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Real-Time Double-Difference Location and Monitoring of Fine-Scale Seismogenic Properties, with Application to Northern California

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Using the DDRT (double-difference in real-time) software package, we are now routinely estimating high-precision locations of earthquakes in northern California. The DDRT system automatically cross-correlates waveforms of new events with waveforms from past nearby earthquakes and computes accurate differential phase arrival times. Correlation and pick delay times are subsequently inverted to estimate a vector connecting the new event to its neighbors from a DD base catalog with accurately known locations. The DDRT system produces a continuously-updated, high-resolution earthquake catalog for northern California containing more than 500,000 events from 1984 to present. We present solutions for integrating DDRT into the AQMS system.
The DDRT system facilitates near-real-time seismicity analysis, including the ability to search at an unprecedented resolution for spatio-temporal changes in seismogenic properties. As one example, we present results from using the DDRT system to monitor repeating earthquakes. We developed a comprehensive catalog of repeating earthquakes for northern California against which new events can be compared. We identified 640 clusters of repeating M>2 events, with events in each cluster exhibiting similar magnitudes (measured from relative amplitudes), high waveform correlation coefficients over long windows, and DD locations that resolve a common rupture surface. We are establishing baseline characteristics for each sequence such as recurrence intervals and their coefficient of variation (CV). CVs for these clusters range from close to zero to nearly two, indicating a range of behavior between periodic occurrence, random occurrence, and temporal clustering. Changes in recurrence intervals, especially for sequences with CV$\sim$0, can be monitored as they may indicate changes in the loading rate. Using these sequences, we also present results from retrospective forecast experiments based on near-real time hazard functions.