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Investigation of Finite Sources through Time Reversal

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Under certain conditions time reversal is a promising method to determine earthquake source characteristics without any a-priori information (except the earth model and the data). It consists of injecting flipped-in-time records from seismic stations within the model to create an approximate reverse movie of wave propagation from which the location of the hypocenter and other information might be inferred. In this study, the backward propagation is performed numerically using a parallel cartesian spectral element code. Initial tests using point source moment tensors serve as control for the adaptability of the used wave propagation algorithm. After that we investigated the potential of time reversal to recover finite source characteristics (e.g., size of ruptured area, rupture velocity etc.). We used synthetic data from the SPICE kinematic source inversion blind test initiated to investigate the performance of current kinematic source inversion approaches (http://www.spice-rtn.org/library/valid). The synthetic data set attempts to reproduce the 2000 Tottori earthquake with 33 records close to the fault. We discuss the influence of various assumptions made on the source (e.g., origin time, hypocenter, fault location, etc.), adjoint source weighting (e.g., correct for epicentral distance) and structure (uncertainty in the velocity model) on the results of the time reversal process. We give an overview about the quality of focussing of the different wavefield properties (i.e., displacements, strains, rotations, energies). Additionally, the potential to recover source properties of multiple point sources at the same time is discussed.