IMPLICATIONS OF A WINTER CIRCULATION ANOMALY IN THE CATALANO-BALEARIC SEA FOR DEEP MIXING AND PHYTOPLANKTON DISTRIBUTIONS.

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Abstract
The reduction of deep mixing extent and changes in phytoplankton distributions due to an anomaly in the circulation during winter are presented and compared with a typical winter.

Keywords: Deep mixing, phytoplankton, NW Mediterranean, marine circulation

Introduction

Deep mixing is a well known feature occurring at open sea in the Northwestern Mediterranean during winter. After the strong mixing pulses once the ocean is stratifying again there is an important spring phytoplankton bloom which is using the nutrient enrichment at the photic level. The extent and distribution of strong mixing is controlled both by northerly winds and the current pattern. Usually the circulation describes a cyclonic path with maximum current speeds near the continental slopes. In the centre a typical doming of isopycnals (1) which, under the typical winter conditions, is preconditioning the surface waters for deep mixing that will be triggered by strong northerlies. Only during very mild winters (2), mixing might not get the deepest layers.

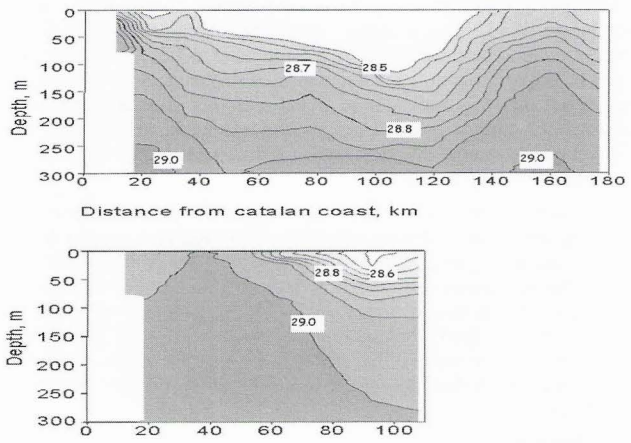

Fig. 1. Vertical sections of density across the Catalano-Balearic sea. Up: winter 1999, Down: winter 2000

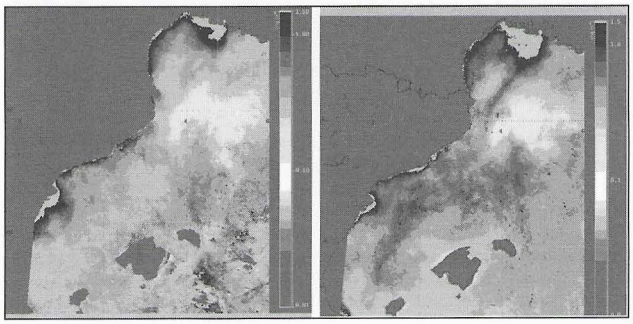

Fig. 2. Seawifs images of chlorophyll. Left: winter 1999, Right: winter 2000.

It has been agreed that the variability in the extent of the deep mixing process is directly related to the "severity" of the winter and the intensity and persistence of northerlies. This assumption however impliclty includes that the variability of the circulation pattern in the northern half of Western Mediterranean is relatively small or, at least, it maintains its cyclonic tendency over all the northern basin.

Results and discussion

In winter 1999 a persistent anticyclonic eddy was detected in the centre of the Catalano-Balearic sea (3). The classical doming of isopycnals was then limited preventing the southern extent of deep mixing process, even when the atmospheric conditions were suitable. The water mass involved in this anticyclonic eddy was a relatively new AW, with low surface salinity, instead of the classical old one with higher salinity. Consequently the surface of the central part of the Catalano-Balearic basin remained stratified during this winter. In other words, it was impossible to reach the surface density values high enough so that they become available for deep mixing. This anomaly imposed a severe restriction to the deep mixing extent south of 42°N and created a W-E frontal situation across the basin around this parallel. As a result, the northern current was deflected towards the east and did not reach the southern half of the Catalan slope. It was there replaced by a current from the south.

The biological distributions obtained from two oceanographic winter cruises in the Catalano-Balearic sea (Winter 1999 and 2000), carried out respectively under the anomalous and typical winter conditions, reveal the effects of the anomaly both near the coast and in open sea.

In 1999, high chlorophyll concentrations (chl_*a*), associated with diatoms, developed in the northern part of the study area and very close to the Catalan coast, while the anticyclonic eddy remained dominated by haptophytes (including *Phaeocystis* and coccolithophorids) and other flagellates, and presented relatively low chl_a concentrations. In winter 2000, elevated phytoplankton biomass values could be also found in the central zone, including diatoms.

The subsequent development of the winter phytoplankton bloom, as seen through SEAWIFS images, also presented marked differences between the winters of 1999 and 2000. From January to March, chl_*a* in the whole Catalano-Balearic Sea appeared to be lower in 1999 than in 2000. However in the northern part of the Western basin, chl_*a* in 1999 were much higher than in 2000 but the opposite happened in the area to the West of the Balearic Islands. These chl_*a* patterns appear to be linked to the presence of the anticyclonic eddy and its role blocking the typical circulation pattern.

Both the changes in total phytoplankton biomass and the dominance of different phytoplankton assemblages have ecological consequences. Diatom dominance favours the so-called classical food web (phytoplankton-mesozooplankton-fish), while small flagellates tend to enter the microbial food web. The reported observations suggest that the presence of anticyclonic eddies like that registered in 1999 may have important biogeochemical implications in addition to limiting the extent of deep mixing processes.

References

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