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The characteristics of the surface wave propagation for the 2011 off the Pacific coast of Tohoku earthquake

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In the past decade or so, very dense arrays of strong ground-motion instruments such as the K-NET and the KiK-net have been developed across Japan by the NIED. These networks enable us to visualize the behavior of the seismic wave propagation from large earthquakes. Furumura et al. (2003) examined the seismic radiation and regional propagation characteristics during the 2000 Tottori-ken seibu earthquake (Mw6.6) by means of visualization of wave propagation using data recorded at the K-NET and KiK-net stations. Recovering broadband seismograms from short-period seismograms for the Hi-net data, Maeda et al. (2011) visualized the surface wave propagation for the 2007 Sumatra earthquake. They took into account not only amplitude information but phase information, and found the interference of two surface waves incoming from slightly different arrival directions. The visualization of wave propagation with phase information may have a great potential for revealing the details of wave propagation. In this study, we tried to visualize surface wave propagation with phase information for the 2011 off the Pacific coast of Tohoku earthquake. We used the acceleration waveform data recorded at 525 stations of the K-NET and 628 surface stations of the KiK-net. Considering the mean interval of these stations, we applied a bandpass filter from 0.05 Hz to 0.1 Hz to seismograms and integrated them into velocity waveforms. Then, we made snapshots every one second for each component, and combined them into animation. It was confirmed that some large wave packets concentrically propagated.

In time traces, wave packets with their maximum amplitudes propagated at an apparent group velocity around 3 km/s, which is equivalent to surface wave velocities for such a frequency band. These wave packets were radiated from the source region at ˜50 s after the initial rupture, which implies that they were surface waves produced at the second large wave source. Focusing on the wave packets, we found a tear of a surface wave on snapshots at Tohoku region. In order to reveal the cause of this tear, we examined their particle motions. Before making particle motions, we corrected the installation azimuth of accelerographs when needed. From the particle motions, it was revealed that transverse components were predominant in the northeastern area to the tear, whereas radial components were predominant in the southwestern area. Hence, Love wave should be predominant in the northeastern area, and Rayleigh wave in the southwestern area. This result is consistent with theoretical radiation pattern of Love wave and Rayleigh wave (Lay and Wallace, 2002).

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Keywords: surface wave, visualization, the 2011 off the Pacific coast of Tohoku earthquake, radiation pattern