THE TEMPERATURE AND SALINITY VARIABILITY OF THE MEDITERRANEAN OUTFLOW DURING THE TWENTIETH CENTURY

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Abstract
In order to investigate the contribution of Mediterranean Water (MW) in the warming of the Atlantic intermediate layer, we focused our analysis on the ocean area closer to the Strait of Gibraltar, where the MW source water is well observed. Temperature and salinity data from Medar/Medatlas II and MODB were used in order to correlate possible changes in the thermohaline characteristics of the Mediterranean Sea with influences on the spreading of the Mediterranean Water outflow in the eastern North Atlantic, and to identify possible variations and trend if any.
Keywords : Temperature, Salinity, Strait Of Gibraltar.

One of the key processes of the thermohaline circulation is the water mass transformation due to external forces and the continued renewal and stratification of the entire water column. In this context, the marginal seas like the Mediterranean Sea, Arctic Sea and Greenland, Iceland, and Norwegian Seas play a fundamental role by contributing on feeding the global ocean with dense dense water.

In particular the Mediterranean water (MW) is one of the intermediate-type water masses observed in the North Atlantic. It is composed by a mixture of Levantine Intermediate Water (LIW) and deep waters produced within the Mediterranean basin, and enters the Atlantic Ocean through the narrow strait of Gibraltar with a mean volume exchange of about 1 Sv.

The MW lies between 800 and 1300 meter depth characterized, albeit density compensated, by significant salt and temperature anomalies, with $\Delta S \approx 1$ psu and $\Delta T \approx 2°C$ with respect to the overlying North Atlantic Central water. In most of the North Atlantic the core of MW is clearly recognizable along the average isopycnal $\sigma_\theta \approx 27.60$ surface and at $\approx$ 1000 meter.

The Gulf of Cadiz, including also the Strait of Gibraltar, is the transition sub-basin where the pure Mediterranean water undergoes for the first time a strong mixing and entrainment with the Atlantic water. It can be considered as the sub-basin where the source water of the MW observed in the Nord Atlantic is originated. In particular, for our study, we selected the northern region of the Gulf of Cadiz, between 35.5°N and 37.0°N and west of 5.9°W, where most of the water of Mediterranean origin flows and is clearly observed.

Data were gathered from different data banks. Unfortunately, the collected data are not uniformly distributed in time, making the analysis more suitable for the last fifty years, and moreover the data set can give a good behaviour of MW properties within the last century.

Temperature and salinity observations in the Gulf of Cadiz area show seasonal, interannual and decadal variations. Figure 1 shows salinity and temperature records at a depth of 1200 m including the standard deviation of the data. The standard deviation around the mean value can be quite variable. It has been calculated by assembling the data from the same month over the entire period; moreover it is obtained combining data from different cruises and often from different parts of the basin. Looking at the entire time series, the temperature shows a warming trend of 0.11°C/decade, and salinity an increase of 0.035 psu/decade. These results compared with those, for example, computed by Potter and Lozier [1] (temperature 0.101 $\pm$ 0.024 °C/decade and salinity 0.0283 $\pm$ 0.0067 psu/decade), based on hydrographic data collected since 1955, confirm that the Mediterranean outflow waters in the eastern North Atlantic show a density compensated increase in both temperature and salinity.

Any possible mechanisms to explain the observed variability of MW, certainly involve the variability of the Mediterranean water mass in connection with the physics of the Strait of Gibraltar.

In particular, our analysis has taken into consideration those processes occurring during the first stages of the spreading of MW in the North Atlantic that are most likely to be affected by changes occurring inside the Mediterranean Sea, like hydraulic control and warming of the Mediterranean source water.

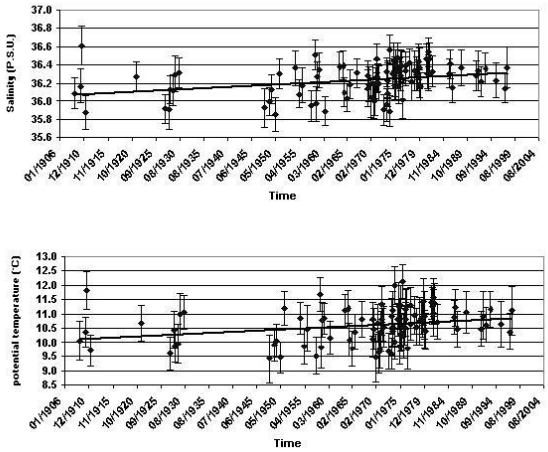

Fig. 1. Salinity and temperature records at a depth of 1200 m with linear trends.

Reference

Potter R.A. and Lozier M.S., 2004. On the warming and salinification of the Mediterranean outflow waters in the North Atlantic. *Geophys. Res. Lett.*, 31(1), L01202, doi:10.1029/2003GL018161.