震源の破壊過程と波数分散性を考慮した2011年東北津波の数値計算

Simulation of the 2011 Tohoku earthquake including rupture process of seafloor motion and wave dispersion

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The 2011 Tohoku earthquake tsunami gave us a lot of physical data to study the generation process of mega-tsunami. After this event, tsunami scientists tried to make an initial tsunami source model by using tsunami waveform inversion analysis, so that some of models are used for the tsunami damage estimation in practice. Although a number of seismic source models also have been derived by seismologists by using geodetic data, teleseismic data and strong motion data, few studies used their models for the tsunami simulation. It is generally believed that fault models, which are determined by the tsunami inversion analysis and by the seismic inversion analysis, do not correspond with each other, however a series of phenomena such as earthquakes and tsunamis should be expressed as a single model. In this study, we conducted a numerical simulation of the 2011 Tohoku tsunami using the seismic source model, and discuss an importance of considering rupture processes of seafloor motion and wave dispersion effects of tsunami propagation.
In order to describe tsunami generation from detailed seafloor deformation, we adopted the seismic source model by Yagi and Fukahata (2011), which is estimated the rupture process from teleseismic P-wave data using the newly inverse method that takes into account the uncertainty of the Green’s function. This model provides rupture velocity and rise time to prescribe kinematic seafloor deformation with the planar fault model of Mansinha and Smylie (1971). Tsunami waves are computed using the dispersion potential model (Shigihara and Fujima, 2014), which is based on the staggered leap-frog implicit scheme; dispersive terms in the equation of motion is solved separately. The grid nesting method that we newly developed for the dispersion potential model are used for the bathymetry dataset with three levels of grid resolution (1350m, 450m and 150 m). The computed results were compared to the time history of the sea surface elevation observed at GPS buoys where are located along off the Sanriku coast. Considering the rupture velocity and the rise time makes the tsunami generation process slowly, and contributes the reproducibility of overall wave profiles. In addition, the wave dispersion effects on decrease of the leading wave height. The computed results agree well with observation, we found that both of the physical processes, that is the rupture process of the seafloor and the dispersion effect, must be considered if we want to simulate tsunami propagation using the seismic source model precisely.

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