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Estimation of corner frequency using the spectral ratio method and attenuation structure beneath NE Japan

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Seismic attenuation is sensitive to temperature, water content, chemical composition and partial melting in a different way from that of velocity. Hada et al. (2010) estimated 3-D attenuation structure beneath northeastern (NE) Japan, using the method of Eberhart-Phillips and Chadwick (2002). In this method, spectra of waveforms from local earthquakes were used to determine simultaneously whole ray path attenuation terms, t*, spectral level, c_0 and corner frequency, fc. However, it is difficult to estimate accurate t* because of a strong trade-off between t* and fc. Here, we estimate an exact value of fc of each earthquake, using the spectral ratio method, and determine t* precisely for each event-station pair.

We apply Multi-window Spectral Ratio method (Imanishi and Ellsworth, 2006) to S-wave coda, instead of direct waves, to obtain more stable spectral ratios. This method can remove the effects of a radiation pattern of source mechanism, site amplification, and heterogeneous structure. We analyzed 641 intraslab earthquakes (M>2.5) beneath NE Japan for the period from 2006 to 2009. Waveforms were recorded at a nation-wide seismograph network with a sampling frequency of 100 Hz. First, spectral ratios of two earthquakes were calculated for common stations for five moving windows by overlapping half duration of each window length of 0.25s. All the calculated spectral ratios were then stacked, and fc of each earthquake was estimated by fitting the average spectral ratio to an omega-squared source model at frequency ranges of $S/N > 3$. Finally, t* of each event-station pair was estimated from the decay of spectrum at higher frequencies than fc.

The obtained results show that fc and t* are estimated more precisely than by Hada et al. (2010). Estimated corner frequencies follow cube-root scaling with seismic moment and 0.1-10 MPa stress drop. In addition, t* calculated for adjacent earthquakes are very similar to each other, indicating the stability of our strategy used in this study. Estimated t* shows a prominent along-arc variation with small t* (low attenuation) in the fore arc and high t* (high attenuation) in the back arc, which probably reflect the difference in the nature of the mantle wedge structure. In the next step, we will perform tomographic inversion using the calculated t* and estimate 3D seismic attenuation structure to understand ongoing subduction-zone processes in the mantle.