Geophysical Research Abstracts
Vol. 19, EGU2017-5813-1, 2017
EGU General Assembly 2017

Estimating High Frequency Energy Radiation of Large Earthquakes by Image Deconvolution Back-Projection

Dun Wang (1), Nozomu Takeuchi (2), Hitoshi Kawakatsu (2), and Jim Mori (3)

(1) China University of Geosciences, Wuhan, China (dunwang2004@yahoo.com), (2) Earthquake Research Institute, The University of Tokyo, Tokyo, Japan, (3) Disaster Prevention Research Institute, Kyoto University

With the recent establishment of regional dense seismic arrays (e.g., Hi-net in Japan, USArray in the North America), advanced digital data processing has enabled improvement of back-projection methods that have become popular and are widely used to track the rupture process of moderate to large earthquakes.

Back-projection methods can be classified into two groups, one using time domain analyses, and the other frequency domain analyses. There are minor technique differences in both groups. Here we focus on the back-projection performed in the time domain using seismic waveforms recorded at teleseismic distances (30-90 degree). For the standard back-projection (Ishii et al., 2005), teleseismic P waves that are recorded on vertical components of a dense seismic array are analyzed. Since seismic arrays have limited resolutions and we make several assumptions (e.g., only direct P waves at the observed waveforms, and every trace has completely identical waveform), the final images from back-projections show the stacked amplitudes (or correlation coefficients) that are often smeared in both time and space domains. Although it might not be difficult to reveal overall source processes for a giant seismic source such as the 2004 Mw 9.0 Sumatra earthquake where the source extent is about 1400 km (Ishii et al., 2005; Krüger and Ohrnberger, 2005), there are more problems in imaging detailed processes of earthquakes with smaller source dimensions, such as a M 7.5 earthquake with a source extent of 100-150 km. For smaller earthquakes, it is more difficult to resolve space distributions of the radiated energies.

We developed a new inversion method, Image Deconvolution Back-Projection (IDBP) to determine the sources of high frequency energy radiation by linear inversion of observed images from a back-projection approach. The observed back-projection image for multiple sources is considered as a convolution of the image of the true radiated energy and the array response for a point source. The array response that spreads energy both in space and time is evaluated by using data of a smaller reference earthquake that can be assumed to be a point source. The synthetic test of the method shows that the spatial and temporal resolution of the source is much better than that for the conventional back-projection method. We applied this new method to the 2001 M 7.8 Kunlun earthquake using data recorded by Hi-net in Japan. The new method resolves a sharp image of the high frequency energy radiation with a significant portion of supershear rupture.