The Contributions of Seismogeodesy to Earthquake and Tsunami Early Warning

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Recent progress in real-time GPS has allowed the on-the-fly integration of GPS and accelerometer data for broadband monitoring of medium to large earthquakes. We will present results of an innovative method for combination of seismic and geodetic measurements via a tightly-coupled Kalman filter integrated within the framework of precise point positioning with ambiguity resolution, where strong motion accelerations are combined with raw GPS observations yielding broadband strong motion velocity and displacement waveforms. We will demonstrate the potential these data products hold for earthquake early warning. With results from several events ranging in magnitude from Mw 4.6 to Mw 9.0we will show that scaling relationships obtained from broadband displacements do not saturate at high magnitudes and could potentially extend the range of usability of traditional rapid magnitude estimates. Furthermore we will demonstrate how these data products can be used to model the seismic source; obtaining centroid moment tensor and slip inversion estimates in only a few minutes after origin time with minimal operator interaction. We will show the impact that such rapid source models have on quick tsunami computations and the potential for source-model based tsunami early warning as opposed to the current data-base driven approach. Finally, we describe the operational real time analysis system that has been implemented to support earthquake and tsunami early warning for the Western US.