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# Possible Rupture Scenario for the Area Off-Ibaragi Prefecture in the 2011 Off the Pacific Coast of Tohoku Earthquake

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The 2011 Off the Pacific Coast of Tohoku Earthquake (Tohoku Earthquake, Mw 9.0) was one of the most devastating earthquakes in Japanese history. It ruptured a very broad area of the plate boundary along the Japan Trench, from the northern end of offshore Aomori prefecture to the southern end of offshore Ibaragi prefecture. The largest aftershock (Mw 7.7) occurred 30 minutes after the main shock offshore Ibaragi Prefecture (Off-Ibaragi area). The rupture of this aftershock was not involved in the rupture of the main shock. It might be useful for the assessment of future seismic hazards to understand what physical mechanism stopped the main shock rupture at the edge of the rupture area of this largest aftershock, and if this area can rupture simultaneously with a future huge earthquake. Some studies have addressed these questions based on structural heterogeneities imaged by tomography in the Tohoku region (Liu et al., 2014) or on compilations of observations of subduction zones around the world. However, more investigations based on numerical simulation studies might be necessary to elucidate the physical mechanisms.

In this study, we have carried out dynamic rupture simulations to understand the mechanisms of rupture arrest of the Tohoku earthquake. The simulations assume a slip-dependent friction law (Ida, 1972) and use the 3D Spectral Element Method (Galvez et al., 2013), which is numerically stable and accurate even for subduction earthquake models with low dipping angle. To set the initial stress conditions for the simulation, we use constraints based on a slip-deficit map inferred from the analysis of GPS data (Ikuta et al., 2012) and the estimates of inter-seismic recurrence time along the Japan Trench by the Headquarter of Earthquake Research Promotion in Japan (2011).

In contrast with the real Tohoku Earthquake, the main shock rupture resulting from our simulation propagated to the Off Ibaragi area, indicating that the initial part of the rupture had enough energy to break through the Off Ibaragi area. Factors that we did not include in this simulation, such as attenuation and smaller-scale features of the megathrust geometry due for instance to subducted seamounts, might have played an important role in the rupture arrest in the southern end of the Tohoku earthquake in 2011.

Keywords: Rupture Simulation, Dynamic Model, The 2011 Off the Pacific Coast of Tohoku Earthquake, Slip Deficit