A STUDY OF WATER CIRCULATION ALONG THE EGYPTIAN MEDITERRANEAN COAST USING A THREE DIMENSIONAL NUMERICAL MODEL

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The Egyptian Mediterranean coast lies between longitudes 25°30'E and 34°E and extends northward to latitude of 33°N. Its water volume is 224 801,54 km^3 and it has a surface area about 154 840 km^2. Striking feature of this area are the presence of different water masses which converage and mix. The Princeton Ocean Model (POM) which makes use of a curvilinear orthogonal grid and of a sigma-coordinate system was used to study the general circulation of the Egyptian Mediterranean waters. The model was described in detail by BLUMBERG and MELLOR (1987).

The model bathymetry was obtained from the bilinear interpolation of the depth data into the model grid. The model grid contains 35 x 11 points with a resolution ranges from 22 to 27 km (fig. 1). The model has three open boundaries to the West, East and North.

The model has been initialized with the temperature and salinity seasonal averages prepared by the National Institute of Oceanography and Fisheries (NIOF) at the following 22 depth layers : 0, 10, 20, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1200, 1500, 2000, 2500 and 3000 m depth. The average values of temperature and salinity were mapped on a 1/2° x 1/2°. The monthly heat flux were computed on a 1/2° x 1/2° grid.

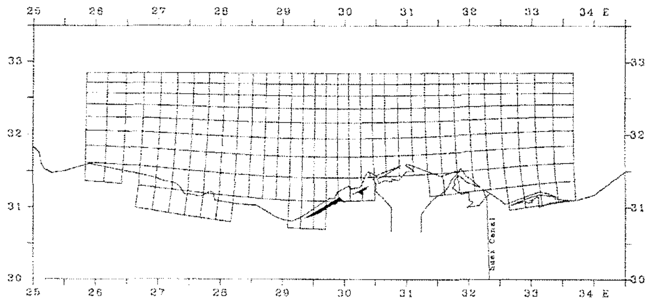

Fig. 1. The model grid.

Three numerical experiments are suggested to be performed using different kinds of surface forcings. In experiment-1, we examine the effects of seasonal water temperature and salinity fields only, by eliminating any seasonality in the surface heat and salinity fluxes and the wind stress forcing. The surface current velocity fields for the winter and summer seasons are shown in figure 2 and 3, respectively.

The surface circulation of the Egyptian waters is dominated by the easterly low along the coast and by the Mersa Matruh anticyclonic circulation in the western part of the area. In the present work, Mersa Matruh gyre exhibits a strong winter to summer variability reversing from anticyclonic to cyclonic.

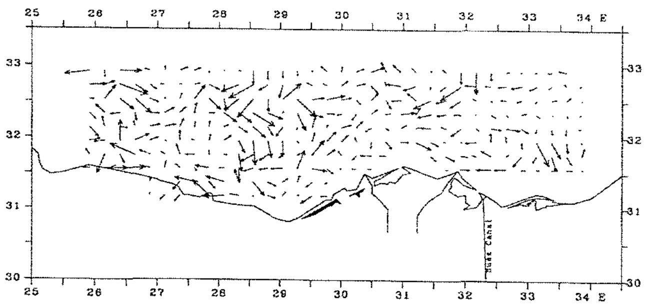

Fig. 2. Experiment-1 : Current velocity at the surface during the winter

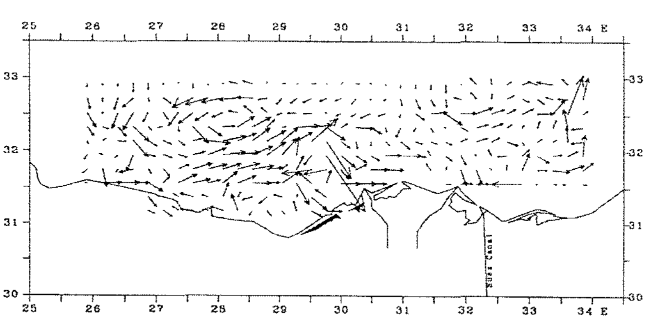

Figure 3. Experiment-1 :Current velocity at the surface during the summer

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CIRCULATION PATTERN OF THE EGYPTIAN MEDITERRANEAN WATERS DURING WINTER AND SUMMER SEASONS

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The water circulation of the Egyptian Mediterranean waters was computed during winter and summer seasons using the dynamic method. The reference level was raken at the 1000 db surface. In the shallow parts of the area where the depths were less than the depth of the reference level, Groen's method was applied. The dynamic height anomaly differences between stations were used for computing the geostrophic current speed and direction at the centre of each grid.

The oceanographic data used were selected from several expeditions carried out by Egypt and different countries for the last 27 years (1959-1986). Water temperature and salinity data have been taken from 162 hydrographic stations in winter and 152 in summer. The winter was represented by the data collected during the period from January to March, while the summer was determined by the period from July to September. The average values of temperature and salinity of these data were computed, using the optimum interpolation of the correlation algorithm, for stations distributed in a regular grid half degree latitude by half degree longitude for the both seasons.

Charts of surface circulation constructed for the winter and summer seasons areshown in figure 1. The surface circulation is dominated by the Atlantic water inflow along the North African coast and by two major gyres. The Mersa Matruh anticyclonic gyre in the western part of the Egyptian coast, was observed and discussed in details by ÖZSOY *et al.* (1989).

In the eastern side of the study area, off El-Arish city, the circulation is cyclonic in winter. This circulation exhibits a strong winter to summer variability, reversing from cyclonic to anticyclonic. In the scientific literature there is no evidence of the existence of such a gyre. Consequently, we will call it El-Arish gyre.

Dynamic topography for the 50 and 100 m levels reveals the same general pattern of those observed at the surface for the winter. While in summer, El-Arish gyre is completely disappeared. At the deeper levels (250 and 500 m), small eddies appear within the major gyres as well as between them. The Mersa Matruh gyre split into multiple centres. The eddy centres are shifted horizontally with depth. El-Arish gyre could still be identified only in winter and consists of two small centres.

The geostrophic current velocity at the edges of Mersa Matruh gyre varies between 12,5 and 29,1 cm/sec. in winter and between 6,5 and 13,1 cm/sec. in summer. The current velocity reaches its maximum values (~ 40 cm/sec.) at El-Arish gyre in winter. The current velocity at the two gyres decreases with increasing depth. The North African current affects the surface waters down to a depth of 100 m, and that its mean velocity varies between 6 and 38 cm/sec.

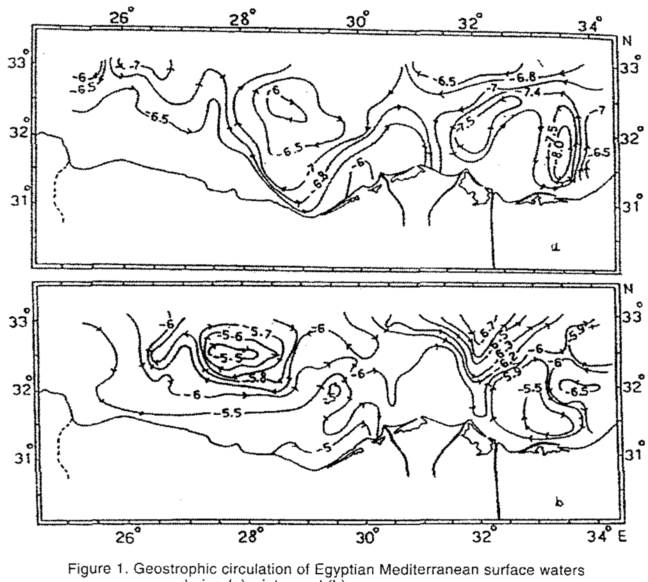

Figure 1. Geostrophic circulation of Egyptian Mediterranean surface waters during (a) winter and (b) summer seasons.

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ÖZSOY E., HECHT A., UNLUATA U., 1989. Circulation and hydrography of the Levantine basin : results of POEM coordinated experiment 1985/86. *Prog. Oceanogr.*, 22 : 125 - 170.