March 2015
SCEC Rupture Dynamics
Code Comparison Workshop

Ruth A. Harris (U.S. Geological Survey)
Ralph Archuleta (UC Santa Barbara)
INTRODUCTION

Welcome!

Thank you very much Tran for making our workshops happen!

Thank you very much to Michael for all of his hard work on the benchmarks!

2015 Gold Star Modelers

MICHAEL BARALL, JEREMY KOZDON, SHUO MA, Team SAM BYDLO
KENNETH DURU, Team DUNYU LIU/ BIN LUO, KANGCHEN BAI, YOSHI KANEKO, DANIEL ROTEN, ZHEQIANG SHI Team ALICE GABRIEL/THOMAS ULRICH, YUKO KASE

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Plans for this workshop

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

*Introduce ourselves

*Meet a new code

*Learn about exciting research frontiers for earthquake source studies

*Examine results from the latest benchmarks, TPV29, 30, 31, 32

*Discuss our next steps, including ideas for SCEC5
What our Group Does: We Test Computer Codes Used to Simulate Earthquakes

- **Initial Fault Stresses**
- **Geologic Structure**
  (Fault Geometry & Material Properties)
- **Failure Criterion**
- **Computer Codes**
  that Simulate Earthquakes as Spontaneous Ruptures
- **Ground Shaking**
  (Seismograms), Fault Slip, etc.

what we’re testing
how we do the test: we compare these results among the codes

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

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

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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
- Slip-weakening friction

TPV4
- Slip-weakening friction

TPV5, 205
- Rate-state friction using an ageing law

TPV6-7
- Thermal pressurization, rate-state friction, slip-law, strong rate-weakening

TPV8, TPV9
- Slip-weakening friction

TPV10, 210, 11
- Rate-state friction using a slip law with strong rate-weakening

TPV12
- Thermal pressurization, rate-state friction, slip-law, strong rate-weakening

TPV13
- Slip-weakening friction

TPV101
- Rate-state friction using an ageing law

TPV102
- Rate-state friction using a slip law with strong rate-weakening

TPV103
- Thermal pressurization, rate-state friction, slip-law, strong rate-weakening

TPV104
- Thermal pressurization, rate-state friction, slip-law, strong rate-weakening

TPV105-2D
- Thermal pressurization, rate-state friction, slip-law, strong rate-weakening

TPV14-15, 18-21, 24, 25
- Slip-weakening friction

TPV16-17
- Slip-weakening friction

TPV22-23
- Elastic, Viscoplastic

TPV26-27
- 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

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

TPV29, 30
Elastic, viscoplastic

TPV31, 32
Discontinuous, Continuous

2015 BENCHMARKS

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2015 Barall Metrics SRL article


Our group 2011 SRL article


Our group 2009 SRL article


links available on our website [http://scecdata.usc.edu/cvws](http://scecdata.usc.edu/cvws)

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# SCEC Rupture Dynamics Code Comparison Workshop

*Monday March 23, 2015*

*Kellogg West Conference Center, Cal Poly Pomona, CA*

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<tr>
<th>Time</th>
<th>Session Title</th>
<th>Presenter(s)</th>
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<tbody>
<tr>
<td>10:00</td>
<td>Introduction to the Workshop</td>
<td>Ruth Harris</td>
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<tr>
<td>10:23</td>
<td>Meet a New Code</td>
<td>Jeremy Kozdon</td>
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<td>10:30</td>
<td>Wasatch Front Earthquake Simulations</td>
<td>Ralph Archuleta</td>
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<td>11:00</td>
<td>Lessons from Parkfield for Earthquake Interaction</td>
<td>Nadia Lapusta</td>
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<td>11:30</td>
<td>High Performance Computing of Dynamic Rupture Scenarios</td>
<td>Alice Gabriel</td>
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<td>on Natural Fault Zones with SeisSol</td>
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<td>12:00</td>
<td>Lunch</td>
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<td>13:00</td>
<td>Metrics and Benchmark Results, Part 1</td>
<td>Michael Barall</td>
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<td>14:00</td>
<td>A Case for Multi-Fault Rupture in the So. CA Earthquake of 12/08/1812</td>
<td>Julian Lozos</td>
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<td>14:30</td>
<td>Dynamic Models of Earthquakes and Tsunamis Offshore Ventura, CA</td>
<td>Kenny Ryan</td>
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<td>15:00</td>
<td>Break</td>
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<tr>
<td>15:30</td>
<td>Benchmark Results, Part 2</td>
<td>Michael Barall</td>
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<td>16:15</td>
<td>Norm Speaks</td>
<td>Norm Abrahamson</td>
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<td>16:45</td>
<td>Additional Group Discussion</td>
<td>Ruth Harris/ All</td>
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Next Benchmark Plans (SCEC2015 Proposal)

*Vertically-layered 1D Velocity Structure

*3D Velocity Structure

Planning for SCEC 5 (SCEC5 Proposal)

Next group paper?