EVIDENCE OF TWO DRIVING MECHANISMS OF THE WESTERN MEDITERRANEAN UPPER LAYER CIRCULATION : FRESHWATER COASTAL INPUT AND DEEP WATER FORMATION

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Off Nice, the Ligurian current, when considered over a whole year, is equally composed of Tyrrhenian and Algero-Provençal fluxes. A marked seasonal cycle, which appears off Nice and also through the Corsican channel (with a maximum flux occuring in December and January, and a minimum in August and September), cannot be related to wind or atmospheric pressure variations (Bethoux et al., 1982).

Since October 1981, systematic CTD sections have allowed the study of the spatio-temporal variations of the Ligurian current. Heavy rains occured in December 1981, after a severe drought in the Western Mediterranean Sea (Prieur et al., 1983). Increases in the Ligurian current have been correlated with freshwater inputs from precipitation and the Var and Arno rivers discharges (Bong, 1983). A twenty days lag correlation between freshwater inputs and baroclinic fluxes shows that the upper layer Ligurian current (0-200 m depth), of about 1.4 $10^6 m^3/s$ average value, results from two components : a constant one of about 0.8 $10^6 m^3/s$ and a variable one, forced by freshwater. The latter chiefly comes from the Tyrrhenian Sea while the former originates essentially from the Algero-Provençal basin and strengthens the concept of a deep water forcing (Bethoux and Prieur, 1983).

In the Western Mediterranean Sea, outgoing deep waters (of about 50 $10^{12} m^3/y$ entering the Alboran Sea ; Bethoux, 1980) are compensated by Eastern Intermediate waters and by about 13.5 $10^{12} m^3/y$ of North-Western surface waters. These waters, converted into deep waters during winter, progressively go towards the Straits. The central area of cyclonic circulation, where the transformation occurs, represents nearly half of the North-Western basin (1.4 $10^{11} m^2$). The surface layer contribution to the deep water formation results in the disappearance of an annual layer of 96 m thickness. This creates an initial domed structure and an hypothetic lowering of the sea surface. A compensating gravity wave propagating from the Atlantic towards the Ligurian Sea takes at least 3.6 hours. They allow a minimal lowering of the surface of (96 x 3.6) / (365 x 24) = 0.04 m. That is about half of the dynamical differential height calculated off Nice, and may explain the geostrophic flux off Calvi (Corsica).

Also, different possibilities of propagating gravity waves, owing to the bathymetry, allow Atlantic surface water paths through the Balearic Islands. A curved line, between the Catalonian Coast, North of Minorca and Sardinia, may constitute an isochronous propagation line. In the infra red satellite images of sea surface temperature, a similar line corresponds to a thermal gradient (Philippe, 1980).

The deep water formation area coincides evidently with one affected by wind (Mistral). So, in the North-Western basin, the deep water driving mechanism could give the same outlines as the wind forced upper layer circulation (i.e McDonald et al., 1983). But, qualitatively and quantitatively, it explains the Atlantic water path towards the Ligurian Sea. On the other hand, the freshwater driving force explains the channeling of the Ligurian current above the continental slope and the arrival of the Tyrrhenian flux.

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