FORCING MECHANISMS OF THE AEGEAN SEA CIRCULATION

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Abstract

The mechanisms involved in the seasonal patterns of the Aegean Sea circulation are studied with the use of a numerical model (POM). By performing a series of experiments with different atmospheric forcing and lateral boundary conditions, which are compared with recent observations in the Aegean Sea, the surface circulation in the basin is being investigated. It is shown that both the seasonal pattern of the wind field and the seasonal thermohaline forcing are important in producing the observed circulation, while specific features of the circulation are associated to only one component of the atmospheric forcing.

Key-words: Surface Circulation, Aegean Sea, Modelling

Introduction

Despite the progress in direct observations and modeling efforts during the last two decades, the circulation of the Aegean Sea is yet far from being well defined and understood. Recent observations with Lagrangian drifters [1] emphasized the complex and variable character of the circulation pattern that can be attributed to the very irregular topography, the strong seasonality of the atmospheric forcing, and the presence of many different water masses.

If we attempt to summarize the known circulation characteristics (from historical data, recent drifter deployment, and modeling techniques), there seems to be a general cyclonic circulation in the Aegean Sea. A very important characteristic feature of the circulation pattern in the basin is the surface inflow of the brackish Black Sea Water (BSW) from Dardanelles, which creates a front with the ambient saltier waters of Levantine origin following the general cyclonic pattern. However, the most active dynamic features are the mesoscale cyclonic and anticyclonic eddies and boundary currents which can extend to several Rossby radii of deformation (around $O(10$ km)). In this study we aim to identify the mechanisms involved in basic features and the overall circulation of the Aegean Sea, performing numerical model experiments.

Method

The numerical experiments were carried out with the Princeton Ocean Model (POM) [2]. The domain is extended outside the Aegean Sea, in order to incorporate the effects of the Mediterranean Sea general circulation. In the first experiment both seasonal wind and seasonal thermohaline forcing, derived from the ECMWF reanalysis, are used to drive the model. The BSW inflow as well as major rivers runoff is also included in the model configuration. The results are compared with observations and major features of the surface circulation have been identified. The next two experiments include only one driving field, either wind or thermohaline forcing, to investigate the different role and importance of each one on the circulation pattern. Finally, the effect of different later boundary conditions (e.g. no BSW inflow) is investigated with additional experiments.

Results and Discussion

The full forcing experiment reproduces the general cyclonic patter of the surface circulation as well as the most important mesoscale features (Fig. 1). Although most of them present strong seasonality, features such as the cyclonic eddies in the Chios basin (central Aegean), the boundary current along the eastern coast of the Evoia island, the anticyclonic circulation in the northeastern Aegean, the Myrtoan Cyclone and the East Cretan Cyclone are robust in the model results.

The wind- and thermohaline-driven experiments produce results with comparable surface circulation strength, but in several cases the circulation patterns are very different. When only the wind forcing drives the model a strong current following diagonally the central Aegean is dominating. This is associated with the pattern of the wind-stress curl field which is negative north of this axis and positive in the southern part of the basin. This results to a anticyclonic circulation in the northernmost part of the basin which alters significantly the circulation pattern and a cyclonic one in the southern part of the basin. Although features such as the anticyclone in the northeastern Aegean are intensified, others such as the Evoia Current and the cyclonic features in the northern Chios basin disappear. Additionally, this circulation pattern recirculates the brackish BSW in the northern part of the basin resulting in very low surface salinity while in the same time the exchange between the north and south Aegean at the eastern part of the basin is diminished.

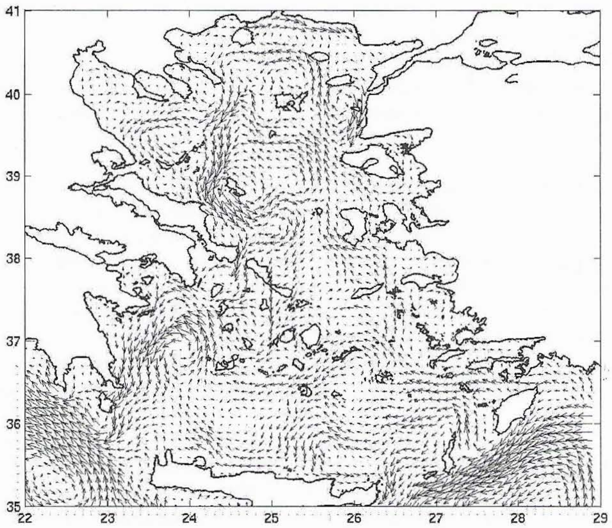

Fig. 1. Model derived surface circulation in the Aegean Sea during mid-July.

The presence of the thermohaline forcing enhances the cyclonic circulation in the northern Aegean, creating strong density fronts in the region. All the cyclonic features are present as well as the Evoia Current. The circulation around the island of Samothrace reverses most of the year.

The absence of the BSW inflow results in a considerable decrease of the surface circulation strength in the northern Aegean as a consequence of reduced density gradients there. On the other hand, the circulation in the southern Aegean remains almost unchanged, suggesting a relative decoupling between the two sub-basins.

References

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