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The Levantine water in the Tyrrhenian Sea : double diffusion and basin scale mixing

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Double diffusive processes have now been encountered in many oceanic regions. They occur sporadically in space and in time and can increase the vertical diffusion coefficient by several order of magnitude. In this paper, an attempt is made to parameterise this micro-scale phenomena. The salt and heat fluxes, calculated from salt-finger theory, can be compare to the salt and heat balance in the Levantine Intermediate Water (LIW) tongue during its incursion in the Tyrrhenian basin, which offers a natural model to undertake such a study. Similar objectives have been pursued in the mediterranean out flow off Gibraltar (Lambert & Sturges, 1977. Hebert, 1988).

The Tyrrhenian sea is a semi-enclosed basin with a large opening of 180nm in the south between Sicily and Sardinia. The average depth is 1000m with a deep channel of 2000m in the eastern part, communicating between Sicily and Tunisia with the western basin. In the northern part it is opened to the Ligurian sea, between Corsica and the italian mainland. The deepest passage, on the corsican side, only reaches 410m.

Most of the LIW which enters the basin following the sicilian cost, between 300 and 600m, is believed to return to the western basin with a southward flow along the sardinian cost (Garzoli & Maillard,1979). All the hydrological sections (from the presently available data base) achieved between Sicily and Sardinia indeed show two distinct cores of warmer and saltier water having respectively in and out geostrophic flow. Estimates of these flows are however strongly dependent on the chosen reference levels: Climatological data of the section have been inversed using Singular Value Decomposition method (Mémery & Wunsch, 1989) in order to deduce more realistic values of the water, salt and heat fluxes through this section.

It has also been shown (Molcard & Tait, 1977) that double diffusive processes of salt finger type (Williams, 1975) are present in the deep basin of the Tyrrhenian sea and are responsible for the large homogeneous layers separated by sharp interfaces observed in the region. Laboratory and theoretical investigations directed at estimating the associated diapycnal salt fluxes (Stern, 1976. Turner, 1967. Schmitt, 1988) lead to an estimate of the average vertical salt flux out of the LIW.

The loss of salt and heat in the LIW during its incursion in the Tyrrhenian basin can therefore be compared to the expected loss due to double diffusion. Required time for the necessary amount of salt and heat to be drawn out of the levantine water, according to the vertical salt flux deduced from double diffusion theory, is discussed in view of the expected renewal time of the LIW deduced from the in and out fluxes, and the present knowledge of the general circulation in the basin.

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O-IV9

Heat Storage in the Western Mediterranean Sea

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Heat budget plays an importan role in the dynamic of the oceans. Several studies on the heat exchanges between the atmosphere and the sea surface and on heat and water budgets can be found in literature, but only few works regard the heat storage in the Mediterranean Sea.
In this work are presented some results which describe the geographical distribution of the heat storage in the first 100 m. of Western Mediterranean Sea, based on climatological data of sea temperature.

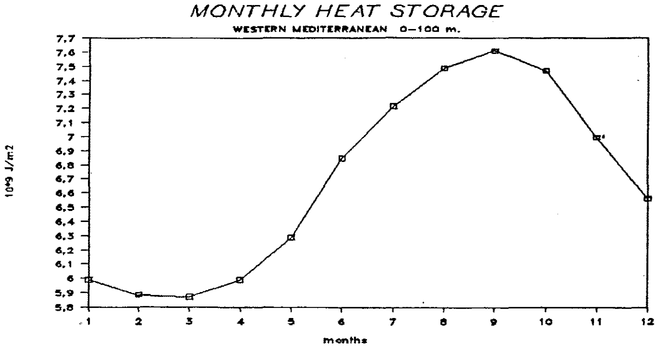
Data used come from the ENEA-CREA La Spezia (I) environmental data-bank. The WMTS (Western Mediterranean Temperature Salinity) data-set is made of about 12,000 TS profiles for the Western Mediterranean from 1911 to 1985 selected with a resolution of 0.5 degree square to obtain monthly mean profiles. Vertical resolution is that of standard levels.
Monthly heat storage in J/m^2 is computed by:

$$H= \varrho\ Cp \sum_i 1/2\ [T(i)+T(i+1)]\ [Z(i+1)-Z(i)]$$

ϱ = 1,027 Kg/m^3 seawater density
Cp= 1,487 $J/Kg^{\circ}K$ specific heat capacity
Zi= i-level depth
Ti= i-level temperature

The error assuming ϱ and Cp constant is negligible compared with other sources of errors. Computation was performed for the 0-100 m. and for the 0-300 m. layers.

The annual trend of the monthly mean heat storage in the two considered layers for the entire Western Mediterranean shows that most of the heat storage variation occurs in the first 100 m. The amplitude of the annual signal for the 0-300 m. layer is only about 2% grater then the 0-100 one. Heat storage in the first 100 m. ranges from a minimum of 5.9 $10^9 J/m^2$ in March to a maximum of 7.6 10 J/m2 in September (Fig.1).
The geographical distribution of the amplitude of the annual signal shows an high variability (Fig.2). It can give an idea of the amount of the heat exchange in a region and it is in good agreement whit some general circulation schemas. Higher values (more then 2.6 $10^9 J/m^2$) are reached in the Algerian Provencal Basin; in the Alboran Sea, the inflow of Atlantic Waters makes the signal amplitude rather small (about 1.4 $10^9 J/m^2$). Low values are also found in the Ligurian Sea and in the Gulf of Lion (less then 1.6 10^9 J/m^2). Here the maximum of the heat storage is reached in October instead of September as in the other regions.



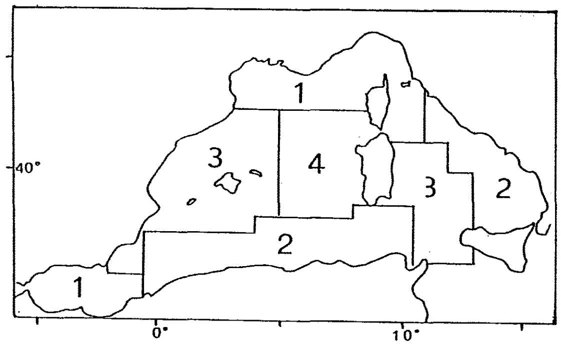


FIG.2 Amplitude of the annual signal

1	1.2-1.6 10E9 J/m2
2	1.6-2.0
3	2.0-2.4
4	2.4-2.8

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