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Characteristics of the 2011 Tohoku-oki earthquake revealed by the seismograph networks operated by NIED

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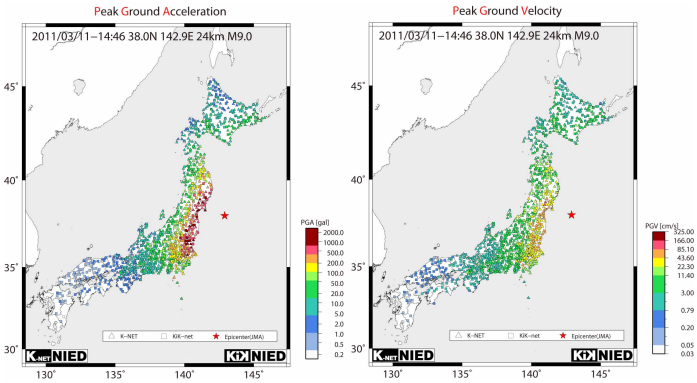
An Mw 9.0 megathrust earthquake attacked the Tohoku region of March 11, 2011 and strong shaking (MMI>10) was observed in a wide area across East Japan. This earthquake is the first M9-class earthquake that is closely recorded by dense seismograph network. In this paper we describe the characteristics of the earthquake observed by the seismograph network (K-NET, KiK-net, Hi-net and F-net) which are managed by the National Research Institute for Earth Science and Disaster Prevention (NIED).

The earthquake was recorded by nearly 1200 K-NET and KiK-net stations with peak ground accelerations of 2933 gal and more than 1g at 20 stations. The waveforms ordered by latitude from north reveal a very complex source process; An initial strong phase originating near the hypocenter is clearly observed. A subsequent seismic phase uniformly delayed by approximately 40 s suggests a second event at nearly the same location. A later seismic phase is strongly observed to the south 100 s after the first phase. This phase suggests that a third strong event took place of shore of Fukushima-Ibaraki. The rupture of an asperity at this location would be in agreement with the strong shaking observed in this region.

Applying a multi-line linear waveform inversion method to the 33 strong-motion waveforms, we obtained a moment magnitude of 9.0 and a peak slip of 33m. The estimated model has one large slip area which extends from the area near the hypocenter to the shallow part of the fault plane, located far off the coast of Miyagi prefecture. The estimated slip time functions at the largely slipped area have two peaks and these peaks are corresponding to the two remarkable phases observed on the record. Though aftershocks having various types of focal mechanisms are widely distributed from off Iwate to off Chiba, few interplate aftershocks with thrust focal mechanisms occurred within the large slip area but occurred in its surroundings.



Keywords: 2011 Tohoku-oki earthquake, megathrust earthquake, K-NET, KiK-net, Hi-net, F-net