S069-P002 Time: May 29 17:15-18:45

Source model of Off Miyagi Earthquake of November 3, 2002, estimated from strong motion records

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Introduction

Because of its location on convergent plate boundary, Japan has been hit by many earthquakes. Especially, interplate earthquakes have repeated in relatively short period and caused severe damage to a large area. Many researches on rupture process of interplate earthquakes have been done mainly from tele-seismic and tsunami data. However, there are few studies using strong motion data. In this study, we estimated source model of earthquake which occurred in the East Off of Miyagi Prefecture in November 3, 2002, from strong motion records, in order to know minute source process of an interplate earthquake.

Method

We simulate strong ground motions using the empirical Green's function method proposed by Irikura (1986), and compared observed and simulated waveforms. We are assuming that strong ground motion is mainly generated from the area called Strong Motion Generation Area (SMGA), which includes the hypocenter. The rupture is assumed to start from the hypocenter and propagate radially with Vr=3.0 km/s, which is about 70% of S wave velocity in the source area. Our model parameters are the size (length and width), rupture starting point, and the rise time of SMGA. Records of an MJ=4.7 aftershock are used as an empirical Green's function. Because the distribution of aftershocks implies that the fault plane of the mainshock is thought to have a low dipping angle toward to the west, we choose the nodal plane of focal mechanism with the lower dipping angle as the fault plane. We use records of eight K-NET and KiK-net stations whose epicentral distance is within 85 km. Two parameters needed for synthesis, N, an integer number for division of SMGA into subfaults and C, ratio of stress drop of large and small earthquakes, are determined from ratio of seismic moment of two earthquakes and that of amplitude spectra of two earthquakes in the high frequency range. We use N=5 and C=2.0. Target waveforms are two-horizontal components of 0.3-10 Hz bandpass-filtered seismograms for ten seconds from two seconds before the arrival of S wave onset. The best model is obtained from the minimum residual between envelopes of observed and simulated acceleration waveforms. We also check the matching between observed and simulated displacements.

Result

We got good simulation results when we chose 4.8 km for the length, 2.8 km for the width, 0.15 seconds for the rise time, and the second deepest subfault of north side for rupture initiation point of SMGA. We found that there were few aftershocks in the SMGA. If we regard the obtained SMGA as an asperity, we could define asperity size ratio as area of SMGA divided by the expected area estimated from scaling relation between seismic moment and asperity size derived from inland earthquakes (Somerville et al., 1999). Asperity size ratio for this earthquake is about 0.2. It is pointed out on intraplate earthquakes (depth is up to about 100 km) that asperity size ratio depends on depth (Asano et al., 2002). Asperity size ratio we got here is a little smaller than that for intraplate earthquakes at the same depth estimated from Asano et al. (2002), which is 0.4-0.5. Depth dependency of asperity size ratio is quite important for constructing the characterized source model for strong motion prediction by scenario earthquakes. However, discussions on not only depth dependency but also regional characteristics will be needed with analyzing other events.

We used seismograms by K-NET and KiK-net, focal mechanism solution by F-net and information of hypocenter by JMA. We are grateful for these data.