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Study on source characteristic of great inland-earthquakes (Mw>7) generated by the quasi-dynamic multi-cycle simulation

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A set of large inland earthquake (Mw>7) rupture scenarios is generated using two-step dynamic rupture modeling approach. In the first step, a set of different-size earthquakes with dynamic input parameters is produced by quasi-dynamic multi-cycle simulation (Hillers et al., 2006; Hillers et al., 2007) governed by rate- and state-dependent friction low. In the second step, single-event full-dynamic modeling under the slip-weakening friction law (Ida, 1972; Andrews, 1976) is performed using the input parameters generated by the multi-cycle simulation.

A spatial coherence analysis method (Song and Somerville, 2010) is employed in order to examine cross-coherence structures between key kinematic source parameters (e.g. final slip, peak slip velocity, and rupture velocity) of the generated spontaneous dynamic rupture models. Through this analysis, several important features of spatial cross-coherence structures are found. For great earthquake with Mw >7, the peak slip velocity distributions correlate well with the high rupture velocity distributions with almost zero distance, but the correlation distances of both peak slip velocity and rupture velocity with respect to the final slip range between 5 and 20 km toward rupture propagation direction.

These results give important information for the RECIPE of the strong ground motion prediction. According to the existing RECIPE for construction of the characteristic source models, we assume that asperity areas generating strong ground motions are the same as large slip areas on the fault. However, from the spatial coherence results in this study it is recognized that the asperity area for great inland crustal-events (Mw>7) are not always coincident with the large slip areas.

Based on the RECIPE, we assume that the horizontal locations of large surface-displacement estimated from the active fault survey are corresponding to those of large final-slip distributions during past earthquakes. However, it is suggested that the asperity areas, which generate the strong ground motions (e.g. the area with large slip velocity), might not be directly corresponding to large surface-displacement estimated from the active fault survey.

The RECIPE has been made based on the analysis of inversion results by Somerville et al. (1999), they mainly used intermediate size events less than Mw 7. So it is necessary to examine whether cross-coherence structures of kinematic source parameters are same between Mw < 7 and Mw > 7 events, carrying out additional multi-cycle simulation for smaller events with Mw < 7.

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Keywords: multi-cycle simulation, dynamic source parameters, cross-coherence structures, RECIPE for the prediction of the strong ground motions