GROUND MOTIONS PREDICTION FOR HAZARD ASSESSMENT IN THE VALLEY OF MEXICO ASSOCIATED WITH EARTHQUAKES IN THE TRANS-MEXICAN VOLCANIC BELT

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1. Abstract

The Trans-Mexican Volcanic Belt (TMVB) is an active chain being deformed by an intra-arc extensional fault network. Although several earthquakes have originated in the TMVB, the background seismicity is very low, in consequence, the seismic hazard studies, based only in the instrumental seismicity catalog results in moderate seismic hazard. Nevertheless, the 1912 Acambay (Ms=6.9) earthquake has long recurrence periods, occurred within the Acambay Graben, located approximately 100 km northwest of Mexico City. To help improve the seismic-hazard assessment for such rare events, we propose the simulation of several realistic scenario earthquakes in 3D, within the central part of Mexico, with an hp-discontinuous Galerkin finite element method (DG-FEM) that handles both unstructured domain decomposition (h-adaptivity) and different approximation orders per element in space (p-adaptivity) (DGCrack, Tago et al., 2012). It solves the velocity-stress formulation of the visco-elastodynamic equations in three dimensions with quality factors, Qs and Qp, chosen to be nearly constant in the frequency range of interest. We present results of the tetrahedral meshing of the Central part of Mexico. We build broadband kinematic scenarios following the methodology proposed by Pulido et al., 2015. The simulations of the strong motions, are generated in the reference station CU up to 0.75 Hz.

2. Historical Seismicity.

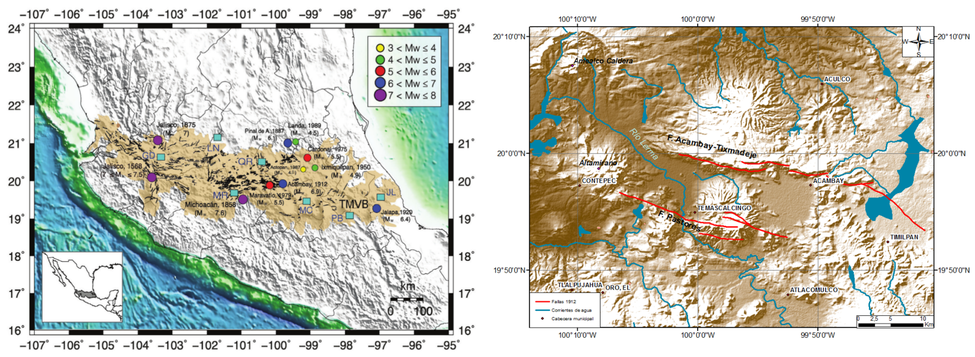

Figure 1.(left) Spatio-Temporal historical earthquakes distribution in the center of Mexico (Bayona and Ordaz, 2017). (rigth) Some fault traces in Acambay Graben.

Over the last century two large earthquekes ocuured in the TransMexiacn Volcanic Belt (TMVB). In 1912 near the Acambay town, about 90 km from Mexico City and in 1920near Xalapa city. There are several historical reports of crustal earthquekes in the region, the oldest in december of 1568.

3. Construction of the Tetrahedral mesh.

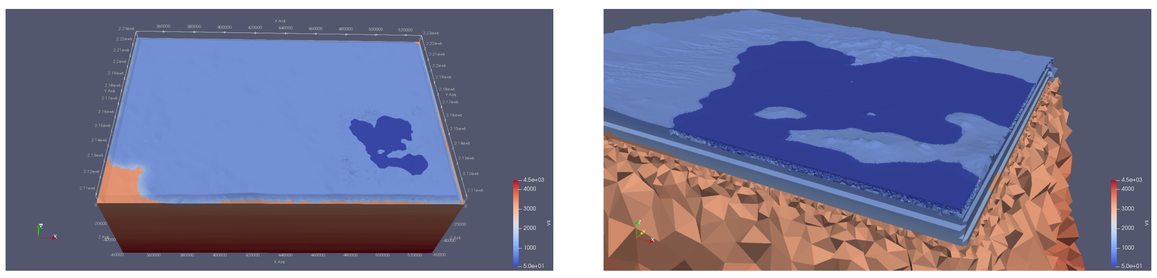

Figure.2 (left) Vs 3D velocity model (rigth) Tetrahedral mesh zoom of Valley of Mexico.

For building this mesh, incorporating real tomography, 3D velocity model (Spica et. al., 2016), 2 km thick layer of low velocity in TMVB, 3D basin model for the Valley of Mexico (Cruz-Atienza et al., 2016; Singh et. al., BSSA 1997) with a planar model of the Acambay-Tixmadejé fault, has been implemented with Tetgen (Si, 2006) mesher combine with h-refinement iterative procedure to obtain local adapted mesh with an average of 3 elements per minimum wavelength.

4. Towards Strong Ground Motions in Valley of Mexico.

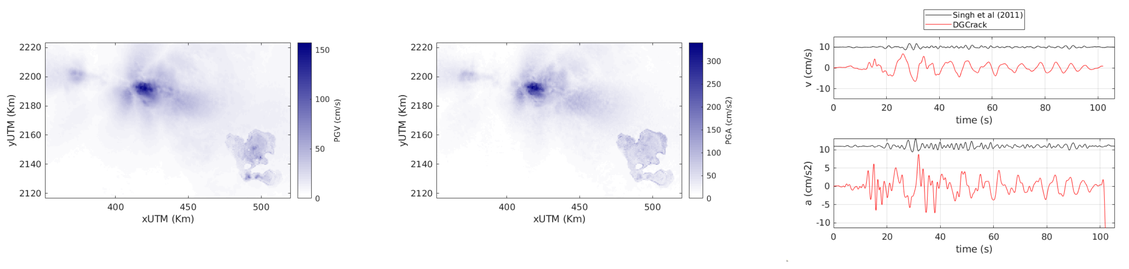

Figure 3. (left) Horizontal PGV map. (center) Horizontal PGA map. (right) Comparison from DGCrack and synthetic data obtained using empirical green functions (Sing et., al., 2011) (up) Velocities (down) Acelerations.

A simulation up to 0.75 has been done, the PGV and PGV were generated in the whole surface of the model and velocity and aceleration seismograms were generated in the reference station in CU. The seismograms are compare with ones obtained using a couple of small earthquakes in Actopan in 2003 and 2010 as empirical green functions by Singh et al (2011).

5. Broadband Wavenumber Slip Scenarios.

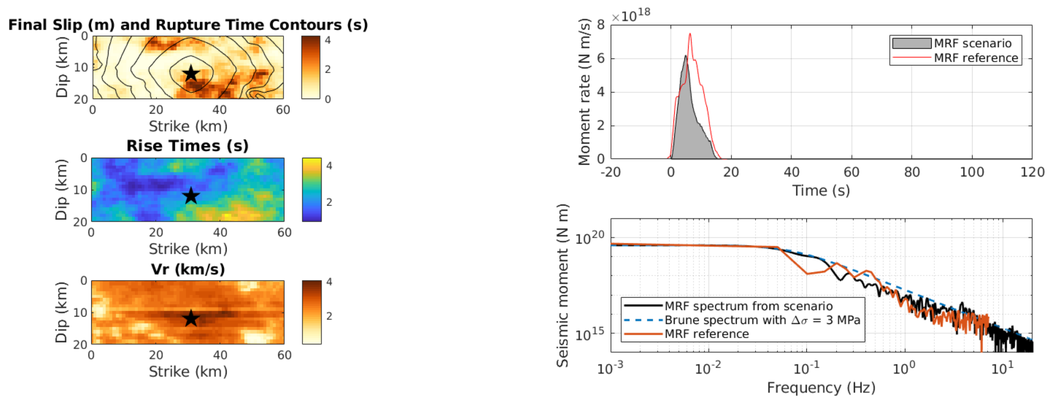

Figure 4.(left) Final slip distribution with rupture time contours, rise time and rupture velocity. (rigth) MRF Spectrum from scenario.

A plane fault of 60 km along strike and 20 km along dip, with subfaults of 1 km, has been build to generate a Mw=7.0 Earthquake in Acambay. The source time parameters (rise time, peak slip rate and rupture time) following Schemedes et. al., (2013).

Key References

- Etienne et al., An hp-adaptive discontinuous Galerkin finite-element method for 3-D elastic wave modelling. Geophysical Journal International, 2010.
- Cruz-Atienza et al., Long Duration of Ground Motion in the Paradigmatic Valley of Mexico. Nature-Scientific Reports, 2016.
- Schemedes et al., A kinematic rupture model generator incorporating satial interdependency of earthquakes source parameters, Geophysical Journal International, 2013.
- Singh et. al.,Estimation of Ground Motion in Mexico City from a Repeat of the M âĹij 7:0 Acambay Earthquake of 1912, BSSA, 2011.

Main Goals and Future Directions

- Compile more information about historical seismicity in Central Mexico.
- Build plausible Kinematic and dynamic scenarios base on planar and nonplanar faults in Acambay area.
- Estimate PGA, PGV and spectral responses throughout the Valley of Mexico using response spectral ratios (Rosenblueth and Arciniega,1992; Reyes, 1999).
- Include probilistic approach to the assessment of seismic hazard of Valley of Mexico due to earthquakes in the center part of Mexico.