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Toward a new seismic hazard model for Guadeloupe: Model development and sensitivity analysis

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Abstract

The probabilistic seismic hazard model for Guadeloupe developed for this study is based on a detailed analysis of historical and instrumental seismicity, coupled with a comprehensive understanding of the regional seismic sources and their seismic behavior. The model provides a comprehensive assessment of seismic risk for the region, taking into account both the local and regional seismicity and the resulting ground-motion characteristics. The model is designed to be used for a wide range of applications, including seismic design and risk management.

Updated Seismic Catalogue

A new catalogue of earthquakes (STR 2021) covering the historical and instrumental periods in the Lesser Antilles is developed to define a robust scenario sample. The catalogue is compiled from various sources, including earthquake catalogues, instrumental data, and historical records.

Seismic Source Models

The seismic source models (SSMs) are made of volumes of the earth crust and individual faults of their planes exhibiting the same seismotectonic regime and seismicity occurrence features. These SSMs are an evolution of Martin et al. (2005) and include:

- Surface crustal volumes (30-30 km, black limits);
- Volumes related to interplate coupling interfaces (50-50 km) and to subduction planes of the American plate, Caribbean plate and Atlantic plate;
- Major Goris and More-Piton quaternary faults, near Pointe-à-Pitre, St. Lucia, Barbados, and seismicity of St. Vincent.

Ground Motion Models

The ground-motion models (GMMs) are selected and adapted for each subduction zone and crustal domain. The GMMs are the basis for the ground-motion prediction equations (GMPEs) used in the model.

Smoothed Seismicity

The smoothing approach is an alternative to the source zone seismicity model, allowing for the local variability of seismicity. A wide range of GMMs were selected and adopted to better account for the regional uncertainties in the activity rates.

Sensitivity Analysis

The sensitivity analysis was carried out in order to better characterize the center, body, and radius of the identified source volumes with respect to the expected ground-motion characteristics.

Discussion & Conclusions

The analysis for a return period of 475 years shows that for the STR 2021 catalogue, the hazard variability amplitude is in the range 15-30%. The models based on seismicity are adapted to source volumes with the relative hazard levels from the adapted kernel model. The impact of fault models is a function of the distance between the faults and the epicenters.

Additional comparisons were made with respect to the use of either of the GMMs for the STR 2021 catalogue showing that the range of variability of ground-motion parameters (about 30%).

The analysis of the hazard model was carried out following the logical tree at 15 points corresponding to the seismic source zones, and the results were compared with the ground-motion characteristics and the seismic hazard model.