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Direct observation of rupture propagation during the 2011 off the Pacific coast of Tohoku earthquake using a small array

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A great earthquake of Mw 9.0 took place on March 11, 2011 at the plate boundary between the Pacific plate and the North-American plate off the coast of Tohoku and Kanto region, Northeast Honshu, Japan. Strong ground motions from the earthquake were recorded at 4 stations of a small seismic array, which is located at about 120km to the westward north west of the epicenter. The seismometers of the array are deployed with an aperture of about 500m, and a seismogram at a station is correlated well to those at the other stations in frequencies lower than 2 Hz. Two prominent bursts and at least two following smaller bursts can be identified on the strong-motion records which lasted for longer than 200s. Peak ground acceleration exceeds the full scale of a seismometer of 2 *g* on the horizontal components, and is larger than 1 *g* even on the vertical component. We perform semblance analysis to estimate rupture propagation during the earthquake using coherent seismograms in frequencies of 0.5-2Hz. According to the results, the rupture during the earthquake seems to consist of at least four stages. Rupture propagated to the north or northwest from the epicenter in the beginning 50s forming the first burst, then proceeded to the southwest from around the epicenter in the next 50s during the second burst. The rupture farther extended southwestward in the following 40s, and finally migrated to the south for about 30s. This is a *direct* observation of rupture propagation during the earthquake, because no assumptions are made on the earthquake source process. Projecting the rupture propagation to a linear fault, we have estimated apparent rupture velocity to be about 2km/s on average for the initial 100s of the rupture.

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Keywords: The 2011 off the Pacific coast of Tohoku earthquake, rupture propagation, array, semblance