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Modeling of earthquake cycles along the Nankai Trough: Recurrence interval variation due to the stressing rate change

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A recent numerical simulation study on seismic cycles along the Nakai Trough indicated the structural anomaly beneath Kii Peninsula controls the separation of rupture areas and the difference of occurrence timings of great earthquake pairs (Tonankai and Nankai earthquakes) [Hori, 2006]. Their results cannot, however, reproduce large variations from 100 to 200 years in recurrence interval of historical earthquake cycles, since the variation of size and recurrence time is caused only by the heterogeneity of stress and strength associated with time-lags in consecutive rupture of earthquake pairs.
Therefore, in addition to the frictional heterogeneity beneath Kii Peninsula, we apply a hierarchical frictional property model of Hori et al. (2009), in which asperities with small fracture energy (G_c) and nucleation size (L) is surrounded by asperities with larger $G_c$and L, to Tonankai and Nankai source regions. For an example of the hierarchical distribution of friction, we first apply the same distribution as Hyodo and Hori (2009, Abstract of SSJ fall meeting). In mapping the frictional property to the 3D geometry of subducting Philippine Sea plate(PHS) of Baba (200 3), we assume the plate interface is buried in a homogeneous elastic half space and the 5km-depth contour of upper surface of PHS corresponds to the free surface of the elastic half space in order to avoid artificial loadings from the topmost of plate boundary.
As a result, time-predictable seismic cycles with the large variation of size and recurrence interval (341-535 years) are generated in spite of the simultaneous rupture of great earthquake pairs in every cycle. Thus, it is confirmed that hierarchical frictional property generates large variation of recurrence time intervals not only on plane fault model but also on the 3D geometry of PHS. This variation is not caused by local stress variation related to a barrier at the Kii peninsula (Hori, 2006 ; Kodaira et al., 2006) but by the variation of stress accumulation rate in a rupture initiation area in each seismic cycle as in Hori et al. (2009). Therefore, we can estimate the frictional properties of the barrier, which controls at least the time variation between Tonankai and Nankai events, independent to the recurrence interval.

Keywords: large variation of size and recurrence interval, hierarchical asperity, Nankai Trough