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Challenges to developing a unified earthquake catalog for seismic hazard assessment in South America – Addressing magnitude homogenization and depth uncertainties

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ABSTRACT

Constructing a unified earthquake catalog is an important step in developing regional seismic hazard models in South America with a broad seismotectonic environment that includes very active subduction zones and fault systems as well as stable regions. Several earthquake catalogs (international: GEM, USGS NEIC, GCMT, ISC, etc.; and regional: CERESIS, IGEPN, RSNC) provide records of seismicity, characterized by different magnitude types and uncertainties. We evaluate the completeness and quality of each catalog for the purpose of merging multiple data sources into a high-quality comprehensive historical catalog. Challenges include homogenizing magnitudes to a common magnitude scale and addressing uncertainties in hypocenter location and common default values reported for focal depth. Here, we present the sensitivities of magnitude-rate distributions (i.e. recurrence periods) - at the level of seismic source zones - to these procedures and their underlying assumptions.

One challenge in developing a comprehensive catalog is the homogenization of magnitudes to a single magnitude scale, in this case, the moment magnitude scale, Mw. Reporting agencies provide magnitude data on many different scales (Mw, mb, MS, ML, MD, etc.). Many authors have published global relations connecting magnitude scales (e.g., Scordilis et al., 2006, GEM Homogenization equations). However, scaling equations are varied and many employ simple linear regressions, which have a potential to induce systematic errors in magnitude conversion, introducing apparent catalog incompleteness and bias to magnitude-frequency distributions. We use the ISC Bulletin, which provides a compilation of magnitudes from different reporting agencies for each earthquake, to develop general orthogonal regressions (GOR) for scaling to Mw. We compare GOR models for South America data for each catalog (reporting agency) at seismic source zone levels to global equations, applying both to assess the impact of these approaches on magnitude-rate distributions.

In building a unified catalog, attention must be given to uncertainties in the focal depth in order generate a realistic view of potential ground motions. Catalogs often provide default depth solutions when hypocenter depth cannot be well-determined. In order to constrain the realistic depth distribution of seismicity in a source zone, we present a magnitude- and location- dependent bootstrap methodology for resampling default depths using available, well-determined depth data. We show the impact of this procedure on recurrence rates for shallow and deep seismicity.

KeyWords: magnitude homogenization, unified catalog, recurrence.