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Earthquake Nucleation on Faults with a Revised Rate- and State-Dependent Friction Law

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Quasi-static nucleation on a frictional fault embedded in an elastic medium is known to be sensitive to the frictional properties. Earlier works have employed 'aging' and 'slip' versions of rate- and state-dependent friction (RSF) law, but some clear flaws have been known; the aging law wrongly predicted linearly increasing slip-weakening distance with the amount of strength reduction, whereas the slip law could not reproduce observed time-dependent healing at very low velocities. Recently Nagata et al. [1] proposed a revised version of RSF by incorporating a stress-weakening effect newly found in laboratory experiments and by correcting the frictional parameters 'a' and 'b' largely, where 'a' and 'b' are the coefficients of RSF. It seems to be free from the previously known flaws and we here reexamined nucleation by using the revised RSF. From numerical simulations, two major differences were found. 1) For weakly velocity-weakening range of $0.85<a/b<1$, nucleation has characteristics of both unidirectional slip-pulse regime found in the slip law case and crack-like expansion regime in the aging law case. 2) Fixed-length patch regime occurs over a wider condition of a/b up to 0.85 in contrast with the previously reported range of $a/b<0.5$ implying strongly velocity-weakening faults.