1 Abstract
We have developed a forward modeling technique to retrieve source parameters of a distant event, using an optimal combination of the 2D and 3D data, including P- and S-wave propagation, fault strike, depth, dimension, and rupture speed. The technique is based on empirical Green's functions (EGFs) of the 2003 Big Bear sequence. Because the EGFs have been calculated for various rupture parameters and are available on a grid in space, this forward modeling approach allows full use both of the static and amplitude information produced by rupture propagation. Assuming simple 1D Haskell source models, we parameterize the source-time function of a studied event as the convolution of a step function, the rise time \( \tau \), and the rupture time \( t_r \) (Fig. 1). This assumption is based on the observation that small earthquakes have a source-time function that can be parameterized as the convolution of two boxcars, featuring the rise time \( \tau \) and the rupture time \( t_r \). We use the relative source time function, \( \delta(t) \), of the large event as a reference to calculate the misfit as a function of the relative source time function, \( \delta(t) \) of the large event as:

\[
\text{misfit} = \frac{1}{N} \sum_{i=1}^{N} \left[ \int_{-\tau}^{t_r} \left( \delta(t) - \delta_{\text{ref}}(t) \right)^2 dt \right]
\]

where \( \delta_{\text{ref}}(t) \) is the relative source time function of the large event.

1.1 Modeling Approach

The direct consequence of rupture propagation on a flat plate is the azimuthal dependence of the observed source-time function (STF). In brief, if a seismic station is sampling the whole azimuthal range, the STF will vary smoothly and have a smaller amplitude. An aperture function can be used to decrease the misfit on the estimation of the rupture parameters, as illustrated in Fig. 1. To do so, use both the 2D and 3D data, it is possible to improve the azimuthal sampling of the source-time function and retrieve STFS. Moreover, provided corrections for the difference in the near event, the southern stations, and rupture parameters can be retrieved.

2 Introduction

2.1 Rupture Directivity

Rupture directivity is a measure of the direction in which the rupture is propagating, and it can be used to infer the geometry of the fault plane. The observed source time function (STF) is a convolution of two boxcars, featuring the rise time \( \tau \) and the rupture time \( t_r \). We can solve for the STF as a grid search method by minimizing the misfit between the reference STF and the observed STFs for the southern stations.

2.2 Rupture Velocity

The rupture velocity can be calculated by minimizing the difference between the observed STFs and the predicted STFs. The predicted STF is given by the convolution of the rupture velocity and the source-time function.

3 Methodology

3.1 Source-Time Function

We can parameterize the source-time function of a studied event as the convolution of a step function, the rise time \( \tau \), and the rupture time \( t_r \) (Fig. 1). This assumption is based on the observation that small earthquakes have a source-time function that can be parameterized as the convolution of two boxcars, featuring the rise time \( \tau \) and the rupture time \( t_r \). We use the relative source time function, \( \delta(t) \), of the large event as a reference to calculate the misfit as a function of the relative source time function, \( \delta(t) \) of the large event as:

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\]

where \( \delta_{\text{ref}}(t) \) is the relative source time function of the large event.

3.2 Rupture Time

Rupture time \( t_r \) can be estimated by minimizing the difference between the observed STFs and the predicted STFs. The predicted STF is given by the convolution of the rupture time \( t_r \) and the source-time function.

3.3 Rupture Velocity

The rupture velocity can be calculated by minimizing the difference between the observed STFs and the predicted STFs. The predicted STF is given by the convolution of the rupture velocity and the source-time function.

4 Results

4.1 Rupture Time

The rupture time \( t_r \) can be estimated by minimizing the difference between the observed STFs and the predicted STFs. The predicted STF is given by the convolution of the rupture time \( t_r \) and the source-time function.

4.2 Rupture Velocity

The rupture velocity can be calculated by minimizing the difference between the observed STFs and the predicted STFs. The predicted STF is given by the convolution of the rupture velocity and the source-time function.

5 Discussion and Conclusions

5.1 Rupture Velocity

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5.2 Rupture Time

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