WINTER 2009. A NEW STEP IN THE WESTERN MEDITERRANEAN TRANSITION

J. Salat [1]*, M. Emelianov [1], P. Puig [1], J. Font [1] and J. L. Fuda [2]
[1] Institut de Ciències del Mar (CSIC), Barcelona, Spain - salat@icm.csic.es
[2] Centre d'Océanologie de Marseille (COM), Marseille, France

Abstract

The signal of Deep Water Formation (DWF) activity in winter 2009 has been tracked through the HydroChanges (HC) time series, particularly in the classical MEDOC point (HCM: 42°N, 5°E) and on the Catalan continental rise (HCC: 41°28'N, 3°40.4'E), and from CTD data obtained during three cruises during 2009. The results pointed out to an absence of cascading and a new step towards a salinisation of the WMDW newly formed by open sea convection in the western side of NW Mediterranean. The updated data reveal that older WMDW, slightly colder and less saline, has been displaced towards the SE. The salinity of the newly formed WMDW after winter 2009 was ~ 0.005 higher than the previous one, with a potential density increase of 0.002-0.004 kg/m^3.

Keywords: Deep Waters, Water Convection, Western Mediterranean

Introduction

A new structure of the WMDW since 2005 forming a 'hook' in the θS diagram has been extensively described in recent papers and summarized in the CIESM Monograph 38 [1], being one of the major effects of what has been termed as Western Mediterranean Transition (WMT). The structure of the WMDW shows three water types: a θS minimum below the LIW, corresponding to the WDMW before 2005, followed by a relative maximum of θS and a new relative minimum of θS at the bottom. This three points, or water types forming the 'hook' structure will be named respectively as 'O', 'N' and 'C' as in [2]. This presentation is devoted to the characteristics and distribution of the WMDW newly formed in winter 2009. To avoid confusions, the whole structure of the WMDW present before the 2009 modification will be indicated as PDW, and the contribution of this year as NDW.

Data available and results

After two relatively mild winters of 2007 and 2008 with almost no activity of DWF, HCM series from 2200 m depth, displayed an abrupt shift of S (+0.010) and θ (+0.040°C) between 13 and 15 February 2009 [3]. While θ slowly recovered the previous values, the S shift lasted at least until the end of May, when the mooring was recovered. Data from the HCC site, at 1850 m depth, showed similar shifts 5-6 days later (Fig.1). As in HCM, θ progressively recovered the old values and S was slightly reduced during the next months, but when the mooring was recovered in September, a difference of (+0.006) still persisted. Therefore, the potential density of the deepest layer suffered an increase between 0.002 and 0.004 kg/m^3 in 2009. Unfortunately no CTD probe was available during the recovery operation to examine the hydrographic structure above the mooring site.

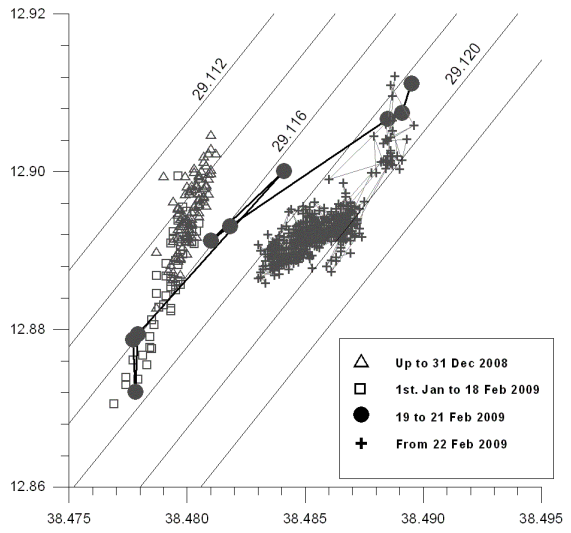

Fig. 1. θS diagram of the HCC series

In both HCM and HCC moorings near bottom currents and turbidity were also recorded. At the HCC site, the current was steadily slow (<10 cm/s towards the south) until 19 February. Then it became unstable with some fluctuations that lasted one week. After this instability episode the current shifted towards the SE during two weeks. After 7 March, currents recovered the southwards direction but with much stronger velocities (>30 cm/s) up to 12 March when slowed to <10 cm/s again. Suspended sediments were low except during the acceleration period (8-12 March), being consistent with a signal of local sediment resuspension.

Data from CTD casts in the NW Mediterranean after this DWF period were obtained in the framework of the FAMOSO Project in March (8-23), May (1-13) and September (14-20) 2009. Although sampling in those cruises was not dedicated to study the spreading of the newly formed WMDW (NDW), data obtained can be suitable for this purpose as there were several deep casts between HCM and HCC sites. The first CTD casts in March showed almost homogeneous waters from 0 to 2400 m in front of the Catalan coast (41°30'N, 3°30'E) with θ and S corresponding to the NDW values observed in the HC series. This NDW was present in several stations not only in March but also in May and still in September, at least in the NW sector. The thickness of the layer occupied by the NDW was higher (>300 m) in the stations located near the continental slope, becoming thiner towards the east and south. Accordingly, the whole PDW structure was displaced upwards and southeastwards.

Discussion

February 2009 has been much colder and windy than the two precedent years in the western side of the Gulf of Lions and along the Catalan coast. Northerlies were very frequent and some of them were very strong (*e.g.* the storm of 4-7 March with sustained winds of 40 m/s). Under such atmospheric forcings a response similar to that in winter 2005 could be expected, with strong convection and deep cascading. However, there is no evidence of this latter phenomenon in 2009, probably due to the water properties over the shelf at the beginning of the stormy period. While autumn 2004 and winter 2005 were very dry, autumn 2008 end winter 2009 were wet. Therefore salinity over the shelf had to be much lower than in 2005 thus preventing an excessive increase of the density. However, in open sea, the convection could be as active as it was in 2005 involving again important amounts of LIW over a large area, including zones near the continental slope where WIW formation typically takes place. For instance, the short time interval between the shift in HCM and HCC (less than one week for a distance of >120 km), or the structure found in the first CTD casts of the FAMOSO cruise in March, reveal a probable local origin of the perturbation. From now, the NDW reaching the bottom layer should mix with the C water type of PDW near the bottom contributing to a new increase of salinity in the bottom layer and pushing upwards, one step more, the O water type (from before the start of the WMT in 2005). As these O waters are located just below the LIW, a further decrease of the salinity of the intermediate waters reaching the western slopes can be expected in the following years, as it has been observed in the MOW at Gibraltar after the WMT.

References

1 - CIESM, 2009. Dynamics of Mediterranean deep waters. N° 38 in *CIESM Workshop Monographs* [F. Briand, Ed.], 132 pages, Monaco.

2 - Salat, J. Emelianov M. and López-Jurado J.L., 2007. Atypical Western Mediterranean Deep Water formation during winter 2005. *Rapp. Comm. int. Mer Médit.*, 38: 197.

3 - Fuda J.L, Bengara L., Ben Ismail S., Curtil C., El Moumni B., Font J., Lefevre D., Millot C. Taupier-Letage I., Raimbault P., Rougier G. Sammari C. and Tamburini C., 2009. Recent dense water formation in the Med western nasin, as observed by HYDROCHANGES. *In:* F. Briand (ed.), Dynamics of Mediterranean deep waters. *CIESM Workshop Monographs*, 38, pp 29-33.