アイソクロン・バックプロジェクション法による地震の震源過程のイメージング

Investigation of source process of earthquakes from isochrones back-projection of high-frequency seismograms

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Conventional methodologies for calculation of the earthquakes source process are based on inversion procedures which require the calculation of complete source-stations Greens functions. On the other hand alternative procedures have been developed in order to directly retrieve an image of the rupture process from high frequency seismograms (Spudich et. al. 1984, Kao and Shan 2004, Ishii et. al. 2005). In this study I extend the Isochrones-Backprojection methodology (Festa et al., 2006), to image the source process of earthquakes, by incorporating the use of high frequency seismograms around the source area (Pulido et. al. 2008). I take full advantage of the dense strong motion networks available in Japan to model the source process of recent Japanese earthquakes.

The isochrones-backprojection method (IBM) differs from conventional earthquake source inversion approaches, in that the calculation of Green's functions is not required. The idea of the procedure is to directly back-project amplitudes of seismograms envelopes around the source into a space image of the earthquake rupture. The method requires the calculation of theoretical travel times between a set of grids points distributed across the fault plane and every station, which are adjusted by a station correction factor, for a 1D velocity model. Next I calculate the rupture time of every grid within the fault plane by assuming some arbitrary constant rupture velocity value, and obtain the isochrones times for every station. I select waveforms that have clear P and S wavelets, which means stations located approximately between 40 km and 100km from the epicenter. I extract P-wave windows between the origin time of the earthquake and the theoretical arrival of the S-wave, and taper 1s of the waveforms at the end. I band-pass filter the data between 1Hz and 30Hz, and calculate the waveforms envelopes using the root-mean-square of the original waveforms and their Hilbert transform. A total **grid brightness** is calculated by adding weighted-averaged envelope amplitudes for a window centered at every isochrone time crossing the grid. The envelopes amplitudes at each isochrone time are corrected before the summation by a directivity factor (Madariaga 1977), to account for the rupture propagation effect on the waveforms. The final result is a distribution of the brightness across the fault plane, which gives us an idea of the location of asperities within the fault plane.

We obtained an image of the source process of recent Japanese crustal earthquakes, by using data of the K-NET and KiK-net strong motion networks operated by NIED, and applying the Isochrones Backprojection Method (IBM). Our method has the capability to quickly map asperities of large earthquakes, and is able to provide stable estimates of the fault rupture velocity. We investigate the resolution of our source models by performing synthetic tests, to explore the effect of choice of parameters and station coverage on the accuracy of resolved source images.

References

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