2018 Update of the National Seismic Hazard Model

- Petersen, Shumway, Powers, Mueller, Rezaeian, Moschetti, McNamara, Frankel, Rukstales, Boyd, Thompson, Hoover, Luco, Clayton, Zeng, and Field
## 2018 NSHM Update and Schedule (Petersen)

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<th>CEUS</th>
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| GMMs (i.e., NGA-East for USGS, NGA-E Seed models, new published GMMs) | WUS Sedimentary Basin Amplification Effects  
Reweighting of GMMs | Seismicity Catalog (completeness)  
Computer Code Updates |

- Deadline for publication of peer-reviewed models was March 2017
- NSHMP workshop for public comment March 7-9, 2018 (Newark, CA)
- Public comment period to review draft model now through ~July, 2018
- Finalize and submit 2018 NSHM to journal (needed for BSSC meeting August 15)
- Peer review of 2018 NSHM by journal and Steering Committee
- Hope to publish 2018 NSHM in journal by summer of 2019
Results of Workshop

1. Strong support for considering **NGA-E for USGS** and new CEUS amplification factors (concern that 13 models looked like backbone model- need to compare with final NGA-E 17 models when they are published)

2. Support for including updated **NGA-E Seed** models and newly published information (Graizer, Pezeshk et al. models)

3. Support for adding additional aleatory uncertainty to account for F-peak resonance from basins in CEUS (Atkinson, Stewart, Al Atik, Goulet, Parker)

4. Support for including WUS basin amplification terms for long periods (both amplification and deamplification- Stewart, Campbell, Boore, Bozorgnia)

5. Support for updating catalog and improving computer code details
CEUS proposed catalog completeness zones

2014 NSHM CEUS catalog zones

2018 NSHM CEUS catalog zones

1970 for zone 1, 1930 for zone 2, 1975 for zone 3, and 1980 for zones 4-6 and for the rest of the CEUS outside of the zones.

Changes due to seismicity patterns and magnitude conversions and types

More detail on poster 120, Hoover et al. in today’s session on NSHM 2018 and beyond
Comparisons of Mean GMM for M 7 (10 km), M 5 (10 km)

Comparison of Median Ground Motions, $V_{s30} = 3,000$ m/s
Logic Tree for CEUS GMMs in the 2018 NSHM Update

CEUS GMMs < 1000 km (RLME/GridSrc)

NGA-East for USGS GMMs (0.667)

Updated NGA-East Seed GMMs (0.333)

13 Models (weights based on frequency and magnitude)

14 Models (varying weights, see Logic Tree)

See next slide for Updated NGA-East Seed Logic Tree
Logic Tree for Updated NGA-East Seed Ground Motion Models

Updated NGA-East Seed GMMs < 1000 km (RLME/GridSrc)

1 Geometric spreading different from R⁻¹ or R⁻¹.3
2 Graizer16 is an update of the NGA-East Seed model Graizer15
3 Graizer17 is an alternative to the Graizer16 model
4 SP16 is an update of the NGA-East Seed model SP15
5 Reference empirical
6 Simulation-based hybrid
Comparison of Sigma (aleatory variability)

\[ M = 5 \]
\[ R = 50 \text{ km} \]
\[ V_{S30} = 3,000 \text{ m/s} \]

\[ M = 7 \]
\[ R = 50 \text{ km} \]
\[ V_{S30} = 3,000 \text{ m/s} \]
Soil Amplification

Comparison of Amplification Factors (Hard Rock to $V_{S30} = 760$ m/s)

- NGA-East (Linear and Non-Linear)
- Frankel (1996)
- Atkinson and Boore (2011)
Comparison of 2018 (2/3NGA-E, 1/3Seeds) vs 2014

These are current results but NGA-E for USGS sigma team will revise the model for short periods <0.1s. We expect that the numbers will rise slightly compared to this model.
Areas with local Z models (depths to Z1.0 and Z2.5)
Data for basin amplification

1. Observed basin effect
2. Difference between basins
3. Large uncertainty
4. M9 and Cybershake indicate even higher ground shaking
Northridge and Landers earthquakes (LA basin)
Comparison of 5 Second Total Mean Hazard for the LA Basin
CVM S4.26m01 (Lee et al., 2014) basin terms vs. default basin terms
2% in 50 Years Probability of Exceedance, NEHRP Site Class D (V_s50 = 260 m/s)

Comparison of 5 Second Total Mean Hazard for Los Angeles, CA (34.1, -118.3)
NEHRP Site Class D (V_s50 = 260 m/s)

Comparison of 5 Second Total Mean Hazard for Long Beach, CA (33.8, -118.2)
NEHRP Site Class D (V_s50 = 260 m/s)

Difference

Ratio
Comparison of 5 Second Total Mean Hazard for the Bay Area
BayArea10 (Aagaard et al., 2010) basin terms vs. default basin terms

2% in 50 Years Probability of Exceedance, NEHRP Site Class D ($V_{S30} = 260$ m/s)

Comparison of 5 Second Total Mean Hazard for San Francisco, CA (37.8, -122.4)
NEHRP Site Class D ($V_{S30} = 260$ m/s)

- 2014 NSHM - Default
- 2018 NSHM - Default
- 2018 NSHM - BayArea10

10% in 50 yr. $\Delta$: 0.00g, 0%
5% in 50 yr. $\Delta$: 0.00g, 0%
2% in 50 yr. $\Delta$: 0.00g, 0%

Annual Frequency of Exceedance
5 Second Spectral Acceleration (g)
## 2020 NSHM Update (Petersen)

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- Please submit your published, peer reviewed models by June 30th, 2018 for consideration in the 2020 NSHM Update!
Conclusions

• Catalog changes: incorporate updated catalog and magnitude completeness zones in CEUS. Minor changes to hazard.
• Aleatory variability CEUS (sigma): We are applying envelope of EPRI (2013) model and PhiS2S model. New CEUS sigmas are higher than sigmas applied in 2014.
• Amplifications for CEUS: New models by Stewart et al. (linear) and Hashash et al. (nonlinear)
• Epistemic uncertainty CEUS: NGA-E for USGS (wt 2/3) and Seed models (wt 1/3)
• Basin amplifications WUS: comparisons show using basin amplification terms from NGAW2 and local seismic velocity models result in up to 40% higher hazard at long periods and soft soil sites.
• New models consider broad range of periods and site classes that were not available in 2014 nationwide.
• Comments considered until mid July, 2018.