Geophysical Research Abstracts
Vol. 19, EGU2017-557, 2017
EGU General Assembly 2017


# What favors the occurrence of subduction mega-earthquakes?

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Most of mega-earthquakes (MEqs; Mw > 8.5) occur at shallow depths along the subduction thrust fault (STF). The contribution of each subduction zone to the globally released seismic moment is not homogenous, as well as the maximum recorded magnitude MMax. Highlighting the ingredients likely responsible for MEqs nucleation has great implications for hazard assessment.
In this work, we investigate the conditions favoring the occurrence of MEqs with a multi-disciplinary approach based on: i) multivariate statistics, ii) analogue- and iii) numerical modelling.
Previous works have investigated the potential dependence between STF seismicity and various subduction zone parameters using simple regression models. Correlations are generally weak due to the limited instrumental seismic record and multi-parameter influence, which make the forecasting of the potential MMax rather difficult.
To unravel the multi-parameter influence, we perform a multivariate statistical study (i.e. Pattern Recognition, PR) of the global database on convergent margins (Heuret et al., 2011), which includes seismological, geometrical, kinematic and physical parameters of 62 subduction segments.
PR is based on the classification of objects (i.e. subduction segments) belonging to different classes through the identification of possible repetitive patterns. Tests have been performed using different MMax datasets and combination of inputs to indirectly test the stability of the identified patterns.
Results show that the trench-parallel width of the subducting slab (Wtrench) and the sediment thickness at the trench (Tsed) are the most recurring parameters for MEqs occurrence. These features are mostly consistent, independently of the MMax dataset and combination of inputs used for the analysis. MEqs thus seem to be promoted for high Wtrench and Tsed, as their combination may potentially favor extreme (i.e. in the order of thousands of km) trench-parallel rupture propagation.
To tackle the uncertainties related to the short observational timespan with respect to the seismic cycle duration, we are systematically testing the influence of Wtrench and Tsed with novel 3D analogue and numerical models, respectively.
Analogue models consist of a gelatin wedge underthrusted by a planar, 10° dipping slab including a rectangular patch with velocity-weakening frictional behavior. The experimental setup, specifically designed for the purpose, has the advantage of varying Wtrench from 50 cm to 1.5 m (i.e. 300 to 1000 km in nature), thus offering the opportunity to investigate its influence on MMax.
Numerical models are performed using the visco-elasto-plastic Seismo-Thermo-Mechanical code (STM; van Dinther et al., 2013). The 2D setup has been modified including a layer of sediments on top of the subducting plate to test the role of Tsed on MMax.
Results coming from the different adopted methodologies will be coupled to develop an integrated conceptual model, pointing out the potential cause-effect relationships between subduction zone parameters and the MMax of STF earthquakes