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Quasi-dynamic earthquake fault systems with rheological heterogeneity

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Seismic risk and hazard estimates mostly use pure empirical, stochastic models of earthquake fault systems tuned specifically to the vulnerable areas of interest. Although such models allow for reasonable risk estimates, such models cannot allow for physical statements of the described seismicity. In contrary such empirical stochastic models, physics based earthquake fault systems models allow for a physical reasoning and interpretation of the produced seismicity and system dynamics. Recently different fault system earthquake simulators based on frictional stick-slip behavior have been used to study effects of stress heterogeneity, rheological heterogeneity, or geometrical complexity on earthquake occurrence, spatial and temporal clustering of earthquakes, and system dynamics. Here we present a comparison of characteristics of synthetic earthquake catalogs produced by two different formulations of quasi-dynamic fault system earthquake simulators. Both models are based on discretized frictional faults embedded in an elastic half-space. While one (1) is governed by rate- and state-dependent friction with allowing three evolutionary stages of independent fault patches, the other (2) is governed by instantaneous frictional weakening with scheduled (and therefore causal) stress transfer. We analyze spatial and temporal clustering of events and characteristics of system dynamics by means of physical parameters of the two approaches.