Toward a Continuous Monitoring of the Horizontal Displacement Gradient Tensor Field in Southern California using CGPS Observations from PBO

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We have developed a cGPS network-processing tool for detection of anomalous strain transients within the Plate Boundary Observatory network in southern California. Position estimates from cGPS are interpolated (through a joint inversion of strains and position estimates) to provide a model solution for the horizontal displacement gradient tensor field as a function of time. Regularization of the solution is achieved by adjusting a single isotropic strain variance parameter until the reduced chi-squared misfit between model and observed displacement approaches 1.0. Additional constraints are provided by a priori information on fault style and orientation, along with the application of Pacific-North America displacement boundary conditions. A geodetic reference solution is subtracted from the epoch solution and the significance of residual strains is tested using a t-statistic. Tests using synthetic cGPS observations, generated in the SCEC IV Transient Detection Exercise, show that anomalous strains associated with slow-slip over 6-8 week time frames, totaling less than 1 cm, can be detected with high confidence (assuming uncertainties in daily positions estimates of ± 3 mm). Analysis of PBO cGPS time series since July 2010 shows a complex field of significant anomalous strain, primarily associated with post-seismic processes.

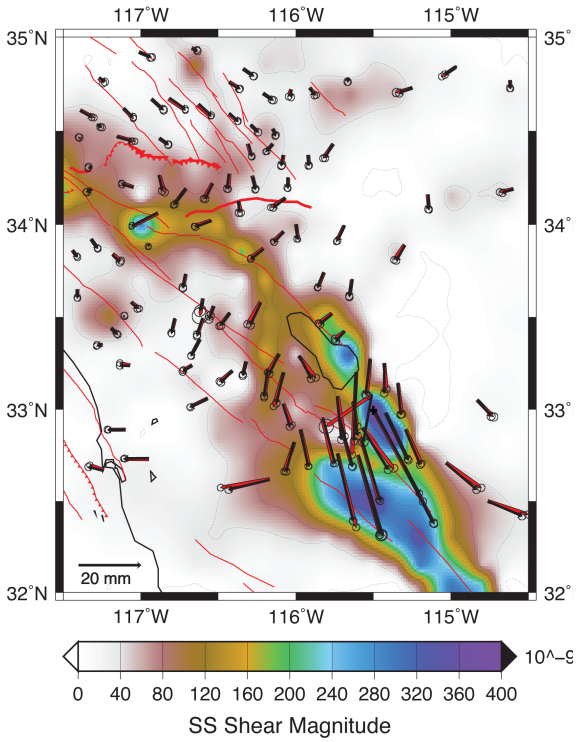

Figure 1. Anomalous strains and displacements in southern California during the period spanning (27 August 2010 – 27 August 2012). Red, observed displacement differences; bold, model displacement differences (95% confidence ellipses) on top of contoured model shear- strain-rate magnitudes (pure strike-slip style). The anomalous strain is dominated by the postseismic effects of El Mayor–Cucapah earthquake.