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津波地震と巨大地震の震源過程の違いについて
Difference in the seismic rupture process between slow tsunami and megathrust earthquakes

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After the 2011 Tohoku earthquake, we know that huge co-seismic slip can occur at shallow part of subduction zone where slow tsunami earthquakes have been detected (e.g. the 1986 Meiji-Sanriku earthquake). To understand the nature of megahrust earthquakes as well as slow tsunami earthquakes, it is important to investigate the slip behavior in the area. We estimated spatio-temporal slip-rate distribution of megathrust and slow tsunami earthquake using the a novel seismic source inversion method (Yagi and Fukahata, 2011, GJI) and a Hybrid Back-projection method (Yagi et al., 2012, EPSL), and then compared the observation results to simulation results using simplified fault models and the mechanism of thermal fluid pressurization. We inverted and projected the slip-rate function on fault for the 1992 Nicaragua slow tsunami earthquake, the 2006 Java slow tsunami earthquake, the 2010 Mentawai slow tsunami earthquake, and the 2011 Tohoku megathrust earthquake. In the slow tsunami earthquakes, we found a smooth and slow slip (~0.1m/s) that continued over 50 s near the trench, while pulse-like slip was detected in and around the main-shock hypocenter. On the other hand, in the case of the 2011 Tohoku megathrust earthquake, we also found a smooth and fast slip (~1.0 m/s) that continued over 80 s near the trench. The slow tsunami and megathrut earthquakes have a release of seismic energy in the downdip area that triggered smooth slip in the updip area. The difference of slip-rate between the analyzed slow tsunami earthquakes and Tohoku megathrust earthquake may suggest the existence of a non-linear rupture characteristic in the shallowest megathrust faults. Next, we performed dynamic rupture simulations using simplified fault models. We found that small fluctuations of initial shear stress near a trench, within 1 MPa, lead to differences in seismic moment release greater than two orders of magnitude. Moderate slip events with trapezoidal source time functions appear to occupy a transition position, between shallow megathrust earthquakes with surface rupture and smaller ordinary earthquakes without surface rupture. We interpret this result as representing the differences in interplate slip between shallow megathrust earthquakes, tsunami earthquakes, and ordinary earthquakes in the same region. The observation and numerical simulation results suggest that the dynamic frictional weakening in the shallower segment plays a crucial role in the interaction between the deeper and the shallower segments.

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