Geophysical Research Abstracts
Vol. 14, EGU2012-1471, 2012
EGU General Assembly 2012

Moment tensor inversion using uncalibrated sensors

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We present a new inversion method for seismic moment tensors using amplitudes of waves measured at stations with uncalibrated sensors. Moment tensor inversion is one of the most common tools for retrieving the source mechanisms of earthquakes but also a data-demanding procedure which requires a good velocity model, an accurate hypocentre location and high-quality data (with a high signal to noise ratio), recorded by many stations with good azimuthal coverage. However the quality of data cannot always be considered optimum as problems related to the functioning of the stations are common.

The inversion presented allows overcoming the mentioned deficiencies of data and allows the retrieval of moment tensors of sets of earthquakes together with the amplifications of uncalibrated stations. Therefore, the inversion is capable to detect a reverse polarity, incorrect orientation of sensors or anomalous site effects caused by local geological conditions. The robustness and accuracy of the inversion are tested on synthetic data with different noise levels, station configurations and a variety of focal mechanisms. The mean and standard deviations of the retrieved amplifications highlighted that the inversion code performed better with a higher number of stations with known amplifications, a lower level of noise and a higher number of analyzed even confirming that the inversion code works well and yields robust results.

Finally, the method is applied to a dataset of 234 events with highly accurate hypocentre locations recorded in the West-Bohemia region in order to check the quality of the local seismic network and identified stations with amplification problems. Anomalous amplifications are detected at three of the 22 stations operating in West-Bohemia region probably linked to site effects due to local geological conditions.

The method can be particularly advantageous for the moment tensor inversions of laboratory data, where the coupling effects between the sensor and a rock sample are difficult to quantify, or for inversions of mining and boreholes data, where the calibration and orientation of the sensors are frequently unknown.