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Effect of Large tidal variation on storm surge in the coast sea of western Korea

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For the storm surge and wave prediction in the coastal region with a very complex topography, the coupling model was developed by applying the two dimensional shallow water equations and the wave model (SWAN). The nested scheme was employed to the model and each domain was simultaneously parallelized by MPI.

Two models are integrated into one coupling model by modifying their two source codes. The wind dependent drag coefficient and the radiation stress are dynamically computed by SWAN with the water surface level and currents. Then, the data of SWAN is transferred to the storm surge prediction model (SSP-Model) which calculates the water surface level and currents using the data transferred from SWAN. The data computed by SSP-Model are also transferred to SWAN. This process is repeated during the computation of the coupling model. The wind and atmospheric pressure are provided to SSP-Model in the coupling model and the only wind is offered to the wave model. The meteorological data is estimated by Fujita model. On open boundaries, the tide was imposed by the tide prediction model which makes the coupling model predict the real tide.

For the storm surge prediction, the characteristic of the topography in the target area is important in the western coastal region which is very complex and has many headlands and islands. In addition, the tidal range has been recorded as up to 10m at the target region. Thus, the high resolution of the computational domain is needed to predict sufficiently accurate storm surge and wave at the coastal region. Therefore, the nested scheme is applied to the coupling model. In this study, the computational regions are nested by four subsequent domains and the coupling model consists of four sub-coupling models which are parallelized by MPI on the Windows platform to reduce the labor effort and the time. In other words, the prediction of the storm surge and wave is simultaneously conducted from the ocean to the coastal region without any pause.

The first computational domain covers the whole Yellow Sea including the Taiwan, the west region of Japan and the East Sea (Japan Sea) to secure the sufficient time and the fetch for the development of waves. The second and third domains cover the intermediate water depth at the western coastal region of Korea. The target region in the fourth domain includes breakwaters, headlands, harbor as well as islands.

In order to investigate the applicability of the coupling model, the hindcast simulation of Typhoon 0603 was carried out. The typhoon hit the southwest of Korea on July 10 in 2006 and passed through the middle of the Korean Peninsula. It disappeared in the East Sea (Japan Sea) on July 11 and remained the property damage of 600,000USD and the life loss and missing of 8 persons in Korea.

The observations of the meteorological data, significant wave height and water level in the fourth domain were available and compared with the result of the computation. In addition, the observations in the first domain were investigated in comparison with the result of the computation. The results showed that the typhoon model did not accurately reproduce the wind speed and direction at Gunsan in the fourth domain, resulting in the overestimated water level indicated by the blue circle (Fig.1). However, the water levels computed in the first domain showed good agreement with the observation when considering the errors of the computed and observed tides (Fig. 2).

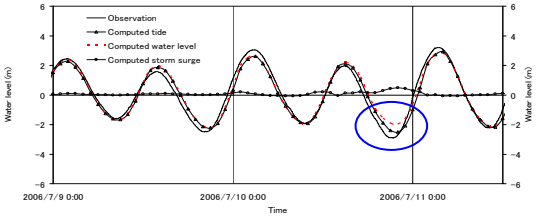

Fig.1 The comparison of water level at Gunsan.

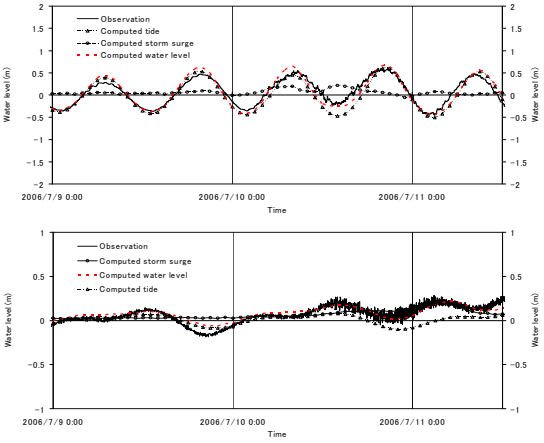

Fig.2 The comparisons of water levels at Pusan (upper) and Sokcho (lower).