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Towards a rapid automated kinematic source inversion: applications to Mw 6.5-8.0 earthquakes in Japan

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A main problem for stable and automated routines for the inversion of kinematic earthquake sources arise from the overparameterization of the rupture model, as occurs for example using slip map representations. Using such an approach, it is possible to well reproduce observations, but the inversion is often unstable and solutions ambiguous, as several different source models may equally well fit the observations. To overcome this problem and implement an automated kinematic inversion, we adopt the eikonal source model to represent the extended earthquake source. This model offers a flexible and realistic description of the rupture process, which is fully described by only 13 parameters. We use a multi-step inversion strategy, which has already been successfully applied at local and regional distances, in order to retrieve both point and extended source parameters. Significant source information, including focal mechanism, source depth, magnitude, centroid location, resolution of the fault plane ambiguity, rupture size, average slip and directivity effects can be provided. We include specific applications to a set of moderate to large earthquakes occurred in Japan, using broadband seismic data at regional and teleseismic distances. Quality and stability of inversion results are first discussed, by using full waveform information. Point source parameters are always well determined, while kinematic parameters such as the rupture extension, the average slip and the unilateral or bilateral character of the rupture can be resolved in many cases. The possibility of providing fast solutions, which are needed within early-warning systems, is further discussed.