Implementation and validation of a wave forecasting system for the Portuguese Coast

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Abstract

This work describes the implementation and validation of a wave forecasting system for the Portuguese Coast based on the WAVEWATCH III (WWIII) model. The wave forecasting system was implemented following a downscaling approach (multi-grid) and was validated by using wave buoys data.

Keywords: modelling, waves, downscaling, validation, forecasting

1. Introduction

The MARETEC wave forecasting system for the North Atlantic and Portuguese Coast based on the WAVEWATCH III (WWIII) model was updated to the released version 3.14 with the development of new operational tools. The system's main aims are to provide wave forecasting results to assist in the management of wave energy devices, verify appropriate conditions and best locations to deploy floating barriers to contain oil spills, force local high resolution wave models and assess the sediment transport on the coast, through the coupling with hydrodynamic models.

2. Methodology

The system was implemented following a downscaling approach (multi-grid) to properly represent the propagation of waves generated in the North Atlantic into the regional and local higher resolution domains (Fig.1). The grid resolutions range from approximately 0.5° x 0.5° in the North Atlantic domain to 0.05° x 0.05° in the Portuguese Coast domain. The wind forcing is provided by the Global Forecast System (GFS), from the National Oceanic and Atmospheric Administration (NOAA), with a spatial resolution of 0.5° x 0.5°.

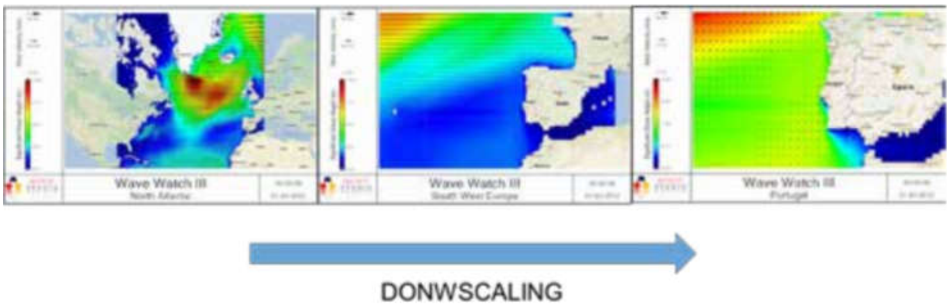

Figure 1 Nesting from the North Atlantic domain to the Portuguese Coast domain

3. Operational Tools

The standard input/output format of spatial data sets used by MARETEC is the Hierarchical Data Format (HDF5), which makes possible the management of extremely large and complex data collections. A tool was developed to convert HDF5 files into WWIII input format (HDF5_to_WWIII). This tool allows forcing WWIII with wind results from different meteorological models (GFS, MM5, WRF) already used by MARETEC to force MOHID modelling system applications. Therefore, currents and water level simulated by MOHID can be converted with the same tool in WWIII format and used as input for the wave simulations. On the other hand, WWIII wave results can be considered in the MOHID applications by using another tool to convert WWIII output format to HDF5 (WWIII_to_HDF5).

3.1 Automatic Running Tool

In order to run WWIII automatically and in operational mode, the Automatic Running Tool (ART) previously developed to allow automatic simulations of MOHID applications was adapted for the operational wave forecasting system. The daily forecast of waves is currently published online at http://forecast.maretec.org/.

4. Validation

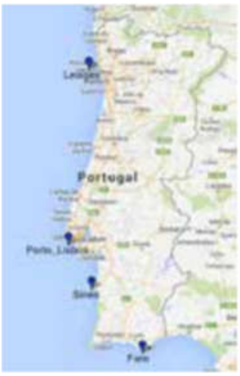

Figure 1 Location of the wave buoys

The wave modelling system was validated on the Portuguese Coast for the entire year of 2012 by using data of wave buoys presented in Fig.2 (Leixões, Lisbon, Sines, Faro). The analysed wave parameters were: significant wave height (Fig.3), mean wave period (Fig.4) and mean wave direction (Fig.5). Statistics are shown in tables I, II and III.

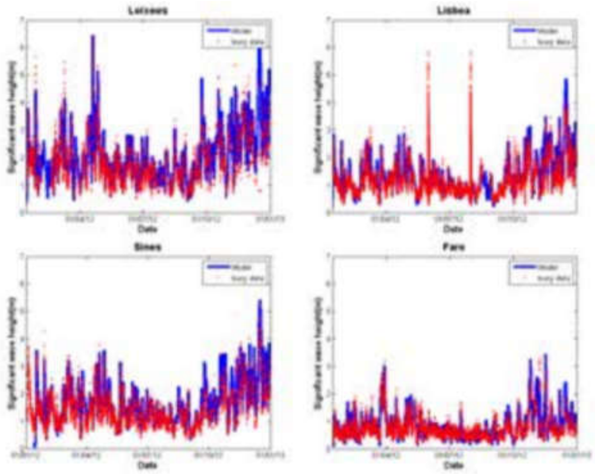

Figure 3 Time series of significant wave height

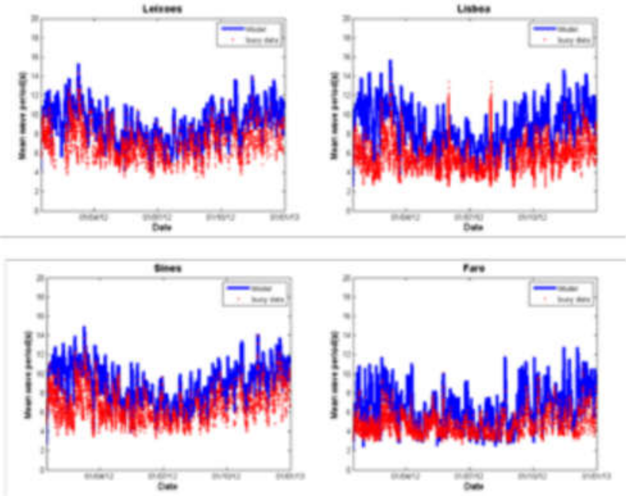

Figure 4 Time series of mean wave period

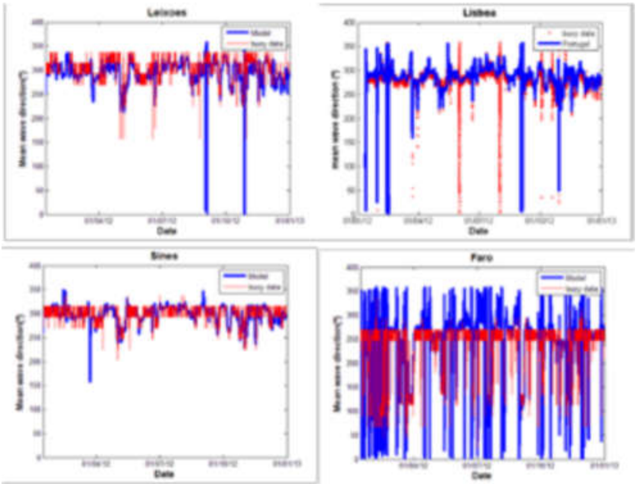

Figure 5 Time series of mean wave direction

	Pearson	RMSE	Bias
Leixões	0.93	0.39	0.18
Lisboa	0.92	0.29	0.10
Sines	0.93	0.34	0.17
Faro	0.88	0.23	0.05

Table I Statistics for significant wave height

	Pearson	RMSE	Bias
Leixões	0.82	2.23	2.00
Lisboa	0.70	3.44	3.05
Sines	0.76	2.74	2.38
Faro	0.62	2.16	1.40

Table II Statistics for mean wave period

	Pearson	RMSE	Bias
Leixões	0.64	24.4	-9.41
Lisboa	0.47	30.00	3.80
Sines	0.68	14.17	-2.07
Faro	0.59	68.30	3.52

Table III Statistics for mean wave direction

The wave forecasting system results showed a good agreement with data. However, the results can be improved locally with the nesting of higher grid resolution domains, especially for the wave direction obtained in Faro. The consideration of currents and water level in these domains may also improve the results. Furthermore, a better spectral resolution will be tested, with 50 frequencies instead of 25 and 36 directions instead of 24 used in this study.

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