Presentation for March 11, 2016
Kellogg West Conference Center
Cal Poly Pomona, CA

March 2016
SCEC Rupture Dynamics Code Comparison and Validation Workshop

Ruth A. Harris (U.S. Geological Survey)
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 for all of his hard work on the benchmarks!

Winter 2015-2016 Gold Star Modelers

KANGCHEN BAI, MICHAEL BARALL, SAM BYDLON, Team XIAOFEI CHEN/ ZHENGUO ZHANG, ERIC DAUB, YOSHI KANEKO, Team DUNYU LIU/ BIN LUO, SHUO MA, DANIEL ROTEN, THOMAS ULRICH

Harris March 2016

Plans for this workshop

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

*Introduce ourselves

*Meet a new code in our group

*Learn about an exciting research frontier for earthquake source studies

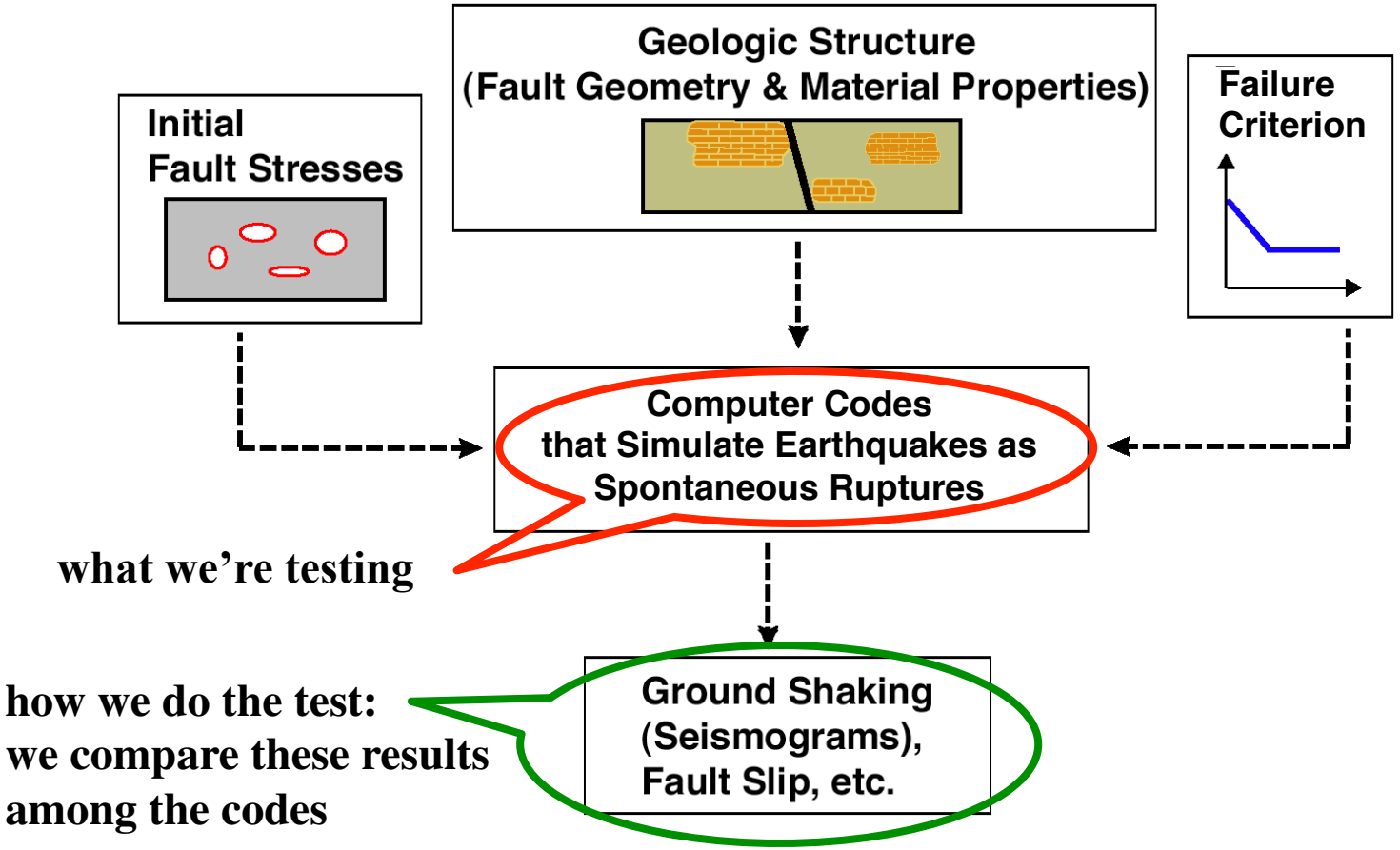
*Examine results from the latest benchmarks, TPV33 and TPV34

*Learn about pioneering work on the 1979 Imperial Valley earthquake

*Learn about the SCEC Broadband Platform

*Discuss how our group should conduct 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 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.

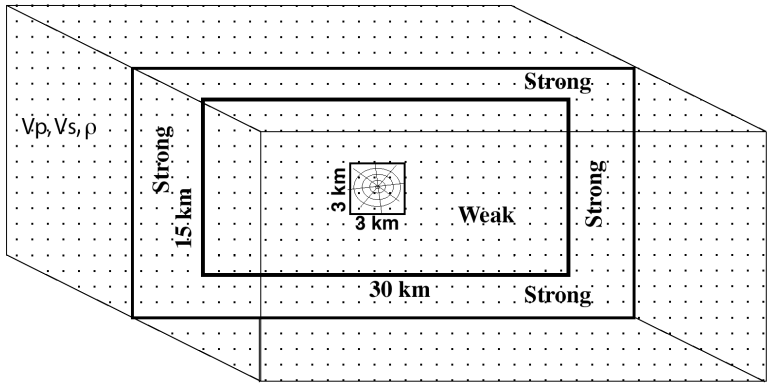
Funding

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

Code Comparison Strategy

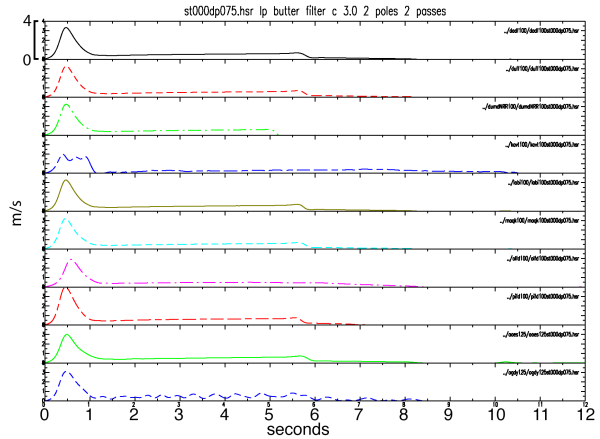
Start simply

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

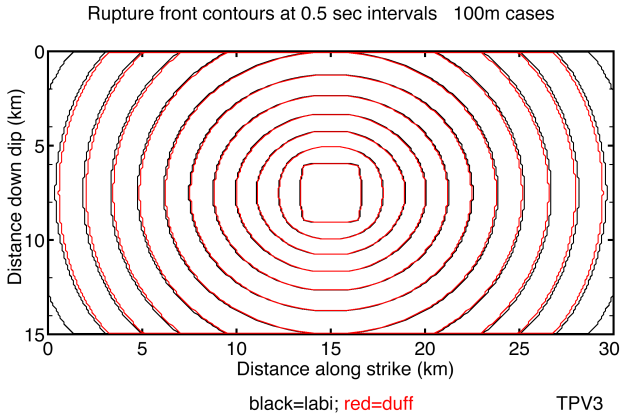


homogeneous initial stresses

slip-weakening friction

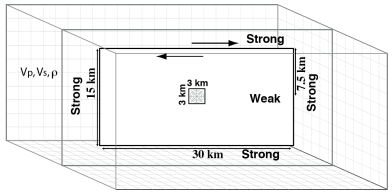


Some Results

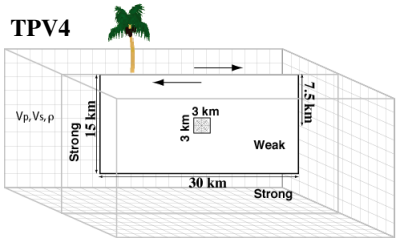


Code Comparison Benchmarks – Incrementally add complexity

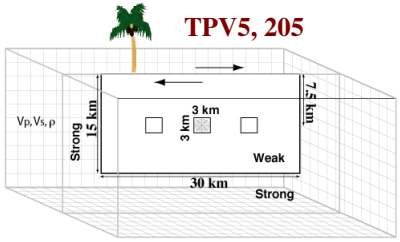
TPV3



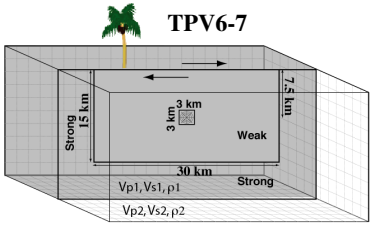
TPV4



TPV5, 205

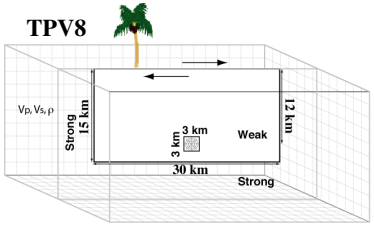


TPV6-7

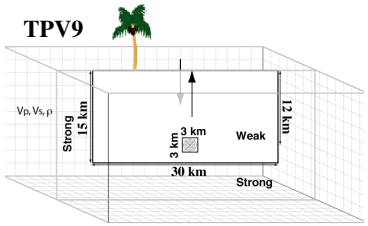


Slip-weakening friction

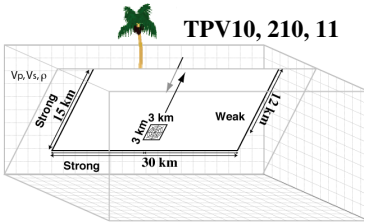
TPV8



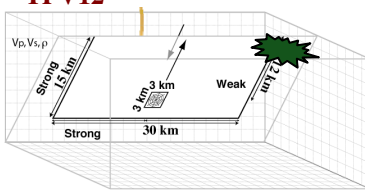
TPV9



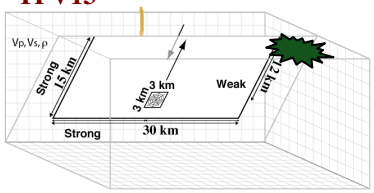
TPV10, 210, 11



TPV12

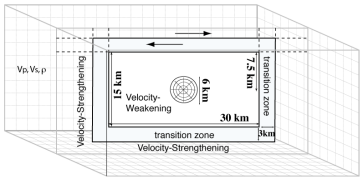


TPV13

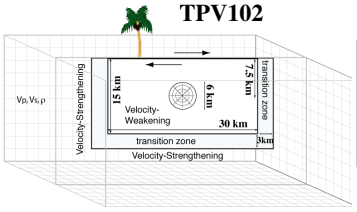


Slip-weakening friction

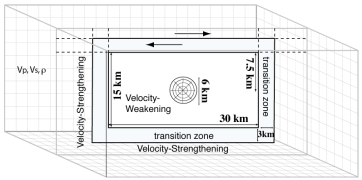
TPV101



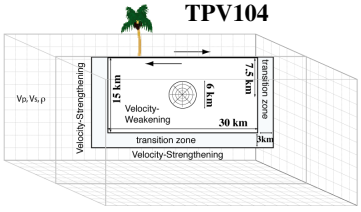
TPV102



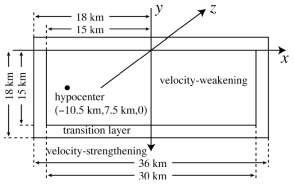
TPV103



TPV104



TPV105-2D

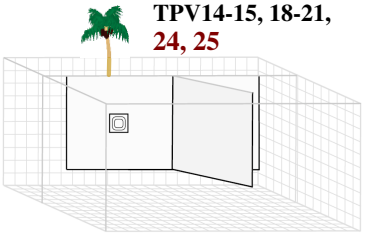


Rate-state friction using an ageing law

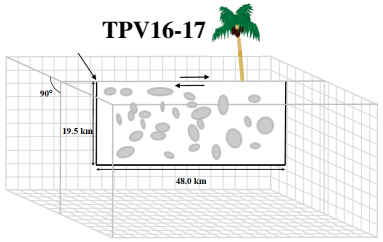
Rate-state friction using a slip law with strong rate-weakening

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

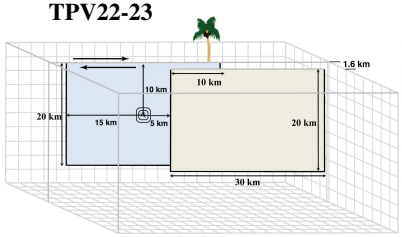
TPV14-15, 18-21, 24, 25



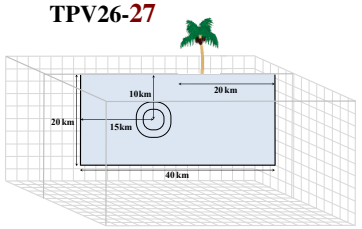
TPV16-17



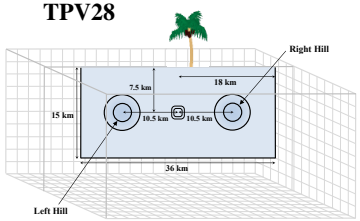
TPV22-23



TPV26-27



TPV28



Slip-weakening friction

Elastic, Viscoplastic

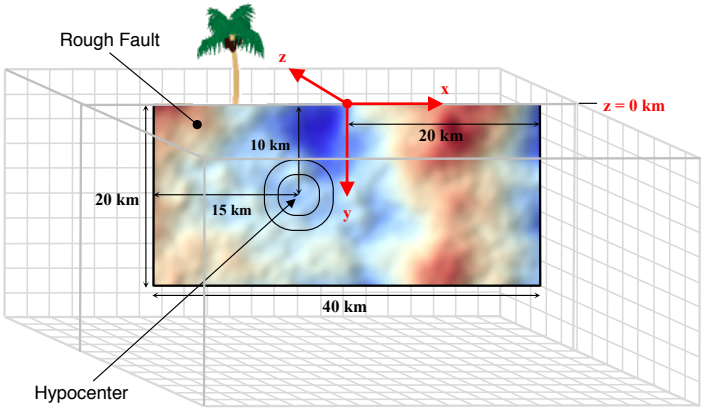
Slightly Rough Fault

Harris March 2016

Code Comparison Strategy

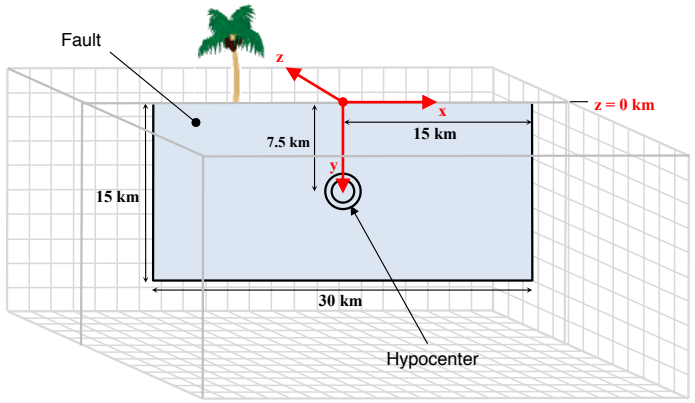
Incrementally adding complexity: fault roughness, layered velocity structure

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



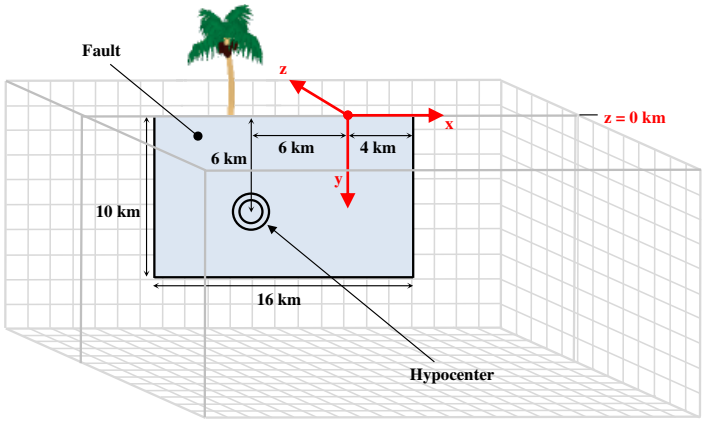
TPV31, 32
Discontinuous, Continuous

Winter 2014-2015 BENCHMARKS

Code Comparison Strategy

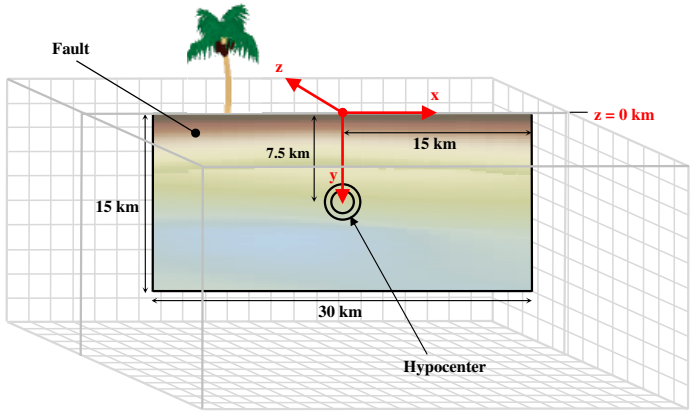
Incrementally adding complexity: vertically layered velocity structure, CVM-H

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

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**

Harris March 2016

SCEC Rupture Dynamics Code Comparison Workshop

Monday March 11, 2016
Kellogg West Conference Center, Cal Poly Pomona, CA

10:00	Introduction to the Workshop	*Ruth Harris*
10:15	Meet a New Code	*Eric Daub*
10:45	TPV33 Benchmark Results	*Michael Barall*
11:30	Dynamic Fault Weakening and Strengthening by Gouge Compaction and Dilatancy in a Fluid-Saturated Fault Zone	*Evan Hirakawa*
12:00	*Lunch*	
12:55	Imperial Valley Earthquake, Verification, Transitioning to Validation	*Ruth Harris*
13:00	Introduction to the 1979 Imperial Valley Earthquake	*Ralph Archuleta*
13:30	TPV34 Benchmark Results	*Michael Barall*
14:15	*Short Break*	
14:30	Some Insights on Imperial Valley from Kinematic Modeling and Validation	*Rob Graves*
15:00	Broadband Platform Validation Exercise	*Christine Goulet*
15:30	*Short Break*	
15:45	Group Discussion: how are we going to validate using Imperial Valley, etc.?	*All*

Plans for the rest of this year
(SCEC2016 Funded Proposal)

***Spontaneous Rupture Code Validation**

***Ideas for Testable Full-cycle Earthquake Simulators**

Harris March 2016