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Aftershock modeling based on Coulomb stress-triggering and ground shaking

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In recent years, the triggering of earthquakes has been discussed controversially with respect to the underlying mechanisms and the capability to evaluate the resulting seismic hazard. Apart from static stress interactions, other mechanisms including dynamic stress transfer have been proposed to be part of a complex triggering process. Significant differences are expected in the spatial distribution of aftershocks. However, testing different hypothesis requires the consideration of the large uncertainties involved in stress calculations. In particular, the uncertainties resulting from non-unique inversion results for the slip-models, variability of aftershock mechanisms, and spatial inhomogeneities of material and pre-stress, are shown to have a significant impact on the model forecasts. Furthermore, aftershock interactions are important but explicit calculation of all secondary (small-scale) stress changes is not feasible. Therefore, we take secondary aftershock triggering into account by using the epidemic type aftershock sequence (ETAS) model where the spatial probability distribution of direct aftershocks is assumed to be correlated to the mainshock induced static Coulomb-stress changes. For calculating Coulomb-stress changes, we use published and random slip models. For comparison, we test the likelihood values of the same model where we assume that the direct aftershocks are triggered by ground shaking or a combination of ground shaking and Coulomb-stress changes. As an approximation of the shaking level, we use ShakeMap data which are available in near real-time after a mainshock and would allow a simple first-order forecast of the aftershock activity. We present the test results for several well-known mainshock-aftershock sequences.