Comparisons between Boussinesq type and numerical error models in far-field dispersive tsunami calculation

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We should consider frequency dispersion for the calculation of far-field tsunami. To take the dispersion effect into account in numerical simulation, Boussinesq (dispersion) term is often added to the shallow water equations. Solving the dispersion term requires an implicit method with high computational cost. On the other hand, a numerical error model also simulates the dispersion phenomena treating discretization error in the difference equations as the physical dispersion term so that the implicit method is not needed. However, the numerical error model determines grid interval and time step to be term of the discretization error corresponding the physical dispersion term. For far-field tsunami, optimized grid interval is about 5arc-min which would be too coarse to investigate the detail nature of dispersion. In this study, we compared tsunami waveforms calculated by the Boussinesq type model and ones by the numerical error model to discuss prediction accuracy and computational efficiency. For the calculation using the Boussinesq type model, the grid interval was set to be 0.5 arc-min to suppress the discretization error. For the numerical error model, the grid interval of 5 arc-min was used to match the discretization error to the physical dispersion. We calculated tsunami generated by the 2011 Tohoku earthquake for 28 hours. Calculated tsunami waveforms from the two models were compared at DART stations over the Pacific Ocean. The comparisons indicated that there is no significant difference between the tsunami waveforms from the two models for the leading waves. But, at the stations near the earthquake source, the water level of the later waves is greatly different. The Boussinesq type calculation and the numerical dispersion model took about 151 hours and only 18 minutes, respectively, to finish the calculation.

Keywords: far-field tsunami, dispersion

