

Rupture process of the 2007 Noto Hanto earthquake from automatically picked-up S waves

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Although JMA made a mistake at the source depth when the earthquake early warning (EEW) was issued, the Horiuchi system installed in the National Research Institute for Earth Science and Disaster Prevention (NIED) successfully gave the correct warning of the Noto Hanto earthquake in 2007 with the correct epicenter as well as the correct source depth. In this study, taken for granted that the correct information of the hypocenter and original time are in hand already, we developed a program to automatically pick up the arrivals of S phases and using these S phase waveform data to reveal the source rupture process of the Noto Hanto earthquake.

Picking-up of arrivals of the P first motion is well studied and successfully applied in EEW systems (e.g., Horiuchi et al. 2005). In addition to the ratio of short time average (STA in short) with long time average (LTA in short) calculated for the vertical component, we introduced a polarity parameter to pick up the P-wave arrivals. The polarity parameter is such a function of the eigenvalues of the cross power of the three-component records that it always reaches the maximum when the signal is dominant in a certain direction. Since the background noises come from random azimuths and P wave is from a certain source, introduction of the polarity parameter makes the program more robust even in the case of successive occurrences of foreshocks. In the case of the S-wave arrivals, we first calculated the STA/LTA ratio for the horizontal components. Then we introduced a new parameter (K_i) which is a function of the cross-power eigenvalues, incident angle of the dominant signal, and ratio of the S-wave energy with the total energy. Combination of the STA/LTA ratio with the K_i parameter, the program can automatically pick up the S-wave arrivals.

We applied the above-mentioned method to the K-NET records (3 components at 18 stations) for the Noto Hanto earthquake. The selected S-wave accelerograms are then twice integrated into displacement records with application a 0.1~1.0Hz bandpass filter. We used a depth of 10 km as the source depth and introduced a N58E fault plane (with a dip angle of 66 degrees) with a dimension of 33km (along strike) and 18km (along dip). The fault plane is divided into 3km by 2km sub-faults. The synthetic waveforms from such a fault model fit well the observation data. Our waveform inversion results showed that rupture started at the deep portion and propagated landward to the shallow part with duration of about 10 seconds. The maximum slip (2.8m) is observed in the shallow portion. The total amount of the seismic moment is $1.2E19Nm$.

In conclusions, we aimed at automatic inversion and developed a program to automatically pick up the S-wave arrivals. We constructed a kinematic fault model, which well explained the observation data. However, we would point out that real-time waveform inversions could not be practical unless we had right hypocenter information, right fault plane information, and, especially, a right velocity structure model.