VARIABILITY ON ISOPYCNAL AND ISOBARIC SURFACES ASSOCIATED TO THE WESTERN MEDITERRANEAN TRANSITION

Patricia Zunino [1]*, Katrin Schroeder [2], Gian Pietro Gasparini [2] and Manuel Vargas-Yañez [1]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Málaga, Fuengirola, Spain - pzunino@ma.ieo.es
[2] Consiglio Nazionale delle Ricerche. Istituto di Scienze Marine, La Spezia, Italy

Abstract

In the deep layers of the Western Mediterranean, an almost constant trend towards higher temperature and salinity has been observed since the 50´s, with an acceleration on these trends in the 90´s decade, as a result of the propagation of the EMT signature, from east to west. Indeed, an exceptional deep water formation event has been documented in winter 2004/2005 in this basin. After this intense event, the large volume of new deep water formed has caused an uplifting of the old deep water, replenishing the deep basin with the new warmer and saltier water. In order to detect the effects of water mass changes and vertical displacement, we investigated the variability of seawater properties on isopycnal and isobaric surfaces from 1995 to 2008, with special attention to the last years, when the WMT have been happening.

Keywords: Western Mediterranean, Deep Waters, Density

The recent acceleration of deep temperature and salinity changes in the Western Mediterranean (WMED) [1] has been followed by a major change in the basin after 2005 deep water formation processes. These events have produced the basin-wide spreading of a deep thermohaline anomaly, which is called Western Mediterranean Transition (WMT, [2]). Temperature and salinity changes on isobaric surfaces have two effects added: changes along isopycnal surfaces (related to water mass changes) and those induced by the vertical displacement of isopycnals (related to wind stress curl and formation rate of deep water) [3]. These authors proposed the following equation to evaluate how the two effects lead to changes on each pressure level:

$$\left.\frac{d\theta}{dt}\right|_p = \left.\frac{d\theta}{dt}\right|_\sigma - \left.\frac{dp}{dt}\right|_\sigma \frac{\partial\theta}{\partial p}$$

This methodology has recently been applied for the first time in the WMED [4]. The aim of the present work is to indentify how intense deep water events could move upward old deep water and what would be the effect of the vertical displacement of isopycnals (referred to as heaving [3]) when temperature and salinity changes are studied on isobaric surfaces. We focus on the WMT because of the larger volume of deep water formed than previous years. Therefore, the heaving should have an important effect on temperature and salinity changes estimated on isobaric surfaces.

We have analyzed temperature and salinity data from the DYFAMED station from 1995 to 2008, as well as data from different surveys carried out from 2004 to 2008 on board of the R/V Urania, owned by CNR-ISMAR.

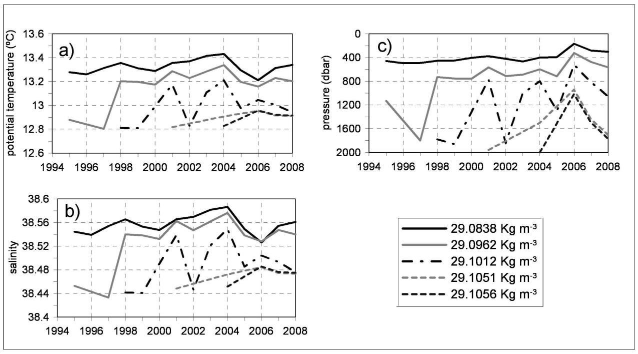

Fig. 1. A) Potential temperature, b) salinity and c) pressure evolution along some selected density surfaces from 1995 to 2008. Data from the DYFAMED station.

Preliminary results show salinity and temperature increases along both isopycnals and isobaric surfaces since 1995 up to 2004 in the intermediate and deep layers (fig 1 a and b show temperature and salinity evolution along isopycnal surfaces). But, after the WMT event, temperature and salinity increase in the bottom layers while they decrease in the intermediate layer. Concerning the WMT, the volume of deep water generated during this event is larger than in previous years [5], causing the upward displacement of old deep water (Figure 1c shows the shallowest levels achieved by all the represented isopcynals in 2006). The effect of this upward movement was a cooling and freshening on isobaric surfaces (dashed black line in fig 2 A and B). In this case isopycnal and heaving contribution have the same sign, adding both effects, resulting in a cooling and freshening effect on isobaric surfaces which are larger than those that really affected the water masses by themselves.

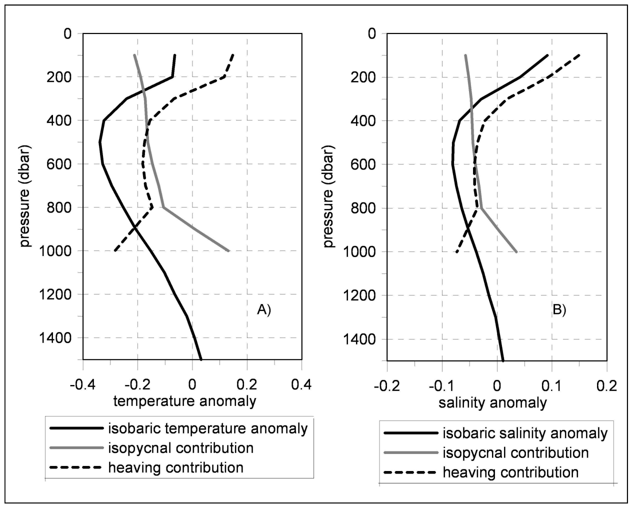

Fig. 2. A) T and B) S anomalies on isobaric surfaces (black line), and their both contributions: isopycnal (grey line) and heaving (dashed black line). These anomalies correspond to 2006 (after the WMT) with the 2004 (before the WMT) profile as reference.

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