Effect of near source velocity structures on the long-period ground motions: comparison of the observed ground motions between two moderate magnitude earthquakes in the Nankai trough subduction zone

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The Headquarters for Earthquake Research Promotion (HERP), Japan, has estimated probabilities of 70 to 80 % for the next magnitude 8-9 class earthquake within the next 30 years in the Nankai trough area under some assumptions. Moderate magnitude earthquakes are not very frequent in the Nankai trough compared with those in the Japan trench area in northeast Japan. On April 1, 2016, an Mw 5.8 earthquake occurred in the coseismic slip area of the 1944 Tonankai earthquake independent of the 2004 southeast off Kii peninsula earthquake sequence. In this meeting, we present some comparisons based on the strong-motion and broadband recordings between two moderate magnitude earthquakes in the Nankai trough. The first event is the 2004 Mw 6.5 southeast off-Kii peninsula earthquake, an aftershock event in the sequence inside the Philippine Sea plate near the Nankai trough axis. The second event is the 2016 Mw 5.8 southeast off-Mie Prefecture earthquake, an independent event in the rupture area of the 1944 Mw~8 Tonankai earthquake. The centroid depths were 11 and 14 km for the 2004 and 2016 events, respectively. Despite the large difference in the moment magnitude between the two events, the JMA magnitude (Mj) was equal to 6.5 for the both events. We found that the short-period ground motions (e.g., response spectra at periods < 1 s) as well as the much longer-period ground motions (> 20 s) for the 2016 event scaled generally well with the moment magnitude. In contrast, the ground motions from the 2016 event were comparable to those from the larger moment magnitude event at equal distances at periods of about 2 to 20 s in wide areas. An examination of the existing subsurface velocity model suggested that the difference in the relative location of the two events with respect to the thick accretionary prism of low seismic velocity most probably caused the difference in the amplitude of the intermediate period seismic waves in the region. As a result, Mj is conceived to be equal for the both events because the Mj is estimated using the displacement amplitude of intermediate period (< 6 s) ground motions. The observed acceleration response spectra at periods of about 2 to 10 s were clearly underestimated for the 2016 event by the ground motion prediction equation (GMPE) employing Mw in the GMPE. On the other hand, GMPE employing the Mj described generally well the observed data. The results suggested that the plate boundary earthquakes in the Nankai trough may excite strong long-period ground motions of engineering importance, and these ground motions appear to be better explained by Mj than Mw in the GMPEs unless some further correction terms are applied to the Mw based GMPEs for the moderate magnitude earthquakes in the Nankai trough subduction zone.