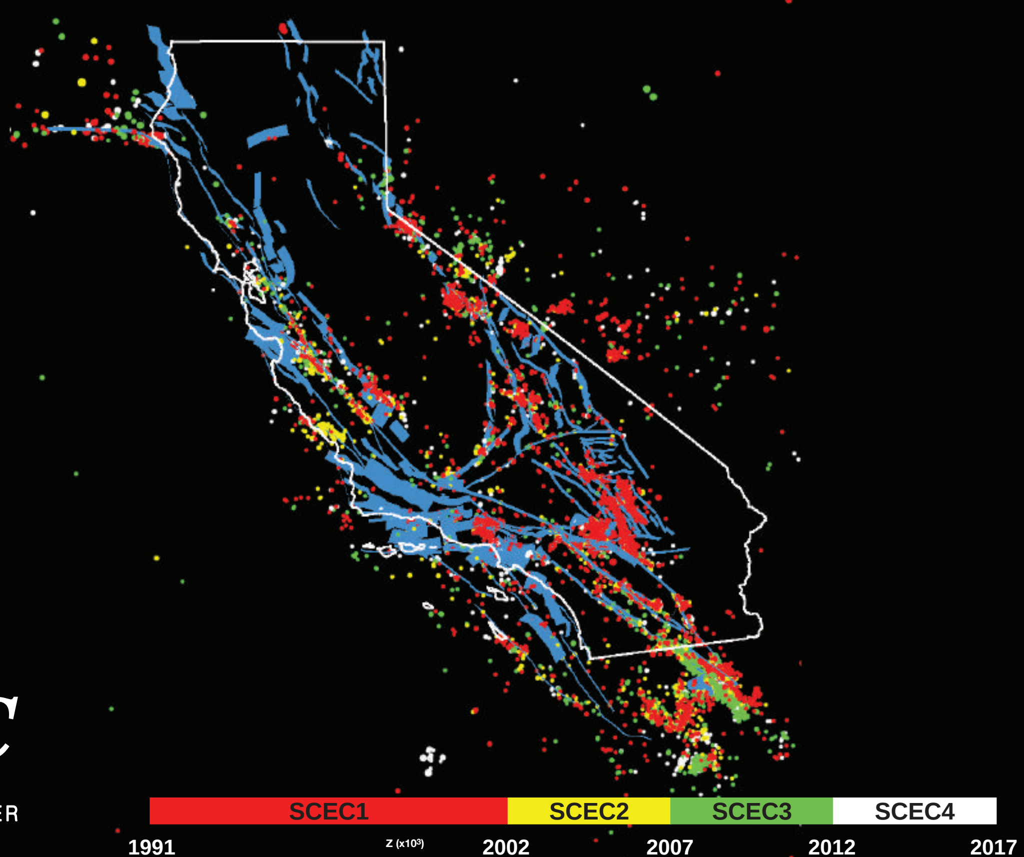
Southern California Earthquake Center

ANNUAL MEETING 2015



SCEC-VDO Visualization of M3+ Earthquakes (1991-2015) with UCERF3 Fault Model

SCEC

AN NSF+USGS CENTER

MEETING PROGRAM

September 12-16, 2015

Core Institutions and Board of Directors (BoD)

The Board of Directors (BoD) is the primary decision-making body of SCEC; it meets three times annually to approve the annual science plan, management plan, and budget, and deal with major business items. The Center Director acts as Chair of the Board. The liaison members from the U.S. Geological Survey are non-voting members.

USC **Tom Jordan***	Harvard **Jim Rice**	UC Los Angeles **Peter Bird**	UC Santa Cruz **Emily Brodsky**	USGS Pasadena **Rob Graves**
Caltech **Nadia Lapusta****	MIT **Tom Herring**	UC Riverside **David Oglesby**	UNR **Glenn Biasi**	At-Large Member **Roland Bürgmann**
CGS **Chris Wills**	SDSU **Steve Day**	UC San Diego **Yuri Fialko**	USGS Golden **Jill McCarthy**	At-Large Member **Michele Cooke**
Columbia **Bruce Shaw**	Stanford **Paul Segall**	UC Santa Barbara **Ralph Archuleta**	USGS Menlo Park **Ruth Harris, Steve Hickman**	*Chair **Vice-Chair

Science Working Groups & Planning Committee (PC)

The leaders of the Disciplinary Committees and Interdisciplinary Focus Groups serve on the Planning Committee (PC) for three-year terms. The PC develops the annual Science Collaboration Plan, coordinates activities relevant to SCEC science priorities, and is responsible for generating annual reports for the Center. Leaders of SCEC Special Projects (i.e., projects with funding outside the core science program) also serve on the Planning Committee. They ensure the activities of the Special Projects are built into the annual science plans.

	Disciplinary Committee			
PC Chair **Greg Beroza***	Seismology **Egill Hauksson*** **Elizabeth Cochran**	Tectonic Geodesy **Jessica Murray*** **Dave Sandwell**	EQ Geology **Mike Oskin*** **Whitney Behr**	Computational Sci **Yifeng Cui*** **Eric Dunham**
	Interdisciplinary Focus Groups			
PC Vice-Chair **Judi Chester***	USR **John Shaw*** **Brad Aagaard**	SoSAFE **Kate Scharer*** **Ramon Arrowsmith**	EFP **Jeanne Hardebeck*** **Ilya Zaliapin**	EEII **Jack Baker*** **Jacobo Bielak**
* PC Members	FARM **Greg Hirth*** **Pablo Ampuero**	SDOT **Kaj Johnson*** **Thorsten Becker**	GMP **Kim Olsen*** **Christine Goulet**	
	Special Projects			TAGs
	CME **Phil Maechling***	CSEP **Max Werner*** **Danijel Schorlemmer**	WGCEP **Ned Field***	GMSV **Nico Luco** **Sanaz Rezaeian**
	Technical Activity Groups (TAGs *continued*)			
	Code Verification **Ruth Harris**	SIV **Pablo Ampuero**	EQ Simulators **Terry Tullis**	Transient Detection **Rowena Lohman**

CEO Planning Committee (CEO PC)

The Communication, Education, and Outreach Planning Committee (CEO PC) comprises of stakeholders representing CEO program focus areas (public education and preparedness; K-14 education initiative; experiential learning and career advancement; and the implementation interface). The CEO PC provides guidance for CEO programs, reviews reports and evaluations, and identifies synergies with other parts of SCEC and external organizations.

* Board liaison ** PC liaison *** AC liaison	**Tim Sellnow*****, Chair U Central Florida	**Kate Long***** CalOES	**Danielle Sumy** IRIS
	Jacobo Bielak** CMU	**Salley McGill** CSUSB	**Chris Wills*** CGS

Advisory Council (AC)

The external Advisory Council (AC) provides guidance in all aspects of Center activities, including basic and applied earthquake research and related technical disciplines, formal and informal education, and public outreach. Members of the AC are elected by the Board for three-year terms and may be re-elected. The Council meets annually to review Center programs and plans, and prepares a report for the Center.

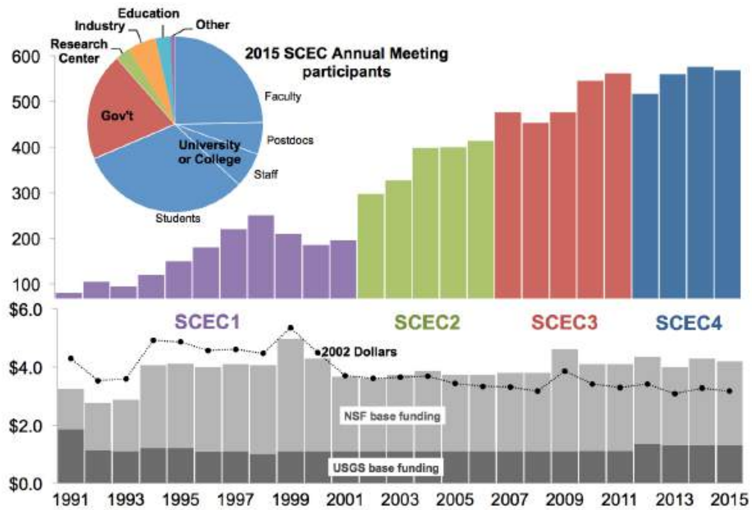
Gail Atkinson, Chair Western U	**Donna Eberhart-Phillips** UC Davis	**M. Meghan Miller** UNAVCO	**John Vidale** U Washington
Norm Abrahamson PG&E	**Kate Long** CalOES	**Farzad Naeim** John A Martin	**Andrew Whittaker** MCEER/Buffalo
Roger Bilham U Colorado	**Warner Marzocchi** INGV Rome	**Tim Sellnow** U Central Florida	

Center Management

	Center Administration	Communication, Education & Outreach	Information Technology
Center Director **Tom Jordan**	Associate Director **John McRaney**	Associate Director **Mark Benthien**	Associate Director **Phil Maechling**
Co-Director **Greg Beroza**	Special Projects/Events **Tran Huynh**	Education Programs **Bob de Groot**	Research Programmer **Scott Callaghan** **David Gill** **Masha Liukis** **Kevin Milner** **Fabio Silva**
Exec Dir Spec Proj **Christine Goulet**	Contracts & Grants **Karen Young**	Strategic Partnerships **Sharon Sandow**	
	Admin Coordinator **Deborah Gormley**	Digital Products **John Marquis**	Systems Programmer **John Yu**
		Communications **Jason Ballmann**	

Welcome to the 2015 SCEC Annual Meeting!

It's the fourth year of SCEC4 and the 25th SCEC Annual Meeting! At this meeting, we'll have a chance to share recent research accomplishments with the full SCEC community and discuss plans for achieving our ambitious science goals.



Upper bar chart shows registrants at SCEC Annual Meetings 1991-2015. Pie chart shows the demographic profile for 2015 pre-registrants (568 total). The lower bar chart is the history of SCEC base funding in as-spent millions of dollars; the connected dots are the base-funding totals in 2002 dollars.

The SCEC Science Planning Committee has configured a program that will keep you very busy during your stay in Palm Springs. Five workshops will be held on Saturday and Sunday. At 6pm Sunday evening, Professor James Rice from Harvard University will kick off the main meeting as our Distinguished Speaker with a talk on "Heating and Weakening of Faults During Earthquake Slip."

The agenda will feature keynote speakers on thought-provoking subjects that feed into discussions of major science themes, poster sessions on research results, technical demonstrations, education and outreach activities, and some lively social gatherings. The overall goal of the meeting is to assess the progress towards goals set forth in the SCEC4 proposal, to forge new collaborations and to put the finishing touches on the SCEC5 proposal.

Veterans of past SCEC meetings know that much of the action happens in the poster sessions. As in the past few years, posters will stay up for the entire meeting to allow more face-to-face interactions on the nitty-gritty aspects of SCEC scientific research. As always, we will be looking for ways to improve the meeting, so give us your feedback on any and all aspects of the meeting.

We hope you are inspired by the science, the meals, the cameraderie, and that you take a moment to contemplate the tectonic landscape of Palm Springs, and its place in spectacular natural laboratory of southern California.

Thomas H. Jordan, Director

Gregory C. Beroza, Co-Director

Table of Contents

Go to meeting website:

www.scec.org/meetings/2015am

@SCEC #SCEC2015

Cover Image

3D view of the history of M3+ earthquakes in and around California during SCEC1, SCEC2, SCEC3, and most of SCEC4 (1991-2015) layered with the UCERF3 Fault Model [Field *et al.*, 2015]. Visualization done using SCEC Virtual Display of Objects (SCEC-VDO), produced by interns from the SCEC Undergraduate Studies in Earthquake Information Technology (UseIT) Program, *courtesy of Kevin Milner (University of Southern California).*

Saturday, September 12

08:30 - 09:00	Workshop Check-In at Plaza Ballroom Foyer of Hilton Palm Springs
09:00 - 17:00	**A Workshop to Begin Building a Community Rheology Model (CRM) of the Southern California Lithosphere** Conveners: Liz Hearn, Wayne Thatcher, Yuri Fialko, Greg Hirth, Gary Fuis, and Thorsten Becker Location: Plaza Ballroom A&B
09:00	Overview on CRM goals and ingredients (Liz Hearn) - CRM goals and plan per SCEC5 proposal - Outcomes from this workshop - Structure of today's workshop
09:20	Discussion
09:30	Active-source results for southern California; comparison with noise-source Vs modeling (Gary Fuis)
10:00	Earthquake-source Vp and Vp/Vs modeling of southern CA; interpretation of top and bottom of seismogenic zone (Egill Hauksson)
10:15	Interpretation of Vp/Vs in the shallow crust from active source studies (Rufus Catchings)
10:30	Directed Discussion (Gary Fuis and All)
11:00	Break
11:15	Rock Mechanics and Exhumed Fault Constraints (Greg Hirth)
11:40	The problem (and potential) of using seismic anisotropy to constrain effective viscosity and strain localization in Southern California (Phil Skemer)
11:55	Constraints from xenoliths on the rheology of southern California lower crust and lithospheric mantle (Whitney Behr)
12:10	Integrating fault zone microstructural observations with rock mechanics data (Fred Chester)
12:25	Directed Discussion (Greg Hirth and All)
13:00	Lunch
14:00	How can the CRM contribute to improved understanding of secular and transient deformation in Southern California and loading of seismogenic faults? (Yuri Fialko)
14:25	Links between short-term and long-term deformation boundary conditions from regional geodynamic models (Thorsten Becker)
14:40	Effects of heterogeneous rheology on deformation, inferred slip rates and inferred stresses (Liz Hearn)
14:55	Linear rheologies versus lab-derived flow laws and heterogeneity of lithosphere deformation (Roland Bürgmann)
15:10	Directed Discussion (Yuri Fialko and All)
15:30	Break
15:45	Wrap-Up Session: How to put all the pieces together (Liz Hearn and Co-PI's) - Perspectives on disciplinary sessions: 5-minute summaries and discussions - Next steps: Priorities for SCEC4 2016 RFP; SCEC5 objectives and staged interim goals; discussion
17:00	Adjourn

Saturday, September 12

09:00 - 17:00 **SCEC CSEP/USGS/GEM Workshop: Epistemic Uncertainties in Earthquake and Ground Motion Forecasts**

Conveners: Max Werner, Danijel Schorlemmer, Tom Jordan, Andy Michael, Morgan Page, Marco Pagani
Location: Plaza Ballroom C&D

09:00 Welcome, Introductions, Meeting Objectives (M. Werner and D.Schorlemmer)

CSEP & OEF: Overview and Status

Moderator: D. Schorlemmer Reporter: M. Liukis

09:10 CSEP Overview and Status (M. Werner)

09:35 Current CSEP & OEF Activities in New Zealand (D. Rhoades)

09:50 Five-year Japanese earthquake predictability experiment with multiple runs since 2009 including the 2011 Tohoku-oki earthquake and the 2014 Northern Nagano earthquake (N. Hirata)

10:05 Status and Challenges for Implementing CSEP in China (C. Jiang)

10:20 Operational Earthquake (and Loss) Forecast in Italy: The CSEP Legacy and Future Perspectives (W. Marzocchi)

10:35 Status of OEF Development at the USGS (M. Blanpied)

10:45 Testing UCERF2 [and UCERF3?] (D. Schorlemmer)

10:50 Break

OEF, Aftershocks and Retrospective Experiments

Moderator: P. Maechling Reporter: A. Llenos

11:05 Testing UCERF3-ETAS (N. Field)

11:15 Retrospective Canterbury Experiment (M. Werner)

11:25 Ensemble Model Earthquake Forecasts during the 2010-2012 Canterbury, New Zealand, Earthquake Sequence (M. Taroni)

11:35 Organization of teh Collaboratory for Interseismic Simulation and Modeling [CISM] (T. Jordan)

11:40 Dynamic Ensemble Model Testing and Global Earthquake Forecast Evaluation (A. Strader)

11:50 Panel Discussion: Epistemic Uncertainties in CSEP (W. Marzocchi and D. Rhoades)

- How should epistemic uncertainties be handled in testing and evaluation?

13:00 Lunch

Evaluating Hazard Models

Moderator: W. Marzocchi Reporter: N. van der Elst

14:00 Testing PSHA against accelerometric data and intensities (C. Beauval)

14:15 GEM Hazard Modelling and Testing (M. Pagani)

14:30 Testing IPEs and Seismic Hazard Maps (S. Mak)

14:45 Discussion

- How should GEM & USGS ground motion forecasts and hazard models be evaluated?
- How can T&E results feed into hazard model updates?

15:30 Break

	Induced Seismicity
	Moderator: M. Page Reporter: M. Taroni
15:45	Earthquake Rate Models for Evolving Induced Seismicity Hazard in the Central and Eastern U.S. (A. Llenos)
15:55	Forecasting Next Year's Earthquakes in Oklahoma: Scientific and Public Policy Challenges (B. Ellsworth)
16:05	Discussion
	- CSEP Experiments of Induced Seismicity Forecasts
16:45	Wrap-Up and Next Steps M. Werner and D. Schorlemmer
17:00	Adjourn

Sunday, September 13

07:00 - 18:00 **SCEC Annual Meeting Registration & Check-In** at Hilton Lobby

07:00 - 08:00 **Breakfast** at Hilton Poolside

08:00 - 12:00 **SCEC Collaboratory for Interseismic Simulation and Modeling (CISM) Workshop**
Conveners: Tom Jordan, Phil Maechling
Location: Palm Canyon Room

08:00	Introduction and Overview of CISM (T. Jordan)
08:10	State of Forecast Development and Considerations for CISM
	Moderator: T. Jordan
	- USGS (M. Blanpied and N. Field)
	- New Zealand (D. Rhoades and A. Christophersen)
	- Europe (W. Marzocchi and D. Schorlemmer)
	- CSEP (M. Werner)
08:50	Earthquake Simulators
	Moderator: T. Tullis
	- RSQSim Code Development (K. Richards-Dinger)
	- Potential Applications of RSQSim for the CISM Project (J. Dieterich)
	- Panel Discussion (Participants in Earthquake Simulators Technical Activity Group)
10:10	Ground Motion Forecasting
	Moderator: G. Beroza
	- CyberShake and UCERF3 (K. Milner)
	- Validation of Ground Motion Models (C. Goulet)
10:40	CISM Infrastructure
	Moderator: P. Maechling
11:00	Objectives and Plans for CISM
	Moderator: T. Jordan
12:00	Adjourn

Sunday, September 13

10:00 - 12:00 **Open Discussion: Estimating Fault Zone Properties using Space-Based Measurements**

Conveners: Andrea Donnellan (NASA JPL), Ramon Arrowsmith (ASU), Yehuda Ben-Zion (USC)
Location: Oasis 3

Everyone is welcome to join in the discussion.

We are developing a concept for a spaceborne gazing imager that would serve as a community resource for fault zone studies. Gazing imaging, or Structure from Motion (SfM), measurements are increasingly being applied to studying fault zones. The method combines images from several vantage points to provide topography, reflectance, and imagery over fault zones (see http://www.kiss.caltech.edu/study/gazing2014/index.html). Resulting topography can be used to study geomorphology of fault zones, while reflectance and imagery can be used to estimate material properties, texture, and porosity of the zone and surrounding area. Images collected before and after surface rupturing earthquakes would provide 3D change maps. Combining these measurements with other data should improve estimates of strain partitioning across the fault zone, fault rock damage, strength, and healing. Current SfM methods rely on balloons, drones, and aircraft. A spaceborne platform would allow for global, systematic, repeated measurements of fault zones. We are seeking community input on the science that could be achieved with a spaceborne imager, potential targets (globally), and the needed resolution to achieve the science goals.

12:00- 13:00 Lunch at Hilton Restaurant, Tapestry Room, and Poolside

13:00 - 17:00 **SCEC Community Software for Extreme-Scale Computing in Earthquake System Science Meeting**

Conveners: Tom Jordan, Phil Maechling
Location: Palm Canyon Room

13:00	Introductions, Overview, Milestones, and Logistics (T. Jordan and P. Maechling)
13:30	Physics in High-Frequency Simulations (K. Olsen)
14:15	Validation Procedures for High-F and CyberShake (R. Taborda)
15:00	Break
15:15	Extreme Scale Software (Y. Cui)
16:00	Future CyberShake (P. Maechling)
16:45	Wrap-Up (T. Jordan and P. Maechling)
17:00	Adjourn

Sunday, September 13

13:00 - 17:00 **SCEC Community Stress Model (CSM) Workshop**
Conveners: Bruce Shaw, Joann Stock, Jeanne Hardebeck, and Thorsten Becker
Location: Horizon Ballroom

13:00 Overview (B. Shaw)

Stressing Rate, Seismicity, and Stress

13:10 A Comparison of 17 Strain-Rate Models from GPS Geodesy (D. Sandwell)

13:25 Alignment of Stressing Rate from GPS with SHmax Orientations from Stress Inversions (E. Hauksson)

13:45 Crustal Stress: Constraints from Seismology, Geodesy, Topography, and Gravity (K. Luttrell)

14:05 Comparison of Off-Fault and Interseismic Stressing Patterns with Seismicity (M. Cooke)

CSM Website

14:30 The CSM Web Site and Facilitating User Access (T. Becker)

14:45 Break

Data Constraints on Stress

15:00 Scales of Stress Field Variation Determined from Borehole Observations in Southern California (J. Stock)

15:30 Questions and Audience Discussion on Borehole Stress

15:40 Stress Orientation from Active Deformation of Borderland Basins (M. Legg)

15:55 Heat Flow Constrains on Off-Fault Stresses in Central California (N. Sleep)

Snap Talks

16:00 Community-Contributed Presentations on Results and Forward Directions (1-2 slides maximum)

16:30 Wrap-Up Panel Discussion on Directions Forward

17:00 Adjourn

13:00 - 15:00 **California Earthquake Clearinghouse: Training and Fieldwork Limited Liability Certification (Session 1)**
Conveners: Anne Rosinski, Maggie Ortiz, and Mike Oskin
Location: Oasis Room 2

13:00 Introduction to Clearinghouse and SCEC Response

13:15 Introduction to Disaster Service Workers Program

13:30 Overview of National Incident Management System (NIMS)

13:45 Safety in the Field

14:00 Clearinghouse Operations After an Earthquake (checking in, coordination calls, briefings, overflights, etc.)

14:15 Data Collection

14:30 Questions/Discussion

14:40 Oath

14:45 Concluding Remarks

15:00 Adjourn

15:00 - 17:00	**California Earthquake Clearinghouse: Training and Fieldwork Limited Liability Certification (Session 2)** Conveners: Anne Rosinski, Maggie Ortiz, and Mike Oskin Location: Oasis Room 2
15:00	Introduction to Clearinghouse and SCEC Response
15:15	Introduction to Disaster Service Workers Program
15:30	Overview of National Incident Management System (NIMS)
15:45	Safety in the Field
16:00	Clearinghouse Operations After an Earthquake (checking in, coordination calls, briefings, overflights, etc.)
16:15	Data Collection
16:30	Questions/Discussion
16:40	Oath
14:45	Concluding Remarks
17:00	Adjourn
16:00 - 20:00	**Poster Set-Up** in Plaza Ballroom
17:00 - 18:00	**Welcome Social** in Hilton Lobby and Plaza Ballroom
18:00 - 19:00	**Distinguished Speaker Presentation** in Horizon Ballroom Heating and weakening of faults during earthquake slip (James R. Rice)
19:00 - 20:30	**Welcome Dinner** at Hilton Poolside
19:00 - 21:00	**SCEC Advisory Council Meeting** in Palm Canyon Room
21:00 - 22:30	**Poster Session 1** in Plaza Ballroom

Monday, September 14

07:00 - 08:00	**SCEC Annual Meeting Registration & Check-In** at Hilton Lobby
07:00 - 08:00	Breakfast at Hilton Poolside
08:00 - 10:00	**The State of SCEC** in Horizon Ballroom
08:00	Welcome and State of the Center (Tom Jordan)
08:30	Agency Reports - National Science Foundation (Jim Whitcomb) - U.S. Geological Survey (Bill Leith) - FEMA/NEHRP (Wendy Phillips) - NASA (Ben Phillips)
09:00	Communication, Education, & Outreach (Mark Benthien)
09:20	SCEC Science Accomplishments (Greg Beroza)
10:00 - 10:30	Break
10:30 - 12:30	**Session 1: SCEC Special Fault Study Areas** Moderators: Kate Scharer, Scott Marshall San Gorgonio Pass Special Fault Study Area (Michele Cooke) The Ventura Special Fault Study Area: Assessing the potential for large, multi-segment thrust fault earthquakes and their hazard implications (John Shaw)

12:30 - 14:00	Lunch at Hilton Restaurant, Tapestry Room, and Poolside
14:00 - 16:00	**Session 2: SCEC Community Models** in Horizon Ballroom Moderators: Brad Aagaard, Rowena Lohman Blending data and dynamics into equilibrium for the Community Stress Model (Peter Bird) The Community Geodetic Model (Jessica Murray)
16:00 – 17:30	**Poster Session 2** in Plaza Ballroom
19:00 - 21:00	**SCEC Honors Banquet** at Woodstock Ballroom, Hard Rock Hotel
21:00 - 22:30	**Poster Session 3** in Plaza Ballroom

Tuesday, September 15

07:00 - 08:00	Breakfast at Hilton Poolside
08:00 - 10:00	**Session 3: Earthquakes — From the Lab to the Field** in Horizon Ballroom; Moderators: Judi Chester, Cliff Thurber FARockM Perspectives on Earthquake Processes from the Lab to the Field (Greg Hirth) Shallow structure of the San Jacinto fault zone and detailed catalog of seismic sources based on spatially-dense array data (Yehuda Ben-Zion)
10:00 - 10:30	Break
10:30 - 12:30	**Session 4: Physics-Based Forecasting and Ground Motions** in Horizon Ballroom; Moderators: Eric Dunham, Edward Field Getting Real: The Promise and Challenges of 3D Ground-Motion Simulations (Arthur Frankel) Physics-based Earthquake Forecasting: Encouraging Results from a Retrospective CSEP Evaluation of Forecasting Models during the 2010 Canterbury, New Zealand, Earthquake Sequence (Max Werner)
12:30 - 14:00	Lunch at Hilton Restaurant, Tapestry Room, and Poolside
14:00 - 16:00	**Session 5: Connecting Hazard to Risk** in Horizon Ballroom; Moderators: Jacobo Bielak, Sanaz Rezaeian From Seismic Hazard to Risk: Summary of Critical Issues and How SCEC Research Can Foster New Solutions (Christine Goulet) Managing Earthquake Hazards and Risks to Implement an Infrastructure Resilience Program (Craig Davis)
16:00 - 17:30	**Poster Session 4** in Plaza Ballroom
19:00 - 21:00	Dinner at Hilton Poolside
19:00 - 21:00	**SCEC Advisory Council Meeting** in Boardroom
21:00 - 22:30	**Poster Session 5** in Plaza Ballroom
22:30 - 23:00	Poster Removal from Plaza Ballroom

Wednesday, September 16

07:00 - 08:00	Breakfast at Poolside
08:00 - 10:00	**Session 6: Post-Earthquake Rapid Scientific Response** in Horizon Ballroom; Moderators: Mike Oskin, Ken Hudnut
	The Gorkha Mw=7.8 earthquake: an incomplete Himalayan rupture (Roger Bilham)
	The high frequency 'anomaly' that saved lives: Site effects and damage patterns of the 2015 Gorkha Earthquake (Domniki Asimaki)
10:00 - 10:30	Break
10:30 - 12:30	**The Future of SCEC** in Horizon Ballroom
10:30	Report from the Advisory Council (Gail Atkinson)
11:00	This Next Year: 2016 SCEC Science Collaboration (Greg Beroza)
11:45	Towards SCEC5 Priorities (Tom Jordan)
12:30	Adjourn
12:30 - 14:30	**SCEC Planning Committee Lunch Meeting** in Palm Canyon Room A
12:30 - 14:30	**SCEC Board of Directors Lunch Meeting** in Palm Canyon Room B

Distinguished Speaker Presentation — Sunday

Heating and weakening of faults during earthquake slip, *James Rice (Harvard University)*

Sunday, September 13, 2015 (18:00)

Field and borehole observations of active fault zones show that earthquake shear is often highly localized to principal slipping zones of order 10s of microns to a few mm wide, lying within a broader gouge layer typically of order of a few cm wide, and with all that being a feature located within a much broader zone of cracked/damaged rock bordering the fault over a scale of 1-10s m width. Fault gouges are often rate-strengthening, especially at higher temperatures, and are then resistant to shear localization under typically slow laboratory deformation rates. However, extreme localization due to shear heating and development of highly elevated pore pressure is shown to be a predicted and lab-verified consequence of rapid straining. That pressurization can develop in fluid which pre-exists in the gouge as groundwater, or in the volatile H2O or CO2 phases emerging at high pressure from thermal decomposition reactions in hydrated silicates (clays, serpentines) or carbonates. These processes join the ubiquitous weakening by flash-heating at frictional asperity contacts to make conventional friction properties almost irrelevant at seismic slip rates. Results have implications for the mode of slip-rupture propagation in earthquakes (self-healing vs. crack-like) and shed new light on why statically strong faults like the SAF can produce large ruptures which show negligible localized heat outflow and little evidence of melt formation, at least in the shallow to middle crust. As some have recently advocated, evaluating the susceptibility of major fault zones to extreme thermal weakening, when feasible, should became a component of seismic hazard analysis.

James R. Rice, born 1940 in Frederick, MD, is the Mallinckrodt Professor of Engineering Sciences and Geophysics at Harvard, appointed jointly in its School of Engineering and Applied Science and Department of Earth and Planetary Sciences. From 1965 to 1981 he was a faculty member in the Division of Engineering at Brown. His prior education was at Lehigh, with a 1962 Sc.B. in engineering mechanics, and a 1963 Sc.M. and 1964 Ph.D. in applied mechanics.

Rice's research focuses on the mechanics and related hydrologic, materials and thermal science underlying earth and environmental processes. That has included analyses of earthquake nucleation, dynamic rupture propagation, and aseismic deformation transients in fault zones, landslide processes, and more recently, tsunami propagation and meltwater interactions with glacier and ice sheet dynamics. Earlier, his work addressed plastic deformation and cracking processes in mechanical and materials engineering, and related analytical and finite-element computational methodology. His path-invariant integral studies, originally focused on understanding crack tip stress fields in non-linear engineering materials, principally metallic alloys, were quickly adapted to slip weakening descriptions of rupture surfaces in landslides and earthquakes, and later to atomic scale treatments of dislocation nucleation from crack tips in crystal lattices, for assessing the origins of ductile vs. brittle response.

Rice's contributions have been recognized by numerous awards, including the Timoshenko and Nadai Medals of the American Society of Mechanical Engineers, the von Karman and Biot medals of the American Society of Civil Engineers, the Bucher Medal of the American Geophysical Union, the Néel Medal of the European Geosciences Union, and the Reid Medal of the Seismological Society of America. He has been elected to the USA National Academies of Engineering and of Science, to foreign membership in the Royal Society, London, and in the French Académie des Sciences, and has received honorary doctorates from several universities.

For Rice's publications, see http://esag.harvard.edu/rice/RicePubs.html, and/or a full cv, see http://esag.harvard.edu/rice/RiceCV.html.

Plenary Talk Presentations — Monday

San Gorgonio Pass Special Fault Study Area, *Michele L. Cooke, David D. Oglesby, and John D. Yule*

Monday, September 14, 2015 (10:30)

The largest irregularity along the San Andreas fault occurs in the San Gorgonio Pass (SGP) region where active strands disaggregate into a distributed zone of faulting, rather than having deformation restricted to a single active strand. Forecasting the earthquake hazards in this complex region requires addressing three fundamental questions: 1) What is the subsurface geometry of active faulting through the SGP? 2) What is the earthquake potential in the SGP region? 3) What is the probability of a through-going San Andreas rupture? The SGP SFSA has taken a multi-disciplinary approach to address these three questions. One focal point throughout SCEC4 has been the activity level of the northern route through the pass along the Mill Creek and Mission Creek strands of the SAF. The role of this route in passing slip through the pass is critical for understanding potential earthquakes in the region. Through field studies, investigations of microseismicity, geodetic inversions for slip rate and crustal deformation models, we have vastly increased the data available to assess the activity of the Mill Creek/Mission Creek strand and honed our understanding of the partitioning of deformation throughout the fault system. New strike-slip rates have filled a critical gap within previous data along the SAF. Microseismicity shows anomalously high stress drops within of the SGP that may reveal stress levels critical for rupture dynamics. Dynamic rupture models of realistically geometrically complex faults demonstrate that the development of earthquake rupture through the pass is highly sensitive to initial stress levels as well as fault geometry. The important question of through-going rupture history has been addressed with deep trenches that show that the last event to rupture through the SGP may have been ~1400 AD. The emerging view from the work reveals a fault system that typically arrests ruptures as they approach the pass, yet occasionally allows through-going, very large events. This view is consistent with lowered strain accumulation, measured strike-slip rates and strike-slip rates from kinematically consistent models within the SGP. The SGP workshops have showcased the impressive collection of collaborative research emerging from the SFSA. Through such interdisciplinary dialog we are successfully integrating a variety of datasets to form a clearer understanding of active faulting in this region that has the potential for devastating earthquakes.

The Ventura Special Fault Study Area: Assessing the potential for large, multi-segment thrust fault earthquakes and their hazard implications, *John H. Shaw, Michael Barall, Reed Burgette, James F. Dolan, Eric L. Geist, Jessica Grenader, Thomas Gobel, William Hammond, Egill Hauksson, Judith A. Hubbard, Kaj Johnson, Yuval Levy, Lee McAuliffe, Scott Marshall, Craig Nicholson, David Oglesby, Andreas Plesch, Laura Reynolds, Thomas Rockwell, Kenny J. Ryan, Alexander Simms, Christopher C. Sorlien, Carl Tape, Hong Kie Thio, Steve Ward*

Monday, September 14, 2015 (10:30)

The SCEC Ventura Special Fault Study Area (SFSA) promotes interdisciplinary science investigating the prospects for large, multi-segment thrust fault earthquakes in southern California. The SFSA is centered on the north-dipping Ventura – Pitas Point fault and overlying anticline, which are located at the juncture of several of the largest and fastest slipping faults in the Transverse Ranges. Holocene marine terraces above the anticline suggest that it deforms in discrete 7-9 m uplift events, with the latest event occurring ~950 years ago.

Recent excavations across the fold scarp above the blind Ventura fault show evidence for at least two large-displacement (4.5 to 6m uplift), paleo-earthquakes in the Holocene that may be correlated with uplift of marine terraces along the coast. Geophysical studies of the larger fault system that extends offshore also document discrete Holocene seafloor deformation. Current efforts are focused on developing a comprehensive understanding of coastal uplift and subsidence patterns that record both the activity of the 140 km long Ventura – Pitas Point – North Channel fault system and a series of active north- and south-dipping faults in its hanging wall and footwall. Seismological studies show that thrust and strike-slip earthquakes occur throughout the region, and are consistent with NNE-SSW compression. Geodetic observations (GPS, InSAR, and leveling studies), and fault system models also indicate rapid shortening (2.7 to 8 mm/year) and uplift (> 2 mm/yr) rates across portions of this structure. Mechanical models of the Ventura fault system predict slip rates that agree with geologic estimates of fast slip, with the maximum slip predicted near the coast. Together, these results support the occurrence of large thrust fault earthquakes involving the Ventura fault system.

To assess the hazards posed by these earthquakes, the SFSA has supported numerical simulations that suggest ruptures of the Ventura – Pitas Point fault system will produce large surface displacements and significant, long duration ground motions (> 0.5 m/s, PGV) over a large area of southern California. As these ruptures will likely extend offshore, they also pose the threat of generating tsunamis. Recent studies examining sedimentary deposits along the coast have suggested possible paleo-tsunami deposits, as well as rapid coastal subsidence events that may be caused by paleo-earthquakes. Numerical modeling of tsunamis shows significant run-ups (up to 8 m) along large areas of the coastline for equivalent modeled seafloor offset. These studies confirm that large thrust fault earthquakes pose considerable seismic and tsunami hazards to coastal southern California. SCEC is at the forefront of efforts to better characterize these hazards.

The Community Geodetic Model, *Jessica R. Murray, Rowena Lohman, and David Sandwell*

Monday, September 14, 2015 (14:00)

The SCEC Crustal Motion Map (CMM) provided average geodetic velocities from southern California data collected through 2004. Core SCEC4 science targets require input that captures spatiotemporal variations at high resolution. The Community Geodetic Model (CGM) aims to provide this by leveraging the complementary features of Global Positioning System (GPS) and Interferometric Synthetic Aperture Radar (InSAR) data. Advances since the completion of the CMM, including a larger continuous GPS network, the launch of new SAR satellites, and development of InSAR time series analysis techniques, provide essential CGM building blocks. Raw GPS and InSAR data are being analyzed and combined via appropriate models to generate GPS station time series, spatially gridded InSAR time series, and a self-consistent integration of the two.

Creating the CGM requires synthesis of existing analyses and development of new methodologies. In a series of in-person and virtual workshops, geodesy experts and potential users have defined the target CGM product, identified important decision points in CGM development, evaluated candidate methodologies, and adjusted the plan accordingly.

By comparison of continuous GPS time series from several processing centers we have uncovered and addressed discrepancies. We are finalizing a consensus approach for merging these time series and incorporating campaign data. GPS-derived secular velocities are needed to constrain some InSAR analyses and have intrinsic value to the broader SCEC community for interseismic deformation studies. Calculating these rates is complicated by factors such as long term postseismic signals, particularly in regions with little pre-earthquake GPS data, and the potential for bias introduced by the scale term applied during GPS reference frame alignment. These are topics of ongoing evaluation and decision-making by CGM contributors.

An important finding is that some InSAR time series derived without GPS constraints show good agreement with GPS even at long spatial scales and thus might provide deformation time series in regions with sparse GPS coverage. The new Sentinel-1a and ALOS-2 satellites now supply ascending and descending data for southern California with short baselines and frequent repeats, opening exciting new avenues for improved InSAR time series analysis and atmospheric corrections. Through the CGM effort thus far we have laid the groundwork to capitalize on these unique observations in the coming years.

Blending data and dynamics into equilibrium for the Community Stress Model, *Peter Bird*

Monday, September 14, 2015 (14:00)

With 3-D tensor models of stress in the lithosphere in southern California, SCEC could: (a) determine the shear stress on active faults to constrain the physics of slip; (b) predict Coulomb stress changes for operational earthquake forecasting; and (c) test the realism of long-term earthquake sequence simulators. One basis for models is data: stress directions (from focal mechanisms and boreholes), and stress intensity (only from boreholes). But earthquakes rarely occur deeper than 15~20 km, and boreholes rarely deeper than ~6 km. Therefore, data must be supplemented by dynamic models using: laboratory flow laws, a geotherm model, a Moho model, relative plate motions, and locations of active faults. One dynamic model uses code Shells, which solves for 2-D equilibrium of vertically-integrated stresses using 2-D velocity models and 3-D structure. While this model predicts full stress tensors, they are discontinuous and noisy. A newer approach is to model the stress anomaly field as the sum of topographic and tectonic stress anomaly fields. In program FlatMaxwell, the topographic stress is defined as the convolution of topography (and deep density anomalies) with analytic solutions for an elastic half-space. The tectonic stress is modeled by sums of derivatives of a Maxwell vector potential field. The whole stress field is then best-fit (by weighted least squares) to both data and the dynamic model. In practice, FlatMaxwell models are limited in spatial resolution to no more than 6 wavelengths along each side of the model domain. Thus they are quite smooth, and cannot represent stress discontinuities at the Moho predicted by the Shells model. Results to date show a low-amplitude stress anomaly, with peak shear stress of 120 MPa and peak vertically-integrated shear stress of 2.9×10^12 N/m. Channeling of deviatoric stress along the strong Peninsular Ranges and Great Valley is seen. In southern California, deviatoric stress and long-term strain-rate are negatively correlated because regions of low heat-flow act as stress guides while deforming very little. In contrast, active faults lie in areas with higher heat-flow, and their low strength keeps deviatoric stresses locally modest. Opportunities for future CSM advances include: [1] collecting more data; [2] tuning the Shells dynamic model; [3] using a different dynamic modeling code; and/or [4] applying a similar Maxwell equilibrium filter to models of the interseismic stress rate.

Plenary Talk Presentations — Tuesday

FARockM Perspectives on Earthquake Processes from the Lab to the Field, *Greg H. Hirth*

Tuesday, September 15, 2015 (08:00)

Laboratory rock mechanics and complimentary analyses of fault zone microstructures provide numerous constraints on processes that promote or limit earthquake nucleation and rupture. I will provide my perspective on how SCEC has fostered important directions in rock mechanics, where we stand currently and the role that rock mechanics and structural studies can play in future SCEC initiatives. (1) Preceding the Annual Meeting, we will be holding a workshop on the Community Rheology Model (Convened by Hearn, Becker, Fialko, Fuis, Hirth and Thatcher) to discuss, among several topics, how to integrate our understanding of rheology and physical properties into a practical model of lithospheric deformation in Southern California. Here, I will provide a brief summary of the efficacy (and limitations) of using laboratory based flow laws in such models, and how to integrate observations of microstructures from exhumed fault rocks and xenoliths into a systems-based analysis of deformation in the lithosphere. (2) Perhaps the biggest role that SCEC has played in the rock mechanics community is through its impact on focusing effort towards understanding (and applying) the processes that promote dynamic fault weakening. I will provide an update on where this field stands and highlight areas where a combination of laboratory and theoretical studies need to advance, drawing from our own work and that of the community. One issue that stands out as particularly important is constraining the processes that lead to strain localization during both interseismic/quasi-static and dynamic fault slip. (3) A common link between these topics is identifying the deformation conditions at the “brittle-ductile transition”. Here I will discuss recent experimental work from our lab, in which we analyze how grain-scale plasticity influences the “effectiveness” of the effective pressure law, and how these processes may control the depth of the seismogenic zone and how it evolves with changing temperature, strain rate and lithology. In addition, I will illustrate why higher temperature/higher pressure experiments may be a key for not only constraining these processes, but also understanding the apparent discrepancy between interpretations regarding the strength/effective viscosity of major faults in California.

Shallow structure of the San Jacinto fault zone and detailed catalog of seismic sources based on spatially-dense array data, *Yehuda Ben-Zion*

Tuesday, September 15, 2015 (08:00)

I review results (*) on imaging the shallow structure of San Jacinto fault zone and detection/location of seismic energy sources using data of a spatially-dense Nodal array centered on the Clark branch of the fault. The array operated at the Sage Brush site south of Anza for about 4 weeks in 2014 with 1108 vertical (10 Hz) geophones in about 650 m x 700 m box configuration. Continuous waveforms with signals generated by the ambient seismic noise, earthquakes, and Betsy gunshots were recorded with useable frequencies up to 200 Hz. The shallow structure imaging is done with surface and body waves extracted from the ambient noise, arrivals from local and teleseismic earthquakes, and waves generated by the gunshots. The results document very low seismic velocities and attenuation coefficients, strong lateral and vertical variations, seismic trapping structure, local sedimentary basin, and overall lithology contrast across the fault. The detection/location techniques include stacking, beamforming, matched field processing, and templates generated by these methods. The analysis uncovers many hundred of daily earthquakes not detected by the regional networks and several different types of surface noise sources.

*The research was done in collaboration with F. Vernon, Z. Ross, P. Roux, D. Zigone, G. Hillers, H. Meng, M. Campillo & others

Getting Real: The Promise and Challenges of 3D Ground-Motion Simulations*,*
Arthur Frankel and William Stephenson

Tuesday, September 15, 2015 (10:30)

3D ground-motion simulations improve our prediction of ground shaking for future large earthquakes. For the Seattle basin, there are clear observations of basin-edge focusing and basin-edge generated surface waves that we have successfully modeled using the 3D finite-difference method. In 2007, we published probabilistic seismic hazard maps for Seattle of 1 Hz spectral accelerations, based on 3D simulations for 540 earthquake rupture scenarios for sources that dominate the probabilistic hazard. These maps were derived from synthetic seismograms at 7200 receiver sites spaced 280m apart. We also investigated how 3D random heterogeneities in seismic velocities can affect forward directivity pulses and basin surface waves. The Hanford basin in eastern Washington is another case where basin-edge generated surface waves are observed in recordings and matched by 3D simulations. Our current challenge is producing broadband (0-10 Hz) synthetic seismograms for M9 earthquakes on the Cascadia subduction zone using 3D simulations up to 1 Hz, as part of the M9 project of the University of Washington. The central task of this study is to consider a variety of rupture scenarios and provide realistic synthetic seismograms to structural and geotechnical engineers so that they can evaluate the range of performance of buildings and soils. Strong-motion and teleseismic recordings of the M9.0 Tohoku and M8.8 Maule earthquakes, as well as observations of some large crustal earthquakes, indicate that higher frequency (≥ 0.5 Hz) radiation is generated at localized portions of the fault that are not the same as where the maximum slip occurs. This implies that the wavenumber spectra of stress and slip on a fault vary along the fault plane, with smooth and rough patches. For the M9 Cascadia simulations, we use high stress drop M8 sub-events combined with background slip with relatively long rise times. We present an example for the Seattle basin that demonstrates the importance of using geologic information to constrain inversions for seismic velocities based on Rayleigh wave phase velocities. A 3D simulation using the smoothed southern edge of the Seattle basin determined from the surface-wave inversion cannot reproduce the basin-edge focusing observed during the Nisqually earthquake. This focusing is well explained by a 3D simulation with a velocity model containing an abrupt southern edge of the basin derived from geologic information and seismic reflection profiles.

Physics-based Earthquake Forecasting: Encouraging Results from a Retrospective CSEP Evaluation of Forecasting Models during the 2010 Canterbury, New Zealand, Earthquake Sequence*, Maximilian J. Werner and the CSEP Canterbury Working Group*

Tuesday, September 15, 2015 (10:30)

Despite much progress in our understanding of the physical mechanisms of earthquake nucleation, clustering and triggering, physics-based earthquake forecasting remains a major challenge. For instance, evaluations of the predictive power of the static Coulomb stress change hypothesis for earthquake clustering have up to now concluded that Coulomb-based forecasts could not compete with statistical models, which exploit statistical regularities of observed seismicity patterns. In sharp contrast to previous results, a recent experiment by the Collaboratory for the Study of Earthquake Predictability (CSEP) suggests that newly developed and improved Coulomb-based models are now competitive alternatives that can outperform statistical models. The CSEP experiment consisted of a retrospective evaluation of time-dependent forecast models during the complex and fatal 2010-12 Canterbury, New Zealand, earthquake cascade. Fourteen models were developed by groups in New Zealand, Europe and the US, including statistical, physics-based and hybrid models. We evaluated the models from the time just after the Mw7.1 Darfield earthquake until February 2012 using three forecast durations (1-year, 1-month and 1-day). We found that the information content of physics-based and hybrid model forecasts is greater than or comparable to that of statistical model forecasts at all forecast horizons. Differences are greatest for 1-yr horizons, where variants of the Coulomb model and a hybrid model outperform a reference ETAS model by a probability gain per earthquake of about 7. These results offer some encouragement for a physical basis for earthquake forecasting. We speculate on further model developments as well as the use of finite earthquake rupture simulators for the purpose of earthquake forecasting.

From Seismic Hazard to Risk: Summary of Critical Issues and How SCEC Research Can Foster New Solutions*, Christine A. Goulet*

Tuesday, September 15, 2015 (14:00)

Seismic risk analysis is gaining popularity as a tool for civil engineering design. It is not only the basis for the performance-based earthquake engineering (PBEE) design approach, it is now included, in a simplified fashion, into the latest building codes and design guidelines. Risk combines hazard, exposure and vulnerability to provide probabilities of various outcomes such as structural collapse, loss of life, and exceedance of given threshold repair costs or downtime. Overall, better risk quantification helps stakeholders make better decisions and will contribute to a more sustainable society. Example applications of risk-informed decision include the design of new critical facilities, such as hospitals, dams and bridges, and the prioritization of retrofitting for our aging building stock and infrastructure.

In this presentation, I will cover a “big picture” view of seismic hazard risk. The presentation is focused on risk from ground-motion hazard, but the take-away points are applicable to other types of seismic hazard as well, such as from surface fault rupture, liquefaction, or earthquake-triggered landslides. Often, the factor controlling risk, especially at long return periods, is the seismic hazard itself, and more specifically its associated uncertainty and variability. After showing examples on how hazard impacts risk, I will explore different avenues that SCEC researchers can take to help improve hazard quantification and thus, lead to better risk assessment. The combination of fundamental and applied research conducted under the SCEC umbrella is unique. With contributions from both the core research program and the special projects, the SCEC community can have a meaningful impact on seismic resilience.

Managing Earthquake Hazards and Risks to Implement an Infrastructure Resilience Program, *Craig A. Davis*

Tuesday, September 15, 2015 (14:00)

The Los Angeles Water System is implementing a Seismic Resilience Program as part of a larger city-wide plan to improve the City’s seismic resilience as outlined by the Mayor in his “Resilience by Design” report. The Water System Resilience Program comprehensively covers all aspects of water system business. Some key components to the program are aqueduct crossings of the San Andreas Fault, fire following earthquake, and developing a seismic resilient pipe network. This presentation provides a brief overview of the resilience program. The Los Angeles Water System is a large and complicated geographically distributed system exposed to many different seismic hazards posing different risks to the loss of services and ability to restore them following an earthquake. A significant problem exists on how to quantify the different hazards (e.g. liquefaction, landslide, faulting, ground shaking), having a wide range of probabilities of occurrence, that threaten large spatially distributed systems. Each hazard is quantified differently and there is no accepted methodology for uniform incorporation across the systems. This problem is compounded when system dependencies and cascading effects must be considered, such as the interaction of water, power, and gas systems associated with fire following earthquake. A seismic resilient pipe network (SRPN) is designed and constructed to accommodate damage with ability to continue providing water or limit water outage times tolerable to community recovery efforts. An SRPN is an attempt to optimize pipe replacements in an existing network to reduce risks to communities from future earthquake impacts on the water system. The ability to understand the true risks of service losses is inhibited by hazard quantification and how to distribute across the network. Los Angeles intends to implement the seismic resilience program with risk-informed decisions. Improved mapping of geologic earthquake hazards incorporating the magnitudes of ground deformations and improved quantification allowing application of all hazards with uniform confidence in system models are aspects which can greatly improve community resilience.

Plenary Talk Presentation — Wednesday

The Gorkha Mw=7.8 earthquake: an incomplete Himalayan rupture, *Roger Bilham*

Wednesday, September 16, 2015 (08:00)

Although an earthquake near Kathmandu had been anticipated for more than two decades, the Mw7.8 Gorkha earthquake of 25 April 2015 was smaller than expected and in the wrong place. Within ten seconds of shaking its 150x60 km2 rupture had lifted Kathmandu 1m, and shifted it bodily 1.8m to the south (http://youtu.be/VS6WVz4V0ps). Yet local accelerations (≈0.25g) were lower than in historical Himalayan earthquakes, thereby averting a much worse disaster. The official deathtoll exceeded 8700, half a million homes were damaged or destroyed, and 4.5 million rendered homeless. Had the earthquake occurred, not at midday on Saturday, but 12 hours earlier, or during school hours the deathtoll could have been 4-6 times larger. The main tectonic feature of the earthquake is that it failed to rupture the entire Himalayan décollement to the surface, a feature we now recognize as common to half a dozen Himalayan Mw<7.9 earthquakes in the past several centuries, including one that ruptured almost the same area in 1833.

The remote scientific response to the earthquake (global seismic data and Insar) was immediate and effective, but public knowledge in Nepal about the earthquake in the weeks following the mainshock remained hazy. Government and University researchers, anxious not to alarm citizens during the rumble of frequent aftershocks were reluctant to mention the growing realization that a large earthquake could still occur to the west of Kathmandu. Amid the information vacuum many survivors began to reassemble the wreckage of their homes using identical methods that led to their collapse, under the impression that no future earthquake would occur.

A strong and immediate scientific presence in the mezzoseismal zone of a large earthquake is essential to capture time sensitive seismic data, and to inform the public and local officials of the best available seismic information as it becomes known. With a few notable exceptions the response to the Nepal earthquake was slow, with earthquake investigative teams arriving more than a month after the event. Delays were caused by the absence of funds for an instantaneous response, and by the mistaken perception that scientists would impede rescue and recovery missions. As a result important macroseismic indicators of mainshock intensities were lost when the Mw=7.3 aftershock destroyed already weakened buildings. Fortunately many photos and videos of damage in the mainshock captured some of this lost information.

The high frequency 'anomaly' that saved lives: Site effects and damage patterns of the 2015 Gorkha Earthquake, *Domniki Asimaki*

Wednesday, September 16, 2015 (08:00)

Although the M7.8 Gorkha mainshock ruptured a segment of the Main Himalayan Thrust directly below Katmandu, structural damage across the valley was much lower than expected. Strong motion data prominently featured a 5-sec pulse that reverberated in the basin, but were severely depleted of high frequency components that would have been catastrophic for the typical low-rise, non-ductile structures in Katmandu. By contrast, systematic damage was observed on the tops of hills and ridges and at the basin edges, most likely the result of ground motion amplification due to three-dimensional site effects. Isolated cases of liquefaction and lateral spreading of the unconsolidated sediments were also observed, but have not yet revealed a systematic damage pattern. To date, several questions linger about the causative factors of the high frequency 'anomaly', which limited structural damage to the very few high-rise buildings in Katmandu, and triggered localized liquefaction and widespread slope stability failures. In this talk, I will use observational evidence from earthquake reconnaissance by several individuals and organizations and a new dataset of strong motion records from an array across Katmandu to shed light to some of these questions, raise some more, and highlight the lessons learned in Nepal that can help build a safer Los Angeles.

Poster Session Schedule

View full abstracts at www.scec.org/meetings/2015am

Sunday, September 13, 2015

21:00 – 22:30 Poster Session 1

Monday, September 14, 2015

16:00 – 17:30 Poster Session 2

21:00 – 22:30 Poster Session 3

Tuesday, September 15, 2015

16:00 – 17:30 Poster Session 4

21:00 – 22:30 Poster Session 5

Earthquake Engineering Implementation Interface (EEII) — Posters 001-005

001 **Validation and Insights of Utilizing Simulated Ground Motions for Building Response Assessments,** *Nenad Bijelic, Ting Lin, and Gregory Deierlein*

002 **Engineering Validation of Simulated Ground Motions for Skewed-bridges Response Assessment,** *Carmine Galasso, Farzin Zareian, Peyman Kaviani, and Alexandra Tsioulou*

003 **Considering rupture directivity in selecting ground motion ensembles for seismic response analysis in the near-fault region,** *Karim Tarbali*

004 **Using Building Strong Motion Data to Quantify Blast Pressure Fields in Urban Environments,** *Anthony T. Massari*

005 **Damage Maps for the 2015 M7.8 Gorkha Earthquake from Spaceborne Radar Interferometry,** *Sang-Ho Yun, Kenneth Hudnut, Susan Owen, Frank Webb, Mark Simons, Patrizia Sacco, Eric Gurrola, Gerald Manipon, Cunren Liang, Eric Fielding, Pietro Milillo, Hook Hua, Alessandro Coletta*

Ground Motion Prediction (GMP) — Posters 006-031

006 **On the Use of Simulated Ground Motions as a Means toConstrain Near-Source Ground Motion Prediction Equationsin Areas Experiencing Induced Seismicity,** *Samuel A. Bydlon, Eric M. Dunham, Abhineet Gupta, N. Anders Petersson, and Ossian O'Reilly*

007 **Broadband (0–8 Hz) Ground Motion Variability From Ensemble Simulations of Buried Mw 6.7 Thrust Earthquakes Including Rough Fault Descriptions and Q(f),** *Kyle Withers*

008 **Quantification of ground motion reductions by fault zone plasticity,** *Daniel Roten, Kim B. Olsen, Steven M. Day, and Yifeng Cui*

009 **0-5 Hz Verification and Validation of Deterministic Ground Motion Prediction of the 2014 M5.1 La Habra, CA, Earthquake,** *Kim B. Olsen, Jacobo Bielak, Scott Callaghan, Po Chen, Yifeng Cui, Steven Day, David Gill, Robert Graves, Tom Jordan, Naeem Khoshnevis, En-Jui Lee, Phil Maechling, Daniel Roten, William Savran, Fabio Silva, Zheqiang Shi, Ricardo Taborda, Kyle Withers,*

010 **Kinematic Ground Motion Simulations on Rough Faults Including Effects of Random Correlated Velocity Perturbations,** *Robert W. Graves and Arben Pitarka*

011 **Toward a 3D Kinematic Rupture Generator Based on Rough Fault Spontaneous Rupture Models,** *William H. Savran and Kim B. Olsen*

012 **Testing the SH1D Assumption for Geotechnical Site and Basin Response Using 3D Finite Difference Modeling,** *Arthur J. Rodgers and Arben Pitarka*

013 **Physics-based and empirical models of site response for SCEC ground motion simulations,** *Carlos Gonzalez, Albert Yang, Jian Shi, and Domniki Asimaki*

014 **Stochastic characterization of 3D mesoscale seismic velocity heterogeneity in Long Beach, California,** *Nori Nakata and Gregory C. Beroza*

015 **3D Canterbury Velocity Model (CantVM) – Version 1.0,** *Brendon A. Bradley, Robin Lee, Ethan Thomson, Francesca Ghisetti, Christopher McGann, and Jarg Pettinga*

016 **Improvements of ground motion duration metrics with empirically derived scattering impulse response functions,** *Jorge G. F. Crempien, Ralph J. Archuleta, and Chen Ji*

017 **Progress Report on Improvements to the Composite Source Model for the Broadband Platform, With Emphasis on High Frequencies,** *John G. Anderson*

018 **Hybrid broadband ground motion simulation of the 2010-2011 Canterbury earthquakes,** *Hoby N.T. Razafindrakoto, Brendon A. Bradley, Ethan Thomson, and Robert W. Graves*

019 **Broadband ground motion modelling of a major Alpine Fault Earthquake (New Zealand),** *Caroline Holden and Anna Kaiser*

020 **A non-ergodic Ground-Motion Prediction Equation for California with Spatially Correlated Coefficients,** *Nicolas M. Kuehn and Niels Landwehr*

021 **Uncertainty, variability, and earthquake physics in GMPEs: The source component,** *Annemarie S. Baltay, Thomas C. Hanks, and Norm A. Abrahamson*

022 **How Much Can the Total Aleatory Variability of Empirical Ground Motion Prediction Equations Be Reduced Using Physics-Based Earthquake Simulations?,** *Thomas H. Jordan, Feng Wang, Robert Graves, Scott Callaghan, Kim Olsen, Yifeng Cui, Kevin Milner, Gideon Juve, Karan Vahi, John Yu, Ewa Deelman, David Gill, Philip J. Maechling*

023 **Impact of Uncertainty in Magnitude-Area Scaling Relations on BBP Broadband Simulations,** *Andreas Skarlatoudis, Jeff Bayless, and Paul Somerville*

024 **IDA Demonstrates nSpectra as a Valuable New IM,** *William P. Graf, Yajie J. Lee, and Jeff Bayless*

025 **Simulating ground motions from large mega-thrust earthquakes in the North Island of New Zealand,** *Marina Merlin, Yoshihiro Kaneko, and Caroline Holden*

026 **Update of PBR comparison with hazard maps for the line between the San Jacinto and Elsinore faults,** *James N. Brune and Richard Brune*

027 **Comparing Precariously Balanced Rocks to synthetic seismograms: A scale model approach,** *Richard J. Brune and James N. Brune*

028 **Kinematic rupture process of the 2014 Mw 6.0 Napa earthquake: A case study of the uncertainty of peak slip,** *Cedric Twardzik, Mike Floyd, Chen Ji, and Gareth Funning*

029 **Erosion rate for hoodoos at the Red Rock Canyon State Park, California,** *Abdolrasool Anooshehpoor, Richard J. Brune, and James N. Brune*

030 **Ground motions from scenario earthquakes in the Wasatch fault zone, Utah, and implications for seismic hazard in the Wasatch Front,** *Morgan P. Moschetti, Stephen Hartzell, Leonardo Ramirez-Guzman, Arthur Frankel, and Peter Powers*

031 **Simulation of seismic-wave propagation during the 1927 ML 6.25 Jericho earthquake,** *Shahar Shani-Kadmiel, Michael Tsesarsky, and Zohar Gvirtzma*

Community Modeling Environment (CME) — Posters 032-043

032 **Robust Hazard and Risk Assessment Through Robust Simulation,** *Yajie Lee, Zhenghui Hu, William P. Graf, Charles K. Huyck, and Michael T. Eguchi*

033 **Integrated Static and Dynamic Stress Models for Investigating Tremor Source Regions,** *Hector Gonzalez-Huizar, Sandra Hardy, Aaron A. Velasco, Bridget Smith-Konter, and Karen M. Luttrell*

034 **UCVM: An Open Source Software Package for Querying and Visualizing 3D Velocity Models,** *David Gill, Patrick Small, Philip Maechling, Thomas Jordan, John Shaw, Andreas Plesch, Po Chen, En-Jui Lee, Ricardo Taborda, Kim Olsen, Scott Callaghan,*

035 **Modeling and removal of non-tectonic loading in GPS time series for improved vertical rate estimates in Southern California,** *Adrian A. Borsa, Thorsten W. Becker, and Duncan C. Agnew*

036 **Extending the BKT Memory-Efficient Displacement-Based Internal Friction Model for Representing Attenuation in Wave Propagation Simulations,** *Md Monsurul Huda and Ricardo Taborda*

037 **Evaluation of the SCEC Seismic Velocity Models through Simulation and Validation of Past Earthquakes,** *Shima Azizzadeh-Roodpish, Ricardo Taborda, Naeem Khoshnevis, and Keli Cheng*

038 **Designing a Regional Scale Simulation and Data System for Enhanced Earthquake Hazard and Risk Assessments of Electrical and Gas Systems,** *Carola Di Alessandro, David McCallen, Norman Abrahamson, Philip Harben, and Shawn Larsen*

039 **The SCEC Broadband Platform: Open-Source Software for Strong Ground Motion Simulation and Validation,** *Fabio Silva, Philip Maechling, Scott Callaghan, Christine Goulet, and Thomas Jordan*

040 **Development of Parallel IO Interface for High Performance SEISM-IO Library,** *Jiyang Yu, Daniel Roten, and Yifeng Cui*

041 **A Petascale software framework for pseudospectral algorithms and multiscale phenomena simulations,** *Dmitry Pekurovsky*

042 **Using CyberShake Workflows to Calculate a 1 Hz Urban Seismic Hazard Map on Large-Scale Open-Science HPC Resources,** *Scott Callaghan, Philip Maechling, Gideon Juve, Karan Vahi, Robert W. Graves, Kim B. Olsen, Kevin Milner, David Gill, Yifeng Cui, Thomas H. Jordan*

043 **SCEC Open-Source Ground Motion Simulation Software,** *Philip J. Maechling, Scott Callaghan, Kevin Milner, Maria Liukis, Fabio Silva, and David Gill*

Collaboratory for the Study of Earthquake Predictability (CSEP) — Posters 044-045

044 **Recent Achievements of the Collaboratory for the Study of Earthquake Predictability,** *Maria Liukis, Maximilian Werner, Danijel Schorlemmer, John Yu, Philip Maechling, Jeremy Zechar, Thomas H. Jordan, the CSEP Working Group*

045 **GEAR1 forecast: Distribution of largest earthquakes,** *Yan Y. Kagan and David D. Jackson*

Working Group on California Earthquake Probabilities — Posters 046-047

046 **Alternative Rupture Basis for UCERF3,** *Glenn P. Biasi*

047 **EZ-FRISK implementation of the USGS 2014 NSHM seismic source model and ground motion prediction equations,** *Jason Altekruse, Alireza Haji-Soltani, Katherine Reyes, and Osman El Menchawi*

Earthquake Forecasting and Predictability (EFP) — Posters 048-065

048 **Supercycles and Synchronization Signatures in Synthetic Seismic Sequences,** *Kevin R. Milner and Thomas H. Jordan*

049 **Virtual Quake: Using Simulators to understand earthquake predictability and an Open Source model for scientific software development,** *Mark R. Yoder, Kasey W. Schultz, Eric M. Heien, John B. Rundle, Donald L. Turcotte, and Jay W. Parker*

050 **Virtual Quake and Tsunami Squares: Scenario Earthquake and Tsunami Simulations for Tsunami Early Warning,** *Kasey W. Schultz, Michael K. Sachs, Mark R. Yoder, Eric M. Heien, John B. Rundle, Donald L. Turcotte, Andrea Donnellan, J Q. Norris*

051 **The Performance of Triangular Fault Elements in Earthquake Simulators,** *Michael Barall and Terry E. Tullis*

052 **Verification of Earthquake Simulators Using Self-Consistency Metrics,** *John M. Wilson, John B. Rundle, and Mark R. Yoder*

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The Southern California Earthquake Center (SCEC) is an institutionally based organization that recognizes both **core institutions**, which make a major, sustained commitment to SCEC objectives, and a larger number of **participating institutions**, which are self-nominated through the involvement of individual scientists or groups in SCEC activities and confirmed by the Board of Directors. Membership continues to evolve because SCEC is an open consortium, available to any individual or institution seeking to collaborate on earthquake science in Southern California.

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Core institutions are designated academic and government research organizations with major research programs in earthquake science. Each core institution is expected to contribute a significant level of effort (both in personnel and activities) to SCEC programs, as wells as a yearly minimum of $35K of institutional resources (spent in-house on SCEC activities) as matching funds to Center activities. Each core institution appoints an ***Institutional Director*** to the Board of Directors.

SCEC membership is open to participating institutions upon application. Eligible institutions may include any organization (including profit, non-profit, domestic, or foreign) involved in a Center-related research, education, or outreach activity. As of August 2014, the following institutions have applied for and approved by the SCEC Board of Directors as participating institutions for SCEC4.

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Participating institutions do not necessarily receive direct support from the Center. Each participating institution (through an appropriate official) appoints a qualified ***Institutional Representative*** to facilitate communication with the Center. The interests of the participating institutions are represented on the Board of Directors by two Directors At-Large.

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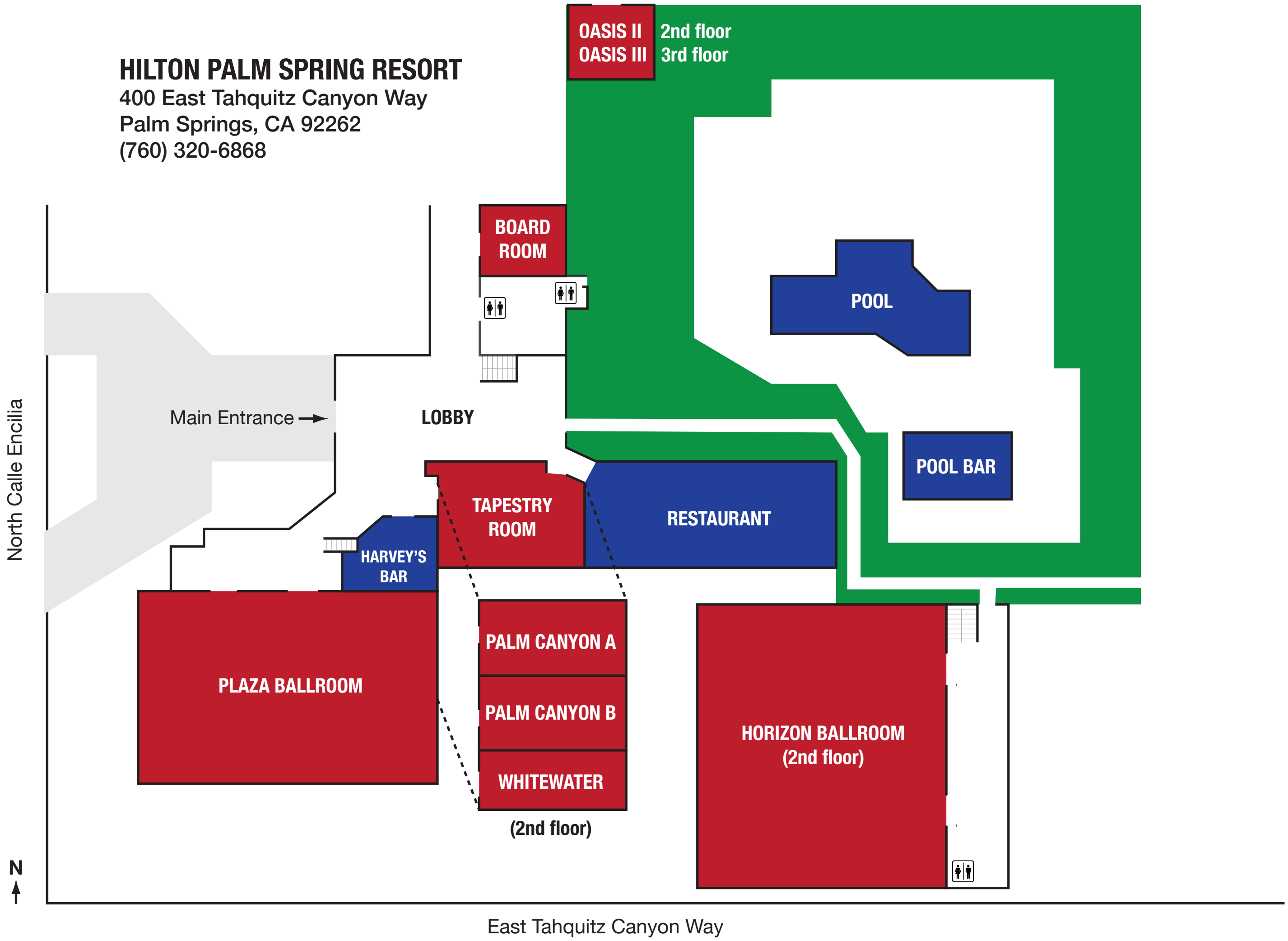
CICESE (Mexico)
DPRI Kyoto (Japan)
ERI Tokyo (Japan)
ETH Zürich (Switzerland)
IGNS (New Zealand)
Nat'l Central U (Taiwan)
Nat'l Chung Cheng (Taiwan)
Nat'l Taiwan U (Taiwan)
U Bristol (United Kingdom)
U Canterbury (New Zealand)
Western Univ (Canada)

Apply as a Participating Institution

E-mail application to John McRaney [mcraney@usc.edu]. The application should come from an appropriate official (e.g. department chair or division head) and include a list of interested faculty and a short statement on earthquake science research at your institution. Applications must be approved by a majority vote of the SCEC Board of Directors.



SATURDAY, September 12

09:00-17:00 Workshop: Community Rheology Model (Plaza A&B)
09:00-17:00 Workshop: CSEP/USGS/GEM (Plaza C&D)

SUNDAY, September 13

07:00-18:00 Registration and Check-In (Lobby)
07:00-08:00 Breakfast (Poolside)
08:00-12:00 Workshop: CISM (Palm Canyon)
10:00-12:00 Discussion: Estimating Fault Zone Properties (Oasis 3)
12:00-13:00 Lunch (Restaurant and Poolside)
13:00-17:00 Workshop: Community Stress Model (Horizon)
Workshop: Community Modeling Environment (Palm Canyon)
13:00-15:00 Workshop: Earthquake Response Training Session 1 (Oasis 2)
14:00-20:00 Poster Set-Up (Plaza)
15:00-17:00 Workshop: Earthquake Response Training Session 2 (Oasis 2)
17:00-18:00 Annual Meeting Ice-Breaker (Lobby, Harvey's, Plaza)
18:00-19:00 Distinguished Speaker Presentation (Horizon)
19:00-20:30 Welcome Dinner (Poolside)
19:00-21:00 SCEC Advisory Council Dinner Meeting (Tapestry)
21:00-22:30 Poster Session (Plaza)

MONDAY, September 14

07:00-08:00 Registration and Check-In (Lobby)
07:00-08:00 Breakfast (Poolside)
08:00-10:00 Session: The State of SCEC (Horizon)
10:30-12:30 Session: SCEC Special Fault Study Areas (Horizon)
12:30-14:00 Lunch (Restaurant, Tapestry, Poolside)

MONDAY, September 14 (continued)

14:00-16:00 Session: SCEC Community Models (Horizon)
16:00-17:30 Poster Session (Plaza)
19:00-21:00 SCEC Honors Banquet (Hard Rock Hotel Ballroom)
21:00-22:30 Poster Session (Plaza)

TUESDAY, September 15

07:00-08:00 Breakfast (Poolside)
08:00-10:00 Session: Earthquake - From the Lab to the Field (Horizon)
10:30-12:30 Session: Physics-Based Forecasting and Groun Motions (Horizon)
12:30-14:00 Lunch (Restaurant, Tapestry, Poolside)
14:00-16:00 Session: Connecting Hazard to Risk (Horizon)
16:00-17:30 Poster Session (Plaza)
19:00-21:00 Dinner (Poolside)
21:00-22:30 Poster Session (Plaza)
22:30-23:00 Poster Removal (Plaza)

WEDNESDAY, September 16

07:00-08:00 Breakfast (Poolside)
08:00-10:00 Session: Post-Earthquake Rapid Scientifc Response (Horizon)
10:30-12:30 Session: The Future of SCEC (Horizon)
12:30 Adjourn 2015 SCEC Annual Meeting
12:30-14:30 SCEC PC Lunch Meeting (Palm Canyon A)
SCEC Board Lunch Meeting (Palm Canyon B)