The SCEC Community Stress Model (CSM) : current status

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SCEC CSM Workshop #4
October 27, 2014
Community Stress Model (CSM) strategy:

• Goal: a model or set of models of stress and stressing rate in the southern California lithosphere.

• Collect and compare existing stress and stressing rate models contributed by the SCEC community.

• Encourage new data compilation and modeling activities to address identified gaps.

• Validate models using observations and physical constraints.

• Make CSM models and data available to the community through the CSM website.
Contributed Models:

Stress:

1) Inversion of focal mechanisms for stress orientation. – Wenzheng Yang and Egill Hauksson (Caltech); Jeanne Hardebeck (USGS).

2) Finite element model including topography, depth-dependent rheology, frictional faults, and long-term deformation model. – Peter Bird (UCLA).

3) Inversion for stress field that fits topography, fault loading from dislocation model, tectonic loading, and focal mechanisms. – Karen Luttrell (USGS), Bridget Smith-Konter (Texas), and David Sandwell (UC San Diego).

4) Smoothing of World Stress Map (mostly focal mechanisms for southern California). – Peter Bird (UCLA); Jeanne Hardebeck (USGS).

5) Global model from density-driven mantle flow, plus lithosphere gravitational potential energy, fit to geoid and global plate motions. – Attreyee Ghosh and Thorsten Becker (USC).
Average Stress Model and RMS variation between models.

* Average of Bird; Luttrell, Smith-Konter & Sandwell; and Yang & Hauksson models, everywhere at least two of these models are defined.
Stress Models: differential stress ($s_1-s_3$) versus depth.

Solid line/symbol: median. Dashed line: middle 68%.
Contributed Models:

Stressing Rate:

1) Block model fit to geodetic data. – Jack Loveless (Smith) and Brendan Meade (Harvard).

2) Fault loading from dislocation model using geologic and geodetic slip rates. – Bridget Smith-Konter (Texas), and David Sandwell (UC San Diego).

3) Fault loading from dislocation model plus static stress changes from earthquakes. – Anne Strader and David Jackson (UCLA).

4) 3D local boundary element model fit to slip rates (LA, Ventura, San Gregorio). – Michele Cooke (UMass) and Scott Marshall (Appalachain State).

5) UCERF3 deformation models translated to stressing rate. - Models of Bird, Johnson, and Zeng, translated by Liz Hearn.
Average Stress Rate Model and RMS variation between models.

* Average of Loveless & Meade; Smith-Konter & Sandwell; Strader & Jackson; Cooke & Marshall; UCERF3 ABM; UCERF3 NeoKinema; and UCERF3 Zeng.
Average Stress Rate Model and RMS variation between models.

* Average of Loveless & Meade; Smith-Konter & Sandwell; Strader & Jackson; Cooke & Marshall; UCERF3 ABM; UCERF3 NeoKinema; and UCERF3 Zeng.
### Community Stress Model

#### Current contributors & model downloads

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Community Stress Model

Stressing Rate Comparison
The submitted stressing rate models generally agree on the scalar stressing rate close to the faults of the San Andreas system. There are significant disagreements along some faults, however, related not only to which faults were included in particular fault-based models, but also in the stressing rates along those faults and the decay of stressing rate away from the faults. (06/2013)

Matrices below show comparisons between models for four different metric (click '?' for explanations), if appropriate.

Depth [km]
Metric [hvdot, vdot, ldot, ddot]

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Models

Existing Models:

Mainly upper-crustal models, heavily based on focal mechanism and geodetic data.

Identified Needs:

- More physics-based models.
- Extend depth through lithosphere.
- Constraints on absolute level of stress.
Data and Constraints

Existing Data:

1) Yang, Hauksson, and Shearer focal mechanism catalog.

2) World Stress Map (in southern California: mostly focal mechanisms, some borehole data primarily in southern central valley).

3) Additional borehole data contributed by Joann Stock (mostly Ventura).

4) GPS and InSAR (interface through Community Geodetic Model).

Identified Needs:

- More borehole data (CA Department of Oil and Gas, industry?)

- Other types of data and constraints: heat flow, anisotropy, fault orientation and rake, fault slip rates.

- Simple validation tests: e.g. verify that stress models drive slip in correct direction for faults of Community Fault Model.
Looking Forward

Thinking about the future of the CSM in the short and long term:

2015 SCEC Proposals:

- Identify short-term goals: e.g. complete current modeling and data collections efforts, perform model validation tests, etc.

- Proposals to target these immediate goals (due November 7.)

CSM in SCEC 5:

- What is our longer-term vision for the CSM in SCEC 5?