

Semi-automatic P-waveform inversion for focal mechanisms and moment tensors using the principal component analysis

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We present a moment tensor inversion of waveforms of P waves using the principal component analysis (PCA). The method is based on the assumption that a point source generates P waves with waveforms identical at all receivers irrespective of azimuths and take-off angles of the corresponding rays. We proceed in the following way. First, records of P waves are aligned for all stations using the cross-correlation analysis. Second, the principal component decomposition is applied to extract the common waveform of the P wave and to calculate the respective PCA coefficients. Third, the PCA coefficients are used as the P-wave amplitude factors in the standard amplitude inversion for the moment tensors. The robustness and accuracy of the proposed inversion method is analyzed on numerical tests and on real observations of 2014 earthquake swarm activity in West Bohemia, Czech Republic. It is shown that even though the method works in a semi-automatic regime, it yields very accurate results which are comparable or even better than those obtained by the standard waveform inversion or the inversion of P-wave amplitudes picked manually. The method is particularly suitable for analysis of extensive datasets of local natural or induced seismicity, where manual processing of individual earthquakes is not feasible.