The SCEC Community Stress Model (CSM) : current status

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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).*

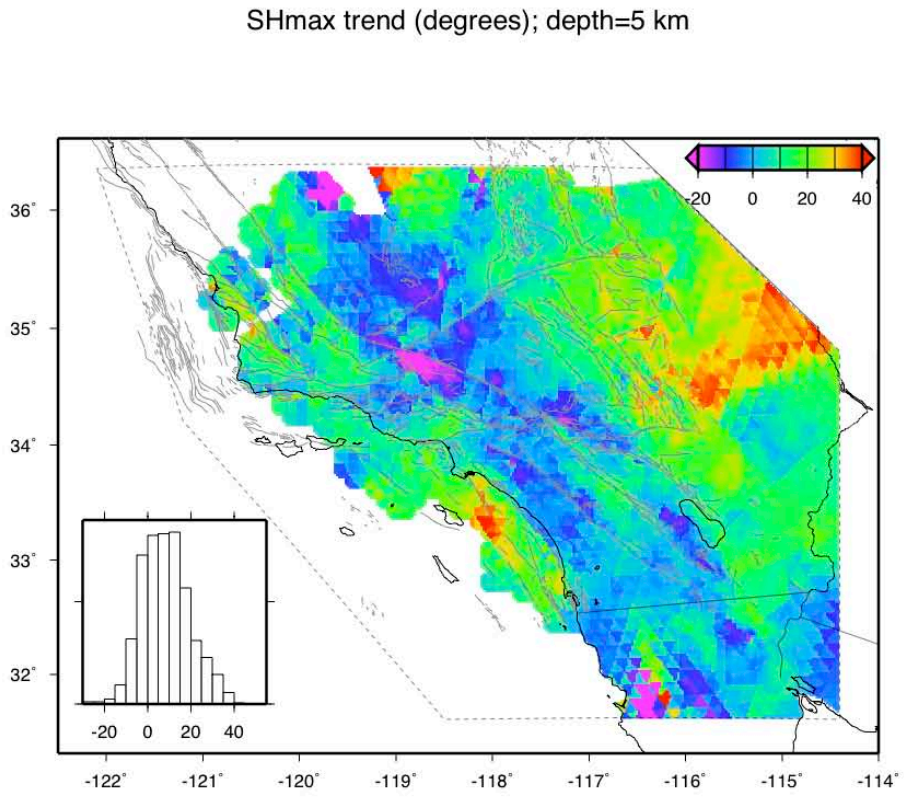
2) Finite element model including topography, depth-dependent rheology, frictional faults, and long-term deformation model. – *Peter Bird (UCLA).*

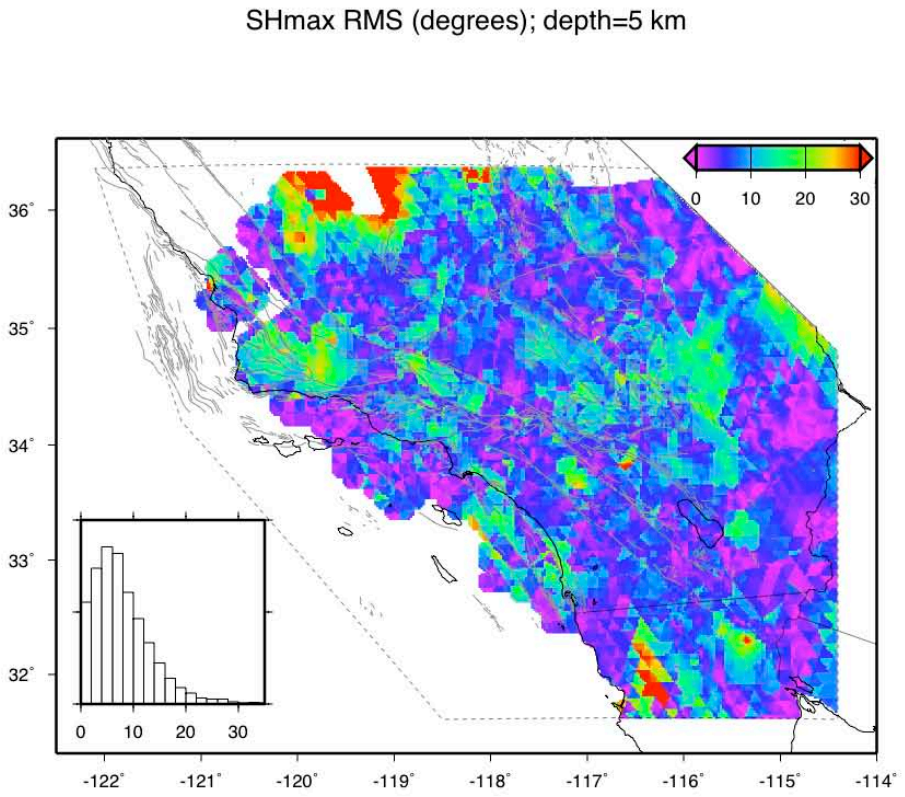
3) Inversion for stress field that fits topography, fault loading from dislocation model, tectonic loading, and focal mechanisms. – *Karen Luttrell (USGS), Bridget Smith-Konter (Texas), and David Sandwell (UC San Diego).*

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).*

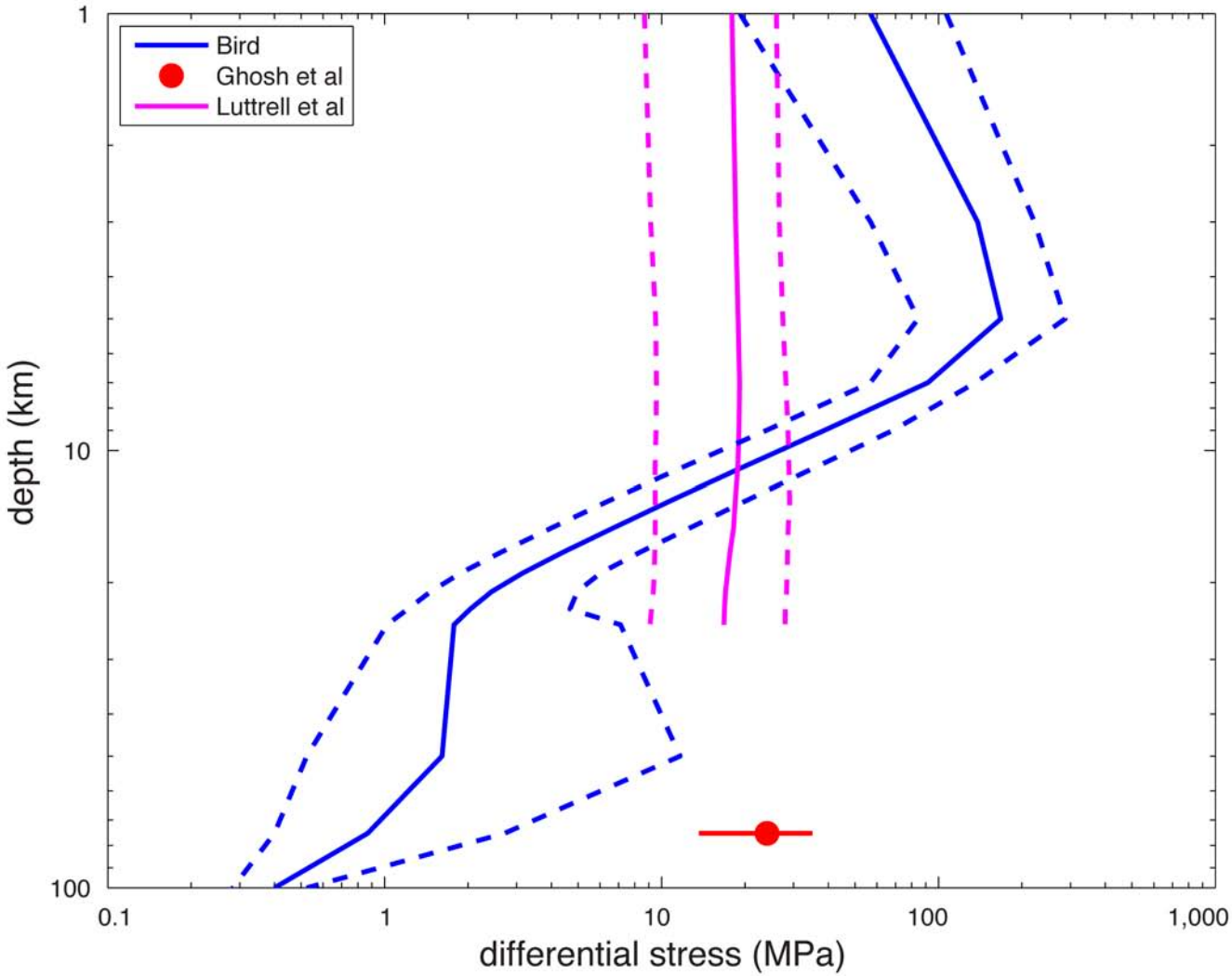
Average Stress Model and RMS variation between models.





* Average of Bird; Luttrell, Smith-Konter & Sandwell; and Yang & Hauksson models, everywhere at least two of these models are defined.

Stress Models: differential stress (s1-s3) 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).*

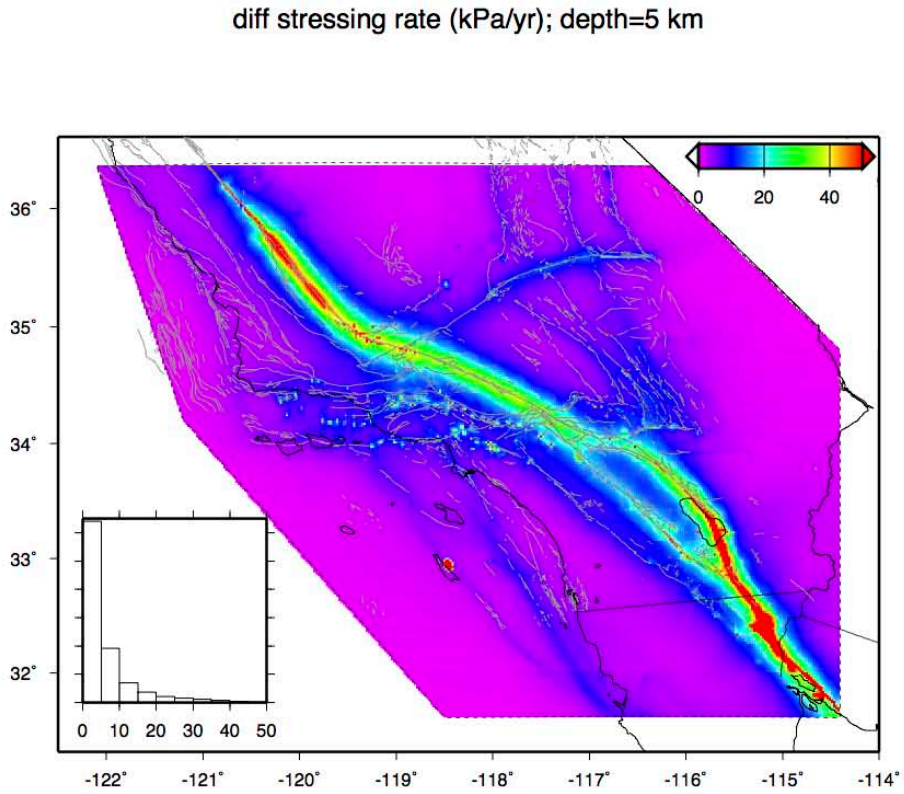
2) Fault loading from dislocation model using geologic and geodetic slip rates. – *Bridget Smith-Konter (Texas), and David Sandwell (UC San Diego).*

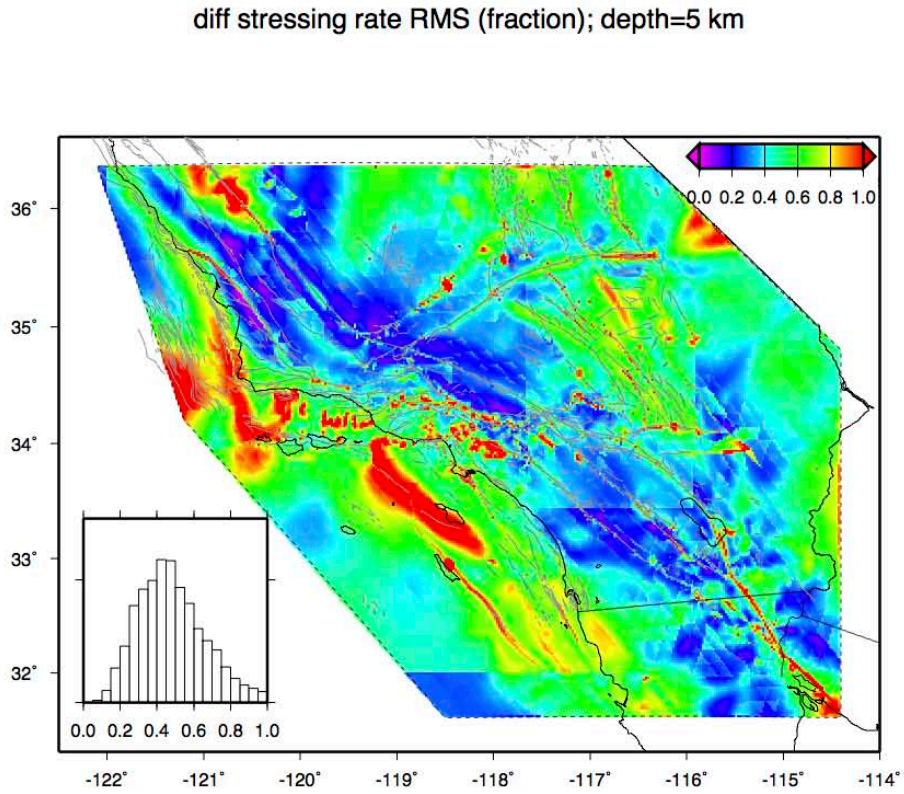
3) Fault loading from dislocation model plus static stress changes from earthquakes. – *Anne Strader and David Jackson (UCLA).*

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.

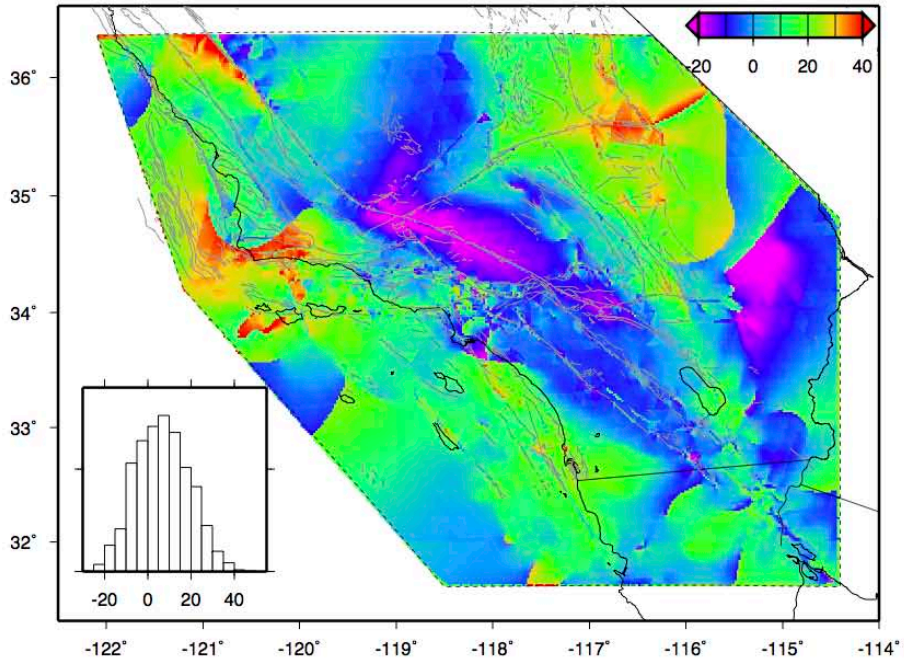




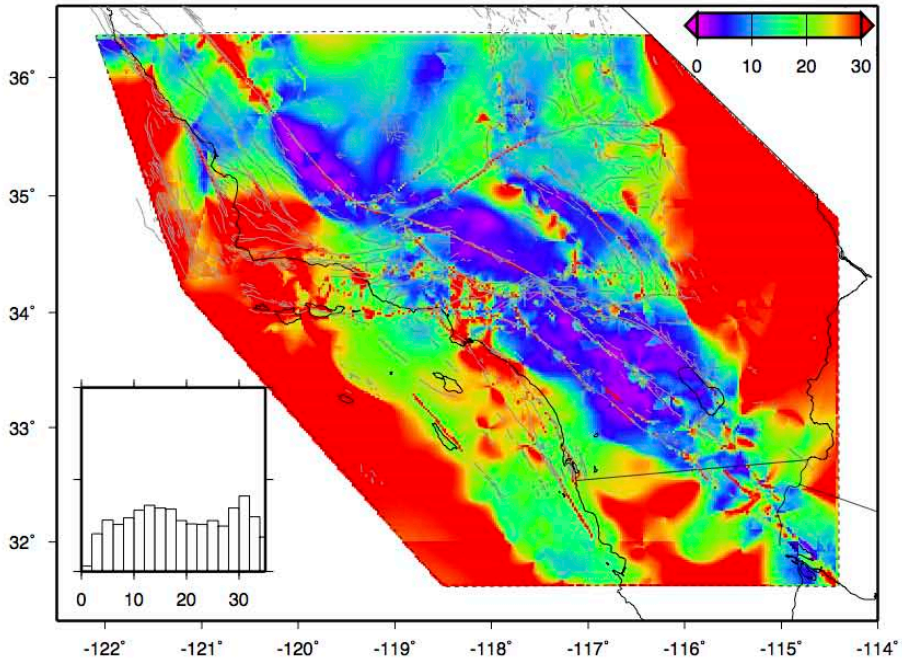
* Average of Loveless & Meade; Smith-Konter & Sandwell; Strader & Jackson; Cooke & Marshall; UCERF3 ABM; UCERF3 NeoKinema; and UCERF3 Zeng.

Average Stress Rate Model and RMS variation between models.

SHmax trend (degrees); depth=5 km

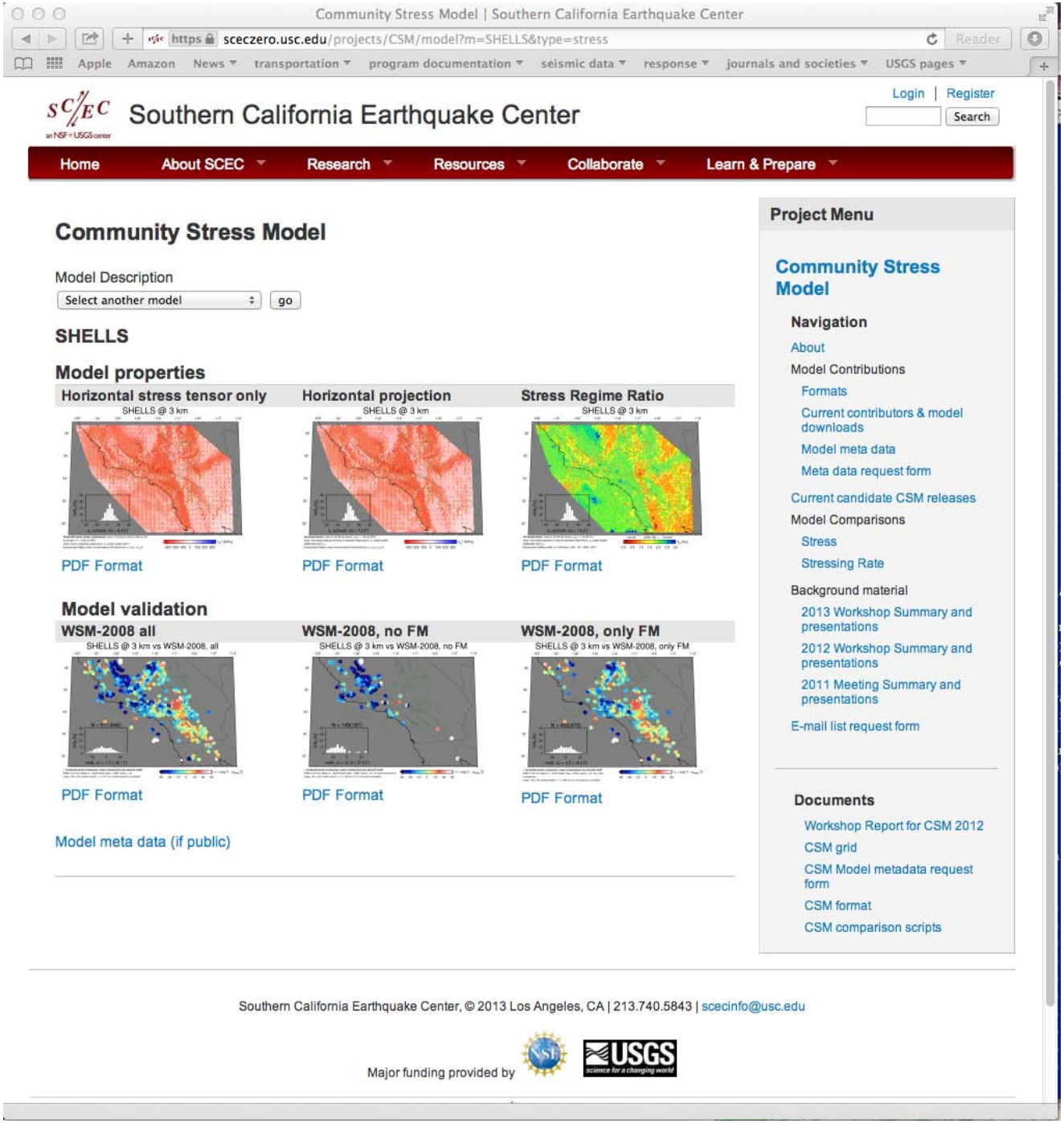


SHmax RMS (degrees); depth=5 km



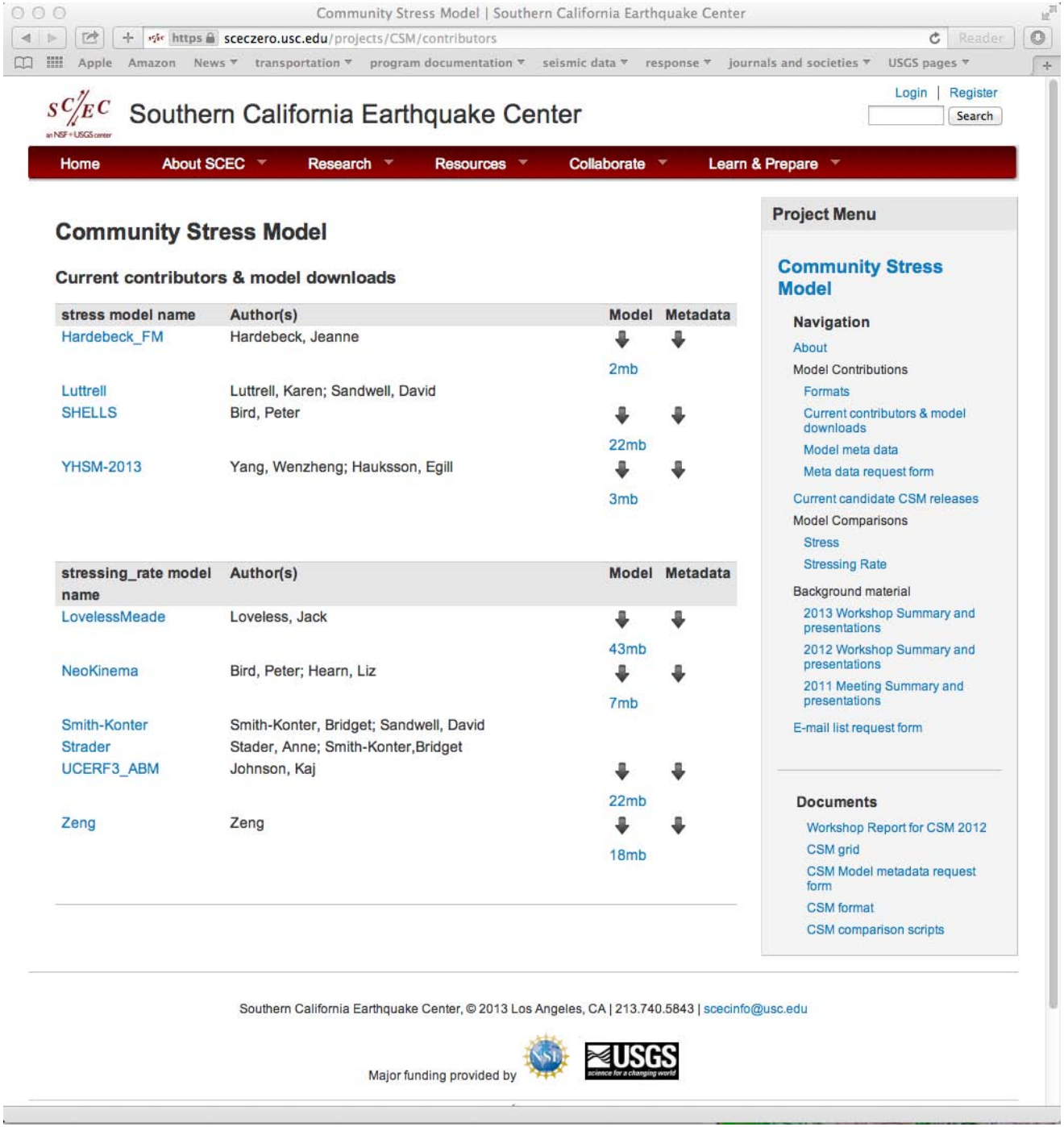
* Average of Loveless & Meade; Smith-Konter & Sandwell; Strader & Jackson; Cooke & Marshall; UCERF3 ABM; UCERF3 NeoKinema; and UCERF3 Zeng.

CSM Website: View Models

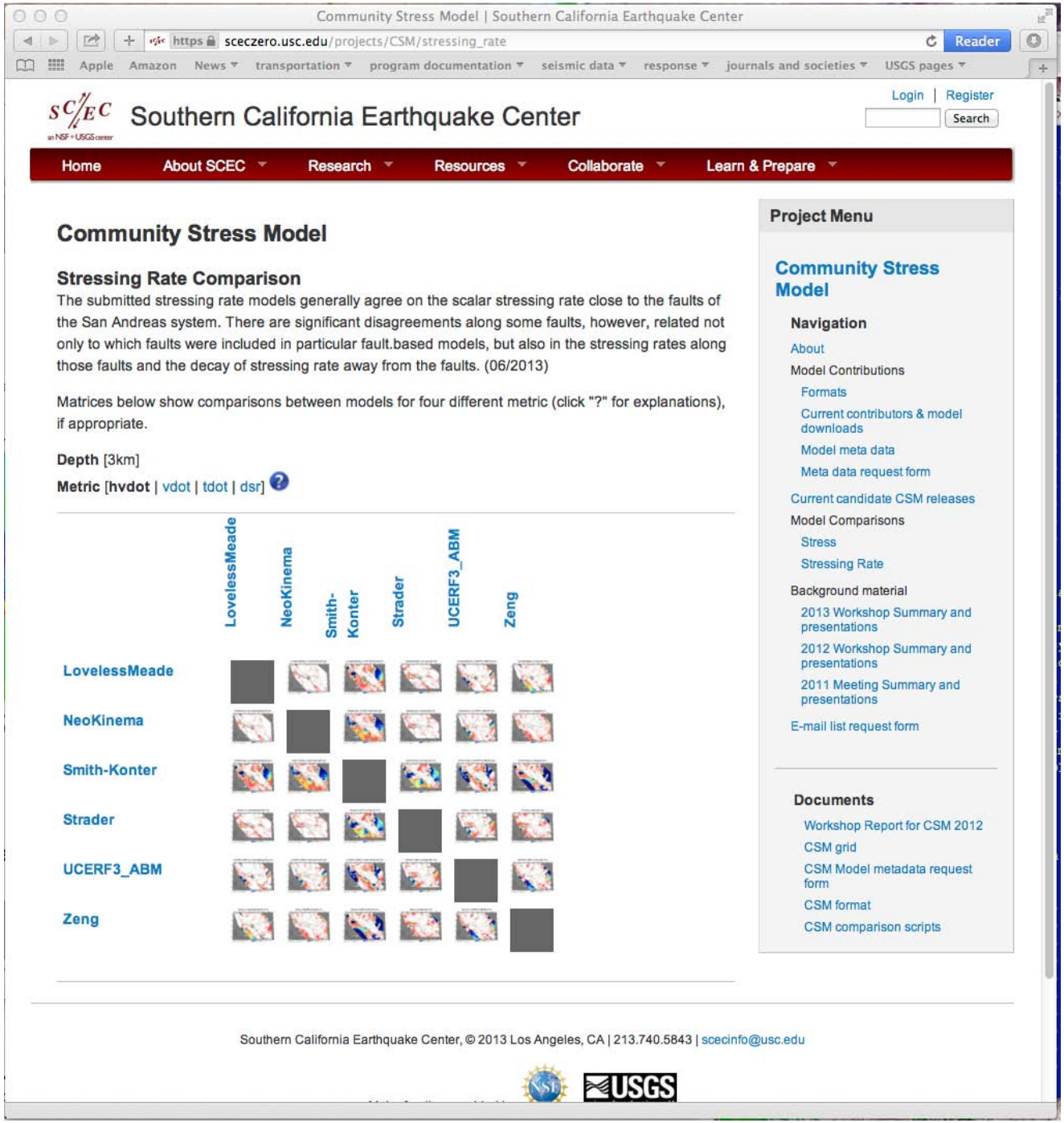


CSM Website: Download Models

(those with contributor's permission)



CSM Website: View Model Comparisons



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?