3d Dynamic Earthquake Rupture Simulations In The Sea Of Marmara

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Abstract

The 1912 Mürefte and 1999 Izmit 7.4 earthquakes are the last devastating events of the western and eastern sections of the Marmara region, respectively. The center of the Sea of Marmara, the region between locations of these two earthquakes, is prone to creating another large earthquake. The main objective of our study is to determine 3D dynamic earthquake rupture scenarios, considering non-planar and heterogeneous stress distribution in the Sea of Marmara. Recent studies show that some segments of the North Anatolian Fault (NAF) beneath Marmara are partially creeping. In this study, it is the first time that we attempt to generate realistic earthquake scenarios by putting constrains on initial stress on the fault using regional stress from earthquake focal mechanisms, in addition to stress release during past earthquakes and strain accumulation during interseismic period using geodetical measurements on slip-rate and locking depth at various segments along the NAF beneath the Sea of Marmara. In order to constrain the regional stress we relocate six cluster of earthquakes and derive their not only focal mechanism solutions but also stress tensor orientations in the Sea of Marmara. We use 3D Finite Element Method (PyLith) for dynamic earthquake simulations and tetragonal mesh for better smoothing at the fault bends, which allows us to implement nonplanar fault geometry and initial stress heterogeneity using slip-weakening friction law. We place constraints on initial shear stress from geodetic and seismic studies of locking depth and interseismic strain accumulation. We consider more than 80 rupture scenarios and calculate slip distribution, rupture velocity and moment magnitude in addition to slip-rate and traction on the fault surface, and displacement and velocity on the ground surface. We find that for the most scenarios possible earthquake magnitude does not exceed Mw7.2. In addition, in none of the possible scenarios we obtain super-shear rupture velocity. We find that depending on the location of the initiation point, asperities in the partially creeping segments and loaded initial stress, the rupture may not extend into the Prince's Island Segment.

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