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Fast kinematic source inversion using Green's function interpolation

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The increasing interest in obtaining fast, automated and reliable solutions for earthquake source parameters is currently requiring improved procedures to reduce computational time. The most time consuming step is typically the generation of Green's function databases, from where Green's functions are recovered during the application of the inversion technique. While automatic moment tensor solutions have been implemented and are now available for a wide range of earthquake magnitudes and using different seismic datasets, similar procedures for the retrieval of kinematic parameters are still not yet available. The Kinherd project's aim is to provide an automated inversion technique to retrieve parameters, describing the characteristics of extended earthquakes. The problem related to the Green's functions computation gets especially critical, when dealing with the inversion of kinematic parameters, since the Green's functions have to be evaluated on a dense grid in space and time. Such requirement arises from the necessity of resolving small-scale source characteristics, when using a wide range of source-receiver configurations. The amount of Green's functions to be computed increases dramatically, with the number of source depths, epicentral distances, and velocity models one wants to consider. To reduce the density of Green's functions in the initial databases, we propose to interpolate analytical Green's functions, considering the entire waveform. The technique we employ is the generalized f-k trace interpolation method, a data adaptive interpolation method initially developed for the oil industry. The interpolation is equivalent to a complex number division in the f-k domain. This method has the advantages of being fast and adapted to 2D as well as 3D data, which suit well our objectives. We present results of the successful application of this method to synthetic and real data. Computation of the RMS shows that the results are more precise compared to linear interpolation. Moreover the number of Green's function in the initial database can be reduced by at least 50%. Finally, we consider a synthetic earthquake and compare between the results obtained with and without interpolation.