

RECENT EVOLUTION OF THE MIXED LAYER ANOMALIES AND THEIR EFFECTS ON COSTAL ECOSYSTEMS IN THE MEDITERRANEAN SEA

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Abstract

This study aims at linking changes in the thermal stratification of the upper water column to the occurrence of mass mortalities of benthic invertebrates, which are increasingly reported in the Mediterranean Sea. We analyze changes of the mixed layer depth and of the mixed layer temperature for the period 1945-2011 by using all hydrographic temperature profiles available in the basin. Results show a widespread increase of thickness and temperature of the mixed layer. It is shown that most mass mortalities occurred when anomalously high mixed layer temperature and thickness has been observed.

Keywords: Mortality, Mediterranean Sea, Global change

Introduction

The reported frequency of mass mortality events of benthic invertebrates in the Mediterranean Sea has increase during the last decades and most of them are consistent with positive temperature anomalies at basin scale [1]. Several studies have also directly associated these events to sudden deepening of the mixed layer [2]. This layer is one of the most important upper ocean features and it is commonly estimated from temperature or density profile data. Our analysis considers the whole Mediterranean Sea for the period 1945-2011. It aims to identify the effect of MLD (Mixed Layer Depth) and MLT (Mixed Layer Temperature) on mass mortality events.

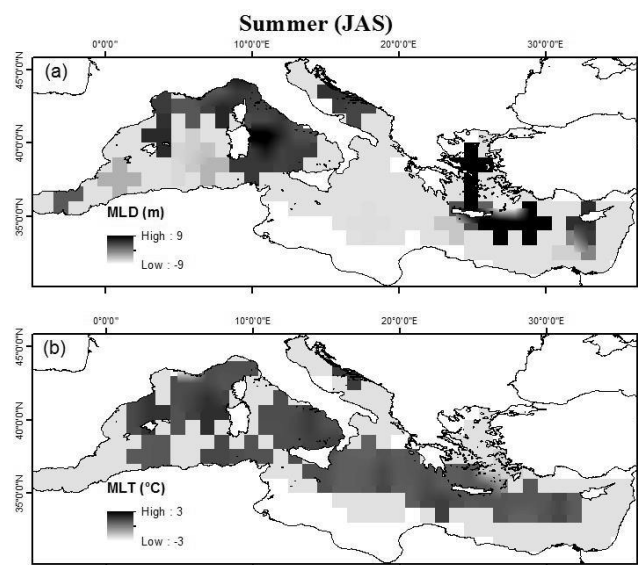


Fig. 1. Variations of MLD (a) and of MLT (b) in summer. Depth/temperature variations are computed as difference between average depth/temperature values in the period 1983-2011 and those in the period 1945-1982 in 1°lat x 1°lon cell.

Materials and methods

We analyzed a hydrographic temperature profiles in the Mediterranean Sea, including bottles, MBT, XBT and CTD, mainly extracting data from the MEDAR/MEDATLAS database [3]. Mass mortalities events have been identified on the basis of published studies. The "three segments profile" model has been selected among different procedures as it has been shown to yield robust results for most temperature profiles [4]. This method approximates the upper water column with three segments representing mixed layer, thermocline and deep layer. The parameter values defining these three segments are determined by an optimization procedure that minimizes the root mean square error of the idealized profile with respect to the observations.

Results and discussion

Changes in the stratification of the upper water column across the Mediterranean Sea have been assessed comparing mean values of the MLD and MLT for the periods 1983-2011 and 1945-1982, and their difference has been binned in boxes of 1°lat×1°lon. These two periods have been chosen because all reported mass mortalities occurred after 1983 (Fig. 1). Most cells show an increase of MLD (Figure 1a) with the exception of the Algerian and of the South Ionian Seas. A clear signal of MLT increase is evident for the whole basin (Figure 1b). In 12 out of 18 location where mass mortalities were reported, the MLT was higher than its mean over the period 1945-1982. Further, 10 events occurred when the MLD was deeper than its mean over the period 1945-1982 (Fig. 2).

Therefore, our results, extensively discussed in [4], show a widespread increase of thickness and temperature of the mixed layer in the last three decades (1983-2011) they support a recent warming of the upper water column and its link with mass mortality events.

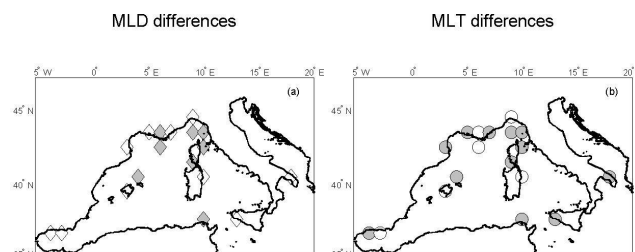


Fig. 2. MLD (a) and MLT (b) during mass mortality events. White/grey rhombus show that the MLD during mass mortality events was deeper/shallower than the mean MLD over the period 1945-2011. White/grey circles show that the MLT during mass mortality events was lower/higher than the mean MLT over the period 1945-1982.

References

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