Presentation for March 1, 2017
SCEC Boardroom
Los Angeles, CA

March 2017
SCEC Rupture Dynamics Code Validation Workshop

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Ralph J. Archuleta (UC Santa Barbara)

INTRODUCTION

Welcome!

Thank you very much to Tran for making our workshops happen!

Thank you very much to Michael and Shuo for their work on the benchmark!

Winter 2016-2017 Gold Star Modelers

KHURRAM ASLAM / ERIC DAUB, KANGCHEN BAI,
MICHAEL BARALL, SAM BYDLON / KYLE WITHERS,
DUNYU LIU, SHUO MA, DANIEL ROTEN,
THOMAS ULRICH, ZHENGUO ZHANG

Harris March 2017

Plans for this workshop

*See a quick overview of our group's activities to date

*Introduce ourselves

*Learn about exciting research frontiers

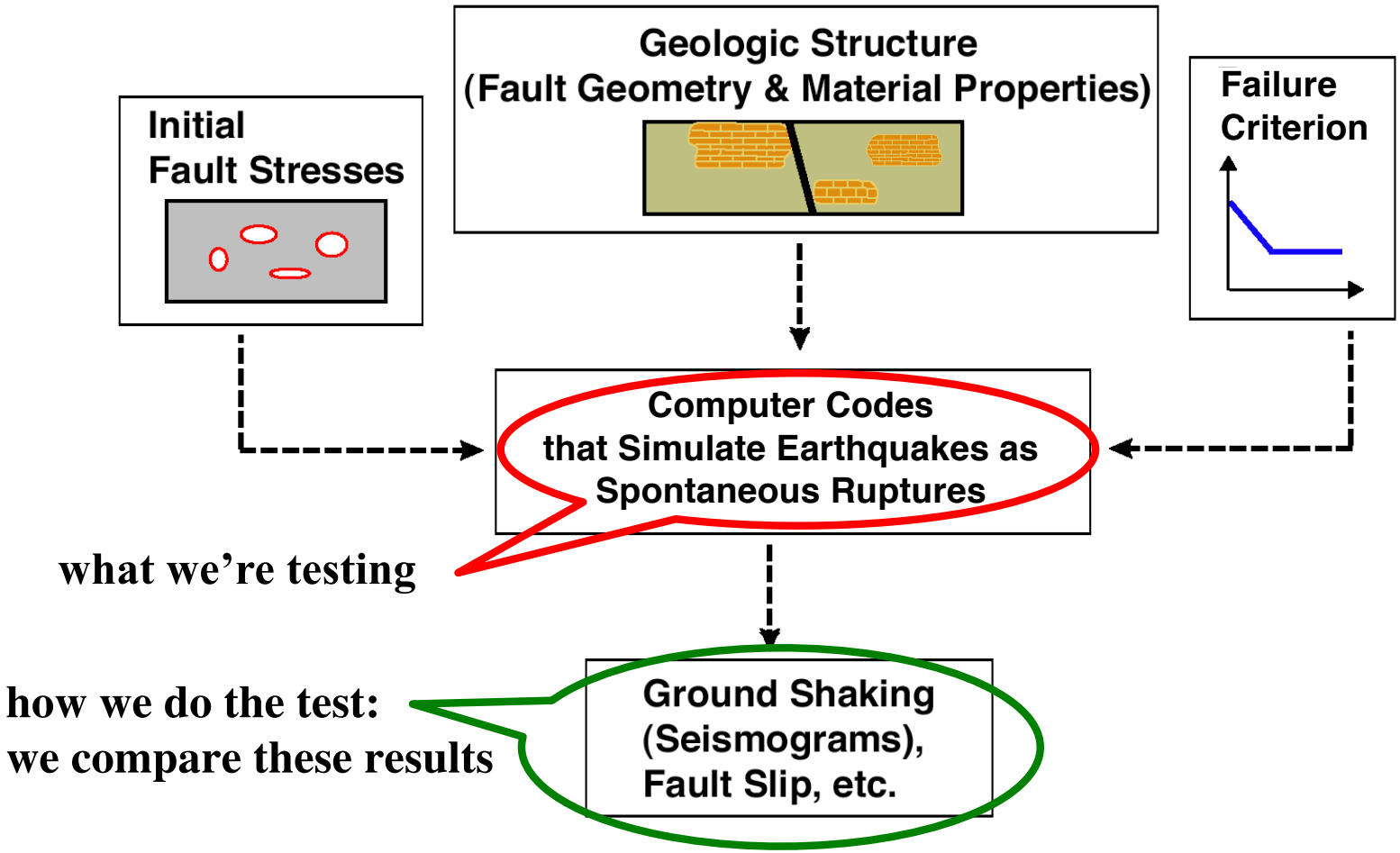
*Meet a newly updated code in our group

*Examine results from the newest benchmark, TPV35

*Learn about the Kaikoura earthquake

*Discuss how our group should move forward with code validation

What our Group Does: We Test Computer Codes Used to Simulate Earthquakes



Please see our website http://scecdata.usc.edu/cvws

Goal of our Code Group

Compare and validate the computational methods
currently used by SCEC and USGS scientists to simulate (spontaneous)
earthquake rupture dynamics and the resulting ground motion

Some Specific Objectives

Understand if our methods are producing the same results when using
the same assumptions about friction, crustal structure, fault geometry, etc.

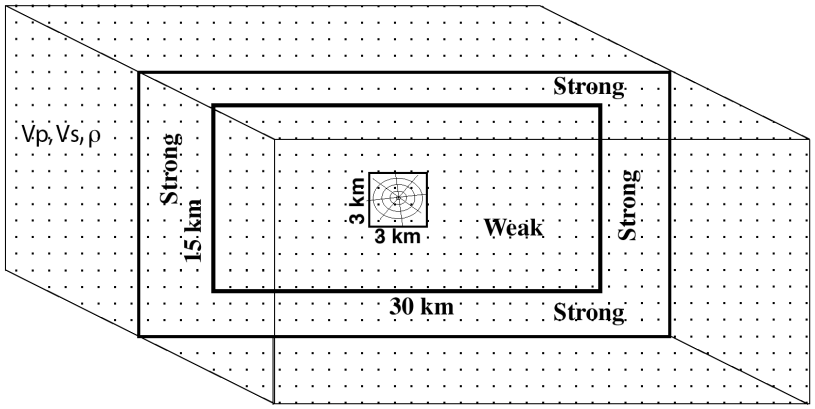
Funding

This project receives funding from SCEC, the USGS, and PG&E

Code Comparison Strategy

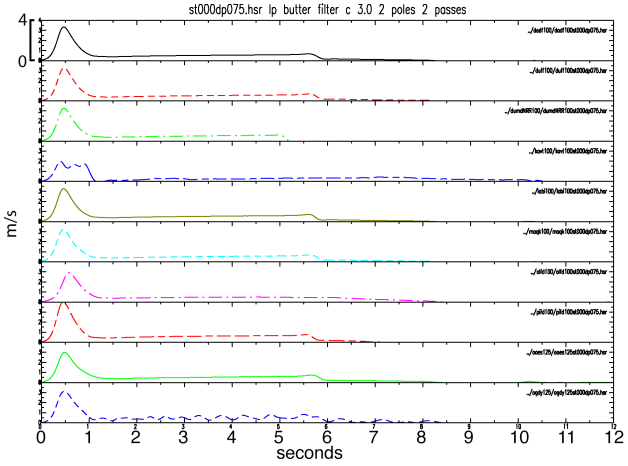
Start simply

Spontaneous rupture on a **vertical strike-slip fault set in a homogeneous (materials) elastic Fullspace**

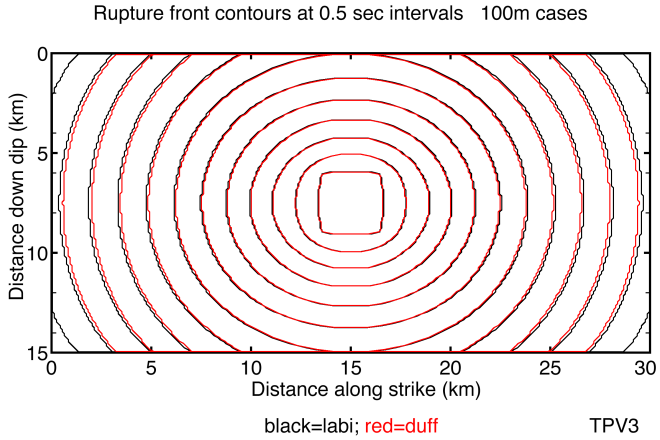


homogeneous initial stresses

slip-weakening friction

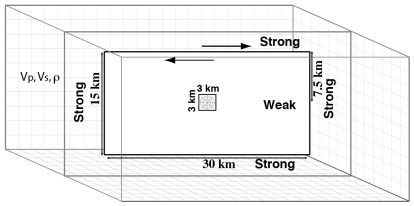


Some Results

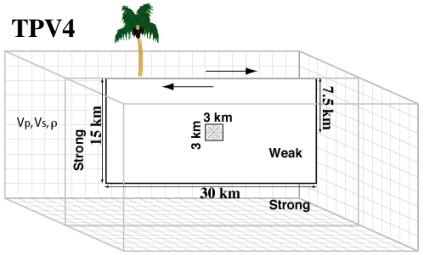


Code Comparison Benchmarks – Incrementally add complexity

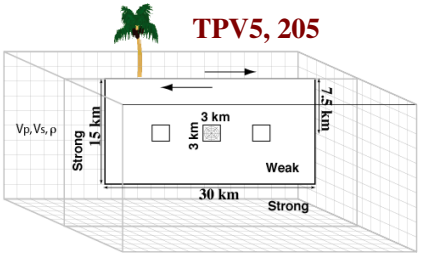
TPV3



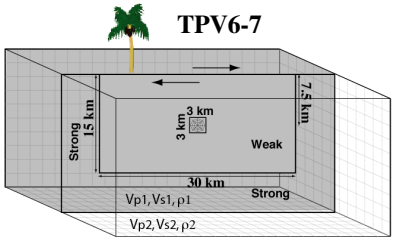
TPV4



TPV5, 205

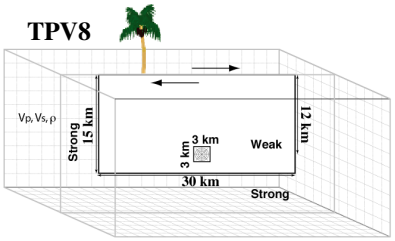


TPV6-7

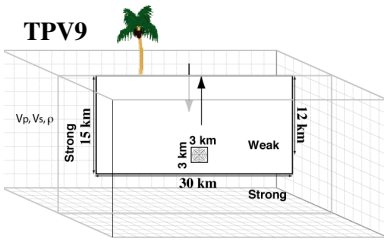


Slip-weakening friction

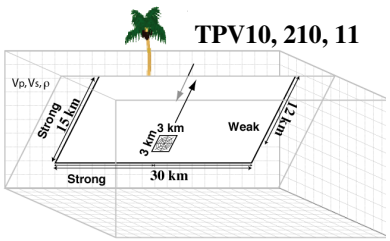
TPV8



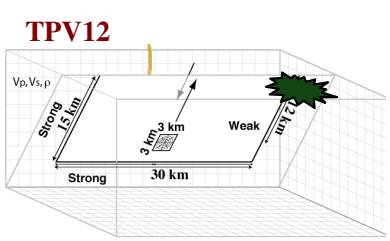
TPV9



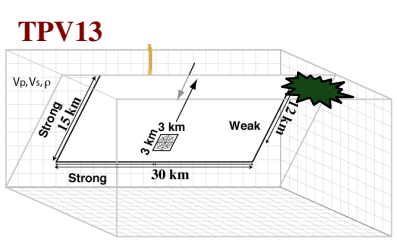
TPV10, 210, 11



TPV12

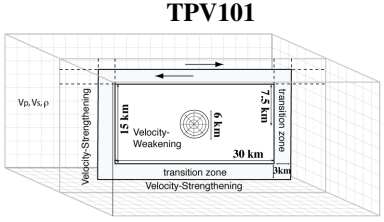


TPV13

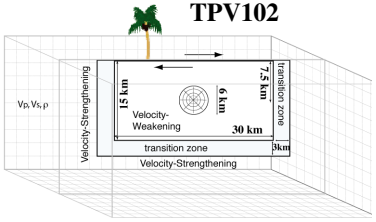


Slip-weakening friction

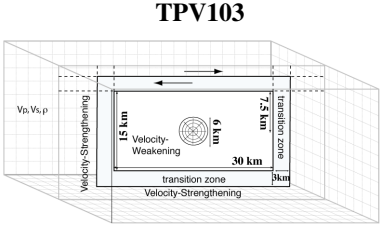
TPV101



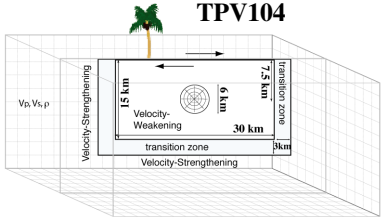
TPV102



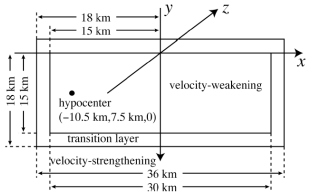
TPV103



TPV104



TPV105-2D

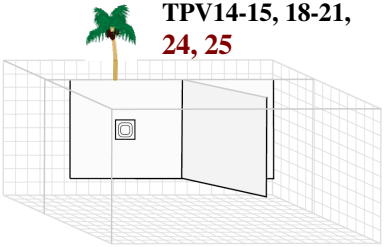


Rate-state friction using an ageing law

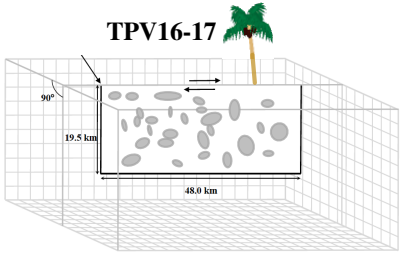
Rate-state friction using a slip law with strong rate-weakening

Thermal pressurization, rate-state friction, slip-law, strong rate-weakening

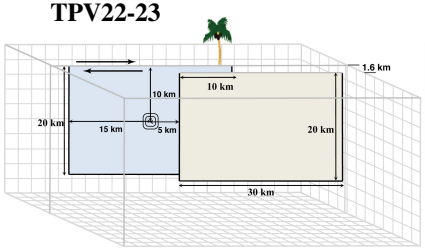
TPV14-15, 18-21, 24, 25



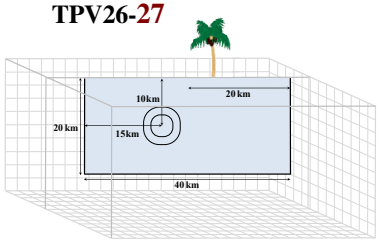
TPV16-17



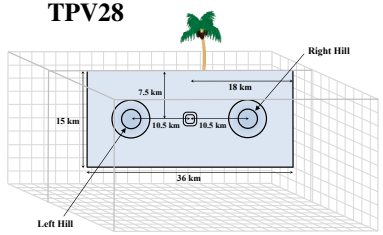
TPV22-23



TPV26-27



TPV28



Slip-weakening friction

Elastic, Viscoplastic

Slightly Rough Fault

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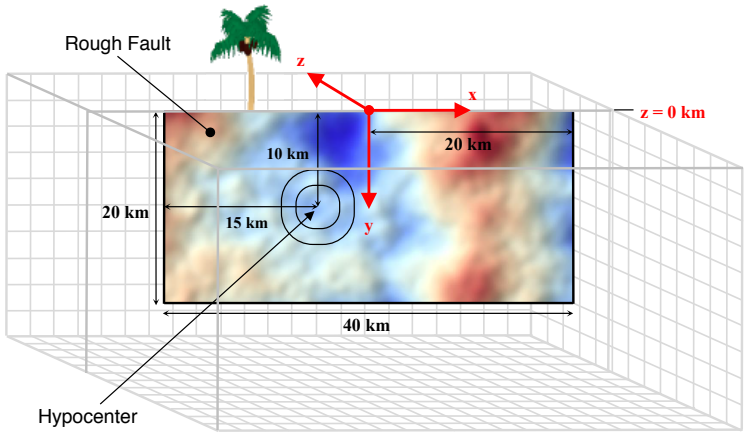
Code Comparison Strategy

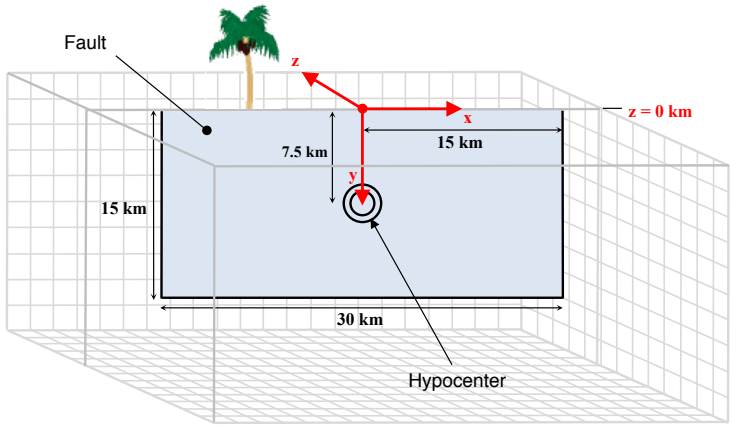
Incrementally adding complexity: fault roughness, layered velocity structure

Rupture on a **rough** vertical strike-slip fault set in a homogeneous material **elastic/viscoplastic** halfspace, Slip-weakening friction



TPV29, 30
Elastic, viscoplastic

Rupture on a vertical planar strike-slip fault set in an elastic, **1D discontinuous** and **1D continuous horizontally-layered velocity structure**, Slip-weakening friction



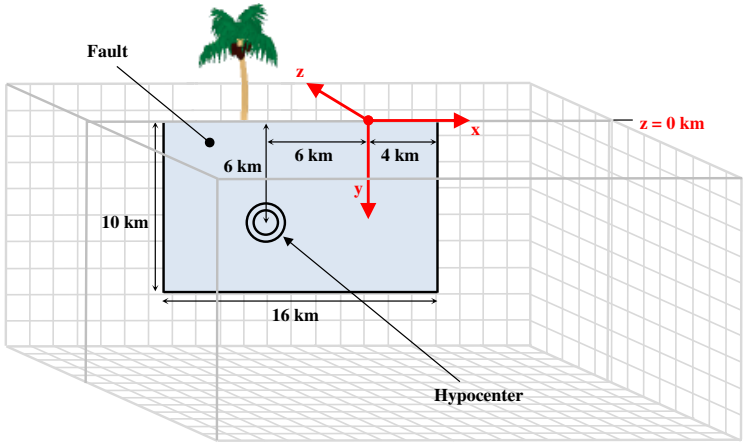
TPV31, 32
Discontinuous, Continuous

Winter 2014-2015 BENCHMARKS

Code Comparison Strategy

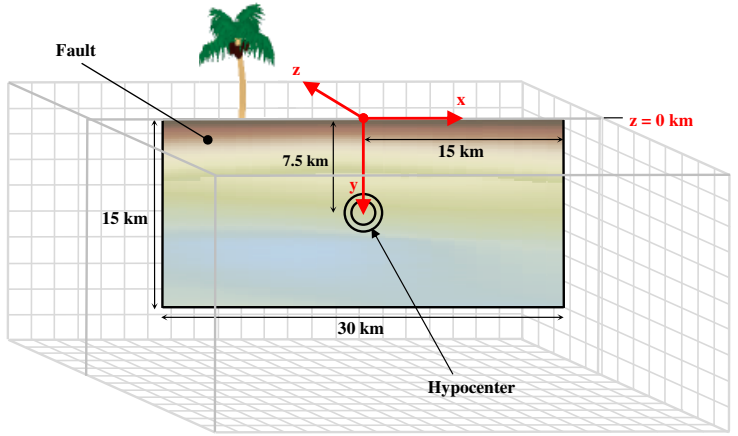
Incrementally adding complexity: vertically layered velocity structure, CVM-H

Rupture on a vertical planar strike-slip fault set in a 1D **vertically-layered material structure (low-velocity fault zone)**, elastic halfspace, Slip-weakening friction



TPV33

Rupture on a vertical planar strike-slip fault set in a 3D **CVM-H-ish near Imperial Valley material structure**, elastic halfspace, Slip-weakening friction



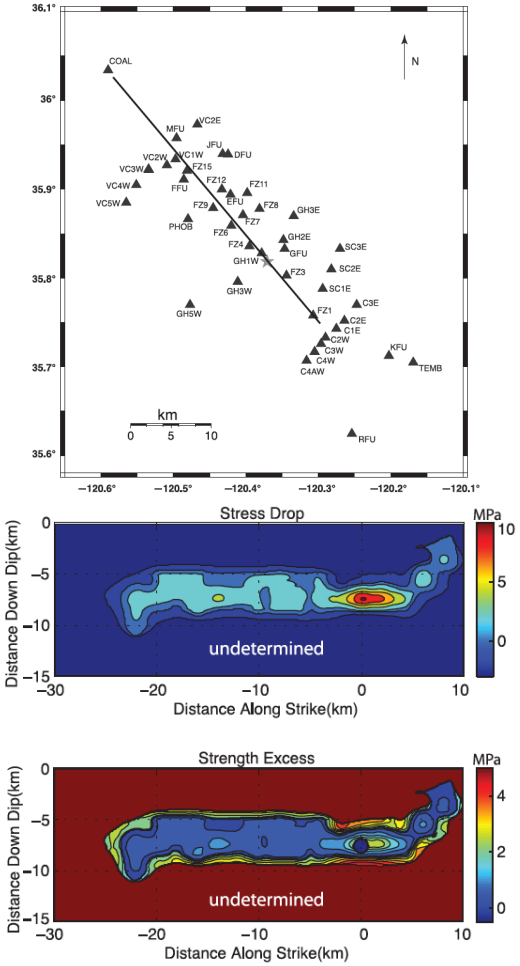
TPV34

Winter 2015-2016 BENCHMARKS

Code Comparison Strategy, Aiming Towards Validation

Real Earthquake: 2004 Parkfield M6.0

Rupture on a vertical planar strike-slip fault set in a 3D-ish velocity structure, Elastic, Slip-weakening friction



Ma et al., JGR 2008, Figs. 10, 4

Figure 37. Oblique aerial photograph of the San Andreas fault, town of Parkfield, Stop 7 (marked with red dot), and abundant geomorphic evidence for the presence of an active fault. View is northeastward; photograph taken March 2003.

Rymer et al., GSA Field Guide, 2006, Fig. 37

TPV35

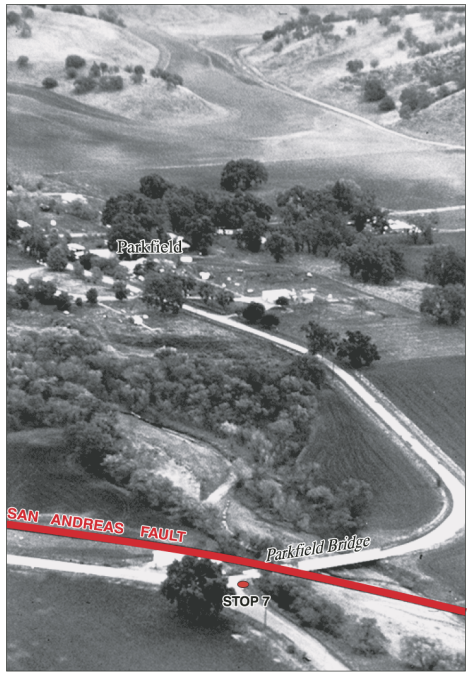


Figure 39. Oblique aerial view of the San Andreas fault and Parkfield (in midground); location of Stop 7 is at bridge (Parkfield Bridge) in lower right. View is northeastward; photograph taken in 1984 by W.H. Bakun.

Rymer et al., GSA Field Guide, 2006, Fig. 39

Winter 2016-2017 BENCHMARK

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2015 Barall Metrics SRL article

Barall, M., and R.A. Harris, **Metrics for comparing dynamic earthquake rupture simulations**,
Seismological Research Letters, vol. 86, 223-235, 2015.

Our group 2011 SRL article

Harris, R.A., M. Barall, D.J. Andrews, B. Duan, S. Ma, E.M. Dunham,
A.-A. Gabriel, Y. Kaneko, Y. Kase, B.T. Aagaard, D.D. Oglesby,
J.-P. Ampuero, T.C. Hanks, and N. Abrahamson,
Verifying a Computational Method for Predicting Extreme Ground Motion,
Seismological Research Letters, vol. 82, 638-644, 2011.

Our group 2009 SRL article

Harris, R.A., M. Barall, R. Archuleta, B. Aagaard, J.-P. Ampuero,
H. Bhat, V. Cruz-Atienza, L. Dalguer, P. Dawson, S. Day,
B. Duan, E. Dunham, G. Ely, Y. Kaneko, Y. Kase, N. Lapusta, Y. Liu,
S. Ma, D. Oglesby, K. Olsen, A. Pitarka, S. Song, and E. Templeton,
The SCEC/USGS Dynamic Earthquake-Rupture Code Verification Exercise,
Seismological Research Letters, vol. 80, 119-126, 2009.

links available on our website **http://scecdata.usc.edu/cvws**

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SCEC Rupture Dynamics Code Validation Workshop

Wednesday March 1, 2017
SCEC, Los Angeles, CA

10:00	Introduction to the workshop	*Ruth Harris*
10:20	Unraveling earthquake dynamics with SeisSol: Megathrust ruptures, off-fault plasticity and rough faults	*Betsy Madden*
10:50	Meet a newly updated code - PyLith	*Brad Aagaard*
11:20	Parkfield Model 1	*Arben Pitarka*
11:50	Parkfield Model 2	*Shuo Ma*
12:20	*Lunch*	
13:30	Parkfield benchmark results	*Michael Barall*
14:15	Seismogenic zone depth control on the likelihood of fault stepover jumps	*Kangchen Bai*
14:45	*Break*	
15:15	Complex rupture process during the 2016 M7.8 Kaikoura (New Zealand) earthquake	*Yoshi Kaneko*
15:45	Group Discussion: code validation	*All*
17:30	Adjourn	

Plans for the rest of this year
(SCEC2017 Hopefully Funded Proposal)

***Spontaneous Rupture Code Validation**