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Tsunami inundation modeling of the 2011 Tohoku tsunami using the source estimated from the offshore tsunami records

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As the number of offshore tsunami stations comes up, it is becoming possible to estimate tsunami source in real time by exclusively using offshore tsunami information. The issue we would like to discuss in this study is how accurate is it in terms of coastal tsunami prediction? In order to investigate this, we performed a tsunami inundation modelling of the 2011 Tohoku tsunami and compared with the tsunami field survey. We used the Saito et al. (2011) source model inverted from the offshore tsunami waveforms alone, although it was not a real-time solution, in the numerical simulation. The nonlinear Boussinesq equations were solved for the tsunami propagation because tsunami soliton fission was observed during the 2011 tsunami, which is split short-period waves around tsunami crest caused by combination of wave nonlinearity and dispersion. We also applied a variable nested algorithm which allows the spatial resolution of the study region to be easily increased. The finest grid spacing was set to be 2/9 arcsec (about 5m). The three dimensional shape of buildings and structures from lidar measurements were directly embedded on the digital elevation model to include the effect of them on tsunami inundation. Our dispersive tsunami code (JAGURS) was fully parallelized with MPI and OpenMP libraries so that the large scale dispersive modeling could be implemented within realistic computation time. According to Aida (1978), the geometric mean K and geometric standard deviation k was used to evaluate the reproducibility of the numerical simulation. For our numerical simulation results, the K and k were calculated to be 0.97 and 1.27, respectively. These values satisfy the adequacy criteria for tsunami numerical modeling established by the Japan Society of Civil Engineers (2002) (0.95 $<$K $<$1.05, k $<$1.45). Accordingly, the present study showed the reliability of the tsunami prediction procedure that uses tsunami sources obtained with the offshore tsunami records alone.

Keywords: 2011 Tohoku tsunami, Nonlinear dispersive theory, Simulation