# Estimation of seismic energy sources inferred from Source-Scanning-Algorithm method: Case of the 2018 M6.6 Hokkaido Eastern Iburi Earthquake and the 2019 M6.7 Yamagata-Oki Earthquake

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The Source-Scanning-Algorithm(SSA) has been reported to be an effective method for imaging the distribution of seismic energy sources in time and space (e.g. Kao et al., 2004). SSA calculates the Brightness(Br) value by adding the absolute values of the waveform amplitudes from stations at respective theoretical arrival times, and the distribution of seismic energy sources is identified by the maximum of the Br value. As this approach does not require the knowledge of the actual fault plane, we can see the source distribution immediately.
In this study, we determined the energy source distribution of two significant earthquakes. One is the 2018 M6.6 Hokkaido Eastern Iburi Earthquake and another is the 2019 M6.7 Yamagata-Oki Earthquake. In our analysis, we use waveform data of strong-motion stations (JMA, K-NET, KiK-net and Local government sites) whose epicenter distances are within a certain range so that the respective lengths of one period of all waveforms are about the same. We used the waveforms of the P waves for summing, and then bandpass-filtered from 4.0 to 20.0 Hz to remove low-frequency noise. The grid point whose interval is 1km, are placed around the epicenter. The travel-times of P waves from all grid points to all stations are calculated using JMA2001(Ueno et al.,2001). Finally all Br values are calculated for each grid point by 0.01 sec sampling interval.
The results were compared with the source process determined by JMA to ensure appropriate features of the fault movements. In the case of the 2018 M6.6 Hokkaido Eastern Iburi Earthquake, the maximum of Br value has two peaks both in time and space. At about 1 to 2 sec after the origin time(OT) the distribution of the high Br value is near the epicenter determined by JMA, and then the Br value attenuates, and rises again at about 6 to 8 sec. Although the region with a high Br value has a difference of several km from the one with a large moment release by the source process analysis, two peak times are almost the same. In another case, that is the 2019 Yamagata-Oki Earthquake, at about 4 to 6 sec after OT the distribution of high Br value extends about 8km from the epicenter to the west-northwest. The region of high Br value and the large moment release region almost match although two peak times have a slight difference.
We also used resolution test to ensure spatial and temporal accuracy of an imagining obtained by SSA. Assuming that several test waveforms were emitted from the epicenters (virtually located around the epicenter) and observed at the stations which were used in the actual analysis at the time based on theoretical travel-time, we compared the distribution of the high Br value and the location of the hypocenters. In either case the two positions almost matched.

 