SCEC Crustal Motion Map:
Collaborative Analysis

Report for 2006

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The Southern California Earthquake Center has supported the development of a number of community models, one of which is the Crustal Motion Map, or CMM (formerly known as the Horizontal Deformation Velocity Map). Version 3.0 of this was released in August 2003; see *http://epicenter.usc.edu/cmm3*.

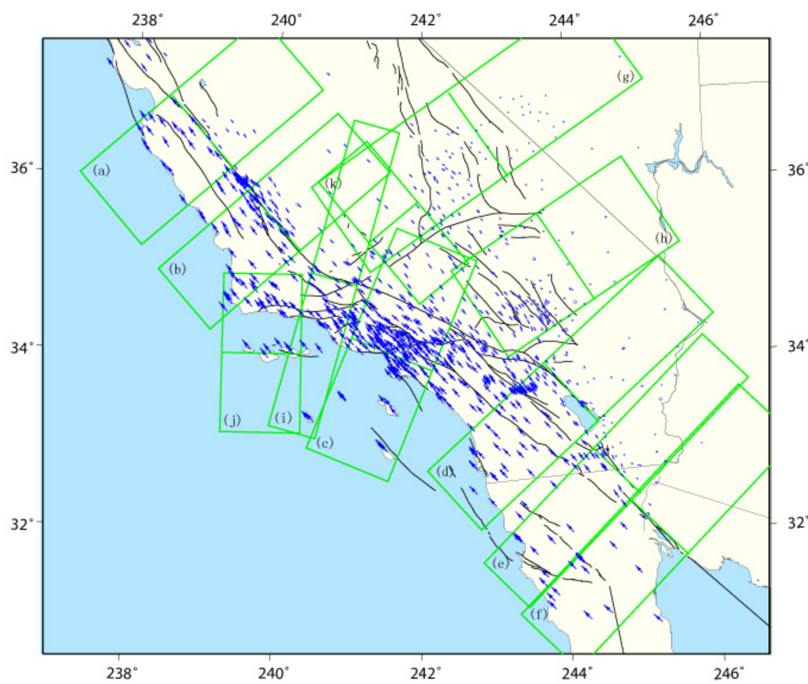

Figure 1

Over the past year we have completed the final version of the SCEC Crustal Motion Map (CMM 4.0). As noted in our earlier reports, this version includes data running through a later time period (up to the Parkfield earthquake in late 2004), so that we have been able to include all sites of the SCIGN network. We have also included survey-mode data that was not available to us at the time of producing CMM 3.0. We have combined GPS data observed from 1986 to 2004, EDM data from 1980 to 1992, and VLBI data from 198? to 1992 to derive site motions for an area that includes southern California, southwest Nevada, and northern Mexico. We have estimates of horizontal secular velocities with uncertainties less than 3 mm/yr for over 1000 sites, together with estimates of coseismic displacements from the Joshua Tree, Landers, Northridge, Hector Mine, and San Simeon earthquakes. We have also estimated vertical rates with uncertainties less 3 mm/yr for several hundred sites. Finally, time series are available from which post-seismic motion can be estimated for Landers and Hector Mine.

In parallel with our work to complete the CMM for southern California, we have incorporated into our analysis data from northern California and adjacent areas of Oregon and Nevada to support the work of the Working Group on California Earthquake Probabilities (WGCEP) funded by the California Earthquake Authority (CEA). In mid-year we provided the WGCEP a CMM incorporating about 1400 sites with horizontal velocity uncertainties less than 2 mm/yr.

At the time of this report, we have a manuscript in preparation that will document in the open literature the GPS data available in the SCEC archive; the procedures used in our analysis; appropriate error models for the velocities, coseismic offsets, and estimates of postseismic deformation; and tectonic inferences that we and others have made from the CMM products.

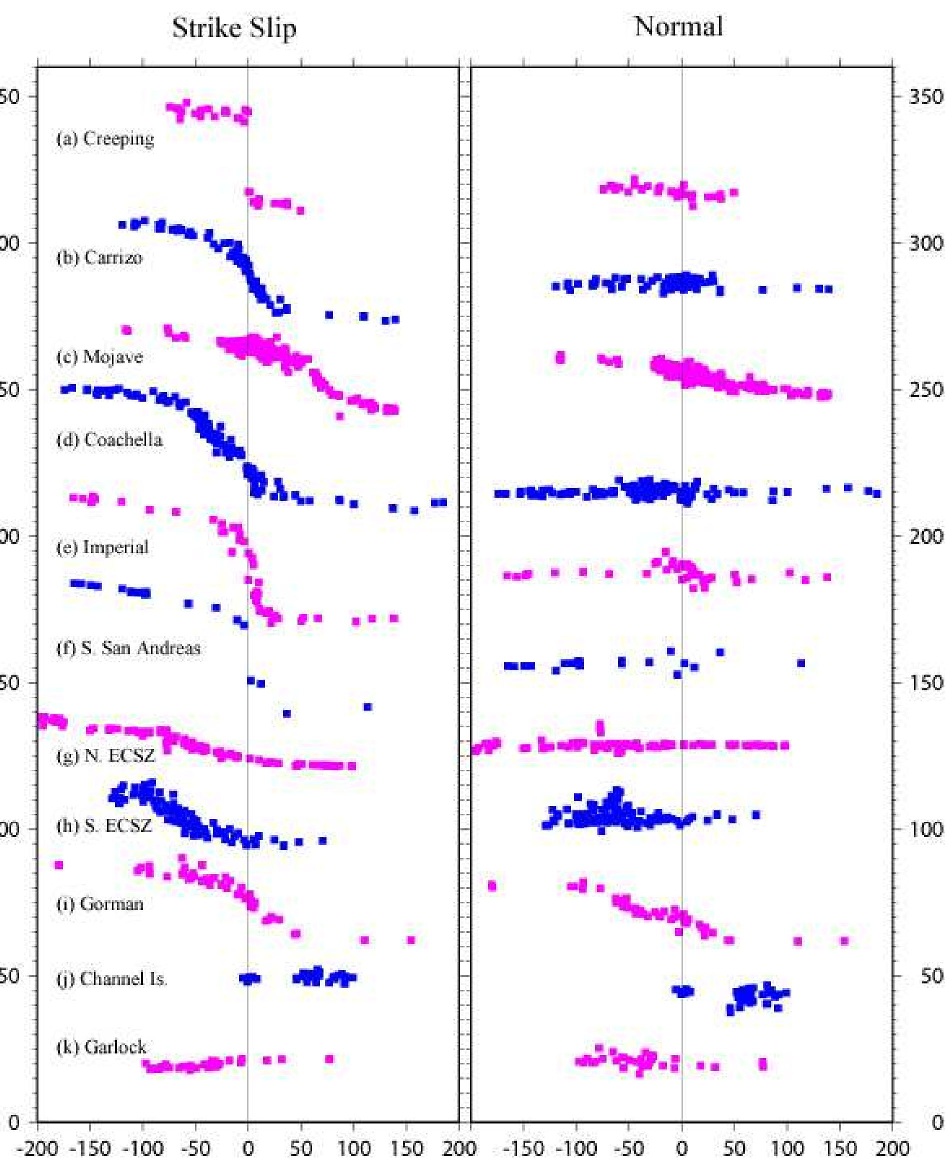

Figure 2

To properly account for the uncertainties of the aggregated input data files, we have scaled their variance/covariance matrices so that the weighted post-fit residual variance is about equal to the number of degrees of freedom in each dataset. Thus the total weighted residual variance of the combined datasets is also about equal to the number of degrees of freedom, and the parameter uncertainties reported are close to one standard deviation. The error estimates only capture explicitly those errors that contribute directly to residuals, but there is sufficient diversity and redundancy in the measurements that we think it unlikely that there is any large undetected systematic error in relative velocities within southern California.

In our most recent processing of the GPS data, we have set up computational procedures that will allow the data to be reprocessed using the standards, models, and reference frames employed by the PBO Analysis Centers, so that the PBO velocity field can be extended 20 years backward in time, thus providing a picture of deformation through the Parkfield, Hector Mine, Northridge, and Landers earthquakes.

Figure 1 shows horizontal station velocities; the orange boxes denote the regions from which velocity data are selected to be displayed in profiles. Velocities are referenced to stable North America by constraining station velocities of 21 IGS sites to their model predicted values with small uncertainties.

Figure 2 shows the velocity profiles (fault parallel and normal velocities) across major fault segments. A through F are along the San Andreas, from the creeping zone in central California to Mexico. The other profiles cover other subsidiary areas. The error bars represent 1-σ uncertainty. The San Andreas boxes show a familiar pattern: to the north, a step in velocity across the fault and little deformation away from it; moving south the width of the deforming zone becomes broader and then narrows again in the Imperial Valley. None of these profiles shows large amounts of fault-normal motion. The Eastern California Shear Zone shows a similar pattern, though with less total motion. Shortening is observed across the Tehachapi and Ventura areas.