Three-dimensional seismic velocity structure around the Tokyo Metropolitan area, focusing the subducting Philippine Sea plate

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1. Introduction

Beneath the Tokyo Metropolitan area, the Pacific and the Philippine Sea plates subduct under the Eurasian plate and a triple junction is located off the southeast of Tokyo. There are many active faults in and around this area. We investigate the 3D seismic velocity structure here with the seismic tomographic method. The National Research Institute for Earth Science and Disaster Resilience (NIED) constructed the High-sensitivity seismograph network (Hi-net) after the 1995 Kobe earthquake and began the operation in 2000. The Earthquake Research Institute, the University of Tokyo (ERI U-Tokyo) constructed the Metropolitan Seismic Observation network (MeSO-net) and began operation in 2008 (Hirata et al, 2009) and this network was transferred to NIED in 2016. We used arrival time data detected by these networks operated by NIED as well as other organizations and applied the seismic tomographic method for these data.

2. Data and method

The target region, 34-37°N and 138-142°E, covers the Tokyo Metropolitan area. We applied 6,296,216 P- and 4,463,943 S-wave arrival times from 148,763 earthquakes recorded at approximately 798 stations including the NIED Hi-net, MeSO-net, and so on to the seismic tomographic method (Matsubara et al., 2004). In this study, we used arrival time data at the Hi-net and the routine seismic network from 2000 to 2022 and those at the MeSO-net stations from 2008 to 2016. We placed grids with horizontal interval of 0.05° and resolution size is 0.1° which is the half of the results for whole Japanese Islands by Matsubara et al. (2022). The inversion reduces the RMS of the P-wave traveltime residual from 0.405 s to 0.139 s and that of the S-wave data from 0.665 s to 0.185 s after 19 iterations.

3. Results and discussions

The subducting Pacific and the Philippine Sea plates are clearly imaged as high-velocity zones with low-velocity oceanic crusts at the top of those plates. Beneath the Toko Bay, the upper boundary of the Philippine Sea plate is located at depths of 20-25 km. We compared the results of data with only the routine seismic stations without the MeSO-net stations and those of data using the MeSO-net stations as well as the routine seismic stations. The results with data from the MeSO-net stations imaged the high-velocity Philippine Sea plate with its low-velocity oceanic crust more clearly than those with data without the

MeSO-net stations (Figure). We can also detect the contact zone of the high-V Philippine Sea and the Pacific plates. The most effective zone of MeSO-net is the shallow zone at depths of 0-10 km in the Kanto Plain

The previous studies also imaged the subducting plates, however, they did not image the shallow zone since the approximately 20-km interval of seismic stations can mainly use only vertical ray paths to the stations and less horizontal ray paths within the upper crust. The dense MeSO-net stations located around the Tokyo area contributed to clarifying the seismic velocity structure at the shallow zone at depths of 0-15 km.

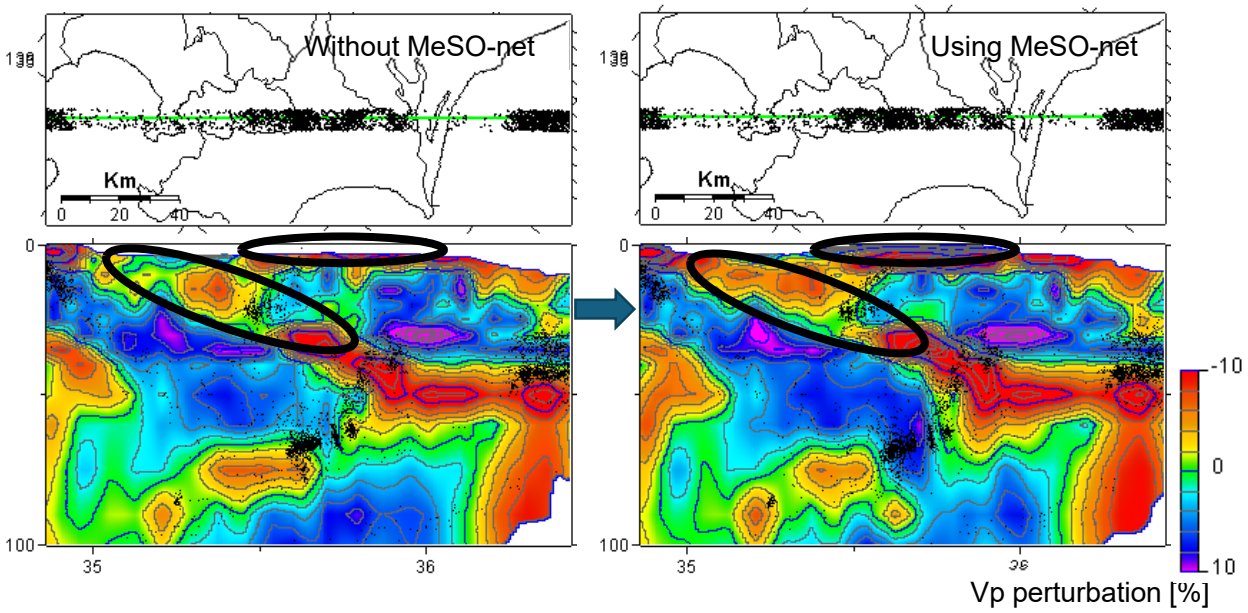

Figure: NE-SW vertical cross section of Vs perturbation

References

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