

Seismological structural changes around source regions of slow earthquakes in Nankai subduction zone inferred from broadband receiver functions

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Coupled phenomena of tremors accompanying short-term slow slip events and very low frequency earthquakes (Ito et al., 2007) have been detected at deeper parts of seismogenic regions on the Nankai Subduction Zone in southwestern Japan. Elucidating detailed seismological structures on plate interfaces hosting slow earthquakes is very important to understand mechanisms and relationships of slow earthquakes and megathrust earthquakes. Few studies, however, have proposed detailed velocity structure models and their spatio-temporal variations with high resolution receiver functions (RFs) on plate interfaces. In this study, we calculate broadband RFs around source regions with slow earthquake events in the Nankai Subduction Zone. We also investigate frequency dependency of RFs to constrain detailed physical features near the plate interface.

RF method is one of the best approaches to estimate the velocity structure beneath seismic stations by extracting P-to-S phases converted on velocity discontinuity from teleseismic waveforms. In southwestern Japan, Shiomi et al. (2008) confirmed the oceanic Moho discontinuity in the Philippine Sea Slab. In usual cases, high cut filter (e.g. 0.6Hz: Shiomi et al., 2008) is used when deconvoluting vertical component waveforms from horizontal ones in order to avoid instability on calculation. Akuhara et al. (2017) recently calculated high frequency RFs up to 4 Hz using ocean bottom seismometers equipped off the Kii peninsula, and confirmed the existence of a thin low velocity zone composed of a fluid-rich sediment layer along the Nankai trough megathrust fault. In this study, we calculate RFs applying the Extended-Time Multitaper method modified by Shibutani et al. (2008) and the frequency dependency of RFs is examined by taking different frequency ranges up to 0.5, 1, 2, 3 and 4 Hz.

We have used Hi-net and F-net seismograms provided by National Research Institute for Earth Science and Disaster Resilience in Japan. We confirm that spectra of teleseismic waveforms have sufficient SN ratios up to 3 or 4 Hz. Fig.1 shows an example of the RFs at NKTH located on the Kii peninsula. The RFs at most of the stations contain positive and negative phases around 3-4 s after P-wave arrival, which correspond to oceanic Moho discontinuity and the plate interface, respectively. The amplitude and the arrival time of these phases depend on backazimuth, suggesting that dependency on the incident angle of a ray to the subducting plate interface. In case of a downdip for the subducting slab, incoming P-waves have lower incident angles and generate smaller convert S-waves. On the contrary, an updip case, incoming P-waves have higher incident angles and generate larger convert S-waves.

At higher frequency RFs (Fig.1, right), the phases from the plate interface are generally sharper than those at lower frequency, whereas the phases corresponding to oceanic Moho seems to tend to be broader or split into several phases, suggesting that the oceanic Moho is not a simple velocity discontinuity but would consists of several layers. The split positive phase just after the negative phase from the plate interface may relate to the thin low velocity zone inferred from Akuhara et al. (2017).

Keywords: Receiver function, Broadband receiver function, Slow earthquake, Nankai subduction zone

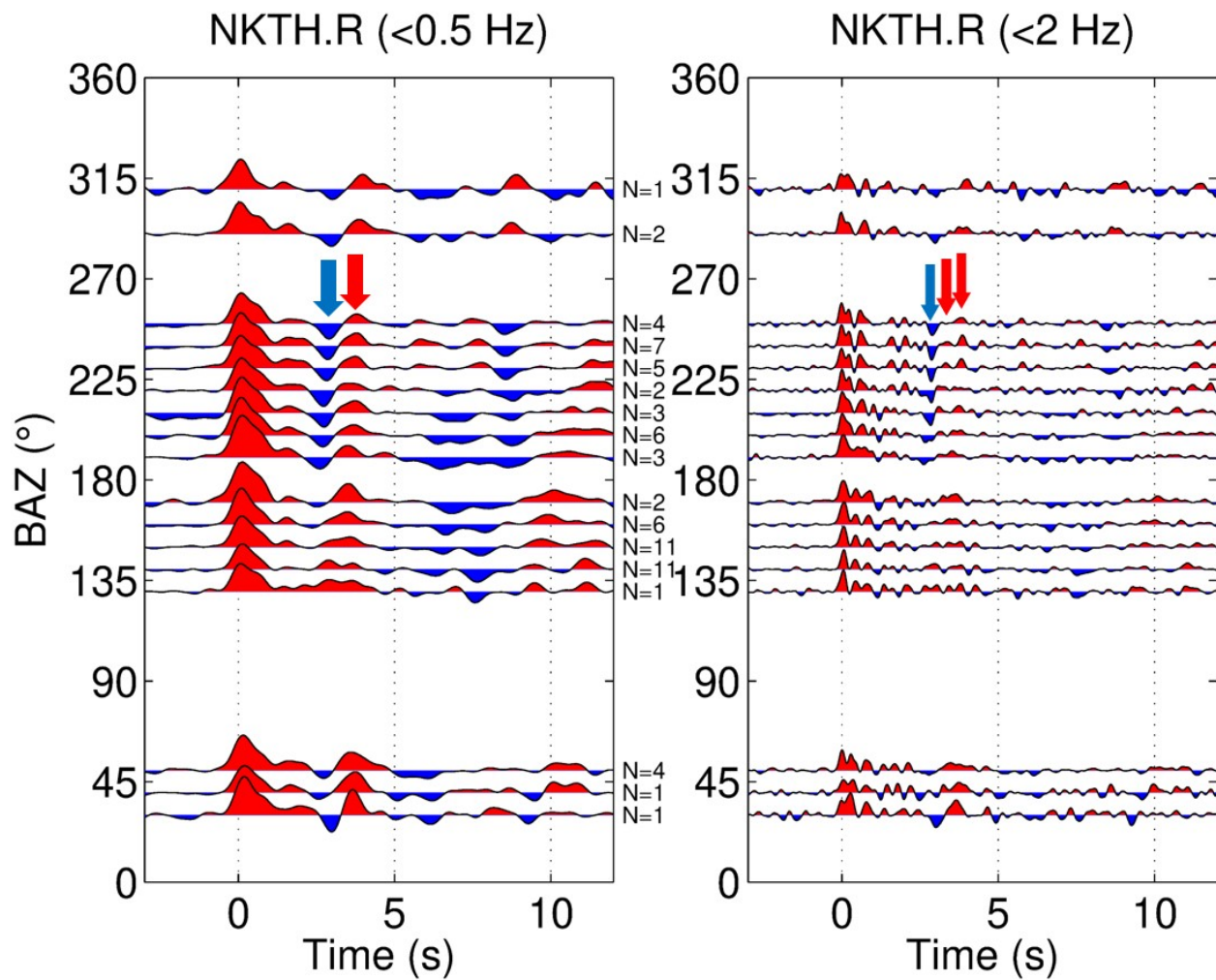


Fig. 1 Radial receiver functions (RFs) on NKTH with frequency ranges up to (left) 0.5 Hz and (right) 2 Hz. The vertical and horizontal axes denote delay time from P-wave arrival [s] and backazimuth [degree], respectively. Areas colored in red and blue show the positive and negative amplitudes, respectively. N is the number of RFs stacked every 10 degrees. Red and blue arrows indicate later phases from the oceanic Moho and the plate interface, respectively.