PSHA input model documentation for Conterminous United States of America (California included) (USA)

GEM Hazard Team

Version history

Table 1 summarises version history for the USA input model, named according to the versioning system described here, and indicating which version was used in each of the global maps produced since 2018. Refer to the GEM Products Page for information on which model versions are available for various use cases. The changelog describes the changes between consecutive versions and are additive for all versions with the same model year.

Table 1 – *Version history for the USA input model.*

Version	2018.1	2019.1	2022.1	2023.1	Changelog
v2014.0.0	X				Version of the model released by the USGS in 2014, translated into OpenQuake.
v2014.1.0		X			Update to the model to include the cluster model. Hazard increases up to 0.06g PGA in New Madrid for 10% PoE in 50 years.
v2014.2.0			X		Updated the configurations to use the mosaic defaults, added the standard outputs, and changed the definition of reqv in the job.ini (necessary to run the current version).
v2018.0.0				X	The 2018 version of the USGS model covering the conterminous USA including California. Converted to OQ Engine format by GEM.

The following text describes v2018.0.0.

Authors: *UCERF3 (California)*: Field, E.H., Biasi, G.P., Bird, P., Dawson, T.E., Felzer, K.R., Jackson, D.D., Johnson, K.M., Jordan, T.H., Madden, C., Michael, A.J. and Milner, K.R. *Conterminus USA (outside California)*: Petersen, M.D., Shumway, A.M., Powers, P.M., Mueller, C.S., Moschetti, M.P., Frankel, A.D., Rezaeian, S., McNamara, D.E., Luco, N., Boyd, O.S. and Rukstales, K.S.

1 Summary

The 2018 United States National Seismic Hazard Model (Petersen et al., 2020), covers the conterminous United States and was developed by the United States Geological Survey (USGS) within the National Seismic Hazard Model Project (NSHMP). The California portion of the the model is covered by the time-independent version of the Uniform California Earthquake Rupture Forecast version 3 (UCERF3; Field et al., 2015).

The model has been translated from its original format into the OpenQuake (OQ) engine by GEM.

Note: In former versions of the Mosaic, UCF and the rest of the conterminous USA were treated as separate models.

2 Tectonic overview

The contiguous US occupies central North America; tectonic activity is primarily found in the western plate margins, most clearly defined as the San Andreas Fault System in California (the boundary between the North American and Pacific plates) and the Cascadia subduction zone (where the Juan de Fuca plate subducts beneath North America) in northern California north to southern British Columbia. These plate boundaries lead to distributed deformation within the North American crust as well. Subduction at the Cascadia trench is oblique, leading to the northward translation of the forearc (western Oregon and Washington), which is linked to shortening at the northern end of the forearc where it impinges into more stable British Columbia; this is expressed as faulting in the Puget Sound region of Washington State. Some fraction (roughly 1/4 to 1/3) of Pacific-North American relative motion is accommodated within North America rather than on the San Andreas Fault. This fraction is distributed through many strike-slip and normal faults within the Basin and Range and Eastern California Shear Zone provinces of eastern California through Utah. The Basin and Range province as well as the Rocky Mountains also have many normal fault systems with very low slip rates that may still produce M 7+ earthquakes such as the Hebgen Lake and Borah Peak earthquakes. Though strain rates are negligible, old faults in the central and eastern US are episodically reactivated, and have historically produced damaging earthquakes such as the New Madrid and Charleston earthquakes sequences in early US history. Because of the cold cratonic crust and low attenuation, ground shaking from these earthquakes may be much higher than in the more active American West.

3 Basic Datasets

See Petersen et al. (2020) and Field et al. (2015) for a description of the datasets used for developing the hazard model.

4 Hazard Model

4.1 Seismic Source Characterisation

The seismic source characterisation incorporates: (1) smoothed seismicity models; (2) background source zones in areas without recent earthquake activity and (3) fault sources that characterize earthquakes on active faults. Details of the earthquake source models can be found in Petersen et al. (2020), Moschetti et al. (2015), and Frankel et al. (2015).

4.2 Ground Motion Characterisation

The model applies ground motion prediction equations (GMPEs) for stable continental regions, shallow crustal earthquakes, subduction interface earthquakes, and deep intraslab earthquakes. The GMPEs are discussed in more detail in Rezaeian et al. (2015).

Active Shallow Crust	**Weight**
BooreEtAl2014NSHMPMean	0.25
ChiouYoungs2014NSHMPMean	0.25
AbrahamsonEtAl2014NSHMPMean	0.25
CampbellBozorgnia2014NSHMPMean	0.25
Stable Shallow Crust	**Weight**
NGAEastUSGSSammons16	0.0219
NGAEastUSGSSammons13	0.0117
NGAEastUSGSSeedPEER_GP	0.0385
NGAEastUSGSSammons5	0.0304
NGAEastUSGSSammons11	0.0143
NGAEastUSGSSeedHA15	0.03736
NGAEastUSGSSammons14	0.0244
NGAEastUSGSSeedB_ab95	0.00736
NGAEastUSGSSeedB_bs11	0.00736
NGAEastUSGSSammons10	0.0187
NGAEastUSGSSeed2CVSP	0.01841
NGAEastUSGSSammons4	0.0461
NGAEastUSGSSammons8	0.0584
NGAEastUSGSSeedPZCT15_M2ES	0.01813
NGAEastUSGSSeedYA15	0.03736
NGAEastUSGSSeedSP15	0.03626
NGAEastUSGSSammons15	0.0245

NGAEastUSGSSammons1	0.0492
NGAEastUSGSSammons2	0.0663
NGAEastUSGSSeed2CCSP	0.01841
NGAEastUSGSSammons6	0.0731
NGAEastUSGSSammons12	0.0195
NGAEastUSGSSammons17	0.0236
NGAEastUSGSSeedGraizer17	0.01813
NGAEastUSGSSammons3	0.0595
NGAEastUSGSSammons7	0.0681
NGAEastUSGSSeedGraizer16	0.01813
NGAEastUSGSSeedB_bca10d	0.02209
NGAEastUSGSSeedPZCT15_M1SS	0.01813
NGAEastUSGSSammons9	0.0573
NGAEastUSGSSeedFrankel	0.03737
Subduction Interface	**Weight**
AbrahamsonEtAl2015SInter	0.3334
AtkinsonMacias2009	0.3333
ZhaoEtAl2006SInter	0.3333
Subduction Inslab	**Weight**
ZhaoEtAl2006SSlabNSHMP2014	0.5
AbrahamsonEtAl2015SSlab	0.5

Table 2 – *GMPEs used in the USA model.*

5 Results

Hazard curves were computed with the OQ engine for the following:

- Intensity measure types (IMTs): peak ground acceleration (PGA) and spectral acceleration (SA) at 0.2s, 0.3s, 0.6s, 1.0s, and 2s
- reference site conditions with shear wave velocity in the upper 30 meters (Vs30) of 760-800 m/s, as well as for Vs30 derived from a topography proxy (Allen and Wald, 2009)

Hazard maps were generated for each reference site condition-IMT pair for 10% and 2% probabilities of exceedance (POEs) in 50 yrs. Additionally, disaggregation by magnitude, distance, and epsilon was computed for the following cities: Seattle, Washington D.C., Denver, San Francisco, Los Angeles and Seattle. The results were produced as csv files and bar plots for each of the following combinations:

- hazard levels for 10% and 2% POE in 50 yrs
- PGA and SA at 0.2s, 0.3s, 0.6s, and 1.0s
- Vs30=800 m/s

All calculations used a ground motion sigma truncation of 5. Results were computed for sites with 6 km spacing

Visit the GEM Interactive Viewer to explore the Global Seismic Hazard Map values (PGA for Vs30=800 m/s, 10% poe in 50 years). For a comprehensive set of hazard and risk results, see the GEM Products Page.

6 References

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