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Extreme seismic hazard assessment: Application to the Tibet –Himalayan region

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Recent disasters due to great earthquakes revealed a weakness in seismic hazard assessments: ground shaking due to the earthquakes was significantly underestimated. Large-magnitude, rare and hence extreme seismic events are not accounted in the analysis of ground shaking in the most cases due to the lack of information and unknown re-occurrence time of extremes. Our present knowledge about earthquakes is based on observed (recorded) and historical (e.g., from paleo-seismological and archaeological studies) data. We present a new approach to assess regional seismic hazard, which incorporates observed seismicity and modeled extreme events into the ground motion analysis, and apply this approach to probabilistic seismic hazard assessment in the Tibet-Himalayan region. Initially earthquakes are simulated for several thousand years; the synthetic earthquakes occur on the modeled faults due to realistic movement of modeled lithospheric blocks, stress localization and release. The large-magnitude events from the modeled catalogs together with the observed earthquakes are used to generate a set of composite stochastic catalogs. These composite catalogs are employed for Monte-Carlo probabilistic seismic hazard assessment. The results provide information about strong shaking, which could be anticipated in the region, in terms of peak ground acceleration. The resulted seismic hazard map is compared with those modeled earlier and with observed strong-motion data. Our approach to seismic hazard assessment provides a better understanding of ground shaking due to possible large-magnitude events and could be useful for seismic risk assessment, earthquake engineering purposes, and emergency planning.