Validation of the method to estimate the crustal thickness using the cross-correlations of broad-band seismic ambient noise

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Central Indonesia has complex tectonic structures characterized by several subduction zones in the northern and eastern parts and many active faults (e.g., Palu Koro, Matano and Hamilton faults). These complexities frequently produce shallow crustal earthquakes over the region. Because of that, an understanding of crustal structure beneath the region is necessary for further seismological studies. Budiati et al. (2019) used waveform data recorded at 10 BMKG broadband stations around Sulawesi Island, Indonesia to estimate the spatial variation of the crustal thickness and its relation with active tectonics. The present study aims to verify the reliability of the procedure used in Budiati et al. (2019) by applying the same method to estimate the Moho discontinuity in Tohoku region, Japan, where the discontinuity has been investigated by many studies. We collect 5-month continuous waveform data from vertical components at 10 F-net stations in Tohoku region. According to the Budiati et al. (2019), the continuous data are divided into 20-minute segments with time shift of 5 minutes. We extract surface waves (Rayleigh waves) by calculating the CCFs between the data from two different stations and stack the daily-averaged CCFs over 5 months. We further compress the two-sided signal into one-sided signal by taking the average of positive and negative lag part of the CCFs to stabilize the dispersion curves of group velocities. To fit the synthetic and the observation dispersion curves, we adjust the two layered crustal velocity model from CRUST 1.0 (Laske et al., 2013) by subtracting 5%-10% of the average initial model. The best crustal thickness is obtained by minimizing RMS and visual estimation. In the present study, we only focus on periods of 10s to 30s which are sensitive to structural changes at depth between 20km –30km. Our current results indicate that beneath Tohoku region, among 16 pairs, there are 5 pairs showing reliable crustal thickness. The estimated crustal thickness at inland area are consistent with Zhao et al. (1990) and Nakajima et al. (2002). These agreements can confirm the reliability of our procedure in estimation of crustal thickness beneath the land area using two simple layers. While for other pairs, the estimated Moho discontinuities become shallower than those obtained in the previous studies. We observe that several pairs passing through the ocean have low group velocity at shorter periods and cannot be explained only by the two layered model. The large discrepancy of group velocities at shorter periods indicates that the estimated Moho depth is unreliable even if the model can explain the velocity at longer periods.

