Geophysical Research Abstracts
Vol. 19, EGU2017-17264, 2017
EGU General Assembly 2017

How material contrast around subduction faults may control coseismic slip and rupture dynamics: tsunami applications for the case study of Tohoku

Antonio Scala (1,2), Shane Murphy (1), Fabrizio Romano (1), Stefano Lorito (1), Gaetano Festa (2), Manuela Volpe (1), and Alessio Piatanesi (1)

(1) INGV, Rome, Italy (antonio.scala@ingv.it), (2) Department of Physics, Università di Napoli, Italy

Recent megathrust tsunamigenic events, e.g. Maule 2010 (M8.8) and Tohoku 2011 (M9.0), generated huge tsunami waves as a consequence of high slip in the shallow part of the respective subduction zone. Other events, (e.g. the recent Mentawai 2010, M7.8, or the historical Meiji 1896, M8.2), referred to as tsunami earthquakes, produced unexpectedly large tsunami waves, probably due to large slip at shallow depth over longer rupture durations compared to deeper thrust events.

Subduction zone earthquakes originate and propagate along bimaterial interfaces separating materials having different elastic properties, e.g. continental and oceanic crust, a stiffer deep mantle wedge, shallow compliant accretionary prism etc. Bimaterial interfaces have been showed, through observations (seismological and laboratory) and theoretical studies, to affect the rupture: introducing a preferred rupture direction as well as asymmetric rupture velocities and shear stress redistributions. Such features are predominantly due to the break of symmetry between the two sides of the interface in turn ascribable to the complex coupling between the frictional interfacial sliding and the slip-induced normal stress perturbations.

In order to examine the influence of material contrast on a fault plane on the seismic source and tsunami waves, we modelled a Tohoku-like subduction zone to perform a large number of 2D along-dip rupture dynamics simulations in the framework of linear slip weakening both for homogeneous and bimaterial fault. In this latter model, the rupture acts as the interface between the subducting oceanic crust and the overriding layers (accretionary prism, continental crust and mantle wedge), varying the position of the shear stress asperity acting as nucleation patch.

Initial results reveal that ruptures in homogeneous media produce earthquakes with large slip at depth compared to the case where bi-material interface is included. However the opposite occurs for events nucleating at intermediate depths: the compliant accretionary prism favours slip up to the free surface leading to larger events compared to the homogeneous case. These preliminary findings will be further investigated considering different material contrasts between the slab and the overriding accretionary prism to mimic the slowness of the sedimentary wedge. This will contribute to assess the influence of these contrasts in more realistic environment on the seismic source features and, in turn, on the conditional probability of exceedance for maximum tsunami wave height for a M9 event.

Several source parameters, such as coseismic slip, rupture duration, rupture velocity and stress conditions, derived from the numerical simulations will be compared to those inferred from real events using existing finite fault catalogues (e.g. USGS, SRCMOD, etc.).