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ERROR PREDICTION AND CORRECTION OF THE SIMULATED WAVE DATA AT THE PERSIAN GULF FOR DIFFERENT CLIMATIC CONDITIONS

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Introduction

Due to the lack of wave measured data, predicted wave data are used to determine wave climate in many regions. Nowadays spectral wind wave model are the most practical tool for wave prediction. Since the outputs of these models generally contain some errors, their results should modify based on the measured data. In this study, a new approach based on the error prediction of simulated wave data at the observing stations and distributing the errors in the computational domain was implemented for updating of the model outputs. To do so, wave simulation was carried out over the Persian Gulf and the results were compared with the measured data. The results are presented in the next section. It should be noted that this paper contains the results of a defined study at the Transportation Research Institute namely "developing a hybrid model for wind-wave prediction in the Persian Gulf".

Results and discussion

The third generation SWAN model [1] was employed for wind wave simulation over the Persian Gulf. The model was forced by the ECMWF Operational wind data with 0.5 degree spatial resolution. Wave simulation was carried out in the spherical coordinate system. The wave measured data at Bushehr station were employed for assessment of the results and error prediction approach. Fig. 1 depicts time series of the measured and simulated wave height and period by the default and calibrated coefficient. It should be noted that the whitecapping dissipation coefficient was used to calibrate the model.

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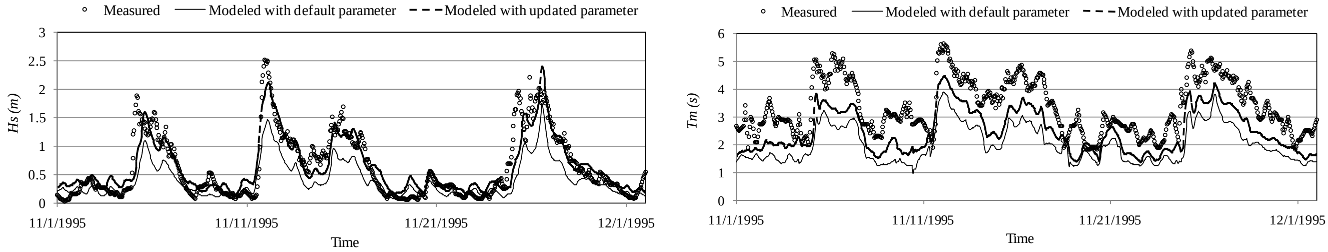

Fig. 1) Time series of the measured and simulated wave height and period by the default and calibrated coefficient

As seen, calibrating of the model parameter leads to greater consistency between modeled and measured H_s especially in case of high waves at Bushehr station. In addition, low waves (less than approximately 40 cm) are generally overestimated. It should be noted that the wave periods are still underestimated after calibrating of the model parameter based on the modeled wave height. Therefore, error prediction approach is considered for further improvement in the results. If the X be the wave parameter (H_s or T_m), then the error of the wave prediction can be defined as:

$$E_{modeled} = X_{measured} - X_{modeled} \quad (1)$$

where $X_{modeled}$ is the simulated wave parameter and $X_{measured}$ is the corresponding measured value. If $E_{modeled}$ can be estimated by an appropriate method, then the modified wave parameter ($X_{modified}$) can be obtained by the following equation.

$$X_{modified} = X_{modeled} + E_{predited} \quad (2)$$

where $E_{predicted}$ is the estimated error of the wave parameter prediction which is estimated by artificial neural networks (ANN). The best inputs for the error prediction networks of the H_s are the mean wind speed, mean wind direction, wind duration and the modeled H_s. For the error prediction network of the T_m, the modeled wave height was replaced with the modeled wave period. Fig. 2 illustrates time series of the updated wave parameters using ANN against the measurements at Bushehr station.

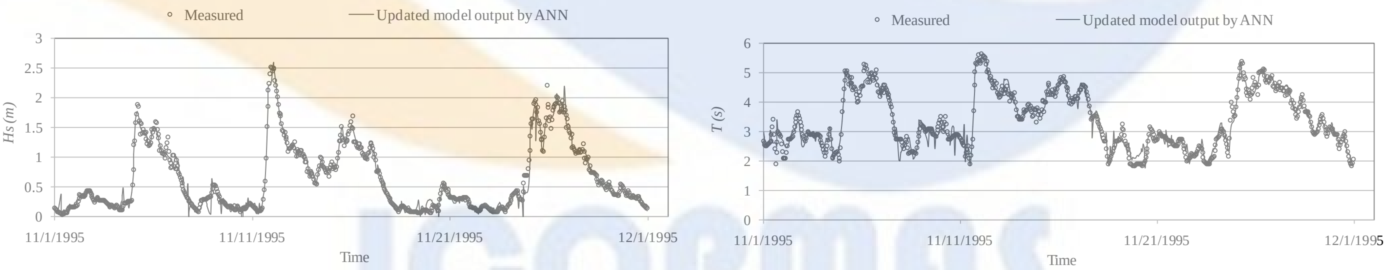

Fig. 2) Time series of the measured and updated wave height and at Bushehr station

Compared to Fig. 1, it can be seen that the results of error prediction combined with the SWAN output have a great consistency with the measured values. Contrary to coefficient calibration, all ranges of the wave parameters are improved. In other words, the employed assimilation approach appropriately covers the error sources of the simulation and results in the improvement in a wider range of output parameters. In addition, both the wave height and period are accurately predicted. After error prediction at the observation stations, this error is distributed over the computational domain and the simulated wave parameters are improved in the other grid points. The results of this stage also show the improvement of the results in the domain. More details can be found in the prepared reports at the Transportation Research Institute [2].

Conclusion

The results of this study showed that combination of the numerical simulation of the wind waves and error prediction leads to improvement of the wave prediction results. Using this approach, both the wave heights and periods are accurately predicted. In addition, a wider range of the wave parameters are modified. In the developed approach, the different wave climate conditions that have different behavior are distinguished in the error prediction step.

References

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