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Kinematic and dynamic source parameters of the 2005 Miyagi-oki earthquake

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It is indicated that interplate earthquakes with magnitude of about 7.5 have occurred repeatedly in the Miyagi-oki region, northeastern Japan, with a recurrence interval of about 37 years. The 1978 Miyagi-oki earthquake occurred with a magnitude of 7.4, and 27 years later, the 2005 event occurred in the same region with a magnitude of 7.2. Wu et al. [in review] estimated rupture processes of the two events using teleseismic and strong motion records. According to their results, 1) both events ruptured from almost the same hypocenter, 2) the 1978 event consists of southern two asperities and northern large asperity, and the 2005 event ruptured only the southern two asperities. The estimation of dynamic source parameters of the two events may lead to understanding of recurrence and interaction between asperities of interplate earthquakes. Furthermore, for the construction of a source model to evaluate strong motions due to future Miyagi-oki earthquakes, it is important to examine a relationship among dynamic and kinematic source parameters of these previous events.

In this study, we construct a dynamic source model of the 2005 Miyagi-oki earthquake based on the Wu's kinematic source model. Then we evaluate the relationship among dynamic and kinematic source parameters. We construct a spontaneous dynamic rupture model of the 2005 event by forward modeling. We solve the elastodynamic equation using the finite difference method with the staggered grid to simulate the spontaneous dynamic rupture on the fault plane in an infinite homogeneous medium. The grid interval and the time increment are 0.2 km and 0.01 sec, respectively. As a boundary condition of the fault plane, we assume the slip-weakening law. A distribution of static stress drop is assumed based on the final slip distribution of Wu's kinematic source model and a constant slip-weakening distance is assumed to be 0.4 m over the whole fault plane. Based on above assumptions, a distribution of fracture energy is modeled by calibrating a distribution of strength excess to fit the rupture time distribution of Wu's model.

In Wu's kinematic source model, the 2005 Miyagi-oki event has two asperities: one is close to the hypocenter and the other is 40 km away from the hypocenter in the down-dip direction. In our preliminary dynamic model, the fracture energy in the second asperity is modeled to be about half of that in the first asperity so that the second asperity ruptures significantly. Consequently, the relationship between fracture energy and $¥Delta¥sigma L_h^{1/2}$ (i.e. stress intensity factor), where $¥Delta¥sigma$ and L_h are the static stress drop and the hypocentral distance, respectively, indicates different trends in the first and second asperities.