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Spatial inhomogeneity of deep low-frequency tremor activity evaluated from seismic radiation energy and duration

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Deep low-frequency tremor occurs associated with deep very low-frequency earthquake (VLF) and short-term slow slip event (SSE) on the interface of subducting Philippine Sea plate in southwestern Japan. Because they occur at the downdip part of the megathrust seismogenic zone, they are expected to be related to megathrust earthquake. Spatio-temporal distribution of tremor has been well investigated to get a whole picture of tremor activity. However, during very active tremor period, envelope correlation between stations becomes relatively poor because of complicated waveforms. Then, it is difficult to detect and locate tremor source during such active periods. On the other hand, radiation energy evaluated by squared velocity amplitude can be estimated robustly even if each waveform is complicated.

In this study, we developed a new tremor detection method with estimation of seismic radiation energy and centroid location. This method extracts at first tremor sequence defined as a continuous tremor activity with amplitude exceeding a threshold. Therefore, miss-detections of active tremor were reduced and it leads to more qualitative estimation of tremor activity. This method was applied to tremor data in the Nankai subduction zone in 10.5 years starting from 2004.

From spatial distribution of seismic radiation energy by tremor, we found that very large tremor energy is radiated from western Shikoku area compared to that of previous studies. Spatial distribution of total duration and energy rate of tremor shows that tremor zone can be classified into two types. One is an area which has high energy rate and long total duration such as western part of Shikoku or western part of Tokai. Another is an area which has low energy rate and short total duration such as central western part of Shikoku or central part of Kii. On the other hand, a region of western Shikoku area has low energy rate but has long total duration. Therefore, this part cannot be classified into two types. Comparison between distribution of tremor activity and epicenters of large VLF suggests that most of VLF epicenters were distributed on the area which has high energy rate and long total duration.

High energy rate indicates that the size of tremor is large. Therefore, tremor zone can be classified into area characterized by large size of tremor with long period or area characterized by small size of tremor with short period. On the other hand, a part of western Shikoku is characterized by small size of tremor with long duration. This suggests that the size and duration of tremor are independent each other and the tremor activity indicates spatial inhomogeneity.

Keywords: tremor, energy rate, duration