

SCEC CSM Workshop

Pomona, CA

January 15-16, 2019



- Welcome
- Overview
- Logistics
- Introductions



Croesawu Kaabo Namaste Heten Mirepres iBiala Qaimarutin
 Velkomin Dobrodošli Hospedar
 Bienvèni Bonvenon Selamat Datang Acolliir Swagata Recoger
 Velkommen Sambut Bienvenue Ongietorri TonHap Laukiamas
 ڤي ڤي ڤي Yokôso Gnindi Swaagat
 Fáilte Siyakwamukela Karibu Khoshumadi Tervetuloa Karibuni
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 Hozta добре дошъл Mirakaza Neza Toivottaa Welkom Sango da zowa 迎
 Herzlich Willkommen Degemer Kalosllthate Verweklom
 Moguah সবাগত Benvingut Teretunud Ontvangen Bonavinuta
 Woezor Welkom Dobredojde E.KomoMal Maligayang Pagdating Hwangyong Hamnida
 MirèSevini Uvitani Hean Ngibeah



Tue



58° 48°

Wed



58° 51°



Workshop Conveners



Jeanne
Hardebeck



Thorsten
Becker



Karen
Luttrell



Joann
Stock



Patricia
Persaud



History of the CSM

Last year of SCEC 3

September 14, 2011: Palm Springs **Workshop on Strategies for Implementing a Community Stress Model**

SCEC 4: 2012-2016

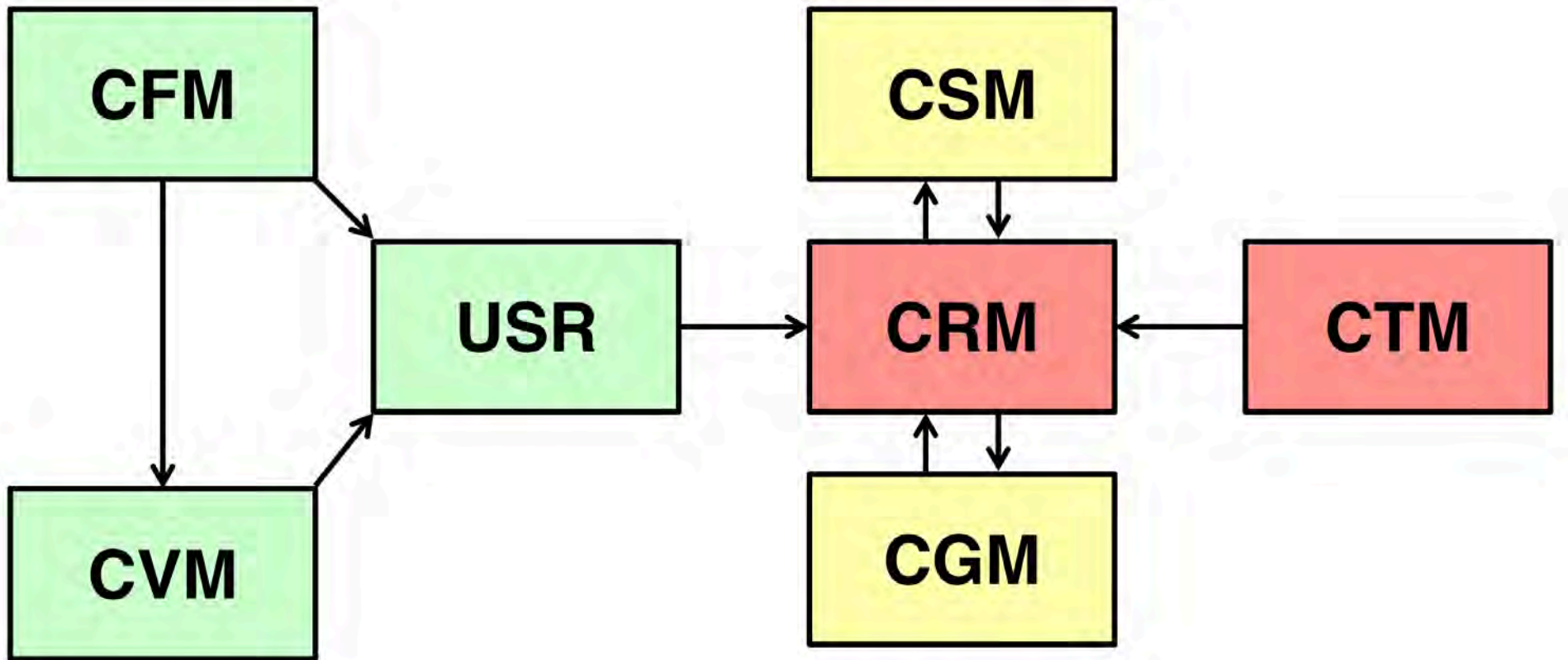
October 15-16, 2012: USC **SCEC Community Workshop: Community Stress Model**
May 29-30, 2013: Menlo Park **SCEC Community Workshop: Community Stress Model**
October 27, 2014: Pomona **SCEC Community Workshop: Community Stress Model**
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SCEC 5: 2017-2021

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The SCEC5 Community Models: CXM



Model key:
F = Fault S = Stress
G = Geodetic T = Thermal
R = Rheology V = Velocity
USR = Unified Structural
Representation

The Original CSM Mandate

- “SCEC4 has committed to the development of the Community Stress Model (CSM) to provide the SCEC community with better constraints on the stress field, and with a means to formally test physical connections between observations and stress models.”
- “Moreover, **even the discussions of the issues involved** in the construction of a CSM (such as the completeness of physical models, noise, and uncertainties) **are expected to lead to scientific progress.**”

2011 Workshop: Where do we start?

- “**Lively discussions ensued**”, including on
 - “the degree of homogeneity or heterogeneity of crustal stress”
 - “how to best model it”
 - “how to ... get started on the assembly of a stress indicator database”
- “...the logical first step ... is to compile all of the existing relevant data and stress models ... into common formats.”

2012 Workshop: Initial Contributions

- **16 models submitted**
 - Stress rate orientation and magnitude (~11 models)
 - Agree on major faults
 - Less agreement off-fault and with depth
 - Stress orientation (1 or 2 models)
 - Agree (all constrained by focal mechanisms)
 - Stress magnitude (3 models)
 - Disagree on magnitude and magnitude of variation

2012 Workshop: Initial Contributions

- “**Our call for data was not met with much response**”
 - “high-priority need”
- “the majority of submitted models **did not include any uncertainty**”
- Other topics
 - Stochastic Stress Heterogeneity
 - IT needs

2013 Workshop: Filling in obvious gaps

- Stressing Rate models and the Community Geodetic Model
- Geodynamic models: beyond the upper crust
 - Physics-based vs data-driven
 - Use global models to provide boundary conditions for regional SoCal models
- Data and Validation: ... still a key need...
- **Releasing CSM version 0.0**
 - Stress orientation: Yang and Hauksson [GJI, 2013]
 - Stressing Rate: “committee of geodeticists charged...”

2014 Workshop: Getting more specific

- Update on development of Physics-based models
- Update on identifying and obtaining data
- Individual models and CSM v0.0 are available, but “**may be under-utilized by the SCEC community**”
 - Advertise availability?

2015 Workshop: Focus on the Users

- Present current results
- Get more borehole data
- **LOTS OF COMMUNITY INTEREST!**

PARTICIPANTS

Brad Aagaard (USGS)	Gary Girty (SDSU)	Yu-Pin Lin (USC)	Valerie Sahakian (SIO)
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Abhijit Ghosh (UC Riverside)	Ting Lin (Marquette)	Omid Saber (Cntr for Tectonophysics)	

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CSM in SCEC5

- ***Basic Earthquake Science Question Q1. How are faults loaded across temporal and spatial scales?***
 - **P1.c. Constrain how absolute stress and stressing rate vary** laterally and with depth on faults, quantifying model sensitivity, e.g., to rheology, with inverse approaches.
 - **P1.d. Quantify stress heterogeneity** on faults at different spatial scales, correlate the stress concentrations with asperities and geometric complexities, and model their influence on rupture initiation, propagation, and arrest.
 - **P1.e. Evaluate how the stress transfer** among fault segments **depends on time**, at which levels it can be approximated by quasi-static and dynamic elastic mechanisms, and to what degree inelastic processes contribute to stress evolution.

CSM specifics in SCEC5

- **CXM Research Priority: Community Stress Model**
 - Assess **sensitivity of stress and deformation patterns to parameter variations** to facilitate determining what level of detail is needed in the CRM and CTM, and to provide insights on uncertainties
 - **Compile diverse constraints on stress** (e.g. from borehole or anisotropy measurements) and evaluate the accuracy and precision of the CSM
 - **Resurrect the CSM website** using materials from the former website, including tools for comparing different CSM's. Coordinate with SCEC and CXM leaders to link it to the CXM website. Generate new stress and stressing rate estimates for the CSM.

CSM in SCEC5... Commitees

- **Interdisciplinary Working Group: SCEC Community Models (CXM)**
 - Research Strategies:
 - Collect **additional observations** to improve resolution of a community model and/or resolve discrepancies among competing models
 - Develop viable **alternative community models** that facilitate representation of the epistemic uncertainty
 - Develop methods to **characterize uncertainty** in each of the community models
 - Validate and/or **test individual community models against independent data** and/or verify consistency across multiple community models (e.g., consistency of stress predictions from the CTM and CRM with the CSM)
 - **Use community models** in simulations to forecast behavior, including estimates of the uncertainties in predicted values.
 - **Expand community participation** in model development, validation, and application through workshops, tutorials, and participation in and/or collaboration with related efforts (e.g., EarthCube)



CXM

Liz Hearn

Scott Marshall

CSM in SCEC5... Committees

- **Interdisciplinary Working Group: Stress and Deformation over Time:**
 - ... characterize the present-day state of stress ... 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.
- **Research Priority:**
 - **Contribute to the Community Stress Model (CSM).** Compile diverse stress constraints (e.g. in situ stress from borehole breakouts or anisotropy measurements) and evaluate the accuracy of the CSM. Develop spatio-temporal (4D) representations of the stress tensor in the southern California lithosphere using stress constraints and geodynamic models of stress.
 - Develop earthquake cycle **stress models consistent with paleoseismic chronologies** (slip estimates and event dates) that investigate stress accumulation and stress drop sequences over multiple earthquake cycles.
 - **Apply stress and deformation measurements** at various time scales **for hypothesis testing** of issues pertaining to postseismic deformation, fault friction, isotropic and anisotropic rheology of the lithosphere, seismic efficiency, the heat flow paradox, stress and strain transients, stress complexities at earthquake gates and fault system evolution.



SDOT

Kaj Johnson

Bridget Smith-Konter

CSM in SCEC5... Committees

- **Seismology Disciplinary Committee Research Strategies:**
 - ... **develop constraints** on crustal structures and state of stress
- **Tectonic Geodesy Disciplinary Committee Research Priorities**
 -Work with other SCEC scientists to **develop the Community Stress Model** as well as an improved understanding of how stress varies from the earthquake cycle timescale to the mountain building timescale
- **Computer Science Disciplinary Committee Research Priorities**
 - Community Models (CXMs):
 - **Develop tools** that can **accelerate community building** of new (or existing) community models. ...
 - **Develop tools** that can help **integrate different community models** between themselves and/ or with simulation software. ...



Seismology

Yehuda Ben-Zion

Jamie Steidl



Computational Science

Eric Dunham

Ricardo Taborda



Tectonic Geodesy

Gareth Funning

Manoochehr Shirzaei

Our Goals This Week

The goal of this workshop is to **plan a coordinated research approach** to further the development of the SCEC Community Stress Model (CSM).

The CSM has made considerable progress in compiling stress orientation models and stressing rate models for the upper crust, and we will **plan how to build on these efforts going forward**.

We will focus on **five research themes** that are key for future progress:

- (1) physics-based models of stress in the lithosphere,
- (2) borehole stress indicators,
- (3) absolute stress,
- (4) stress heterogeneity, and
- (5) user needs, model validation, and uncertainty.

Workshop participants will **discuss the current status** of research on each theme, and **identify what is needed to make progress** with respect to the CSM. A small number of invited talks on each theme will be followed by group discussions to identify needs and opportunities.

Our group has a diverse range of experiences and expertise

Grad students

Post Docs

Asst Profs

Assoc Profs

Full Profs

National Labs

~~USGS~~ :(

Ask questions!



SCEC code of conduct

The Southern California Earthquake Center is committed to providing a **safe, productive, and welcoming environment** for all participants. We take pride in fostering a diverse and inclusive SCEC community, and therefore expect all participants to abide by the SCEC Activities Code of Conduct, as approved by the SCEC Board of Directors in June 2018.



Logistics

- Give your talk files to Tran
 - Posting online? Internally?
- Participants are both in-person and remote
 - Use the cursor to point on the screen
- Others?
- Thanks SCEC staff!



Introductions

