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A moment-tensor catalog for intermediate magnitude earthquakes in Mexico

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Located among five tectonic plates, Mexico is one of the world's most seismically active regions. The earthquake focal mechanisms provide important information on the active tectonics. A widespread technique for estimating the earthquake magnitud and focal mechanism is the inversion for the moment tensor, obtained by minimizing a misfit function that estimates the difference between synthetic and observed seismograms. An important element in the estimation of the moment tensor is an appropriate velocity model, which allows for the calculation of accurate Green's Functions so that the differences between observed and synthetics seismograms are due to the source of the earthquake rather than the velocity model. However, calculating accurate synthetic seismograms gets progressively more difficult as the magnitude of the earthquakes decreases.

Large earthquakes (M>5.0) excite waves of longer periods that interact weakly with lateral heterogeneities in the crust. For these events, using 1D velocity models to compute Greens functions works well and they are well characterized by seismic moment tensors reported in global catalogs (eg. USGS fast moment tensor solutions and GCMT). The opposite occurs for small and intermediate sized events, where the relatively shorter periods excited interact strongly with lateral heterogeneities in the crust and upper mantle. To accurately model the Green's functions for the smaller events in a large heterogeneous area, requires 3D or regionalized 1D models.

To obtain a rapid estimate of earthquake magnitude, the National Seismological Survey in Mexico (Servicio Sismológico Nacional, SSN) automatically calculates seismic moment tensors for events in the Mexican Territory (Franco et al., 2002; Nolasco-Carteño, 2006). However, for intermediate-magnitude and small earthquakes the signal-to-noise ratio could is low for many of the seismic stations, and without careful selection and filtering of the data, obtaining a stable focal mechanism is difficult. The selection of data windows and filter parameters is tedious without a tool that allows easy viewing of the data prior to the inversion.

Therefore, we developed a graphical user interface (GUI), based on Python and the python library ObsPy, that processes in a iterative and interactive way observed and synthetic seismograms prior to the inversion. The processing includes filtering, choosing and discarding traces and manual adjustment of time windows in which synthetics and observed seismograms will be compared. We calculate the Green Functions using the SPECFEM3D_GLOBE algorithm (Komatitsch et al.,2004) which employs a velocity model that is composed of a mantle and a crustal model, S362ANI (Kustowski et al., 2008) and CRUST2.0 (Bassin et al., 2000), respectively. We invert the observed seismograms for the seismic moment tensor using a method developed for earthquakes in California (Liu et al., 2004) and implemented for earthquakes in Mexico (De la Vega, 2014). In this work, we introduce the GUI, the inversion method and the results from the moment-tensor inversions obtained for intermediate-magnitude earthquakes (4.5<M<5.0) analyzed in Mexico.