

## The 2011 Megathrust Earthquake off Northeast Japan and Multiple Earthquake Cycles in Subduction Zones

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The occurrence of earthquakes is the sudden release of tectonically accumulated stress by faulting. In the case of interplate earthquakes, the stress accumulation is caused by the interseismic gradual increase of slip deficits in source regions, and so the occurrence of earthquakes can be also regarded as the sudden recovery of the slip deficits. Since the crustal deformation due to the interseismic slip-deficit increase is detectable by GPS array observations as well as that due to the coseismic slip-deficit recovery, we can now monitor the slip-deficit and -recovery processes at plate interfaces through the inversion analysis of GPS array data. On March 11th of 2011, the Mw9.0 mega-thrust earthquake occurred at the North American and Pacific plate interface off Tohoku, Japan. The inversion analysis of GPS data for an interseismic period (1996-2000) before this earthquake has shown the five remarkable slip-deficit zones distributed on the plate interface along the southern Kuril-Japan trench. On the other hand, from the inversion analysis of coseismic GPS data, we revealed that the fault slip of the 2011 mega-thrust earthquake has a bimodal distribution with the northern main peak of 25 m and the southern sub peak of 6 m, which correspond to the Miyagi-oki and Fukushima-oki slip-deficit zones, respectively. In the Miyagi-oki slip-deficit zone, ordinarily large (M7.5) earthquakes with about 3 m coseismic slip have repeated every 40 years in the past two centuries. The occurrence of extraordinarily large earthquake with 25 m coseismic slip in the same slip-deficit zone suggests a possibility of scale-dependent multiple earthquake generation cycles, and leads to the conclusion that the so-called asperity is not a physical substance but a concept representing the spatial irregularity in frictional properties of faults.

Keywords: subduction zone, megathrust earthquake, stress accumulation, slip deficit, multiple earthquake cycle, scale dependence