ASSESSMENT OF AN OPERATIONAL SYSTEM FOR FORECASTING HYPOXIC EVENTS IN THE EMILIA-ROMAGNA COASTAL AREA (NORTHERN ADRIATIC SEA)

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Abstract

Hypoxic/anoxic events affect quite frequently the northern Adriatic Sea during the warm season, especially the Po delta and the Emilia-Romagna coastal areas of south of it. Such events derive from a combination of physical, chemical and biological processes. A hydrodynamic model with a biogeochemical flux module has been producing daily 72-hour forecasts of the northern Adriatic area since June 2007. Available data have been compared to model forecasts. Computed statistics demonstrated a good model skill in forecasting hydrodynamics of the area, while skill in forecasting dissolved oxygen resulted much lower; the latter has been improved by correcting the forecast for the mean bias computed using buoy measurements of the previous 7 days.

Keywords: Adriatic Sea, Coastal Models, Anoxia, Oxygen, Coastal Waters

Anoxic and hypoxic events are observed quite frequently in the northern Adriatic Sea during the period from late spring until autumn, especially in the Po delta and the Emilia-Romagna coastal areas south of it [1]. Anoxic events are observed also in the Gulf of Trieste and, rarely, in the much wider area between the Po delta and the Istrian Peninsula. Such events negatively affect environmental conditions, fisheries, tourism of the area. In the northern Adriatic Sea, some key factors for development of hypoxic conditions are related to river runoff (influencing phytoplankton bloom, stratification of the water column, light penetration) and coastal inputs, hydrodynamics, atmospheric conditions, reactivity of the seafloor.

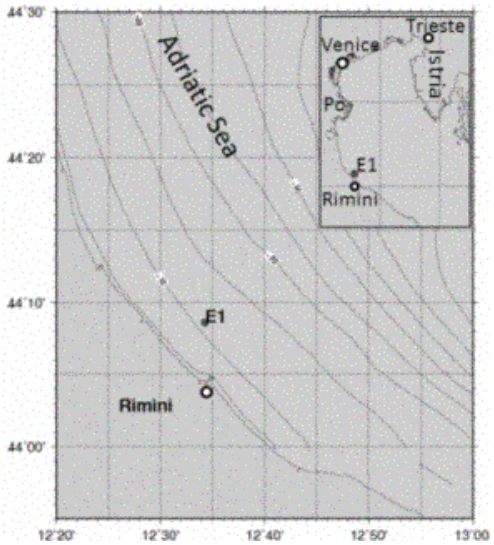

Fig. 1. Map of the study area with the E1 buoy position and the main bathymetric lines; the insert show the wider northern Adriatic area.

The European LIFE project EMMA (contract LIFE04/ENV/IT 000479) was devoted to define an observing-forecasting system, plus a Decision Supporting System relying on the information provided by the latter, in order to help local authorities in the management of such events. The project focused on the Rimini area (fig. 1), where the meteo-oceanographic buoy E1 has been deployed and it is being transmitting near real time data since August 2006 (data are showed online at http://e1.bo.ismar.cnr.it). The observing system was complemented by regular monitoring of "Daphne II" vessel of ARPA SO Daphne along the Emilia-Romagna coastal area. Additional, non-periodic cruises were being held with R/V Dallaporta and R/V Urania in order to assure the buoy maintenance and to provide *in-situ* data in a wider area (also for model initialization).

The forecasting system is based on a 3-D hydrodynamic model, the Regional Ocean Modeling System (ROMS; [2]) integrated with the Fennel (a Fasham-like) biogeochemical fluxes module (which includes dissolved oxygen and carbon dynamics). The model grid covers the whole Adriatic Sea with an horizontal resolution of 2 km and 20 *s*-levels [2] in vertical. The fluxes of heat, water and momentum through the air-sea interface are interactively computed (using the ROMS SST) from the COSMO-I7 operational atmospheric model forecasts, managed by the Hydro-Meteo-Clima Service of the Emilia-Romagna Region (ARPA-SIMC) in the framework of the Limited Area Model Italy (LAMI) agreement. Real time Po river runoff is considered by the model as a source of both freshwater and nutrients, while climatologic values are used for other rivers (as real time data are presently not available). Nutrient inputs from Emilia-Romagna coast, particularly relevant during the summer season, are simulated with 13 additional point sources. From June 2007 the system is being producing every day the forecast for the next 72 hours (according to the present time span of COSMO-I7 forecast); the current ROMS forecast is initialized by a restart file produced by the ROMS run of the day before.

Forecasts produced by the model are compared to several kind of data: temperature, salinity, dissolved oxygen time series measured by moored buoys (E1 in particular); sea level time series measured by coastal tide gauges; vertical profiles of temperature, salinity and dissolved oxygen acquired during oceanographic surveys and regular monitoring; sea surface temperature and chlorophyll measured by satellite. Statistics have been computed in order to assess the forecasting skill. It results that temperature and salinity forecast are being maintaining for over two years of integration a good correlation with measured data and a quite low Root Mean Square Error (rmse), with any data assimilation or insertion in the model. Performance of dissolved oxygen forecast is worst, with a lower correlation and a higher rmse, but most of the rmse derives from a mean bias. This should be mostly due to processes unresolved by the biogeochemical module, like benthic respiration. Work is in progress aiming to improve the system, also by including in the model simplified benthic processes; meanwhile dissolved oxygen forecasts in the Rimini area show a good performance by removing the mean bias computed from the data measured by E1 buoy during the 7 days preceding the new forecast.

To our knowledge, this is the first operational system able to produce short-term forecast of hypoxic/anoxic events in a Mediterranean Sea area.

References

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