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Modeling large precursory slip at the deeper extension of the seismic region along the Nankai Trough, SW Japan – Interaction between slow slip events and brittle nucleation –

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At the subduction zone along the Nankai Trough, SW Japan, large earthquakes around M8 had occurred repeatedly, and short-term aseismic slips were inferred from various observations before the recent 1944 and 1946 events. They were within several days before the earthquakes, and each could have been caused by 2 m slip on the plate interface at the deeper extension of the seismic region before each event (Linde and Sacks, 2002).

In this study, we conduct 2D quasi-dynamic earthquake cycle simulation to model such aseismic slip acceleration in the deeper extension of brittle seismic fault. We consider a flat plate interface with a shallow dipping angle of 30° for the depth 0-50 km mimicking the Nankai Trough. In the present study, we examine the effect of low cut-off velocity (V_{cx}) under different brittle nucleation size (L_{cr}). Introducing V_{cx} beyond which friction becomes velocity strengthening, and adopting L_{cr} larger than the size of the region where elevated stress by interseismic loading present are two known mechanisms to produce aseismic slip events. We here consider both of them simultaneously. We assume depth-dependent V_{cx} changing from 10^{1} to 10^{-9} m/s under two L_{cr} values lager/smaller than the brittle-to-ductile transition zone size.

Our simulation results show that they have different effects. Low V_{cx} pushes the position of aseismic slip to the deeper extension of the brittle seismic region because slip deficit accumulates in the V_{cx}-transition zone during the interseismic period when slip velocity is below V_{cx}. As a result, aseismic slip extends over a deeper and wider region. This aseismic slip does not accelerate up to seismic because of low V_{cx}. Accordingly it is a 'slow slip event'. On the other hand, L_{cr} larger than the transition zone size allows significantly large aseismic slip across the brittle-transition border that is shallower than slow slip events. This is typical brittle nucleation from which dynamic earthquake begins. Our results show that the interaction between the deep slow slip event and shallow brittle nucleation can possibly produce precursory preslips as large as those inferred for the past giant earthquakes in the Nankai Trough.