Geophysical Research Abstracts
Vol. 18, EGU2016-13291, 2016
EGU General Assembly 2016


# Coupling geodynamic earthquake cycles and dynamic ruptures

Iris van Zelst (1), Ylona van Dinther (1), Alice-Agnes Gabriel (2), and Arnauld Heuret (3)

(1) Computational Seismology, Institute of Geophysics, ETH Zürich, Zürich, Switzerland (iris.vanzelst@erdw.ethz.ch), (2) Department of Earth and Environmental Sciences, Geophysics, LMU Munich, Munich, Germany, (3) Université de Guyane, Cayenne, Guyane

Studying the seismicity in a subduction zone and its effects on tsunamis requires diverse modelling methods that span spatial and temporal scales. Hundreds of years are necessary to build the stresses and strengths on a fault, while consequent earthquake rupture propagation is determined by both these initial fault conditions and the feedback of seismic waves over periods of seconds up to minutes. This dynamic rupture displaces the sea floor, thereby causing tsunamis. The aim of the ASCETE (Advanced Simulations of Coupled Earthquake and Tsunami Events) project is to study all these aspects and their interactions. Here, we present preliminary results of the first aspects in this modelling chain: the coupling of a seismo-thermo-mechanical (STM) code to the dynamic rupture model SeisSol.

STM models of earthquake cycles have the advantage of solving multiple earthquake events in a self-consistent manner concerning stress, strength and geometry. However, the drawback of these models is that they often lack in spatial or temporal resolution and do not include wave propagation. In contrast, dynamic rupture models solve for frictional failure coupled to seismic wave propagation. We use the software package SeisSol (www.seissol.org) based on an ADER-DG discretization allowing high-order accuracy in space and time as well as flexible tetrahedral meshing. However, such simulations require assumptions on the initial fault stresses and strengths and its geometry, which are hard to constrain due to the lack of near-field observations and the complexity of coseismic conditions. By adapting the geometry as well as the stress and strength properties of the self-consistently developing non-finite fault zones from the geodynamic models as initial conditions for the dynamic rupture models, the advantages of both methods are exploited and modelling results may be compared.

Our results show that a dynamic rupture can be triggered spontaneously and that the propagating rupture is qualitatively comparable to its quasi-static STM equivalent. After homogenizing our frictional formulation more, a quantitative comparison of displacements and stresses will show the importance of both dynamic feedback on fault strength and our different modeling techniques. Finally, we will analyze the importance of using these self-consistent initial conditions by comparing the observed slip and sea floor displacements to output from models with traditional initial stress and strength conditions, such as constant, depth-dependent or a stochastic initial stress state. Tsunamis are briefly addressed by presenting an update of a database containing the geometrical and mechanical parameters of subduction zones (Heuret et al., 2011). In particular, a catalog of tsunamis relating to subduction earthquakes will be built and analysed. Preliminary results of the statistical analysis are presented to study under which physical conditions subduction zone tsunamis are most likely to occur. This will guide future studies to determine optimized initial stress and strength conditions.