Complex earthquake cycle simulations using a two-degree-of-freedom spring-block model

Abe, Y[(1)] and Kato, N[(1)]

(1) Earthquake Research Institute, Univ. of Tokyo, Tokyo, Japan
email yuta-abe@eri.u-tokyo.ac.jp

In order to understand quasi-periodic or complex earthquake cycles observed, for example, along the Nankai trough, southwestern Japan, we conduct numerical simulations using a two-degree-of-freedom spring-block model and a rate- and state-dependent friction law. The model is essentially the same as that used by Yoshida and Kato (2003, Geophys. Res. Lett.). Each block is dragged by a driver through a spring of stiffness k_0 and the two blocks are connected by a spring of stiffness k_{12}. The frictional parameters (a, b and L) of two blocks are set at different values so that stick-slip periods of the two blocks would be different to examine interaction between them. Unstable slip is expected to occur for $k_0 + k_{12} < k_c$, which is given by $\sigma_n(b-a)/L$. For each parameter set, we observed thousands of slip events to examine the statistical properties. Observed slip patterns can be classified into three as follow: (1) Periodic occurrence of unstable slips, where the two blocks slip simultaneously or with a short delay time, (2) quasi-periodic occurrence of unstable slip, with variable recurrence times and delay times between the two blocks, and (3) complex slip pattern including unstable slip and episodic slow slip. As the frictional parameters close to the stability transition boundary, earthquake patterns become complex. We will analyze the statistical properties of simulated earthquake cycles and closely examine the bifurcation points where earthquake patterns shift.