MEDITERRANEAN FORECASTING SYSTEM: SUB-MODEL FOR THE CYPRUS AND NORTH-EAST LEVANTINE BASINS

George Zodiatis[1*], Robin Lardner[1], Alex Lascaratos[3], Georgios Georgiou[2], Gerasimos Korres[4] and Michalis Syrimis[2]

[1] LPO-Oceanography Section, DFMR, Nicosia, Cyprus
[2] Department of Mathematics & Statistics, University of Cyprus, Nicosia, Cyprus
[3] Oceanography group, Department of Meteorology, University of Athens, Greece
[4] Department of Marine Sciences, University of the Aegean, Mytilini, Greece

Abstract

A high resolution nested coastal/shelf model for the sea area in Cyprus and NE Levantine is implemented to fulfil the objectives of the MFS-Mediterranean Forecasting System pilot project. The Cyprus model is nested within the Aegean Levantine regional coarse grid model for fully prognostic runs. The project results show the feasibility of the approach for the development of the operational MFS.

Keywords : Levantine Basin, mesoscale phenomena, currents, open sea

Introduction

The Mediterranean Forecasting System is a multinational project, funded by the European Union, that is designed to produce NRT forecasts of the temperature, salinity and flow fields in the Mediterranean Sea [1]. The model results will provide invaluable input to marine environmental prediction models, such as pollutant models, used within the framework of the various contingency plans for response to marine pollution incidents. The system consists of a basin-wide monitoring capability, supplemented by a number of centres able to model the coastal shelf areas with state of the art hydrodynamic mod-elling, and complemented by an information network for exchange of observational data and model results.

The oceanographic models in the project are : 1) an Ocean General Circulation Model (OGCM) with 1/8°x1/8° resolu-tion over the whole Mediterranean Sea; 2) few Regional Models nested within the OGCM, with a 5 km resolution and 3) several nested models in various coastal/shelf regions, with 2-3 km resolution.

Results and Discussion

The Cyprus Coastal Model (CYCOM) is one of the coastal/shelf models for the waters in the NE Levantine Basin surrounding Cyprus (Fig.1). It is nested within the Aegean-Levantine regional model (ALERMO) which covers the Eastern Mediterranean Sea. Both CYCOM and ALERMO use numerical schemes that are modified versions of POM (the Princeton Ocean Model). The POM model [2] has been used within the framework of the MFSPP to simulate the flows in both region-al and coastal/shelf sea areas of the Mediterranean Sea. The MFS is to be interfaced with 3-10 days forecasts of atmospheric forcing pa-rameters from operational weather centres, but in the MFSPP, which is designed to establish the hierarchy of models and the communication network, the computa-tions have been based on the ECMWF perpetual year surface forcing.

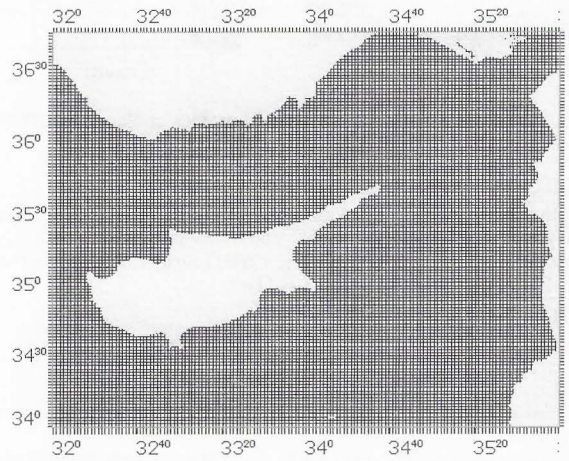

Figure 1. Cyprus model grid, 146x122x30 grid cells.

The CYCOM numerical algorithm uses an Arakawa C-grid and time splitting, with the barotropic mode com-puted with a step of 5 sec and the vertical structure and temperature and salinity fields updated with a step of 450 sec. Horizontal sub-grid mixing is modelled by an eddy viscosity defined by the Smagorinsky scheme while vertical mixing is treated by the turbulent energy scheme of Mellor and Yamada. The surface boundary conditions for temperature and salinity were taken to include terms providing relaxation to climatol-ogy, in the form

$$\frac{K_H}{D}\left.\frac{\delta T}{\delta \sigma}\right|_{\sigma=0} = \frac{Q}{\rho C_p} + \frac{C_1}{\rho C_p}(T^* - T)$$

$$\frac{K_H}{D}\left.\frac{\delta T}{\delta \sigma}\right|_{\sigma=0} = W_s + C_2 (S^* - S)$$

where the heat and salt fluxes, Q and W_s, are com-puted using monthly ECMWF forcing (wind stress, solar radiation, back radiation, evaporation and precipitation). D the water depth, σ the sigma coordinate, K_H the vertical diffusivity, C_p the specific heat, T^*, S^* the climatological T, S fields and C_1, C_2 relaxation coefficients.

For T^* and S^* the monthly mean surface values from the MED6 database were used, modified according the method of Kilworth so that linear interpolation between successive values produces the observed monthly means.

The model domain has open boundaries on the west and south sides at which it is nested within the ALERMO regional model and it is essential that the mesoscale features generated in the Levantine Basin by the regional model should influence the model solution in the CYCOM shelf model. The ALERMO output of velocities, temperature and salinity were extracted at intervals of 10 days and interpolated spatially to the open boundary points of the CYCOM grid and also in time to each time step. The barotropic velocities normal to the boundary were imposed in the form of a Flather mixed radiation/specification condition while the tangential components as well as the baro-clinic components of velocity were strictly imposed on the shelf model. The temperature and salinity were imposed from ALERMO at points where there was inflow while at outflow points these variables were computed simply by advection from the inside of the shelf region.

A principal demand for the success of the nested models is that the results of the shelf model should reproduce the dominant features found by ALERMO for the Cyprus Basin. To the west of Cyprus the flow in both models is dominated by a strong northerly jet which forms the eastern extension of the Rhodos cyclonic gyre, and is at the same time the northerly branch of the Mid-Mediterranean Jet. This jet bi-furcates SW of Cyprus and the other branch flows eastwards, actually south of the CYCOM model region, and enters this region in the SE corner as a northward current. It again branches, partly flowing westwards where it forms a cyclonic activity south of Cyprus and partly continuing northwards into the Lattakian Basin. With some seasonal variations, the current flows from the Lattakian basin, round the NE tip of Cyprus and turns westwards into the Cicilian Basin where it is known as the Asia Minor current, and is known to transfer warm waters as far west as the Aegean Sea. In this basin the main jet follows a meandering path, flowing north of a significant cyclonic eddy lying off the northern coast of Cyprus, with generally anti-cyclonic activities to both east and west of it. The nested models show consisteny between the coarse and fine grid results, as well as reproducing the main features that are known to exist in the CYCOM model region.

References

1. EuroGOOS, 1997.The strategy for EuroGOOS. EuroGOOS Pupl., 1, 132pp.
2. Blumberg, A. F., G. L. Mellor, 1987. A description of a three-dimensional coastal ocean circulation model, Three Dimensional Coastal Ocean Models, edited by N. Heaps, 208 pp., American Geophysical Union.