Stochastic modeling of slow earthquakes comparable to observations

*Naofumi Aso[1], Ryosuke Ando[2], Satoshi Ide[2]

1. Tokyo Institute of Technology, 2. University of Tokyo

Slow earthquakes are often modeled using rate-and-state friction law with heterogeneously distributed parameters. However, we never know the exact friction law nor the perfect distribution of frictional parameters. Also, other physics are also proposed to contribute to the slow process, including pore fluid. Since any deterministic approaches cannot adequately capture the temporal stress change at a specific site because of the inherent unpredictability caused by various nonlinear processes, we instead focus on the stochastic approach to model slow earthquakes.
In stochastic modeling, we artificially add stochastic fluctuations in numerical simulations. When the result agrees with observations, the stochastic fluctuations are found to represent underlying physics. Then, we can make some predictions that could be evaluated by further observations. After capturing many characteristics of the stochasticity, we could finally approach physics. Although the deductive approach based on specific physics is often taken in earthquake source physics, the experimental approach has the potential to fill the gap between modeling and observations.
Here, we demonstrate that the consideration of stochastic stress fluctuations in ordinary crack simulations can reproduce a variety of observations of slow earthquakes, including burst-like tremor initiation, the existence of tremor front, decelerating tremor migration, and precursory slow earthquakes. The identical model can also reproduce both crack-like and pulse-like ordinary earthquakes by simply changing the strength drop and initial stress level.

