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A simple monitoring method for evaluation of activity of deep low-frequency tremor

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Deep low-frequency tremor in southwest Japan occurs at the downdip side of the seismogenic zone along the strike of the subducting plate boundary. Major tremor activity is sometimes associated with the short-term slow slip event with duration of a several days. Even though the detail mechanism of the relationship between the tremor and slip is still unknown, these are strongly related each other. The tremor activity might be useful as an indicator for interplate slip at the downdip side of the seismogenic zone because the detection capability of the slow slip event is poorer than that of tremor. Obara (2008) pointed that the detection number of tremor source during each episode of tremor and slip is roughly proportional to the moment of estimated slow slip event. By using the relationship of the number of tremor and the moment of slow slip event, the slip history was estimated based on the tremor activity without geodetic detection of the slow slip event. As a result, the slip history is nearly constant at any regions along the belt-like tremor zone not only in western Shikoku where the slow slip event is always detected but also in other area where the slow slip event is rarely detected. Therefore, the precise monitoring of tremor activity is important for the monitoring of interplate slip at the transition zone. So we need to construct the complete and stable tremor catalog is important.

At present, there are a few catalogs of tremor activity in southwest Japan constructed systematically. One is the low-frequency earthquakes listed in the unified earthquake catalog managed by Japan Meteorological Agency (JMA). Another is the tremor catalog based on the envelope correlation method (ECM) developed by Obara (2002) or Suda et al.(2004). The low-frequency earthquake in the JMA unified catalog is located by the manually phase picking of clear isolated phase in the tremor wavetrain. The spatial resolution of the low-frequency earthquake is very good. However, it is very difficult to identify the signal during the very active stage of tremor because of the complexity of tremor waveforms. Therefore, in many cases the low-frequency earthquake catalog does not reflect the active tremors. On the other hand, ECM is the automated hypocentral determination process based on coherency of envelope pattern in neighbor stations. The detection capability of the tremor by ECM is better than that of low-frequency earthquake by JMA; however, the spatial resolution is not so good. ECM cannot detect tremor source during the active stage with multi-source because the envelope pattern becomes very complicated. In order to improve the detection capability, Maeda and Obara (2008) developed the hybrid method combining the ECM and tremor amplitude inversion method. This is based on the observational fact that the spatial distribution of tremor amplitude is explained by geometrical spreading from the tremor source. By using this hybrid method, we can retrieve the tremor activity more complete even though the spatial resolution is nearly the same as ECM. This might be available to evaluate the energy release quantitatively.

In order to evaluate above tremor catalogs, we developed a new simple method to glance the tremor activity without any picking and determination process. The envelope seismogram with a pathband of 2 to 16 Hz is divided into 10 minutes time window and medium value is calculated in each time window. Except very large earthquakes with duration longer than 10 minutes, we can remove most of all local earthquake and teleseismic signals. This new monitoring system enables to check the time evolution of amplitude of tremor activity. In this paper, we compare the three tremor catalogs; JMA low-frequency earthquake catalog, tremor catalog by ECM and hybrid method based on the new simple monitoring chart.