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A physics-based earthquake simulator and its application to seismic hazard assessment in Calabria (Southern Italy) region

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The characteristic earthquake hypothesis is not strongly supported by observational data because of the relatively short duration of historical and even paleoseismological records. For instance, for the Calabria (Southern Italy) region, historical information on strong earthquakes exist for at least two thousand years, but they can be considered complete for M > 6.0 only for the latest few centuries. As a consequence, characteristic earthquakes are seldom reported for individual fault segments, and hazard assessment is not reliably estimated by means of only minor seismicity reported in the historical catalogs.
Even if they cannot substitute the information contained in a good historical catalog, physics-based earthquake simulators have become popular in the recent literature, and their application has been justified by a number of reasons. In particular, earthquake simulators can provide interesting information on which renewal models can better describe the recurrence statistics, and how this is affected by features as local fault geometry and kinematics. The use of a newly developed earthquake simulator has allowed the production of catalogs lasting 100,000 years and containing more than 100,000 events of magnitudes $\geq$ 4.5. The algorithm on which this simulator is based is constrained by several physical elements, as an average slip rate due to tectonic loading for every single segment in the investigated fault system, the process of rupture growth and termination, and interaction between earthquake sources, including small magnitude events. Events nucleated in one segment are allowed to expand into neighboring segments, if they are separated by a given maximum range of distance.
The application of our simulation algorithm to Calabria region provides typical features in time, space and magnitude behaviour of the seismicity, which can be compared with those of the real observations. These features include long–term periodicity of strong earthquakes, short-term clustering of both strong and smaller events, and a realistic earthquake magnitude distribution departing from the Gutenberg-Richter distribution in the moderate and higher magnitude range.
Lastly, an attenuation law has been applied to all the events reported in the synthetic catalog for the production of maps showing the exceedance probability of given values of peak acceleration (PGA) on the territory under investigation.