IMPACT OF THE EASTERN MEDITERRANEAN TRANSIENT (EMT) ON THE NORTHWESTERN MEDITERRANEAN SEA (NWMS): THE CASE OF THE EXCEPTIONAL 2004-05 CONVECTION EVENT

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Abstract
Spectacular convection occurred in the NWMS during 2004-05: the convection area was exceptionally large, and Western Mediterranean Deep Water (WMDW) formed this winter was warmer and saltier than usually. We perform numerical oceanic simulations to assess the respective contributions of oceanic and atmospheric conditions to this event. Our results suggest that WMDW characteristics are mainly related to the NWMS heat and salt contents before the convection. The increase of those characteristics in 2004-05 is due to an increase of those contents, due to the absence of strong convection during the 90's. Convection intensity is related both to the winter atmospheric conditions and to the autumn NWMS stratification. The EMT modified this stratification in autumn 2004, potentially doubling the volume of WMDW formed.
Keywords: Deep Waters, Gulf Of Lions, Western Mediterranean, Water Convection, Air-Sea Interactions

Open ocean deep convection takes place in a few regions of the world ocean, among which the NWMS [1]. In this region, the combination of cyclonic circulation and strong winter surface buoyancy losses associated to northern wind events (Mistral, Tramontane) induces deep convection events, at the origin of the formation of WMDW. During winter 2004-05, an exceptionally strong convection event was observed by several experimentators [2, 3, 4]: it covered an area much larger than usually, and the WMDW formed this winter was significantly saltier and warmer than the values reported in the literature.

Two major explanations for the exceptional characteristics of this convection event (intensity and WMDW characteristics) were proposed by those authors: the first one relates the exceptional intensity of this convection event, as well as the change of the characteristics of the WMDW formed this winter to the atmospheric conditions. The second one relates them to the effect of the EMT on the Ligurian Intermediate Water (LIW), hence on the oceanic conditions. To determine which element played a role in this event, and how, we performed several numerical simulations.

First we performed a realistic numerical simulation of the Mediterranean oceanic circulation during the 1958-2006 period. The long term analysis of this simulation was performed by [5], who validated the long-term evolution of the temperature and salinity in the basin and showed that the model is able to reproduce correctly the EMT. This control simulation is able to reproduce very realistically the 2004-05 NWMS convection event, in terms of chronology, intensity and WMDW characteristics.

We also performed sensitivity simulations, in order to assess the contributions of the oceanic and atmospheric conditions to this convection event. The results show that, for given atmospheric conditions, the temperature and salinity of the WMDW are linearly related to respectively the heat and salt contents of the NWMS just before the convection event (Fig. 1). They suggest that the change of WMDW characteristics observed in 2004-05 was related to an increase of those heat and salt contents during the last decade. The model suggests that this increase was not due to the EMT, but to the absence of deep convection during the 90's enabling salt and heat to accumulate in the LIW. This absence of strong convection was related to the weakness of the winter buoyancy loss during this period. WMDW characteristics are therefore not influenced by the atmospheric conditions during its formation, but by the evolution on those conditions on the long term. The EMT induced a deepening of the LIW in the Western basin, observed by [6] and reproduced by the model, that resulted in a decrease of the stratification of the water column compared to what could have been the case without the EMT. Our results show that, for given atmospheric conditions, the intensity of deep convection in terms of WMDW formed is linearly related to the stratification of the water column just before the convection event. Moreover, in 2004-05, convection reaches the bottom in all the simulations, whatever the pre-convection stratification. It therefore appears that the strong atmospheric conditions during winter 2004-05 were responsible for the intensity of the convection this year, but that the EMT accentuated this intensity by weakening the stratification, and potentially doubled the volume of WMDW formed.

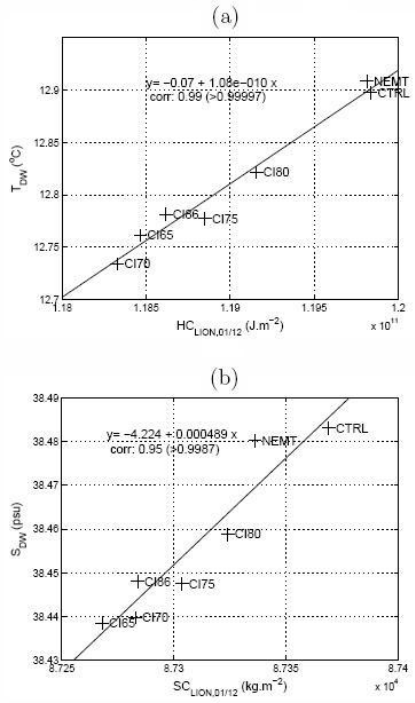

Fig. 1. Relations between the pre-convection heat (a), resp. salt (b), content over the Gulf of Lions and the WMDW temperature, resp. salinity.

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