Geophysical Research Abstracts
Vol. 16, EGU2014-3100, 2014
EGU General Assembly 2014

Modeling Seawater Layer Effects on Ground Motion at Ocean-Bottom Floor Sites From Offshore Earthquakes

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The analysis and modeling of ground motion waveforms recorded at the ocean-bottom floor and teleseismic distances from offshore earthquakes requires a good understanding of seawater layer and ocean-bottom topography effects. We study these effects by simulating ground motions from shallow double-couple point sources using a 3D subduction zone seismic velocity model. Three component synthetic seismograms are calculated along linear arrays located on the ocean-bottom floor and beneath the source. We use a 3D staggered grid finite-difference method (Pitarka, 1999) to simulate wave propagation in heterogeneous structures with solid-liquid boundaries based on the scheme proposed by Okamoto and Takenaka (2005). In this scheme the continuity of normal stress and discontinuity of the shear stress across the solid-air and solid-fluid boundaries is implicitly satisfied using finite difference operators of second order accuracy. By progressively including geological features and a water layer into the 3D model we are able to analyze separately their effects on wave propagation as well as contributions to down-going waves recorded at teleseismic distances. Our simulation results suggest that coupling between ocean-bottom topography and seawater affect both P and S coda waves. Water-layer reverberations of P waves are visible in the simulated ocean-bottom seismograms. Additionally, reverberations of the water phase pwP (reflected from the air-water interface), the depth phase pP (reflected from the water-crust interface), and P-S converted waves generated at the water-crust interface form a ringing pattern in the coda of the down-going P wave which is observed at teleseismic distances. The amplitude of seawater generated waves depends on the source location relative to the ocean-bottom floor.
This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-06NA25946/ NST11-NCNS-TM-EXP-PD15.