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Spatial Clustering of Triggered Tectonic Tremor and Its Relation to Seismic Structure in the Shallow Japan Trench

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The Japan Trench subduction zone hosts various types of seismic activities, such as Mw 9.0 Tohoku-Oki megathrust event or VLFEs. Frequent activity of ambient tectonic tremor had not observed, but recent development of S-Net (cabled network of OBSs) and intense free-fall/pop-up type OBS observation near the trench resulted in discovery of very frequent activity of shallow tremor along the whole subduction margin except offshore Miyagi region, where the megathrust event ruptured the most [*Nishikawa et al.*, 2019 *Science*; *Ohta et al.*, 2019 GRL; *Tanaka et al.*, 2019 GRL]. However, the identified tremors are located using the envelope cross correlation method, which has poor resolution in depth of determined hypocenter. Hence, the depth of the shallow tremors is not well constrained and it is not clear whether shallow tremor occur in the plate interface like as deep tremor.

Here, we attempt to locate hypocenters of shallow tremors with high precision by analyzing multiple OBS arrays. Total of three OBS arrays were installed near the trench axis around 36.8˚N, 142.5˚E, where is the southern outer rim of a region ruptured by the megathrust event [*Iinuma et al.*, 2012]. Each array consists of one broad band OBS, and six 1Hz short period OBSs. Those seven OBSs form a triangular array with diameter of 1 km, and 300 m to 500 m of interstation distance. The observation was conducted between September 2016 and October 2017. We located ambient tremor reported by Ohta et al. (2019) and dynamically triggered tremor reported by Ohyanagi et al. (2018, AGU) with the beamforming technique to estimate back azimuth and apparent velocity of the tremors. Subsequent to locating the tremors, we also estimate its relative energy rate.

With our method, we are able to locate 892 tremor events out of 1989 events identified in *Ohta et al.* (2019). Most of the events are located around the plate interface, and none of them are located within accretionary wedge.

Within a whole tremorgenic region, we see spatial heterogeneity in the activity of the tremor between an up-dip part and a down-dip part. Frequent activity of the tremor is observed in the up-dip part although the down-dip part has less frequent activity compares to the up-dip. The up-dip part also hosts some triggered tremors and ambient tremors with high relative energy rate, while we do not see any tremor with high relative energy rate or triggered tremor in the down-dip part. According to *Tsuru et al*. (2002), the up-dip part corresponds to a region where thick sediment is subducted under the accretionary wedge. On the other hand, the down-dip part has very thin or no subducted sediment layer exists. The spatial heterogeneity of the tremor activity may govern by heterogeneity in distribution of the sediment.

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