SMALL SCALE FEATURES OF THE ALBORAN SEA CIRCULATION INFERRED FROM HYDROLOGICAL AND ICTHYOPLANCTONICAL DATA

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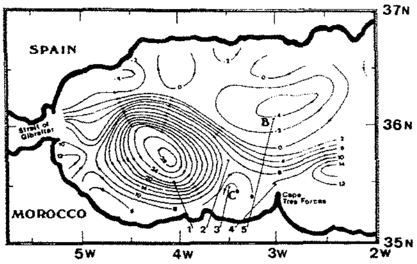
In July 1993, the "Instituto Español de Oceanografia" carried out the ICTIOALBORAN-93 survey in the Alboran Sea, performing 65 hydrographic (CTD) and biological stations. Figure 1 shows the dynamic topography (cm-dyn) of the surface referred to 200 db. The western Alboran anticyclonic gyre appears well developed while the eastern gyre is notoriously smaller. West of Cape Tres Forcas, a reduced area of cyclonic circulation was observed (area C, fig. 1). The T-S characteristics of the surface waters here suggest that they have been drawn away from the northern part of the Atlantic Current (AC), (zone B, fig. 1) where warmer and saltier surface waters are found in summer. This is confirmed by the analysis of fish larvae distribution of three mesopelagic species whose adults live in open sea between 200 and 1000 m depth. Two of them, *Benthosema glaciale* and *Maurolicus muelleri*, are abundant north of 36°N in the Alboran Basin, where their maxima larvae concentrations were found. However, a noticeable abundance of them was also found in the core of this cyclonic area, south of 36°N, and negligible amounts in the stations around it. The simultaneous lack of larvae of *Ceratoscopelus maderensis* in the core confirms additionally the intrusive nature of this small-scale feature, since these larvae were found all over the southern portion of the western basin, that seems to be their adult's habitat. The presence of this surface water here could be explained by a significative north to south cross-stream ageostrophic circulation in the vicinity of Cape Tres Forcas or, alternately, by barotropic instability of the AC forced by the local topography. The second hypothesis seems more probable since this small-scale feature is not regularly observed, which would be the case under the first assumption. The variability of the Alboran Sea anticyclonic gyres and the inflowing AC has been (and still is) widely investigated by means of field studies (CANO & CASTILLEJO, 1972), satellite imagery (HEBURN & LaVIOLETTE, 1990), numerical (PRELLER, 1986) and laboratory (WHITEHEAD & MILLER, 1979) models. There is a general agreement on the key role played by topography in configuring the gyres. The small Alboran island and the prominent Cape Tres Forcas, near 3°W, must have influence not only in the size and location of the Western gyre but on the formation and size of the Eastern one, for the AC enters the eastern basin following a path which lies between both of them.



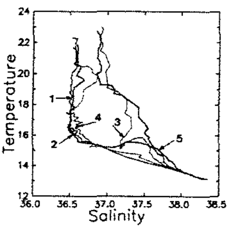


Fig. 1 (left). Dynamic topography of the sea surface referred to 200 db. Numbers 1 to 5 label hydrographic stations whose T-S diagrams are shown in fig.2.
Fig. 2 (right). T-S diagrams. The arrows identify the stations and indicate the depth of 50 m.

Satellite imagery is a powerful tool to study the time variability of the gyres, provided that the surface thermal structures reflect the underlying dynamics. HEBURN and LaVIOLETTE analyzed a considerable set of images from the years 1982 and 1986. All of the images belonged to one of the three situations sketched in figure 3, the simultaneous absence of both gyres never being observed. From the results of their analysis it is not possible to elucidate which is the most likely situation; the actual situation seems to evolve continuously. The path of the AC in the Alboran Sea can be modelled as a baroclinic Rossby wave strongly modified by topography, which reduces its "natural" length-scale to make it fit into the basin (PRELLER 1986, HEBURN & LaVIOLETTE, 1990). From this point of view, situation 3-a seems more unstable than either 3-b or 3-c, due to the strong curvature of the stream in the southern meander. For instance, what would happen if conditions in the inflowing Atlantic Water (AW) through the Strait of Gibraltar were changed and the size of A_1 increased ? Part of this AW should remain inside A_1 and, as it grows up, the curvature of the Jet near Cape Tres Forcas would be emphasized, favouring barotropic instability and cyclonic eddy shedding, which would remain trapped between A_1 and the African coast. Water parcels of the leftwards side of the stream (looking downstream) should be caught during the instability. After the eddy shedding, the AC would enter the eastern basin following a more eastward direction. Less AW is arriving at the eastern basin during the growth of A_1 and, probably, the size of A_2 would be reduced if part of the AW inside it is drained to feed the Algerian Current. All this would lead to situation 3-c from 3-a. In the frame of this highly simplified dynamics, the ICTIOALBORAN-93 survey would have been carried out shortly after the hypothetical shedding, as the water of its core is still distinguishable from the surrounding waters.

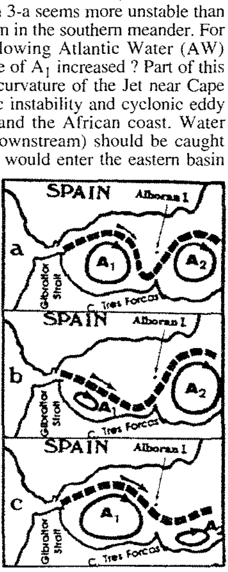


Fig. 3.Three possible situations of the gyres current system in the Alboran sea.

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