GLOBAL EARTHQUAKE MODEL
working together to assess risk

PSHA input model documentation for Alaska (ALS)

GEM Hazard Team

Version history

Table 1 summarises version history for the ALS 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 ALS input model.*

Version	2018.1	2019.1	2022.1	2023.1	Changelog
v2007.0.0	X	X	X		First version of the model implemented in OpenQuake.
v2007.1.0				X	The gmmLT.xml was revised by incorporating the GMPEs recommended by Mueller et al. (2015) for Alaska.

The following text describes v2007.1.0.

Authors: R.L. Wesson, O.S. Boyd, C.S. Mueller, C.G. Bufe, A.D. Frankel, M.D. Petersen

1 Summary

The 2007 seismic hazard model for Alaska (USA) was developed by the United States Geological Survey (Wesson et al., 2007). The model covers the state of Alaska including the Aleutian Islands. The model has been translated from its original format into the OpenQuake (OQ) engine by GEM.

2 Tectonic overview

Alaska sits at the northwestern edge of the North American continent. Active faulting in the region is related to the interaction of the neighboring Pacific and Eurasian plates with North America. The Pacific plate subducts underneath central and western Alaska at the Aleutian subduction zone; plate convergence is about 60 mm/yr at the eastern end of the subduction zone and 80 mm/yr in the west. The 1964 Gulf of Alaska earthquake has been estimated at M_w 9.2, one of the largest earthquakes in history; this event occurred on the Aleutian megathrust. Relative motion between the Pacific and North American plates is oblique, and the substantial strike-slip component is taken up on faults in the interior of Alaska; this slip is mostly localized on the right-lateral Denali fault system, which hosted the 2001 M_w 7.9 Denali earthquake. The Denali fault slips about 10 mm/yr. Additional faults in the upper plate of the subduction zone, such as the Fairweather Fault and the Chugach-St. Elias thrust belt, may be important sources of earthquakes in the relatively populated south of Alaska. However, active faults relating to the relative motions of Eurasia and the hypothesized 'Bering microplate' in western Alaska are distributed throughout the state and pose some hazard.

Source: Yeats, 2012. Active Faults of the World. Cambridge University Press.

3 Basic Datasets

See Wesson et al. (2007) for a description of the datasets used for developing the hazard model.

4 Hazard Model

4.1 Seismic Source Characterisation

The seismic source characterisation (SSC) consists of various seismic source typologies to describe earthquake occurrence in different tectonic settings. Distributed seismicity is used to model both active shallow and deep intraslab seismicity, while fault sources are used to model seismicity occurring on shallow crustal faults and large subduction interface events.

The OQ implementation uses three OQ source typologies. The background (gridded) seismicity models are implemented as collections of **Point Sources**. Crustal faults are modelled using **Simple Fault Sources**, and and subduction faults are modeled using **Complex Fault Sources**.

Epistemic Uncertainties The SSM considers epistemic uncertainty in the characterisation of active shallow crustal faults. Each is modelled with both characteristic and Guteberg-Richter (GR) magnitude frequency distributions (MFDs), with the magnitude depending on the MFD type; the two occurrence models are weighted equally in the logic tree. In the case of the Fairweather fault, the characteristic MFD considers the on- and offshore fault lengths separately, while the GR MFD treats it as a single fault.

4.2 Ground Motion Characterisation

The table below shows the ground motion characterisation (GMC), which comprises a set of ground motion prediction equations (GMPEs) for each of the three main tectonic regions: *Active Shallow Crust*, *Subduction Interface*, and *Subduction IntraSlab*.

Epistemic Uncertainties For every tectonic region, epistemic uncertainty is considered by using multiple GMPEs, each with an associated logic tree weight.

Subduction IntraSlab	**Weight**
SiEtAl2020SSlab	0.5
ParkerEtAl2020SSlab	0.5
Active Shallow Crust	**Weight**
AbrahamsonEtAl2014	0.25
BooreEtAl2014	0.25
CampbellBozorgnia2014	0.25
ChiouYoungs2014	0.25
Subduction Interface	**Weight**
SiEtAl2020SInter	0.5
ParkerEtAl2020SInter	0.5

Table 2 *– GMPEs used in the ALS 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: Anchorage. 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

Allen, T. I., and Wald, D. J., 2009, On the use of high-resolution topographic data as a proxy for seismic site conditions $Vs30$, Bulletin of the Seismological Society of America, 99, no. 2A, 935-943

Mueller, C. S., Briggs, R. W., Wesson, R. L., and Petersen, M. D. (2015). Updating the USGS seismic hazard maps for Alaska. Quaternary Science Reviews, 113, 39-47.

Wesson, Robert L., Boyd, Oliver S., Mueller, Charles S., Bufe, Charles G., Frankel, Arthur D., Petersen, Mark D., 2007, Revision of time-Independent probabilistic seismic hazard maps for Alaska: U.S. Geological Survey Open-File Report 2007-1043

Last processed: `Friday 9th June, 2023 @ 10:25`

www.globalquakemodel.org
If you have any questions please contact the GEM Foundation Hazard Team at: hazard@globalquakemodel.org