The 2010 USGS Seismic Hazard Model for South America

The 2010 USGS seismic hazard model for South America is described in Petersen et al. (2010) (see also the USGS Website). We provide here a short description of the OpenQuake-engine implementation of the model.

Basic Datasets

Earthquake catalogue

The earthquake catalogue was compiled using instrumentally recorded earthquakes from four global catalogues:

- The Centennial catalogue (Engdahl and Villaseñor, 2002) link;
- The EHB catalogue (Engdahl et al., 1998) link;
- The USGS/NEIC catalogue (http://neic.usgs.gov) and;
- The ISC catalogue (http://www.isc.ac.uk).

The Seismic Source Model

The seismic source model employs different seismic source typologies to model seismicity occurring in different tectonic settings. Gridded seismicity is used to model both spatially variable seismicity as well as zones of uniform seismicity. Fault sources are instead used to model shallow crustal faults and large subduction interface faults.

Gridded seismicity models are implemented as collections of point sources (following the NRML pointSource definition). Crustal and subduction interface faults are instead modeled as simple (NRML simpleFaultSource) and complex fault sources (NRML complexFaultSource) when associated to a Gutenberg-Richter magnitude-frequency distribution, and as characteristic fault sources (NRML characteristicFaultSource) when associated to a Characteristic model.

The entire source model can be divided into a number of sub-models:

- Active shallow crust gridded seismicity
- Subduction intraslab gridded seismicity
- Stable continental crust gridded seismicity
- Active shallow crust faults
- Stable continental crust faults
- Subduction interface faults

The map below depicts the annual occurrence rate per source (between minimum and maximum magnitudes) for the different source models included in the hazard model.Click the *show map layers* icon to view different source models and base layer maps.

Total occurrence rate
(number of events / year)

- < 1e-6
- 1e-6 - 1e-5
- 1e-5 - 1e-4
- 1e-4 - 1e-3
- 1e-3 - 1e-2
- 1e-2 - 1e-1
- 1e-1 - 1
- 1 - 10
- >= 10

.my-legend .legend-title { text-align: left; margin-bottom: 5px; font-weight: bold; font-size: 80%; } .my-legend .legend-scale ul { margin: 0; margin-bottom: 5px; padding: 0; float: left; list-style: none; } .my-legend .legend-scale ul li { font-size: 80%; list-style: none; margin-left: 0; line-height: 18px; margin-bottom: 2px; } .my-legend ul.legend-labels li span { display: block; float: left; height: 16px; width: 30px; margin-right: 5px; margin-left: 0; border: 1px solid #999; } .my-legend .legend-source { font-size: 70%; color: #999; clear: both; } .my-legend a { color: #777; }

The Ground Motion Model

The ground motion model distinguishes between four main tectonic regions:

- Active Shallow Crust
- Stable Continental Crust
- Subduction Interface
- Subduction Intraslab

For each tectonic region, various GMPEs are used to account for epistemic uncertainties.

Active Shallow Crust	**Weight**
Boore and Atkinson 2008	0.333
Campbell and Bozorgnia 2008	0.333
Chiou and Youngs 2008	0.333

Stable Continental Crust	**Weight**
Toro et. al. 1997	0.25
Frankel et. al. 1996	0.125
Campbell 2003	0.125

Atkinson and Boore 2006 (140 bar stress drop)	0.125
Atkinson and Boore 2006 (200 bar stress drop)	0.125
Tavakoli and Pezeshk 2005	0.125
Silva et. al. 2002	0.125

Subduction Interface	**Weight**
Zhao et. al. 2006	0.5
Atkinson and Boore 2003	0.25
Youngs et. al. 1997	0.25

Subduction Intraslab	**Weight**
Geomatrix 1993	0.5
Atkinson and Boore 2003 (Global model)	0.5

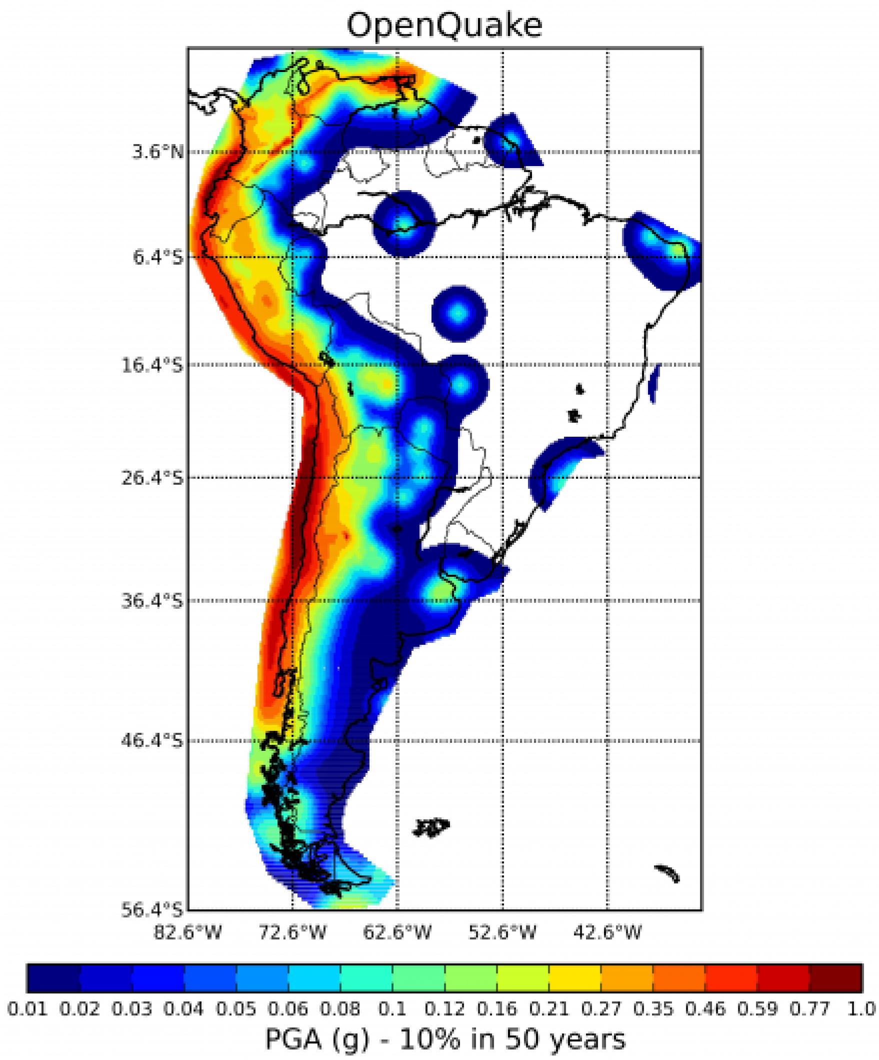
Reference site condition

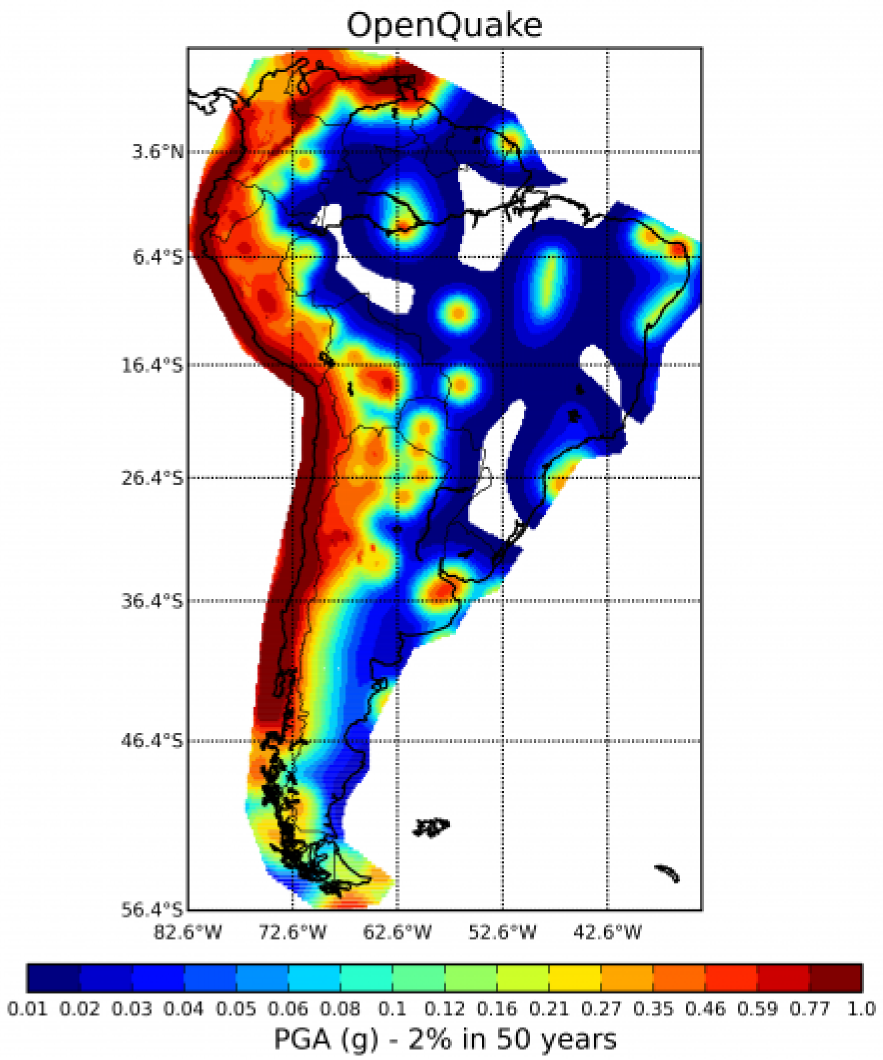
The NEHRP B/C site condition is assumed to be the reference site conditions for the hazard model. This is equivalent to a Vs30 (shear wave velocity in the uppermost 30 meters) = 760 m/s. Almost all GMPEs utilized for active shallow crust and subduction interface accept Vs30 as prediction variable. The remaining GMPEs are used with coefficients corrected for the B/C site conditions. |

Hazard Results

Hazard maps

The figures below represent hazard maps for peak ground acceleration, corresponding to 10% and 2% probabilities of exceedance in 50 years, computed with the OpenQuake-engine.


OpenQuake
3.6°N
6.4°S
16.4°S
26.4°S
36.4°S
46.4°S
56.4°S
82.6°W
72.6°W
62.6°W
52.6°W
42.6°W
0.01 0.02 0.03 0.04 0.05 0.06 0.08 0.1 0.12 0.16 0.21 0.27 0.35 0.46 0.59 0.77 1.0
PGA (g) - 10% in 50 years



References

- Petersen, M., Harmsen, S., Haller, K., Mueller, C., Luco, N., Hayes, G., Dewey, J. and Rukstales, K. (2010), Preliminary Seismic Hazard Model for South America, in LA SISMOLOGÍA EN SUDAMÉRICA Y LOS MECANISMOS DE PREVENCIÓN Y MITIGACIÓN DEL PELIGRO Y RIESGO SÍSMICO, Daniel Huaco Editor, Lima, Peru. Link - not available: 20/01/2015

Model Summary Table

This table summarises the main characteristics of the original implementation of this model

1	**Datasets availability**	
1.1	Earthquake catalogue	Not available
1.2	Geological database	Not available
1.3	Strong-motion database	Not available
1.4	Site characterization database	Not available
Notes		
2	**Methodology for model development**	

2.1	Scientific participation (SSHAC levels) and review process	Level 2
2.2	Documentation describing model preparation	Not available
2.3	Codes used for model preparation	Partially available
Notes		
3	**PSHA input model**	
3.1	**Seismic Source Model**	
3.1.1	Area sources	Not included
3.1.2	Grid sources	to model distributed seismicity in the shallow active crust and the inslab seismicity
3.1.3	Crustal faults	Included
3.1.4	Subduction faults	the subduction interface sources are modelled as faults
3.1.5	Non-parametric ruptures	Not included
3.1.6	Magnitude-area scaling relationships	Not explicit defined in Petersen et al. (2010)
3.2	**Ground Motion Model**	
3.2.0	Tectonic regionalisation	Not included
3.2.1	Models for active shallow seismicity	Included
3.2.2	Models for subduction interface	Included
3.2.3	Models for subduction intraslab	Included
3.2.4	Models for stable continental regions	Included
3.2.5	Models for deep non-subduction sources	Not included
3.2.6	Models for volcanic areas	Not included
3.3	**Site Response Model**	
3.3.1	Based on GMPEs	Yes, hazard is computed for a reference soil condition corresponding to NEHRP B/C boundary (Vs30=760 m/s)
3.3.2	Based on site-response analysis	No
3.4	**Epistemic uncertainties**	
3.4.1	Seismic Source Model	Not included
3.4.2	Ground Motion Model	Included using a logic tree (see the ground motion model section)
3.4.3	Site Response Model	Not included
Notes		
4	**Hazard Input Description**	
4.1	Hazard input document	Not inlcuded
4.2	Input files	Not inlcuded
Notes		
5	**Calculation**	
5.1	Software	Suite of Fortran codes developed by the USGS-NSHM group.
5.2	**Results**	
5.2.1	Hazard curves	Not directly available
5.2.2	Hazard maps	Not directly available
5.2.3	Uniform hazard spectra	Not directly available
5.2.4	Disaggregation	Not directly available
5.2.5	Stochastic event sets	Not considered

5.2.6	Ground motion fields	Not considered
Notes		

Download The OpenQuake-engine Input Model

The OpenQuake-engine input model (NRML format) can be downloaded at the link provided below - Please read the license and disclaimer attached to the model.

N.B. This is a model adapted by GEM Hazard Team to the OpenQuake-engine from the original model developed by the USGS. This explains minor differences you might encounter between the results presented in the OpenQuake platform and those disseminated by the original Organisation.

Download