On the Variability of the Mediterranean Outflow Water in North Atlantic HYCOM Simulations

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1. Introduction

Several questions remain unanswered about the role and importance of the Mediterranean Overflow Water (MOW) for the Atlantic Ocean circulation and the global thermohaline circulation. Of particular interest is the temporal variability of the MOW and the mechanism(s) responsible for such variability on interannual and decadal scales. The source of the MOW variability can be attributed to changes in the North Atlantic Central Water (NACW) entrained in the Gulf of Cadiz, changes in the source water (i.e. Mediterranean Sea water), or both.

Potter and Lozier (2004) analyzed the variability the MOW at the depth of 1150m from observations collected between 1955 and 1993 in the vicinity of the Gulf of Cadiz. They found a positive trend in both temperature (0.101 +/- 0.024ºC/decade) and salinity (0.0283+/- 0.0067psu/decade). More recently, Leadbetter et al. (2007), analyzing data from transects at 36ºN performed in 1959, 1981 and 2005 found a 20-year reversal in the water mass trends of MOW. This reversal trend consists in a warming and saltening of the MOW between 1959 and 1981, and a cooling and freshening between 1981 and 2005. Yet, the variability of the water in the western Mediterranean Sea shows weaker positive trend in the intermediate and deep layers till 2000 (0.035ºC/decade; 0.01psu/decade, Rixen et al. 2005) and higher trends in the last years (+0.30ºC/+0.02psu; Millot et al., 2006).

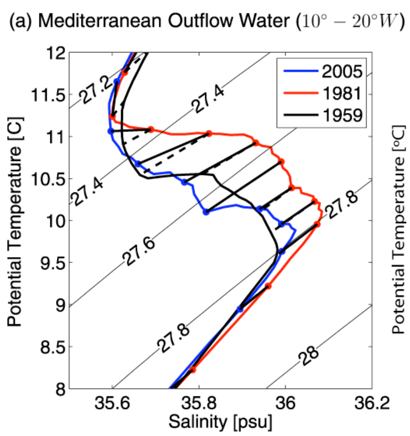

Figure 1: Mean observed θ/S profile of a section at 36ºN between 10º-20ºW at the depth of the MOW on neutral density (from Leadbetter et al., 2007).

2. Objectives and Method

In this study, we aim at determining the component(s) (i.e. Mediterranean Sea water or entrained NACW) responsible for the observed 20-year reversal trend. We use a 1/3º Atlantic configuration of the HYbrid Coordinate Ocean Model (HYCOM-http://www.hycom.org/) with the Price and Yang (1998) box model used as boundary condition for the Mediterranean outflow. A 56-year realistic experiment forced by NCEP interannual atmospheric fields (1948-2003) is performed to test the ability of the model to reproduce the observed variability. This interannual experiment is compared with a control experiment forced with climatological atmospheric fields. Each experiment starts from the same 20-year spin-up that uses the GDEM3 climatology as initial state. The northern and southern boundaries are treated as closed and the T/S values are relaxed toward the GDEM3 climatology. In the Price and Yang box model, the salt and heat budgets of the Mediterranean Sea are constant. Therefore, no variability of this marginal sea is introduced in the system.

3. Results

When compared to the observations, HYCOM presents a warmer and saltier Mediterranean tongue at 36ºN between 10º and 20ºW. However, the model succeeds in reproducing the variability observed by Leadbetter et al. (2007), showing that this 20-year reversal trend comes from the Atlantic Ocean and not from the Mediterranean Sea. The analysis of the results of the Price and Yang box model also shows that this variability results mostly from the variability of the entrained water (North Atlantic Central Water) in the Gulf of Cadiz (not shown). The comparison with the climatological run (Fig 2c) shows that the observed variability is not internal variability to the Atlantic Ocean or due to a model's drift but is actually by the atmospheric forcing.

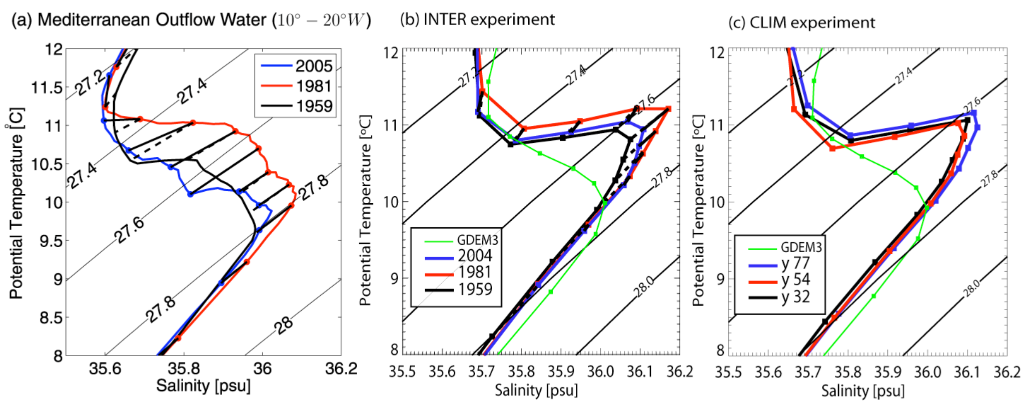

Figure 2: Mean θ/S profile of a section at 36ºN between 10º-20ºW at the depth of the MOW for a) observations (Leadbetter et al., 2007), b) for experiment INTER and c) experiment CLIM. The initial state (GDEM3) profile is plotted in green.

Acknowledgments.

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