Geophysical Research Abstracts
Vol. 18, EGU2016-9803, 2016
EGU General Assembly 2016

Incorporation of experimentally derived friction laws in numerical simulations of earthquake generated tsunamis

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Seismological, tsunami and geodetic observations have shown that subduction zones are complex systems where the properties of earthquake rupture vary with depth. For example nucleation and high frequency radiation generally occur at depth but low frequency radiation and large tsunami-genic slip appear to occur in the shallow crustal depth.

Numerical simulations used to describe these features predominantly use standardised theoretical equations or experimental observations often assuming that their validity extends to all slip-rates, lithologies and tectonic environments. However recent rotary-shear experiments performed on a range of diverse materials and experimental conditions highlighted the large variability of the evolution of friction during slipping pointing to a more complex relationship between material type, slip rate and normal stress.

Simulating dynamic rupture using a 2D spectral element methodology on a Tohoku like fault, we apply experimentally derived friction laws (i.e. thermal slip distance friction law, Di Toro et al. 2011) Choice of parameters for the friction law are based on expected material type (e.g. cohesive and non-cohesive clay rich material representative of an accretionary wedge), the normal stress which is controlled by the interaction between the regional stress field and the fault geometry. The shear stress distribution on the fault plane is fractal with the yield stress dependent on the static coefficient of friction and the normal stress, parameters that are dependent on the material type and geometry.

We use metrics such as the slip distribution, ground motion and fracture energy to explore the effect of frictional behaviour, fault geometry and stress perturbations and its potential role in tsunami generation. Preliminary results will be presented.

This research is funded by the European Union’s Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 603839 (Project ASTARTE - Assessment, Strategy and Risk Reduction for Tsunamis in Europe) and by the ERC CoG NOFEAR project 614705