Presentation for March 15, 2013
USGS, Menlo Park, CA

March 2013
SCEC Rupture Dynamics Code Comparison Workshop

Ruth A. Harris
(U.S. Geological Survey)

Plans for this workshop

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

*Introduce new group members

*Learn about the SCEC Community Stress Model

*Examine the results from the latest benchmarks

*Plan our next steps

*Visit the USGS rock mechanics lab

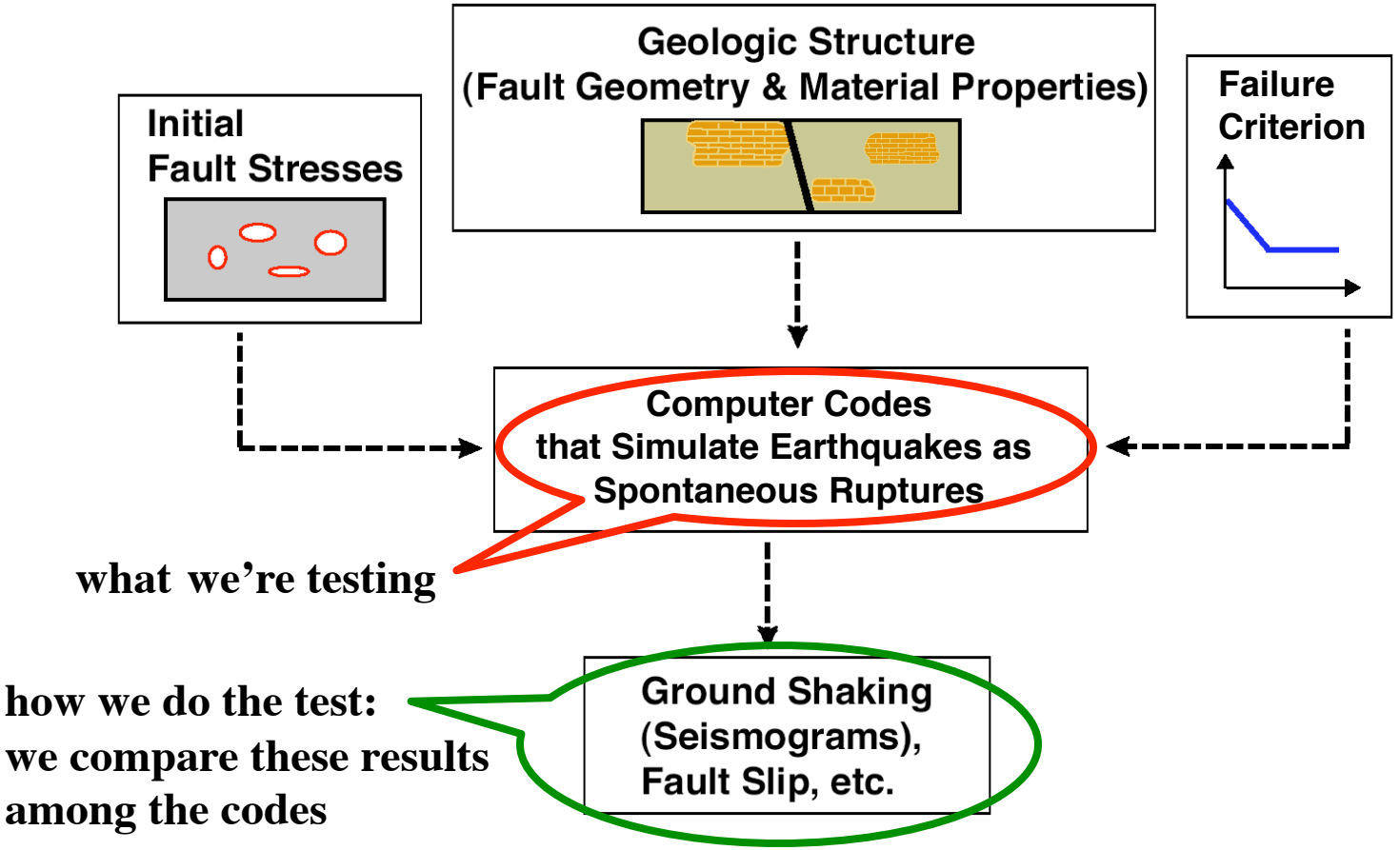
*Learn about and discuss models of the 2011 Tohoku earthquake

SCEC Rupture Dynamics Code Comparison Workshop

Friday March 15, 2013
U.S. Geological Survey, Menlo Park, CA

10:00	Introduction to the Workshop	*Ruth Harris*
10:15	The SCEC Community Stress Model	*Brad Aagaard*
10:35	The Benchmark Assignments and Results	*Michael Barall/ All*
11:35	Discussion of Future Plans	*Ruth Harris/ All*
12:15	*Lunch*	
13:15	Laboratory Tour of the Big Block	*Brian Kilgore/ Greg McLaskey*
14:20	Use of Dynamic Rupture Modeling in Earthquake Engineering Applications: User Needs and Schedule	*Norm Abrahamson*
14:40	*Break*	
15:00	*Tohoku Earthquake Dynamic Rupture Models*	
15:00	Tohoku: Slip-Weakening Friction in an Elastic Model	*Benchun Duan*
15:30	What can a simple slip-weakening model of the Tohoku earthquake tell us?	*Yihe Huang*
16:00	Tohoku: Thermal Pressurization in an Elastic Model	*Junle Jiang/ Nadia Lapusta*
16:30	Shallow Subduction Earthquakes: Slip-Weakening Friction in an Elastoplastic Model	*Shuo Ma*
17:00	Additional Group Discussion	*Ruth Harris/ All*
17:30	Adjourn	

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



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

Overall Goal of our Code Verification Group

Compare the computational methods
currently being used by SCEC and USGS scientists to
simulate (spontaneous) earthquake rupture dynamics

Some Specific Objectives

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

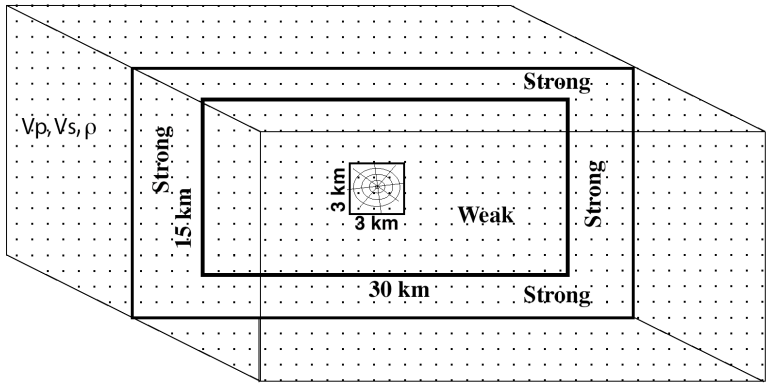
Funding

This project has been funded by the Southern California Earthquake Center,
the U.S. Geological Survey, the U.S. Dept. of Energy, and the PG&E Company

Code Comparison Strategy

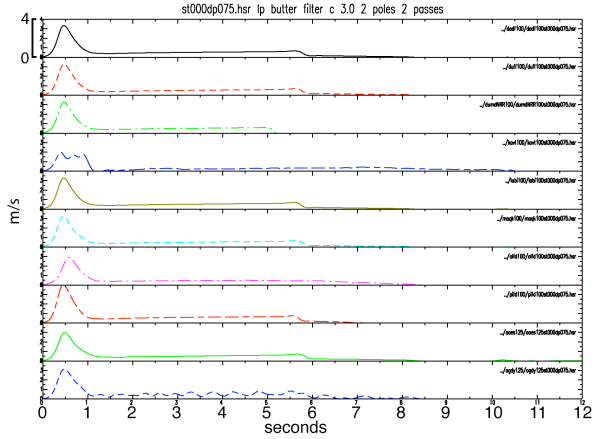
Start simply

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

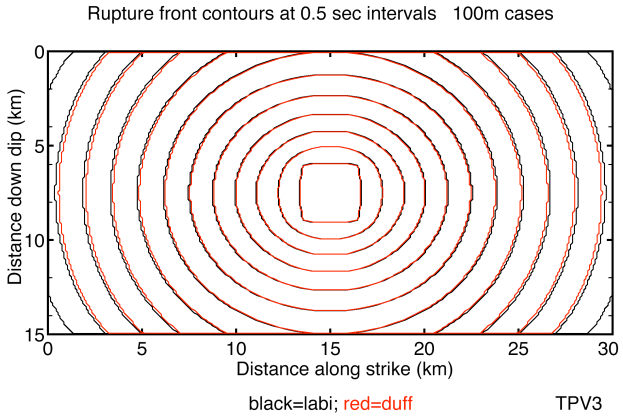


homogeneous initial stresses

slip-weakening friction

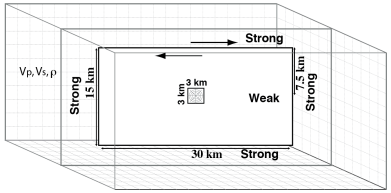


Some Results

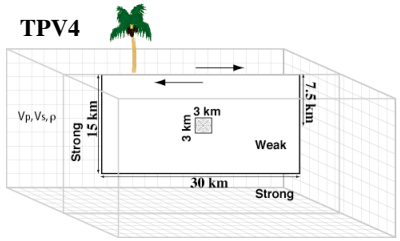


Code Comparison Benchmarks – Incrementally add complexity

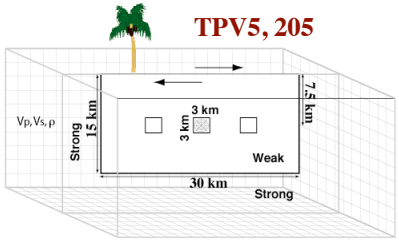
TPV3



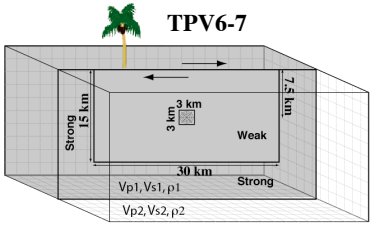
TPV4



TPV5, 205

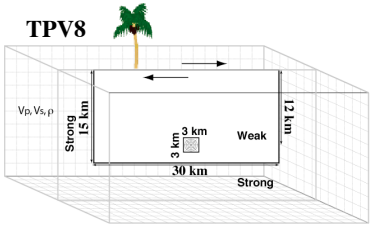


TPV6-7

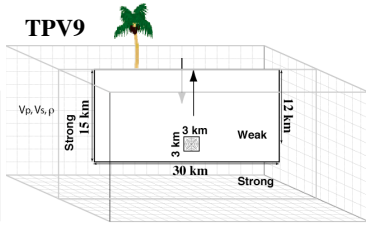


Slip-weakening friction

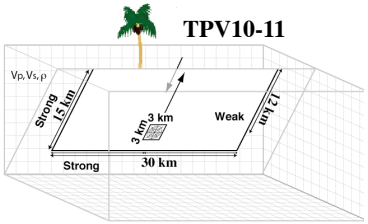
TPV8



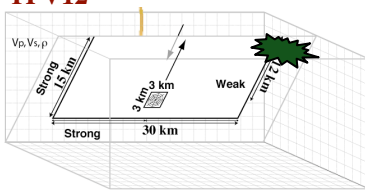
TPV9



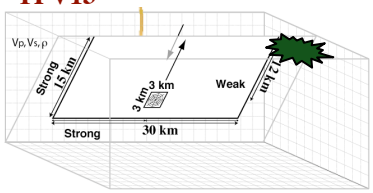
TPV10-11



TPV12

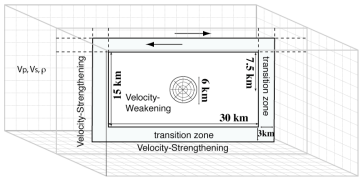


TPV13

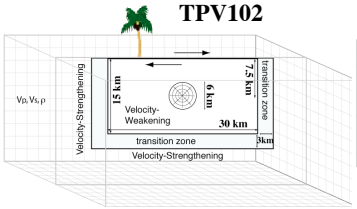


Slip-weakening friction

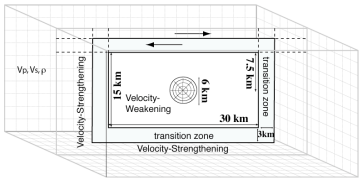
TPV101



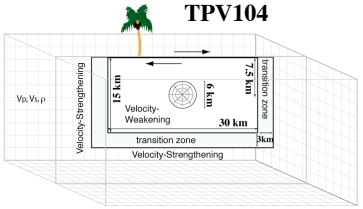
TPV102



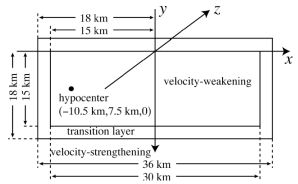
TPV103



TPV104



TPV105-2D

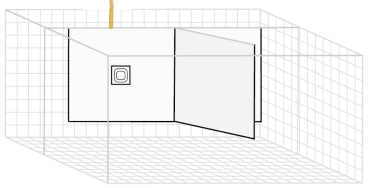


Rate-state friction using an ageing law

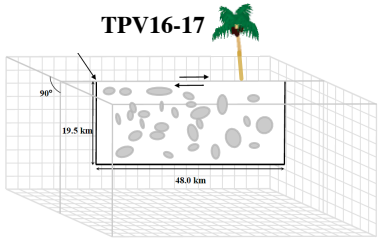
Rate-state friction using a slip law with strong rate-weakening

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

TPV14-15, 18-21



TPV16-17



Slip-weakening friction

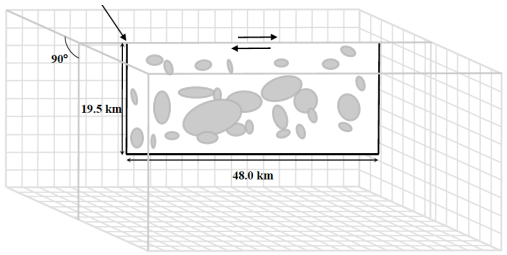
Slip-weakening friction

Harris March 2013

Code Comparison Strategy

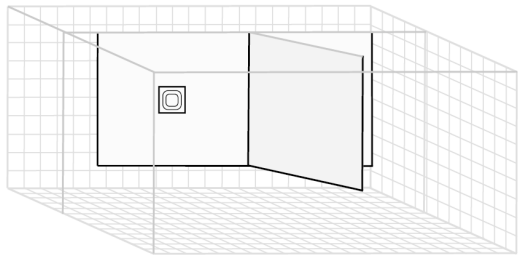
Incrementally adding complexity: stress, fault geometry

Rupture on a vertical strike-slip fault set in a homogeneous material elastic halfspace, **Heterogeneous initial Stresses,** Slip-weakening friction



TPV16, 17

Rupture on a **Branching** strike-slip fault set in homogeneous (material) **Plastic yielding**, Slip-weakening friction

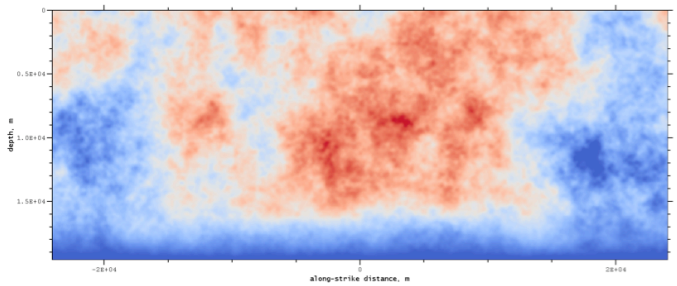


TPV18, 19, 20, 21
elastic, plastic, elastic, plastic

2012 BENCHMARKS

TPV16 (Heterogeneous Initial Stress, SW Friction, Elastic, Vertical Strike-Slip Fault)

Assumptions



Contour Plot

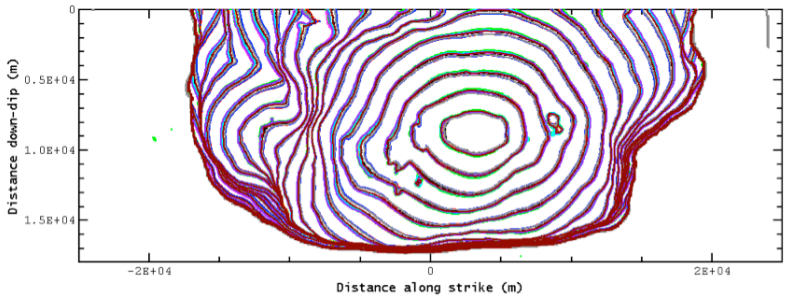
Benchmark: tpv16 (Vertical strike-slip fault, heterogeneous initial stress)

File: cplot (rupture contour plot)

Back to File List Logout

<< < Page 1 of 1 > >>

Results



aagaard.2 (Brad Aagaard - PyLith v1.7.0a - Tet4 75m)
barall.2 (Michael Barall - Finite Element - FaultMod - Denser Mesh)
cruz-atienza (Tago/Cruz-Atienza - 3D Discontinuous Galerkin Code - DGCrack)
dalguer (Luis Dalguer - Finite Difference - DFM)
duan (Benchun Duan - Finite Element - EQdyna)
gabriel (Alice Gabriel - Finite Difference AWP-ODC)
kaneko (Yoshihiro Kaneko - Spectral Element - SPECFEM3D)
kase (Yuko Kase - Finite Difference)
ma (Shuo Ma - Finite Element - MAFE)
somala (Surendra Somala - Spectral Element - SESAME)

Results

Time-Series File

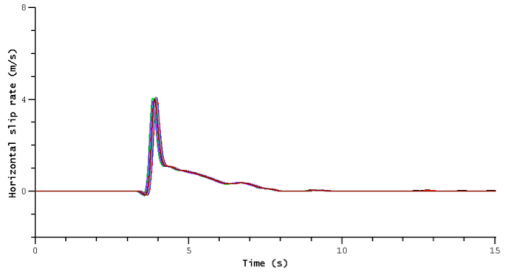
Benchmark: tpv16 (Vertical strike-slip fault, heterogeneous initial stress)

File: faultst000dp000 (strike 0.0 km, dip 0.0 km)

Field: h-slip-rate (Horizontal slip rate (m/s))

Back to Field List Logout

<< < Page 1 of 1 > >>



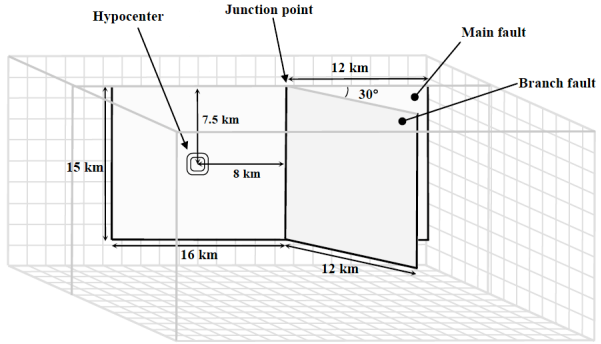
aagaard.2 (Brad Aagaard - PyLith v1.7.0a - Tet4 75m)
barall.2 (Michael Barall - Finite Element - FaultMod - Denser Mesh)
cruz-atienza (Tago/Cruz-Atienza - 3D Discontinuous Galerkin Code - DGCrack)
dalguer (Luis Dalguer - Finite Difference - DFM)
duan (Benchun Duan - Finite Element - EQdyna)
gabriel (Alice Gabriel - Finite Difference AWP-ODC)
kaneko (Yoshihiro Kaneko - Spectral Element - SPECFEM3D)
kase (Yuko Kase - Finite Difference)
ma (Shuo Ma - Finite Element - MAFE)
somala (Surendra Somala - Spectral Element - SESAME)

2012 Benchmark Success

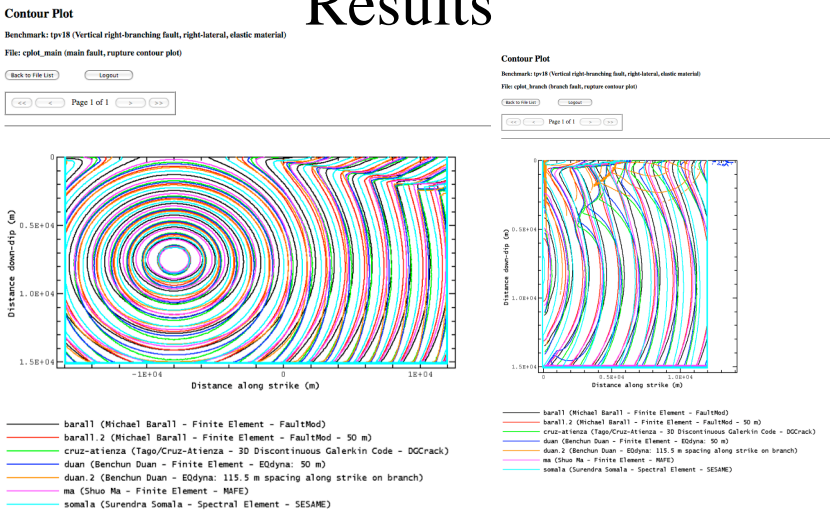
Harris March 2013

TPV18 (SW Friction, Elastic, Branched Vertical Strike-Slip Fault)

Schematic



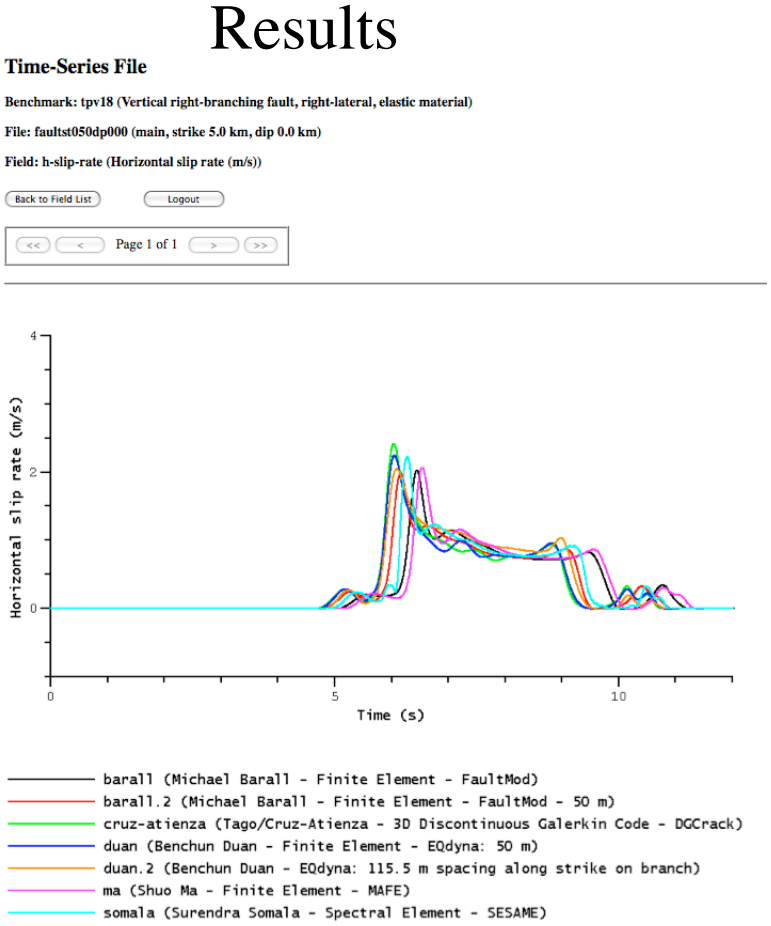
Results



Main Fault

Branch

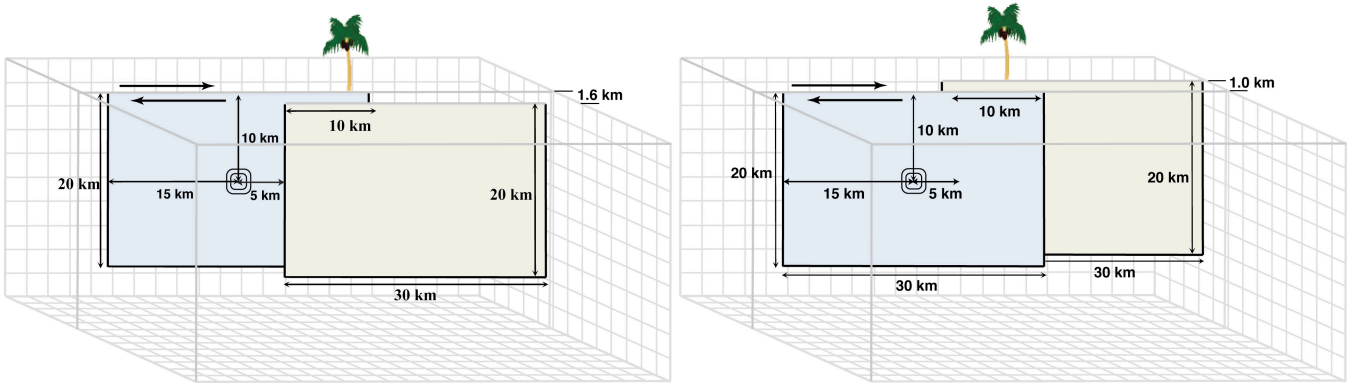
Results



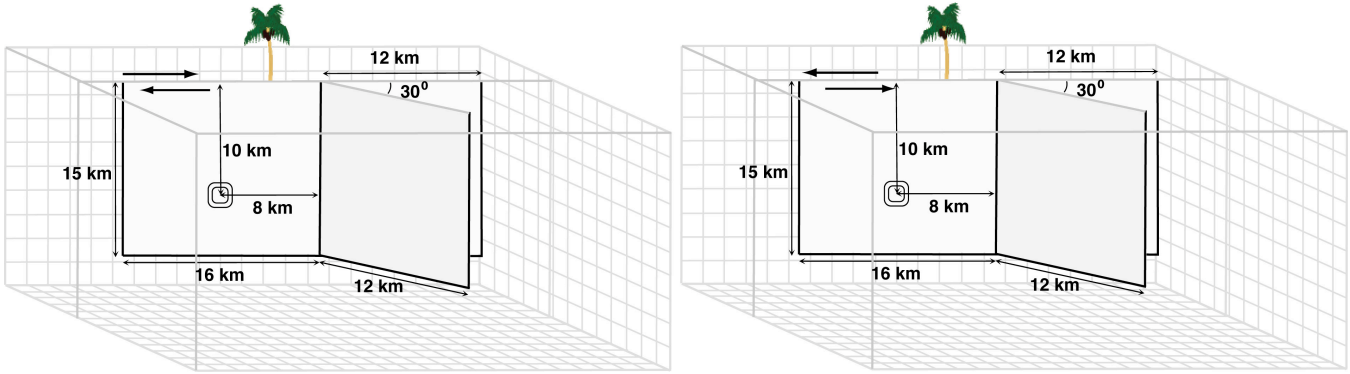
2012 Benchmark Challenge

Harris March 2013

2012-2013 Benchmarks: Two-Fault Stepovers
TPV22-23 (SW Friction, Elastic, Stepover in Vertical Strike-Slip Faults)



2012-2013 Benchmarks: Revisiting the Fault Branch
TPV24-25 (SW Friction, Elastic, Branched Vertical Strike-Slip Fault)



Harris March 2013

Our 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, N. Abrahamson,
Verifying a Computational Method for Predicting Extreme Ground Motion,
Seismological Research Letters, vol. 82, 638-644, 2011.

Our 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

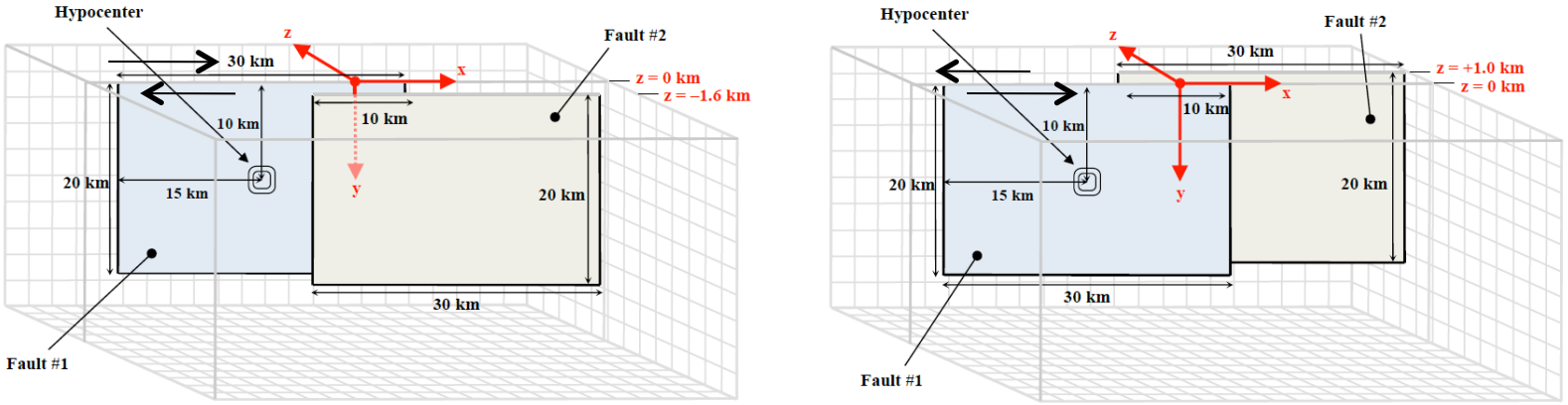
http://scecdata.usc.edu/cvws

SCEC Rupture Dynamics Code Comparison Workshop

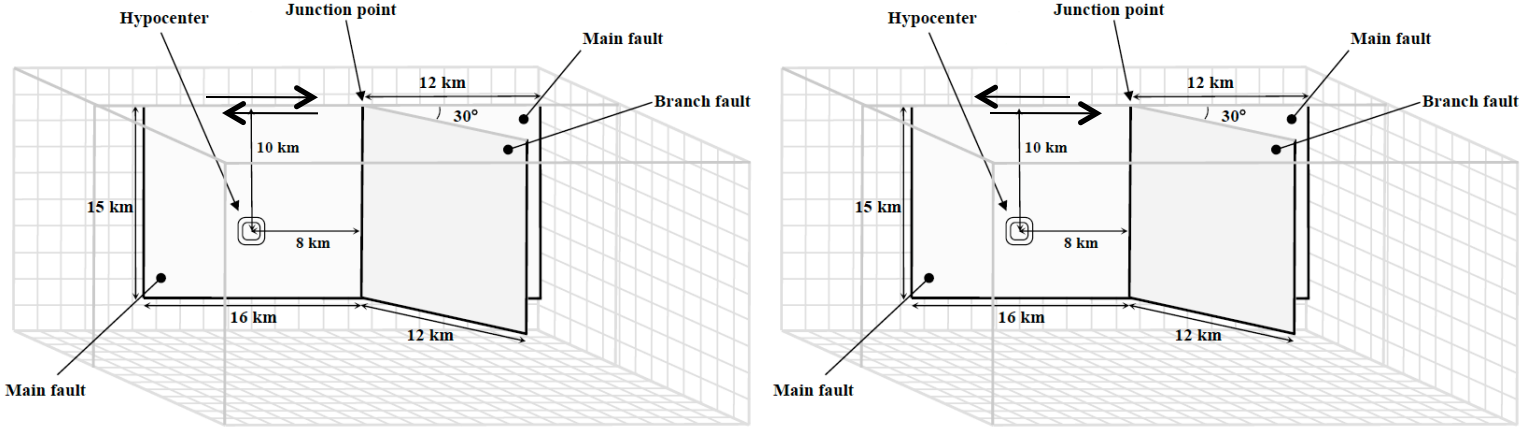
Friday March 15, 2013
U.S. Geological Survey, Menlo Park, CA

10:00	Introduction to the Workshop	*Ruth Harris*
10:15	The SCEC Community Stress Model	*Brad Aagaard*
10:35	The Benchmark Assignments and Results	*Michael Barall/ All*
11:35	Discussion of Future Plans	*Ruth Harris/ All*
12:15	*Lunch*	
13:15	Laboratory Tour of the Big Block	*Brian Kilgore/ Greg McLaskey*
14:20	Use of Dynamic Rupture Modeling in Earthquake Engineering Applications: User Needs and Schedule	*Norm Abrahamson*
14:40	*Break*	
15:00	*Tohoku Earthquake Dynamic Rupture Models*	
15:00	Tohoku: Slip-Weakening Friction in an Elastic Model	*Benchun Duan*
15:30	What can a simple slip-weakening model of the Tohoku earthquake tell us?	*Yihe Huang*
16:00	Tohoku: Thermal Pressurization in an Elastic Model	*Junle Jiang/ Nadia Lapusta*
16:30	Shallow Subduction Earthquakes: Slip-Weakening Friction in an Elastoplastic Model	*Shuo Ma*
17:00	Additional Group Discussion	*Ruth Harris/ All*
17:30	Adjourn	

2012-2013 Benchmarks: Two-Fault Stepovers
TPV22-23 (SW Friction, Elastic, Stepover in Vertical Strike-Slip Faults)



2012-2013 Benchmarks: Revisiting the Fault Branch
TPV24-25 (SW Friction, Elastic, Branched Vertical Strike-Slip Fault)



Harris March 2013