DISPERSION OF LONG WAVES ON VARYING BATHYMETRY

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Abstract
Coastal dynamics of swell and long waves is important for morphological changes, near shore circulation, wave amplitude, transport of sediments and pollutants, and also comfort of the boats in harbors and bays. There are different models computing near shore behavior of long waves and tsunamis under different input wave and bathymetric and morphological conditions. NAMI DANCE (developed in collaboration with METU, Turkey and Special Bureau of Automation of Research Russian Academy of Sciences, Russia) and FUNWAVE (developed by James T. Kirby et al., University of Delaware) are two of the selected models for simulations of waves, computations of hydrodynamic characteristics of waves such as water velocities and directions. Both models have the capabilities of solving tsunami propagation considering dispersion. As the case studies these models are applied to two different problems for comparisons, tests and generalization.

Problem 1
In one of these problems the simulations are performed in regular shaped flat bottom basins under the specified Gaussian shape input wave condition (Yoon et al., 2007). The basin depth is taken as 500m, 1000m, 1500m, 3000m. The performance of both models has been tested with different grid size and time step using momentum equations with and without dispersion. According to simulations it is found that in the case of using Nonlinear Shallow Water Equations the results are in agreement in both models. However in the case of dispersion the fairly well agreement is when grid size is selected as double of maximum water depth (Fig.1-9) in all figures horizontal axis represents time in minutes and vertical axis represents water level in meters.

Conclusion:
According to simulations it is found that in the case of using Nonlinear Shallow Water Equations (without dispersion) the results are in agreement in both models. However in the case of dispersion the fairly well agreement is obtained (between two models) when grid size is selected as double of maximum water depth. NAMI DANCE dispersion fits well with FUNWAVE Dispersion (either Nwogu, or Wei or Peregrine) if the grid size is selected as double of dxm.

Figures 11-15 present the water surface profile for gauge 4 with water depth of 1500 m and show that the results are in agreement with the conclusion obtained in the first problem, and similarly the results are not so sensitive to the time step. Also in this problem NAMI DANCE results for NSLW and dispersion are very close to each other.

Figures 15 shows the comparison for flat bathymetry h=1500 m with circular submerged shoal for the dx= 3000 m and dt=0.5 sec. Here is also good fitness for NAMI DANCE (NSLW and dispersion) results with FUNWAVE (ibe=1).

In all cases the leading NSLW wave is taller and shifted forward in space in relation to the dispersive solutions.

Figures 2-3 show the simulation results for flat bathymetry with water height of 1500 m and, grid size of 3000 m (twice the height). The comparisons done for NAMI DANCE by momentum equations considering numerical dispersion with FUNWAVE, ibe=1, Nwogu’s (1993) in figure 2 and for NAMI DANCE solving Nonlinear shallow water equations (NSLW) with FUNWAVE (ibe=4), figure 3. The results are compatible. Figures 5 and 6 include similar comparison for h=3000 m and dx=6000 m showing good fit. Figures 6 and 7 contain comparison for h=3000 m and dx=3000 m for time steps 1, 3 and 8 sec showing that the results are not so sensitive to time step.

In figure 8, comparisons are for dx=2086 m and h=500 m due to both equations with and without dispersion considering.

Figure 9 summarizes the comparison result of simulations for dx=2086 m, h=1000 m with NAMI DANCE and FUNWAVE and also the (Yoon et al., 2007, Fig. 7c). There is a good match among the results of models.

Reference:

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