2015 SCEC REPORT

Improving GPS Crustal Motion Map for Integrated Community Geodetic Model

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Part one: Improving GPS Crustal Motion Map

We have worked on the following tasks for campaign GPS data processing and production of station time series in 2015.

1. Processing and reprocessing of campaign GPS data. We have done all of the daily processing/reprocessing of the southern California campaign data 1986-2014 using GAMIT 10.50. This includes processing all of the campaign data observed 2004-

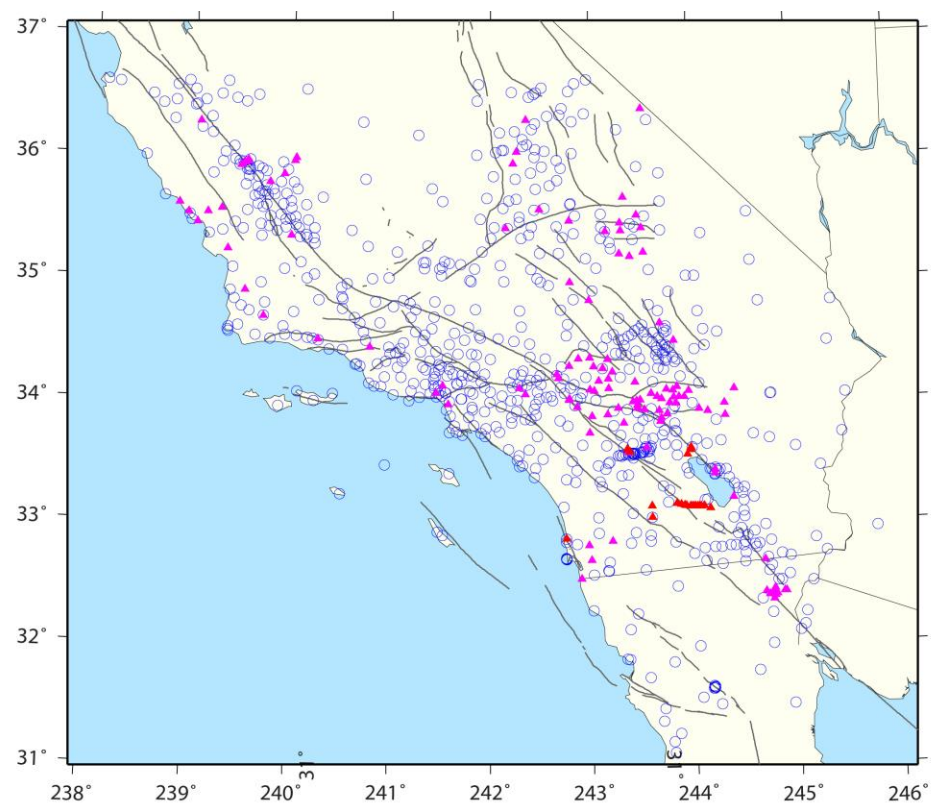

Fig. 1. Campaign GPS sites included in the CMM solution update. Blue circles are the old CMM4 sites, magenta triangles are new sites, and red triangles are also new sites whose data were recently contributed by Scripps.

2014 that were not included in the CMM4 solution and not done in last year's processing, such as the ones collected by the Arizona/Riverside/CSSB groups in the eastern Transverse Ranges region, and the ones collected by USGS in a number of regions. It also includes data collected by the Scripps group and submitted to us a few weeks ago (Fig. 1). A group of California cGPS sites are selected, whose data are processed together to tie the solutions to the continuous network (Fig. 2).

2. <u>Reprocessing of North America tracking network solutions 1994-2014 (Fig. 2) and global tracking network data 1986-2014 (Fig. 3)</u>. This portion of process was started last year and finished this year. Inclusion of these solutions help to stabilize the solution and tie to the SNARF and global ITRF reference frame. Reprocessing of the early global tracking network data are not so important for the 2000-2014 solutions,

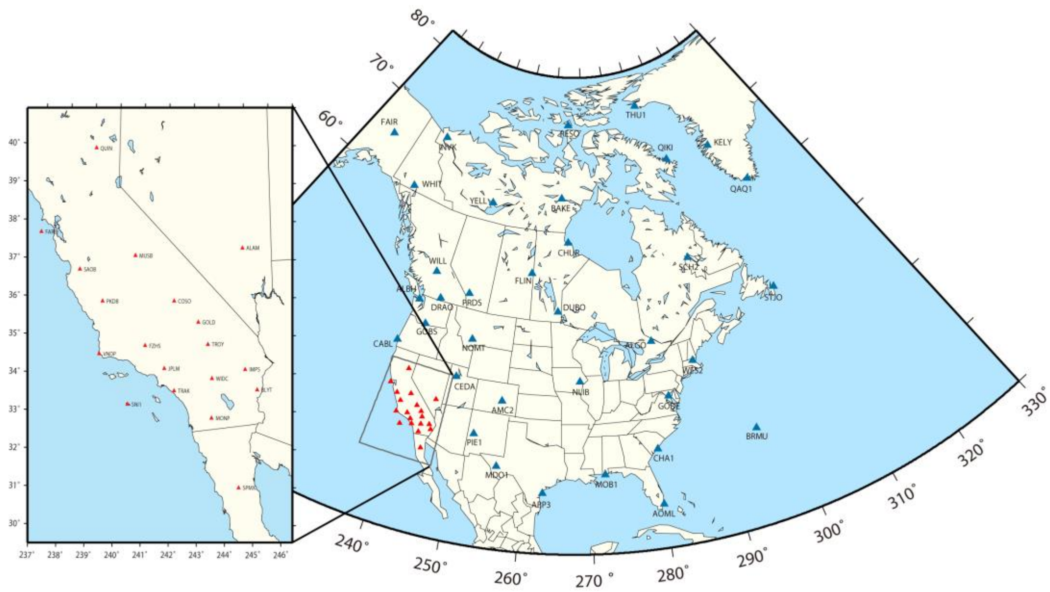

Figure. 2. North America tracking sites (blue triangles) and California continuous sites (red triangles) selected as backbone sites to tie the solution with continuous GPS network solutions and to establish the North America reference frame.

but are important for the 1986-1999 solutions.

3. <u>Combining the campaign daily solutions with North America and global tracking solutions.</u> The loosely constrained campaign solutions are combined with loosely constrained North America and global tracking solutions using the GLOBK software. The combined solutions are also loosely constrained for subsequent use of CMM modeling and production of station position time series.
4. <u>Producing and inspecting campaign GPS station position time series</u>. The QOCA software is used to produce station position time series with respect to a set of reference stations. The time series are then inspected for potential problems, which are then either fixed or have the outlier points discarded, and the process is repeated for further inspection. This is a quite time consuming part of the work and is still ongoing.

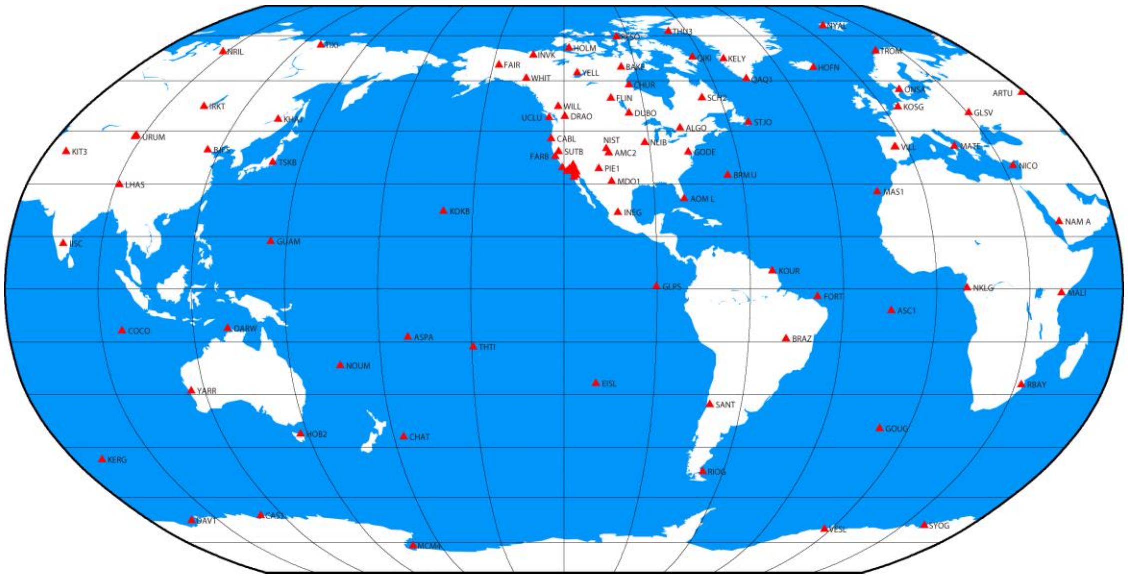

Figure 3. Global tracking sites selected to tie the solutions to the global reference frame.

Part two: Recovery of Secular Deformation Field of Mojave Shear Zone in Southern California from Historical Terrestrial and GPS Measurements

The 1992 Mw 7.3 Landers and 1999 Mw7.1 Hector Mine earthquakes struck the Eastern California Shear Zone (ECSZ) in the Mojave Desert, Southern California. Coseismic and postseismic deformation from these events affect efforts to use Global Positioning System (GPS) observations collected since these events to establish a secular surface velocity field, especially in the near field of the coseismic ruptures. We devise block motion models constrained by both historical pre-Landers triangulation and trilateration observations and post-Landers GPS measurements to recover the secular deformation field and differentiate the postseismic transients in the Mojave region. Postseismic transients are found to remain in the Southern California Earthquake Center (SCEC) Crustal Motion Map Version 4 (CMM4), Plate Boundary Observatory (PBO), and Scripps Orbit and Permanent Array Center (SOPAC) GPS velocity solutions in the form of 2-3 mm/yr excess right-lateral shear across the Landers and Hector Mine coseismic ruptures (Fig. 4). The cumulative deformation rate across the Mojave ECSZ is 13.2–14.4 mm/yr, at least twice the geologic rate since the late Pleistocene ($\leq 6.2 \pm 1.9$ mm/yr). Postseismic GPS time series based on our secular velocity field reveal enduring late-stage transient motions in the near field of the coseismic ruptures that provide new constraints on the rheological structure of the lower crust and upper mantle.

References

Liu, S., Z.-K. Shen, and R. Bürgmann, Recovery of secular deformation field of Mojave Shear Zone in Southern California from historical terrestrial and GPS measurements. J. Geophys. Res. Solid Earth, 120, 3965–3990. doi: 10.1002/2015JB011941, 2015.

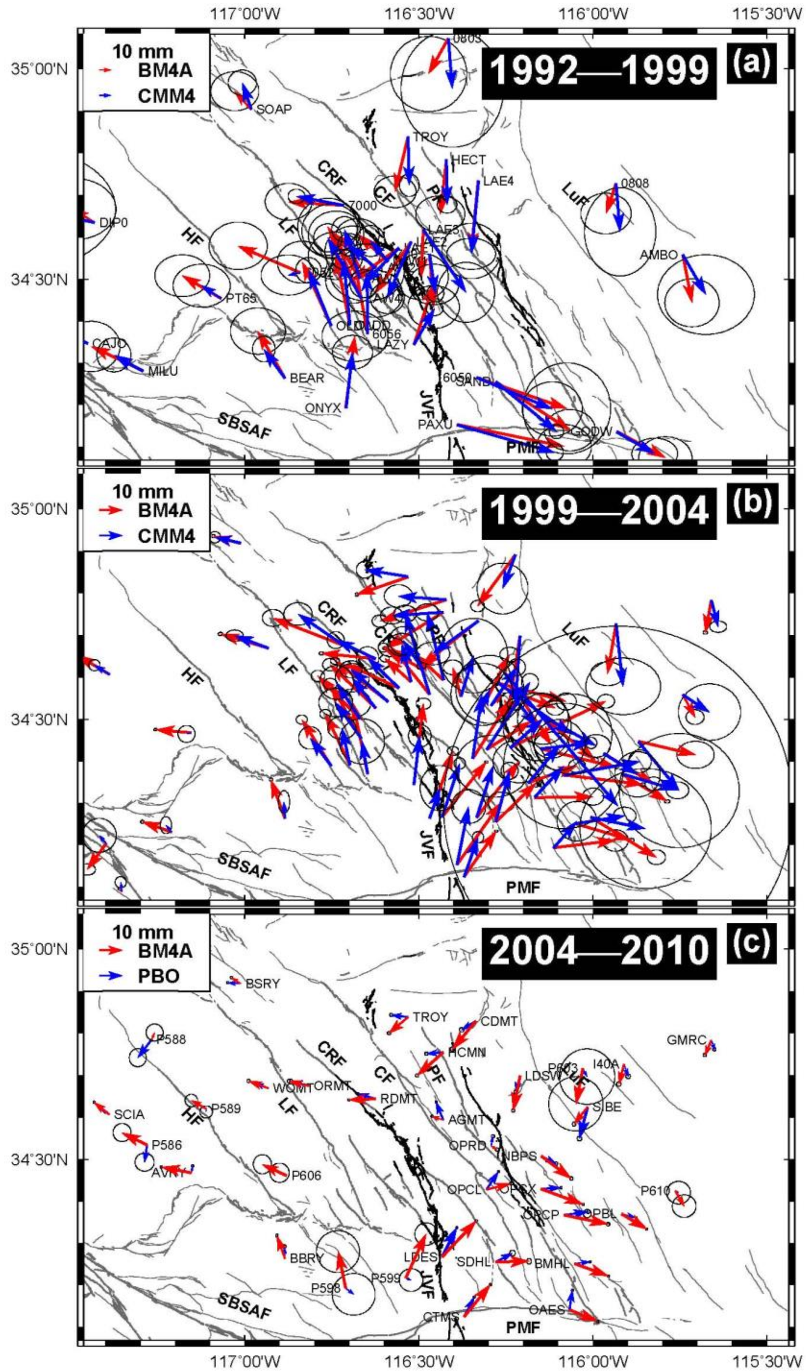

Figure 4. Postseismic displacements in the time spans of (a) post-Landers–Hector Mine, (b) post-Hector Mine–2004.0, and (c) 2004.0–2010.3. Blue and red vectors in (a) and (b) are the CMM4 station displacements less the CMM4 estimated velocity contributions and the BM4A (the optimal model) predicted velocity contributions, respectively. Blue and red vectors in (c) are the PBO station displacements less the PBO estimated velocity contributions and the BM4A predicted velocity contributions, respectively.