Geophysical Research Abstracts
Vol. 18, EGU2016-9597, 2016
EGU General Assembly 2016

Mach-wave coherence in 3D media with random heterogeneities

Jagdish C. Vyas (1), P. Martin Mai (1), Martin Galis (1), Eric M. Dunham (2), and Walter Imperatori (3)

(1) King Abdullah University of Science and Technology (KAUST), (jagdish.vyas@kaust.edu.sa), (2) Stanford University, (3) Swiss Seismological Service

We investigate Mach-waves coherence for complex super-shear ruptures embedded in 3D random media that lead to seismic scattering. We simulate Mach-wave using kinematic earthquake sources that include fault-regions over which the rupture propagates at super-shear speed. The local slip rate is modeled with the regularized Yoffe function. The medium heterogeneities are characterized by Von Karman correlation function. We consider various realizations of 3D random media from combinations of different values of correlation length (0.5 km, 2 km, 5 km), standard deviation (5%, 10%, 15%) and Hurst exponent (0.2). Simulations in a homogeneous medium serve as a reference case. The ground-motion simulations (maximum resolved frequency of 5 Hz) are conducted by solving the elasto-dynamic equations of motions using a generalized finite-difference method, assuming a vertical strike-slip fault. The seismic wavefield is sampled at numerous locations within the Mach-cone region to study the properties and evolution of the Mach-waves in scattering media.

We find that the medium scattering from random heterogeneities significantly diminishes the coherence of Mach-wave in terms of both amplitude and frequencies. We observe that Mach-waves are considerably scattered at distances $R_{JB} > 20$ km (and beyond) for random media with standard deviation 10%. The scattering efficiency of the medium for small Hurst exponents (H <= 0.2) is mainly controlled by the standard deviation of the velocity heterogeneities, rather than their correlation length, as both theoretical considerations and numerical experiments indicate. Based on our simulations, we propose that local super-shear ruptures may be more common in nature then reported, but are very difficult to detect due to the strong seismic scattering. We suggest that if an earthquake is recorded within 10-15 km fault perpendicular distance and has high PGA, then inversion should be carried out by allowing rupture speed variations from sub-Rayleigh to super-shear.