Phase velocity estimation based on spatial gradient of surface wave arrival time of teleseismic earthquakes observed by S-net

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Seismice velocity structure is fundamental information to understand environmental cause of earthquakes and slip behavior on the plate interface. In addition, recent developments of dense seismic network enable us to catch seismic waveforms as seismic wavefield. In the present study, we use S-net data to estimate phase velocity map by calculating spatial gradient of surface wave arrival time of teleseismic earthquakes.

We used long-period accelerometer records of teleseismic earthquakes. We analyzed a teleseismic earthquake occurred in Alaska Bay on January 23, 2018 (depth: 25km, Mw 7.9). We used vertical records to estimate Rayleigh wave phase velocity after converting observed records from XYZ to UNE components. To estimate phase velocity map, we followed Lin et al. (2009). We first applied frequency-time analysis (FTAN) to waveform data of each station to get phase velocity dispersion curve. We then picked surface wave arrival times at certain period and spatially interpolated to get arrival time map. Finally, we obtained phase velocity map by calculating spatial gradient of the arrival time map. We estimated phase velocity maps at 20-50 s by intervals of 5 s.

When we estimate the phase velocity curve, there is the 2π phase ambiguity. Although a reference phase velocity curve allows us to estimate the number of cycles, the discrepancy from the real phase velocity curve and the initial phase effect causes misestimation of the cycle number. Thus, we solved this problem by iteratively update the reference dispersion curve. First, we used PREM 1D model to estimate dispersion curve at each station. In the next step, we used average of the estimated dispersion curves as the reference model. We repeated the procedure until we can obtain a consistent cycle number within the all S-net stations.

The phase velocity is estimated within 3.6-3.9 km and consistent with general phase velocity of Rayleigh wave. We found high velocity anomaly which may be attributed to the subducting slab at the period of 45 s. We also found high velocity anomaly off Miyagi and Fukushima.

To confirm the spatial pattern of the phase velocity, we need to analyze other teleseismic events. We can also estimate azimuthal anisotropy of phase velocity by using several earthquakes of which surface waves propagate in different direction. In addition, we need to examine the method of spatial interpolation for robust estimation of phase velocity map.

Keywords: S-net, surface wave, tomography, Tohoku-oki earthquake, phase velocity

