Source process of the 2005 west off Fukuoka prefecture earthquake (M7.0) derived from regional strong motion data

Ryou Honda[1]; Haruko Sekiguchi[2]; Shin Aoi[3]; Nobuyuki Morikawa[3]; Takashi Kunugi[3]; Hiroyuki Fujiwara[3]

[1] Hot Springs Res. Inst. ; [2] AIST; [3] NIED

We infer the source process of the 2005 west off Fukuoka prefecture earthquake (M7.0) by inverting the regional strong motion waveforms obtained by K-NET and KiK-net (NIED).

* Fault plane model and parameterization of source process:

The geometrical setting of the fault plane model is assumed based on the mainshock hypocenter location (33.7402N, 130.1722E, 9.84km) and the aftershock distribution in 24 hours after the mainshock manually determined using Hi-net(NIED) data, and the moment tensor solution (strike: 306., dip: 87., rake: 17.) determined by F-net (NIED) data. The area of the fault plane model is 40 km long and 20 km wide.

The slip spatio-temporal distribution on the fault plane is represented by a set of element sources discretized in space and in time. The fault plane is divided into 200 of 2 x 2 km**2 subfautls located at 2 km intervals in strike and dipping directions. The slip at any point on the fault plane represented by successively activated six smoothed ramp functions, each of which have a unit duration of 1.0 s at 0.5 s intervals. First time window at each subfault is at R/Vt s (R: distance between the subfault and the hypocenter, Vt : velocity to trigger the first time windows) after the origin time. Theoretical waveform of contribution from each subfault is calculated by the discrete wavenumber method (Bouchon, 1981) an the R/T matrix method (Kennett, 1983) with the stratified medium model by Ukawa et al. (1984). Moving dislocation effect is also introduced in the calculation of subfault waveforms.

* Data

We select 9 stations in 20 - 80 km hypocenter distance from K-NET and KiK-net. The acceleration waveforms are bandpass filtered between 0.1 - 1.0 Hz and integrated into velocity. We used S-wave portion (from 1 s before the S-wave onset to 14 s after) in the waveform inversion.

* Waveform inversion analysis

We use the multi-time -window linear waveform inversion procedure (e.g., Hartzell and Heaton, 1983)

Rake variation constraint and smoothing constraint are assigned in inverting the waveforms. Rake angles are constrained within 17 + - 45 deg. Strength of smoothing is evaluated by ABIC (Akaike, 1980). Different values of the velocity to trigger the first time windows are tested and the value which give smallest residuals is selected.

* Results

The rupture mainly extended from the hypocenter to shallower and to the southeast, i.e., in the direction toward Fukuoka city. Largest asperity appeared to the southeast of the hypocenter, at about 2 - 10 km below the Genkai Island, where many severe damages were reported. The Genkai island was close to the largest asperity and may have been hit by the forward directivity pulse of the largest asperity. Time progression of the rupture shows that the rupture initiated at relatively low level (radiating low level of energy) and at about 3 s later developed into high level on the largest asperity. This feature explains the observations at many stations in which the signal starts at low amplitudes for the first few seconds and then drastically enlarged. This phenomena (initial rupture to main rupture) has been reported for other earthquakes, e.g., 2000 Western Tottori earthquake.

Total moment of the source model was 1.4 x 10**19 Nm; (Mw = 6.7). Large slip area overlaps with the dense aftershock area. The velocity to trigger the first time windows which caused minimum residual was 2.6 km/s, about 70 % of Vs in the source region.