An integrated forecasting system of hydro-biogeochemical and waves in the Tagus estuary

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Abstract

This work describes an integrated forecasting system of hydro-biogeochemical and waves in the Tagus estuary (Portugal). The wave model is based on the WAVEWATCH III (WWIII), while the hydro-biogeochemical model is based on the MOHID modelling system. The integrated forecasting system is running operationally and providing online daily forecast results of hydrodynamics, waves, and water quality (http://forecast.maretec.org/).

Keywords: modelling, hydrodynamic, biogeochemical, waves, forecasting

1. INTRODUCTION

This work describes the implementation of an integrated forecasting system for the Tagus estuary (Portugal), coupling a hydro-biogeochemical with a wave model. The wave model has the physics appropriate to shallow waters, as well as to current-wave interactions. In coastal waters, currents can become important to the growth and decay of waves. Thus, the hydro-biogeochemical model provides currents and water levels to the wave model. On the other hand, the wave model provides wave parameters to the hydro-biogeochemical model. The wave action contributes to increase the bottom shear stress and can be important to the erosion of sediments. The waves can reach different parts of the intertidal zone of the Tagus estuary depending on the tidal cycle, remobilizing the sediments trapped in low velocities areas (Franz et al., 2014a). The turbidity caused by suspended sediments reduces light penetration in the water, affecting photosynthesis and food availability.

2. Model Setup

2.1 Atmospheric Boundary Conditions

The atmospheric forcing for the Tagus Estuary modelling system is provided by the Weather Research and Forecasting (WRF) model, from IST meteorological team (http://meteo.ist.utl.pt/), with a spatial resolution of 3 km x 3 km.

2.2 Wave model

Following the approach of the operational wave modelling forecasting system for the Portuguese Coast, previously implemented by the MARETEC research group, the Tagus estuary wave model is based on the WAVEWATCH III (WWIII). The latest version 4.18 was selected (released by NOAA in March, 2014), which considers an additional important physical process for shallow waters (triad wave-wave interactions). The spectral domain has been divided into 50 frequency (range of 0.035–0.963) and 36 directional bins (directional resolution of 10º).

The open boundary conditions for the wave model have been provided by the operational wave forecasting system for the Portuguese Coast, which has a grid resolution of 5 km x 5 km. An intermediate domain was created for the central zone of Portugal with a grid resolution of 1 km x 1 km. For the Tagus estuary the grid resolution is 200 m x 200 m (Fig.1). To avoid numerical instabilities, the resolution between the father and son grids were improved at most five times.

2.3 Hydro-biogeochemical model

The hydro-biogeochemical model is based on the MOHID water modelling system. The vertical discretization of the hydro-biogeochemical model consists of 14 Cartesian layers overlapped by 7 Sigma layers, with a vertical resolution close to 1 m at the water surface. More details about model setup and validation can be found in Franz et al. (2014b). The open boundary conditions for hydrodynamics and water properties are provided by the Tagus Mouth operational model. The Tagus Mouth model was implemented by the MARETEC research team mainly for the study of the estuary mouth and covers a larger area with a lower resolution (ranging from 2 km to 300 m). This model is also a downscaling of the Portuguese Coast model.

3. Operational System

The integrated forecasting system is running operationally and providing online daily forecast results of hydrodynamics, waves, and water quality (http://forecast.maretec.org/). A scheme of the

system is presented in Fig.2. The hydro-biogeochemical model produces 48h forecasts. Previously, the day before is run with the best ocean and atmospheric conditions, and flow measurements from the hydrometric station of Almourol (http://snirh.apambiente.pt), located in the Tagus river. The hydro-biogeochemical model provides water level and currents for the wave model that currently produces 24h forecasts. In the near future, the wave results will be used by the hydro-biogeochemical operational model for improving the water quality nowcast.

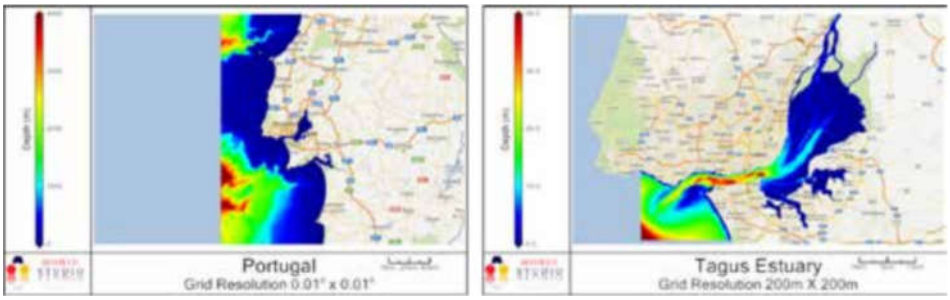

Figure 1 Bathymetry of the Central Portugal and Tagus Estuary domains

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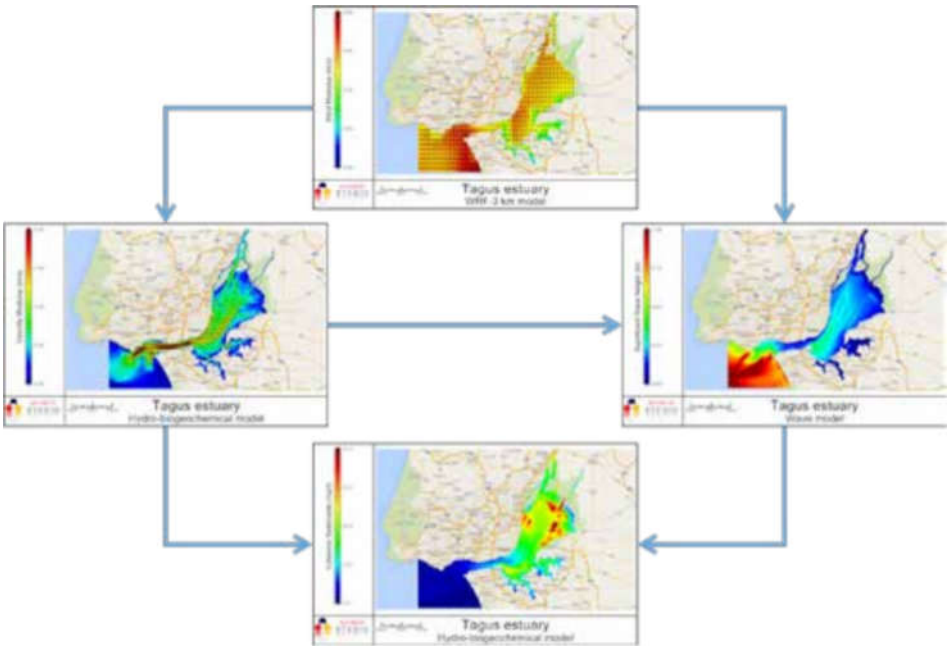

Figure 2 Scheme of the integrated forecasting system

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