

Detection of slow earthquakes in the microseism frequency band (0.05–1.0 Hz) by large-scale waveform stacking

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Slow earthquakes have been intensively studied because of the proximity of their source area to that of megathrust earthquakes and their high sensitivity to regional stress change. They have been classified according to their characteristic time scale into tremors and low frequency earthquake (LFE; >1 Hz), very low frequency earthquake (VLFE; 20-100 sec), and slow slip event (SSE; > 1 day). Microseism noise is dominant in the frequency band between LFE and VLFE, which we call the microseism frequency band, and it is difficult to detect signals of slow earthquakes in this band. As a rare exception, signals in this band accompanied with LFEs and VLFEs were detected on the shallow subduction interface by near-field ocean bottom broadband seismometers with fortuitously low microseism noise (Kaneko et al., 2018). The characteristics of signals in this band are totally unknown for deep slow earthquakes.

In this study, we first report the observation of slow earthquake signals in the microseism frequency band in the western Shikoku region of the Nankai subduction zone, Japan, by stacking a lot of seismograms relative to the timing of high-frequency signals. First, we made synthetic template waveforms and conducted a matched filter analysis using these template waveforms (Ohta & Ide, 2017). Utilizing GPU, we detected about 700,000 events in continuous records at 9 Hi-net stations, operated by National Research Institute for Earth Science and Disaster Resilience, from 2005 to 2015. Their temporal distribution suggests that LFEs are episodic phenomena and their spatial distribution indicates the sources are concentrated in several patches, as reported by previous researches (e.g., Ohta & Ide, 2017). Then we stacked seismograms at the timing of these detected events, after band-pass filtering in different frequency bands (4-8 Hz, 2-4 Hz, 1-2 Hz, 0.5-1 Hz, 0.25-0.5 Hz, and 0.125-0.25 Hz). In-phase waveforms are confirmed in all frequency bands, despite low sensitivity of Hi-net seismometers in lower frequencies than 1 Hz. This result suggests that slow earthquakes radiate broadband signals without characteristic frequencies from 0.125 to 8 Hz.

Keywords: slow earthquakes, LFE, microseism, matched filter, Nankai subduction zone