Detection of small surface displacement accompanying deep low-frequency tremor in Shikoku region, southwest Japan

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In many subduction zones in the world, several types of slow earthquakes occur with different depths on the plate interface and some of them are accompanied by surface displacement. In this study, we focus on small surface displacements coincident with non-volcanic deep low-frequency tremor in Shikoku region in the Nankai subduction zone, southwest Japan.

We use daily coordinates time series from 107 GEONET stations located in Shikoku and tremor catalog compiled by NIED (Maeda and Obara, 2009; Obara et al., 2010) in the period from Jan. 1 2004 to Dec. 31 2008. Since GNSS coordinates changes due to the Bungo Channel long-term slow slip events are well reproduced by S-shaped logistic function, we use the same function to extract small displacement coincident with tremor activity. At first, we convert horizonal components into N50˚W direction after removing annual and semiannual variations and common-mode errors. Next, we fit the logistic function to a data segment with variable time window of 5, 7, and 9 days and estimate an amplitude of the function. The fitting is checked by a correlation coefficient between the observation and calculation. We apply this fitting for entire data period at all stations sliding data segment. Finally, we extract displacement when the amplitude of the fitted logistic function exceeds a certain criterion (1.8 mm in this study) and the correlation coefficient is large enough. If the extracted displacement is coincident with tremor activity within 30 m from the GNSS station, we adopt it as the tremor-related displacement. As a result, 225 events are adopted.

Spatial pattern of the tremor-related displacement seems to be related with the location and mechanism of the tremor event though closer inspection is needed. However, we extract much more small displacements by fitting a logistic function, of which the source is unknown. The logistic function is effective to reproduce transient displacement of the surface but we need to reconsider noise reduction of GNSS time series, time constant of logistic function, time window of the fitting, and so on.

Keywords: GNSS, southwest Japan, Deep low frequency tremor

