Source Inversion Resolution Analysis of the 2004 M_w6.0 Parkfield Earthquake

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The Parkfield earthquake sequence is extremely important for testing ideas of earthquake recurrence and predictability. Historically the Parkfield earthquake series was the impetus for formulating the "characteristic earthquake" hypothesis which still today has great impact on ideas used in seismic hazard analysis. By comparing kinematic inversions of past earthquakes at Parkfield we can determine to what extent these earthquakes are truly "characteristic", and thus, to what extent ideas developed in this region can be extrapolated to future seismicity on the San Andreas Fault and in similar tectonic regimes such as the North Anatolian Fault. In order to compare the source processes of different earthquakes, a quantitative measure of the uncertainty between different inversions is needed.

The long-awaited 2004 M_w6.0 Parkfield Earthquake provides a unique opportunity to probe the resolution limits of source inversions due to the large amount of near-field seismic stations. This earthquake was well recorded by a dense network of strong-motion seismographs and GPS 1-Hz receivers. We investigate the resolution of the nonlinear source inversion performed by Custódio, Liu, and Archuleta [2005]. We compare the resolution bounds given by a singular-value analysis to a bootstrapping analysis already performed by Custódio et al. in which inversions of station subsets were compared.

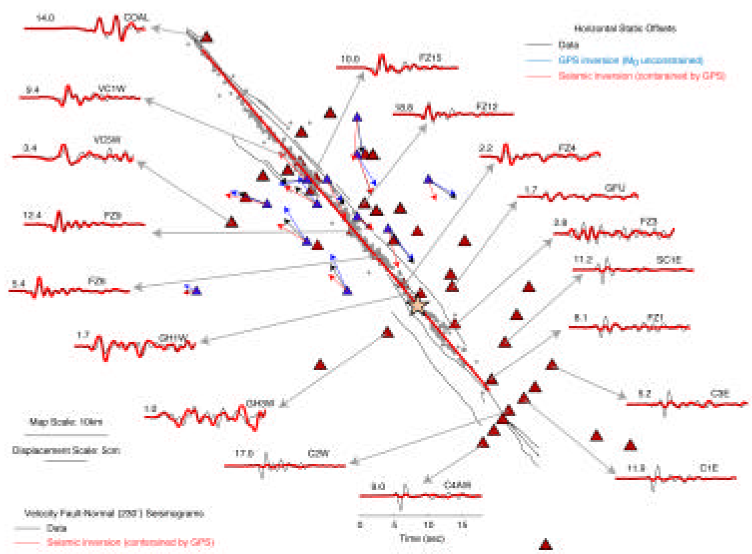

Figure 1. Map of the Parkfield section of the San Andreas Fault, showing the fit to data offered by the rupture model inferred from the inversion of seismic data constrained by GPS data. Small gray dots - aftershocks [*Thurber et al.*, in press]; star - epicenter; red line - modeled fault plane; blue triangles - 1-Hz GPS stations; red triangles - strong-motion seismic stations.

Joint inversions of GPS and strong-motion data can be problematic because the two data sets are in different frequency bands, have different sampling rates, and contain different error terms. Custódio et al. avoid mixing the data by inverting the GPS data independently, and then use the slip distribution obtained as a constraint in the inversion of strong-motion data. The drawback of this approach is that the GPS data is much denser around the northwest portion of the fault, as shown in Figure 1. The GPS data cannot resolve slip on the southwest portion of the fault, and thus using the GPS data to constrain the strong-motion data leads to little total slip in this area.

We calculate the spatial resolution of the GPS data to provide a natural way to weight the static field constraint spatially. In this way, the GPS data can better constrain the northwest portion of the fault while at the same time not prevent the inversion from placing slip on the southeast portion of the fault in areas allowed by the strong-motion data. This avoids the ad-hoc determination of weights that is often used to combine disparate data sets.