

Broadband Platform Validation Exercise for Pseudo-Spectral Acceleration: Review Panel Summary

Douglas Dreger (UCB)

Review Panel

- Gregory Beroza
- Steven Day
- Douglas Dreger (Chair)
- Christine Goulet
- Thomas Jordan
- Paul Spudich
- Jonathan Stewart

Participating Models

Table 2.1.1 Participating Methods

Method identifier	Responsible developers (affiliations)	Key references*
CSM: Composite Source Model	John Anderson (UNR)	Zeng et al. (1994)
UCSB Method	Ralph Archuleta, Jorge Crempien (UCSB)	Liu et al. (2006), Schmedes et al. (2010), and Schmedes et al. (2012)
EXSIM	Gail Atkinson, Karen Assatourians (UWO)	Motozedian and Atkinson (2005), Atkinson et al. (2009), and Boore (2009)
G&P: Graves and Pitarka	Robert Graves (USGS), Arben Pitarka (LLNL)	Graves and Pitarka (2010)
SDSU Method	Kim Olsen, Rumi Takedatsu (SDSU)	Mai et al. (2010), and Mena et al. (2010)

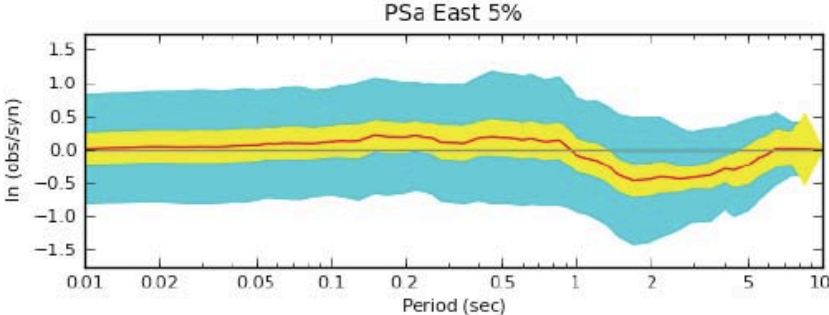
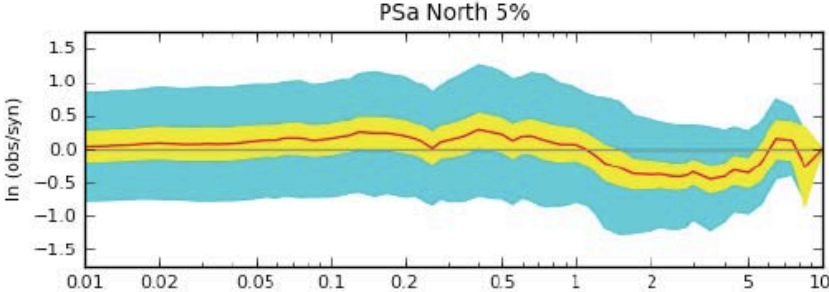
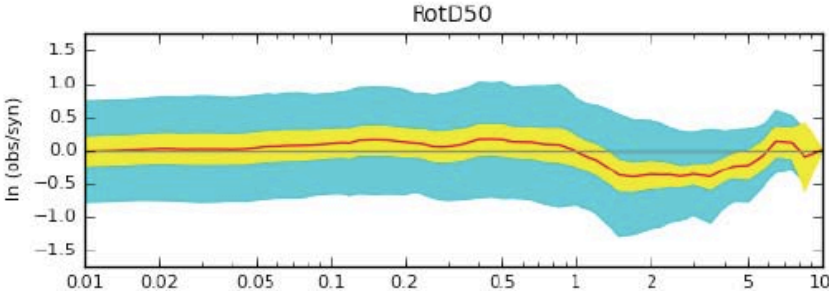
* References listed here are the latest published documentation of the methods. Some methods have been modified since publication. The documents on the current status of each method are provided in Appendices E.

Validation Data, Documentation, and Review Procedure

- June 11-12, 2013 Preparation Workshop
- June 26, 2013 Review Meeting
- Modelers Documentation and Self Assessments
- Simulation Results Provided by the BBP
- Part A
 - Spectral acceleration (5% damped) for 6 events are directly compared to observations (corrected for a rock site condition)
 - Goodness-of-fit plots for single scenarios and averages are provided by the BBP
 - Mean bias plots
 - Distance dependence
 - Spatial dependence
 - Goodness-of-fit (GOF) values are provided in distance, period, and source-type bins
 - The panel developed additional metrics based on provided GOF data
- Part B
 - Plots comparing simulated ground motions to GMPEs for generic M_w 6.2 & 6.6 strike-slip and reverse-slip cases, considering both southern California and northern California velocity models
 - Acceptable thresholds based on the range of published NGA-West1 GMPEs were provided to the panel

Part A Validation – Bias Plot

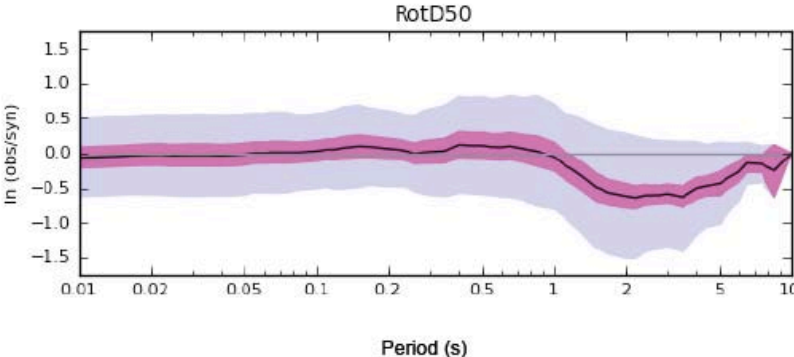
GOF Comparison between LOMAP and simulation 10000021
 R < 85 km



Goodness-of-fit parameter:

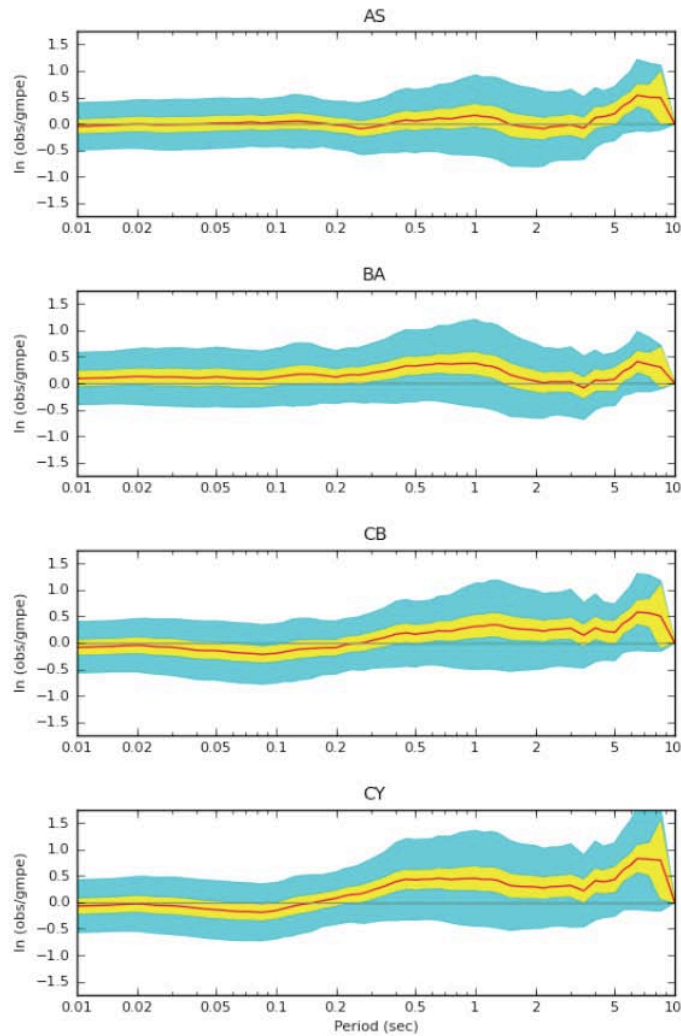
$$y = \ln\left(\frac{Sa_{observed}}{Sa_{simulated}}\right)$$

Combined GOF Plot for LOMAP
 50 Realizations
 SDSU Method

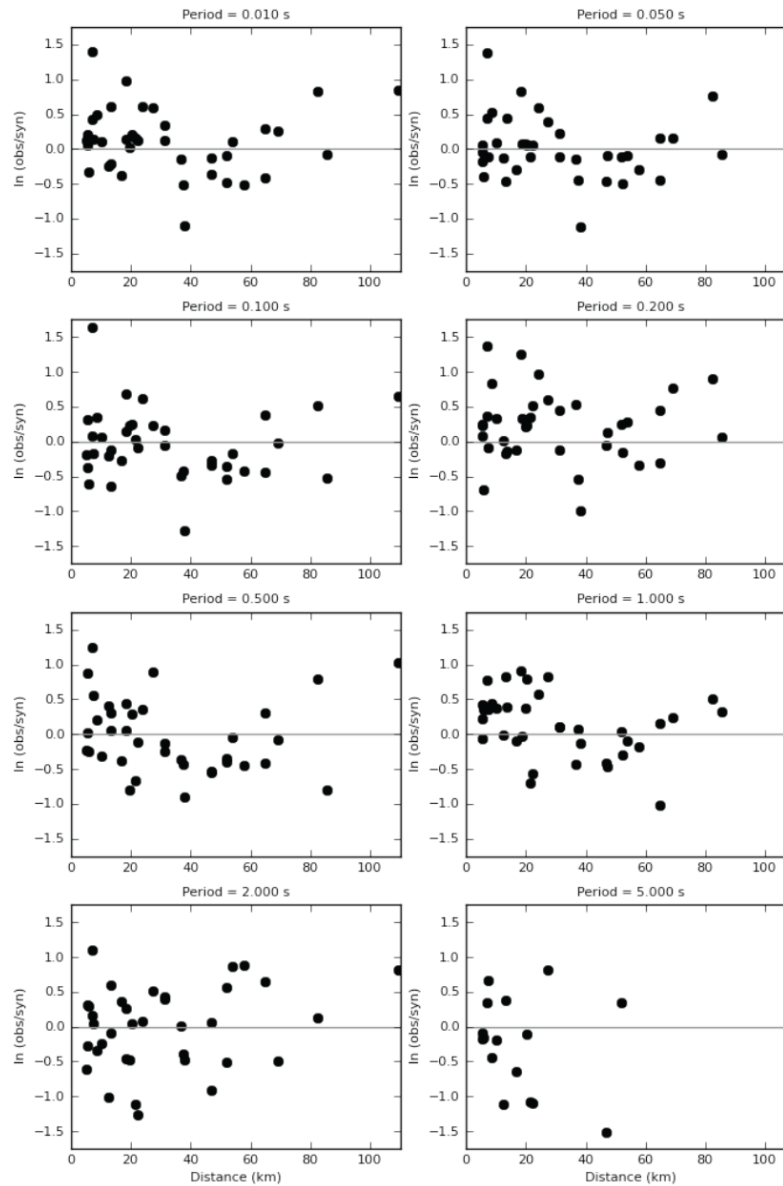


Part A Validation – Bias Plot for GMPEs

Comparison between GMPEs and LOMAP
Number of stations: 40



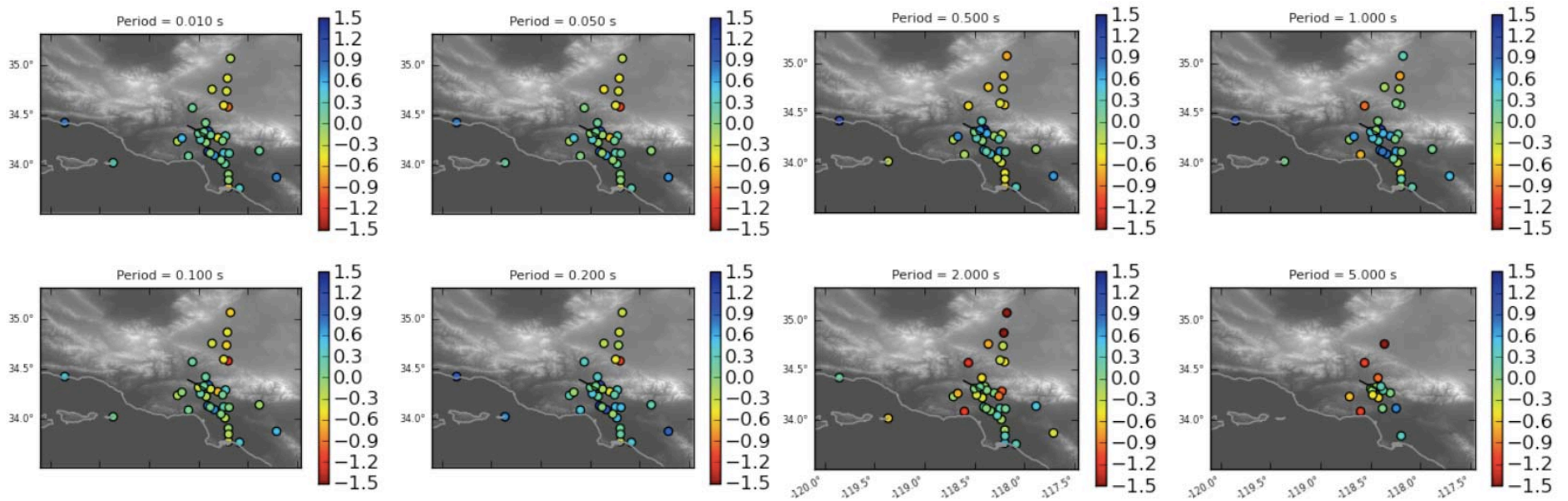
Part A Validation – Distance & Period



One method and
one scenario

Part A Validation – Spatial Observations

GOF Comparison for NR
50 Realizations
GP Method

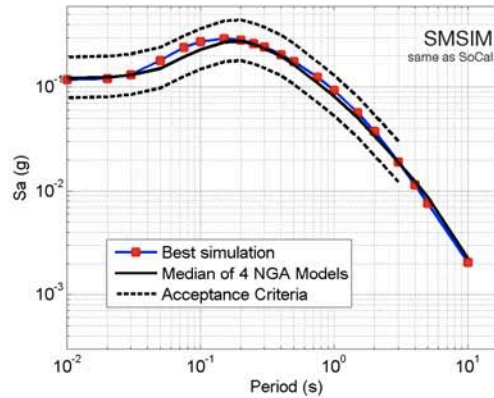
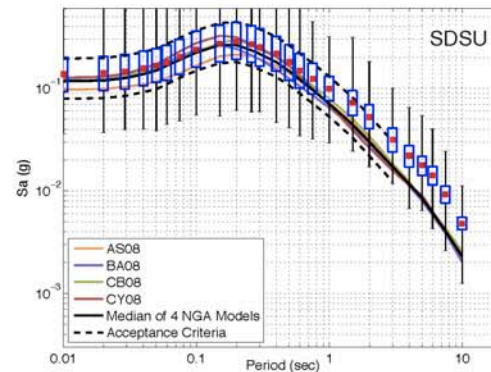
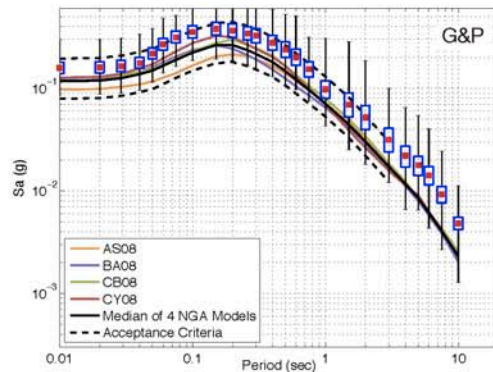
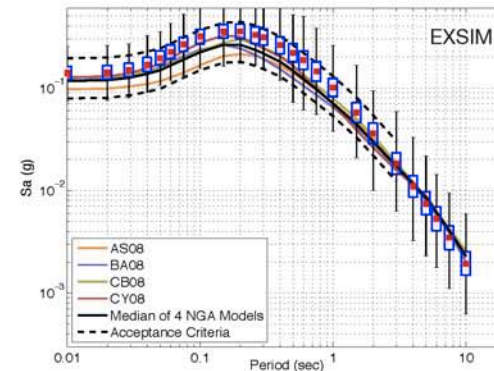
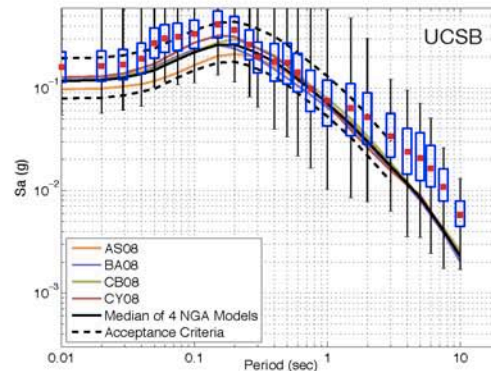
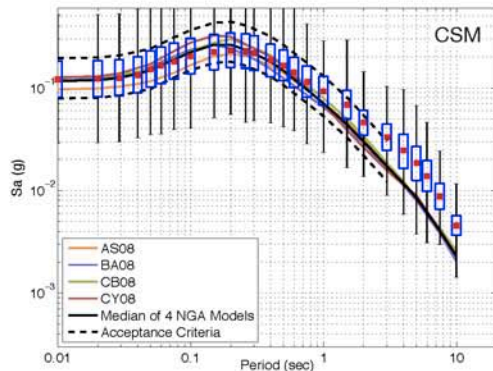


Short-Period

Long-Period

Part B Validation – GMPE Plots

Part B. Northern California (M6.6, SS, $Z_{\text{tor}}=0$ km, $R_{\text{jb}}=20$ km)



Part A Validation

- Direct comparison of observed and simulated spectral acceleration for specific events
 - Whittier Narrows, Landers, North Palm Springs, Northridge, Tottori and Niigata
- Comparisons of mean bias (residual of natural log of simulated ground motion to observed)
 - Failure threshold is $\ln(2)=0.69$
 - Thresholds of 0.5 and 0.35 were considered as passing criterion
- Comparisons of distance dependence of mean bias
 - Distance dependence slope of zero within 95% confidence
- Comparisons of a combination of mean bias and mean absolute bias.
 - Comparison with GMPE

Distance Behavior was Considered

Fit a line through distance binned GOF values

$$\ln\left(\frac{Sa_{obs}}{Sa_{syn}}\right) = a + b \cdot \ln(R)$$

Determine whether $b=0$ lies within 95% confidence.

In the future the specific observations will be used instead of the binned values.

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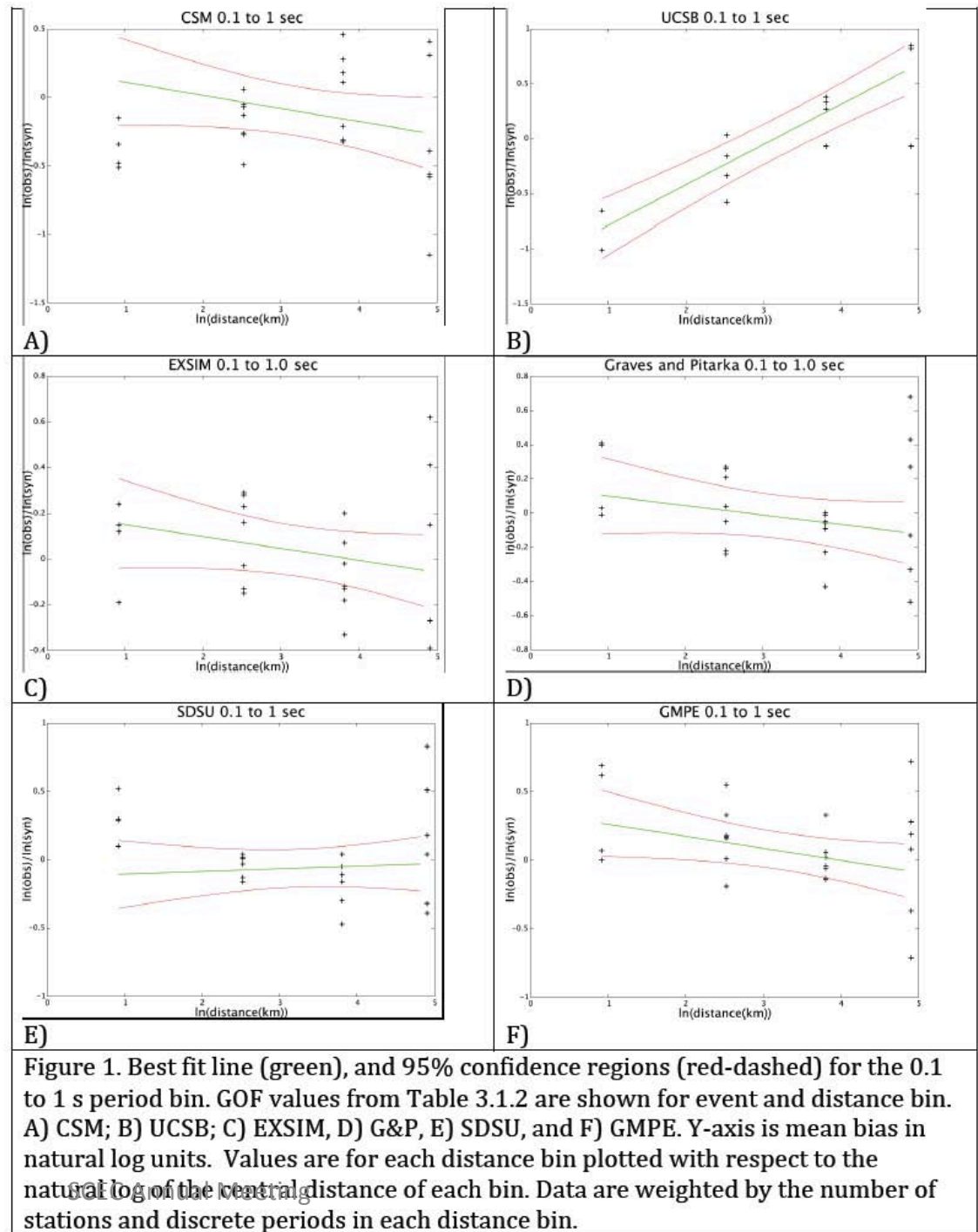


Table 3.2.1 Distance Dependence of Mean Bias

Period	CSM	UCSB	EXSIM	G&P	SDSU	GMPE
0.01 to 0.1 s	0.91	2.63	0.36	0.69	0.60	0.16
0.1 to 1.0 s	0.72	2.65	0.64	0.59	0.19	0.88
1 to 3 s	1.18	2.28	0.48	0.43	0.02	0.68
greater than 3 s	1.32	0.97	0.36	0.97	0.42	0.42

The ratio of the absolute value of slope of a best fit line between data from 4 distance bins (see Figure 1), and the 95% estimate of the slope. The weighted least squares fit for the best line used the number of discrete periods and stations in each period bin to weight each data point.

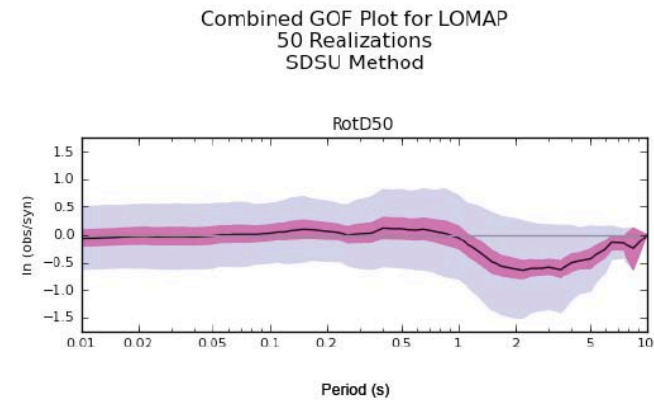
Red shows a ratio of $\text{abs}(b)/b^{95\%}$ greater than 1.0, the zero slope does not lie within the 95% confidence of the estimate.

Green shows cases where $b=0$ lies within the 95% confidence of the estimate. Smaller numbers are generally controlled by small estimates of slope.

Combined Metric & Comparison with GMPEs

$$y_{\text{model}} = w \cdot \langle |x| \rangle + (1 - w) \cdot \langle |x| \rangle$$

$$\frac{y_{\text{model}}}{y_{\text{GMPE}}}$$



Change the values below

Part A, GOF Validation Threshold = 0.35
 Unacceptable Threshold = 0.70
 weight= 0.50

Combined Metric Performance Level
 Exp. to Work Pot. Issues Definite Issues

Combined Metric

	PSA Period Range = [0.01-0.1] s								PSA Period Range = [0.1-1] s								PSA Period Range = [1-3] s								PSA Period Range > 3s							
	Event (Mw, Mech.)	CSM	UCSB	EXSIM	G&P	SDSU	GMPE	SMSIM	CSM	UCSB	EXSIM	G&P	SDSU	GMPE	SMSIM	CSM	UCSB	EXSIM	G&P	SDSU	GMPE	SMSIM	CSM	UCSB	EXSIM	G&P	SDSU	GMPE	SMSIM			
Rrup=[0-5] km	Whittier Narrows (5.89, REV)																															
	North Palm Springs (6.12, ROBL)	0.65	0.79	0.38	0.07	0.44	0.16	0.26	0.51	1.01	0.23	0.12	0.31	0.16	0.42	0.57	1.31	0.20	0.60	0.65	0.15	0.37	0.98	1.62	0.08	1.08	1.09	0.50				
	Tottori (6.59, SS)	1.17		1.18	0.10	0.35	0.23	0.10	0.37		0.41	0.45	0.54	0.62	1.25	0.14		0.19	0.21	0.22	0.11	1.17	0.10		0.23	0.41	0.41	0.41	1.17			
	Niigata (6.65, REV)																															
	Northridge (6.73, REV)																															
	Loma Prieta (6.94, ROBL)	0.74	0.89	0.23	0.22	0.22	0.25	0.38	0.54	0.68	0.25	0.18	0.25	0.21	0.29	0.43	1.10	0.66	0.50	0.54	0.59	0.62	0.41	1.12	0.33	0.66	0.67	0.31	0.39			
	Landers (7.22, SS)	0.34		0.70	0.76	0.90	1.05	1.41	0.34		0.24	0.41	0.34	0.69	1.05	0.27		0.63	0.35	0.29	0.93	1.53	0.98		1.07	0.29	0.29	1.17	2.08			
	Average CA	0.64	0.87	0.36	0.26	0.40	0.32	0.68	0.49	0.77	0.24	0.22	0.28	0.29	0.59	0.37	1.15	0.56	0.42	0.46	0.55	0.84	0.40	1.16	0.61	0.42	0.42	0.54	1.04			
	Average ALL	0.73	0.87	0.29	0.21	0.33	0.31	0.54	0.47	0.77	0.24	0.25	0.33	0.35	0.75	0.34	1.15	0.47	0.39	0.42	0.48	0.92	0.33	1.16	0.48	0.42	0.42	0.42	1.08			
Rrup=[5-20] km	Whittier Narrows (5.89, REV)	0.78	0.88	0.28	0.26	0.28	0.30	0.22	0.51	0.29	0.32	0.20	0.18	0.21	0.24	0.91	0.63	0.21	0.50	0.56	0.44	0.29	1.28	1.02	0.37	1.12	1.05	0.81	0.19			
	North Palm Springs (6.12, ROBL)	0.57	0.72	0.23	0.33	0.24	0.25	0.30	0.46	0.70	0.27	0.33	0.32	0.28	0.33	0.41	0.72	0.26	0.47	0.54	0.39	0.55	0.12	0.33	0.29	0.16	0.16	0.45	1.00			
	Tottori (6.59, SS)	0.66		0.47	0.28	0.50	0.60	0.56	0.31		0.21	0.32	0.23	0.60	0.36	0.47		0.21	0.25	0.29	0.22	0.48	0.31		0.37	0.25	0.25	0.22	1.01			
	Niigata (6.65, REV)	0.49		0.34	0.40	0.40	0.48	0.28	0.28		0.39	0.36	0.27	0.42	0.45	0.69		0.34	0.62	0.67	0.47	0.40	0.74		0.34	0.62	0.64	0.61	0.23			
	Northridge (6.73, REV)	0.44	0.69	0.30	0.25	0.27	0.20	0.17	0.26	0.48	0.37	0.36	0.23	0.32	0.21	0.31	0.58	0.38	0.25	0.30	0.36	0.45	0.25	0.46	0.36	0.27	0.28	0.29	0.18			
	Loma Prieta (6.94, ROBL)	0.32	0.27	0.33	0.20	0.25	0.26	0.18	0.27	0.22	0.27	0.21	0.25	0.29	0.25	0.55	0.75	0.27	0.62	0.67	0.18	0.19	0.32	0.73	0.27	0.46	0.46	0.23	0.56			
	Landers (7.22, SS)	0.79		0.46	0.60	0.56	0.33	0.26	0.44		0.34	0.38	0.38	0.32	0.23	0.51		0.44	0.54	0.56	0.23	0.17	0.61		0.48	0.97	0.97	0.43	0.24			
	Average CA	0.53	0.63	0.28	0.22	0.27	0.22	0.21	0.34	0.40	0.29	0.22	0.23	0.25	0.21	0.51	0.66	0.23	0.44	0.49	0.26	0.24	0.35	0.56	0.29	0.45	0.45	0.25	0.42			
	Average ALL	0.54	0.63	0.25	0.20	0.30	0.25	0.27	0.33	0.40	0.28	0.25	0.23	0.31	0.26	0.52	0.66	0.24	0.44	0.48	0.26	0.24	0.41	0.56	0.28	0.43	0.43	0.28	0.47			
Rrup=[20-70] km	Whittier Narrows (5.89, REV)	0.29	0.33	0.40	0.21	0.31	0.31	0.22	0.33	0.50	0.35	0.23	0.29	0.27	0.24	0.60	0.35	0.30	0.49	0.54	0.52	0.29	0.75	0.44	0.14	0.52	0.52	0.31	0.19			
	North Palm Springs (6.12, ROBL)	0.81	0.72	0.62	0.41	0.46	0.42	0.35	0.60	0.49	0.31	0.25	0.28	0.29	0.24	0.23	0.39	0.44	0.27	0.33	0.41	0.25	0.50	0.59	0.34	0.50	0.50	0.09	0.28			
	Tottori (6.59, SS)	0.35		0.31	0.75	0.26	1.08	0.22	0.50		0.34	0.35	0.37	0.53	0.48	1.04		0.50	0.70	0.74	0.49	0.44	0.73		0.20	0.55	0.55	0.36	0.39			
	Niigata (6.65, REV)	0.61		0.31	0.49	0.29	0.48	0.38	0.51		0.29	0.35	0.38	0.33	0.34	0.99		0.52	0.97	1.00	0.67	0.25	1.19		0.40	1.12	1.12	0.72	0.25			
	Northridge (6.73, REV)	0.22	0.30	0.21	0.18	0.59	0.32	0.17	0.38	0.51	0.29	0.24	0.52	0.24	0.21	0.49	0.51	0.57	0.38	0.44	0.38	0.45	0.64	0.61	0.35	0.63	0.63	0.27	0.18			
	Loma Prieta (6.94, ROBL)	0.48	0.39	0.27	0.38	0.38	0.34	0.42	0.41	0.27	0.28	0.34	0.31	0.24	0.35	0.53	0.87	0.38	0.65	0.68	0.24	0.30	0.22	0.54	0.39	0.42	0.42	0.48	0.67			
	Landers (7.22, SS)	0.29		0.25	0.52	0.33	0.30	0.20	0.29		0.39	0.48	0.39	0.29	0.31	0.72		0.70	0.71	0.74	0.48	0.43	0.77		0.44	0.91	0.91	0.41	0.25			
	Average CA	0.28	0.34	0.28	0.28	0.33	0.27	0.22	0.30	0.44	0.26	0.30	0.35	0.25	0.26	0.55	0.56	0.49	0.53	0.58	0.40	0.32	0.57	0.56	0.30	0.70	0.70	0.27	0.29			
	Average ALL	0.33	0.34	0.29	0.27	0.31	0.30	0.21	0.32	0.44	0.28	0.31	0.35	0.26	0.29	0.69	0.56	0.50	0.63	0.67	0.45	0.33	0.78	0.56	0.31	0.78	0.78	0.42	0.30			
Rrup=[70-200] km	Whittier Narrows (5.89, REV)						0.14							0.49																		
	North Palm Springs (6.12, ROBL)	0.36	0.12	0.15	0.14	0.20	0.25	0.38	0.56	0.15	0.46	0.37	0.43	0.43	0.38	0.27	0.52	0.46	0.39	0.30	0.35	0.50							0.60			
	Tottori (6.59, SS)	0.30		0.54	0.77	0.35	0.63	0.39	0.54		0.53	0.43	0.61	0.38	0.38	1.00		0.52	0.55	0.55	0.51	0.50	0.68		0.81	0.48	0.45	0.32	0.59			
	Niigata (6.65, REV)	0.67		0.31	0.33	0.40	0.49	0.40	1.18		0.44	0.65	0.32	0.81	0.46	1.57		0.52	1.32	1.12	1.05	0.46	1.62		0.33	1.53	1.22	0.92	0.25			
	Northridge (6.73, REV)	0.41	0.55	0.27	0.48	0.33	0.18	0.49	0.53	0.87	0.32	0.55	0.44	0.40	0.53	0.64	0.52	0.87	0.48	0.51	0.56	0.46	0.21	0.15	0.58	0.29	0.29	0.18	0.00			
	Loma Prieta (6.94, ROBL)	0.44	0.57	0.60	0.55	0.65	0.45	0.50	0.48	0.87	0.64	0.69	0.85	0.73	0.58	0.57	0.49	0.88	0.57	0.54	1.19	0.90	0.30	0.38	0.48	0.37	0.37	0.79	0.00			
	Landers (7.22, SS)	0.49		0.08	0.14	0.30	0.18	0.37	0.65		0.32	0.22	0.41	0.22	0.21	0.46		0.37	0.20	0.21	0.45	0.40	0.26		0.35	0.24	0.43	0.78	0.72			
	Average CA	0.36	0.48	0.22	0.21	0.23	0.23	0.36	0.47	0.73	0.25	0.28	0.31	0.34	0.31	0.42	0.44	0.36	0.29	0.28	0.56	0.31	0.26	0.36	0.36	0.25	0.40	0.77	0.66			
	Average ALL	0.43	0.48	0.33	0.39	0.31	0.33	0.37	0.69	0.73	0.29	0.31	0.39	0.34	0.28	0.91	0.44	0.36	0.63	0.57	0.52	0.33	0.97	0.36	0.46	0.85	0.71	0.50	0.52			
Mechanism	Reverse (REV)	0.37	0.43	0.29	0.26	0.33	0.28	0.24	0.39	0.39	0.27	0.28	0.32	0.31	0.26	0.81	0.50	0.42	0.67	0.68	0.56	0.30	1.12	0.54	0.32	1.05	0.95	0.66	0.19			
	Reverse-Oblique (ROBL)	0.33	0.32	0.37	0.24	0.29	0.25	0.27	0.30	0.33	0.26	0.25	0.27	0.26	0.43	0.69	0.31	0.50	0.54	0.30	0.35	0.27	0.61	0.35	0.43	0.43	0.37	0.51				
	Strike-Slip (SS)	0.36		0.21	0.35	0.26	0.47	0.25	0.46		0.29	0.29	0.31	0.35	0.27	0.75		0.42	0.52	0.54	0.37	0.29	0.60		0.37	0.55	0.54	0.30	0.62			
	Normal (NM)																															
	Average ALL	0.36	0.38	0.27	0.23	0.29	0.23	0.24	0.30	0.36	0.23	0.25	0.28	0.25	0.51	0.59	0.39	0.45	0.49	0.31	0.26	0.45	0.58	0.27	0.55	0.54	0.34	0.39				
Totals	Average CA	0.36	0.38	0.27	0.23	0.29	0.23	0.24	0.30	0.23	0.25	0.28	0.25	0.51	0.59	0.39	0.45	0.49	0.31	0.26	0.45	0.58	0.27	0.55	0.54	0.34	0.39					
Average ALL	0.36	0.38	0.29	0.28	0.27	0.30	0.25	0.39	0.36	0.25	0.28	0.29	0.28	0.26	0.70	0.59	0.39	0.58	0.59	0.42	0.27	0.76	0.58	0.29	0.72	0.68	0.42	0.41				

9/8/12

SGEC Annual Meeting

Change the values below ↕

Part A, GOF Validation Threshold = 1.01
 Unacceptable Threshold = 1.50
 weight= 0.50

Combined Metric Performance Level

Exp. to Work Pot. Issues Definite Issues

Combined Metric vs. GMPE

		PSA Period Range = [0.01-0.1] s								PSA Period Range = [0.1-1] s								PSA Period Range = [1-3] s								PSA Period Range > 3s							
Event (Mw, Mech.)		CSM	UCSB	EXSIM	G&P	SDSU	GMPE	SMSIM	CSM	UCSB	EXSIM	G&P	SDSU	GMPE	SMSIM	CSM	UCSB	EXSIM	G&P	SDSU	GMPE	SMSIM	CSM	UCSB	EXSIM	G&P	SDSU	GMPE	SMSIM				
Rup=[0-5] km	Whittier Narrows (5.89, REV)																																
	North Palm Springs (6.12, ROBL)	4.06	4.94	2.38	0.44	2.75	0.16	1.63	3.29	6.52	1.48	0.74	1.97	0.16	2.71	3.80	8.73	1.33	4.00	4.33	0.15	2.47	1.96	3.24	0.16	2.16	2.18	0.50					
	Tottori (6.59, SS)	5.09		5.13	0.41	1.52	0.23	0.43	0.60		0.66	0.73	0.86	0.62	2.02	1.33		1.81	2.00	2.10	0.11	11.14	0.24		0.56	1.00	1.00	0.41	2.85				
	Niigata (6.65, REV)																																
	Northridge (6.73, REV)																																
	Loma Prieta (6.94, ROBL)	2.94	3.56	0.90	0.86	0.86	0.25	1.50	2.61	3.32	1.20	0.88	1.22	0.21	1.41	0.73	1.87	1.13	0.85	0.92	0.59	1.05	1.34	3.67	1.07	2.16	2.20	0.31	1.28				
	Landers (7.22, SS)	0.32		0.67	0.72	0.86	1.05	1.34	0.49		0.35	0.59	0.49	0.69	1.52	0.29		0.68	0.38	0.31	0.93	1.65	0.84		0.91	0.25	0.25	1.17	1.78				
	Average CA	2.00	2.70	1.11	0.80	1.23	0.32	2.13	1.67	2.64	0.83	0.74	0.97	0.29	2.02	0.67	2.09	1.02	0.76	0.83	0.55	1.52	0.74	2.15	1.13	0.77	0.78	0.54	1.93				
Average ALL	2.38	2.84	0.95	0.69	1.08	0.31	1.76	1.35	2.22	0.68	0.72	0.94	0.35	2.18	0.71	2.42	0.99	0.81	0.87	0.48	1.94	0.79	2.76	1.13	0.99	1.00	0.42	2.58					
Rup=[5-20] km	Whittier Narrows (5.89, REV)	2.63	2.98	0.93	0.88	0.93	0.30	0.73	2.49	1.41	1.54	0.98	0.88	0.21	1.17	2.07	1.42	0.48	1.14	1.26	0.44	0.66	1.58	1.26	0.45	1.38	1.30	0.81	0.23				
	North Palm Springs (6.12, ROBL)	2.33	2.94	0.94	1.35	0.98	0.25	1.22	1.63	2.48	0.95	1.16	1.14	0.28	1.18	1.04	1.85	0.67	1.21	1.37	0.39	1.41	0.27	0.72	0.64	0.36	0.36	0.45	2.22				
	Tottori (6.59, SS)	1.09		0.78	0.46	0.83	0.60	0.93	0.52		0.34	0.54	0.38	0.60	0.60	2.14		0.93	1.14	1.32	0.22	2.18	1.42		1.70	1.14	1.16	0.22	4.70				
	Niigata (6.65, REV)	1.02		0.72	0.84	0.83	0.48	0.59	0.67		0.93	0.86	0.64	0.42	1.06	1.48		0.73	1.32	1.44	0.47	0.85	1.21		0.56	1.02	1.04	0.61	0.37				
	Northridge (6.73, REV)	2.20	3.43	1.48	1.25	1.35	0.20	0.83	0.81	1.50	1.14	1.11	0.70	0.32	0.66	0.86	1.61	1.04	0.68	0.82	0.36	1.24	0.86	1.60	1.26	0.95	0.98	0.29	0.63				
	Loma Prieta (6.94, ROBL)	1.23	1.02	1.25	0.77	0.96	0.26	0.67	0.95	0.77	0.95	0.74	0.86	0.29	0.88	3.03	4.17	1.47	3.42	3.69	0.18	1.03	1.42	3.24	1.20	2.02	2.02	0.23	2.49				
	Landers (7.22, SS)	2.43	0.00	1.42	1.85	1.72	0.33	0.80	1.40		1.08	1.21	1.19	0.32	0.73	2.22		1.91	2.33	2.43	0.23	0.74	1.44		1.12	2.28	2.28	0.43	0.56				
	Average CA	2.39	2.86	1.27	0.98	1.20	0.22	0.97	1.34	1.58	1.14	0.88	0.90	0.25	0.82	1.98	2.57	0.90	1.73	1.90	0.26	0.96	1.43	2.29	1.16	1.82	1.84	0.25	1.70				
Average ALL	2.18	2.57	1.02	0.82	1.20	0.25	1.10	1.08	1.30	0.92	0.80	0.74	0.31	0.86	2.00	2.52	0.90	1.67	1.83	0.26	0.94	1.46	2.00	0.98	1.52	1.54	0.28	1.69					
Rup=[20-70] km	Whittier Narrows (5.89, REV)	0.93	1.07	1.31	0.67	1.02	0.31	0.70	1.22	1.83	1.30	0.85	1.07	0.27	0.89	1.16	0.67	0.57	0.94	1.05	0.52	0.56	2.46	1.44	0.46	1.70	1.70	0.31	0.62				
	North Palm Springs (6.12, ROBL)	1.93	1.70	1.46	0.96	1.08	0.42	0.83	2.05	1.69	1.07	0.86	0.97	0.29	0.81	0.56	0.95	1.09	0.65	0.80	0.41	0.60	5.56	6.56	3.78	5.56	5.56	0.99	3.06				
	Tottori (6.59, SS)	0.32		0.29	0.69	0.24	1.08	0.20	0.95		0.64	0.66	0.70	0.53	0.91	2.14		1.02	1.43	1.53	0.49	0.91	2.03		0.54	1.53	1.53	0.36	1.07				
	Niigata (6.65, REV)	1.28		0.65	1.03	0.61	0.48	0.80	1.55		0.88	1.06	1.15	0.33	1.03	1.49		0.78	1.45	1.50	0.67	0.38	1.65		0.56	1.55	1.55	0.72	0.35				
	Northridge (6.73, REV)	0.68	0.94	0.65	0.56	1.86	0.32	0.52	1.62	2.17	1.21	1.00	2.21	0.24	0.89	1.29	1.36	1.52	1.01	1.16	0.38	1.19	2.42	2.30	1.30	2.38	2.38	0.27	0.68				
	Loma Prieta (6.94, ROBL)	1.40	1.13	0.78	1.12	1.12	0.34	1.22	1.72	1.15	1.17	1.45	1.32	0.24	1.47	2.21	3.60	1.56	2.71	2.83	0.24	1.25	0.46	1.11	0.80	0.86	0.86	0.48	1.40				
	Landers (7.22, SS)	0.98		0.85	1.75	1.10	0.30	0.68	1.00		1.34	1.66	1.34	0.29	1.07	1.49		1.45	1.47	1.54	0.48	0.89	1.90		1.07	2.23	2.23	0.41	0.60				
	Average CA	1.02	1.26	1.02	1.02	1.22	0.27	0.83	1.20	1.74	1.04	1.20	1.38	0.25	1.05	1.39	1.42	1.23	1.34	1.46	0.40	0.82	2.15	2.11	1.13	2.62	2.62	0.27	1.11				
Average ALL	1.10	1.15	0.97	0.92	1.03	0.30	0.70	1.24	1.71	1.08	1.22	1.37	0.26	1.12	1.52	1.24	1.10	1.39	1.48	0.45	0.73	1.86	1.33	0.73	1.86	1.86	0.42	0.72					
Rup=[70-200] km	Whittier Narrows (5.89, REV)																																
	North Palm Springs (6.12, ROBL)	1.47	0.47	0.61	0.57	0.82	0.25	1.55	1.32	0.35	1.07	0.87	1.00	0.43	0.89	0.76	1.49	1.30	1.10	0.86	0.35	1.43											
	Tottori (6.59, SS)	0.47		0.86	1.22	0.55	0.63	0.61	1.41		1.38	1.13	1.59	0.38	1.00	1.96		1.02	1.07	1.07	0.51	0.98	2.16		2.56	1.52	1.41	0.32	1.87				
	Niigata (6.65, REV)	1.36		0.62	0.66	0.81	0.49	0.82	1.47		0.55	0.81	0.40	0.81	0.57	1.50		0.50	1.25	1.06	1.05	0.43	1.77			0.36	1.67	1.33	0.92	0.27			
	Northridge (6.73, REV)	2.31	3.14	1.54	2.74	1.86	0.18	2.80	1.34	2.19	0.81	1.39	1.11	0.40	1.34	1.14	0.94	1.57	0.86	0.91	0.56	0.82	1.20	0.86	3.31	1.66	1.66	0.18					
	Loma Prieta (6.94, ROBL)	0.98	1.27	1.33	1.22	1.44	0.45	1.10	0.66	1.19	0.87	0.95	1.16	0.73	0.79	0.47	0.41	0.74	0.48	0.45	1.19	0.75	0.38	0.48	0.61	0.46	0.46	0.79					
	Landers (7.22, SS)	2.72		0.42	0.75	1.64	0.18	2.03	2.95		1.45	1.00	1.86	0.22	0.93	1.02		0.81	0.44	0.46	0.45	0.88	0.33		0.45	0.30	0.55	0.78	0.93				
	Average CA	1.57	2.07	0.96	0.91	0.98	0.23	1.57	1.37	2.13	0.72	0.81	0.90	0.34	0.92	0.76	0.79	0.65	0.51	0.50	0.56	0.56	0.33	0.46	0.46	0.32	0.52	0.77	0.85				
Average ALL	1.30	1.44	1.00	1.18	0.94	0.33	1.12	2.06	2.16	0.85	0.91	1.15	0.34	0.82	1.75	0.85	0.69	1.20	1.10	0.52	0.63	1.94	0.71	0.92	1.70	1.42	0.50	1.04					
Mechanism	Reverse (REV)	1.32	1.52	1.04	0.93	1.18	0.28	0.85	1.24	1.24	0.87	0.89	1.02	0.31	0.83	1.45	0.89	0.75	1.20	1.22	0.56	0.54	1.70	0.82	0.49	1.60	1.45	0.66	0.28				
	Reverse-Oblique (ROBL)	1.35	1.29	1.49	0.96	1.16	0.25	1.09	1.09	1.20	0.96	0.91	0.98	0.27	0.95	1.46	2.32	1.05	1.68	1.83	0.30	1.18	0.74	1.67	0.95	1.18	1.18	0.37	1.41				
	Strike-Slip (SS)	0.76		0.45	0.74	0.54	0.47	0.54	1.33		0.83	0.84	0.88	0.35	0.78	2.01		1.12	1.39	1.45	0.37	0.77	2.03		1.25	1.85	1.81	0.30	2.09				
	Normal (NM)																																
	Average CA	1.58	1.67	1.20	1.02	1.29	0.23	1.06	1.30	1.57	1.00	1.07	1.30	0.23	1.07	1.65	1.90	1.24	1.45	1.58	0.31	0.85	1.32	1.71	0.78	1.60	1.59	0.34	1.14				
Average ALL	1.20	1.27	0.97	0.95	0.92	0.30	0.85	1.40	1.31	0.89	1.00	1.05	0.28	0.95	1.67	1.42	0.94	1.39	1.42	0.42	0.65	1.82	1.40	0.69	1.73	1.64	0.42	0.98					

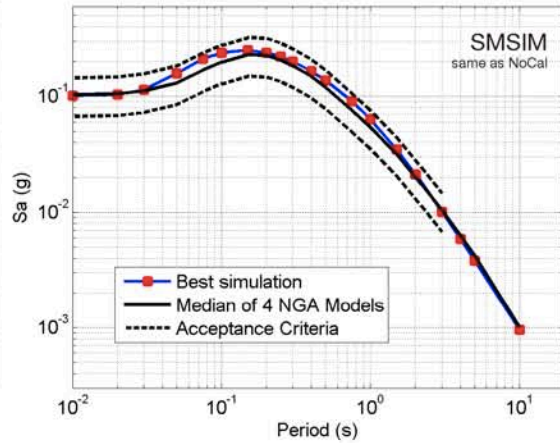
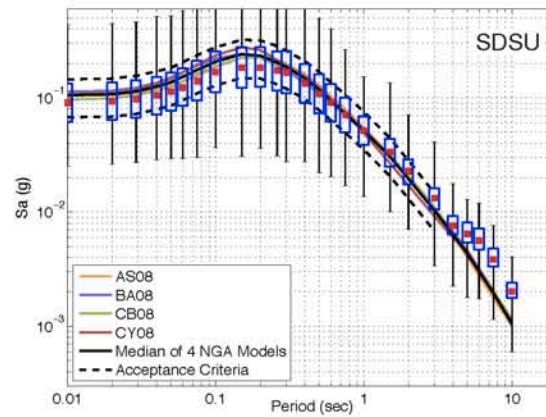
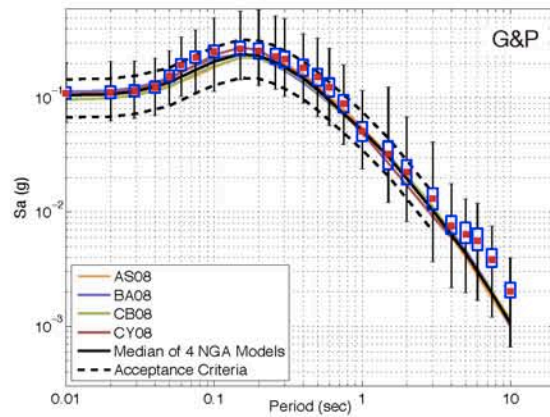
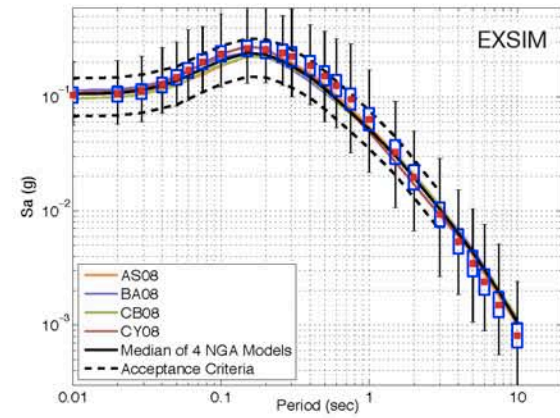
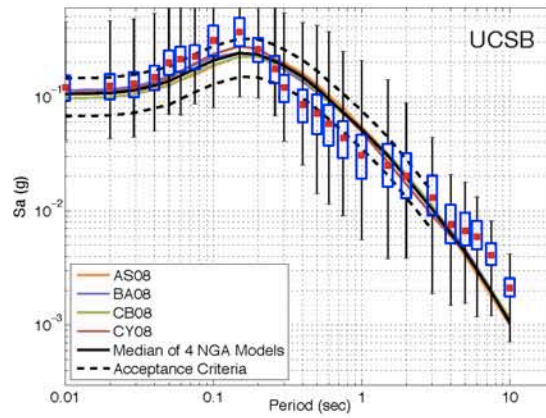
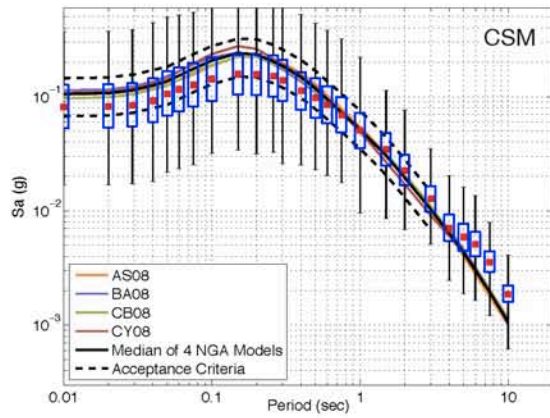
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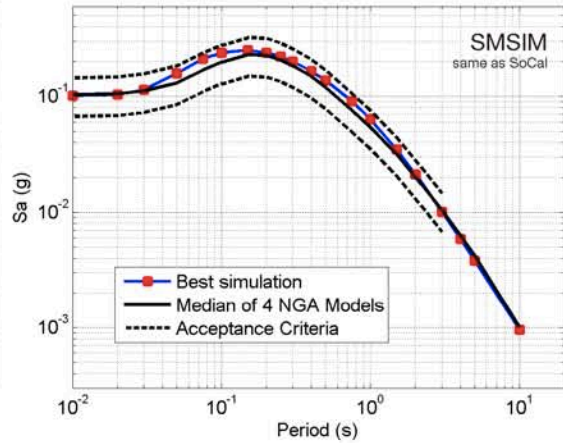
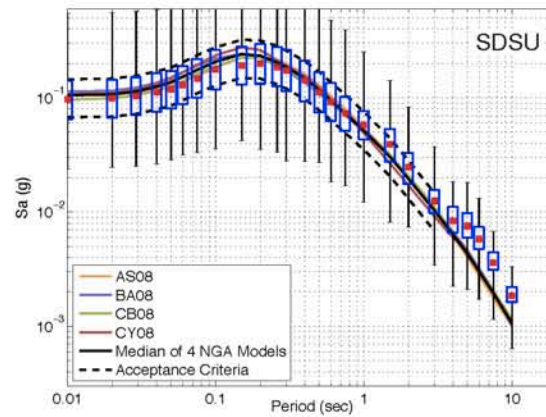
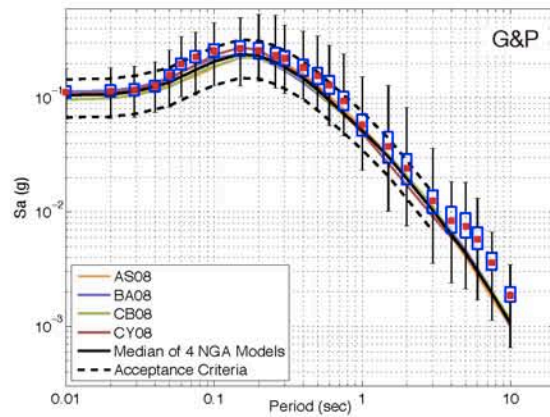
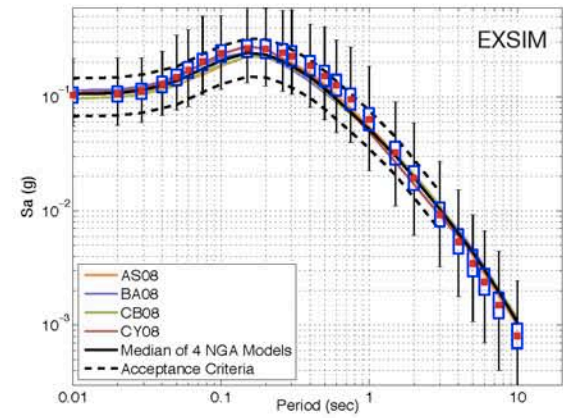
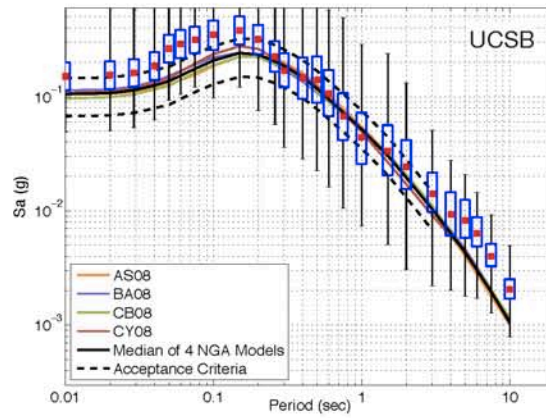
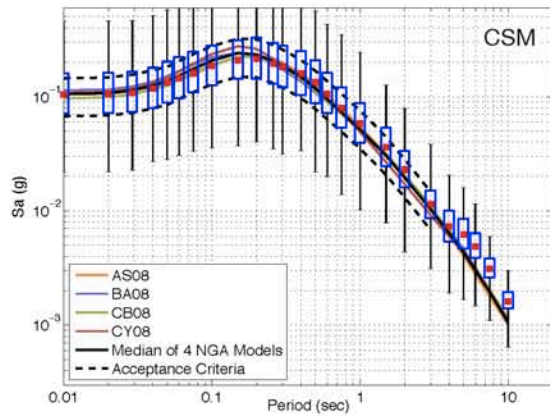
Part B Validation

- Comparison of Mw 6.2 strike-slip case for Southern & Northern California Velocity Models at 20 km distance

Part B. Southern California (M6.2, SS, $Z_{tor}=4$ km, $R_{jb}=20$ km)



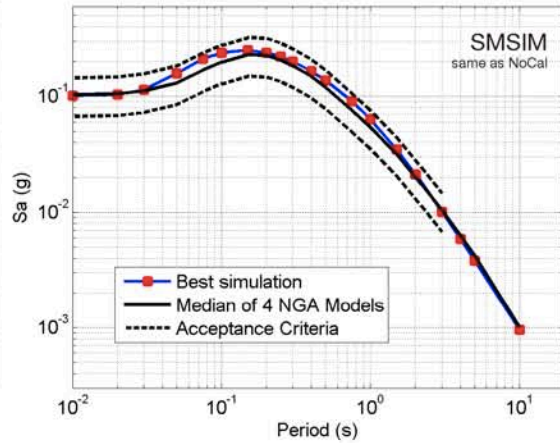
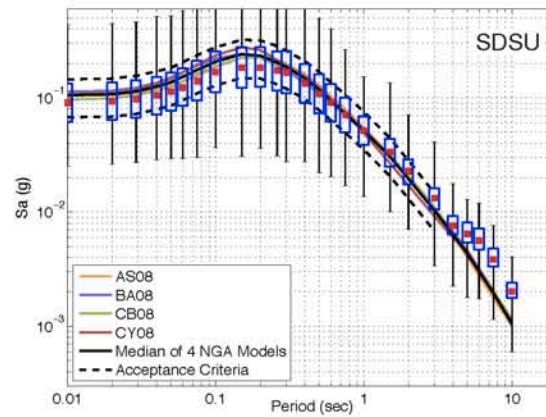
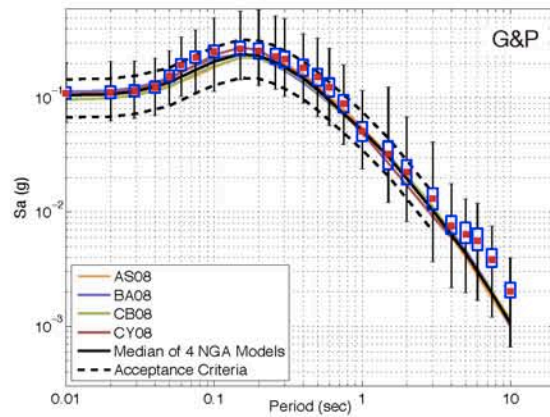
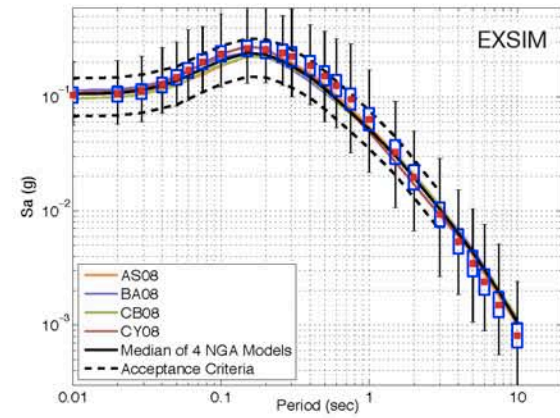
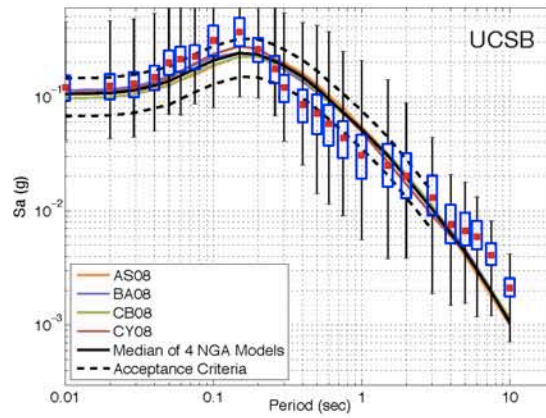
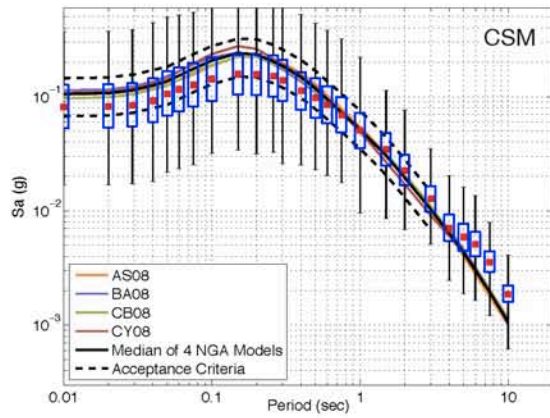
Part B. Northern California (M6.2, SS, $Z_{tor}=4$ km, $R_{jb}=20$ km)



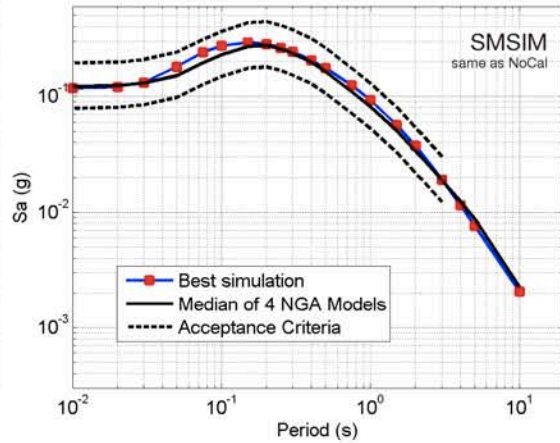
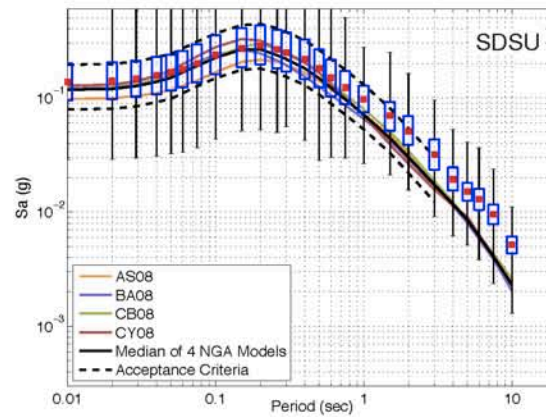
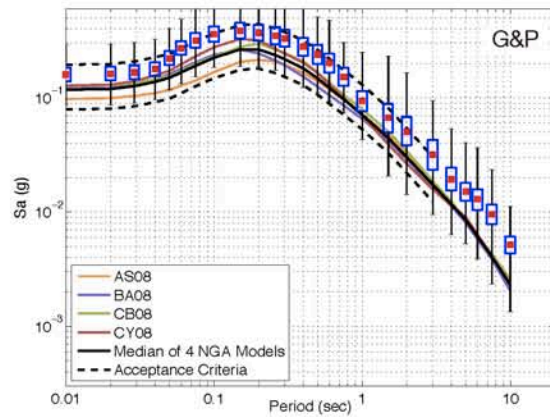
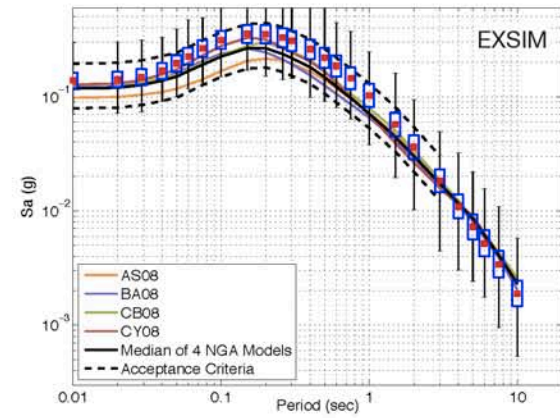
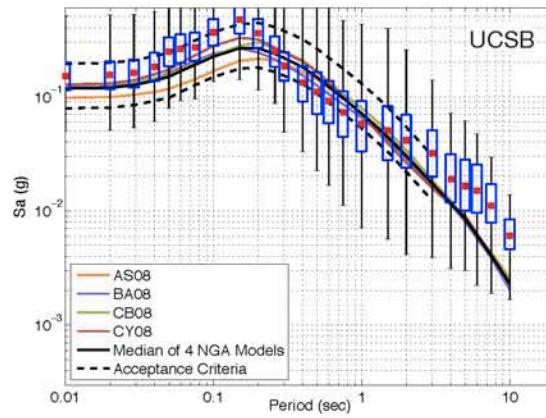
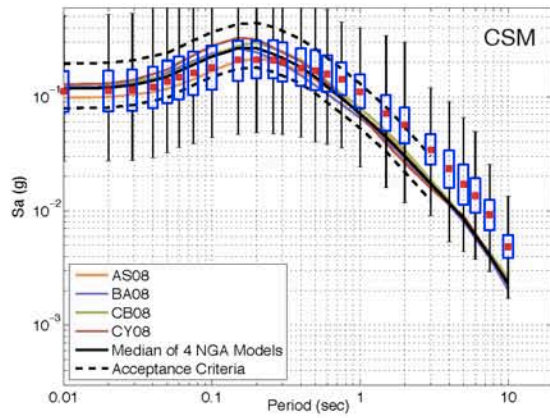
Part B Validation

- Comparison of Mw6.2 and Mw6.6 for Strike-slip case and Mw6.6 for Reverse-slip case

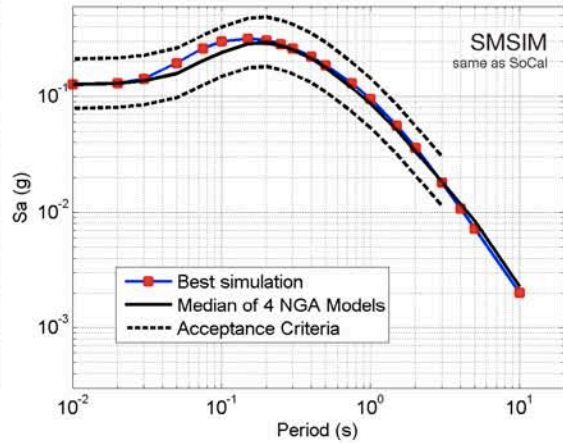
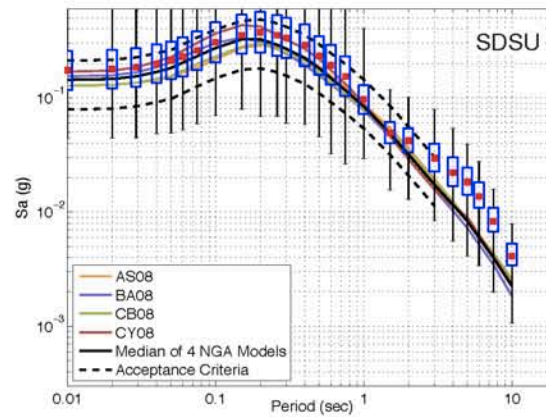
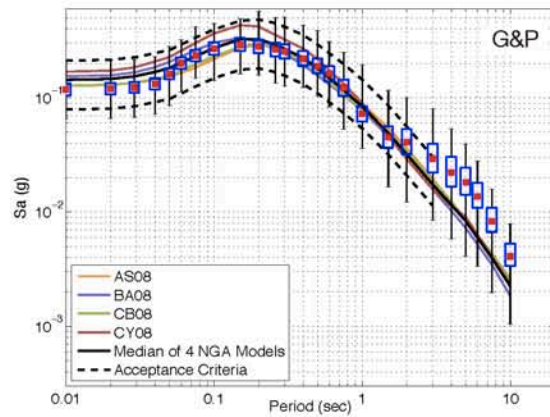
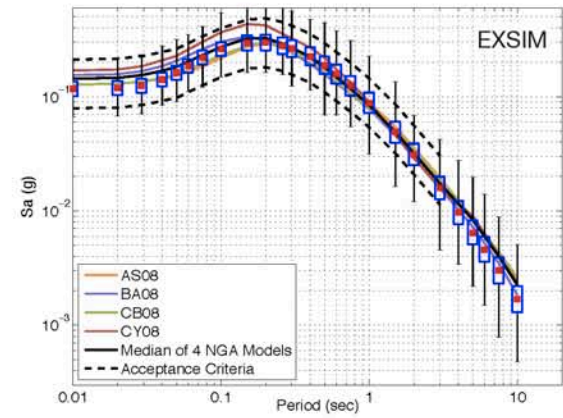
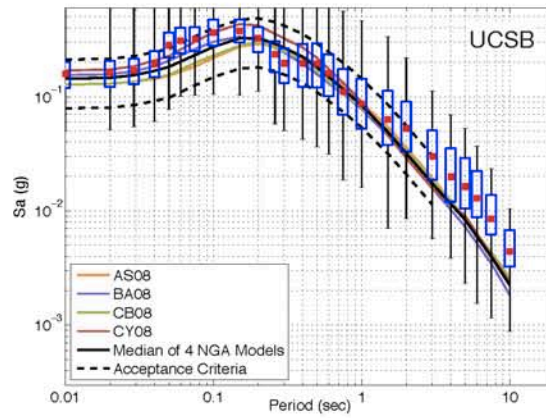
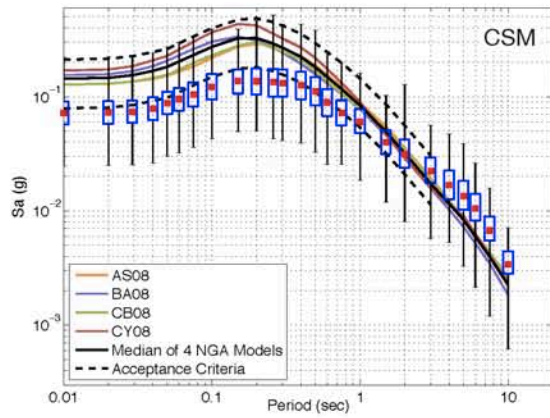
Part B. Southern California (M6.2, SS, $Z_{tor}=4$ km, $R_{jb}=20$ km)



Part B. Southern California (M6.6, SS, $Z_{\text{tor}}=0$ km, $R_{\text{jb}}=20$ km)



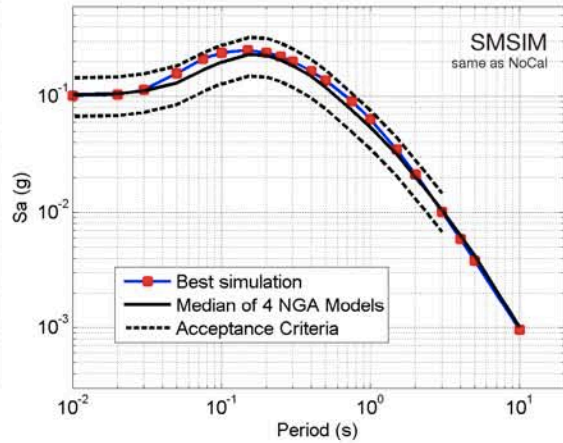
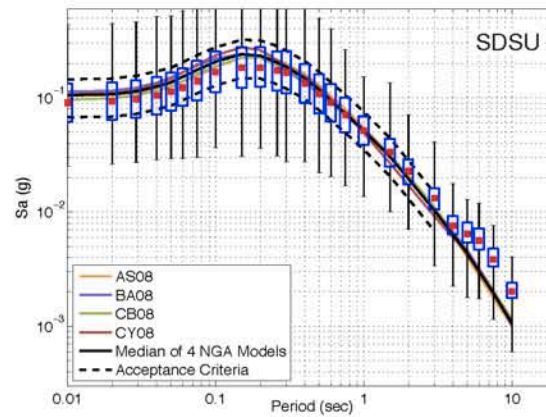
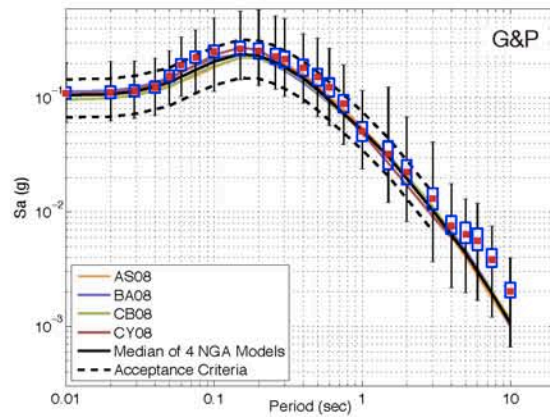
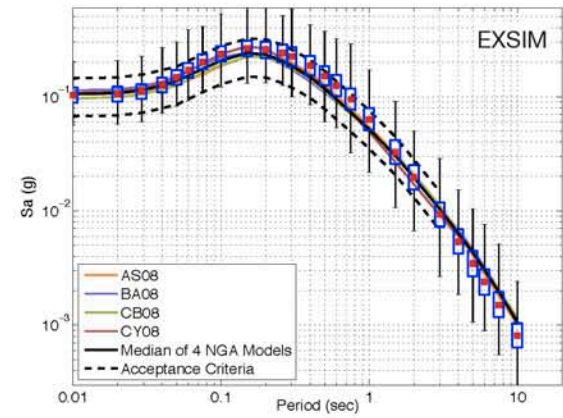
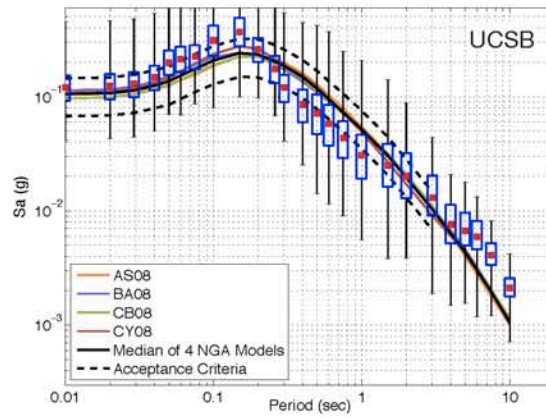
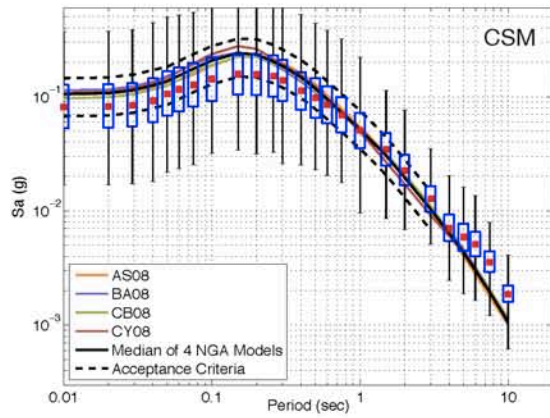
Part B. Northern California (M6.6, 45° REV, $Z_{tor}=3$ km, $R_{jb}=20$ km)



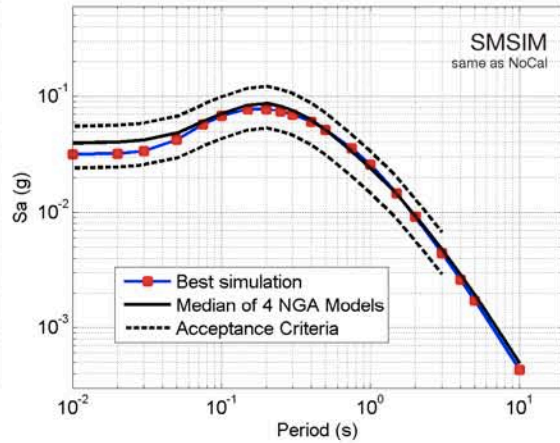
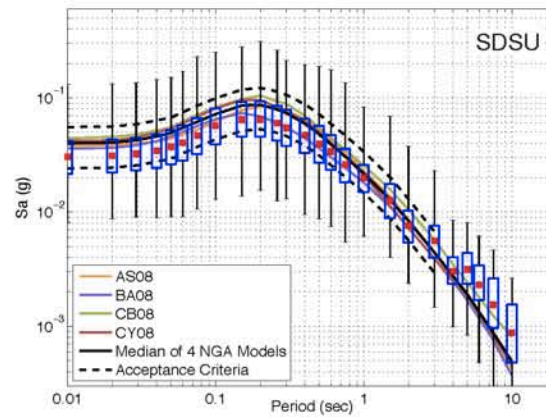
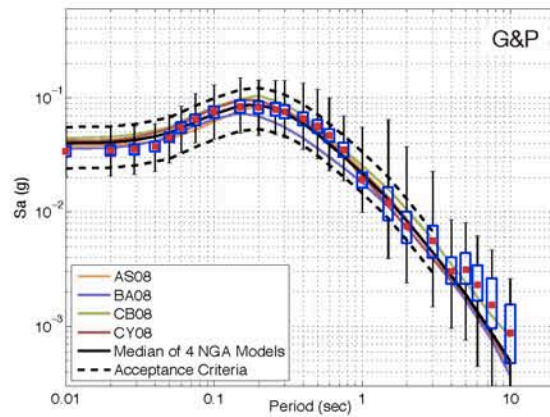
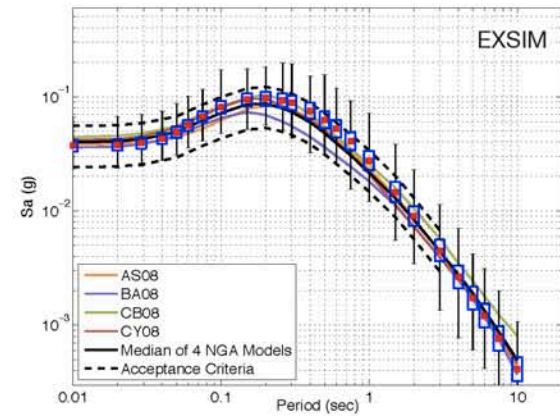
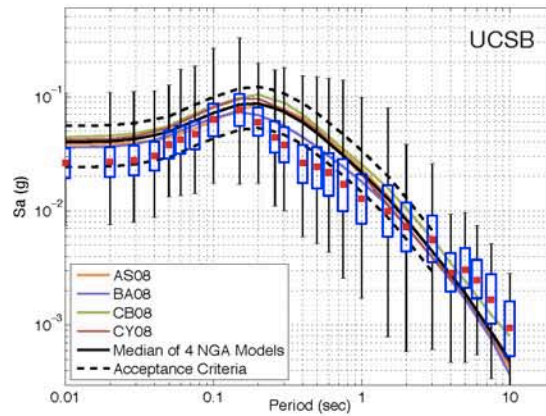
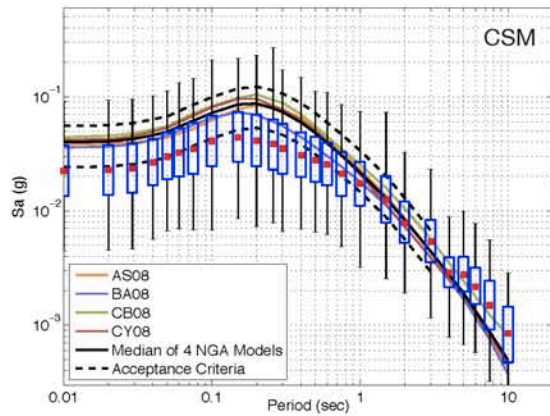
Part B Validation Continued

- Comparison of Mw6.2 Strike-slip cases for distances of 20 and 50 km for the Southern California velocity model.
- Comparison of Mw6.6 Strike-slip cases for distances of 20 and 50 km for the Southern California velocity model.
- Comparison of Mw6.6 Reverse-slip cases for distances of 20 and 50 km for the Southern California velocity model.

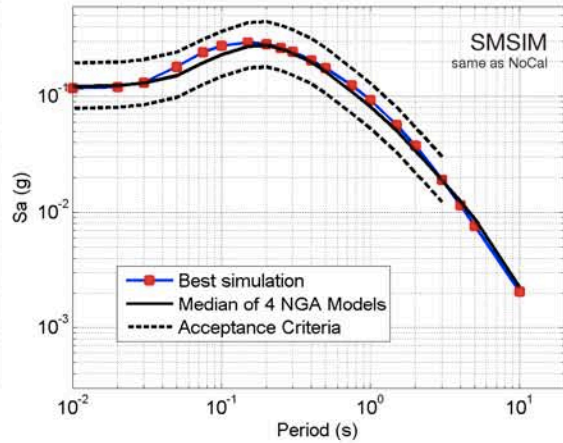
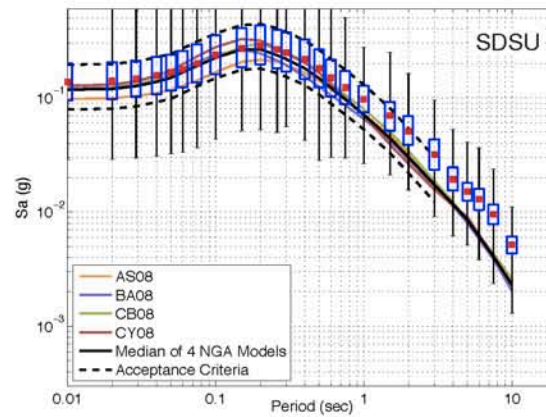
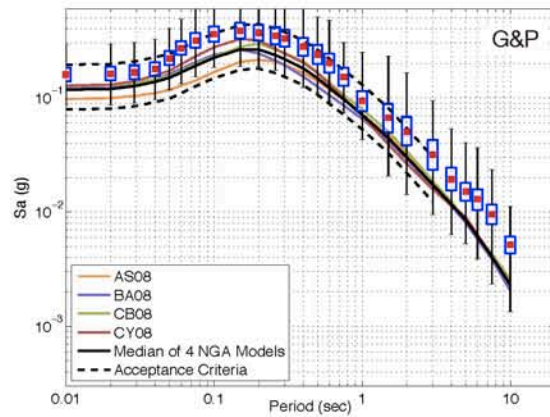
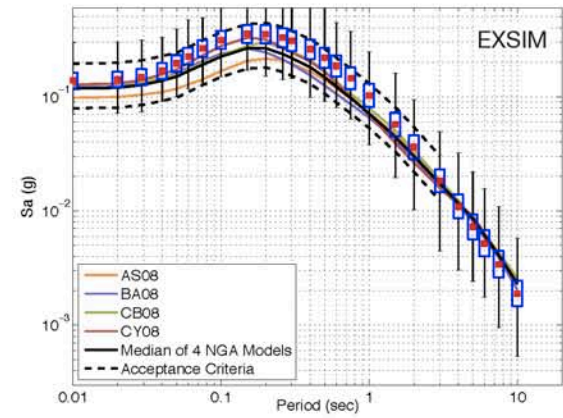
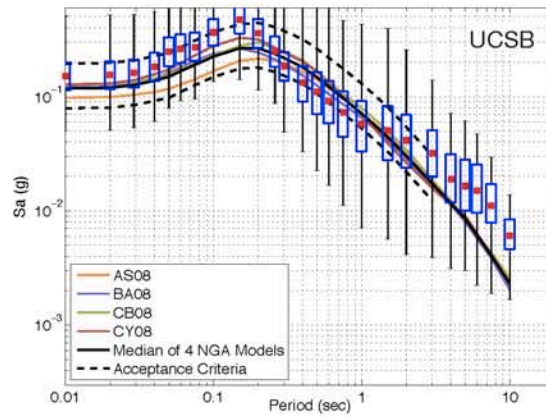
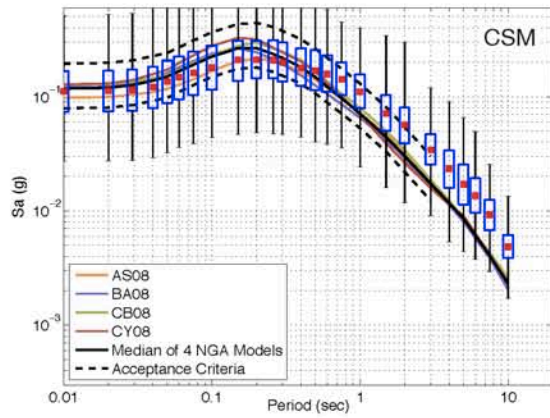
Part B. Southern California (M6.2, SS, $Z_{tor}=4$ km, $R_{jb}=20$ km)



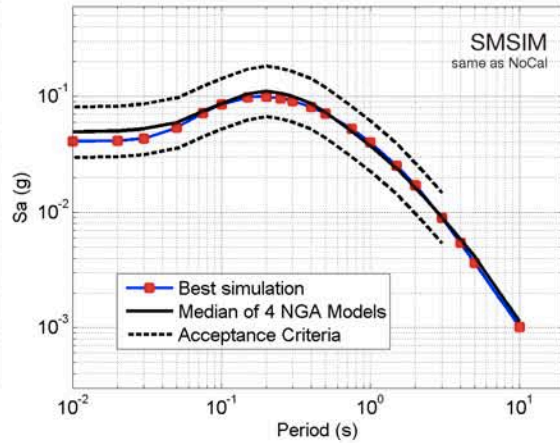
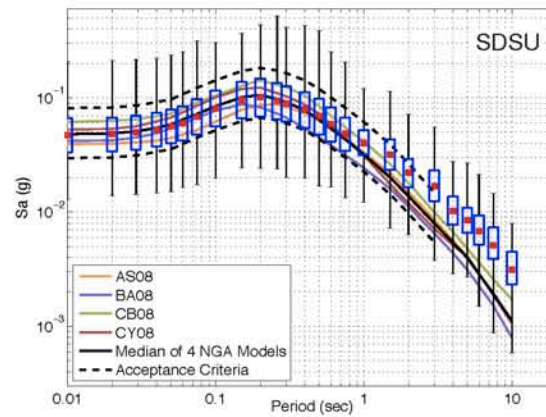
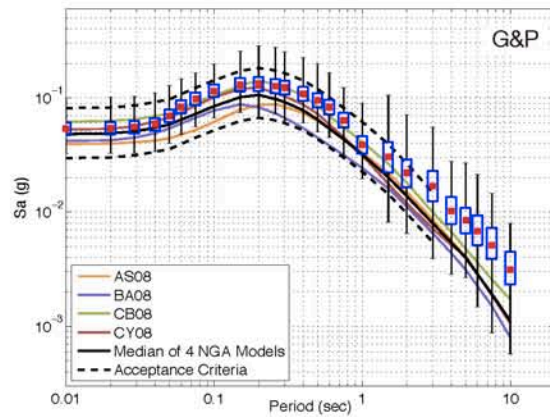
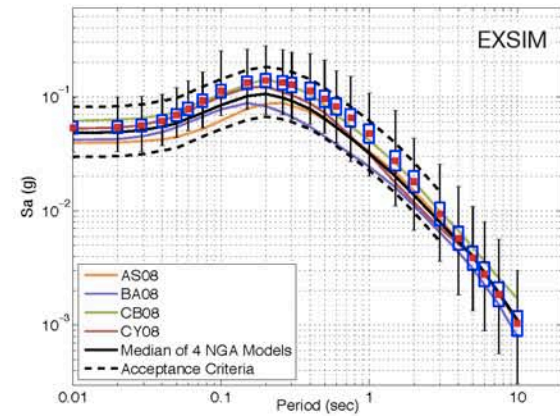
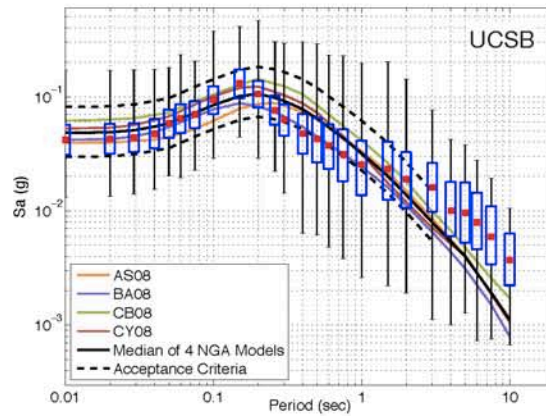
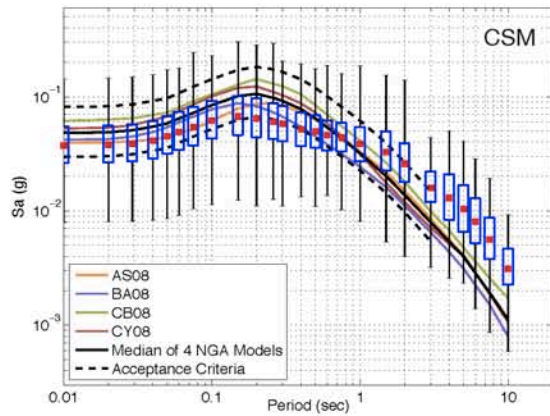
Part B. Southern California (M6.2, SS, $Z_{tor}=4$ km, $R_{jb}=50$ km)



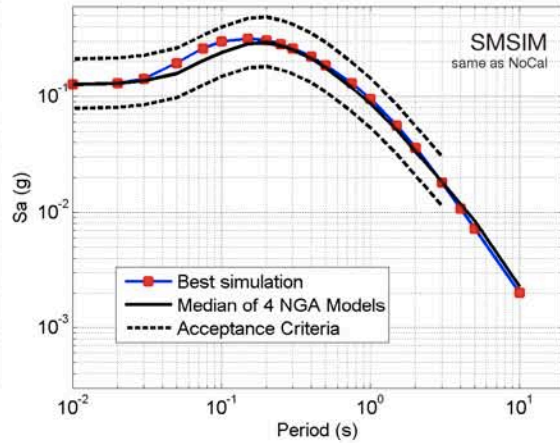
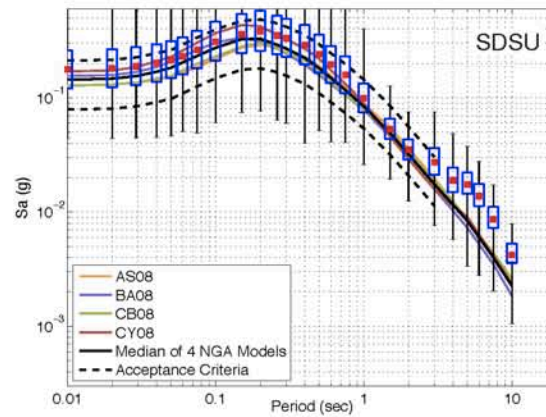
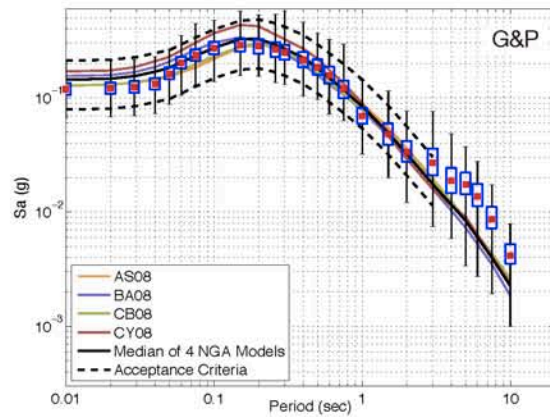
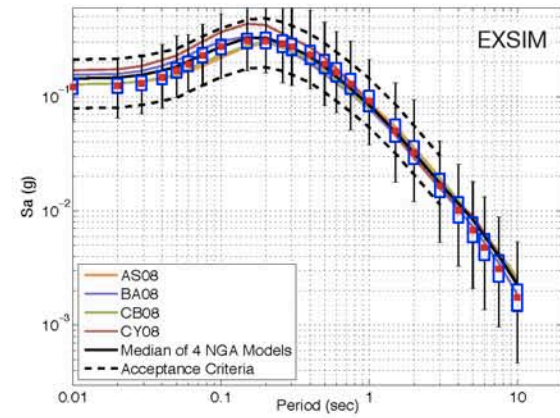
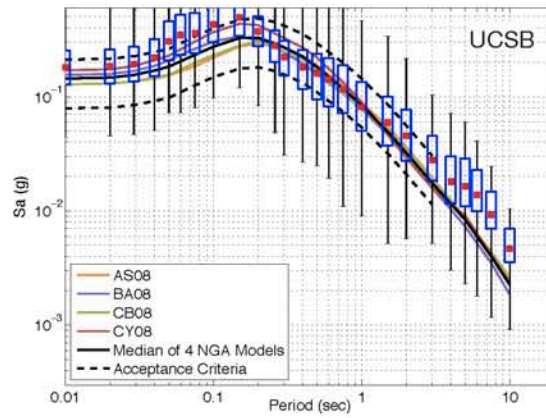
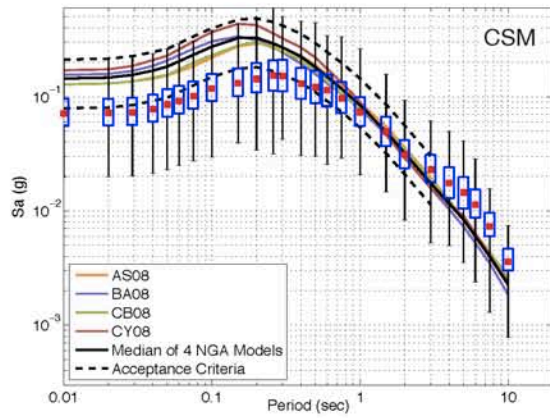
Part B. Southern California (M6.6, SS, $Z_{tor}=0$ km, $R_{jb}=20$ km)



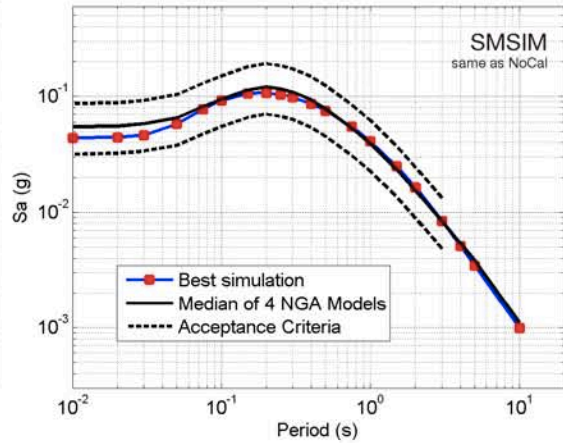
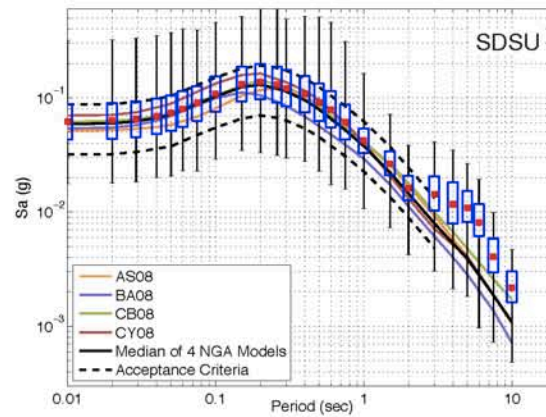
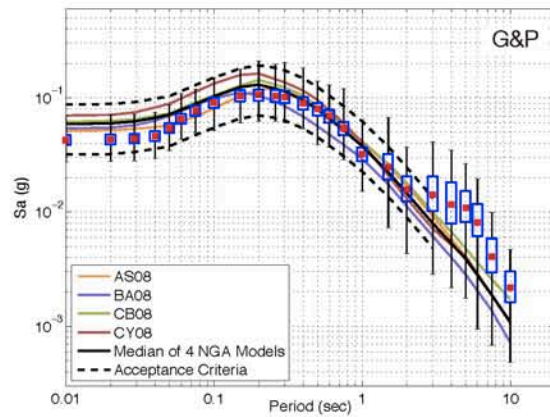
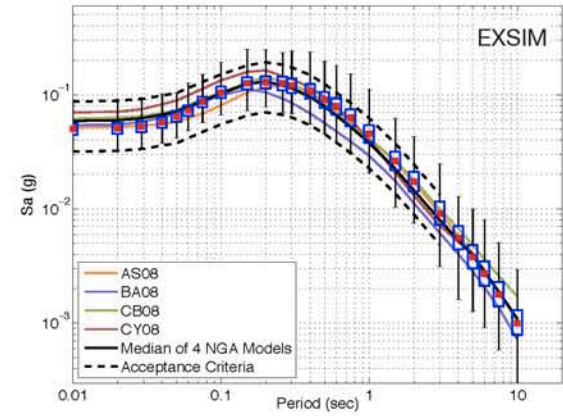
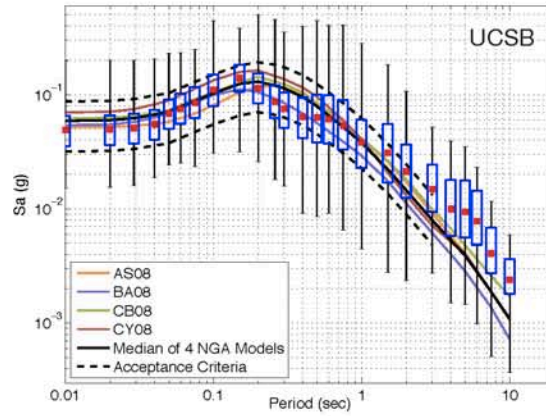
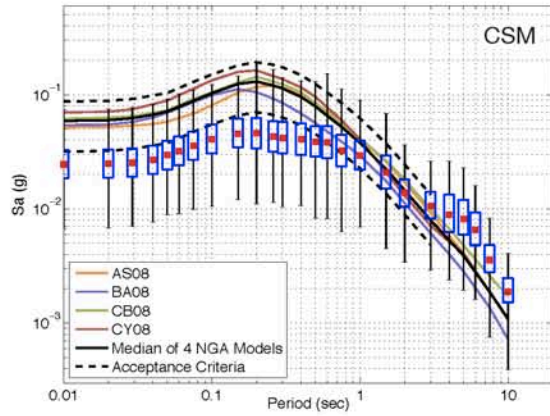
Part B. Southern California (M6.6, SS, $Z_{tor}=0$ km, $R_{jb}=50$ km)



Part B. Southern California (M6.6, 45° REV, $Z_{tor}=3$ km, $R_{jb}=20$ km)



Part B. Southern California (M6.6, 45° REV, $Z_{tor}=3$ km, $R_{jb}=50$ km)



Review Panel Findings

- Details are in a 33 page report with 5 appendices submitted on August 1, 2013
- The BBP objective of a version-controlled numerical test bed with common post-processing tools was successful in producing results enabling straightforward analysis and review.
- All of the currently implemented methods should continue to be refined and improved to provide a variety of options for users and to capture epistemic uncertainty.
- Three methods, EXSIM, G&P and SDSU were found to be suitable for simulation of spectral acceleration from 0.01 to 3 seconds period over the distance range from 0 to 200 km within the validation magnitude range (Mw 5.9-7.2).
- The methods are deemed suitable up to Mw 8 for purposes of assessing relative effects of changes in source geometry, rupture direction, presence of secondary slip on splays, hanging wall effects, etc. Additional work is needed for absolute amplitudes.
- At periods larger than 1 second there is increased bias, and for periods larger than 3 seconds there are significant deviations from GMPEs.