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Regional Travel-time Inversion and Waveform Modeling for 3D Velocity Structure in Southwestern Japan

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In southwestern Japan the Philippine Sea plate (PHSP) subducts along the Nankai trough and this subduction causes megathrust earthquakes along the Nankai trough as well as large intraslab and inland earthquakes in the vicinity. The dip angle of the PHSP subduction varies significantly along the trench strike and the configuration of the PHSP beneath the Chugoku region is somewhat unclear due to the lack of seismicity below 40 km or so. In this region the *sP* phase is widely observed and its amplitude sometimes becomes larger than that of the direct S wave. We previously showed that the arrivals of this strong phase can be explained by incorporating the structure with thin sediment layers above the shallow bedrocks and the slab geometry in the velocity model (Hayashida *et al*., 2010). The agreement between the synthetics with the existing 3D model from the travel-time tomographic inversion (Nakajima and Hasegawa, 2007) and data is reasonable in general. Especially, the computed P-wave arrival times agree with the data well. However, the agreement between the waveforms and the data is not satisfactory for the *sP*- and S-waves at most of the stations. The travel times of *sP*- and S-waves of the synthetics calculated with the tomography model are somewhat slower than those of the data at most of the stations. The unsatisfactory agreement can be attributed to the parameters of the initial velocity model for the tomographic inversion and the difficulty in detecting S-wave travel times accurately. We first improved the 3D model by comparing the synthetics with data recorded for an intraslab earthquake (2001/3/26 M_w5.1, h = 46 km). We calculated synthetics using a standard layered structure used for this region (Asano *et al*., 1986) to fit the arrival times and amplitudes of *sP* phases, and then matched the P- and S-wave arrivals by tuning the slab configurations. The agreements between the synthetics and data were substantially improved at a number of local stations where the pronounced *sP* phase was recorded. At stations located to the north and west of the epicenter, the synthetics calculated with the layered model generally agree with the data in the frequency range between 0.1 and 0.5 Hz. On the other hand, at stations located to the east and south of the epicenter, the agreement was improved by including the slab configuration in the structure, since P and S waves propagate within the slab in these directions. However, the agreements between the synthetics and the data recorded for other earthquakes were not satisfactory due to some uncertainty in the forward modeling. Then, we performed the travel-time inversion again using the improved 3D model as the initial model and the relocated earthquake catalogue of Nakajima and Hasegawa (2007). The improved model better constrains the configuration of the PHSP and can produce synthetics in better agreement with data for other events. Our results suggest that the combination of forward waveform modeling associated with the slab and crust configuration and repeated inversion provides a better 3D model for estimation of ground motions.