

Plans for validations using newly-implemented ground motion parameters

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Outline

- (1) Recently implemented validations (in another SCEC project)
- (2) Plans for validations using newly-implemented ground motion parameters (GMPs)

(1) Recently implemented validations: Anderson (2004) criteria

- Criteria are applied in both the frequency and time domain for a set of measures.
- Measurements are compared at every frequency or time step for which they are computed, with scores for each comparison, which are combined to provide a final score (values ranging from 0 to 10)
- The 10 measures are defined here; table from Anderson (2004)

Number	Symbol	Name: Similarity of	Definition ¹
C1	SDa	Arias duration	$10[1 - \max(F^{IA}(t))]$ where $F^{IA}(t) = N_1^{IA}(t) - N_2^{IA}(t) $ and $N^{IA}(t) = \frac{I_A(t)}{IA}$
C2	SDe	Energy duration	$10[1 - \max(F^E(t))]$ where $F^E(t) = N_1^E(t) - N_2^E(t) $ and $N^{IE}(t) = \frac{I_E(t)}{IE}$
C3	SIa	Arias intensity	$S(IA_1, IA_2)$ where $IA_i = I_{Ai}(T_d)$
C4	SIv	Energy integral	$S(IE_1, IE_2)$ where $IE_i = I_{Ei}(T_d)$
C5	Spga	Peak Acceleration	$S(A_1, A_2)$ where $A_i = \max a_i(t) $
C6	Spgv	Peak Velocity	$S(V_1, V_2)$ where $V_i = \max v_i(t) $
C7	Spgd	Peak Displacement	$S(D_1, D_2)$ where $D_i = \max d_i(t) $
C8	Ssa	Response Spectra	$mean[S(SA_1(f_j), SA_2(f_j))]$, where the average is over all frequencies at which SA is computed in the frequency band being considered.
C9	Sfs	Fourier Spectra	$mean[S(FS_1(f_j), FS_2(f_j))]$, where the average is over all frequencies at which FS is computed by the fast Fourier transform in the frequency band being considered.
C10	C*	Cross Correlation	$C^* = 10 \max[C(a_1(t), a_2(t)), 0]$ where $C(a_1, a_2) = \frac{\int a_1(t)a_2(t)dt}{\left[\int a_1^2(t)dt\right]^{1/2} \left[\int a_2^2(t)dt\right]^{1/2}}$

¹Definitions of functions:

$a_2(t)$, $v_i(t)$ and $d_i(t)$ are an accelerogram and corresponding velocity and displacement, defined for $0 \leq t \leq T_d$. T_d is the total duration of strong ground motions.	$S(p_1, p_2) = 10 \exp\left\{-\left[\frac{(p_1 - p_2)}{\min(p_1, p_2)}\right]^2\right\}$
$I_{Ai}(t) = \frac{\pi}{2g} \int_0^t a_i^2(\tau) d\tau$	$I_{Ei}(t) = \int_0^t v_i^2(\tau) d\tau$

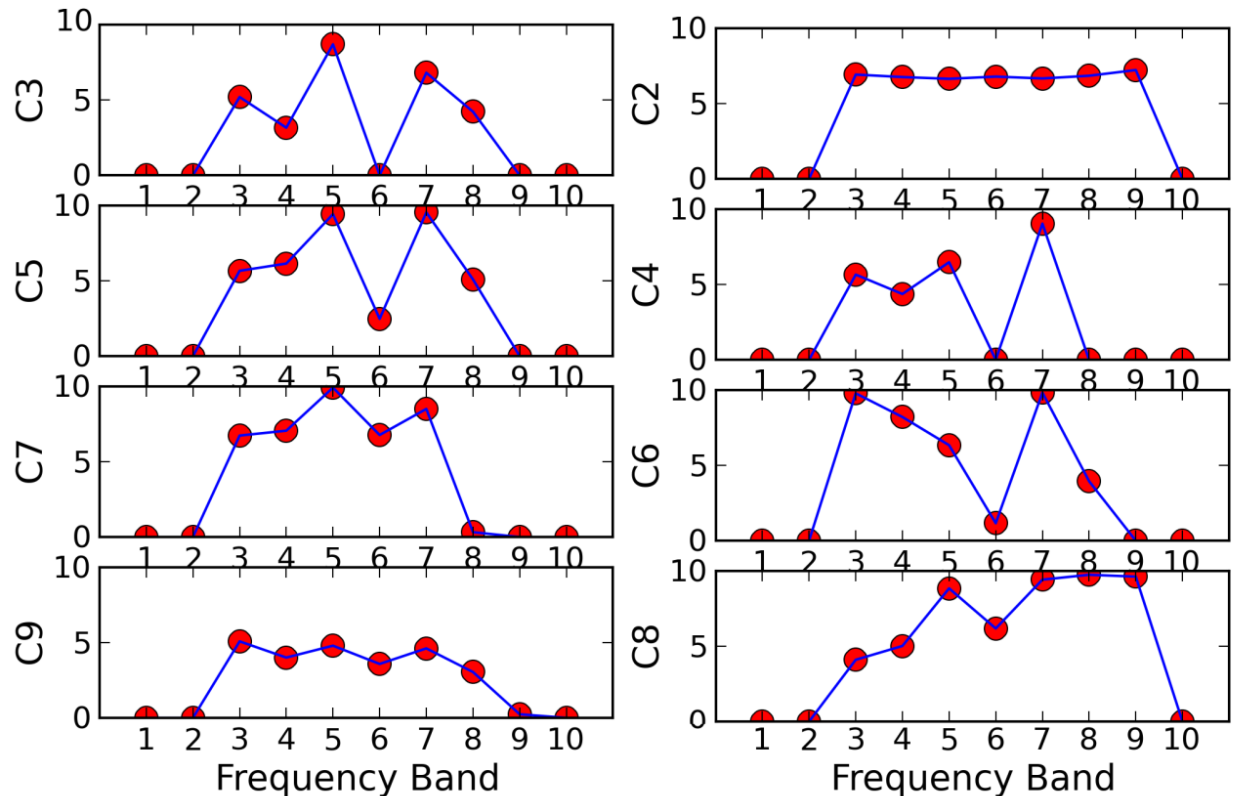
(1) Recently implemented validations: Anderson (2004) criteria

Application for one simulation at one site on the BBP

GoF measurements are computed for the filtered data, so for the frequency bands outside of the useful bandwidth of each record the values are zero.

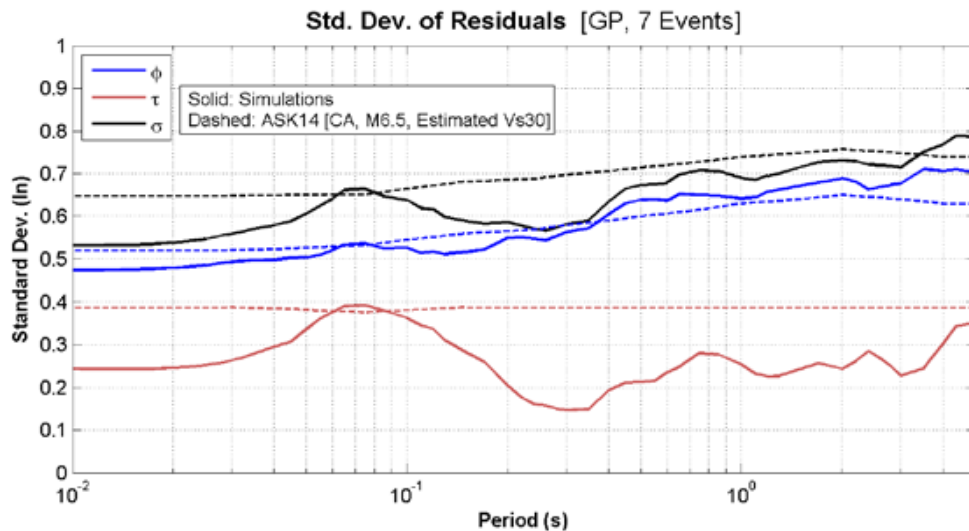
When completed, the BBP will provide an easy-to-read summary that will represent a total score for each earthquake simulation based on all used criteria

whittier - 5005-A-KRE - Score S1 : 3.0

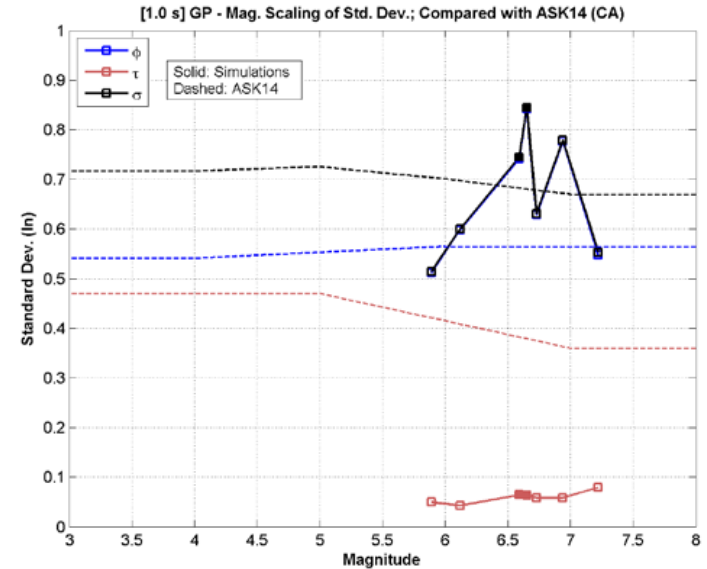


(1) Recently implemented: Variability of 7 Validation Events

Using the Type A residuals from the BBP Validation project (led by Dreger and Goulet), we investigate the existing variability of the simulations.



The GP standard deviation of residuals for the set of seven validation simulations (solid lines) and the Abrahamson et al. (2013) NGA-West2 GMPE standard deviation (dashed lines).



Scaling of τ_{sim} and ϕ_{sim} with magnitude, as well as the magnitude scaling of the Abrahamson et al. (2013b) model (California version, for estimated Vs30).

We have made this qualitative comparison for every simulation method, validation event, and the 4 NGA-W2 GMPEs. No validations yet.

(2) Future plans for validations of new GMSV parameters

GMPs implemented as part of this project (in progress):

Baker et al. Parameters:

- B1. Ratio of inelastic to elastic displacement
- B2. Correlation of spectral acceleration across periods
- B3. Ratio of maximum to median response across orientations

Rezaeian et al. Validation Metrics:

- Ra. Evolution of intensity (for visual inspection) & $[\epsilon_a, \nu_a]$
- Rb. Evolution of predominant frequency (for visual inspection) & $[\epsilon_b, \nu_b]$
- Rc. Bandwidth (for visual inspection) & $[\epsilon_c, \nu_c]$

Rezaeian et al. Parameters:

- R1. I_a
- R2. D_{5-95}
- R3. I_a/D_{5-95}
- R4. ω_{mid}
- R5. ω'
- R6. ζ

Stewart et al. Parameter:

- S1. Duration (same as R2?)

(2) Future plans for validations of new GMSV parameters

3 Groups of Parameters

(a) Spectral

(b) Time Domain

(c) Scalars

- B1. Ratio of inelastic to elastic displacement
- B2. Correlation of PSA**
- B3. Ratio of max/median response
- Anderson Criteria

- Ra. Evolution of intensity
- Rb. Evolution of predominant freq.
- Rc. Bandwidth
- Anderson Criteria

- R1. Ultimate Arias Intensity, I_a
- R2. D_{5-95}
- R3. I_a/D_{5-95}
- R4. ω_{mid}
- R5. ω'
- R6. ζ
- Anderson Criteria (aggregate score)

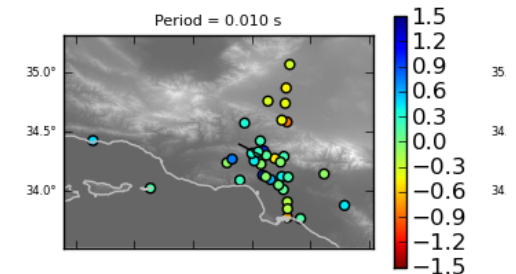
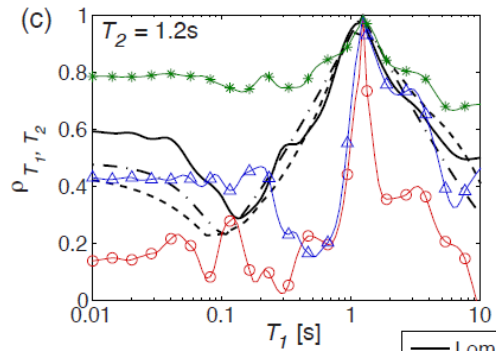
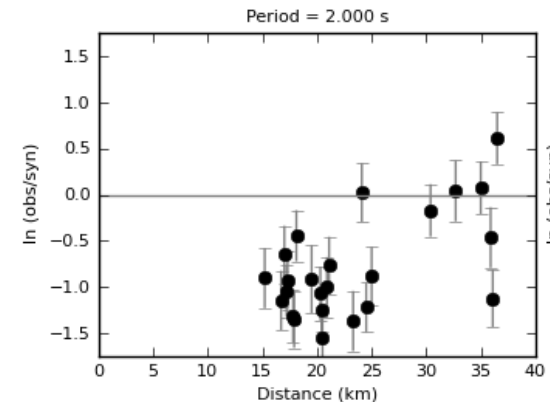
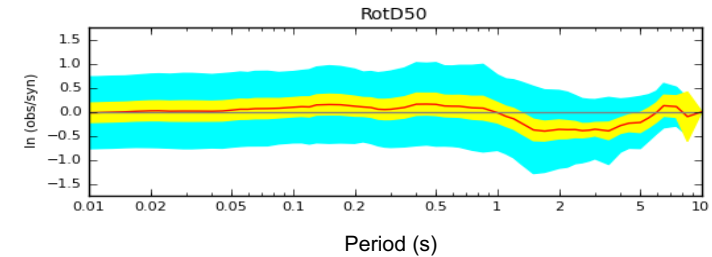
**Note: Correlation of PSA requires more than individual seismograms, i.e. a database, and will be handled separately

(2) Future plans for validations of new GMSV parameters

Validation of GMPs

(a) Spectral

- Bias type GOF plots
- Average GOF with distance
- Map GOF
- Empirical model comparisons

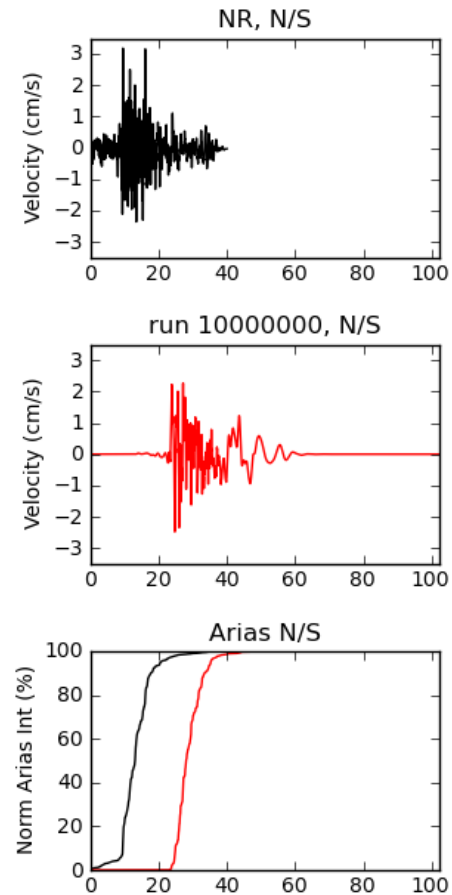


(2) Future plans for validations of new GMSV parameters

Validation of GMPs

(b) Time Domain

- ❑ Qualitative comparisons of recorded vs simulated



(2) Future plans for validations of new GMSV parameters

Validation of GMPs

(c) Scalars

- Including aggregated scores (i.e. Anderson criteria)
- Pass/Fail criteria TBD

(2) Future plans for validations of new GMSV parameters

Validation of GMPs

For (a) Spectral and (c) Scalar GMPs

- ❑ We can summarize the differences for each with the “Evaluation Tables” and also “Distance Dependence of Mean Bias” tables similar to those used in the BBP Validation for PSA

Change file values below: 5
Part A GIP Evaluation Threshold: 0.50
Unacceptable Threshold: 0.70

Equalized Performance Level

Equalized Performance Level	PGA Period Range = 0.1 to 0.1 s										PGA Period Range = 0.1 to 0.5 s										PGA Period Range = 0.5 to 1 s										PGA Period Range = 1 to 3 s									
	CSM	UCSB	EXSIM	G&P	SDSU	GMPE	CSM	UCSB	EXSIM	G&P	SDSU	GMPE	CSM	UCSB	EXSIM	G&P	SDSU	GMPE	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	0.72	2.65	0.64	0.59	0.19	0.88	1.18	2.28	0.48	0.43	0.02	0.68	1.32	0.97	0.36	0.97	0.42	0.42																
0.1 to 1.0 s	0.91	2.63	0.36	0.69	0.60	0.16	0.72	2.65	0.64	0.59	0.19	0.88	1.18	2.28	0.48	0.43	0.02	0.68	1.32	0.97	0.36	0.97	0.42	0.42																
1 to 3 s	0.91	2.63	0.36	0.69	0.60	0.16	0.72	2.65	0.64	0.59	0.19	0.88	1.18	2.28	0.48	0.43	0.02	0.68	1.32	0.97	0.36	0.97	0.42	0.42																
greater than 3 s	0.91	2.63	0.36	0.69	0.60	0.16	0.72	2.65	0.64	0.59	0.19	0.88	1.18	2.28	0.48	0.43	0.02	0.68	1.32	0.97	0.36	0.97	0.42	0.42																

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

- ❑ We will not yet implement *combinations* of the different GMPs.