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Stochastic finite-fault ground motion simulation in seismic hazard assessment – is it worth the extra effort?

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In recent years, there has been increasing focus on replacing ground motions from empirical ground motion prediction equations (GMPE) with simulation-based values in probabilistic seismic hazard assessment (PSHA). Physics based ground motion simulations can incorporate important effects of e.g. slip distribution and rupture directivity, but come at the cost of severe computational effort. One compromise is to apply a stochastic simulation tool which is computationally very efficient and incorporates source characteristics to a reasonable extent. Another challenge when applying any ground motion simulation technique in a predictive study, including PSHA, is that we have little control on the source parameters of future earthquakes. We thus need to simulate scenarios for a range of realistic source parameters to reflect the epistemic uncertainty in the simulated ground motion. But is it then worth the extra effort to simulate ground motion in seismic hazard studies? Or more specifically, can we reduce the uncertainty to a lower level than that of traditional GMPEs? This study aims to answer these questions through stochastic simulation of earthquake scenarios. To account for uncertainties in the source parameters of future earthquakes, realistic ranges of input parameter values are defined through calibration with information on ground motion records of past events, and a large number of simulations are performed to cover these ranges. The simulations are performed for scenario earthquakes located in the city of Managua, Nicaragua, which is underlain by several surface-rupturing active faults of various types. Results are presented in terms of ground shaking and are compared to the results of traditional GMPEs.