

An operational model for the Portuguese coast

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Abstract: An operational model named PCOMS (Portuguese Coast Operational Modelling System) is being used as a forecasting system for the continental Portuguese coast. The PCOMS consists of two nested domains covering the Iberian Atlantic coast and its adjacent ocean. The 3D model is a downscaling of the Mercator-Ocean PSY2V4 North Atlantic solution that runs the MOHID model in full baroclinic mode. The PCOMS is forced with results from meteorological forecast models and water levels from the West Iberia domain as ocean boundary conditions.

A general description of the system and results of model applications will be presented in order to show the modelling system potential. Also several tools for exploitation and visualization of the model results will be described. Presently, the system is already used to provide boundary forcing for local scale model applications via downscaling of the solution.

Key words: Operational model, Portuguese coast, Mohid model

1. INTRODUCTION

Over the last decades, several operational modeling systems have been developed with different level of complexity, objectives and end-users. The development of these systems is responsible for significant scientific and technical achievements related to operational oceanography (Le Traon et al., 2009). Numerical models play an important rule since they provide continuously state estimates and forecasts of coastal and ocean state.

In recent years, operational forecasting systems for the coastal and shelf seas become feasible due to the increasing maturity of numerical models, advances in systematic and real-time monitoring, and progresses in data assimilation techniques and applications (Zhuang et al., 2011). At present, there are increasing requirements for operational forecasting systems in coastal and shelf seas.

The objective of operational forecast is to provide information to deal with marine environment problems and to satisfy needs at different levels from the community. In this perspective, this paper shows the potential contribution that PCOMS results may provide to the public and other end users.

2. PCOMS description

The Portuguese Coast Operational Modelling System for the continental Portuguese coast is a forecast system based on the MOHID model (www.mohid.com). MOHID is an open-source three-dimensional water modelling system, developed by MARETEC (Marine and Environmental Technology Research Center) at Instituto Superior Técnico (IST).

The Portuguese Coast Operational Modelling System is running in full operational mode and produce daily hydrodynamic and ecological results

for the previous day and three days forecast for the Western Iberia Coast.

2.1. Modelling system

The modelling system consists of two nested domains (domain 1 and domain 2) covering the Iberian Atlantic coast and its contiguous ocean (Fig. 1). The domain 1 barotropic model, with a 0.06° resolution, is forced with the FES2004 global tide solution along the ocean boundary. The domain 2 model is forced in the boundary by the domain 1 result.

The domain 2 model is a downscaling of the Mercator-Océan PSY2V4 North Atlantic solution that run the Mohid model in full baroclinic mode with a horizontal resolution of 5.6 km and with 50 vertical levels (43 in Cartesian and 7 in sigma coordinates) with a resolution of down to 1 m near the surface. Temperature and salinity 3D initial conditions are interpolated directly from the Mercator-Océan fields.

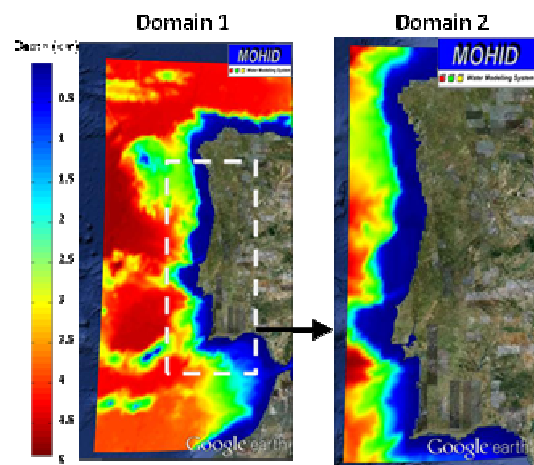


Fig. 1 PCOMS nested domains: domain 1 (Left) and domain 2 (right).

For the atmospheric conditions, the system is one-way coupled offline with the MM5 atmospheric forecast model for the west Iberian coast, running at IST (<http://meteo.ist.utl.pt>). This model provides wind speed, air temperature, mean sea level pressure, surface humidity, cloud cover, downward long wave radiation and solar radiation hourly data with a 9 km spatial resolution.

In order to manage and to automatize the operational procedures, the Maretec-IST developed a software Automatic Running Tool (ART) that preprocess the input files needed by the hydrodynamical-ecological model, execute the model using the Mohid configured files and finally store, graph and distribute the model results via opendap, smartphone and publishing on webpages. At the preprocessing phase, it adapts using different data sources to the model domain i.e. results from atmospheric models MM5 or WRF (Trancoso, 2012), global circulation model results (i.e. Mercator-Ocean), meteorological or flow monitoring stations.

2.2. Validation

Model validation is an essential part of the operational modelling platforms. Operational models validations procedures typically include comparisons with remote sensing data and in situ observations.

PCOMS sea surface temperature (SST) results are daily compared with remote sensing data (Fig. 2) from the ODYSSEA Global SST (<http://ghrsst.jpl.nasa.gov/>). Plots with the difference between model results and remote sensing data are produced and quantitative statistics are calculated to assess model performance. Also comparisons between temperature and salinity profiles and ARGO profiling buoys are performed in a regular basis. For the tidal validation, data from several stations along the Iberian coast is used to validate the model results.

3. MODEL APPLICATIONS

Operational models provide the infrastructure to support marine decision making and also relevant information on the ocean dynamics. PCOMS can address such requirements and is currently used to deal with several problems related with coastal management, marine pollution and safe navigation (Mateus et al., 2012).

PCOMS results can be used as ocean boundary conditions to different local models where a higher model resolution is needed, bringing ocean forecasts to more specific areas. Some of the local model applications are the Ria de Aveiro model to simulate water quality process, the Nazaré and Setubal canyons model to study the sediment dynamics and Mondego estuary model to study the residence time of water in the estuary (Kenov et al., 2012). Other local applications are operational systems nested with PCOMS, such as the Tagus coastal and estuarine area model. In the Tagus case, the solution downscales to smaller domain models to study the effect of local streams on the water quality, to evaluate the impact of a submarine outfall on the water quality and ecological process in the area and as boundary conditions for the Tagus Mouth model (see Campuzano et al., in this volume).

4. MODEL RESULTS EXPLOITATION TOOLS

Several model results exploitation tools using PCOMS outputs are being developed and delivered for the Atlantic Region and for the Portuguese Coast. These interactive tools allow the end-user to exploits the model results. Some of the software tools presently using are described below.

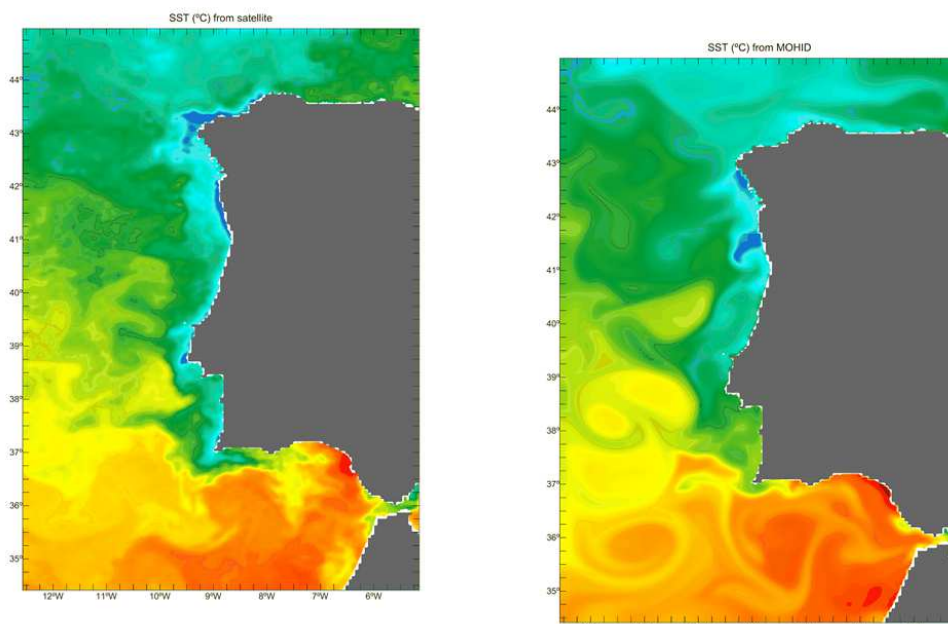


Fig. 2 - SST maps on 7 September 2011 retrieved from remote sensing data (left) and from MOHID model results (right).

4.1. EasyCO web bidirectional tool

This tool is a web-based interface developed in the frame of the EasyCO project (<http://www.project-easy.info/>) and integrates the different systems results for meteo-oceanographic variables (<http://easyco.maretec.org/wbt/>). With this tool the end-user can: a) visualize meteocean forecasts (Fig. 3) for the EasyCO project partners (Atlantic Arc); b) simulate inert spills, floating objects, hydrocarbons and transport of harmful algae blooms; c) simulate fish planktonic stage dynamics (eggs and larvae).

4.2. Mohid Desktop Spill Simulator

Mohid Desktop Spill Simulator is a fast oil and inert spill lagrangian simulator integrating offline meteocean forecasts. Results are generated in seconds, and thus, can be very useful in emergency situations. The numerical model used to simulate spill fate and behaviour is the lagrangian component of MOHID water modelling system. This software was developed in the aim of the ARCOPOL project (<http://www.arcopol.eu/arcopol/>) and can be installed on a pc or laptop (download available at http://arcopol.maretec.org/Tools/SpillSimulator/SpillSimulator_Installer.zip).

4.2. Dynamic risk tool

This system provides coastal pollution risk levels associated to potential (or real) oil spill incidents (http://arcopol.maretec.org/Tools/RiskTool/DynamicRiskTool_Installer.zip). The system takes into account the regional statistic information on vessel accidents and coastal vulnerability indexes (Environmental Sensitivity Index and Socio-Economic Index), the real time vessel information obtained from AIS, the best-available meteocean numerical forecasts and simulated scenarios by the oil spill fate and behaviour component of MOHID water modelling system. This tool was first developed in the frame of the ARCOPOL project and future developments will be made in the scope of the ARCOPOLplus project.

5. CONCLUSIONS AND FUTURE WORK

The Portuguese Coast Operational Modelling System is presently running in full operational mode, producing daily hydrodynamic and ecological results for the Western Iberia Coast. PCOMS results are exported to a web-based information system for real-time dissemination to the public, providing information on the state of the ocean and prediction to all society.

The operational system structure is prepared to be used in an operational environment where products and services can be providing on request, for hindcast or forecast situation.

Although, some model improvements are ongoing, namely the inclusion of the river discharges along the coast and the increase in the model spatial resolution near the coast.

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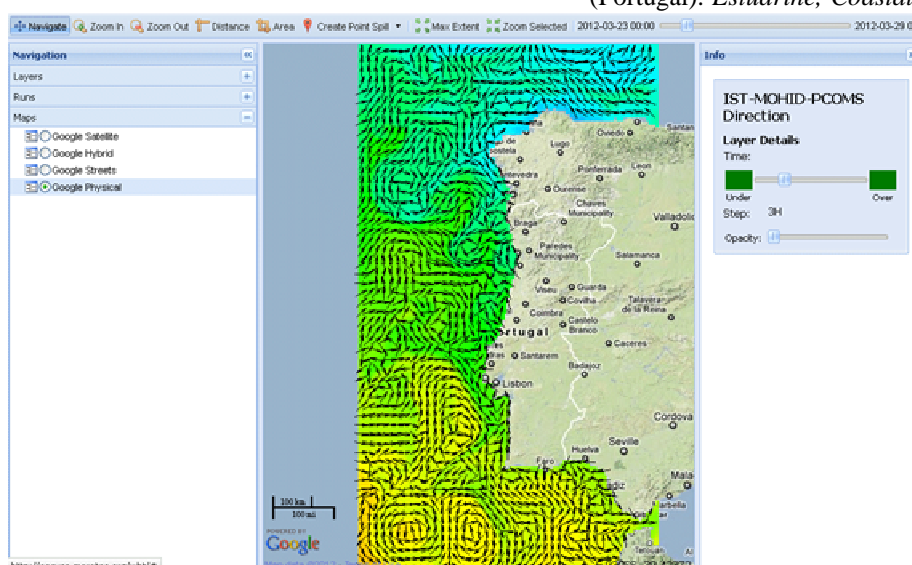


Fig. 3- Example of PCOMS results displayed at the EASYCO web bidirectional tool.

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