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Bayesian ISOLA: new tool for automated centroid moment tensor inversion

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Focal mechanisms are important for understanding seismotectonics of a region, and they serve as a basic input for seismic hazard assessment. Usually, the point source approximation and the moment tensor (MT) are used.

We have developed a new, fully automated tool for the centroid moment tensor (CMT) inversion in a Bayesian framework. It includes automated data retrieval, data selection where station components with various instrumental disturbances and high signal-to-noise are rejected, and full-waveform inversion in a space-time grid around a provided hypocenter. The method is innovative in the following aspects:
(i) The CMT inversion is fully automated, no user interaction is required, although the details of the process can be visually inspected latter on many figures which are automatically plotted.
(ii) The automated process includes detection of disturbances based on MouseTrap code, so disturbed recordings do not affect inversion.
(iii) A data covariance matrix calculated from pre-event noise yields an automated weighting of the station recordings according to their noise levels and also serves as an automated frequency filter suppressing noisy frequencies.
(iv) Bayesian approach is used, so not only the best solution is obtained, but also the posterior probability density function.
(v) A space-time grid search effectively combined with the least-squares inversion of moment tensor components speeds up the inversion and allows to obtain more accurate results compared to stochastic methods.

The method has been tested on synthetic and observed data. It has been tested by comparison with manually processed moment tensors of all events greater than M$\geq$3 in the Swiss catalogue over 16 years using data available at the Swiss data center (http://arclink.ethz.ch). The quality of the results of the presented automated process is comparable with careful manual processing of data.

The software package programmed in Python has been designed to be as versatile as possible in order to be applicable in various networks ranging from local to regional. The method can be applied either to the everyday network data flow, or to process large previously existing earthquake catalogues and data sets.