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高速摩擦挙動を考慮した東北地方太平洋沖地震の 3 次元発生サイクルモデル―先行するすべりと余効すべり
3D modeling of the cycle of a Tohoku-oki earthquake considering high-velocity friction: preceding and postseismic slips

芝崎 文一郎 [1*], 堤 昭人 [2], 氏家 恒太郎 [3], 嶋本 利彦 [4], 伊藤 喜宏 [5]
SHIBAZAKI, Bunichiro[1*], TSUTSUMI, Akito[2], UJIIE, Kohtaro[3], SHIMAMOTO, Toshihiko[4], ITO, Yoshihiro[5]

[1] 建築研究所国際地震工学センター, [2] 京都大学大学院理学系研究科, [3] 筑波大学大学院生命環境科学研究科, [4] 中国国家地震局地質研究所, [5] 東北大学大学院理学研究科
[1]IISEE, Building Research Institute, [2]Kyoto University, [3]University of Tsukuba, [4]China Earthquake Administration, [5]Tohoku University

The preceding, coseismic, and postseismic slips of the 2011 Tohoku-oki earthquake were investigated in detail by several authors. Suito et al. (2011) reported that preceding aseismic slips began occurring in the off Miyagi to off Ibaraki region in 2004, along with M7-class earthquakes. After the 2011 Tohoku-oki earthquake, postseismic slips occurred in an area where coseismic slips were not significant (Ozawa et al., 2012). The occurrences of preceding, coseismic and postseismic slips are controlled by friction properties. The present study investigates preceding and postseismic slips, by using the model developed by Shibazaki et al. (2011). They performed 3D quasi-dynamic modeling of the cycle of a megathrust earthquake in the offshore Tohoku region, Japan, using a rate- and state-dependent friction law with two state variables that exhibits strong velocity weakening at high slip velocities. They set several asperities where velocity weakening occurred at low to intermediate slip velocities. Outside the asperities, velocity strengthening occurred at low to intermediate slip velocities. At high slip velocities, strong velocity weakening with large displacements occurred both within and outside the asperities.

The results of numerical simulations showed that, before the occurrence of M9 class events, M7.5 class earthquakes occurred in the off Miyagi, Fukushima, and Ibaraki regions. Slip velocities increased significantly in the region surrounding strong asperities. M9 class earthquakes initiated around the strong asperities. Following the main event, postseismic slips occurred at the deeper part of the seismogenic zone. In the region that is located below the northern shallow rupture area of the simulated Tohoku-oki earthquake, large postseismic slips occurred. In the off Miyagi region, postseismic slips occurred in the deep area where coseismic slip was small. On the other hand, in the off Fukushima and off Ibaraki regions, small postseismic slips occurred in the region between asperities. The distribution of postseismic slips obtained by our simulation is roughly consistent with the observed actual distribution (Ozawa et al., 2012). In the present model, we set the velocity-strengthening region in the off Ibaraki region close to the Japan Trench. Therefore, significant postseismic slips occurred in the off Ibaraki region close to the trench. If the frictional property in this region is stable, large postseismic slips will be detected by the observation of ocean bottom crustal deformation.

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