Variability of the hydrographic characteristics in the Strait of Sicily and in the Tyrrhenian Sea induced by the Eastern Mediterranean Transient

*A. Ortona**, G. Budillon**, G.P. Gasparini*, G. M. Astraldi* & E. Sansone***

** Istituto di Meteorologia e Oceanografia – Università degli Studi di Napoli "Parthenope", Napoli, Italia

*CNR – Istituto di Scienze Marine, Sezione della Spezia, Forte Santa Teresa, 19036 Pozzuolo di Lerici, Italia

Recent studies (Demirov and Pinardi, 2002) have definitively shown an extended sensitivity of the Mediterranean to the effects produced by the large-scale atmospheric systems.

During the 1985-2003 period the hydrographic monitoring in the Strait of Sicily and Tyrrhenian sea (Fig. 1) evidenced significant changes of the hydrographic characteristics, which can be related to the Eastern Mediterranean Transient (EMT). More specifically, EMT modified the thermohaline characteristics of the intermediate layer (traditionally occupied by LIW) and induced the uplifting of the older Ionian deep waters towards shallower waters, enhancing the passage of a significant volume of transitional EMDW through the Strait of Sicily. The effects on the salt balance through the Strait and on the Tyrrhenian heat and salt budget are also discussed.

STUDIED AREA:

1 Central deep basin - Strait of Sicily
2 Western sill
3 Tyrrhenian entrance
4 Tyrrhenian interior

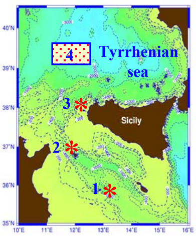


Figure 1

TIME EVOLUTION OF S_{max} CHARACTERISTICS

(1) Central Basin

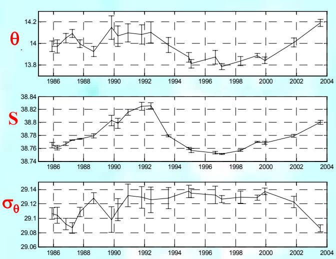


Figure 2

1986: Conditions before EMT

1992: EMT: high salinity phase (Smax= 38.83, TSmax= 14-14.1°C)

1997: EMT: low salinity (Smax = 38.75) and low temperature phase (TSmax=13.79°C)

2003: S= 38.8, TSmax ~14.2 °C

(2) Western Sill

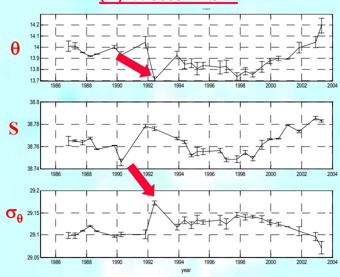


Figure 3

1986-1990: weak oscillations both in temperature and in salinity.

1991-1992: The EMT reaches the western sill. (Salinity rises from about 38.76 to 38.78 during 1991).

After 2000: salinity and temperature increases while density decrease.

* Time evolution of S_{max} in the Tyrrhenian entrance (3) appears similar to that observed in the western sill (not shown here).

(4) Tyrrhenian interior

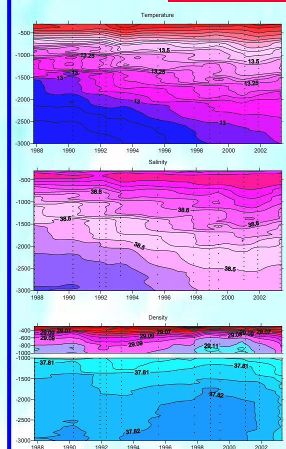


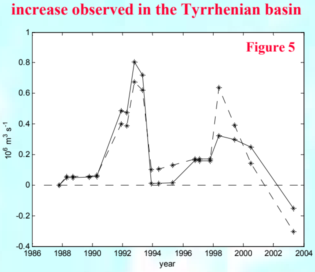
Figure 4

The outcome of the changes observed in the Strait outflow is well evident in the Tyrrhenian basin.

The time evolution of the hydrographic characteristics in the deep water column (Fig. 4) indicates that after 1992, this behaviour concerns almost the entire subsurface waters: the saltier and warmer waters progressively extend its influence in depth. The density field is also modified particularly during 1993-94, when a major homogeneity affected a large portion of the water column.

The mean temperature between 500 and 3000m during the period 1992 – 2001 increased 0.024 °C/yr and 0.008/yr in salt content.

Time evolution of the Sicily outflow correspondent to the heat (continuous line) and salt (dashed line) increase observed in the Tyrrhenian basin



As a consequence of the EMT an huge, impulsive amount of salt and cold water mass has been measured in the Tyrrhenian Sea interior (Gasparini et al., DSR submitted); of course it must be related to the water mass volume entering in the basin and to the temperature and salinity difference between the water entering the basin and the resident water. For a defined time interval Δt the necessary mean water inflow Φ with a mean temperature θ, able to modify the Tyrrhenian temperature Θ from Θ_1 to Θ_2, will satisfy the following relation:

$$\Phi\,(\theta - \Theta_1)\,\Delta t = (\Theta_2 - \Theta_1)\,V$$

where V is the involved Tyrrhenian volume. Figure 5 (solid line) shows how the EMT effect induces different sinking intensities and reaches the highest effect during 1992-93, when Φ reaches 0.9 Sv. The mean value of Φ during the period 1990 – 2000 is about 0.3 Sv. The same computation can be applied to the salinity increase $\Delta S = S_2 - S_1$. The high similarity of the independent estimate, which considers the salinity balance (figure 5, dashed line), confirms that the hydrographic modifications observed in the Tyrrhenian basin have almost the same origin and are due to the Sicilian outflow. The last negative value (both for heat and salt) suggests that during 2003 the Sicilian outflow doesn't transfer water to the deep layer, while the deep Tyrrhenian basin reverses the previous tendency showing a decrease both in salinity and temperature (figure 4).

Evolution of annual mean salinity in the Strait: (a) surface layer; (b) intermediate layer

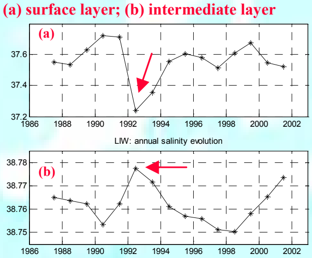


Figure 6

Effects related to the EMT can also be found in the surface layer evolution in the Sicily Strait. The salt conservation observed in the Strait shows that the salt increase in the intermediate layer corresponds to a salt decrease in the MAW (Figure 6).

As a consequence, during the higher EMT phase (1992-94), the eastern basin is reached by fresher surface water, hindering the production of new deep water.

Using the salt export from the Sicily Strait it is possible to estimate the net evaporation in the Levantine basin: during the EMT period the net evaporation was of 0.08 m/yr, while during 70's and 80's it was 0.04 m/yr. This estimate is in agreement with the a net evaporation increase of 0.02-0.04 m/yr estimated for the EMT (Josey , 2003) and confirms that the deep salt increase in the eastern basin is mainly due to a salinity redistribution in the water column, with a decrease in the LIW layer and an increase in the deep and the bottom layers (Roether et al., 1996).

References

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