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Expansion of Aftershock Area Caused by Propagation of Postseismic Sliding: A Numerical Simulation

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It is known that the aftershock areas of large earthquakes often expand with time (e.g., Tajima and Kanamori, 1985; Henry and Das, 2001). This suggests that the stress increase due to coseismic slip gradually propagates outward from the main shock rupture area. It is probable that this propagation of stress increase is caused by the propagation of postseismic sliding, which has been detected for many large earthquakes by geodetic observations mainly with Global Positioning System (GPS). In the present study, I perform a numerical simulation on the expansion of aftershock area caused by the propagation of postseismic sliding. The model fault in an infinite elastic medium is loaded at a constant displacement rate, and the frictional stress on the fault obeys a laboratory-derived rate- and state-dependent friction law (Kato, 2004). Nonuniformity in frictional constitutive parameters is introduced on the model fault plane so that a large asperity for a large earthquake and many possible nuclei of aftershocks around the asperity may be distributed. Nagative values of A-B are assigned for seismic slip areas of the mainshock and aftershocks and positive A-B values for the other regions for aseismic sliding, where A-B expresses the rate dependence of steady-state friction stress and controls sliding mode (seismic/aseismic). The simulation can reproduce aftershocks triggered by stress increase due to postseismic sliding and the expansion of aftershock area. The propagation speed of the aftershock area expansion decreases with the distance from the mainshock asperity or A-B on the velocity-strengthening region, which controls the characteristics of postseismic sliding. This suggests that the A-B value on plate interfaces may be estimated from aftershock data. The simulation indicates that the largest value of the ratio of the linear dimension of the aftershock area to that of the mainshock coseismic slip area is 2 to 3. This is consistent with the observation for large earthquakes at subduction zones.