IMS) seismic sensor network. The diagram below shows comparison of results for PEDAL vs. GA compared to different analyst-reviewed catalogs. Note that there is only one set of PEDAL processing results and one set of GA processing results that are being compared; the different assessment of false events vs. real events is due to which analyst-reviewed reference event catalog is being used to score the results.

- We started by comparing both methods against the LEB ("Late Event Bulletin"), the IDC's most complete analyst-reviewed bulletin.
- PEDAL showed improvement (~100 fewer missed events and ~30 fewer false) but less than expected. Examination of PEDAL "false" events established that many were real.
- Speculating that the time-constraint of LEB production was the issue, Sandia had an expert analyst produce an "Augmented LEB" (ALEB) with no time constraint, but still following the typical LEB minimum criteria of 3 stations.

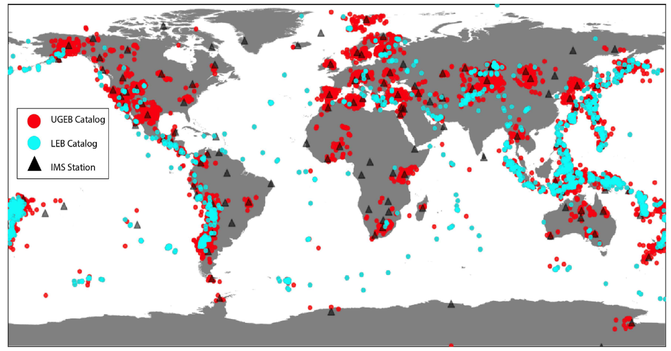


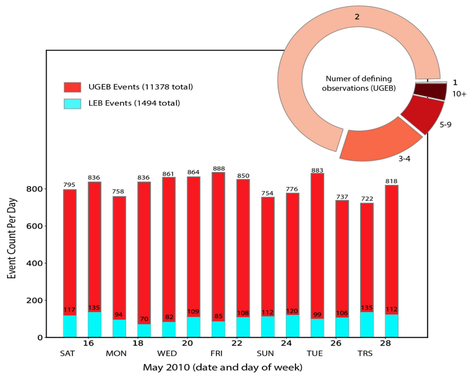
- Comparing against ALEB, PEDAL vs. GA results were better, but the number of missed events still seemed too high, and once again examination of "false" events established that many were real.
- Our expert analyst re-analyzed the data set without any minimum criteria for an event other than being confident that it was real and could be located (including single station locations for arrays). This became the "Unconstrained Global Event Bulletin" (UGEB) described in the panel to the right.
- Comparing against the UGEB, PEDAL results are dramatically better than GA: ~250 fewer missed events and ~350 fewer false events.

Open Release of Event Catalogs

Both the UGEB and the UUEB will be openly released (via a website) upon publication of a journal article describing them:
Linville, L., R. Brogan, C. Young, & K. Aur. Global and local scale high-resolution event catalogs for algorithm testing. Submitted to *Seismological Research Letters*.

Unconstrained Global Event Bulletin (UGEB)





Network: International Monitoring System (IMS)

- Primary (50 total, 30 arrays), Auxiliary (120 total, 7 arrays)

Time Interval: May 15-28, 2010 (2 weeks)

Analyst Starting Point (all events were reviewed):

- Late Event Bulletin (LEB) + waveform correlation processing

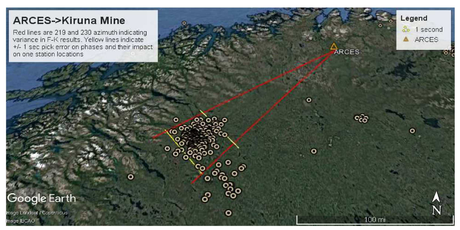
Minimum Event Criteria: None (single station events included)

Event Statistics:

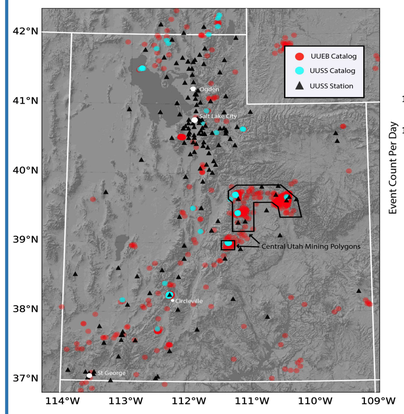
- 1494 starting events → 11,378 UGEB events (662% increase)
- ~883 events/day (little variation)

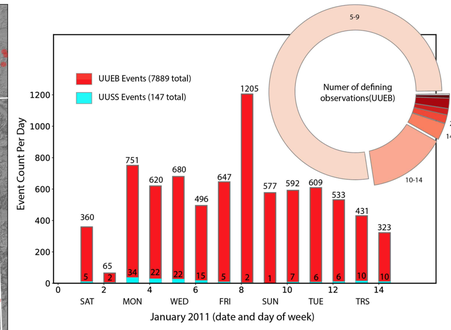
Notable Features:

- Clusters of events around arrays in seismically active arrays
- Several notable sequences, e.g. near WRA possibly related to 1988 M6.6 Tenant Creek earthquake



Unconstrained Utah Event Bulletin (UUEB)





Network: University of Utah Seismic Station network

- ~180 stations (seismometers and accelerometers, 3 component)

Time Interval: January 1-14, 2011 (2 weeks)

Analyst Starting Point (all events were reviewed):

- UU earthquake catalog + UU quarry blast catalog + waveform correlation processing + WCEDS processing (SNL developed waveform backprojection method)

Minimum Event Criteria: 3 stations

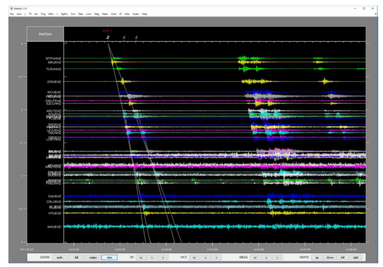
Event Statistics:

- 147 UU catalog events → 7,889 UUEB events (4300% increase)
- ~564 events/day (large variation)

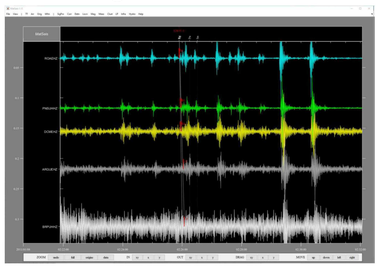
Notable Features:

- Variety of source types: earthquakes, quarry blasts, mining-induced events (MIEs)
- Huge number of MIEs in central Utah coal-mining region (~86% of total)
- Aftershock (862 events) sequence related to January 3, 2011 Mw 4.7 Circleville, Utah earthquake

Circleville Sequence



Mining-Induced Events



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