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Dynamic rupture model of the 2014 northern Nagano, central Japan, earthquake

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The 2014 northern Nagano, central Japan, earthquake (M_{JMA}6.7) occurred in November 22, 2014. The surface ruptures intermittently observed along the Kamishiro fault (Katsube, this meeting), but the southern part of the fault remains to be ruptured. We construct a dynamic rupture model of the earthquake to understand the mechanism of the earthquake and the present condition of the fault.

Fault length and lower depth of the fault is 22 km and 15 km, respectively, based on the aftershock distribution (JMA, 2014; NIED, 2014) and InSAR image (GSI, 2015). Fault strike is N10E, based on the aftershock distribution and the strike of the Kamishiro fault (MEXT et al., 2004). Dip angle of the deeper region than 2 km is 60 degrees, based on the CMT solutions (JMA, 2014; NIED, 2014) and aftershock distribution, and dip angle of the shallower region than 2 km is 45 degrees, based on the analysis of the InSAR data (Yarai, 2015). The southern part of the fault reaches the earth's surface, while upper depth of the northern part is 2 km. Principal stresses are proportional to depth. Azimuth of the maximum principal stress is N65W (MEXT et al., 2004). The minimum principal stress is vertical, and equal to overburden load. We assume hydrostatic condition. The medium has 2-layered structure with 2 km-depth boundary, based on the subsurface structure model around the fault (NEID, 2003). The upper layer has zero stress drop, since it corresponds to sediment layer. We calculate dynamic rupture processes by the finite-difference method (Kase, 2010), assuming the slip-weakening friction law, and search average stress drop that is consistent with the observed seismic moment.

In case that the average stress drop is 3.3 MPa, the seismic moment is 6.21 x 10^{18} Nm (Mw6.5), which is almost agree with the CMT solutions. Rupture first smoothly propagates, because our dynamic rupture model is laterally homogeneous. After the rupture reaches 2 km-depth, the rupture suddenly decelerates because of zero stress drop. The maximum slip on the fault is about 2 m, and the maximum surface slip is about 1.1 m, which is agree with the observed one (Hirouchi et al., 2014).

Keywords: dynamic rupture, 2014 northern Nagano earthquake, Kamishiro fault, numerical simulation