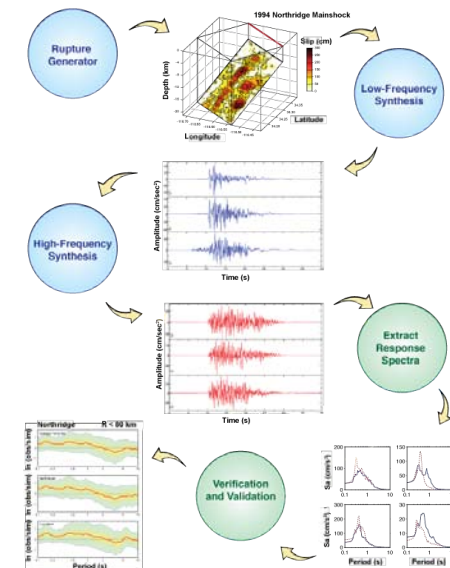


Overview of the SCEC Broadband Platform

Philip Maechling
Information Technology Architect
Southern California Earthquake Center

May 5, 2015

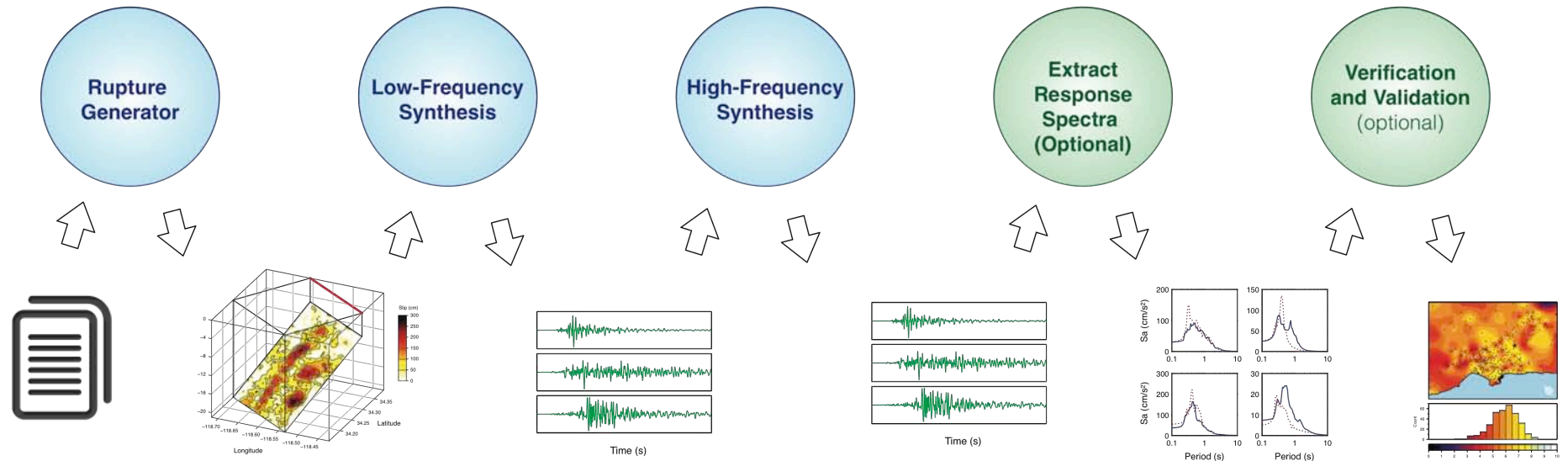


Overview of Broadband Platform

The Broadband Platform (BBP) is an open-source software distribution that:

- **Calculates earthquake ground motions at frequencies above 10Hz across regional distances.**
- **Contains software tools for comparing simulation results against GMPEs and observed ground motion recordings.**
- **Can run large numbers of ground motion simulations and manage the simulation results.**
- **Available for download at:**
http://scec.usc.edu/scecpedia/Broadband_Platform.

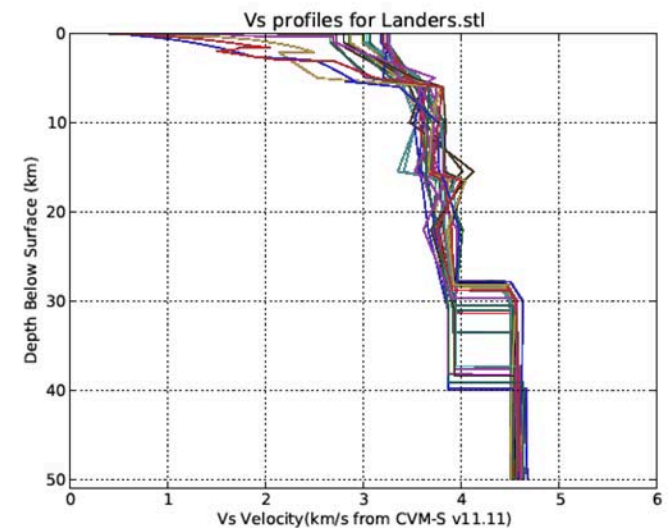
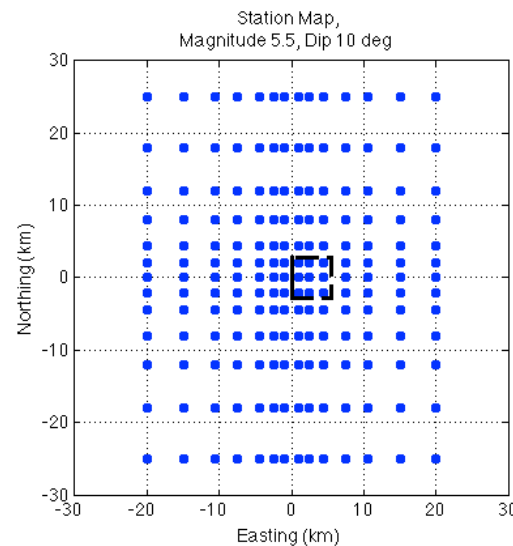
Typical Broadband Platform Computational Stages Including Validation Stages



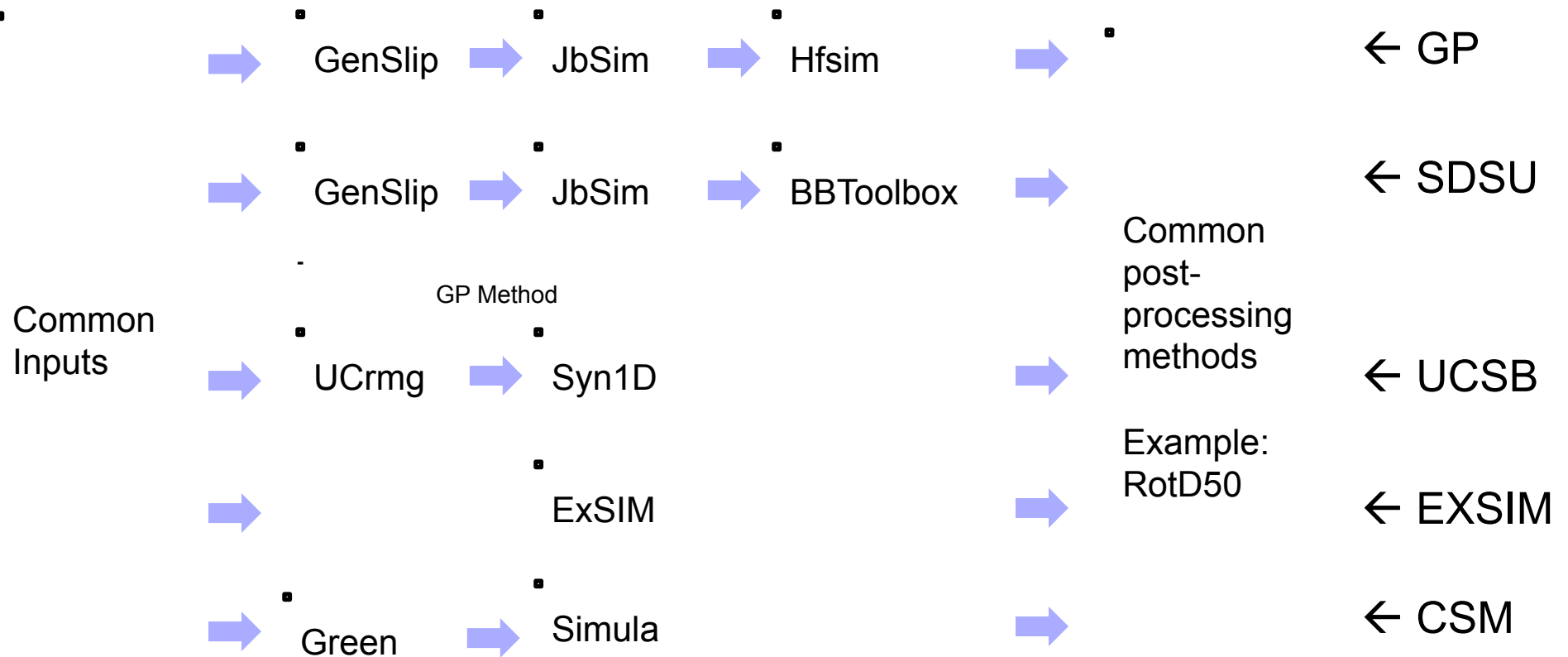
Common BBP Simulation Inputs

- Simple Source Description
- Station List
- Velocity Model 1D Profile

```
MAGNITUDE = 6.67
FAULT_LENGTH = 20.01
DLEN = 0.2
FAULT_WIDTH = 25.01
DWID = 0.2
DEPTH_TO_TOP = 5.0
STRIKE = 122
RAKE = 90
DIP = 40
LAT_TOP_CENTER = 34.3
LON_TOP_CENTER = -118
HYPO_ALONG_STK = 6.0
HYPO_DOWN_DIP = 19.4
DT = 0.01
SEED = 3092096
```



BBP Simulation Methods Implement Computational Stages Differently



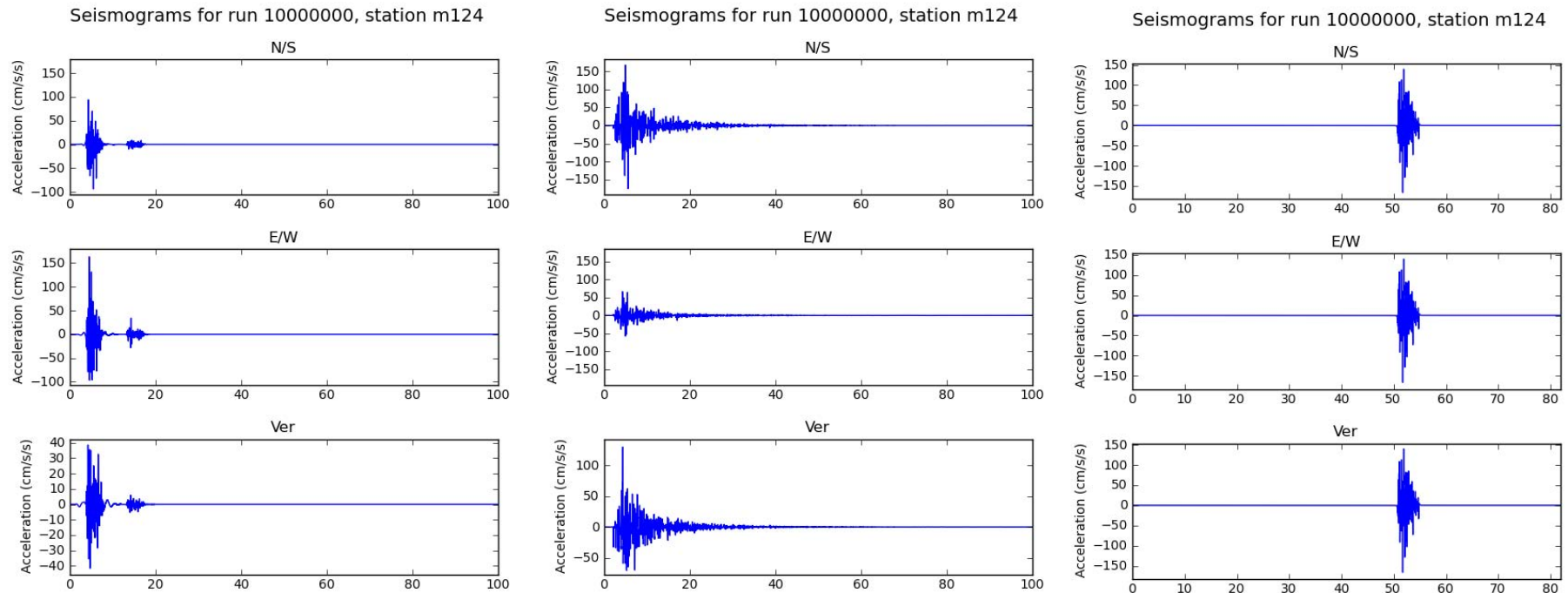
Broadband Platform Supports Multiple Ground Motion Simulation Methods

- **BBP simulations can use one or more of the currently integrated ground motion simulation methods**
 - **Graves & Pitarka – Rob Graves, Arben Pitarka**
 - **SDSU – Kim Olsen, Rumi Takedatsu**
 - **UCSB – Ralph Archuleta and Jorge Crempien**
 - **ExSIM (UWO) – Gail Atkinson, Karen Assatourians**
 - **Composite Source Model (UNR) – John Anderson**

WAVEFORM COMPARISON: GP, SDSU, & ExSIM

STATION ON HANGING-WALL SIDE:

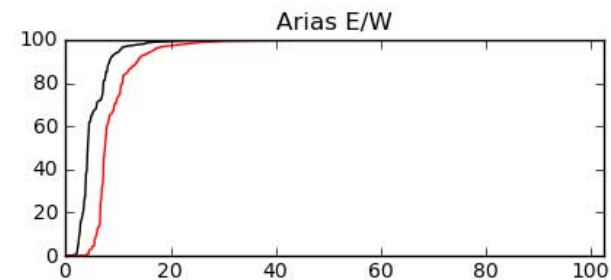
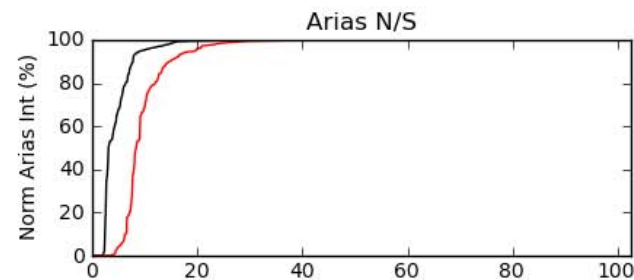
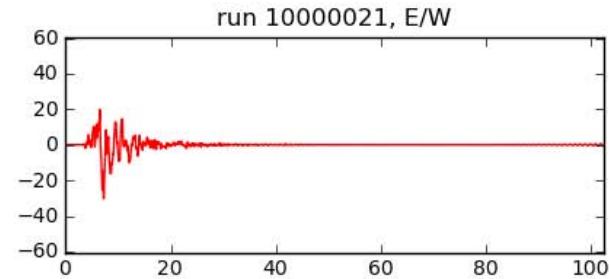
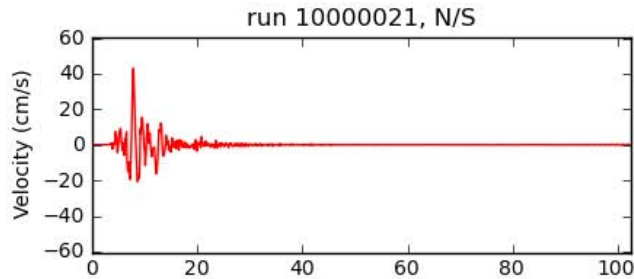
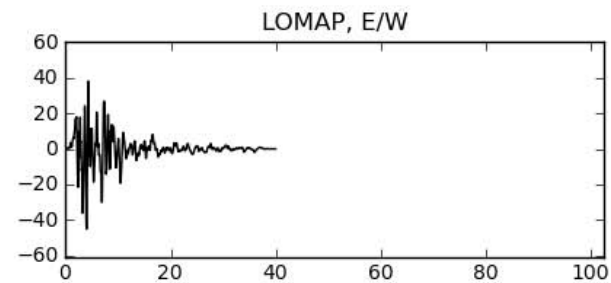
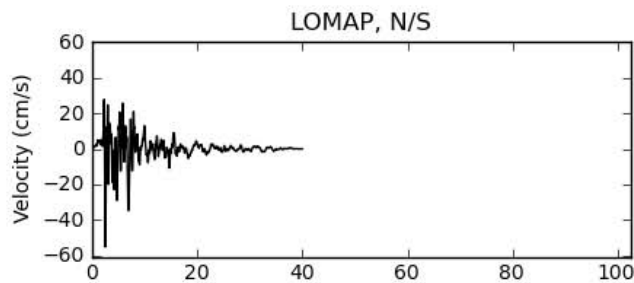
$R_X = 10.5$ km, $R_{JB} = 6.5$ km, $R_{RUP} = 9.2$ km



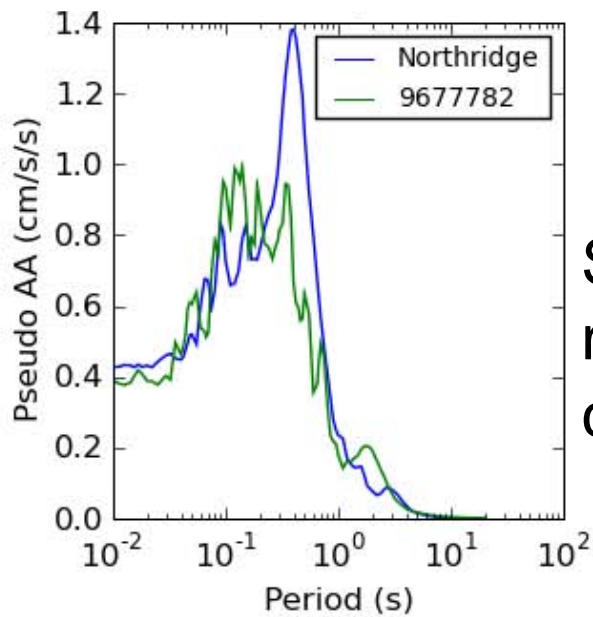
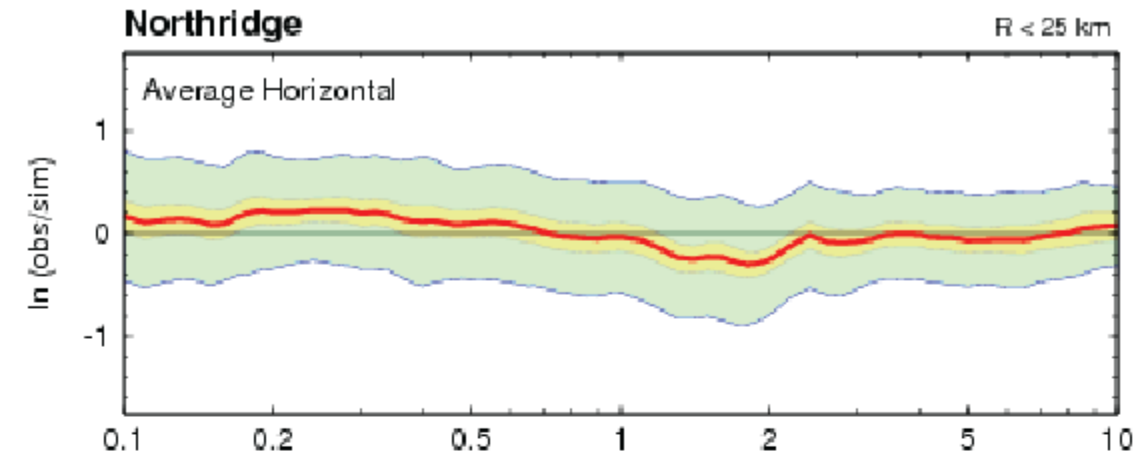
Validation Data Products

Seismogram Comparison

LOMAP vs. run 10000021, station 8001-CLS



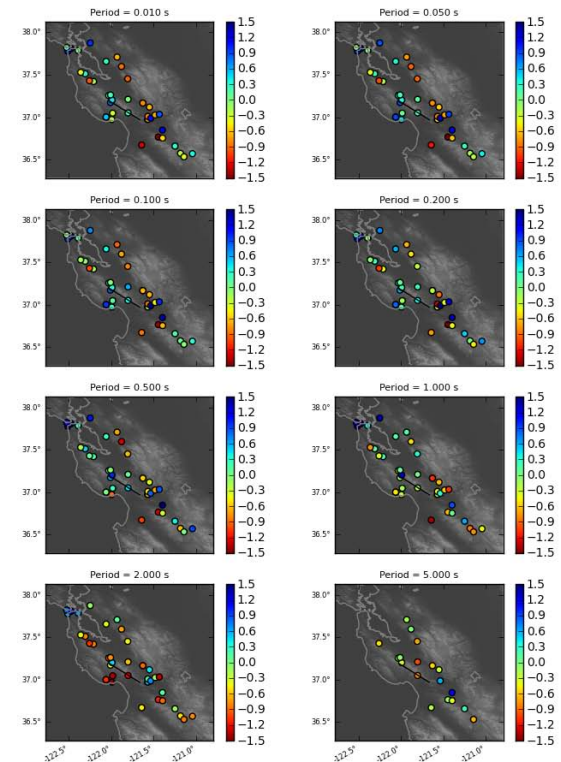
Comparison Data Products



Goodness-of-fit

Spectral
response
comparison

GOF Comparison between LOMAP and simulation 10000021



MAP based
Goodness-of-fit

```
$ run_bbp.py
```

```
Welcome to the SCEC Broadband Platform version 15.3.0.
```

```
=====
```

```
Please select the Broadband Platform mode of operation:
```

- * Validation - Simulates a historical event
- * Scenario - Runs a user-defined hypothetical event

```
Do you want to perform a validation simulation (y/n)? y
```

```
=====
```

```
Please select a validation event from the list below:
```

- (1) Alum Rock
- (2) Chino Hills
- ? 2

```
=====
```

```
The Broadband Platform includes several scientific methods that can be used to calculate synthetic seismograms.
```

```
Choose a Method to use in this Broadband validation simulation:
```

- (1) GP (Graves & Pitarka)
- (2) UCSB
- (3) SDSU
- (4) EXSIM
- (5) CSM (Composite Source Model) - Beta Version
- ? 1

```
=====
```

```
SRC file: /home/sarah/bbp/bbp_val/ChinoHills/common/ch_v14_2_2.src
```

```
=====
```

```
STL file: /home/sarah/bbp/bbp_val/ChinoHills/common/ch_v14_2_2.stl
```

Description of What is Needed to Support Engineering Validation Process

- **Demonstrate that the simulations work**
 - Comparison with ground motions from past earthquakes (part A)
 - Check of the method to simulate future earthquakes (Part B)
- **Repeatable results (stable versions)**
 - Move from researcher codes (frequent tinkering) to fixed versions
- **Usable by someone other than author of method**
 - Clear guidelines on how to implement the methods
 - IT Support for running methods
- **Reviewable**
 - Peer review by someone other than author of code needs to be possible
- **Reasonable costs**

Support Validation Exercises

Supported NGA-E Meetings

- April 2014
- Ran Validation Studies for all available methods (4 methods) and delivered results for evaluation

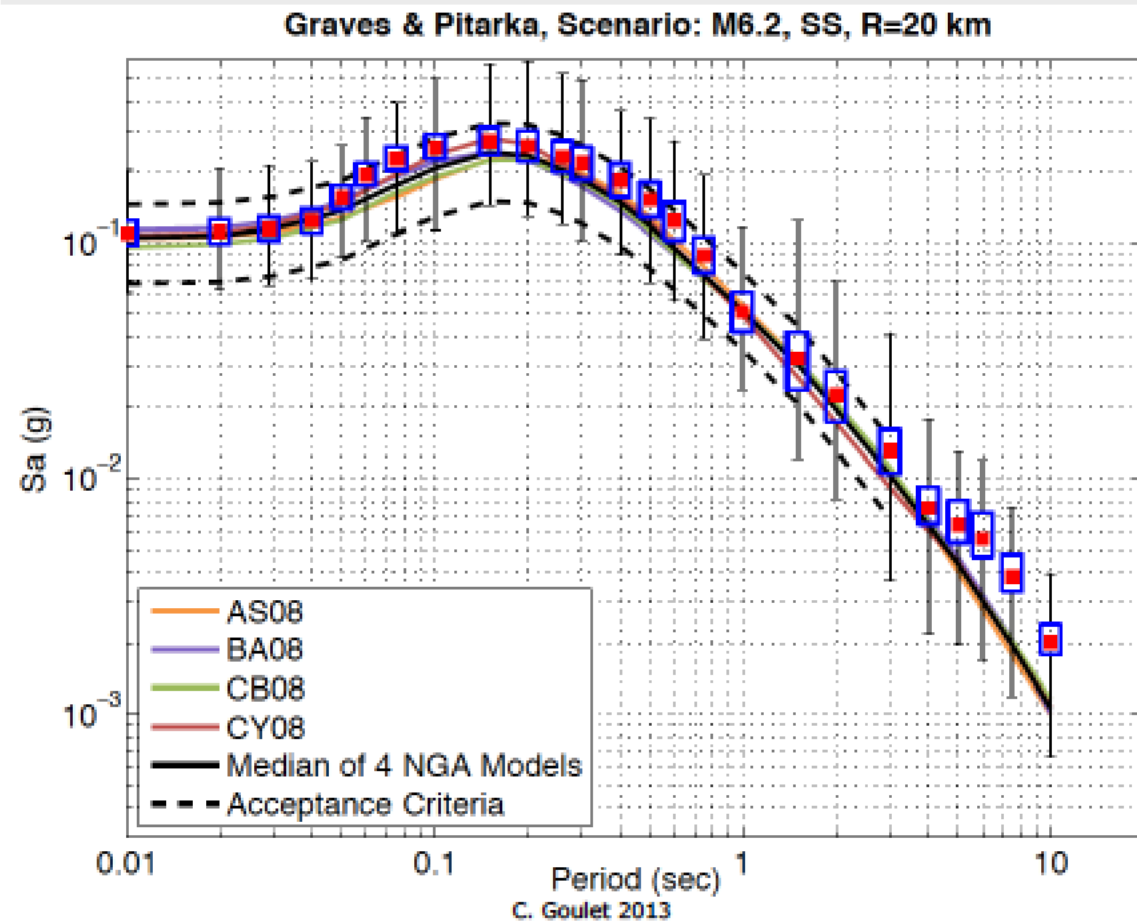
Supported Multiple SWUS SSHAC Meetings

- Sept 2013, Oct 2013, Jan 2014, March 2014
- Ran validation studies using BBP for all available methods (5 methods) and delivered results for evaluation

Helped to develop evaluation tools

- Formatted output to produce “SuperTable” to support evaluation and comparison of results

Evaluation criteria



SWUS Evaluation of Results

Change the values below  and table highlighting will update accordingly.

Part A, GOF Validation Threshold = 0.50 in table below ($-0.50 \leq$ highlighted green values ≤ 0.50)
 Unacceptable Threshold = 0.70 in table below (highlighted red values < -0.70 or > 0.70)

Expected Performance Level

Expected to Work	Potential Issues	Definite Issues
------------------	------------------	-----------------



Event (Mw, Mech.)		PSA Period Range = [0.01-0.1] s							PSA Period Range =]0.1-1] s							PSA Period Range =]1-∞[s																	
		UCSB	EXSIM	G&P	SDSU	GMPE	SMSIM	UCSB	EXSIM	G&P	SDSU	GMPE	SMSIM	UCSB	EXSIM	G&P	SDSU																
Rrup=[0-5] km	Chino Hills (5.39, ROBL)																																
	Alum Rock (5.45, SS)		-1.04	1.04	-0.94	0.94	-0.65	0.65	-1.33	1.33					-1.15	1.15	-1.11	1.11	-0.78	0.78	-1.33	1.33					-1.15	1.15	-1.32	1.32	-1.32	1.32	
	Whittier Narrows (5.89, REV)																																
	North Palm Springs (6.12, ROBL)	0.19	0.30	0.38	0.38	0.11	0.14	0.36	0.36	0.16	0.16			0.96	0.96	0.15	0.31	0.02	0.20	0.22	0.32	0.07	0.24		0.93	0.93	0.20	0.20	-0.45	0.48	-0.51	0.	
	Tottori (6.59, SS)	-0.18	0.21	-1.18	1.18	0.10	0.16	-0.40	0.40	0.23	0.23			1.08	1.08	-0.19	0.63	0.58	0.60	0.40	0.51	0.62	0.62		1.25	1.25	-0.17	0.21	-0.07	0.21	-0.13	0.	
	Niigata (6.65, REV)																																
	Northridge (6.73, REV)																																
	Loma Prieta (6.94, ROBL)	0.16	0.38	0.19	0.38	0.05	0.31	0.19	0.33	-0.12	0.38			0.58	0.58	0.20	0.37	0.15	0.35	0.29	0.37	0.00	0.41		0.65	0.87	0.48	0.97	-0.08	0.52	-0.12	0.	
	Landers (7.22, SS)	1.16	1.16	0.73	0.73	0.91	0.91	0.92	0.92	1.05	1.05			1.58	1.58	0.28	0.28	0.55	0.55	0.45	0.45	0.69	0.69		2.04	2.04	0.61	0.61	0.58	0.58	0.53	0.	
	Riviere-du-Loup (4.6 REV)																																
	Mineral (5.68 REV)																																
	Saguenay (5.81 REV)																																
	Average CA	0.37	0.52	0.11	0.55	0.04	0.49	0.20	0.48	-0.08	0.61			0.86	0.86	-0.02	0.47	-0.01	0.49	0.13	0.44	-0.10	0.58		0.98	1.12	0.18	0.81	-0.24	0.66	-0.28	0.	
Average CENA																																	
Average ALL	0.28	0.47	-0.08	0.64	0.05	0.44	0.11	0.47	-0.04	0.56			0.89	0.90	-0.04	0.50	0.07	0.50	0.16	0.45	0.01	0.58		1.03	1.14	0.13	0.73	-0.22	0.59	-0.26	0.		
Rrup=[5-10] km	Chino Hills (5.39, ROBL)			0.21	0.32	-0.01	0.33	0.17	0.28	-0.40	0.50					0.33	0.44	0.20	0.42	0.29	0.38	-0.14	0.38				0.64	0.64	0.73	0.73	0.65	0.	
	Alum Rock (5.45, SS)			-0.28	0.35	-0.51	0.53	-0.13	0.25	-0.47	0.48					-0.16	0.40	-0.36	0.49	-0.03	0.38	-0.22	0.43				0.25	0.51	-0.24	0.60	-0.27	0.	
	Whittier Narrows (5.89, REV)	-0.17	0.63	0.23	0.32	-0.30	0.41	-0.28	0.43	-0.18	0.41			0.72	0.80	0.23	0.40	-0.15	0.39	-0.16	0.40	0.01	0.40		0.41	0.51	-0.14	0.28	-0.45	0.49	-0.54	0.	
	North Palm Springs (6.12, ROBL)	-0.41	0.55	0.08	0.38	-0.20	0.42	-0.11	0.33	-0.15	0.34			0.57	0.70	-0.13	0.40	-0.24	0.41	-0.17	0.41	-0.19	0.37		0.59	0.70	-0.08	0.44	-0.23	0.60	-0.30	0.	
	Tottori (6.59, SS)	-0.34	0.43	-0.46	0.47	0.32	0.39	-0.29	0.32	0.59	0.61			0.35	0.52	-0.03	0.38	0.31	0.48	0.08	0.38	0.55	0.64		0.37	0.57	0.02	0.39	0.06	0.48	-0.01	0.	
	Niigata (6.65, REV)	-0.27	0.59	0.16	0.52	0.28	0.44	-0.15	0.52	0.40	0.55			0.61	0.62	0.29	0.49	0.19	0.45	-0.01	0.44	0.33	0.51		0.07	0.28	-0.16	0.52	-0.48	0.78	-0.53	0.	

Created Open-Source Software Distributions

- **Released BBP V15.3.0 in March 2015**
 - Version using only open-source compilers
- **Released BBP v14.3.0 in March 2014**
 - Version used in NGA-E activities
- **Released BBP v13.6.1 in June 2013**
 - Version used in SWUS activities
- **Public Software Releases include:**
 - Best available version of each ground motion simulation models
 - Greens functions for multiple regions (LA, Mojave, NorCal, Japan etc)
 - Best available Post-processing software
 - Processing utilities to support cluster-based ensemble runs
 - Installation and basic users guides

Broadband Platform 15.3.0 Release

- **Minimum Distribution**
 - Source distribution
 - LABasin velocity model (needed for unit, acceptance tests)
 - Northridge validation (needed for acceptance tests)
- **Optional Downloads**
 - Mojave, NoCAL, Central Japan, Western Japan, CEUS 1000, Canada 1000 velocity model packages
 - Chino Hills, Alum Rock, Loma Prieta, Landers, North Palm Springs, Saguenay, Riviere-du-Loup, Mineral, Tottori, Niigata validation events
- **Virtual Box including all of the above**

Re-validation of Broadband Platform 15.3.0 Results

- **Re-ran Complete Part-A and Part-B validations**
 - All events, all methods
- **Compared against previous results**
 - BBP 14.3.0 versus BBP 15.3.0
 - Code changes
 - Extra events for UCSB
 - Changes to east events (source file, stations)

[illegible]

SCEC's Broadband Platform Software Sustainability Strategies

- 1. Keep the software development costs at a modest level (~2-3 FTE).**
- 2. Integrate the best available scientific modules into the software.**
- 3. Regularly release improved versions of Broadband as open-source software.**
- 4. Release the software under a license (Apache 2) that is acceptable to commercial companies, and state and Federal agencies.**
- 5. Continue the ongoing group verification and validation exercises to build user confidence in the software.**
- 6. Implement software features and enhancements guided by a users needs and priorities**

Thank you!

The BBP Software is available for download at:

http://scec.usc.edu/scecpedia/Broadband_Platform