Geophysical Research Abstracts
Vol. 19, EGU2017-17550, 2017
EGU General Assembly 2017

Tsunamigenic earthquake simulations with experimentally derived friction laws

Shane Murphy (1), Giulio Di Toro (2), Stefano Lorito (1), Fabrizio Romano (1), Antonio Scala (1,3), Elena Spagnuolo (1), Gaetano Festa (3), Stefano Aretusini (2), Stefan Nielsen (4), and Alessio Piatanesi (1)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy (shane.murphy@ingv.it), (2) University of Manchester, UK, (3) Università degli Studi di Napoli Federico II, Naples, Italy, (4) Durham University, UK

The Tohoku fault has historically produced a range of different types of earthquakes from the M 8.2 1896 Menji tsunami earthquake to the Mw 9 2011 Tohoku mega-thrust earthquake with a number of traditional major thrust events in between. Using dynamic rupture simulations with 2D spectral element methodology we aim to reproduce these events within a single numerical model. To do this, we apply a thermal slip distance friction law that is based on high-velocity rock friction experiments. The choice of frictional parameters varies from clay-like near the surface with a transition to rock-like at depth. A variable effective normal stress is imposed in the wedge based on the dynamic critical taper theory.

By varying the location of a high stress asperity up and down the fault the numerical model can reproduce a number of depth-dependent features (e.g. increasing static stress drop with depth) and the three most destructive types of earthquakes observed on the Tohoku fault (i.e. mega-thrust earthquakes, tsunami earthquakes and traditional thrust earthquakes). When the asperity is located at depth, rupture is constrained to the zone around the asperity and thus standard thrust earthquakes are produced. Near the surface, it is difficult for rupture to propagate down-dip from the clay-rich to the rock-rich layer meaning asperities in the wedge are constrained by the clay to rock transition. Conversely, rupture propagating up-dip can easily rupture into clay-like material producing large, mega thrust earthquakes. Due to these features, those earthquake that nucleate within a particular depth range (the lower end of the transition between the clay - and - rock like material) can produce larger earthquakes compared to those nucleating elsewhere on the fault.