Detecting tectonic tremor through frequency scanning at a single station in the Japan Trench subduction zone

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Slow earthquakes, such as tectonic tremors and slow slip events (SSE), are the most distinctive geophysical phenomena on the subducting plate interface and occur at both ends of updip and downdip of coseismic slip areas. Tremors and SSEs have been observed in the subduction zone at the updip portion near the Japan Trench [Kato et al., 2012; Ito et al., 2013, 2015].
Ito et al. (2015) showed three possible tectonic tremor sequences from the excitation of amplitude of ambient noise accompanying SSE. The tremor signals in these sequences with very weak amplitudes were observed at only one station. Here, we apply the frequency scanning analysis to detect and validate tectonic tremors near the Japan Trench; we re-examine the tremor activities from ocean bottom seismometer (OBS) data.
Sit et al. (2012) proposed “the frequency scanning analysis” to detect tectonic tremors by calculating ratios of the envelope waveforms through different bandpass filters of broadband data at a single station in the Cascadia margin. We apply this analysis to the seismic data recorded at 17 short-period OBS network stations deployed in the Japan Trench axis area off Miyagi, northeast Japan. Three types of bandpass filters with frequencies of 2–4 Hz, 10–20 Hz, and 0.5–1.0 Hz, corresponding to the predominant frequency band of tectonic tremors, local earthquakes, and ocean noises, respectively, are adopted.
The results show three major tremor sequences, which correspond to the tremor sequences reported in Ito et al. (2015), suggesting the occurrence of tremors in the subduction zone. Furthermore, we have successfully detected tremor signals at another two sites, especially from the second tremor sequences. We conclude that the second tremor sequence probably occurred in a slightly far area from the Japan Trench, or with larger magnitude than the other two tremor sequences. We have also estimated the release energy of tremors occurring Japan Trench before the largest foreshock of Tohoku-Oki earthquake.

