Combining GPS and Remotely Sensed Data to Characterize Time-Varying Crustal Motion

SCEC Community Geodetic Model (CGM) Workshop; Menlo Park, California, 30–31 May 2013

Development of more physically realistic models of interseismic crustal strain and stressing rates, postseismic effects over multiple time scales, transient deformation, and lithospheric rheology are examples of research applications requiring measurements of Earth surface motion at high spatiotemporal resolution. To address this need, the Southern California Earthquake Center (SCEC) has initiated a 5-year project to create a Southern California community geodetic model (CGM) that will leverage the complementary strengths of temporally dense GPS and spatially dense interferometric synthetic aperture radar (InSAR) data.

A workshop was held to further develop the CGM project plan, including required features, overall approach, and progression of tasks; to identify active participants; and to strategize coordination of work. The workshop consisted of short talks by GPS and InSAR experts and potential CGM users; substantial time was devoted to discussion.

Considering anticipated CGM applications like those described above, participants identified several requirements. Some, including fine spatial sampling near faults, improved spatial coverage in off-fault regions, daily sampling wherever possible, increased vertical position precision, and decades-long time series, can be achieved now or in the future with new data collection and continued maintenance of existing instruments. Distinguishing background tectonic loading from long-term postseismic effects requires robust preseismic velocity estimates. Although it is too late to obtain such estimates for some GPS sites affected by Southern California earthquakes in recent decades, targeted data collection now could ensure usable observations following future earthquakes. Participants agreed that methodological improvements must address the unique noise characteristics and nonuniform spatiotemporal sampling of GPS and InSAR data to provide realistic covariance estimates for modeling.

The CGM will encompass three components: one drawing on GPS data from temporary and permanent deployments, one based on InSAR, and a combined GPS-InSAR product. This approach will allow further data type–specific technique development, thorough assessment of the individual data types' noise characteristics, and comparison of time-varying crustal motion recorded by GPS and InSAR prior to integration into the combined CGM. The CGM will provide raw position time series (east, north, and vertical for GPS and line of sight for InSAR) on a nonuniform spatial grid and estimates of derived quantities such as outliers, offsets, noise parameters, common mode error, seasonal signals, velocities, coseismic displacements, and postseismic decay.

Over the next year, a GPS-focused working group will compile data and metadata, compare and merge processed positions from different sources, consider the need for targeted data collection, and choose strategies for mitigating noise and quantifying uncertainties. A parallel InSAR working group will conduct a test exercise to compare time series analysis techniques and identify the best approach for use in the CGM.

Participation in the CGM effort is open to anyone with an interest in GPS, InSAR, or crustal deformation. See http://www.scec.org/workshops/2013/cgm/index.html for more information, including slides from the workshop presentations.

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