A numerical investigation for the mesoscale structure of the Rim Current along the Southern Black Sea Coast

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Contrary to the traditional view of circulation in the Black Sea, the recent high resolution data provided by satellites and hydrographic surveys suggest the presence of complex eddy-dominated mesoscale circulation, often masking the general circulation field. The cyclonic boundary current encircling the basin exhibits strong meandering with wavelengths of 100-150 km, accompanied with eddies and coherent structures.

Despite the growing number of observational work on the mesoscale variability of the Black Sea circulation, little is yet known quantitatively about the mechanisms ultimately responsible for their generation, evolution and decay. A series of numerical model experiments has been performed to explore the dominant mechanisms which may lead to variability observed in the structure of the Rim Current. Particular attention is given to the flow structure along the southern coast of basin. The flow was represented by the inflow-outflow model in a channel of approximately 1000 km long and 200 km wide extending in the west-east direction along the Turkish coast.

The barotropic response of the flow, investigated by the nonlinear barotropic PE model, shows that the interaction of the Rim Current with the bottom topography may contribute to the flow meandering and lead to a number of topographically-induced quasipermanent coastal eddies. The curvature of the coastline in the western part of the analysis region is found to be responsible for generating cyclonic vorticity which ultimately tends to split the Rim Current into two branches at approximately 34 E longitude; one branch proceeds eastward along the coast, the other one bifurcates cyclonically towards the interior. This result indicates that the well-known dual-dome cyclonic circulation of the Black Sea is controlled by the geometry of the basin.

The multi-layered (three layer in the present application) model further reveals that the mean flow becomes subject to mixed instability; the baroclinic instability being the dominant one. The finite amplitude topographic and coastline irregularities as well as the local wind stress variability trigger the instability mechanisms leading to generation of time dependent intense meandering flow pattern and formation of filaments and pinched-off eddies, being simultaneously advected downstream. The filaments are strong offshore jets elongated cyclonically across the shelf-slope boundary into the interior of the basin and are found to be generated in the regions of strong coastline curvature. Their considerable transport capacity of mass, momentum and biochemical materials between the coastal and nterior waters are evident from the observations.

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