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Improving the SCEC Crustal-Motion Map: GPS Data Collection

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Introduction

This funding supported field GPS measurements in 1999 by members of the SCEC Crustal Deformation Working Group (“Group E”). The aim of these measurements was to improve the SCEC Crustal-Motion Map (CMM) significantly. The rationale for additional field measurements was that we can get better estimates of velocities by measuring over a longer time (unless there is a large earthquake); we were thus in a position to “harvest” a large number of points measured some time earlier, many measured for surveying purposes at no cost to SCEC. Also, the growth of the continuous GPS network in Southern California means that it is easier to do survey-mode GPS than ever before.

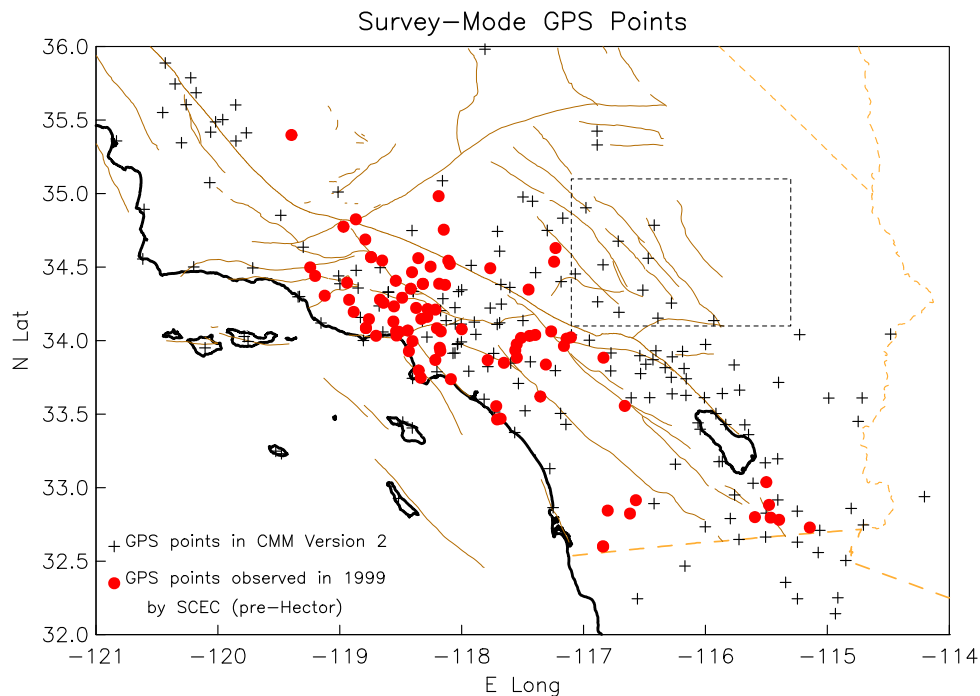


Figure 1

Accomplishments (I): Measuring CMM Points

Our plan for survey-mode GPS was to visit sites that had not been observed for at least 4 years, had adequate prior observational history, and were in areas in which improved coverage

was needed (and in most cases, would not be provided by SCIGN).

Since it is no longer necessary to coordinate large numbers of field parties, we chose a decentralized approach, in which several groups made measurements in different areas. Different regions were surveyed by groups for whom access was easy or who had an interest in the area. All groups could draw on the local pool of field-GPS receivers and other equipment. Figure 1 shows the points surveyed, along with all the GPS points in Version 2 of the CMM; we have added significantly to the coverage in several areas. By institution, the results were:

- **UCLA** collected survey mode GPS data primarily in and around the Los Angeles basin, surveying 70 sites in 1999; these had been occupied previously during the 1992 Gorman, 1993 Inter-county, and 1994 post-Northridge experiments.
- **Harvey Mudd** collected data at 15 sites, mostly in the Riverside and San Bernardino areas along the San Jacinto and San Andreas faults. Unfortunately, many of the marks on their list to visit, turned out to have been destroyed.
- **UCSD** collected data at 15 sites in the Imperial Valley and at points along the Newport-Inglewood, Elsinore, and San Jacinto faults.
- **USC** was to have surveyed 10 points in and around the San Bernardino Mountains; 3 of these had been done the weekend before the Hector Mine earthquake. The next planned field trip was modified to collect coseismic and postseismic data.
- **MIT** was to have surveyed sites in the Landers area and the Coachella valley. Because of the occurrence of the Hector Mine earthquake, this survey was instead modified to cover 21 sites around that earthquake in January 2000, to provide a measure of postseismic deformation at sites measured soon after the earthquake.

Accomplishments (II): Response to the Hector Mine Earthquake

The Hector Mine earthquake of 16 October 1999 called forth a considerable response from the crustal deformation community, since it represents the best opportunity since the Landers earthquake to measure postseismic changes. The results from Landers have been subject to a variety of interpretations, and it was clearly desirable to add more data on this question. Of course, the continuous GPS data from SCIGN offers many advantages over survey-mode measurements for this purpose; but at the time of the earthquake the SCIGN stations installed (purple stars in Figure 2) were all to the south and west, with none being very close to the rupture. Both to get a baseline for later measurements, and to get coseismic offsets, several SCEC institutions (USC, UCLA, and UCSD) began field measurements within 48 hours of the earthquake, though measurements close to the fault were not possible during the first week because of restricted access to the Marine Corps Air-Ground Combat Center (MCAGCC), within which the rupture lies. The first priority was to reoccupy survey-mode GPS points with good prior data (shown in Figure 2 in red for those done by SCEC and green for those done by other groups); fortunately many of these had been occupied in the last 2 years for post-Landers monitoring. We were especially lucky that in 1998 the UCLA student making post-Landers observations, Stan Cindrity, initiated measurements at several points within MCAGCC, one within 1 km of the (later) Hector Mine rupture. In total, including the MIT survey mentioned above, we made measurements at 27 points with previously-existing positions.

GPS Done Around Hector Mine Earthquake

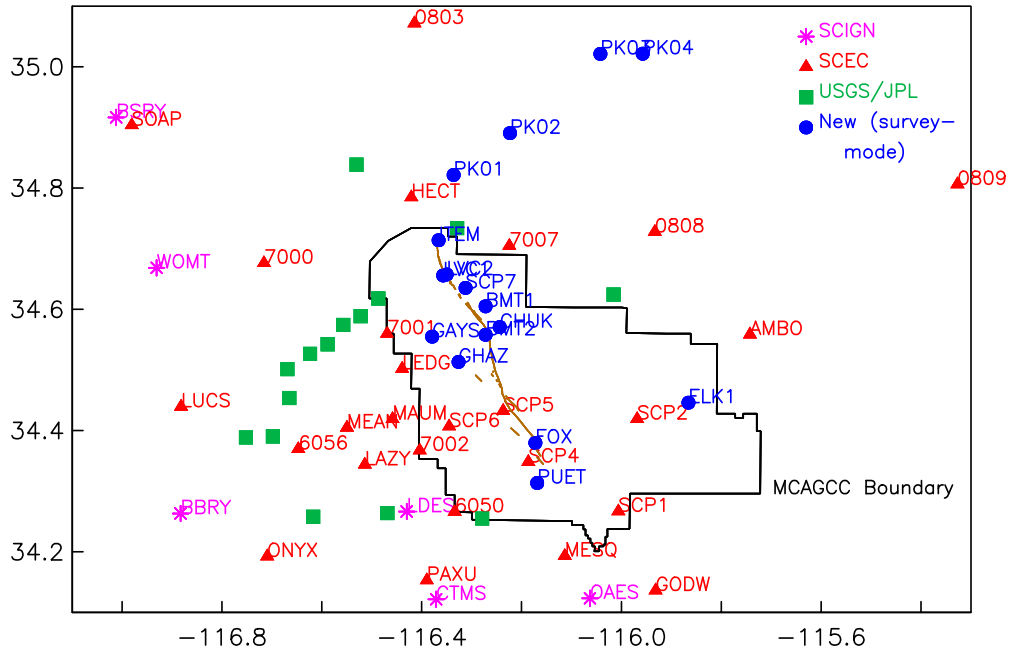


Figure 2

GPS Planned Around Hector Mine Earthquake

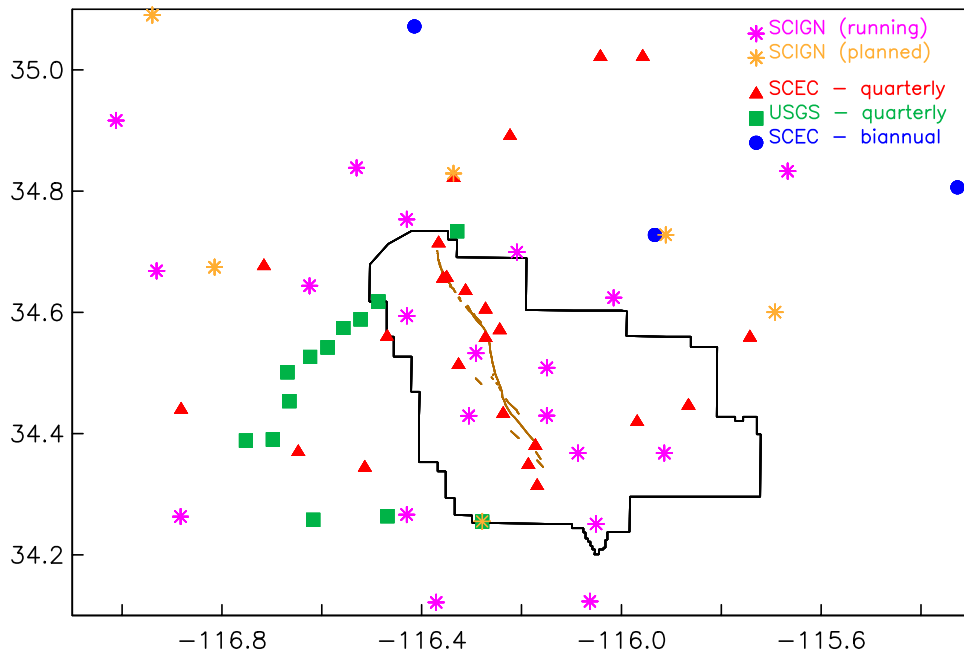


Figure 3

Figure 2 also shows 16 newly-established GPS points, all set up by SCEC. In setting these up, we benefited from the support that SCEC has given to Dr. E. Hearn (MIT); her modelling

results suggest that to distinguish between afterslip and viscoelastic relaxation, data is best collected over a wide range of distances and off the ends of a rupture. For afterslip, displacements are more fault-parallel; for viscoelastic relaxation, displacements look more like the response to a double couple. We therefore extended the USGS Landers profile further to the NE to approximate this for one end of the fault. A number of points were also set near the fault to look for shallow afterslip; we observed 16 such points in all.