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Exploring Large-Scale Cross-Correlation for Teleseismic and Regional Seismic Event Characterization

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The decrease in costs of both digital storage space and computation power invites new methods of seismic data processing. At Lawrence Livermore National Laboratory(LLNL) we operate a growing research database of seismic events and waveforms for nuclear explosion monitoring and other applications. Currently the LLNL database contains several million events associated with tens of millions of waveforms at thousands of stations. We are making use of this database to explore the power of seismic waveform correlation to quantify signal similarities, to discover new events not in catalogs, and to more accurately locate events and identify source types. Building on the very efficient correlation methodologies of Harris and Dodge (2011) we computed the waveform correlation for event pairs in the LLNL database in two ways. First we performed entire waveform cross-correlation over seven distinct frequency bands. The correlation coefficient exceeds 0.6 for more than 40 million waveform pairs for several hundred thousand events at more than a thousand stations. These correlations reveal clusters of mining events and aftershock sequences, which can be used to readily identify and locate events. Second we determine relative pick times by correlating signals in time windows for distinct seismic phases. These correlated picks are then used to perform very high accuracy event relocations. We are examining the percentage of events that correlate as a function of magnitude and observing station distance in selected high seismicity regions. Combining these empirical results and those using synthetic data, we are working to quantify relationships between correlation and event pair separation (in epicenter and depth) as well as mechanism differences. Our exploration of these techniques on a large seismic database is in process and we will report on our findings in more detail at the meeting.