Evaluation of SWAN numerical model & SPM method for wave hindcasting

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Abstract
Wave characteristics are one of the most important factors in design of coastal and marine structures. Therefore accurate prediction of wave parameters is very important. The wave hindcasting process is conducted by field measurements, empirical methods or numerical simulations. In this paper the SWAN third-generation spectral model and SPM (Shore Protection Manual) empirical method have been used for prediction of wave parameters. The field data set for Lake Erie of the Great Lakes in year 2002 has been used for evaluation of these methods. The significant wave height (H_s) and the peak wave period (T_p) were the parameters employed in the study. Rectangular grids have been utilized for identification of bathymetry and the SWAN has been executed in nonstationary mode. The exponential growth from wind input, four-wave nonlinear interaction, whitecapping, and bottom friction have been taken in the simulation. The calibration of SWAN was carried out based on wave height because it is more important than wave period. The results of this study show that the average scatter index of SWAN is about 17 percent for significant wave height and 19 percent for peak period, whereas average scatter index of SPM method is about 54 and 36 percent for significant wave height and peak period.

1-INTRODUCTION

In the marine environment the planning of the sustainable development of economic activities requires long term information about environmental conditions such as waves. Accordingly, the knowledge of wind waves statistical characteristics is necessary in a variety of applications including coastal engineering design, studies of sediments transport and coastal erosion and pollution processes. Due to incompleteness of such information in many regions, the wave characteristics should be produced with an appropriate method. Hindcasting process is conducted by numerical models or empirical methods.

Until now different empirical methods have been developed for wave hindcasting such as SMB (Bretschneider, 1970), Wilson (Wilson, 1965), JONSWAP (Hasselmann et al., 1973), Donelan (Donelan, 1980 & Donelan et al., 1985), Shore Protection manual (SPM, 1984) and Coastal Engineering Manual (CEM, 2003). Furthermore in recent years with development of high speed processors several complicated numerical models have been developed for wave prediction. These models are usually phase-averaged spectral wave model that developed in three generations and consist of various physical processes.

SWAN (Booij et al. 1999, Ris et al. 1999) is one of the most widely applied spectral wave models at present in coastal engineering studies and is freely available for both research and consultancy studies. This model specially designed for coastal applications and can be used from laboratory conditions to ocean scale.

Such numerical models are more time consuming than empirical methods and should have more accurate results.

Weiqi Lin. et al (2002) have used the SWAN model for wave simulating in Chesapeake Bay. Their results show that the SWAN model over estimates significant wave height and under estimate peak wave period. In their simulation all of the wave heights have been below than 1 meter. The SWAN model also has been used for simulating typhoon waves in coastal waters of Taiwan (Ou et al., 2002).

The aim of this study is to evaluate the SWAN numerical model and SPM empirical method by comparing their results with field observations. For this purpose the wave records of Lake Erie of the Great Lakes in year 2002 have been used. For evaluation of the model accuracy the