CORRECTION OF MODELED SEA SURFACE WIND IN ORDER TO IMPROVE WAVE FORECAST

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Abstract

A method for correcting wind input to WAM model is proposed in order to reflect wind gusts, otherwise not present in the atmospheric models output. The method is based on wind field vorticity analysis and does not require any external data. The wave forecast resulting from winds corrected by this method was compared to real data, as well as to forecasts resulting from a different correction technique.

Keywords: wind gusts, WAM model

Introduction

Operational wave forecasting system based on WAM model for the Eastern Mediterranean was implemented in IOLR since fall 1997 [1]. The results of the wave forecast and hindcast produced by the system were compared to true data from Hadera GLOSS station from the beginning of the project.

From the very beginning the comparisons showed that H_s is underestimated and this fault increased with H_s increases. The problem of the wave model underestimating H_s isn't new, it was addressed before, e.g. Cavalieri [2], and it is attributed to negative errors in closed basins. However, it was suggested that during severe storms another factor may influence the H_s growth, namely wind gusts, which, typically, are not represented in the output of meteorological models.

Several methods have been suggested for the introduction of wind gustiness into wave model input. Abdalla and Cavalieri [3] used fluctuations represented by Gaussian process, characterized by coherence in time. Another method proposed adding a constant factor to the wind field. Wave Watch III, as of ver. 1.18 [4] used term dependent on T_{air}-T_W difference to represent atmospheric instability and calculate an effective wind speed.

This paper proposes a new method, based on the assumption that most severe wind gusts occur during the passage of atmospheric fronts, and are indicated by significant changes in the wind direction.

Methods and materials

Hess [5] defines an atmospheric front as zone of rapid transition from one temperature to another. It also noted that significant wind direction changes occur in frontal zones. The frontal zones are characterized by strong atmospheric instabilities, often resulting in severe weather, and are usually accompanied by strong wind gusts.

The quantitative characteristic of vector field direction change is its curl, which leaded to defining "gustiness" of the wind field as

$$G=\left[\frac{\partial(\vec{\nabla}\times\vec{U}_{10})}{\partial U_X}+\frac{\partial(\vec{\nabla}\times\vec{U}_{10})}{\partial U_Y}\right]\cdot\left|\vec{U}_{10}\right|$$

The actual correction was calculated using measured data at Hadera GLOSS station, and resulted in $G_{corr} = 0.399 * Ln(G) + 0.65$

Results and discussion

Two sources of wind input were used during the verification of the method: the SKIRON forecasting system from University of Athens (output every 6 hours, 0.2x0.2° resolution); and the Bracknell model by UKMO (output every 6 hours, 0.833x0.566° resolution). Both T_{air}-T_W and wind vorticity correction techniques were applied and the results were compared to the measured data. The immediate result of the comparisons revealed that the impact of both methods on low resolution wind was insignificant, so that only SKIRON wind was utilized subsequently.

On the synoptic map three frontal zones are clearly visible: a hot one and two cold ones. Predictably dT derived correction is very small in the hot frontal zone, while the vorticity derived correction produces significant values. The correction based on vorticity also increased near the shores, where wind changes its direction.

Another comparison was carried out by using the WAM model for the Levantine basin to produce wave hindcast with wind input corrected by various methods. The results were compared to data measured at Hadera GLOSS station. It is clear that both methods improve the forecasts significantly, when compared to forecasts produced with uncorrected wind input. The preliminary studies confirm that both methods produce similar results, while vorticity derived technique requires less data.

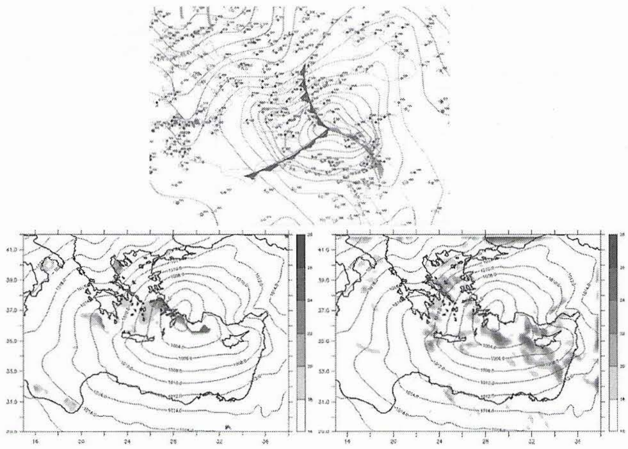

Fig. 1. Frontal zone wind correction, calculated by different methods during severe storm. Top : synoptic map; bottom left : dT derived correction; bottom right : vorcity derived correction.

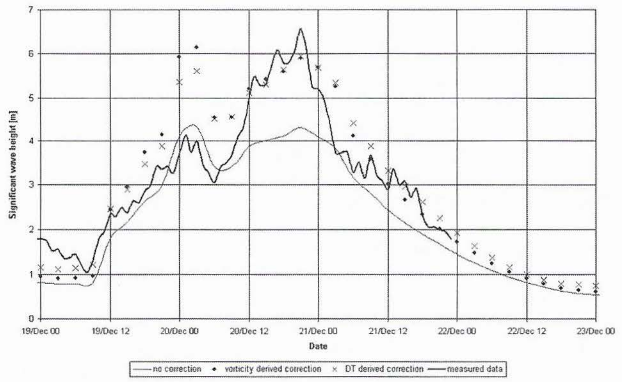

Fig. 2. Comparison of significant wave height with wind input produced by different methods.

Acknowledgments

We want to thank sincerely to Prof. G. Kallos from SKIRON group for providing us with wind data for this work.

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