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Activation of short-term slow slip events and deep non-volcanic tremors due to the Bungo-Channel slow slip event

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In the Nankai subduction zone, slow earthquakes with various time constants occur in the transition region of the subducting plate interface. In particular in the Bungo Channel region, the westernmost part of the slow earthquake belt in southwest Japan, not only short-term slow slip events along with very low-frequency earthquakes and non-volcanic tremors with a recurrence interval of 2 to 3 months, but also long-term slow slip events occurred in 1997, 2003, and 2009-2010 at the shallower part of the subdudting plate interface. It has been observed that very low-frequency earthquakes are associated with these aseismic slips at the further shallower portion near the Nankai trough. These aseismic events also activate tremor occurrences at deeper part in the Bungo Channel region. These suggest that the long-term slow slip events affect the source regions of other slow earthquakes. In our previous study, we focused on activated tremor occurrences during the 2009-2010 long-term slow slip event. We calculated the coulomb stress rate in the tremor source region from the slip history of 2009-2010 long-term slow slip event, and compared it with tremor durations in the three subregions, southwest and northeast of Hiburi Island, and westernmost Shikoku. We found that observed tremor activity changes were consistent with the calculated Coulomb stress rate due to the long-term slow slip event in each subregion.

According to the steady-state seismicity rate theory based on the rate- and state-dependent (R/S) friction law, the calculated Coulomb stress rate should be proportional to the observed tremor duration, but we found that the observation did not satisfy this relation. This is because we assumed that the observed tremor activity change was a direct consequence of the long-term slow slip event. In the model of concurrent occurrence of slow earthquakes, tremors are triggered by the transient stress change due to the short-term slow slip events. In this study, on the basis of this model, we consider a two-step model for the observed activation of tremor occurrence: the long-term slow slip event first activates occurrence of short-term slow slip events, and then they activate the tremor occurrence. Using this model, we have found that the steady-state seismicity rate theory gives a better quantitative explanation to the apparent consistency between the calculated Coulomb stress rate due to the long-term slow slip event and the observed tremor activity.

Keywords: slow slip event, deep non-volcanic tremor, coulomb stress rate, Bungo Channel