

The NRL Mediterranean Sea Model

G.W. HEBURN

Naval Research Laboratory, Stennis Space Center

The circulation in the Mediterranean Sea is extremely complex, consisting of numerous eddies and current meanders, particularly along the north African coast, in the Algerian basin and throughout the Ionian and Levantine basins. Satellite IR and CZCS imagery as well as recent hydrographic surveys (for example the POEM program) reveal a picture of the general circulation in the western and eastern Mediterranean consisting of sub-basin-scale gyres and interconnecting jets. There are many physical factors which exert an influence on the dynamics of the circulation of the Mediterranean Sea; wind stress, hydraulic controlled inflow/outflow through the Straits of Gibraltar and Sicily, intermediate and deep water formation, thermohaline forced circulation and topography.

Various versions of the NRL primitive equations ocean circulation model are used to systematically study the affects of these various forcing mechanisms, individually and in combination, on the circulation dynamics of the Mediterranean Sea. While the general results from various case studies involving wind, hydraulic, thermohaline and topographic forcing suggest that no one mechanism dominates the complex Mediterranean circulation and that non-linear interactions between the directly forced motions and internal flow instabilities play an important role, comparisons of model results from experiments using the ECMWF winds for the period 1981 to 1989 with observational data, both satellite IR and hydrographic, suggest that the winds play a major role in the evolution of the sub-basin-scale gyres seen in the Mediterranean Sea.

Model

The NRL multi-layer primitive equations ocean circulation model is a derivative of the HURLBURT and THOMPSON (1980) Gulf of Mexico model. A full description of the basic model is presented by WALLCRAFT (1991). The version used for most of the recent dynamical studies in the Mediterranean Sea is a three layer, finite depth, hydrodynamic, spherical coordinate version of the basic model. The model domain is presented in figure 1. The lateral boundaries for the model are taken at the 200m isobath. The initial layer thicknesses are taken to be 200m for the upper layer representing the Modified Atlantic Water (MAW), 400m for the second layer representing the Levantine Intermediate Water (LIW) and the remainder in the third layer to the bottom topography representing the Mediterranean Deep Water (MDW). The inflow boundary condition was specified as a steady inflow of 1.2sv through the Strait of Gibraltar in the upper layer with compensating outflow in the second layer. The formation of LIW is parameterized as a steady detrainment for the upper layer to the second layer in the eastern Mediterranean basin.

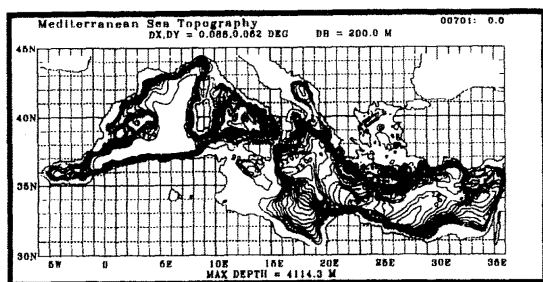


Figure 1.- Mediterranean Sea model Topography

The model was integrated to statical equilibrium using the HELLERMAN and ROSENSTEIN monthly mean wind stress climatology and then integrated for a nine year period with a hybrid wind stress data set using the annual mean from the HELLERMAN and ROSENSTEIN climatology and the monthly mean anomalies from the ECMWF winds for the period from 1981 to 1989.

Results

The results from the simulations using the hybrid wind data set have been compared to satellite IR images for various time periods during the 1980s. The disappearance and reformation of the eastern Alboran gyre during July to August 1982 (HEBURN and LA VIOLETTE, 1990) is well represented in the model simulations. The mean annual cycle of the transport of LIW through the Strait of Sicily is replicated in the model simulations using the climatological wind forcing as well as in the simulations using the hybrid wind forcing data set. The simulations using the hybrid data set also show considerable interannual variability.

The complex series of sub-basin scales gyres and meandering currents observed in the eastern Mediterranean Sea are shown in the model simulations as well. These features also exhibit considerable seasonal and interannual variability. The gyres in the Ionian basin appear to be primarily wind forced with a definite annual cycle.

REFERENCES

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