WATER MASSES AND SEASONAL HYDROGRAPHIC CONDITIONS IN THE SARDINIA-SICILY-TUNISIA REGION

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Abstract

Several hydrographic cruises and long term current measurements carried out in the Sardinia-Sicily-Tunisia region as a part of different EU projects allowed us to significantly improve the knowledge on the water masses flowing into this region and their time variability. The observation of the different water types indicates that the mass exchanges between the two principal sub-basins of the Mediterranean are more complex than previously known. The analysis of the seasonal characteristics of the Modified Atlantic Water (MAW) and the Levantine Intermediate Water (LIW) clearly indicates that they are subject to significant seasonal changes.

Key-words: Hydrography, Sicilian Channel

Introduction

The area between Sardinia, Sicily and Tunisia is a key region for the comprehension of the exchanges between the Eastern and Western Mediterranean basins. It is bounded by three of the most important straits and passages in the Mediterranean: the Sicily Strait to the East, the Sardinia Channel to the West and the Sicily-Sardinia passage to the North. The Sicily Channel, about 140 km wide at the surface, reduces its extension below 200 m with two narrow passages 450 and 325 m deep, respectively. The Sardinia Channel is a zonally oriented passage connecting the Algerian and the Tyrrhenian basins, with a sill depth of about 1900 m. Finally, the Sicily-Sardinia section forms the southern boundary of the Tyrrhenian characterized by two main passages, of which the deepest one tightly connected with the Sardinia Channel. Previous studies (1,2) pointed out the complexity of the processes in the region and the role of the bottom topography in sustaining them, and provided a first estimation of the involved fluxes. The main knowledge about the water masses crossing this region mostly concerns the MAW and the LIW. MAW enters the area from the Algerian Basin and principally flows towards the Sicily Channel and the Tyrrhenian Sea. After having recirculated inside this basin, part of this vein exits again from the Sicily-Sardinia section, while another part outflows from the Corsica Channel. LIW reaches the region trough the Sicily Channel. From it, it flows towards the Tyrrhenian Sea following the same fate as the MAW: most of it outflows again from the Sicily-Sardinia section and only a small part from the Corsica Channel. Concerning the Deep Water, the few available information, indicate the importance of the exchanges between the Algerian and the Tyrrhenian Basins (3). It can be said, however, that, until very recently, most of the knowledge was derived from oceanographic campaigns covering only partially the considered area.

Starting from November 1993 a new experiment was initiated as a part of the MTP1 of the EU. It was mostly based on a seasonal intensive hydrological investigation of the whole region (seven cruises for the period 1993-97) and on direct long term current measurements in the Sicily Strait and the Sicily-Sardinia section. The achieved results permitted to verify the presence and patterns of different water types, some of them not identified before (4,5). In addition, the collected data show that MAW and LIW are subject to a clear seasonal signal. In the following we will describe the principal characteristics of water masses present in the area and some aspects connected with their seasonal variability.

The water types in the Sicily-Sardinia-Tunisia region

The analysis of the hydrographic characteristics along the Sicily Channel indicate that:

a) At the Sicily Strait the MAW is always present with two veins. While the most evident of them is along the Tunisian coast, the other is in correspondence of the southeastern Sicilian Shelf.

b) The Levantine flow is divided by the central ridge enhancing from the Strait of Sicily and constrained in the two resulting channels which induce different dynamic properties in each of the two veins.

c) The Levantine flow is actually composed of two water types: the one known as LIW (T=13.85, S=38.75), and another one colder and denser which always flows close to the bottom of the Tunisian side of the Strait. The latter was identified as a transitional Eastern Mediterranean Deep Water (tEMDW) (T=13.65, S=38.73), resulting from a mixing between LIW and EMDW (5).

d) Both the MAW and LIW display a significant seasonal variability while crossing the Sicily Channel.

The hydrographic data along the Sardinia Channel, besides displaying the inflow/outflow of MAW and the outflow of LIW, indicate that two other water masses enter the considered region (Fig.1):

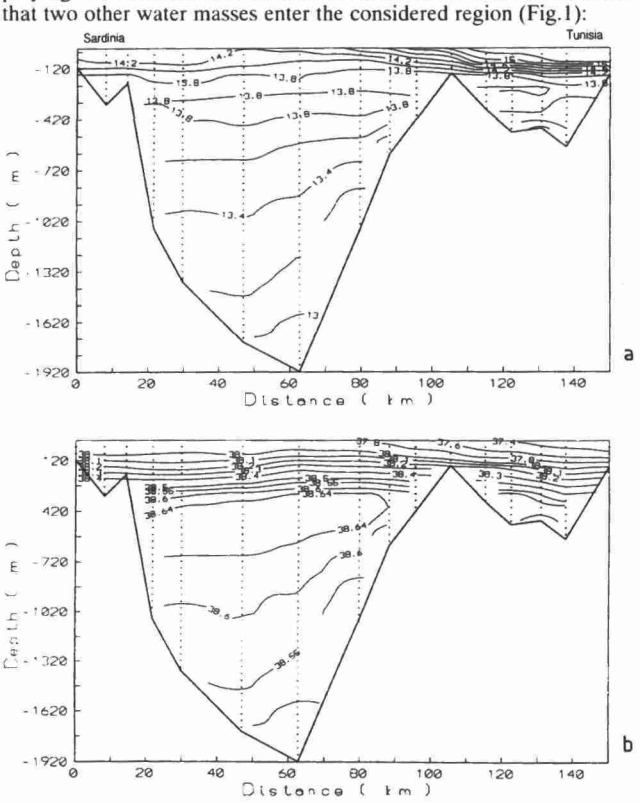

Figure 1 : Sardinia-Tunisia cross-section. (a) Temperature distribution and (b) Salinity distribution during January 1997.

1) one at the bottom of the deepest part of the Channel. The hydrographic characteristics (T=12.80, S=38.44), and the Oxygen values higher than the upper layers, indicate it as a Western Mediterranean Deep Water (WMDW). After having recirculated in the Western Mediterranean, a significant part of WMDW crosses the Sardinia Channel and flows into the Tyrrhenian;

2) the other has the characteristics of the Intermediate Water present the Western Mediterranean (T=13.10, S=38.50). This means that a significant part of LIW flowing in the Western Mediterranean, instead of outflowing from the Strait of Gibraltar, follows the African slope and crosses the Sardinia Channel from where it enters the Tyrrhenian Sea at about 800 m of depth.

After having recirculated in the Tyrrhenian, where they are subject to intense mixing processes that significantly change their original properties, both these waters exit from the basin along the Sardinia slope of the Sicily-Sardinia section.

The seasonal variability of MAW and LIW.

The analysis of hydrographic data all over the region, allowed to verify if the seasonal variability evidenced by the current measurements at the Sicily Strait can even be observed in the hydrographic pattern within the area. Concerning the seasonal signature in the