Geophysical Research Abstracts
Vol. 18, EGU2016-12603, 2016
EGU General Assembly 2016

Influence of hydrodynamic parameters on tsunami run-up uncertainty induced by earthquake random slip distribtutions

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The standard approach in forward modeling of earthquake tsunamis usually assume a uniform slip pattern. This is assumption is used both in deterministic and probabilistic models. However, the slip distribution for an earthquake is subject to (aleatory) uncertainty, and consequently the induced tsunami run-up will have an uncertainty range even given the same moment magnitude and hypocentre earthquake location. Here, we present studies of run-up variability due to stochastic earthquake slip variation in both two and three dimensions. The approach taken is fully idealized, although we draw upon the experience from two of the most destructive events the last hundred years, namely the Mw8 1976 Moro Gulf earthquake and tsunami as well as the Mw9 2011 Tohoku earthquake tsunami. The former event is used to design the two-dimensional stochastic simulations, and the latter event the three-dimensional simulations. Our primary focus is not reproduce past run-up, but rather to investigate how the hydrodynamics influence uncertainty. These quantities include among others the non-hydrodynamic response during generation, frequency dispersion, friction from the seabed, and wave-breaking. We simulate tsunamis for an ensemble of synthetic random slip over an idealized shelf geometry broken into linear segments. The uncertainty propagation from source to run-up for the two different cases are discussed and compared. As demonstrated, both the dimensionality and the earthquake parameters influence the contributions of the hydrodynamic parameters on the uncertainty. Further work will be needed to explore the transitional behaviour between the two very different cases displayed here. The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement 603839 (Project ASTARTE).