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Numerical simulation of temporal evolution of multi-scale earthquake rupture

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Understanding of multi-scale earthquake rupture is a key issue. Our previous studies showed how a small earthquake without any characteristic nucleation process progresses to a big event under a multi-scale heterogeneous fracture energy distribution (Aochi and Ide, GRL, 2004; Ide and Aochi, JGR, 2005). The renormalisation technique we applied with a boundary integral equation method in these studies allows us to rather understand the macroscopic features of a single event by following the basic microscopic process. Now our question is how such a heterogeneous system evolves with time as a sequence of earthquakes. The fault breaks too easily on the whole system from the previously ruptured area as we do not introduce any healing processes. Therefore we assume an immediate healing after each event (no time-dependent healing process of fracture energy is taken into account). We test different rupture criteria, namely how to choose an initial instability in the numerical simulation. A stochastic selection according to the stress condition as an analogy of the Weibull distribution. However, for the first cycle where we start with a uniform stress field, we do not observe any clustered appearance of events. It can mean that the clustering feature of seismicity needs inherent stress heterogeneity due to the previous events and the system needs to be mature following a few cycle of earthquakes. We will have to discuss how a big event occurs and reproduces heterogeneity within its ruptured area.