

Update of the CEUS GMMs in the 2018 NSHM

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USGS 2018 NSHM Update Workshop

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Available CEUS GMMs for the 2018 NSHM

1. USGS 2014 CEUS GMMs
2. Updated NGA-East Seed GMMs
3. NGA-East USGS GMMs*

* NGA-East USGS GMMs published by PEER in March 2017. This is an interim model of the final NGA-East GMMs expected from the NGA-East Project.

Hazard Model Improvements as a Result of the NGA-East Project

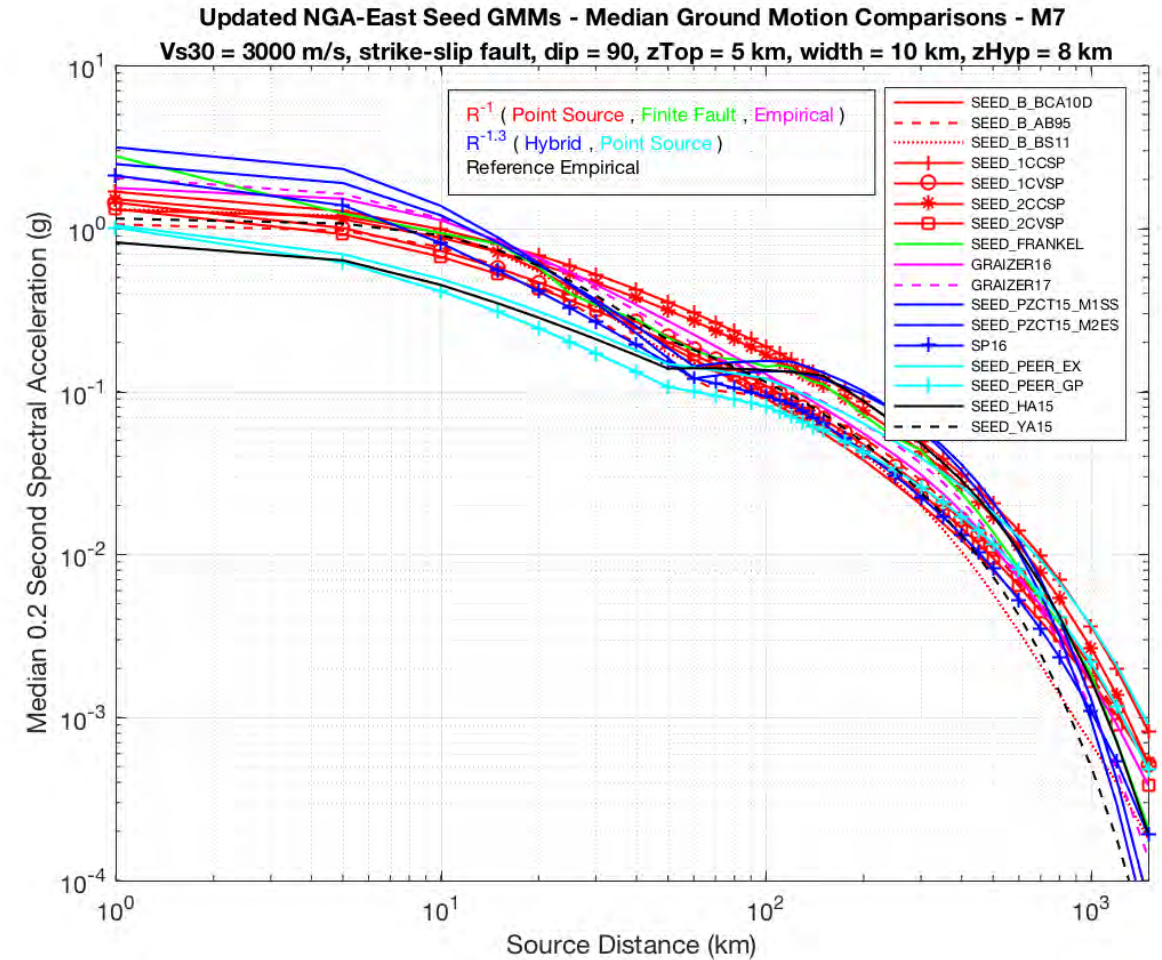
1. M4-8.2, $R_{RUP} \leq 1500$ km
2. Additional periods (short and long)
3. Quantification of epistemic uncertainty in median ground motions (objective sampling of GMMs from Sammon's maps), aleatory variability (sigma) model (with epistemic uncertainty on sigma model)
4. Site amplification model (reference site condition; $V_{s30} = 3000$ m/s)
5. Gulf coast factors

Table 1.1 Minimum 5%-damped PSA periods, T, (and frequencies, F) for NGA-East GMM development, in addition to PGA and PGV.

T (sec)	F (Hz)
0.01	100
0.02	50
0.025	40
0.03	33.33
0.04	25
0.05	20
0.075	13.33
0.1	10
0.15	6.67
0.2	5
0.25	4
0.3	3.33
0.4	2.5
0.5	2
0.75	1.33
1	1
1.5	0.67
2	0.5
3	0.33
4	0.25
5	0.2
7.5	0.13
10	0.1

NGA-East Seed GMMs (19 Final Adjusted Models)

Models	Modeler(s)	Model Type*
B_a04	<i>Boore (2015)</i>	Point Source (R^{-1})
B_ab14		
B_ab95		
B_bca10d		
B_bs11		
B_sgd02		
1CCSP		
1CVSP		
2CCSP		
2CVSP		
YA15	<i>Yenier and Atkinson (2015)</i>	Reference Empirical
PZCT15_M1SS	<i>Pezeshk et al. (2015)</i>	Hybrid ($R^{-1.3}$)
PZCT15_M2ES		
Frankel15	<i>Frankel (2015)</i>	Finite Fault (R^{-1})
SP15	<i>Shahjouei and Pezeshk (2015)</i>	Hybrid ($R^{-1.3}$)
Graizer15	<i>Graizer (2015)</i>	Empirical (R^{-1})
HA15	<i>Hassani and Atkinson (2015)</i>	Reference Empirical
PEER_GP	<i>Hollenbeck et al. (2015)</i>	Point Source ($R^{-1.3}$)
PEER_EX		



*Note: Workshop participants mentioned that some model types may be misclassified.

Updated NGA-East Seed GMMs (17 Final Models)

Models	Modeler(s)	Updates since Publication	Recommendations from Modelers	Final Models
B_a04	<i>Boore (2015)</i>		Modeler recommended using B_ab95, B_bca10d, and B_bs11, with the highest weight on B_bca10d	1. B_ab95 2. B_bca10d 3. B_bs11
B_ab14				
B_ab95				
B_bca10d				
B_bs11				
B_sgd02				
1CCSP	<i>Darragh et al. (2015)</i>		Modelers recommend using all 4 models with equal weight	4. 1CCSP 5. 1CVSP 6. 2CCSP 7. 2CVSP
1CVSP				
2CCSP				
2CVSP				
YA15	<i>Yenier and Atkinson (2015)</i>			8. YA15
PZCT15_M1SS	<i>Pezeshk et al. (2015)</i>		Modelers recommend using both models	9. PZCT15_M1SS 10. PZCT15_M2ES
PZCT15_M2ES				
Frankel15	<i>Frankel (2015)</i>		Modeler recommended using model as is	11. Frankel
SP15	<i>Shahjouei and Pezeshk (2015)</i>	<i>Shahjouei and Pezeshk (2016)</i>	Modelers recommend replacing SP15 with SP16	12. SP16
Graizer15	<i>Graizer (2015)</i>	<i>Graizer (2016), Graizer (2017)</i>	Modeler recommended replacing Graizer15 with G16 and G16v2 (G16v2 is an alternative to G16)	13. G16 14. G16v2
HA15	<i>Hassani and Atkinson (2015)</i>			15. HA15
PEER_GP	<i>Hollenbeck et al. (2015)</i>			16. PEER_GP 17. PEER_EX
PEER_EX				

NGA-East USGS GMMs (13 Models)

Models
NGA_EAST_USGS_1
NGA_EAST_USGS_2
NGA_EAST_USGS_3
NGA_EAST_USGS_4
NGA_EAST_USGS_5
NGA_EAST_USGS_6
NGA_EAST_USGS_7
NGA_EAST_USGS_8
NGA_EAST_USGS_9
NGA_EAST_USGS_10
NGA_EAST_USGS_11
NGA_EAST_USGS_12
NGA_EAST_USGS_13

- Representative model for each cell
- Weights for each model come from Sammon's mapping.
- Weights are period and magnitude dependent.

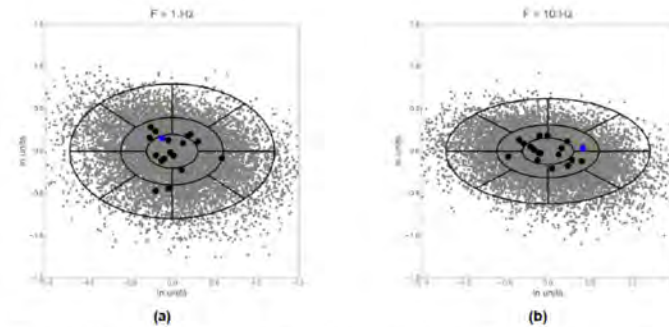


Figure 3.52 Sammon's maps for two different frequencies and 10,000 sampled models (gray points). The partition of the ground-motion space defined by the Project Team are shown as black cells. The mean model is plotted as a red dot, the up/down-scaled models are plotted as + and -, respectively. The seed models are plotted as black dots. The reference model "SP15" is plotted as a blue dot.

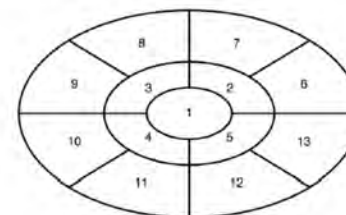


Figure 3.53 Cell index numbers.

NGA-East USGS Sigma (Aleatory Variability) Model

1. The NGA-East Project Team recommends the USGS use the total ergodic sigma model (standard deviation) for the NSHMs.
2. The model is based on the NGA-West2 total ergodic sigma model.

τ = between-event variability (Tau)

Φ = single-station within-event variability (PhiSS)

Table 5.5 Recommended total ergodic sigma model.

Period (sec)	Frequency (Hz)	Components of the Total Ergodic Sigma Model					
		M 5.0		M 6.0		M >= 7.0	
		τ	ϕ	τ	ϕ	τ	ϕ
0.01	100	0.4320	0.6269	0.3779	0.5168	0.3525	0.5039
0.02	50	0.4710	0.6682	0.4385	0.5588	0.4138	0.5462
0.03	33.33	0.4710	0.6682	0.4385	0.5588	0.4138	0.5462
0.04	25	0.4710	0.6682	0.4385	0.5588	0.4138	0.5462
0.05	20	0.4710	0.6682	0.4385	0.5588	0.4138	0.5462
0.075	13.33	0.4710	0.6682	0.4385	0.5588	0.4138	0.5462
0.1	10	0.4710	0.6682	0.4385	0.5588	0.4138	0.5462
0.15	6.67	0.4433	0.6693	0.4130	0.5631	0.3886	0.5506
0.2	5	0.4216	0.6691	0.3822	0.5689	0.3579	0.5566
0.25	4	0.4150	0.6646	0.3669	0.5717	0.3427	0.5597
0.3	3.33	0.4106	0.6623	0.3543	0.5846	0.3302	0.5727
0.4	2.5	0.4088	0.6562	0.3416	0.5997	0.3176	0.5882
0.5	2	0.4175	0.6526	0.3456	0.6125	0.3217	0.6015
0.75	1.33	0.4439	0.6375	0.3732	0.6271	0.3494	0.6187
1	1	0.4620	0.6219	0.3887	0.6283	0.3650	0.6227
1.5	0.67	0.4774	0.5957	0.4055	0.6198	0.3819	0.6187
2	0.5	0.4809	0.5860	0.4098	0.6167	0.3863	0.6167
3	0.33	0.4862	0.5813	0.4186	0.6098	0.3952	0.6098
4	0.25	0.4904	0.5726	0.4144	0.6003	0.3910	0.6003
5	0.2	0.4899	0.5651	0.4182	0.5986	0.3949	0.5986
7.5	0.13	0.4803	0.5502	0.4067	0.5982	0.3835	0.5982
10	0.1	0.4666	0.5389	0.3993	0.5885	0.3761	0.5885
	PGV	0.3925	0.5979	0.3612	0.5218	0.3502	0.5090

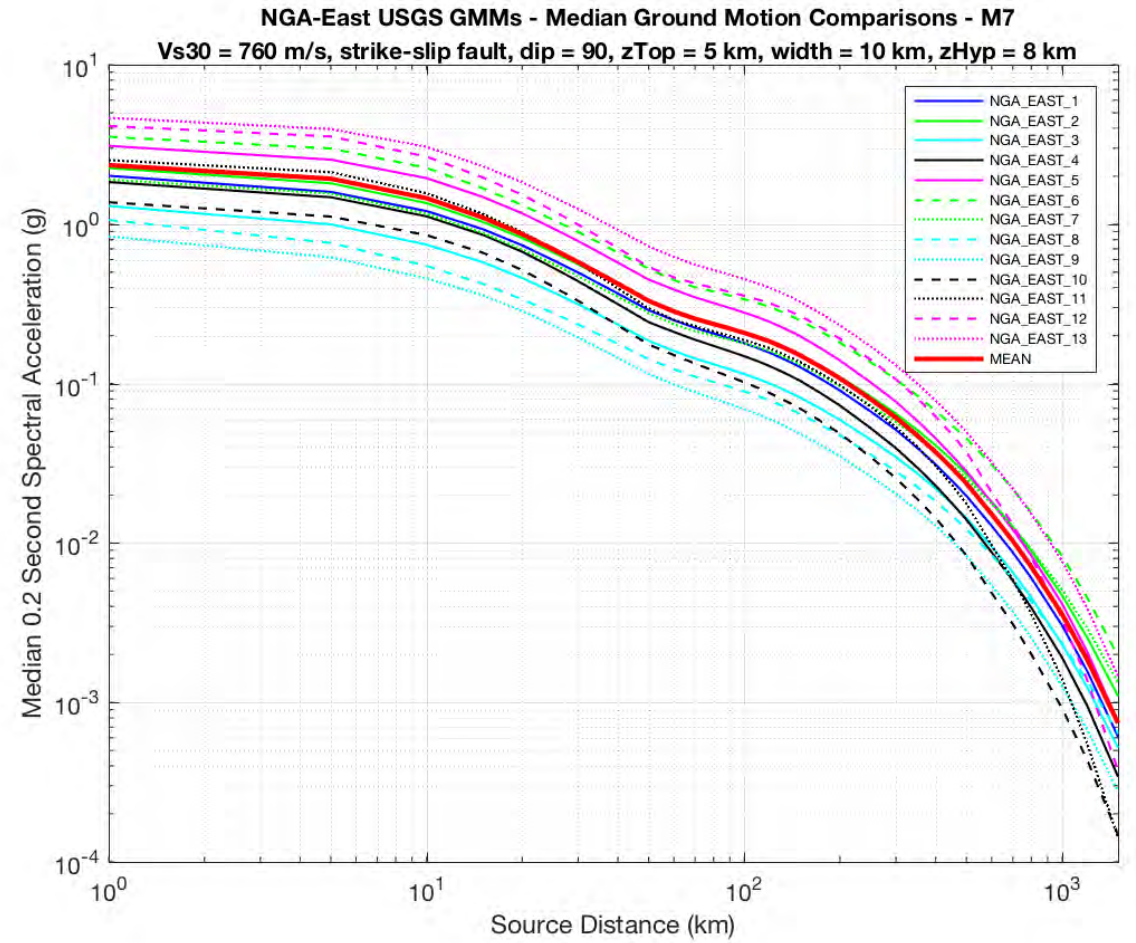
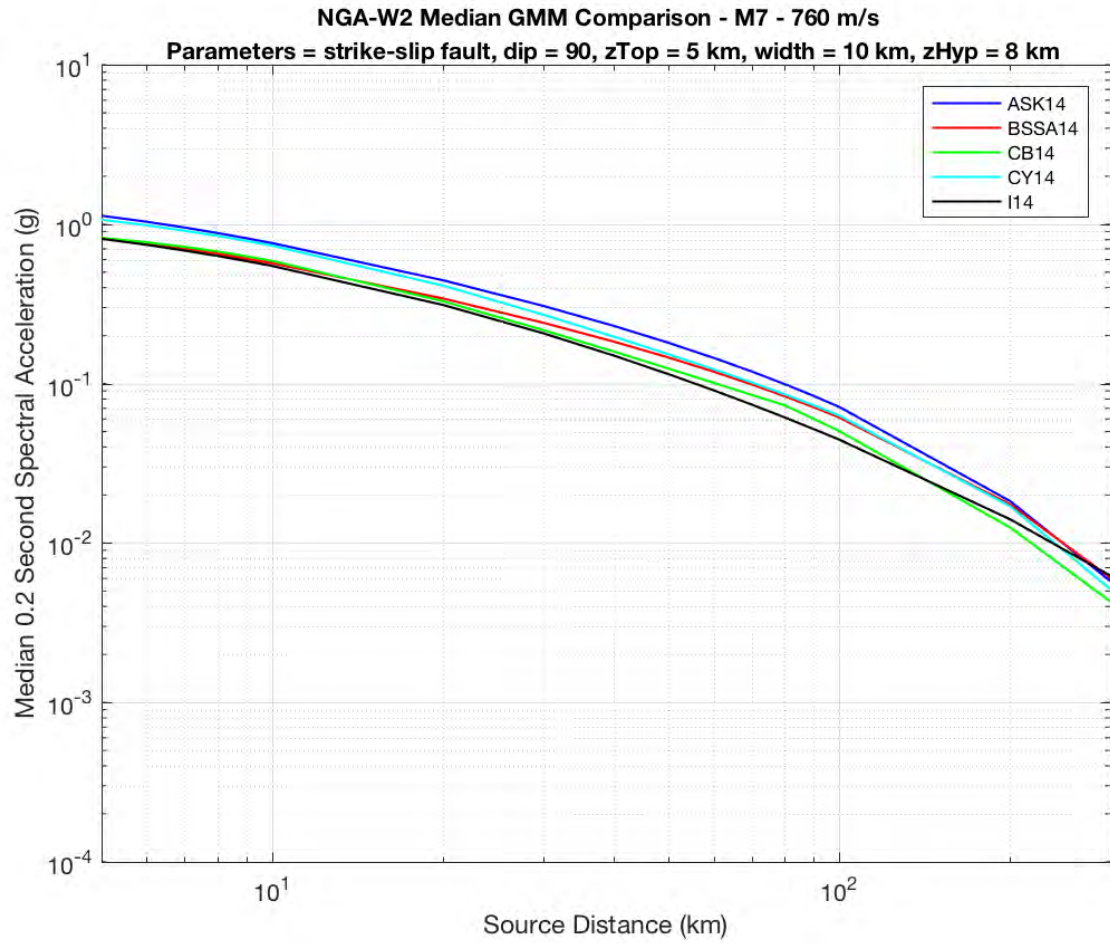
NGA-East Amplification Model

Linear Model: Stewart et al., (2017; PEER Report 2017/04)

Non-linear Model: Hashash et al., (2017; PEER Report 2017/05)

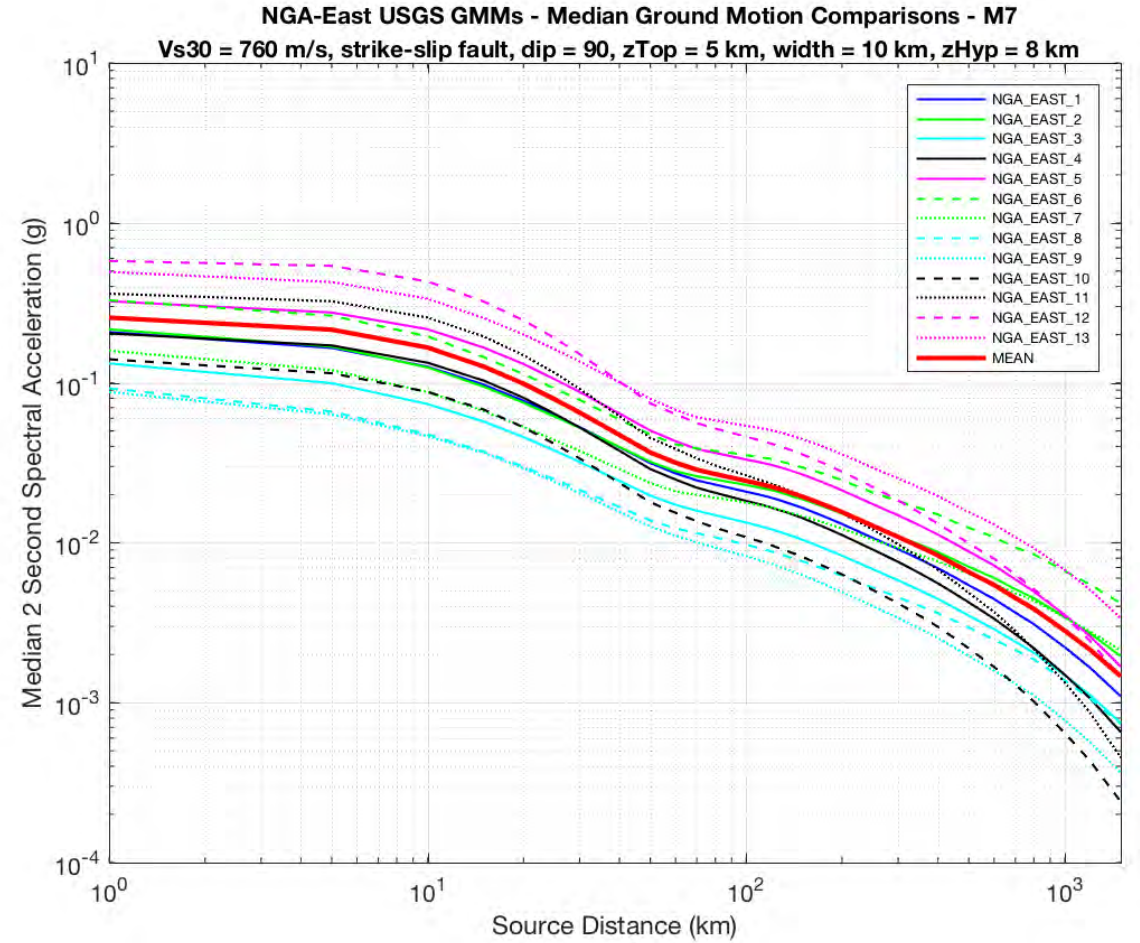
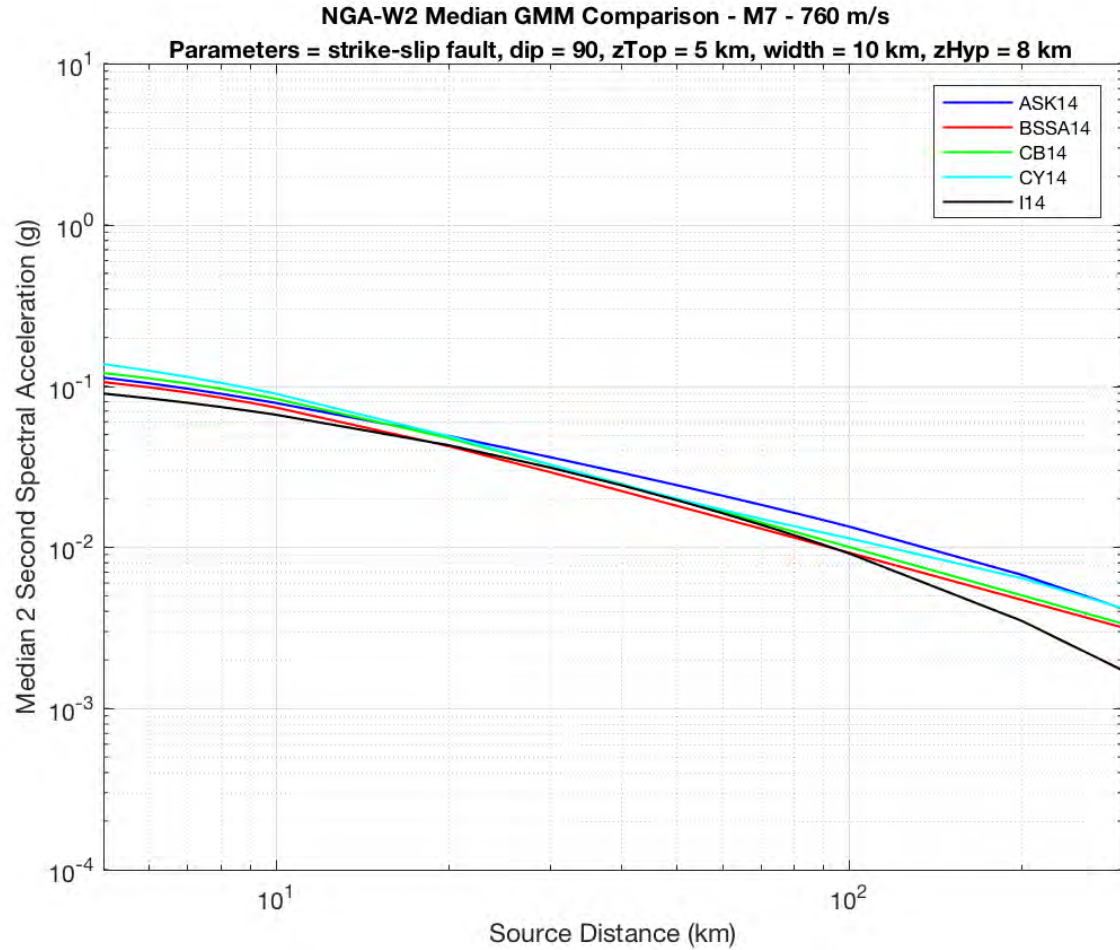
1. We did not have these amplification models in the past (for CEUS), therefore, we were unable to make uniform soil maps for the whole US.
2. Limitations: Only available out to 5 seconds, and down to 200 m/s (no NEHRP Site Classes D/E or E?). No consideration of basins.

NGA-West2 vs. NGA-East USGS GMMs



Note: The USGS added additional epistemic uncertainty to the NGA-West2 GMMs in the 2014 NSHM.

NGA-West2 vs. NGA-East USGS GMMs



Note: The USGS added additional epistemic uncertainty to the NGA-West2 GMMs in the 2014 NSHM.

Comparison of Amplification Models

- Jon Stewart will be discussing the NGA-East amplification model and how it compares to NGA-West2 and NEHRP amplification factors this afternoon.

Considerations/Issues for this Workshop (**Discuss Later Today**)

1. Should we use the NGA-East Seed GMMs, the NGA-East USGS GMMs, or a combination of the two (logic tree with weights)? Should we use the original or Updated NGA-East Seed GMMs (with the new SP16, G16, G17)? The updated NGA-East Seed and NGA-East USGS GMMs combined would require consideration of 30 tables.
2. If we use the NGA-East USGS GMMs, will we need to do Sammon's mapping for all future updates?
3. If we use the NGA-East Seed GMMs how should we weight the models?

Considerations/Issues for this Workshop (cont.) (Discuss Later Today)

4. Should we use the NGA-East USGS recommended total ergodic sigma model for both the NGA-East USGS GMMs and the Updated NGA-East Seed GMMs? Should we be using the epistemic uncertainty part of the sigma model?
5. Should we be using the Gulf coast adjustments?
6. Should we use the new NGA-East amplification factors?