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A stochastic fault-based earthquake simulator for short- and long-term seismicity

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Earthquake simulations are important for several reasons, in particular, they can be used (i) to reproduce observations and thus to develop our system understanding, (ii) as null hypothesis for testing observed anomalies in real seismicity, or (iii) to create possible future earthquake scenarios for deterministic and probabilistic hazard estimations. So far, two distinct model types are mainly used. On the one hand, statistical short- or long-term models as the epidemic-type aftershock sequence (ETAS) or the Brownian passage time (BPT) models and on the other hand, fault-based simulations with spontaneous rupture nucleation and propagation and realistic stress interactions. While physics-based models can link the underlying physical processes with earthquake statistics, statistical earthquake models are designed to successfully fit observed data and can account inherently for the unpredictability of small scale processes and heterogeneities and they are easy to apply and not expensive in computer time. Thus an important goal is to construct "realistic" statistical models which are well-constrained by observations and physics-based models. We have developed a new stochastic simulator for on- and off-fault seismicity which is based on tectonic loading and stress-interactions and is characterized by (i) quasi-periodic recurrence of characteristic on-fault events; (ii) background activity with a power-law distance decay relative to the faults; and (iii) aftershock triggering according to the ETAS model. Here, the stress changes on the fault due to larger off-fault earthquakes are taken into account. In this presentation, we will introduce the model and will show the comparison of such stochastic fault simulations with physics-based simulations for interacting faults.