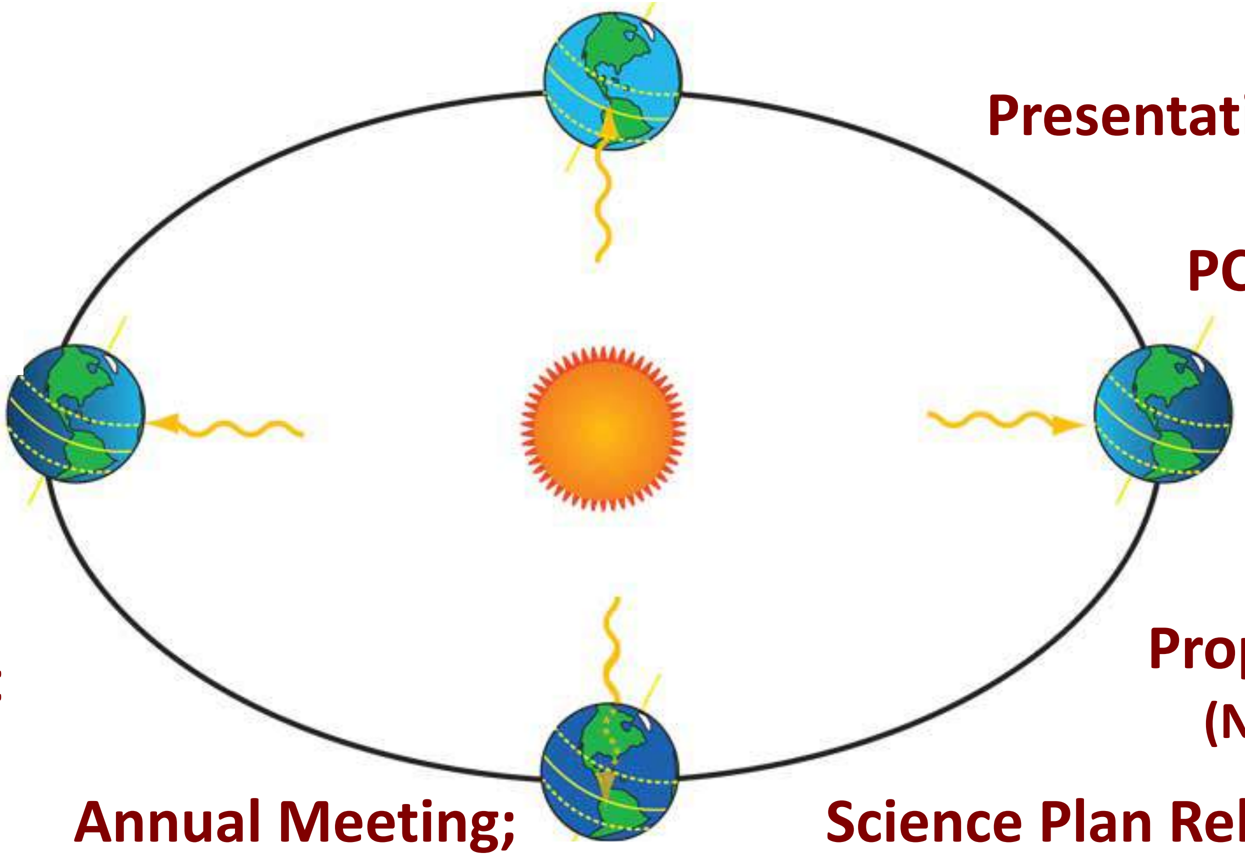
SCEC5 Science Collaboration

Greg Beroza

The SCEC Planning Cycle



SCEC5 Planning Committee

PC Chairs

Greg Beroza, *Chair*

Judi Chester, *Vice-Chair*

Disciplinary Committees

Seismology

Yehuda Ben-Zion

Jamie Steidl

Tectonic Geodesy

Gareth Funning

Manoochehr Shirzaei

Earthquake Geology

Mike Oskin

Whitney Behr

Computational Science

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Interdisciplinary Focus Groups

FARM

Nadia Lapusta

Nick Beeler

SDOT

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EFP

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GM

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EEII

Jack Baker

Jon Stewart

CXM

Liz Hearn

Scott Marshall

SAFS

Michele Cooke

Ramon Arrowsmith

Special Projects

Christine Goulet

Phil Maechling

Themes and Topics of the SCEC5 Science Plan

Theme A. Modeling the Fault System

1. Stress and Deformation Over Time
2. Special Fault Study Areas: Focus on Earthquake Gates
3. Community Models
4. Data-Intensive Computing

Theme B. Understanding Earthquake Processes

5. Beyond Elasticity
6. Modeling Earthquake Source Processes
7. Ground Motion Simulation
8. Induced Seismicity

Theme C. Characterizing Seismic Hazards

9. Probabilistic Seismic Hazard Analysis
10. Operational Earthquake Forecasting
11. Earthquake Early Warning
12. Post-Earthquake Rapid Response

Theme D. Reducing Seismic Risk

13. Risk to Distributed Infrastructure
14. Earthquake Physics of the Geotechnical Layer

CXM Discussion Highlights

- CXM models need to seek some form of formal versioning. This includes providing DPOIs for erach official release of a model.
- Hosting CXM models on scec.org is an important goal, but because of IT restrictions, the scec.org pages should probablyt be relatively static and simply link to external sites where the model builders/maintainers can upload updates easily
- For CRM there are numerous issues related to water, but no clear paths to a solution.
- CXM models would benefit from new tools that help users query and use CXM models in their research.

Distributed Deformation

- Account for and predict the degree of localized vs. distributed deformation at the surface, with the ultimate goal of providing predictions of surface displacement risk (probabilistic displacement maps).
- Understand scaling of off-fault deformation with the magnitude of slip.
- Understand time-dependent properties of fault/damage zones.
- Study similarities of creeping faults and dynamically rupturing faults.
- Build models that capture fault development, growth, thermal pressurization and pore pressure migration in shallow crustal rheology.
- Develop techniques and data that can be used to validate displacement prediction models.

SCEC

2019 Science Priorities:
Stress and Deformation Over Time (SDOT)

Bridget Smith-Konter (U. Hawaii); and Kaj Johnson (Indiana)

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SDOT: Research Objectives

The **Stress and Deformation Over Time (SDOT)** interdisciplinary working group focuses on improving our understanding of how faults in the crust are loaded in the context of the wider lithospheric system. We study:

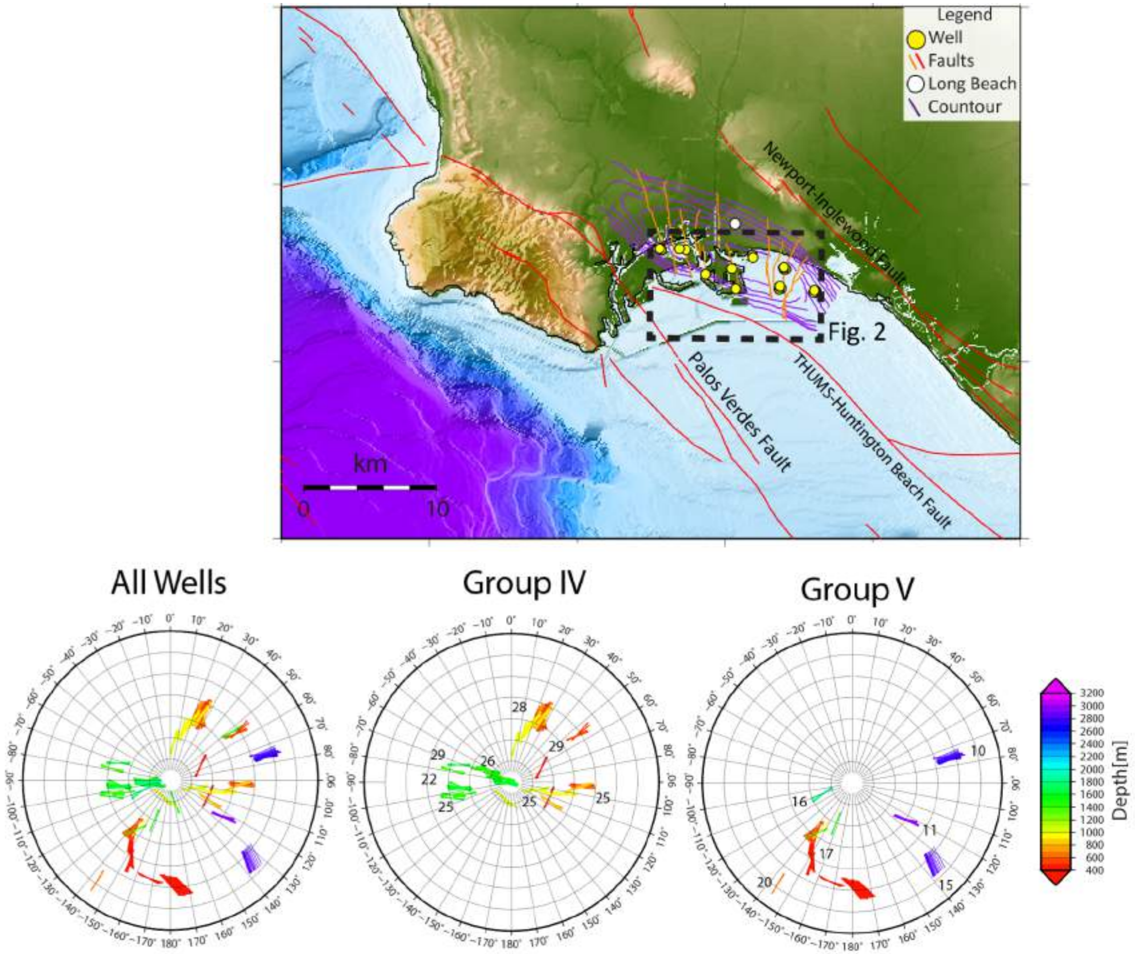
(1) lithospheric processes on timescales from tens of millions of years to tens of years using the structure, geological history, and physical state of the southern California lithosphere as a natural laboratory

(2) present-day state of stress and deformation on crustal-scale faults and the lithosphere as a whole, and to tie this stress state to the long-term evolution of the lithospheric architecture through geodynamic modeling.

A central SDOT goal is to contribute to the development of a physics-based, probabilistic seismic hazard analysis for southern California by developing and applying system-wide deformation models.

SDOT: 2019 Research Priorities

- Develop 4D representations of the stress tensor in the southern California lithosphere using diverse stress constraints (e.g. from borehole or anisotropy measurements) and geodynamic models of stress → CSM
- Apply stress and deformation measurements to probe rheology of the lithosphere and active fault geometry → CTM & CRM
- Develop deformation models that incorporate improved vertical constraints; explore non-tectonic vertical motion signals → CGM



Borehole breakout determined stress regime in the Southern Los Angeles Basin. (top) 36 well locations in the Wilmington oil field. (bottom) Borehole breakouts show the heterogeneity in the elongation directions, with most wells indicating a mainly thrust faulting stress regime, but Well 17 and 11 showing strike-slip components.

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2019 Science Priorities: Tectonic Geodesy

Gareth Funning (UCR); and **Manoo Shirzaei** (ASU)

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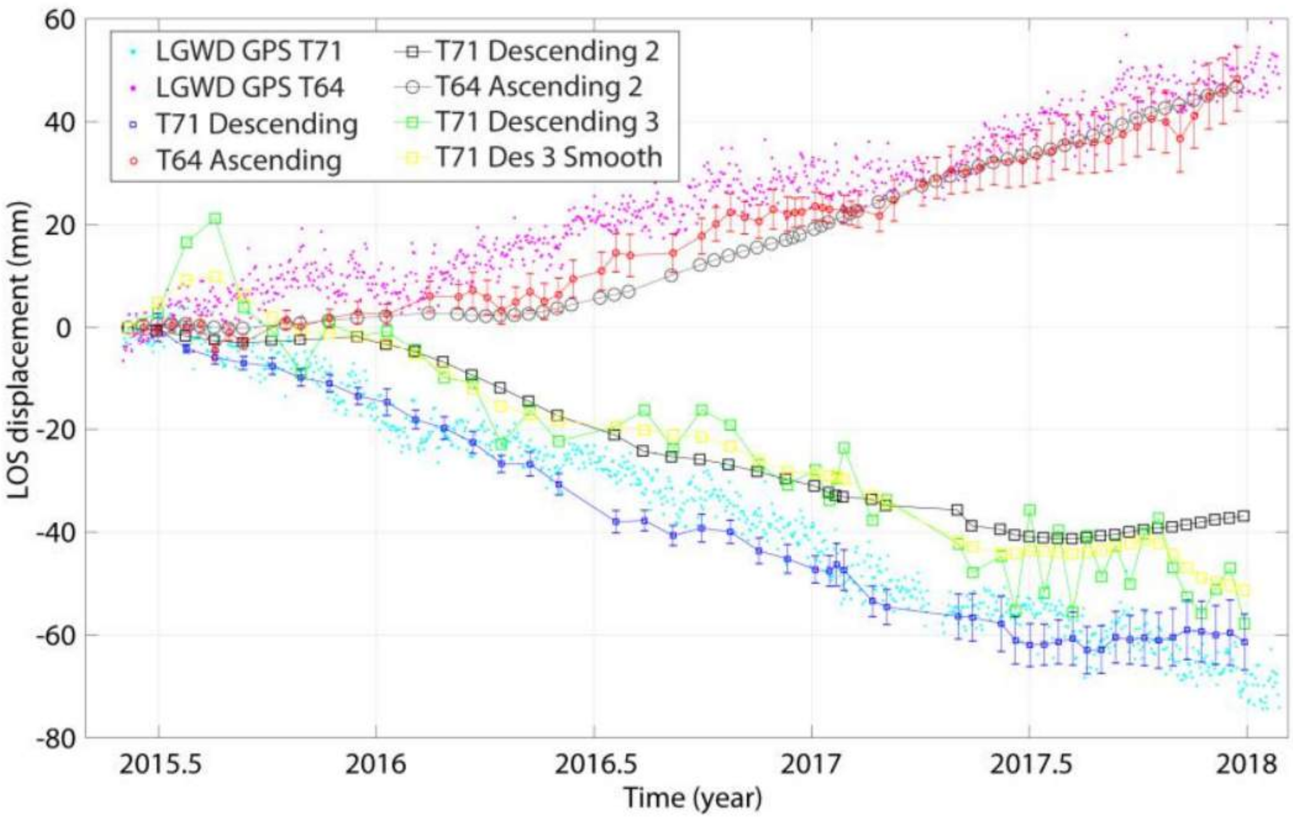
Tectonic Geodesy: Research Objectives

The Tectonic Geodesy disciplinary group uses geodetic measurements of crustal deformation to understand **interseismic**, **coseismic**, **postseismic**, and **hydrologic processes associated with the earthquake cycle** along the complex fault network of the Southern San Andreas system.

In addition, the group is tasked with developing a **Community Geodetic Model (CGM)** for use by the SCEC community in system-level analyses of earthquake processes over the full range of length and timescales. The CGM is built on the complementary strengths of **temporally dense GPS data** and **spatially dense InSAR data**.

Tectonic Geodesy: 2019 Research Priorities

- **CGM production:** Produce combined campaign/continuous GPS time series and Sentinel-1 InSAR time series
- **CGM development:** Test and validate methods for GPS/InSAR time series integration (including multiple sensors and lines-of-sight)
- **Off-fault deformation**: Develop methods for constraining the proportion of the southern California deformation budget that is not accommodated by the major faults, and its uncertainty



Comparison of InSAR and GPS time series fron the CGM InSAR working group. The shapes of the time series agree within error, suggesting a high degree of compatibility between the data types.

What about UCERF4?

- We plan to host workshops to discuss possible improvements ASAP (via CEA funding)
- A day will be devoted to the physics-based simulator questions (continuing yesterday's discussions)

UCERF3 Questions/Issues/Uncertainties:

1) Artificial distinction between on- and off-fault qks
2) What do modeled faults actually represent (braided?)
3) What is the actual fault interconnectivity?
4) Slip rates (GPS vs geology, backslip, block models)
5) Total regional rate of M≥5.0 events (cat. completeness, temporal changes)
6) Paleoseismic RI interpr models for the prob of r
7) Defining date-of-last-ev on all faults
8) Mmax off modeled faults?
9) 70% aseismicity off faults?
10) Smoothed-seismicity model applicability (deformation model alternatives?); uncertainty in each grid cell?
11) Spatial resolution of Gutenberg Richter assumption
12) Better sampling of viable models (U3 held close to U2; physics narrows solution space?)

We need physics-based simulators to help solve these?

14) Likelihood of multi-fault ruptures (plausibility filter vs physics)
15) Manifestation of creep (e.g., area vs slip-rate reduction?)
16) Magnitude-area and slip-length scaling (surface slip obs, depth of rupture)
17) Average slip along rupture (boxcar? multi-rainbow for multi-fault ruptures?)
18) Finite faults + clustering stats requires Elastic Rebound
19) Elastic-rebound predictability (spatial overlap of large aftershocks; COV variations)
20) To what extent can large triggered events nucleate from within rupture area of main shock?
21) Are triggering stats really applicable to larger events, especially sequence-specific ones?
22) Time evolution of MFDs at both low and high magnitudes?
23) Difference between multi-fault rupture and quickly triggered separate event
24) In addition to verification and validation, we also need ***valuation*** of our models (all are wrong; is a new one more useful?)

How do we construct effective and synergistic community models?

What needs to be done to increase the impact of dynamic rupture modeling?

How should SCEC keep up with rapid developments in computational science?

What has shaken out since 2008?