Geophysical Research Abstracts
Vol. 12, EGU2010-4816, 2010
EGU General Assembly 2010

Early detection of rupture directivity using azimuthal amplitude spectra inversion

Simone Cesca, Sebastian Heimann, and Torsten Dahm
Institute of Geophysics, University of Hamburg, Germany (simone.cesca@zmaw.de)

Earthquake directivity effects are related to a predominant direction of the rupture front propagation and have been observed for several earthquakes in the past, based on a variability of waveform and spectral content of the seismic data recorded at different stations. An early detection of the presence of rupture directivity is of great importance towards the correct estimation of ground motions and risks associated to the earthquake occurrence. We present here a simple method for a quick detection of rupture directivity, which may be additionally used to discriminate fault and auxiliary planes and to make first estimates on important kinematic source parameters, such as rupture length and rupture time. Our method is based on the inversion of the apparent duration from single station P-wave seismograms, assuming a point source representation. Synthetic waveforms are calculated based on Green's functions for specific earth models and thus account for wave propagation effects. They are built assuming a spatial point source aproximation and a given focal mechanism, which may be consistently determined using the same dataset and inversion algorithm. The finite apparent duration of the spatial point source is interpreted in terms of rupture directivity: once apparent durations have been estimated for different stations at different azimuths, their azimuthal variation can be used to detect directivity, using theoretical curves associated to different rupture propagation directions along the two possible planes. Since synthetic seismograms for a point source are calculated very quickly, the presence of directivity may be detected within few seconds, once a focal mechanism has been derived. Here the method is first tested using synthetic datasets, both for linear and planar sources. The synthetic tests clearly demonstrate the potential of the method. More stable results are found both for predominat strike-slip mechanisms and mostly unilateral ruptures. However, directivity effects could be correctly detected also for other source configurations. The method has been successfully applied to shallow earthquakes. In particular, we focus on recent earthquakes, which occurred in Peloponnesos, Greece, with magnitudes ranging between Mw 6.2 and 6.8. For the Andravida earthquake (8.6.2008, Mw 6.4), apparent durations could be very well modelled by means of a partially unilateral rupture, mostly propagating northward, which identifies the NNE-SSW striking plane as the rupture plane. This result, both in terms of fault plane discrimination and directivity effects, is in well agreement with a range of published solutions, using alternative methods.