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The roles of dispersion and nonlinear effects in the 2001 Tohoku-Oki earthquake tsunami

SAITO, Tatsuhiko[1*] ; INAZU, Daisuke[1]

[1]National Research Institute for Earth Science and Disaster Prevention

The present study aims to reveal the roles of the dispersion and the nonlinear effects in the 2011 Tohoku-Oki earthquake tsunami. Tsunami simulations were conducted based on the nonlinear dispersive equations with a high-resolution source model. The result successfully reproduced the waveforms recorded in both near shore and deep sea. The calculated inundation area showed a good coincidence with the actual inundation at the Sendai Plain, the widest inundation area during this event. Conducting sets of simulations using different equations, we obtained the followings insights. Although the dispersion was neglected in most studies, the maximum-amplitude distribution was significantly overestimated in the deep sea if the dispersion was not included. The waveform observed at the station in which the largest tsunami height (>2 m) recorded among deep-ocean stations also verified the necessity of the dispersion. It is well known that the nonlinear effects play an important role for the tsunami inside bays and harbors. Additionally, the nonlinear effects needed be considered for the accurate modeling of the later waves even at the offshore stations. In particular, including nonlinear terms rather than including the inundation was more important for the precise modeling of the waves reflected from the coast.

Keywords: tsunami, dispersion, nonlinear wave, the 2011 Tohoku-Oki earthquake