The strait of Gibraltar and Alboran sea circulation : a process study

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The water exchanges through the strait of Gibraltar are one of the major forcing of the Mediterranean circulation. Satellite observations over the Mediterranean basin reveal extremely complex circulation patterns which seem to be highly time-dependent. The knowledge of the physical processes connecting the forcing through the strait of Gibraltar with the dynamics of the water motion in the Western Mediterranean Sea still represents a challenge. The LODYC 3D primitive equations model has been undertaken in order to elucidate these driving interactions. In all the experiments the strait circulation has been initiated by connecting two reservoirs filled with homogeneous waters of different density.

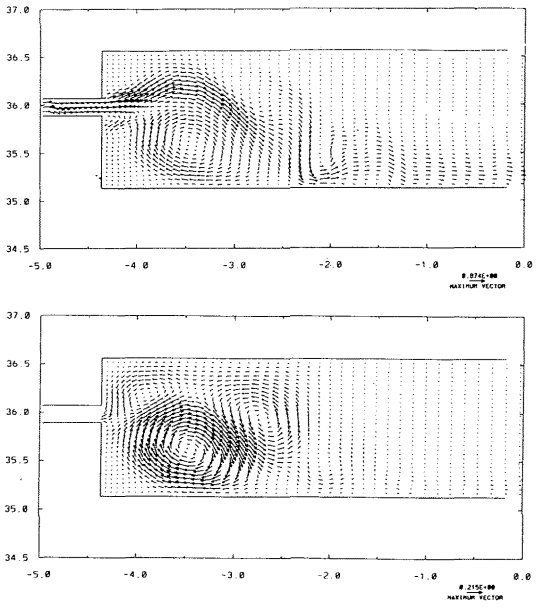
The results are in agreement with observations. In the strait a baroclinic circulation sets up: the light Atlantic water flows into the Mediterranean Sea in the form of a surface layer while the dense Mediterranean water flows out to the Atlantic Ocean near the bottom. The surface water enters the Alboran Sea in the shape of a shallow and narrow buoyant jet with currents over 1 ms-1. After a 3 day spin-up period, the flow transport in the strait reaches a steady value of 1 Sv. The surface inflow presents an internal hydraulic control at the exit within the Alboran Sea. After several days this flow extends in the Alboran basin forming a large anticyclonic gyre that slightly moves northward, while the head of the plume propagates along the southern cost of the Alboran Sea as a coastal Kelvin front.

By this simple academical study we are able to reproduce the high variability of the Alboran Sea circulation during the spin up phase, in particular some mesoscale cyclones that develop North of Gibraltar and displace around the bigger anticyclone (as shown in the figure where the velocity vector field at the sea surface and at 350 m of depth is displayed), as it has been observed both experimentally and through satellite imagery (TINTORE 1991; LA VIOLETTE 1984).

Systematic series of sensitivity experiments have then been performed in order to specify the conditions that control the gyre formation, its space scale and the major characteristics of the inflow and outflow in the strait. The results reveal that the gyre dimensions are very closely related to the density gradient between the two basins and, by a secondary effect, to the presence of the southern coastline in the Alboran Sea. The boundary conditions at the coast as well as a slight inclination towards the north of the Strait, although sometimes argued, do not exhibit any relevant role in the gyre formation and in the overshooting of the inflowing jet.

In addition to these main conclusions it has been possible to identify the physical parameters responsable for the gyre genesis as well as to follow its development till the Alboran Basin general circulation steady state is reached, by studying the potential vorticity conservation and analysing the balance of the dynamical equation terms, as well as referring to mesoscale vortex and modon theories.

In recent numerical experiences we have introduced the real geometry and topography of the investigated region to weigh their impact on the circulation dynamics and structure. A final investigation has been performed by initialazing the density values on the Levitus climatology in order to approach reality.



REFERENCES

LA VIOLETTE P., 1984.- The Advection of the Submesoscale Features in the Alboran Sea Gyre. *J. Phys. Oceanogr.*, 14, 550-565.

TINTORE J., GOMIS D., ALONSO S. and PARRILLA G., 1991.- Mesoscale Dynamics and Vertical Motion in the Alboran Sea. *J. Phys. Oceanogr.*, 21, 811-823.