Modeling tremor with cellular automaton

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Bak, Tang, and Wiesenfeld introduced the concept of self-organized criticality. In this concept, the OFC model was introduced by Olami, Frder, and Christensen as a further simplification of the Burridge and Knopoff model(BK model) and as a nonconservative sandpile model. The Olami-Frder-Christensen model(OFC model) is cellular automaton model which exhibits critical properties such as the Gutenberg-Richter law or the Omori law. In the conventional OFC model, stress doesn’t accumulate during rupture propagation because the rupture propagation time scale is assumed to be much smaller than the loading time scale in the regular earthquakes. If we consider tremor’s model that more sensitive than regular earthquakes, we should consider that rupture propagation time scale and loading time scale is close. Tremor’s loading time scale may be shorter because tremor’s stress drop is smaller. Therefore we introduced a new parameter which represents a degree of balance between rupture propagation time scale and loading time scale into the OFC model. This parameter is defined as the amount of stress that accumulate until one cell finishes sliding. We can think the new OFC model represent tremors when this parameter is large.

The new OFC model can explain the several observational properties of tremors. 1: Tremor can be explained as a swarm of low-frequency earthquakes(LFE). 2:The seismic displacement waveform power spectrum density is lorentzian spectrum. 3: The seismic moment is proportional to the duration. 4: The size distribution power or exponential depends on the new parameter dimensionless loading rate. These results suggest that the dimensionless loading rate is an important parameter to represent tremors and LFE.

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