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Estimating Source Time Function by Time Reversal Method

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Many advanced analysis of the rupture dynamics of both natural and induced seismic events relay on knowledge of events Source Time Function (STF). This function provides information on temporal release of seismic moment from the source directly readout from seismograms. However, its estimation requires removing propagation effects from seismograms . Currently, two different approaches are used to estimate the STF function. The first one proposed originally by Hartzell (1978) called Empirical Green Function approach (EGF) relays on pairing of different events and using a part of seismogram of a smaller event as the Green's function needed to deconvolve STF from seismogram of the larger event. This technique was successfully applied to analysis of many natural events (Mori 2003;, Abercrombie and Rice 2005) as well as to mining induced events (Gibowicz 2009; Domanski 2008; Debski 2018). The second approach relies on using numerically calculated Green's functions and thus requires a very precise knowledge of medium properties. Both approaches have well known advantages and limitations which cause that retrieving STF is quite problematic and subjected to various assumption and simplifications.
In this contribution we report our attempt of developing of a new approach based on the Time Reversal Method (Fink 1997). The proposed approach being a very special kind of inverse technique (direct back projection) fully relies on observed data, does not require strong and subjective assumptions like the EGF approach but only knowledge of the medium. Thus, in principle it combines two aforementioned approaches but avoids many of limitations of each method. We provide basic introduction to TRM technique including classical geophysical application - tremor location and describe its application to retrieving the STF function. Theoretical considerations are illustrated by numerical examples for 2D acoustic case.