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Improving empirical aftershock modeling using additional source information

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Several mechanisms are proposed to underly earthquake triggering, apart from static stress interactions, other mechanisms including dynamic stress transfer are part of a complex triggering process. Significant differences are expected in the spatial distribution of aftershocks. However, testing the different hypotheses is challenging because it requires the consideration of the large uncertainties involved in stress calculations as well as the appropriate consideration of secondary aftershock triggering related to small-scale stress changes induced by pre-mainshock events and aftershocks.
Therefore, we take earthquake interaction 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 alternative source information and mechanisms. We test information of observed surface shaking and the geometry of the ruptured fault. As an approximation of the shaking level, we use ShakeMap data which are available in near real-time after a mainshock and thus could be in principle used for first-order forecasts of the spatial aftershock distribution. Alternatively, we test the use of empirical decay laws related to minimum fault distance and Coulomb stress change calculations based on published and random slip models.
Our test of some well-known aftershock sequences shows that the fault geometry is the most valuable information for improving aftershock forecasts. Furthermore, we find that static stress maps can additionally improve the forecasts of off-fault aftershock locations, while the integration of ground shaking data could not upgrade the results significantly.