Exponential dependence on perturbation stress of earthquake nucleation

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Recent observations have reported that some tremors in slow earthquake are sensitive to stress perturbations caused by ocean tides [1]. According to the preceding studies [1], occurrence frequencies of the susceptible tremors display exponential dependence on the stress magnitude. This study numerically investigates effects on earthquake nucleation growths of the periodic stress perturbations to see if the nucleation developed under the rate-and-state friction law reproduces the stress dependence. The numerical results suggest the exponential dependence on the perturbation stress magnitudes even in the presence of superimposed sinusoidal waves with the different periods. In addition, the exponential rates are found not to be sensitive to a change in the perturbation period or the superposition components of the sinusoidal perturbations, which implies the critical stresses magnitude are independent of a variety of the perturbations.

[1] S. Ide and Y. Tanaka, Geophys. Res. Lett. 41, 3842 (2014); S. Ide, S. Yabe, H.-J. Tai, and K. H. Chen, Geophys. Res. Lett., 42, 3248 (2015).

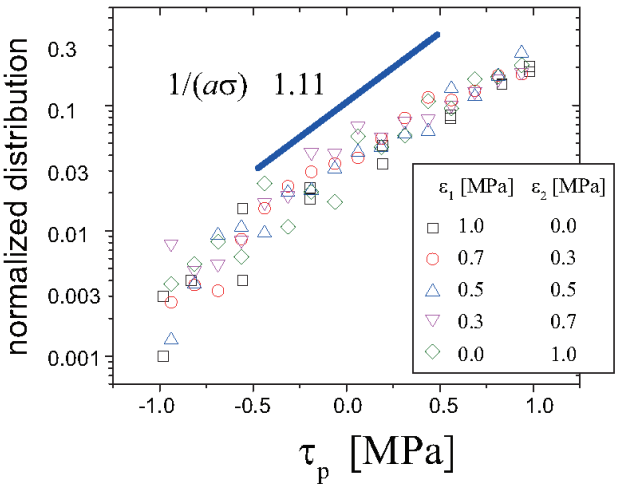

FIG. 1: Numerical results of stress dependence of the nucleation growth under the perturbation $\tau_p = \epsilon_1 \sin(\omega_1 t) + \epsilon_2 \sin(\omega_2 t + \phi_{2,ini})$. Horizontal or vertical axes represents stress magnitude or the normalized distribution, respectively. For each parameter condition, we measured the stresses of 1000 nucleation samples, which grow from randomly generated initial conditions, when the nucleation slip reaches the threshold velocity $V_{thr} = 1.0$ mm/s.

