

# Comparison of approximate numerical models of tsunami

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In almost of all the numerical simulations of tsunami propagation, the long wave, or shallow water approximation (and often linear approximation) is used, because the tsunami wave is generally much longer than the ocean depth, and because the non-hydrostatic fluid equation, i.e., Navier-Stokes equation, is difficult to solve. However these approximations may not be available for tsunami wave propagating on complex sea topography, being generated at source point of tsunami and going up shore line, where short wave components can not be ignored.

In this study, we develop numerical code for tsunami, in which the oblique coordinate system is used to simplify the treatment of the boundary conditions, and compare four approximate equations of tsunami, i.e., liner long-wave, non-linear long-wave, multi-layer hydrostatic, and non-hydrostatic models.

Numerical experiments are carried out for following four model cases, in which the height and wave-length of the initial tsunami wave and the friction of sea floor are different.

(1) In the case that the initial tsunami wave-length and height is 50 and 0.01 times larger than the sea depth, respectively, all the approximate models show almost the same results, because the hydrostatic and infinitesimal amplitude approximation is available.

(2) When the initial tsunami wave-length is 5 times larger than the sea depth, wave dispersion can be seen only for non-hydrostatic model. This indicates that the hydrostatic approximation is not applicable, if the wave length is short.

(3) If the initial wave has a length of 50 times larger than the ocean depth and the same height of the sea depth, the highest part of the tsunami wave precedes, because its wave speed is faster than the other parts and the shape of the wave packet becomes steep at front and gentle at back. This effect is emphasized by the non-liner models.

(4) If the momentum dissipation by the sea bed friction, different results are obtained for four models. In the single-layer models, especially, the large decrease in wave height is observed.

These results suggest that the non-linearity and non-hydrostatics must be considered for the calculation of the tsunami wave propagation near the shore. When the tsunami having the aseismic origin or generated by the slow earthquake, or propagating on the complex topography, the tsunami wave may be affected strongly by the non-linearity, non-hydrostatics, and sea bed friction. However, the numerical calculation including them take much computer resources and thus the development of the numerical code that has the small computer resources, but high accuracy and speed is necessary, for the progress of tsunami study and the prevention of tsunami hazard.