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On the Forcing Mechanisms of the Aegean Sea Surface Circulation

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The mechanisms involved in the seasonal patterns of the Aegean Sea (NE Mediterranean) surface circulation are studied using surface drifter observations and a numerical model. Recent observations with surface drifters 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 surface 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 surface circulation of the Aegean Sea, performing numerical model experiments with the Princeton Ocean Model and comparing with surface drifter observations. 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 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. The full forcing experiment reproduces

the general cyclonic patter of the surface circulation as well as the most important mesoscale features. 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 an 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 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. 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 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 of the surface circulation in the two sub-basins.