# Dynamic modeling of ordinary and slow earthquakes in a single framework

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We try to simulate features of slow and ordinary earthquakes in a single dynamical framework. Key ingredients of our modeling are fluid flow, shear heating and inelastic pore creation due to dynamic fault slip. We assume a fault in a thermoporoelastic medium saturated with fluid. The inelastic porosity is assumed to increase with evolving fault slip. It was shown in our 1-D analysis that only three nondimensional parameters $S_u$, $S'_u$ and $P_0$ govern the qualitative nature of slip behavior (Suzuki and Yamashita, 2010). We observe slip-weakening and strengthening in the ranges $S_u < P_0$ and $S_u > P_0$, respectively. Here, $S_u$ is a parameter proportional to the creation rate of pore; $S'_u$ and $P_0$ are proportional to the permeability and to the initial fluid pressure, respectively. We found in 2-D modeling that ordinary high-speed earthquake ruptures are modeled well if we assume $S'_u$ close to zero and $S_u$ slightly larger than $P_0$ (Suzuki and Yamashita, 2008). We can also simulate features of slow earthquakes relatively well in the 2-D modeling if we assume the inequality $S_u >> P_0$ and relatively large values for $S'_u$ (Suzuki and Yamashita, 2009). In the present study, we specifically examine the generation mechanism of slow slip coupled with tremor. We make much longer calculations in the present study than in the analysis of Suzuki and Yamashita (2009) by developing an efficient numerical method. We find that a nucleated event stops its growth soon after the nucleation if the value of $S_u$ is significantly large because of intense slip-strengthening. However, the fluid continues to flow into the slip zone even after the arresting of fault growth, which eventually reactivates the fault slip. In other words, the fault slip can occur intermittently because of fluid inflow for significantly large values of $S_u$. This can be a model for slow slip event coupled with tremor. Our calculation shows that the fault slip reactivation is more frequent if the value of $S_u$ is larger. It is also shown in the calculation that the seismic moment evolution is largely different between ordinary and slow earthquakes. In conclusion, our fault model can simulate features of ordinary and slow earthquakes in a unified way in terms of the three nondimensional parameters.