Variations of scaling relationships for shallow tremor observed along the Nankai trough

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Scaling relationships of seismic phenomena is one of keys to understand the source processes. Size distributions of slow earthquakes as low-frequency earthquakes (LFEs), non-volcanic tremor (NVT), very-low-frequency earthquakes (VLFE), and slow-slip events (SSEs) have been studied in many locations. Some studies showed that the size distribution follow an exponential law (e.g. Watanabe et al., 2007; Hiramatsu et al., 2008; Chestler and Creager, 2017), while others showed that power law distributions better explain the observations (e.g. Kao et al., 2010; Bostock et al., 2015; Nakamura and Sunagawa, 2015).

Most of previous studies are for slow earthquakes that occur in regions deeper than the source region of megathrust earthquakes, and only a limited number of studies have been carried out for shallow slow earthquakes beneath accretionary prism as observed along the Nankai trough. Although observed characteristics of shallow and deep ones are very similar, physical conditions as temperature and pressure much differs in these region.

In our previous studies (Nakano et al., 2018SSJ, AGU), we obtained the result that shallow tremor follows a power law distribution with b values of about 1. In this study, we further analyzed tremor activities beneath the Muroto fore-arc basin. using data from DONET2. We estimated the seismic energy of tremor signals using the same method as our previous studies, during intensive activities starting in September 2015, April 2016, February 2017, and February 2018. The source region of each activity is different from each other, spanning between off Shiono-Misaki and off Cape Muroto.

The size distribution of each activity mostly follow power-law distributions, but the b value varies from 0.7 and 1.7. We note that the activity in 2016 is also well fitted by an exponential law, probably due to narrow range of observed event size distribution. Similar result has been obtained in the 2018 activity in Kumano. The size distribution deviate from a power law for largest events as observed in Kumano activities. This deviation at larger events would be due to limited system size, expected from the theoretical stochastic model of tremor by Ide and Yabe (2018). The upper limit of event size, and accordingly the system size, varies from activity to activity.

We also investigated the relation between the seismic energy and duration of tremor events. The relation also follows a power law, with slopes of 2.0 to 2.6 in Kumano, and 1.5 to 3.3 in Muroto. These values are again consistent with the expectation value of 2 from the model of Ide and Yabe (2018).

These investigations represent that the scaling relationships of shallow tremor are mostly consistent with the 2D PCA model by Ide and Yabe (2018). Further studies would be necessary to reproduce the observed variations of the scaling parameters.

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