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Seismic nucleation under nonlinear slip weakening friction

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Recent frictional experiments on simulated fault gouge (Chambon et al., GRL 2002) have shown a predominant non linear slip weakening behavior (proportional to $(\delta - \delta_0)^{-\beta}$, $\beta \approx 0.4$, $\delta_0 < 0$, Chambon et al., JGR 2005, submitted), on which are superimposed more classical rate and state variations of smaller magnitude. We numerically study the properties of nucleation phases under this nonlinear slip weakening friction in terms of characteristic size and evolution time. With linear slip weakening, seismic nucleation phases generally behave exponentially, with a characteristic time inversely proportional to the weakening rate (the slope of the friction law). In the nonlinear case, nucleation is sensitive to the weakening rate averaged over the slipping region, which thus depends on cumulated slip. This suggests to study the possible relevance of such properties with the earthquake size dependent scaling of parameters involved in recently proposed algorithms for quick magnitude estimation in early warning systems. We also investigate the contribution of the second order rate and state terms.