INTERANNUAL VARIABILITY OF DEEP WATER FORMATION IN THE GULF OF LION

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Abstract
We are presenting a study of the interannual variability of the oceanic winter convection in the Gulf of Lion in the western Mediterranean Sea with a high resolution oceanic numerical model (5 km) forced by ECMWF analysis (50 km). The experiment concerns the period 1998-2007. The results were compared to recent climatology based on observations. Time and space variability have been quantified in relation with the local atmospheric forcing.
Keywords : Gulf Of Lions, Water Convection.

Introduction
In the western Mediterranean Sea, the Western Mediterranean Deep Water (WMDW) forms in the Gulf of Lion in winter. Using a high resolution numerical Mediterranean model [1] forced by ECMWF analysis (50 km), the interannual variability of the convection was studied from 1998 to 2007. The convection occurs in the region centered on 42^{o}N and 5^{o}E in agreement with the observations [2]. The three phases described in [3] for the deep water formation processes are well noticed in the experiment:

- the doming structure and an initial cooling of the surface waters down to 200 m in fall,

- another cooling of surface waters down to the upper part of the Levantine Intermediate Waters at 400-500 m at the beginning of winter, which is followed by a violent mixing down to deep layers at the end of February or at the beginning of March and that is represented by several chimneys whose diameter is of several kilometers,

- the restratification starting at the beginning or middle of March.

The WMDW temperature is generally higher by 0.1-0.2^{o}C in our experiment than in the literature based on observations [2, 3]. Timeseries of the maximum depth reached by the convection illustrate the high interannual variability in the model with values ranging between 600 m and 1300 m.

Winter convection
For each winter, maps representing the area where the vertical mixing has been at least once deeper than 450 m, have been displayed. The results are in good agreement with those reported in [4] from data analysis. The mean spatial coverage of this area ranges between S_{depth}=4,000 km^2 and S_{depth}=21,000 km^{2}in good agreement with the observations reported in [4]. Time-series of the area where the vertical mixing was deeper than 450 m during each 5-day interval (inside each S_{depth}) were calculated to characterize the intermittency of the preconditioned and deep convection processes during each winter. The results show two different regimes corresponding to:

- Regime 1: only one convective event with a large spatial coverage (75% of S_{depth}) and a short duration (20 days to one month) -which was the case in winters 1999 and 2003 -,

- Regime 2: several convective events with a lower spatial coverage (25% of S_{depth}) but occurring successively during a longer period (2 to 3 months) - which was the case in winter 2000-.

Then we have correlated the 5-day mean spatial coverage to the 5-day mean atmospheric forcing for each winter. It appears that regime 1 seems to be triggered by local heat loss larger than 750 Wm^{-2} associated with strong winds, while regime 2 is triggered by local heat loss of the order of 400 Wm^{-2} associated with moderate winds.

Conclusions
According to this numerical study, the strong mixing phase of the convection during winter depends on several regimes mainly triggered by the local atmospheric forcing. We present the results for the1998-2007 period, the later three years being rich in in situ measurements, which helps the model validation.

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