

The SCEC Community Stress Model (CSM) : current status

*Jeanne Hardebeck
USGS Menlo Park*

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.

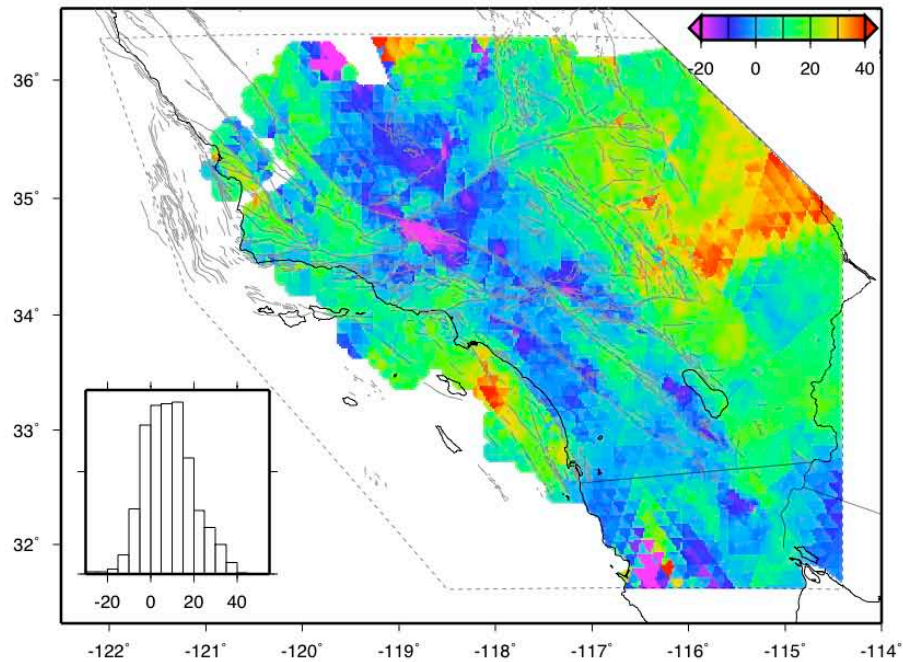
Contributed Models:

Stress:

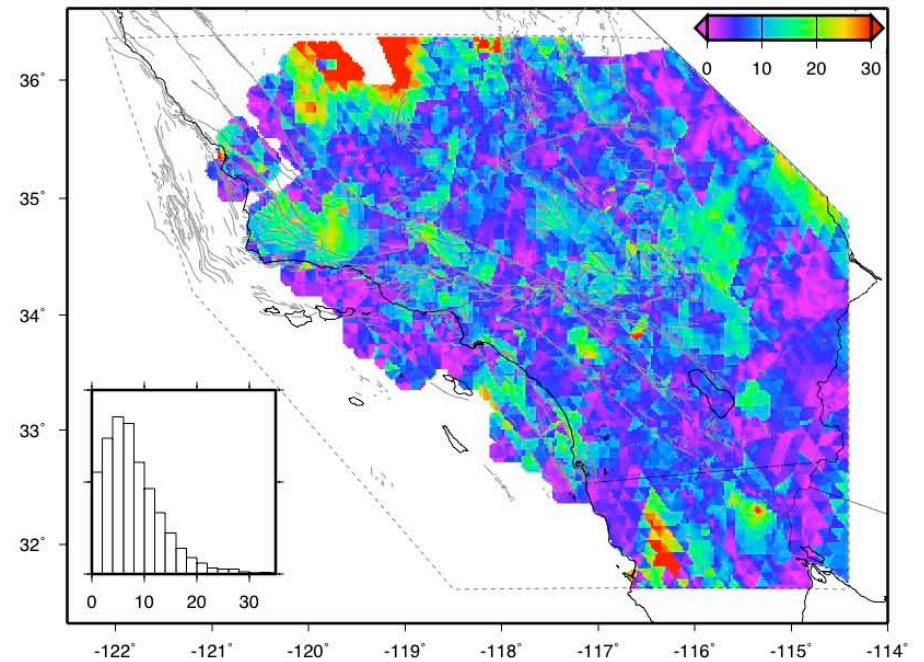
- 1) Inversion of focal mechanisms for stress orientation. – *Wenzheng Yang and Egill Hauksson (Caltech); Jeanne Hardebeck (USGS)*.
- 2) Finite element model including topography, depth-dependent rheology, frictional faults, and long-term deformation model. – *Peter Bird (UCLA)*.
- 3) Inversion for stress 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.

SHmax trend (degrees); depth=5 km

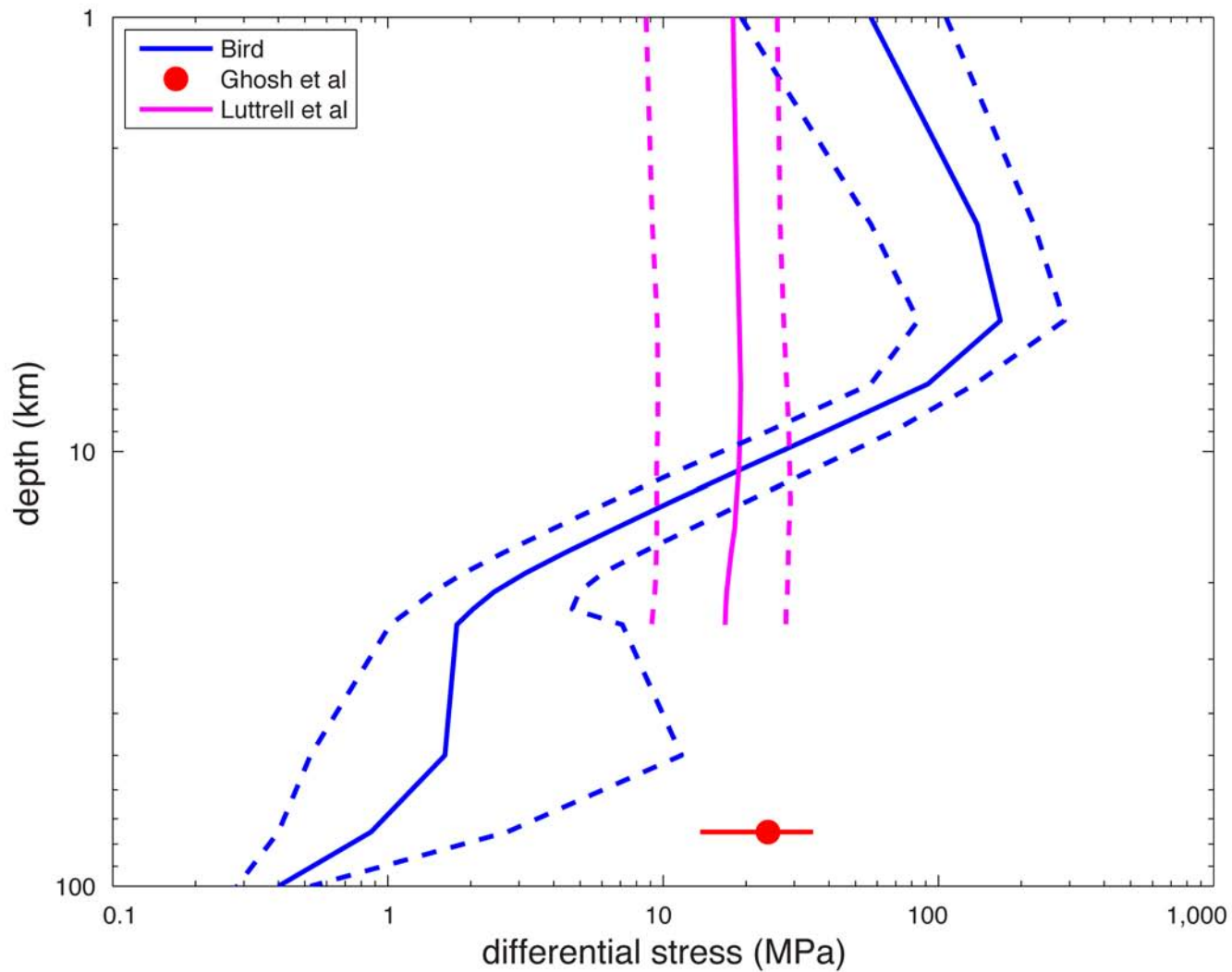


SHmax RMS (degrees); depth=5 km



* 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:

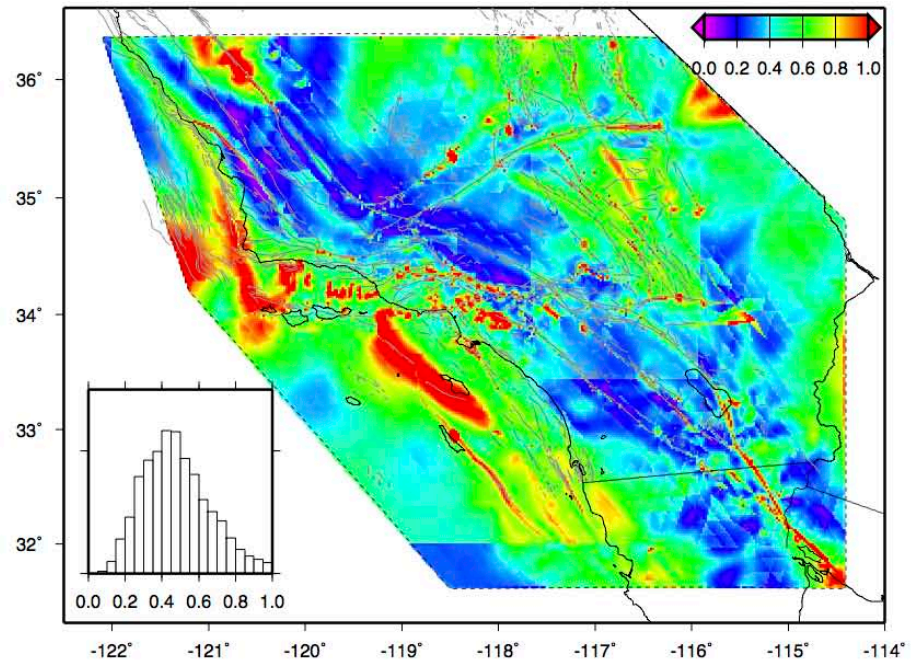
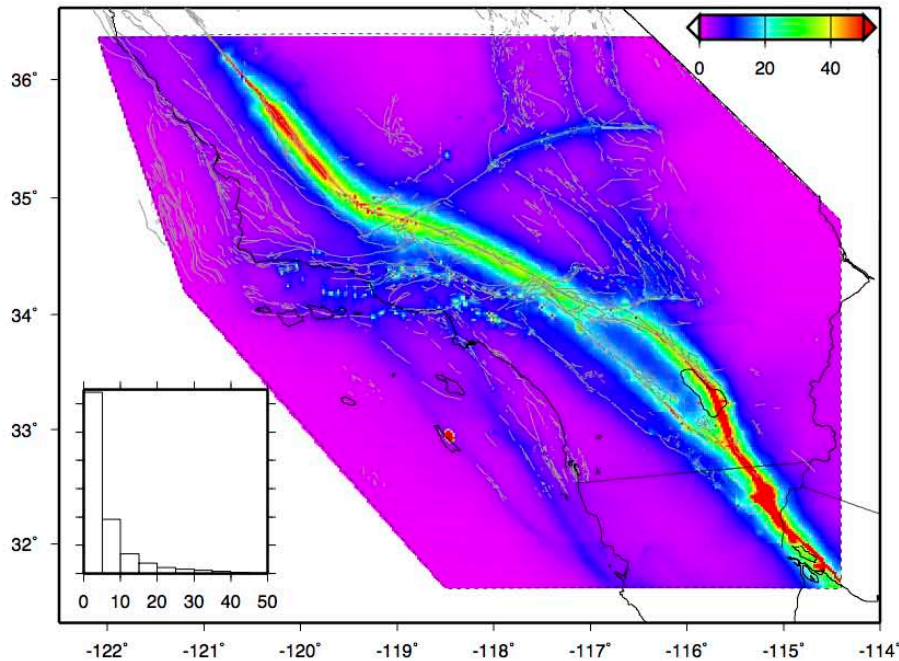
Stressing Rate:

- 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 (Appalachian 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.

diff stressing rate (kPa/yr); depth=5 km

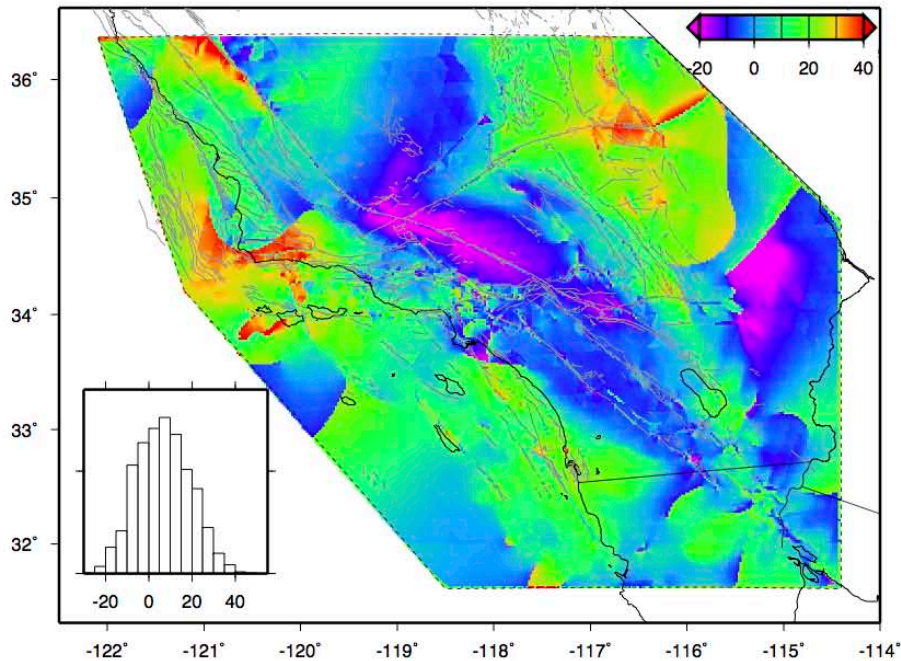
diff stressing rate RMS (fraction); depth=5 km



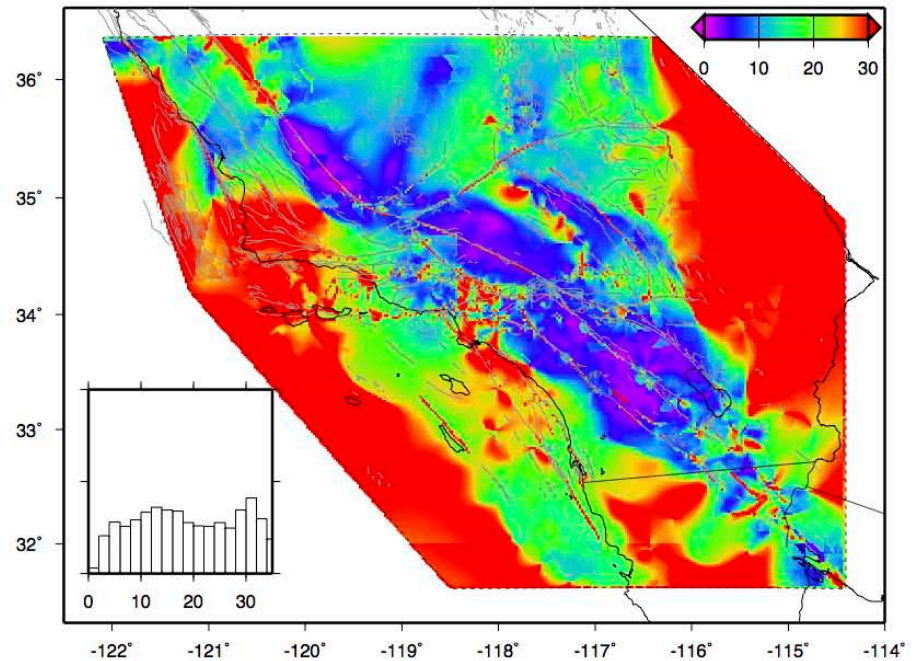
* Average of Loveless & Meade; Smith-Konter & Sandwell; Strader & Jackson; Cooke & Marshall; UCERF3 ABM; UCERF3 NeoKinema; and UCERF3 Zeng.

Average Stress Rate Model and RMS variation between models.

SHmax trend (degrees); depth=5 km



SHmax RMS (degrees); depth=5 km



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

CSM Website: View Models

Community Stress Model | Southern California Earthquake Center

https://sceczero.usc.edu/projects/CSM/model?m=SHELLS&type=stress

Apple Amazon News transportation program documentation seismic data response journals and societies USGS pages

an NSF + USGS center **Southern California Earthquake Center** Login Register Search

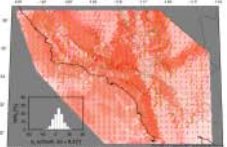
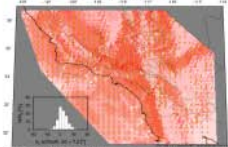
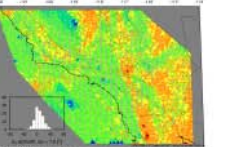
Home About SCEC Research Resources Collaborate Learn & Prepare

Community Stress Model

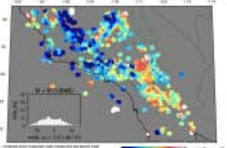
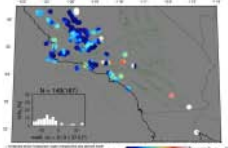
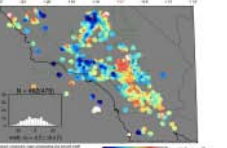
Model Description
Select another model go

SHELLS

Model properties

Horizontal stress tensor only	Horizontal projection	Stress Regime Ratio
		
PDF Format	PDF Format	PDF Format

Model validation

WSM-2008 all	WSM-2008, no FM	WSM-2008, only FM
		
PDF Format	PDF Format	PDF Format

Model meta data (if public)

Project Menu

Community Stress Model



Navigation

- About
- Model Contributions
- Formats
- Current contributors & model downloads
- Model meta data
- Meta data request form
- Current candidate CSM releases
- Model Comparisons
 - Stress
 - Stressing Rate
- Background material
 - 2013 Workshop Summary and presentations
 - 2012 Workshop Summary and presentations
 - 2011 Meeting Summary and presentations
- E-mail list request form

Documents

- Workshop Report for CSM 2012
- CSM grid
- CSM Model metadata request form
- CSM format
- CSM comparison scripts

Southern California Earthquake Center, © 2013 Los Angeles, CA | 213.740.5843 | scecinfo@usc.edu

Major funding provided by  

CSM Website: Download Models

(those with
contributor's
permission)

Community Stress Model | Southern California Earthquake Center

https://sceczero.usc.edu/projects/CSM/contributors

Apple Amazon News transportation program documentation seismic data response journals and societies USGS pages

Login Register

Search

Home About SCEC Research Resources Collaborate Learn & Prepare

Community Stress Model

Current contributors & model downloads

stress model name	Author(s)	Model	Metadata
Hardebeck_FM	Hardebeck, Jeanne	↓ 2mb	↓
Luttrell SHELLS	Luttrell, Karen; Sandwell, David Bird, Peter	↓ 22mb	↓
YHSM-2013	Yang, Wenzheng; Hauksson, Egill	↓ 3mb	↓

stressing_rate model name	Author(s)	Model	Metadata
LovelessMeade	Loveless, Jack	↓ 43mb	↓
NeoKinema	Bird, Peter; Hearn, Liz	↓ 7mb	↓
Smith-Konter Strader UCERF3_ABM	Smith-Konter, Bridget; Sandwell, David Stader, Anne; Smith-Konter, Bridget Johnson, Kaj	↓ 22mb	↓
Zeng	Zeng	↓ 18mb	↓

Project Menu

Community Stress Model



Navigation

- About
- Model Contributions
 - Formats
 - Current contributors & model downloads
 - Model meta data
 - Meta data request form
- Current candidate CSM releases
- Model Comparisons
 - Stress
 - Stressing Rate
- Background material
 - 2013 Workshop Summary and presentations
 - 2012 Workshop Summary and presentations
 - 2011 Meeting Summary and presentations
- E-mail list request form

Documents

- Workshop Report for CSM 2012
- CSM grid
- CSM Model metadata request form
- CSM format
- CSM comparison scripts

Southern California Earthquake Center, © 2013 Los Angeles, CA | 213.740.5843 | scecinfo@usc.edu

Major funding provided by  

CSM Website: View Model Comparisons

Community Stress Model | Southern California Earthquake Center

https://sceczero.usc.edu/projects/CSM/stressing_rate

Apple Amazon News transportation program documentation seismic data response journals and societies USGS pages

an NSF-USGS center Southern California Earthquake Center Login Register Search

Home About SCEC Research Resources Collaborate Learn & Prepare

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 [3km]
Metric [hvdot | vdot | tdot | dsr] ?

	LovelessMeade	NeoKinema	Smith-Konter	Strader	UCERF3_ABM	Zeng
LovelessMeade						
NeoKinema						
Smith-Konter						
Strader						
UCERF3_ABM						
Zeng						

Project Menu

Community Stress Model

Navigation

- About
- Model Contributions
 - Formats
 - Current contributors & model downloads
 - Model meta data
 - Meta data request form
- Current candidate CSM releases
- Model Comparisons
 - Stress
 - Stressing Rate
- Background material
 - 2013 Workshop Summary and presentations
 - 2012 Workshop Summary and presentations
 - 2011 Meeting Summary and presentations
- E-mail list request form

Documents

- Workshop Report for CSM 2012
- CSM grid
- CSM Model metadata request form
- CSM format
- CSM comparison scripts

Southern California Earthquake Center, © 2013 Los Angeles, CA | 213.740.5843 | scecinfo@usc.edu

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?