A possible generation mechanism for multi-segment great earthquakes

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We study a possible generation mechanism of multi-segment giant earthquakes. It is known that giant earthquakes ruptured multiple segments, which are otherwise ruptured one by one. Examples involve 2004 Sumatra earthquake, 1960 Chili earthquake, and series of great earthquakes along the Nankai trough. Evidence for such occurrence histories are summarized in, for example, Satake and Atwater (2007). It has been a mystery why sometimes multiple segments are ruptured in a single earthquake. Here we show a possible model that may account for such a generation histories. We use a one-dimensional horizontal fault embedded in a homogeneous full-space elastic media. Rate- and state-dependent friction law (e.g., Rice, 1993) is employed as a constitutive law, and put two segments. Most of previous studies have assumed that only segments have velocity weakening properties, and the rest of the fault have velocity-strengthening properties. In this study we assume that the entire fault at the similar depth of seismogenic zones have velocity weakening properties with spatially heterogeneous characteristic distance L. This may be understood as an analogy of heterogeneous slip weakening distance Dc as used by Ide and Aochi (2005). We suppose that L outside segments have significantly larger value than their inside. If the frictional properties between two segments are purely unstable, two segments rupture one by one unless otherwise multi-segments are simultaneously ruptured. Recurrence interval at each segment becomes shorter, and the occurrence interval between two segments becomes longer, as time passes from the last multi-segment giant earthquake. This occurrence pattern is similar to what Hori (2006) suggested for recent Nankai events. If the frictional properties between two segments are conditionally stable, we observe transient slip there after single segment earthquakes. Such transient slips following great earthquakes might have been regarded as afterslips.