Characteristics of the initial phase of short-term slow slip estimated by deep low-frequency tremor

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It is observed that the initial phase of far-field P wave velocity pulses of earthquakes reflects the acceleration of rupture velocity and slip velocity (e.g. Iio, 1995). We can expect that the acceleration of slow slip occur in the beginning of the slow slip and a moment function reflects the process, because the slow slip on the plate interface is a similar slip phenomenon on the fault. In this study, we identify the initial phase of a short-term slow slip event (SSE) from a moment function estimated by corresponding deep low-frequency (DLF) tremors and report relationships among the duration and the size (seismic moment) of the initial phase of SSE and the eventual size of SSE.

In this study, we analyze DLF tremors in the Shikoku region, southwest Japan, from January 2001 to May 2007 recorded by Hi-net (Obara et al., 2005). We use the hypocenters of the tremors determined by the envelope correlation method (Obara, 2002; Obara and Hirose, 2006). We use the envelope of the reduced displacement (Aki and Koyanagi, 1981) of DLF tremors as an apparent moment rate function (Hiramatsu et al., 2008) and a conversion factor estimated from a proportional relationship between a total size of DLF tremors and the size of a corresponding SSE to obtain a moment function of the SSE. The moment function of the SSE obtained from DLF tremors tends to show a gradual rise in the beginning, an increase with a constant slope in the middle and a gradual approach to the finial value. We consider that a part of the gradual rise is the initial phase of SSE and a part of the constant slope is the main rupture of SSE. We define the duration of the initial phase as the duration between the onset time determined by DLF tremors and the beginning time of the main rupture obtained by extrapolation of the constant slope.

We analyze 40 and 50 SSEs and recognize the existence of the initial phase for about 50% and 30% of the SSEs in the western and in the middle Shikoku, respectively. The duration and the size of the initial phase tend to be proportional to the eventual size of the events. The size of the initial phase is about 10˜20% of the eventual size. We, therefore, consider that the eventual size of SSE depends on the size of the initial phase of SSE although not all SSEs show the existence of the initial phase.