SCEC5 Science Planning; SCEC4 Science Accomplishments

Greg Beroza (Co-Director)
https://www.scec.org/meetings/2016/am
(draft Science Plan is available there)

Goals of the meeting
- Wrap up SCEC4
- Get started on SCEC5
- Refine the Science Plan (RFP)

2-Hour Plenary Sessions
50/50 Talks/Discussion

Poster Sessions: dedicated time, up all meeting
The SCEC Planning Cycle

Leadership Retreat (June)

Science Plan (RFP) Development (Summer)

Annual Meeting; Science Plan Input (September)
Modeling Fault Systems – Supercycles
(Moderators: Mike Oskin, Kate Scharer)

Moderators will both facilitate the discussion and capture salient points for potential improvements to the Science Plan

Tom Rockwell “Open Intervals, Clusters and Supercycles: 1100 years of Moment Release in the Southern San Andreas Fault System: Are we Ready for the Century of Earthquakes?” (30 minutes)

Dave Jackson “The bridge from earthquake geology to earthquake seismology” (30 minutes)

Open Discussion What research do we undertake in SCEC5 to understand fault system behavior and its relationship to earthquake recurrence? (60 minutes)
Modeling Fault Systems – Community Models  
(Moderators: Brad Aagaard, Michele Cooke)

Liz Hearn  “How Sensitive are Inferred Stresses and Stressing Rates to Rheology? Clues from Southern California Deformation Models” (30 minutes)

Karen Luttrell  “How stressed are we really? Harnessing community models to characterize the crustal stress field in Southern California” (30 minutes)

Open Discussion  What research do we undertake in SCEC5 to advance our understanding of the state of stress? (60 minutes)
Understanding Earthquake Processes
(Moderators: Nick Beeler, Nadia Lapusta)

Amanda Thomas  “Constraints on the Source Parameters of Low-Frequency Earthquakes in Parkfield and Cascadia” (30 minutes)

Koji Okumura  “Kumamoto earthquake: a complex earthquake sequence with large strike-slip ruptures” (30 minutes)

Open Discussion  What research do we undertake in SCEC5 to improve our understanding the full range of earthquake processes? (60 minutes)
New Observations  
(Moderators: Yehuda Ben-Zion, Gareth Funning)

Bill Hammond  “The Ups and Downs of Southern California: Mountain Building, Sea Level Rise, and Earthquake Potential from Geodetic Imaging of Vertical Crustal Motion” (30 minutes)

Monica Kohler  “Offshore Pacific-North America lithospheric structure and Tohoku tsunami observations from a southern California ocean bottom seismometer experiment” (30 minutes)

Open Discussion  What are key new observations, or observational capabilities to pursue in SCEC5? (60 minutes)
Characterizing Earthquake Hazard - OEF
(Moderators: Ned Field, Max Werner)

Nick van der Elst  “Induced earthquake magnitudes are as large as (statistically) expected” (30 minutes)

Matt Gerstenberger  “Blurring the boundary between earthquake forecasting and earthquake hazard” (30 minutes)

Open Discussion  How do move forward in quantifying time-dependent earthquake probabilities in SCEC5? (60 minutes)
Reducing Seismic Risk
(Moderators: Jack Baker, Christine Goulet)

Greg Deierlein
"Utilization of earthquake ground motions for nonlinear analysis and design of tall buildings"
(30 minutes)

C.B. Crouse
"Progress Report of the SCEC Utilization of Ground Motion Simulation (UGMS) Committee"
(30 minutes)

Open Discussion
How can research during SCEC5 make a greater contribution to efforts to reduce seismic risk?
(60 minutes)

We will take a comprehensive last look at input into the Science Plan in a Wednesday morning plenary discussion.
The SCEC Planning Cycle

Annual Meeting; Science Plan Input (September)
Science Plan Released (October)
Proposals Due (November)
PC Review (January)
Presentation to BoD (February)
Director Recommends to Agencies (March)
Science Plan Reviewed (December-January)
Proposal to Agencies (March)
Leadership Retreat (June)
Science Plan Development (Summer)
Annual Meeting; Science Plan Input (September)
Disciplinary Groups: Science planning from a disciplinary perspective.

Interdisciplinary Groups: Science planning on problems that require an interdisciplinary approach. These have evolved (modestly) from SCEC4 to SCEC5

Earthquake Engineering Implementation Interface: develop educational and research partnerships with engineering community and beyond.

Community Models: systematically encode accumulated knowledge of the fault system, including uncertainties: CVM, CFM, CSM, CGM,…

TAGs: Coordinated efforts to test methodologies for critical problems. These will sunset at the end of SCEC4 and need to be re-initiated, or not, in SCEC5, through the science planning process.
Special Projects no longer represented individually, rather as a group by Goulet & Maechling

SoSAFE/GMP generalized to SAFS/Ground Motions

USR re-envisioned to include all models under CXM

<table>
<thead>
<tr>
<th>Special Projects</th>
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<td>CME</td>
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<td>MSW</td>
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Net Result: smaller PC with significant changes in membership

SCEC5 Science Planning Organization

Planning Committee

- SCEC Administration PC Chair & Vice-Chair

Disciplinary Committees

- Geology Disciplinary Committee
- Geodesy Disciplinary Committee
- Seismology Disciplinary Committee
- Comp Science Disciplinary Committee

Focus Groups

- FARM Focus Group
- SDOT Focus Group
- EFP Focus Group
- Ground Motions Focus Group

Working Groups

- SAFS Working Group
- CXM Working Group

Partnerships

- GMSV TAG
- NHERI Partnerships

EEII

Net Result: smaller PC with significant changes in membership
SCEC5 Planning Committee Membership

Geology Disciplinary Committee
Mike Oskin; Whitney Behr

Geodesy Disciplinary Committee
David Sandwell; Gareth Funning

Seismology Disciplinary Committee
Yehuda Ben-Zion*; Jamie Steidl*

Comp Science Disciplinary Committee
Eric Dunham; Ricardo Taborda*

CXM Working Group
Liz Hearn; Brad Aagaard

Special Projects
Christine Goulet; Phil Maechling

FARM Focus Group
Nadia Lapusta*; Nick Beeler*

SDOT Focus Group
Kaj Johnson; Bridget Smith-Kontor*

EFP Focus Group
Max Werner; Ned Field

Ground Motions Focus Group
Eric Dunham; Ricardo Taborda*

SAFS Working Group
Kate Scharer; Michele Cooke*

EEII
Jack Baker, Jonathan Stewart*

12 Rotating:

Ramon Arrowsmith; Egill Hauksson; Elizabeth Cochran; Jacobo Biel; Danijel Schorlemmer; Ilya Zaliapin; Greg Hirth; Pablo Ampuero; Jeanne Hardebeck; Thorsten Becker; Yifeng Cui; John Shaw

Jack Baker, Jonathan Stewart*
Tracking Earthquake Cascades

Box 2.1. Fundamental Problems of Earthquake Science

1. Stress transfer from plate motion to crustal faults: long-term fault slip rates
2. Stress-modulated fault interactions and earthquake clustering: evaluation of mechanisms
3. Evolution of fault resistance during seismic slip: scale-appropriate laws for rupture modeling
4. Structure and evolution of fault zones and systems: relation to earthquake physics
5. Causes and effects of transient deformations: slow slip events and tectonic tremor
6. Seismic wave generation and scattering: prediction of strong ground motion
1. Stress Transfer from Plate Motion to Crustal Faults

UCERF3 Deformation Models: off fault vs. total (Field et al.)

Shells Stress Model (Bird)

Combine GPS & InSAR in a Community Geodetic Model

Liu and Shen

Earthquake Cycle Deformation Model

Takeuchi and Fialko
UCERF3-ETAS

Increased M≥6.7 earthquake likelihoods (gain), relative to long-term model (UCERF3-TD), in 7 days following an M 7 earthquake on the Mojave section of the San Andreas (white box), based on 100,000 UCERF3-ETAS simulations.
Reconciling seismicity and geodetic locking depths on the Anza segment of the San Jacinto Fault

- Models of faults obeying rate-and-state friction
- Stochastic heterogeneity in frictional properties

- Explanation for seismicity below the nominal locking depth – reconciles geodetic-seismic discrepancy.
- Consistent with relative scarcity of repeating events
- Implications for system-size ruptures and interseismic transients

Jiang and Fialko (submitted) Poster 066
Adjusted effective friction incrementally from Shells model (Bird) on 1000 fault elements based on slip-rate error. Most elements move to very low friction. One interpretation is that most active fault surface experiences near-total stress-drop in large earthquakes.
Inferring Crustal Viscosity Structure from the CVM

Equilibrium assemblages and seismic velocities for global compilation of lower crustal rocks (Hacker et al., 2015)

Use Huet et al. (2014) mixing model and single-phase flow laws to calculate bulk viscosity for predicted assemblages.

Estimate viscosity by fitting to CVM.

Shinevar, Behn, Hirth & Jagoutz
Poster 339
Approximating Physical Modeling using Machine Learning

Accelerating Viscoelastic Models via Neural Networks
{phoeberobinson, tthompson, meade}@fas.harvard.edu

Code is written in terms of physics but simpler computational representations often exist and we use neural networks to learn compact forms

Input: Fault geometry & material properties
Output: Displacements & stresses

Parallelized CPU code that runs across 1000 cores

>1000 x acceleration

Use TensorFlow library to build shallow neural networks to learn how code maps Input to Output

Input: Fault geometry & material properties
Output: Displacements & stresses
Earthquake cycle simulations with friction and viscoelasticity

What determines the depth extent of ruptures? Kali Allison and Eric Dunham Stanford University

We use earthquake cycle simulations in a viscoelastic medium to investigate the nature of the brittle-ductile transition and the interplay between distributed viscous flow and fault slip. Examples below are for linear Maxwell model, but our code handles power-law rheologies as well.

- Velocity-weakening friction
- Velocity-strengthening friction
- Brittle
- Transition zone
- Ductile

Viscosity is set by strain rate and the geotherm.

Viscosity (Pa s) vs depth (km):
- Viscosity = 10^{-14} at depth = 10 km
- Viscosity = 10^{-16} at depth = 30 km

Surface displacement vs depth (km):
- Surface displacement = 10^{-14} at depth = 10 km
- Surface displacement = 10^{-16} at depth = 30 km

Examples of strain accumulation:
- Interseismic creep
- Earthquakes

Time since eq (years) vs cumulative slip (m):
- Cumulative slip = 10^{-14} at time since eq = 10 years
- Cumulative slip = 10^{-16} at time since eq = 10 years

Produced primarily by viscous flow:
- Surface displacement

Produced by afterslip:
- Surface displacement

Cumulative slip vs time since eq (years):
- Cumulative slip = 10^{-14} at time since eq = 10 years
- Cumulative slip = 10^{-16} at time since eq = 10 years

Kali Allison and Eric Dunham Stanford University
Plasticity Throughout the Earthquake Cycle

Interseismic slip plotted in blue every 5-a

2D antiplane shear cycle simulations with plasticity

Coseismic plotted in red every 1-s

Plastic response affects each rupture

Damage zone evolves with subsequent rupture

Erickson, Dunham & Kozdon (SCEC poster # 045)

Elastic Cycles

Plastic Cycles

Cumulative Slip (m)

Depth (km)

Integrated Plastic Strain at Surface (m)

Time (years since first event)

\( \gamma^P(t,y,z) \times 10^{-3} \)

Event 1

Event 18

Amount of off-set accommodated by inelastic deformation
2. Stress-Mediated Fault Interactions

Community Stress Model (Yang and Hauksson)

Static and Dynamic Triggering (Meng and Peng)

Differential LiDAR and Stress (Oskin et al.)

Net Injection and IS (Brodsky and Lajoie)
Mechanics of Multifault Ruptures

A) Regional permuted stress allows the calculation of absolute stress at seismogenic depths.

B) Apparent friction of progenitor fault agrees with experimental data, but other faults greatly exceed known strength limits.

C) As regional stress builds, slip on optimally oriented faults is regulated by pinning intersections with a misoriented keystone fault.

D) Static failure of keystone fault spontaneously spreads to other faults that had reached critical loading earlier in the interseismic cycle.

Fletcher, Oskin and Teran, 2016, Nature Geoscience
Models of idealized fault systems reveal how step geometry can affect the distribution of slip

- Numerical models of extensional stepovers indicate random geologic sampling is unlikely to yield representative slip rates (red regions/values, top)

- Summing slip rates on overlapping segments significantly improves the likelihood of obtaining representative rates (bottom)

Resor, Cooke, Marshall, and Madden
Poster 15
A model of the San Jacinto fault illustrates how geometry impacts slip rate along a real fault system

- The location of geologic slip rate studies may govern their suitability for hazard estimates.
- Models can be used to put point measurements of slip into the context of slip distribution throughout a fault system.
- Summing of model slip rates across overlapping segments yields values that are more similar to geodetic slip rate estimates.

Resor, Cooke, Marshall, and Madden
Poster 15
Effect of fault size on recurrence intervals and size distribution of events in simple fault models

Camilla Cattania and Paul Segall

Recurrence variability is greater for longer faults and results from interaction between time to accumulate strain for full ruptures, and time to trigger partial ruptures due to penetration of creep.
Statistical correlation between earthquakes and wastewater disposal volumes in OK (2000-2013) and CA (1980-2013).

- Far from uniform in Oklahoma
- Slightly below uniform in California
Assessing fault zone structure and permeability in regions of active faulting and fluid injection: Can fault maps and structure help evaluate induced seismicity in southern California? (Brodsky & Goebel)
3. Evolution of Fault Resistance During Seismic Slip

- Fluid Pressurization in the Lab (Tullis and Goldsby)
- Supershear on Rough Faults (Bruhat et al.)

High-F Simulations with Fault Roughness (Cui et al.)
Laboratory Experiments on Fault Shear Resistance Relevant to Coseismic Earthquake Slip

Figure 1. Fits of decay in shear stress $\tau(\delta)$ to obtain Rice’s [2006] $L^*$ (see our equation (1)), following step increases in velocity $V$ for experiment 319pfp at 3 different velocities. A single set of material parameters fits all three data sets strongly indicating that the weakening is due to thermal pressurization. Fits in red by John Platt.
Shear stress increase in front of rupture causes gouge compaction, pore pressure increase, and results in less inelastic strain during rupture.

Unlike other dynamic weakening mechanisms, it acts before slip occurs.

Hirakawa and Ma (2016)
Preliminary X-Ray mapping with a synchrotron light source (Stanford) shows that we can map sites of reduced Fe, V, Mn, and Cr on fault surfaces. Modeling constrains T-t paths, and reduction establishes T slip > 570°C.

Evans, Bradbury, Moser, Ault, McDermott, Janecke
Quasi-static crustal deformation models estimate absolute shear tractions within the San Gorgonio Pass

Model considers interseismic loading since last ground rupturing event for each segment

Resolved tractions from regional tensor

Right-lateral shear tractions are only 61% correlated with tractions resolved from remote stress field – rupture models should consider effects of interseismic stressing history on initial tractions.
Reconciling supershear transition of dynamic ruptures with low fault prestress and implications for the San Andreas Fault

Nadia Lapusta, California Institute of Technology

Dynamic imaging of full-field stresses and friction in laboratory earthquakes obtained with the newly developed ultra high-speed digital image correlation method.
The effect of roughness on the nucleation and propagation of shear rupture

Yuval Tal and Brad Hager, EAPS, MIT

Self-affine fractal: \( h(L) = bL^H \)

The average static stress drop on the fault decreases with increasing roughness

Complex nucleation and propagation of the rupture
4. Structure and Evolution of Fault Zones and Systems

Ongoing work on Statewide Community Velocity and Community Fault Models
Preserved shorelines in lidar topography of Pitas Point confirm abrupt, large uplift events in hangingwall of Ventura-Pitas Point Thrust. 

Rockwell et al., BSSA in press

Uplift event ages from Oxcal model combining new and archival, re-calibrated 14C dates
Mechanical Models: Ventura-Pitas Point Fault  
Scott Marshall (Appalachian State), Gareth Funning (UCR), Susan Owen (JPL)

Forward Models Driven by Geodetic Shortening Rates

In General:
• Models using CFM5.0 fit slip rate data better than previous CFM versions

The Ventura-Pitas Point Fault:
• Max slip rates near coast where past slip estimates were made (e.g. Hubbard et al.)
• Slow slip in Santa Barbara Channel
• Flat ramp geometry  
  • Slightly under-predicts long term slip  
  • Produces better slip rates on other key faults
Continuous PBO GPS data

- Shows uplift north of Ventura Basin (dashed line)
- Consistent with interseismic deformation on the Ventura-Pitas Point fault with a flat ramp geometry
- Subsidence near Oxnard/Ventura consistent with groundwater extraction
Persistent Scatterer InSAR: Ventura, CA
Scott Marshall (Appalachian State), Gareth Funning (UCR), Susan Owen (JPL)

InSAR LOS Velocities from Envisat
- Shows uplift north of Ventura Basin (dashed line)
- Consistent with interseismic deformation on the Ventura-Pitas Point Fault with a flat ramp geometry
- Subsidence near Oxnard/Ventura consistent with groundwater extraction
- Subsidence in the Central Valley due to groundwater and hydrocarbon extraction

Poster #167
Evidence for Abrupt Subsidence Event in Carpinteria Marsh at 1.98 ± 0.1 ka

Subtidal Sand

Marsh Sediment

Chronology: 1.98 ± 0.1 ka

Reynolds, Simms, Rockwell, Bentz, Peters
Slip rates of 21-26 mm/yr for the past 100 ka on the Mission Creek strand of the SAF

- Geomorphic mapping and sediment provenance studies in the San Bernardino and Little San Bernardino Mountains combined with new $^{36}\text{Cl}/^{10}\text{Be}$ burial dating and previously published dates of these buried alluvial deposits show the Mission Creek strand is active in the San Gorgonio Pass at Mission Creek.
- Propose reverse fault of Mission Creek strand active during 1964 Palm Springs Earthquake

PI: Kim Blisniuk (SJSU) & collaborators: Julie Fosdick (Uconn), Louis Wersen, (IU), Kate Scharer (USGS), Roland Burgmann (UCB), Greg Balco (BGC)
Slip rate and slip per event studies on the Carrizo section, SAF

- D2 short term rate: 33 mm/yr
- D2: up to 8 m slip in penultimate event or 8 m of slip in previous 3 events
- Channels deposits D1, D3, D4 are too old to represent small offsets
New Cholame section paleoseismic site

- Limited existing paleoearthquake data on this important link between Carrizo and creeping sections of SAF

- Trenches show good evidence for 3 paleoearthquakes and a young ground shaking event.

- Promising as abundant charcoal will enable dating

Poster 128 Williams, Arrowsmith, Akciz, Rockwell, Ludwig
COSICorr reconciles shallow slip deficit for complex earthquake ruptures
Milliner et al., 2015, 2016, and SoSAFE presentation

Landers EQ = More Complex 46 ± 10% Off-Fault Deformation

Hector Mine EQ = Less Complex 39 ± 10% Off-Fault Deformation
Aerial2lidar3D: Development of a standard technique to measure 3D coseismic surface deformation for past and future large earthquakes that lack pre-event lidar data

J. Dolan

Figure 2. a) Point cloud result from pre-Hector Mine air photos produced using Agisoft Photoscan. Density of point cloud is ~ 1 point/m². b) Post-earthquake point cloud from lidar survey with higher density of 8.35 points/m². c) Successful vertical component detected from point cloud matching using ICP algorithm, which clearly reveals the vertical fault motion along the northern end of the Hector Mine rupture. Measurements from this fault scarp are shown in Fig. 3.
Ongoing efforts to improve understanding and representation of fault structure in key areas through improved earthquake detection and precision location.
5. Causes and Effects of Transient Deformations

Transient Detection TAG (Lohman and Murray)

- Phase IIa of the transient detection exercise showing (a) Predicted horizontal deformation during the simulated transient (vectors). Triangles and ellipses indicate location and deforming region found by the detectors. (b) Vertical displacement history at station with maximum displacement, showing the large signal (detectable by eye). (c) Vertical displacement for a more subtle case that resulted in no detections. From Lohman and Murray (2013).

Transient at Bombay Beach (Llenos and McGuire)
Community Geodetic Model V1 - GPS Secular Velocity Grid

GPS velocities from:
- PBO
- reprocessing of campaign data [Zeng and Shen, 2016]
- other dense GPS data [Crowell et al., 2013; McCaffrey et al., 2013]

Interpolation to 0.01˚ grid:
- 10 contributed models
- regridded to fit GPS data
- computed mean and standard deviation
- mean model matched GPS to 0.92 mm/yr.

Uses:
- constrain InSAR at long wavelengths
- expose areas of inadequate GPS coverage
- **assessment of off-fault strain rate**
GPS velocities from:
- PBO
- reprocessing of campaign data
  [Zeng and Shen, 2016]
- other dense GPS data
  [Crowell et al., 2013; McCaffrey et al., 2013]

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Uses:
- constrain InSAR at long wavelengths
- expose areas of inadequate GPS coverage
- assessment of off-fault strain rate
Community Geodetic Model V1 - GPS Strain Rate Grid

GPS velocities from:
- PBO
- reprocessing of campaign data
  [Zeng and Shen, 2016]
- other dense GPS data
  [Crowell et al., 2013; McCaffrey et al., 2013]

Interpolation to 0.01° grid:
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Uses:
- constrain InSAR at long wavelengths
- expose areas of inadequate GPS coverage
- assessment of off-fault strain rate
Improved InSAR Processing

Schmidt et al. (2015) InSAR timeseries method incorporates pixel coherence into the covariance, which performs better than the traditional approach.

Example shows improvement in LOS velocity estimates for the Coachella Valley.
6. Seismic Wave Generation and Scattering

BBP Validation (Dreger et al.)

CyberShake Hazard Maps (Jordan et al.)

Waveguide-to-Basin Validation (Denolle et al.)
Kinematic Rupture Generator

Dynamic Rupture Models → One / Two-Point Statistics → Kinematic Sources

(Savran and Olsen, SDSU)

$\mu_0$ (initial friction)

$\Delta u$ (slip)

$V_{\text{peak}}$

$V_{\text{rup}}$

Mean and standard deviation

Sequential Gaussian Cosimulation of $\Delta u$, $V_{\text{peak}}$, $V_{\text{rup}}$

Source-Time Function

$V(x, t) = \frac{\Delta u(x)}{V_{\text{peak}}(x)} \left( \frac{t - t_{\text{rup}}(x)}{\tau_{\text{peak}}(x)} \right) \exp \left[ - \left( \frac{t - t_{\text{rup}}(x)}{\tau_{\text{peak}}(x)} \right) \right]$

Linear Model Of Coregionalization
The project has developed the first empirical relation for the relative ability of fault bends to stop rupture as a function of bend angle.
Kinematic Rupture on Multi-Segment Faults: The UCSB Ground-Motion Simulation Method

We have extended the capabilities of the UCSB code for ground motion simulation by including fault bending, step-overs and multi-segment kinematic ruptures.

- Each fault segment has its own nucleation point, which is consistent with dynamic rupture simulations.
- The timing of the rupture on the different segments is set such that they agree with dynamic ruptures simulations.
- Validations of the new capabilities have been tested for the 1992 Landers earthquake.

The upper figure shows:

a) The normalized moment-rate functions at each fault segment.
b) Ground-motion velocity produced by each fault-segment.
c) Total ground motion produced at station LCN.
Geodetic and Dynamic Models of the 2010 El Mayor/Cucapah Earthquake
Kyriakopoulos, Oglesby, Funning

Geodetic Model vs Dynamic Rupture model
(Final Slip Models)

Fault geometry produces slip that naturally
Matches Geodetic slip.
Surface topography produces complexity in
Wave and rupture propagation.

Rupture front broken up; Higher
fault slip rate at shallow depth

Surface topographic effects
on dynamic rupture
(Snapshots of Fault Slip Rate)

No Surface Topography

Surface Topography

Additional reflected waves from free surface
3D dynamic rupture modeling of the Hosgri-Shoreline faults. We built a robust and stable 3D mesh of the Hosgri-Shoreline faults using the state-of-the-art software CUBIT. In this mesh, the faults are represented by split nodes and we are able to generate Mw 7.2 earthquakes with branching ruptures using our dynamic rupture module in SPECFEM3D, [Galvez et al., 2014,2016]. Our dynamic rupture simulations have been tested and passed the SCEC/USGS dynamic rupture benchmarks for 3D branching ruptures (TPV24-25) of Harris et al. (2009). The branching rupture scenarios produced here will serve as guidance to build kinematic models that will be used for strong ground motions simulations using the SCEC broadband platform.
We built a stable and robust 3D mesh setting for the Ventura fault including the Lion backthrust. Using this mesh we perform dynamic rupture simulation to explore the potential of splay fault ruptures where the earthquake nucleates at depth on the Ventura fault. The dynamic parameters of the splay rupture will serve as guidance to build kinematic models that will be used for strong ground motion simulations using the SCEC broadband platform.
Higher order, multi-dimensional ambient field analysis improves Green’s function retrieval.

\[ C_{zz} = C_{zzzz} + C_{znnz} + C_{zeez} \]
A stochastic Vs30-dependent velocity model of near-surface sediments in Southern California (GTL v2.0)

Shi, Asimaki, Taborda, Silva and Yong

400 velocity profiles

Combined

San Bernardino basin: GTL vs. GTL v2.0

Profile statistics
SCEC Award #16076: Characterizing seismic site conditions in southern California based on topographically induced stress and bedrock fractures

Moon et al.

- To examine the potential control of topographic stresses on the local variability of Vs30, we measured the spatial distribution of near-surface seismic velocity at sites in the San Gabriel Mountains and the San Bernardino Mountains and compared the results with topographic stress model.

- Our results show that P-wave seismic velocity in the SGM site varies significantly (~25%) within hillslopes and does not linearly correlate with slope, while P-wave seismic velocity in the SBM site shows little variation within the hillslope.

- The correspondence between topographic stress proxy (failure potential for shear fracture) and P-wave seismic velocity in SGM site suggests that bedrock fracture and weathering patterns influenced by topographic stresses may affect the local variability of near-surface seismic velocity.

Figure. Comparison of topographic stress proxy and seismic velocity for SGM site. The vertical distribution of (A) the modeled failure potential from two-dimensional stress model with horizontal stress value of 2 MPa, (B) the measured P-wave velocity, and (C) the averaged S-wave velocity for upper 30 m assuming Vp=V3Vs.
Frictional rheology for nonlinear attenuation: Implications for paleoseismology and strong S-waves

The shear modulus divided by depth versus depth

Notion is that strong shaking damages the shallow subsurface.

After a few events, the shear modulus self organizes such that frictional failure barely occurs.
Thank You
See Anne Rosinski
(will be at the meeting until tomorrow morning)

http://www.californiaeqclearinghouse.org/

UPCOMING CLEARINGHOUSE TRAINING OPPORTUNITY IN S. CALIFORNIA

- CA National Guard Vigilant Guard 17-1
  November 14-20, 2016
- Scenario: Mw6.0 earthquake near Las Vegas, followed 2 days later by Mw7.8 earthquake in Southern CA
- Use materials Clearinghouse developed for 2015 Capstone exercise
- Understanding impacts to back-to-back earthquakes in neighboring states
- Information sharing in support of situational awareness, and understanding of interdependencies between critical infrastructure
- Overflight missions on both Blackhawk and Lakota helicopters; November 16, 2016
- Physical Clearinghouse at Los Alamitos, November 16, 2016. Become a registered Clearinghouse Disaster Service Worker partner
- Participate in afternoon briefing

UPDATE ON USE OF DRONES IN DISASTER RESPONSE – Use of drones during a disaster activation in California REQUIRES coordination with the California Office of Emergency Services, Air Coordination Group. Get the latest information on rapid certification to fly a drone following an earthquake.