THE SICILY CHANNEL RECORD: HOW A MARGINAL SEA RAPIDLY RESPONSES TO CLIMATE CHANGE

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Abstract

Due to its relatively small size and its geographical location, enclosed between continents, the Mediterranean Sea is very sensitive and responds relatively rapidly to atmospheric forcings and/or anthropogenic influences, compared to oceanic timescales. Indeed, the whole Mediterranean region has been defined as a "hot-spot" for climate change [1], as numerical model projections indicate pronounced mean warming and large decrease in precipitation. The long term record of thermohaline properties in the Sicily Channel provides us a unique occasion to observe how fast this climate change response can be in a marginal sea like the Mediterranean Sea: temperature and salinity trends at 400 m are now up to 10 times larger than the trends reported in literature.

Keywords: Temperature, Salinity, Sicily Channel, Mediterranean Sea, Time series

The Sicily Channel (Figure 1) is the most important Mediterranean passage after Gibraltar. It is the relatively shallow boundary between the two main deep Mediterranean basins, the Eastern Mediterranean Sea (EMED) and the Western Mediterranean Sea (WMED). The monitoring of the Sicily Channel [2] is fundamental for the quantification of the heat and salt exchanges between the EMED and the WMED. The amount and characteristics of the intermediate water flowing westward through the Sicily Channel is crucial in modulating the decadal variability of the Mediterranean thermohaline circulation and the intensity and timing of the dense water formation processes occurring in the northern part of the WMED [3]. The Sicily Channel record, one of the longest Mediterranean time series, starts in 1993 with the aim to detect the hydrological variability in the intermediate water layer.

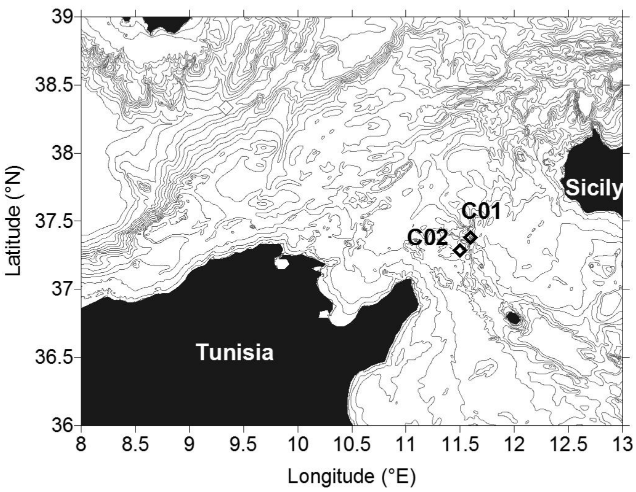

Fig. 1. Location of the moorings in the Sicily Channel (C01 and C02). The sites are part of the CIESM HYDROCHANGES Programme [2].

The long term series at 400 m depth of temperature and salinity (Figure 2) show very important trends: since the beginning of the time series (almost 22 years ago), temperature has increased by about 0.15 °C while salinity has increased by about 0.6 psu. These trends have undergone a dramatic acceleration since 2010, each year reaching higher and higher peak values, and are now up to 10 times larger than the trends reported for intermediate waters in literature (e.g. [4], who reports mean temperature and salinity trends of 0.006 °C/yr and 0.002 /yr, respectively). The intermediate water crossing the Sicily Channel forms both in the Levantine basin and in the Cretan Sea. Analysis of data coming from ARGO profilers and from ship-based CTD suggest that there are important intermediate temperature and salinity peaks in both areas, and that what we observe in the mooring data is a mixture with time-varying mixing percentages of both water masses, Levantine and Cretan Intermediate Waters (LIW and CIW).

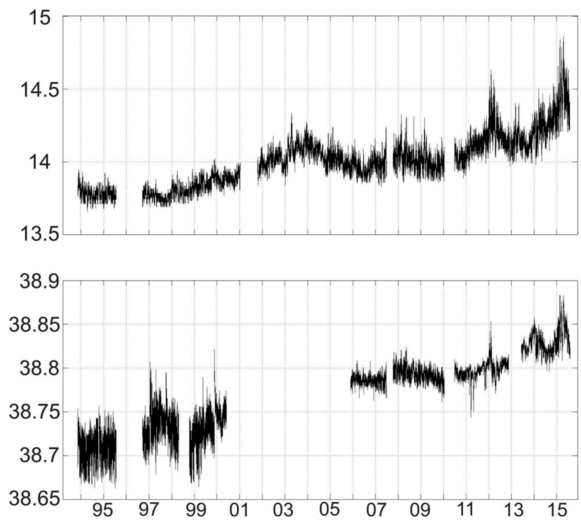

Fig. 2. Time series (3-hourly) of temperature (above) and salinity (below) in the LIW/CIW layer crossing the Sicily Channel (@400m).

It is very likely that the enhancement of the warming trend in LIW/CIW has to be ascribed to an effect of global warming and that the corresponding acceleration in the salinity trend is due to a general reduction of precipitation and riverine inputs and an increase of the evaporation over the Eastern Mediterranean. A recent climatological study [5] reports that the recent drought in the Levant (since 1998) is the driest in the record of the past 500 years. Thus it appears that the Mediterranean is more and more rapidly responding to climate change, and that the concomitant effect of higher regional air temperatures and a stronger evaporation is leading to important water mass changes, that will make more evident the existence of an "oceanographic" teleconnection between the intermediate water formation process in the Levantine basin and the dense water formation in the Gulf of Lion.

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