The Community Geodetic Model (CGM): *Motivation and Workshop Goals*

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The Community Geodetic Model

Motivation:

The next generation modeling of interseismic strain accumulation, postseismic effects over multiple time-scales, lithospheric rheology, and transient deformation, as well as development of a Community Stress Model, that we have targeted for SCEC4 require *spatially and temporally dense time series of ongoing deformation utilizing the complimentary features of GPS and InSAR data*.

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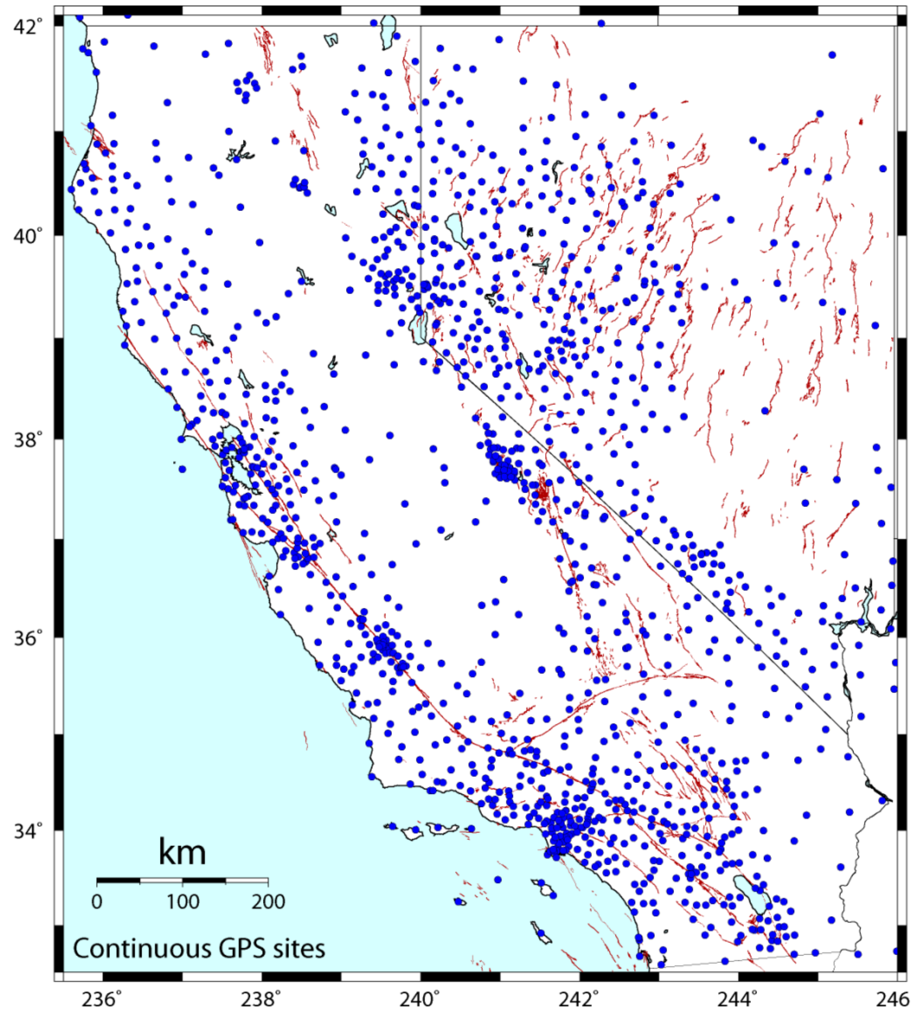
Scientific Objectives for the Community Geodetic Model (CGM)

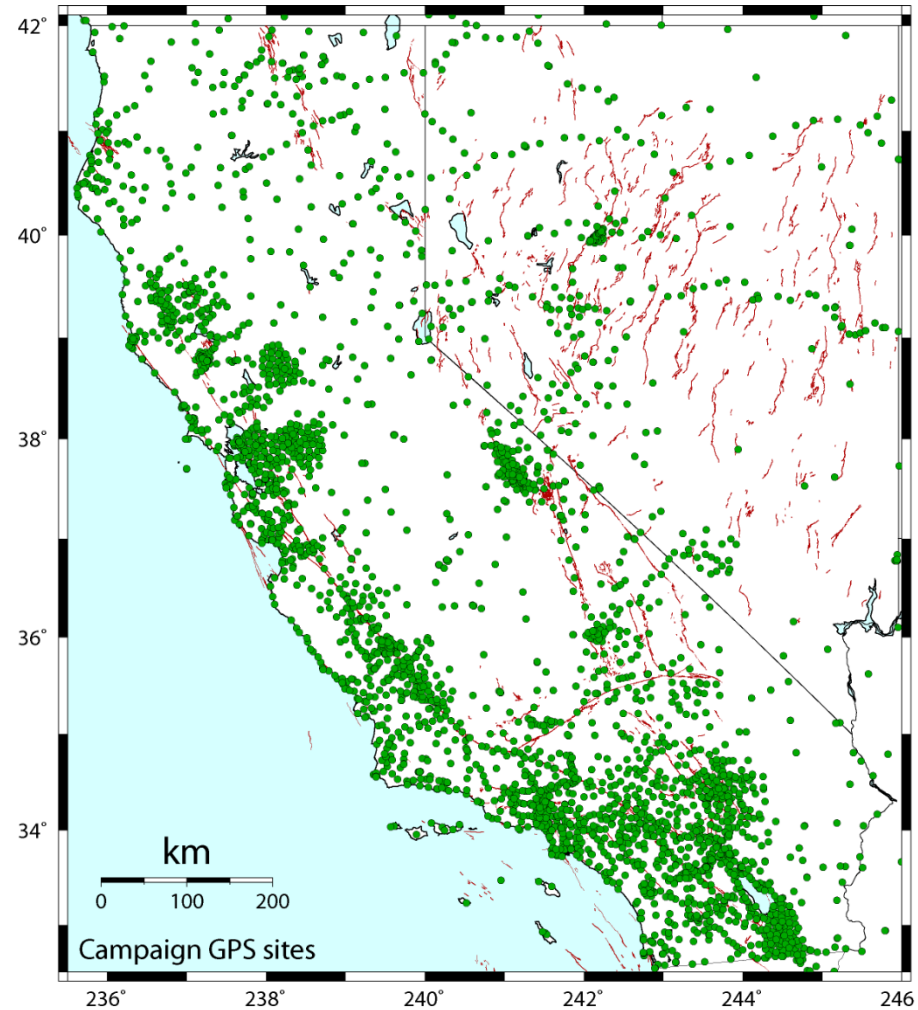
From the SCEC4 proposal, the CGM will:

- Provide a *time-dependent reference frame* for transient detection algorithms, as well as models of interseismic loading to evaluate stress changes and update rupture forecast models as tectonic conditions evolve in California.
- Be used in addressing these fundamental problems of earthquake physics:
  - *Causes and effects of transient deformations: slow slip events and tectonic tremor*
    - Application of geodetic detectors to the search for aseismic transients across southern California. We will use the CGM as the time-dependent geodetic reference frame for detecting geodetic anomalies.
  - *Stress transfer from plate motion to crustal faults: long-term fault slip rates*
    - Constrain long-term deformation and fault-slip models
    - Combined modeling/inversion studies to interpret GPS and InSAR geodetic observations of postseismic transient deformation without traditional simplifying assumptions

Continuous GPS coverage



Campaign GPS coverage



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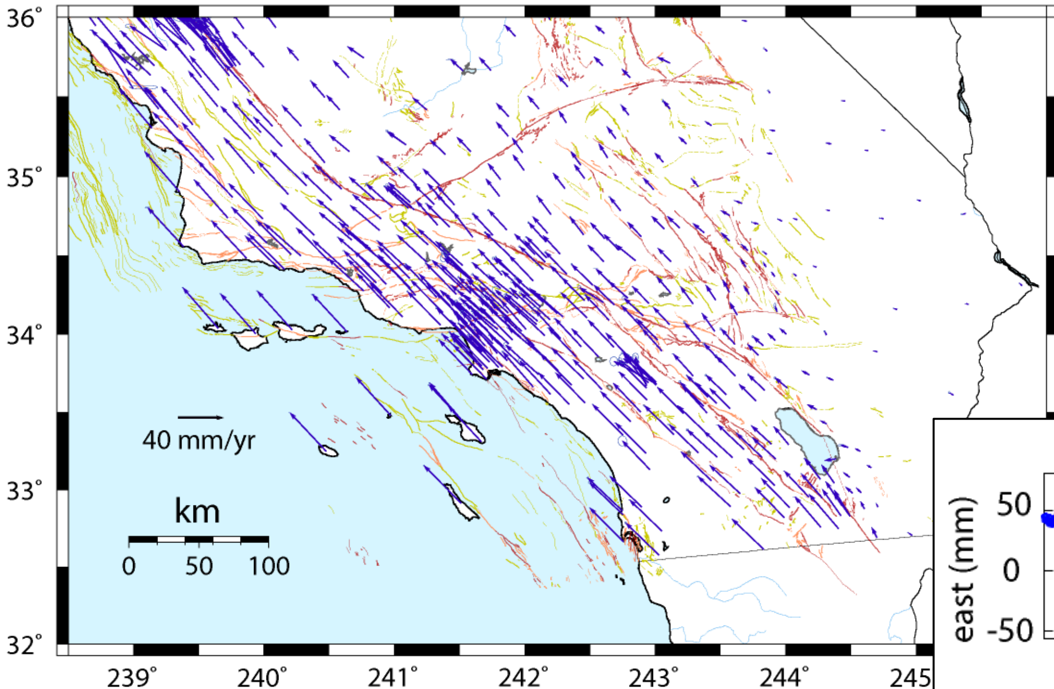
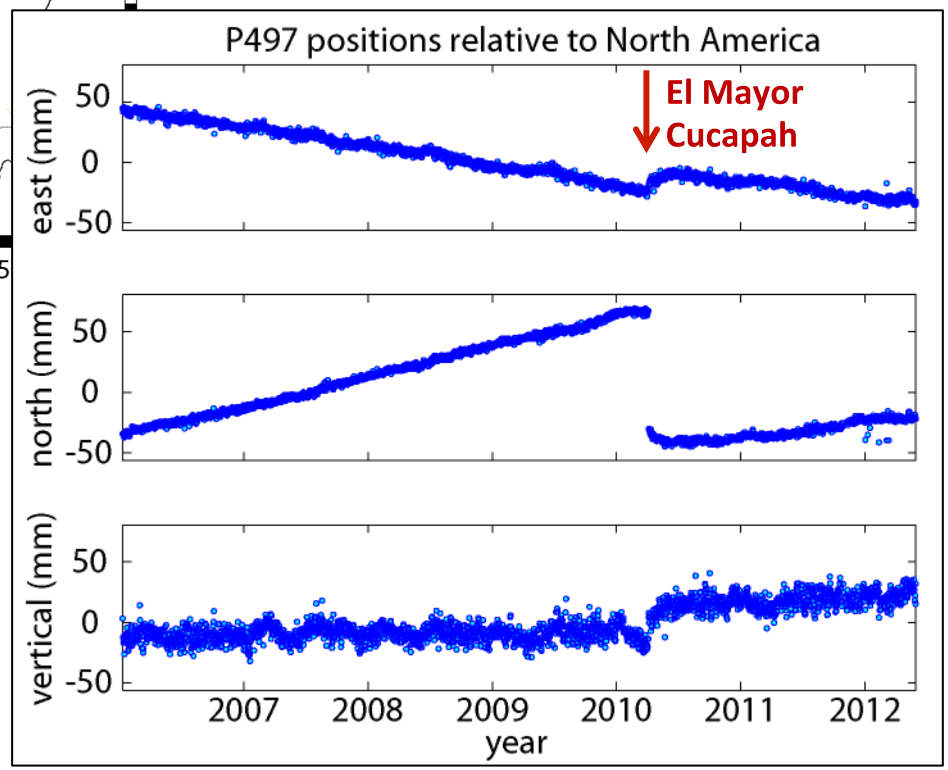
Continuous GPS (CGPS) as well as campaign, or survey-mode, GPS (SGPS) coverage continues to grow, providing a measure of secular deformation throughout California.

GPS data provide temporally dense 3D displacements



In addition to secular velocities (left), CGPS data record time-varying deformation in three dimensions at high temporal resolution (below).



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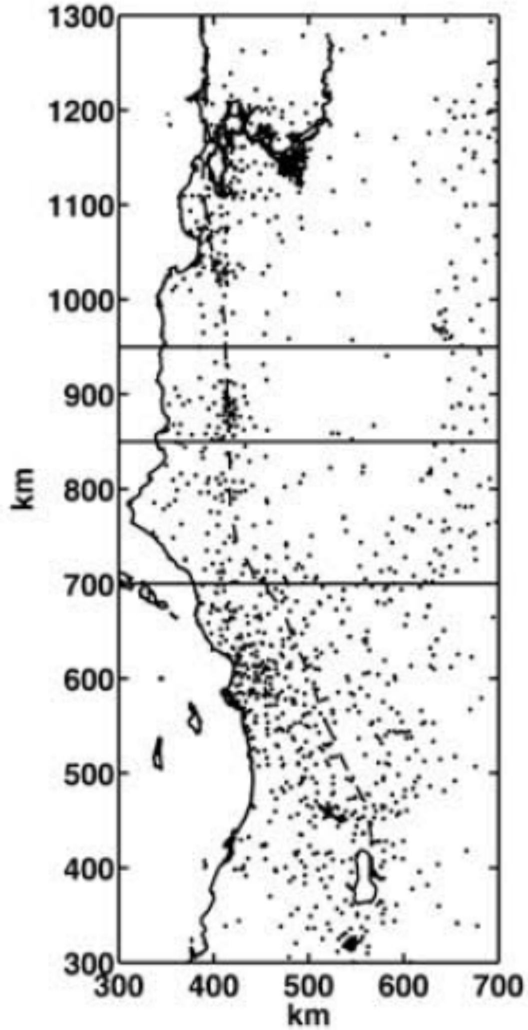
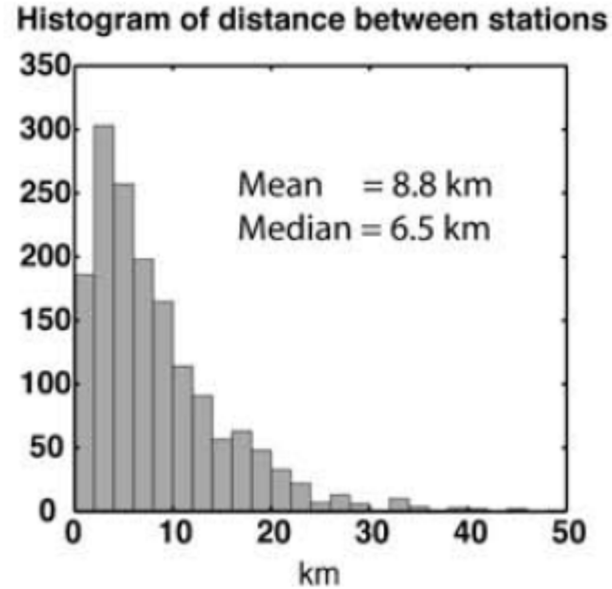
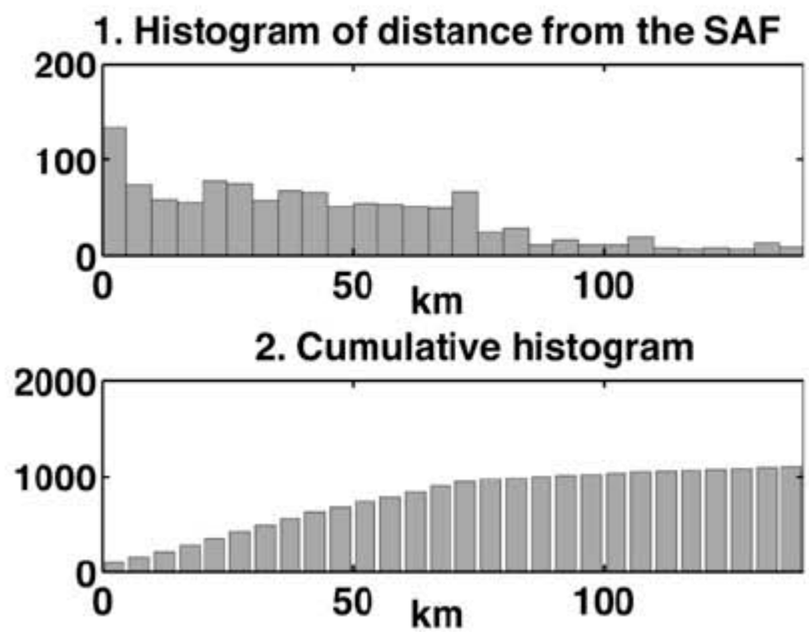
However, station spacing is not uniform around all major faults.

→ *Minimum spatial wavelength observable with irregularly spaced sites is 3 – 4 times station spacing.*







Wei et al. (2010)

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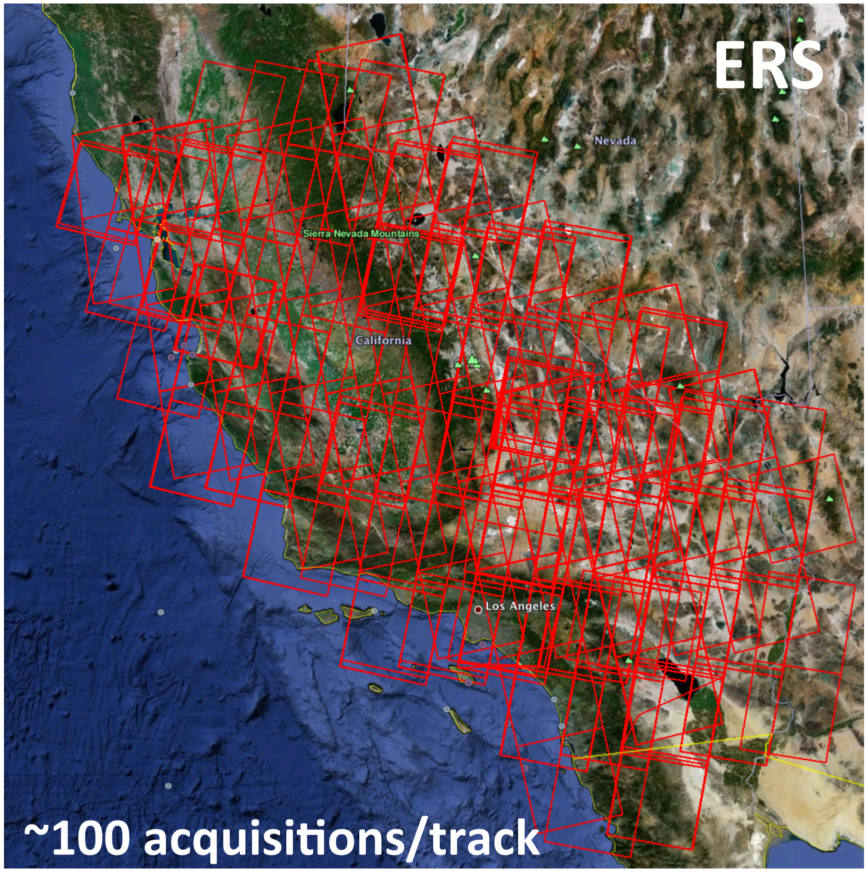
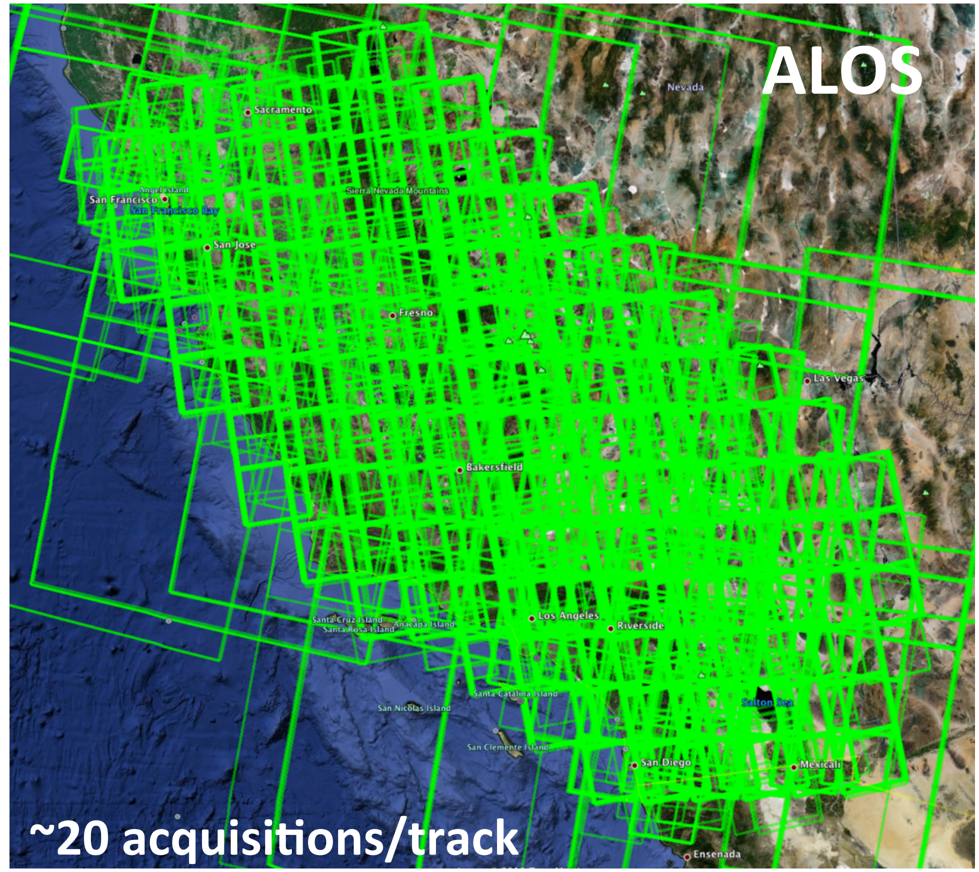
InSAR data provides good spatial coverage





1992-2000; 1995-2011; ~11,000 So. Cal. scenes

2006-2011; ~4100 So. Cal. scenes

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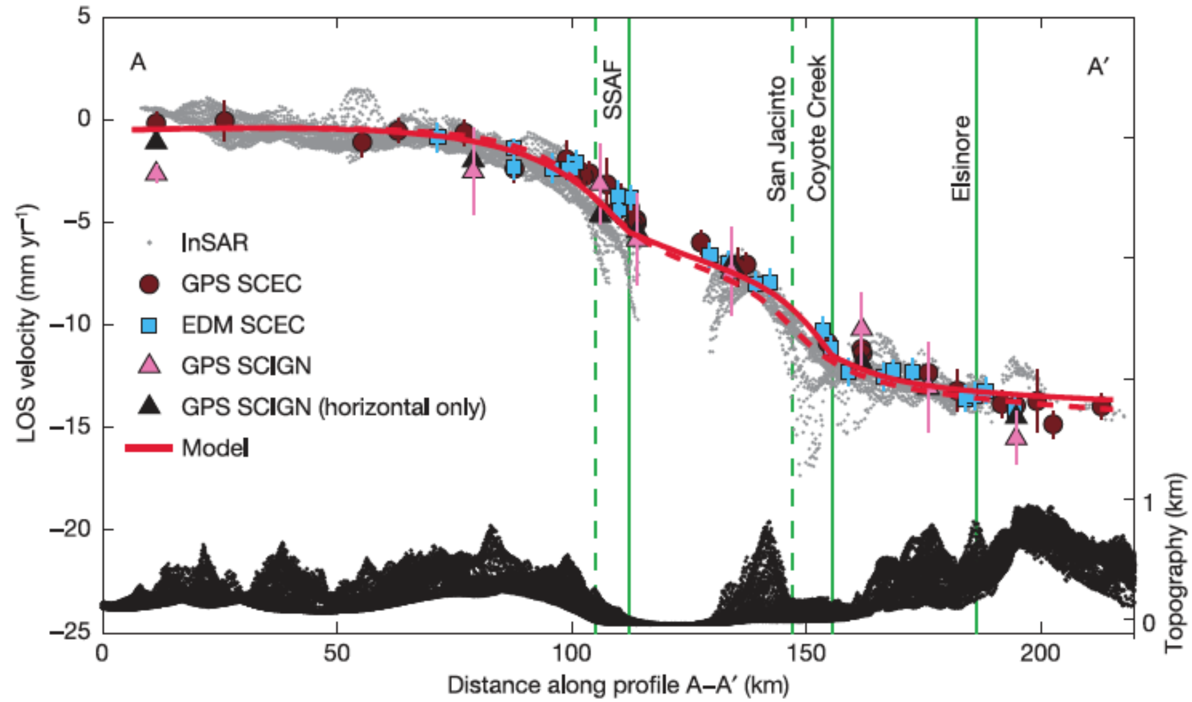
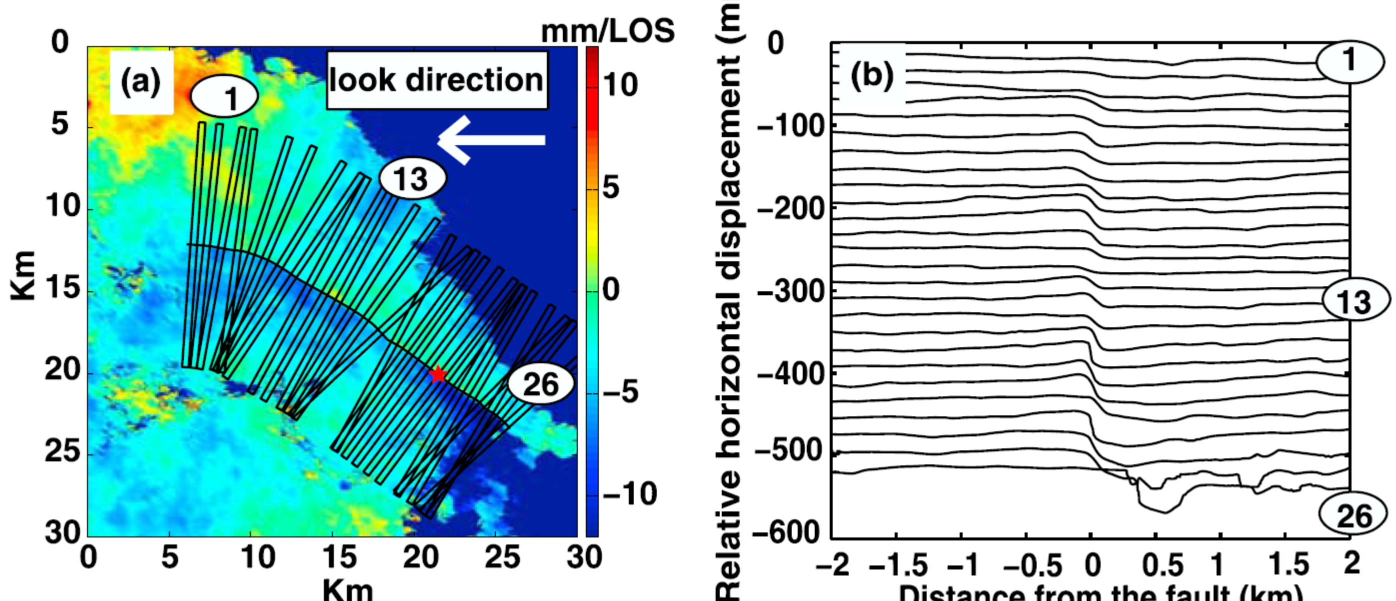
Data from several other platforms, X-band, C-band, L-band also available. Upcoming missions such as ALOS-2 and Sentinel-1 will hopefully provide data into the future.

InSAR complements GPS spatial coverage for studies of interseismic deformation (right) and can record deformation such as creep events not seen with available GPS coverage (below)



Fialko et al. (Nature, 2006)

Wei et al. (JGR, 2009)



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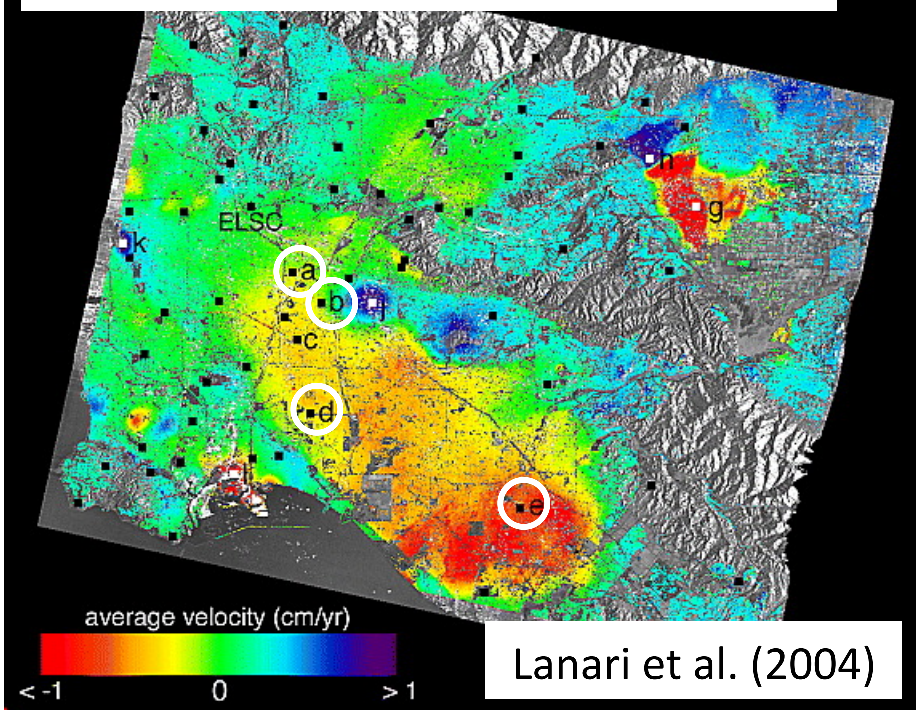
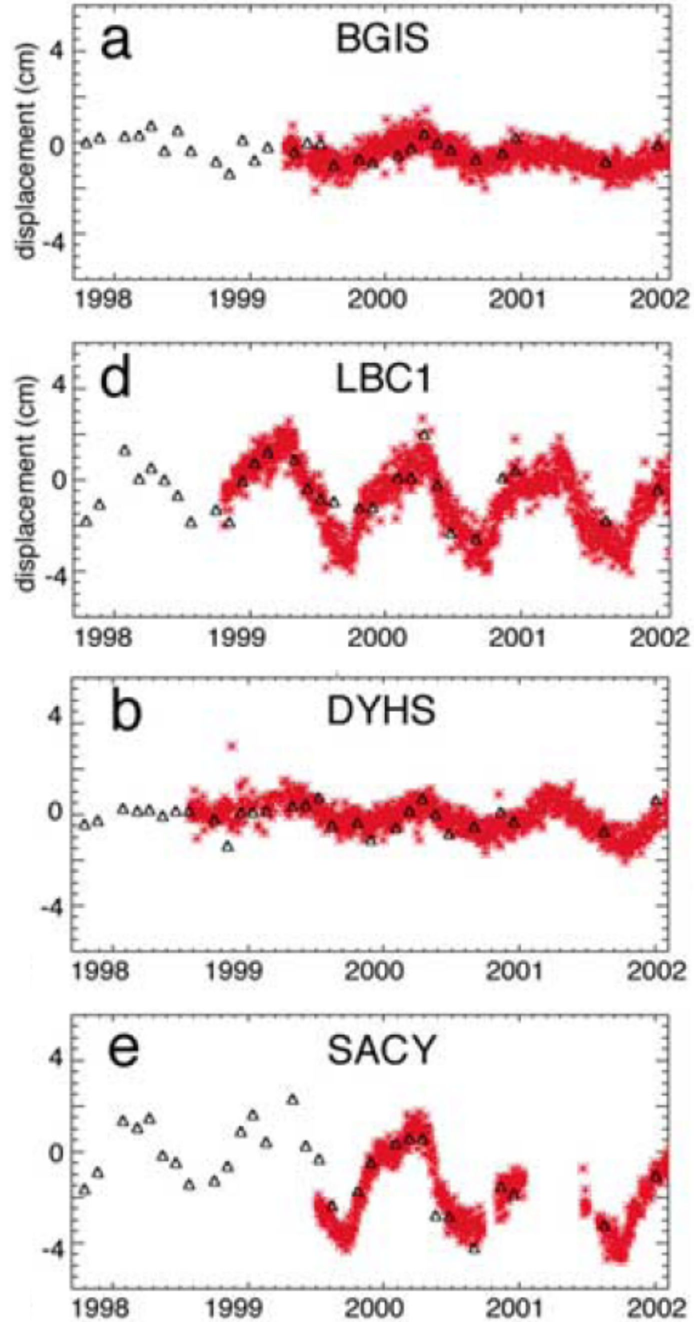
- A variety of InSAR time series analysis techniques (e.g., SBAS, PS-InSAR, StamPS, MInTS, and others) exist.
- Time-varying signals that agree well with GPS can be inferred from InSAR under certain assumptions (e.g., temporal/spatial smoothness).

Example: L.A. Basin aquifer effects



Lanari et al. (2004)



Possible applications for the CGM:

- quantifying slip rates and strain rates and their spatial variations in the complexly-faulted southern California region
- assessing non-tectonic time-varying signals without aliasing
- tracking the space/time evolution of transient deformation at sufficient precision to relate it to other processes such as seismicity
- constraining lithospheric rheology and evaluating its role in earthquake cycle deformation
- aiding the study of fault loading processes and crustal stress using more physically realistic models

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Workshop Goals

- Further develop the big-picture plan for generating the CGM including the overall approach, progression of tasks, time frame, and milestones
- Identify members of the SCEC community who will actively contribute
- Develop a strategy for distributing tasks and coordinating work among groups

Outstanding Tasks

- Identify the range of applications for the CGM
- Evaluate what is currently achievable; how close are we to "model 0"?
- Establish what the CGM will "look like" (see next slide)
- Determine if new data are required
- Identify methodological advances (e.g., for combining data, characterizing noise, accounting for a variety of signals) that would help
- Consider feedback by which improved understanding of physical processes achieved with the CGM might in turn be used to improve future CGM versions

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What will the CGM look like?

- Where on the continuum of data to model will the CGM lie?
- Will there be multiple branches? What would justify this? How will users decide which branch to use?
- What spatial and temporal resolution are required?
- What precision is required?
- What time span will be covered?
- How will we characterize uncertainties?

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