A 3 D dynamic rupture and see floor displacement simulations of the 2011 Mw9 Tohoku earthquake coupled with Tsunamis

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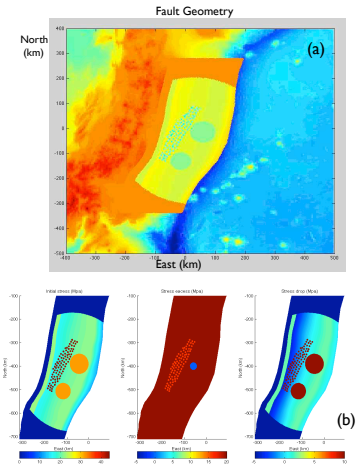
2011 Mw9 Tohoku earthquake - Dynamic rupture model

Introduction

We perform earthquake's dynamic rupture simulations of the 2011 Mw9 Tohoku event governed by the slip weakening friction law with slip reactivation and negative stress drop at the shallow part of the plate interface using SPECFEM3D (D. Peter et. al., 2011) with a recent dynamic rupture implementation, P. Galvez, et. al. 2013, in preparation. Our simulations shows complex patterns of rupture propagation compatible with source inversion models derived from geodetic and seismological observation, as well as ground motion patterns consistent with observations. Based on these simulations, we use the patio-temporal evolution of the the see floor displacement as input for tsunamis' simulations using a shallow water code A. Breuer et. al , 2012. The earthquake takes about in the first 260 seconds that subsequently generates a tsunami wave that gets the the cost of Japan in about 25-30 min after the earthquake.



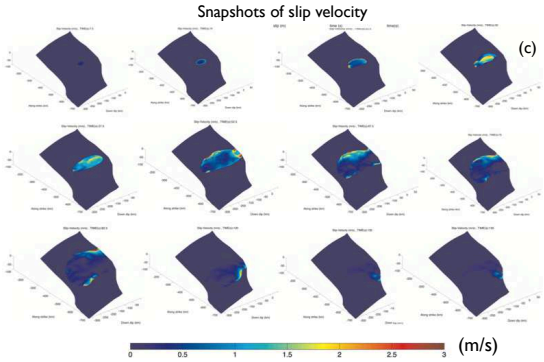


Figure 1. (a) Fault geometry and asperity distribution along the slab. (b) Initial stress distribution on the fault plane. The small asperities are sources of high frequency radiation >0.5Hz located at down dip of the slab. Those sources are located in area with high frequency radiation burst revealed from teleseismic back projection techniques (L. Cheng, et. al. , 2011). Novel near field back projection (N. Maerclin et. al , 2012) shows two big patches (big-orange patches) of high slip at frequencies between (0.1-0.4Hz). c) Snapshots of the slip rate that exhibit the evolution of the earthquake with a slip reactivation model.

EARTHQUAKE (Surface seismic waves and see Floor displacement)

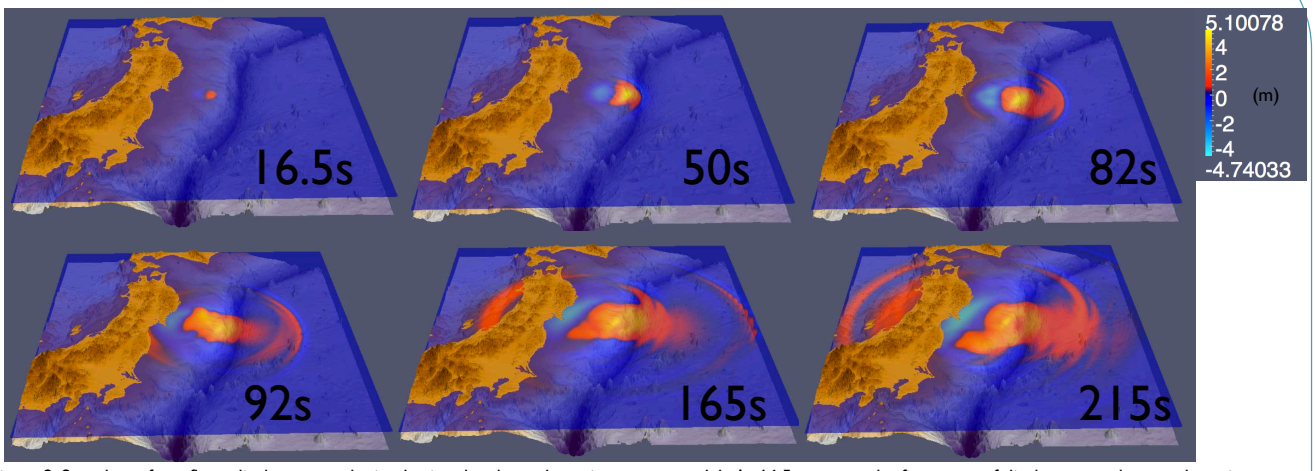


Figure 2. Snapshot of see floor displacement obtained using the above dynamic rupture model. At 16.5s appears the first trace of displacement close to the epicenter and propagates (50s) toward the trench. At 82 seconds we observe the seismic surface wave front traveling outwards the epicenter. At 92 seconds the see floor displacement propagates towards the cost of Japan, that is due to the rupture after 60-100 propagates down-dip increasing the see floor displacement parallel to the trench [165-215 seconds]. The multiple wave front emanating from the source occurs due to the reactivation of earthquake close to the hypocenter.

TSUNAMI (water wave front).

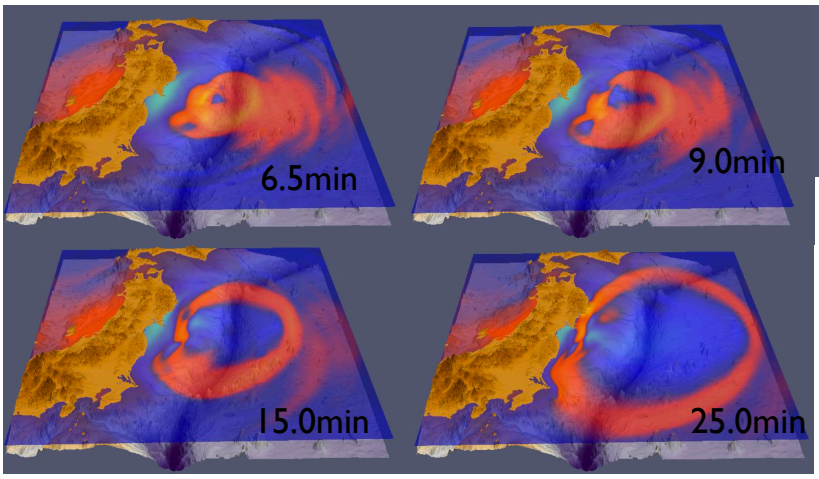


Figure 3. Snapshot showing the tsunami wave front propagation. The wave arrives to the cost of Japan at about 25min. This Tsunami simulation uses as input the spatial-temporal evolution of the see floor displacement generated by the earthquake dynamic model. A shallow water model has been used for this simulation.

Conclusions.

Earthquake and tsunamis are linked phenomena. Here we use the earthquake dynamic modeling that creates the spatial-temporal see floor displacement as input for tsunami generation.