Kinematic and dynamic rupture modeling of the 2024 Mw7.5 Noto earthquake

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The 2024 Mw7.5 Noto (Japan) earthquake, recorded by over a dozen near-fault strong-motion seismometers, high-rate GNSS, and satellite data, presents a rare opportunity to examine the fault rupture evolution and resulting strong ground motions in detail. First, using kinematic rupture modeling, we develop a source model that reproduces the waveform data in the period range of 4 seconds and longer. Our approach integrates 3D velocity and inelastic attenuation models for Japan (Koketsu et al., 2012), along with the topography and bathymetry of the region. To minimize the number of unknown parameters, we employ an a priori fault slip model derived from InSAR data as a constraint for the fault geometry and final slip distribution, while only adjusting the rupture timing and rise time of individual fault segments. Our findings indicate that the earthquake rupture first propagated towards the southwest from the hypocenter, rupturing the largest asperity offshore Monzen. Approximately 24 seconds after the origin time, another rupture initiated propagation towards the northeast from the hypocenter. This delayed rupture towards the northeast may have been caused by the inability of rupture propagation through the zone of negative stress changes induced by the May 5 2023 M6.5 earthquake. Additionally, employing dynamic rupture modeling, we investigate the cause of the large (>0.5 m/s), long-period ground velocities observed in Wajima. Our analysis suggests that these ground velocities were induced by a propagating slip pulse on the fault in the vicinity of the stations and enhanced by the free surface and hanging-wall effects. These results have important implications for both earthquake source physics and ground-motion hazard assessment.

Keywords: Earthquake source processes, Strong ground motion, Earthquake rupture modeling

