SCEC Final Report

Time-dependent analysis of transient GPS signals in the Los Angeles Basin

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Continuous GPS data from the Southern California Integrated GPS Network (SCIGN) provide the potential for detecting and imaging transient deformation in southern California. We identified systematic common mode errors in the filtered SCIGN GPS solutions (SOPAC and JPL) that is characterized by a rapid change in frame drift from southward to northward at approximately ~2000.0. Because these frame-related errors mask smaller tectonic signals we removed them, along with seasonal variations, using a Kalman filter. We also analyzed InSAR time series consisting of over 60 images (ascending and descending tracks) collected by the Radarsat satellite between July 2001 and April 2005, to investigate possible anthropogenic signals in the GPS data. We find position time series for several GPS sites in the northern Los Angeles Basin exhibit an increase in the rate of north-south contraction around 2000, even after anthropogenic effects are taken into account. The rate change is significant at the 1σ, but not 2σ, level when temporally correlated noise in the time series is accounted for. We thus cannot be confident that the apparent signal is tectonic in origin.

We next applied the Extended Network Inversion Filter (McGuire and Segall, 2003) to systematically detect and model transient slip events in southern California using SCIGN coordinate time series. A 3-D fault geometry was reconstructed and re- meshed from the SCEC community fault model (CFM). We use a modified NIF that utilizes triangular dislocations and spatial smoothing on a triangular mesh. To make the Network Inversion Filter computationally feasible, we divided southern California into five partially overlapping subregions (Transverse Range & Ventura Basin, Mojave Desert, Peninsular Range, LA basin, and San Andreas Fault). In addition to well-known transients in the Parkfield and Hector Mine areas, there is suggestive evidence for transient deformation in the Transverse Ranges and Ventura Basin. The filter detected weak transient signals (most < 5mm) starting in ~2005 for stations close to the onshore portion of the Oakridge fault. There is a good correlation between the onset of the transient signals and anomalous precipitation in the area, strongly suggesting a causal relation between the two. The transient motions, however, are preferentially oriented north-south, perpendicular to the local fault strike, which is difficult to reconcile with momument instability or landsliding induced by heavy precipitation.

Our analysis based on CGPS and InSAR data shows that transient signals identified in the SCIGN GPS data reflect the combined effects of anthropogenic sources, postseismic transients, and unusual rainfall events. We cannot preclude possible long-term deformation changes and slip transients; transient slip signals not following large

earthquakes in southern California are typically very weak (several mm or less). The low SNR and interference from many non-tectonic sources complicates transient detection using the current GPS network.

SCEC Publications:

Liu, Z. and P. Segall, Systematic search for transient deformation in southern California GPS data, Eos Trans. AGU,
87(52), Fall Meet. Suppl., Abstract G43B-0995