Locating triggered tremors using envelope back projection

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Surface waves radiated from large teleseismic earthquakes sometimes trigger a series of deep non-volcanic tremors with intervals of 20-30 seconds, which are dominant periods of surface waves [e.g. Miyazawa & Brodsky 2008]. Dynamic stress perturbation due to surface waves in the tremor source region is as low as a few kPa, indicating the tremor source fault is quite sensitive to the stress change. Not all the large surface waves, however, induce triggered tremors. Necessary conditions for triggered tremor are still unknown.

Most of previous studies used the envelope correlation method (ECM) [e.g. Obara 2002] or a method derived from ECM [Wech & Creager 2008] to locate triggered tremors. Time resolution in tremor location is therefore limited by data length used in ECM in those studies. The method with higher time resolution is required because tremor is phenomenon whose time scale is approximately one second. The back-projection method is possible to give higher time resolution because it uses only amplitude information. The source-scanning algorithm [Kao & Shan 2004] is a kind of back-projection method, but not fully applied to triggered tremors. In this study, we applied the envelope back-projection method to records of triggered tremors to determine high-resolution space-time transition of tremor sources.

We focused on triggered tremors in the western Shikoku region of the Nankai subduction zone. We set 2629 source grids with the horizontal interval of 2 km on the model plate boundary [Baba et al. 2002; Nakajima & Hasegawa 2007; Hirose et al. 2008]. Theoretical traveltimes were computed using the 1-D seismic velocity model JMA2001 [Ueno et al. 2002]. We used records from 60 seismic stations of Hi-net, F-net, JMA, GSJ, ERI, Kochi and Kyushu Universities. Records of ground velocity were bandpass-filtered between 2 and 10 Hz and then envelopes were computed using three-component records. We obtained site amplification factors for 2-10 Hz using the coda normalization method [Takemoto et al. 2012] and used them in the analysis. We back-projected squared envelope amplitudes averaged in 0.5 second to the source grids to create back-projection maps with a time interval of 0.5 second. We used only the data from the stations whose epicentral distances are less than 60 km. Tremor epicenter was determined as a weighted average of source locations whose back-projection value is greater than or equal to 90 % of the maximum value.

We searched for clearly triggered tremors in the western Shikoku region between 2004 and 2016 and found them for 9 large earthquakes. Most of envelope peaks were able to be identified as space and time peaks in back-projection maps, and epicenters were determined. The results show that the triggered tremors in the western Shikoku region form two clusters, which correspond to the well-known clusters of tectonic tremor in this region. The western cluster is known as the tremor sweet spot in which tectonic tremors occur most frequently. It has an elongated shape along the NW-SE direction: NW and SE parts correspond to deep and shallow source regions, respectively. Most of the tremors belong to this cluster are located in the shallower part, though some were located in the deeper part. The triggering by the 2004 Sumatra earthquake is particular because triggered tremors occurred widely along the western cluster. Other detailed source characteristics and results for other regions will be shown in the

presentation.

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