A Numerical Simulation Method of Typhoon Waves

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ABSTRACT.

The Typhoon 9711 (Winnie) affected the East China Sea in 1997. In this paper, the radius of maximum winds is calculated by method of experiential formula (MEF) or method of gale cycle retrieval (MGCR), and the parameter typhoon wind model(PTWM), which is derived from Jelesnianski2 wind formula and Fujita pressure formula(FPF), FPF and the third-generation deep-sea wave model(WAVEWATCH-Ⅲ ) are applied to hindcast the storm waves induced by the typhoon Winnie. The comparisons and analyses between the simulation results and observation data indicate that: during the typhoon Winnie, the distribution of modeled storm-waves in Northwest Pacific Ocean, which is simulated by MEF, is more reasonable. Comparing the significant wave height calculated and measurements in three offshore stations, the error is about 10%, and it shows that MEF is better than MGCR.

KEY WORDS: Radius of maximum winds; typhoon 9711; numerical simulation; typhoon waves; hindcast; WAVEWATCH-Ⅲ.

INTRODUCTION

China with long coastline lies in the west bank of Pacific Ocean which is the most active area of tropical cyclones of the world, therefore the disaster which caused by typhoon is very serious in China. Research has shown that the destructivity of the huge waves caused by typhoon is far greater than that of typhoon itself, and every year the direct economic losses amounted to hundreds of millions of dollars. For example, in China neritic province there were 35 times wave processes in 2004, whose significant wave height were above 4 meters, causing direct economic losses amounting to 207,000,000 Yuan. The U.S. National Oceanic and Atmospheric Administration (NOAA) had established several ocean waves service forecast systems by using WAVEWATCH-Ⅲ and had achieved good results already. The ocean waves service forecast systems include the global forecast system having a resolution ratio of 1.25 longitude×1 latitude, and regional forecast system having a resolution ratio of 0.25 longitude×0.25 latitude and covering Alaska sea area, the Northwest Atlantic, Northeast Pacific and North Atlantic (Wen B and Yu F ,2008).

However, the research in this field is far from the best in China. The study is still limited on partial, small-scale sea, and there are not enough wide-scale models that are general and feasible. At present, the domestic research of simulation of the waves using the WAVEWATCH-Ⅲ wave model is still at the exploratory stage. Qi Yiquan transplanted the third-generation ocean wave model WAVEWATCH-Ⅲ to the South China Sea, and simulated ocean waves field of the South China Sea in 1996(Qi Y, Chu PC, and Shi P ,2003). According to the comparison of the model’s output and the satellite altimeter, simulation results of the wind during the winter are better than the results of the summer. The largest error always appears near the minimum wind speed in summer, because in summer wind field of the South China Sea was less stable than in winter, and the wind direction was poltropic. It indicates that this model has certain limitation in the adaptation of the wind field with changing wind direction and low wind speed. The Macao geophysics and meteorological bureau introduced WAVEWATCH-Ⅲ in 2002 to forecast the ocean waves of sea area near the coast. The results showed that the forth season output was the best (Yuan Y, Lao MM, and Feng RQ,2002), because of stabilization of this wind field and the higher wind speed in the whole year. The forecast result also showed that the wave height was overvalued at high-value, while underestimated at low-value due to the sensitivity of the model reaction on wind. There are also other similar results, such as Guo Yanyou established the East China Sea area wave assimilation system based on WAVEWATCH-Ⅲ using optimum interpolation method, which can assimilate the significant wave height observed by the satellite altimeter (Guo Y, Hou Y,2006). The assimilation experiment of the systems on the significant wave height obtained by the T/P altimeter indicated that, the assimilation of wave data could improve the forecasting result of the entire region. Chen Qingfeng had simulated distribution of the wave characteristic quantity in the Northwest Pacific from October 2000 to December and a strong typhoon- Mindulle in 2004 using WAVEWATCH-Ⅲ in his master's thesis. The simulation results and measured data matched well (Chen QF,2005). In order to make two kind of waves forecast pattern, WAVEWATCH and the SWAN , work...