Dynamic rupture simulation for seismic hazard assessment: Application to the Futagawa and Hinagu fault zones (Part 2)

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For probabilistic seismic hazard assessment, evaluations of rupture area to estimate a magnitude for a scenario earthquake and frequency are needed. We propose to provide the basic information for the evaluations using dynamic rupture simulations. Kase et al. (2017) applied the dynamic rupture model for seismic hazard assessment to the Futagawa and Hinagu fault zones. They simulated dynamic rupture models based on information observed before the 2016 Kumamoto earthquake, and showed that the rupture processes initiated at the northeastern end of the Takano-Shirahata segment were consistent with the rupture process of the 2016 Kumamoto earthquake. In this study, we investigate the effect of variations in initial crack locations and the other source parameters on simulation results.
A fault geometry and tectonic stress fields are assumed in the same way as Kase et al. (2017). The Futagawa segment of the Futagawa fault zone and the Takano-Shirahata and Hinagu segments of the Hinagu fault zone are modeled as a continuous vertical right-lateral strike-slip fault plane about 75 km long with surface rupture, based on HERP (2013). Azimuths of the minimum principal stress and stress ratios are assumed, considering the stress inversion result of Matsumoto et al. (2015). We also assume that the principal stresses are proportional to depth, and that the intermediate principal stress is vertical and overburden load.
Two initial crack locations, the southwestern ends of the Futagawa and Takano-Shirahata segment, are assumed. We calculate dynamic rupture processes, using a finite-difference method (Kase and Day, 2006), to search the azimuth of the minimum principal stress and depth coefficient of stress drop consistent with observed right-lateral dislocation on each segment.
Among ruptures initiating at the southwestern end of the Futagawa segment, the ruptures propagating only on the Futagawa segment have right-lateral slips consistent with the observation. Among ruptures initiating at the southwestern end of the Takano-Shirahata segment, on the other hand, the ruptures propagating on the Takano-Shirahata and Futagawa segments have right-lateral slips consistent with the observation. These results agree with the cases initiating at the northeastern ends of both segments (Kase et al., 2017). Thus, the initial crack location does not affect the rupture propagation to the adjacent segments in the ruptures initiating on the Futagawa and Takano-Shirahata segments. In the ruptures initiating on the Hinagu segment, a rupture initiating at the southwestern end is easier to propagate to the Takano-Shirahata segment than that initiating at the northeastern end (AIST, 2018). The difference is caused by rupture directivity. The lengths of the Futagawa and Takano-Shirahata segments are less than 20 km, while the Hinagu segment is 40 km long. Thus, the difference of rupture propagation between the initial crack locations clearly appears in the Hinagu segment.
We also investigate the effect of variations in a critical displacement and a ratio of strength excess and stress drop on simulation results.

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