Integrating real-time GPS into earthquake early warning for northern California

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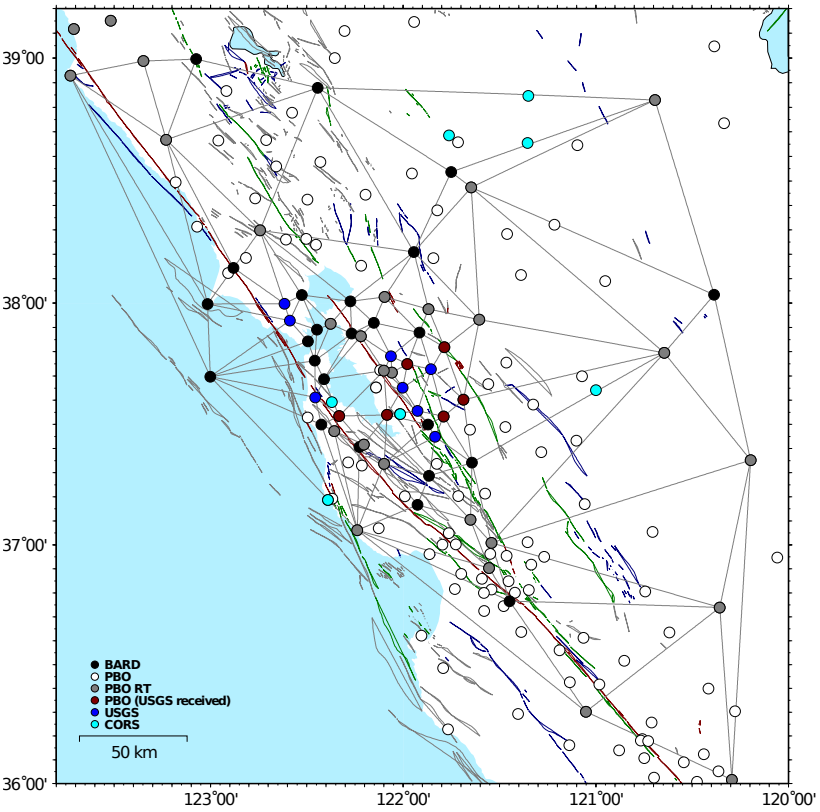
In an effort to integrate real-time GPS into earthquake early warning, the Berkeley Seismological Laboratory (BSL) now generates and archives real-time position estimates using data from 62 GPS stations in the greater San Francisco Bay Area. This includes currently 26 stations that are operated by the BSL, 7 that are operated by the USGS, and 29 stations operated by the Plate Boundary Observatory. We employ a fully triangulated network scheme in which neighboring station pairs are processed with the software trackRT (see Figure). Positioning time series are produced operationally for 172 station pairs; additional station pairs will be added as more real-time stations become available. We evaluate network performance based on likely earthquake scenarios for which we model expected permanent ground displacements at current real-time GPS stations and add these to the real-time stream. Test cases of a Mw 6.8 on the Rodgers Creek Fault and a Mw 7.0 on the Northern San Andreas fault showed that improved station coverage in the North Bay will be critical to accurately characterizing these types of earthquake in real-time. Scenario displacements will be made available in a separate archive.

The BSL earthquake early warning system uses real-time positioning data to measure static offsets in the greater earthquake region when triggered by alarms from the seismic system ShakeAlert, which is based on P-Wave detection. Static offsets are utilized to estimate earthquake parameters, such as magnitude and fault slip. The process flow is implemented in a prototype developed in Python. The tool ingests the time series produced by trackRT and runs basic quality control on these to determine which baselines to use in earthquake parameter determination. The goal of this work is a hardened and transparent real-time GPS system that improves earthquake early warning - in particular magnitude information - for large earthquakes to increase the accuracy of ground shaking predictions. We test the system on data from the 2010 M_w7.2 El Mayor-Cucapah earthquake.



Network map showing processing scheme for real-time GPS displacements at the BSL. Each line represents one "processing pair" for which we will be able to determine relative offsets in the event of an earthquake. A total of 172 pairs are currently being processed to produce continuous estimates of displacement. Open circles show PBO stations that are not currently available in real-time.