MEDITERRANEAN WARMING: ANALYSIS OF SEA TEMPERATURE TIME SERIES FROM THE BUOY ODAS ITALIA 1

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Abstract

Starting from July 2002, hourly measurements of meteorological parameters and sea temperature in the layer between the surface and a depth of 35 m are recorded from the buoy ODAS Italia 1 in the Ligurian Sea. In this work we discuss the temporal evolution of the upper ocean thermal structure in relationship with the atmospheric forcings and the dynamic variability of the basin. Particular attention is also devoted to the investigation of the anomalous warming of the sea surface during summer 2003.

Keywords: air-sea exchanges, offshore buoy, surface ocean variability.

The ocean's effect on weather and climate is governed by processes occurring in the few tens meters of water close to the ocean surface. Nevertheless, in spite of its importance, the physics of this portion of the ocean is still poorly known.

In the conceptual models, the ocean surface has a very simple structure such as a well mixed layer of variable depth near the sea surface connected to the permanent thermocline by a seasonal thermocline. Reality is usually much more complex. The thermal structure of the surface layer depends on both local air-sea energy exchanges and main patterns of the regional dynamics. Therefore, its variability is very high at all time and space scales.

Some experiments have been carried out to determine the vertical thermal structure from satellite sea surface temperature (SST) observations. Such inverse methods make an aprioristic assumption about the truthfulness of a layered structure derived by climatological data sets. Even if this approach may have some useful applications, the use of climatologies, as representative of actual situation, prevents to evidence variations at any time scale. The long term changes will be hidden, as well as the short time variability (from daily to seasonal) of the vertical thermal structure, which has been showed to play important roles in upper ocean dynamics and heat transport.

Fixed offshore platforms provide a great contribution to the studies of the upper ocean supplying continuous long time series of both marine and atmospheric surface parameters under every weather conditions.

Due to its location within the Ligurian Basin, the ODAS Italia 1 buoy, moored at 73 Km far from the coast on a 1380 meter deep water, represents an offshore ideal measuring opportunity (1). It is a spar buoy, about 53 meters long, with a small laboratory on its top. The buoy was specifically designed as a stable measuring platform for air-sea interaction studies and it is equipped with a set of meteorological and marine sensors. In particular, five sea temperature sensors have been positioned along the buoy body at -0.5 m, -12.5 m, -20.0 m, -28.5 m, -35.8 m, respectively. The measurements from the sensors are collected each hour by the onboard acquisition system and transmitted to the station ashore. The buoy is operating in the present configuration since July 2002 (2).

The temporal evolution of the upper ocean thermal structure in relation with the atmospheric forcings and the dynamic variability of the basin is here investigated by means of the analysis of the available time series.

Since the buoy is located in proximity of a frontal region, the associated variability is also investigated. The comparative analysis of the thermal gradient in the marine layer from 10 down to 30 meters of depth and the surface water vapour density reveals a good correlation all year round. Moreover, sea temperature data well evidence the seasonal cycle due to the formation and erosion of the upper thermocline as well as other higher frequency processes. Daily variability is often confined to the upper 12 m, even though strong mixing events are able extend the signal at greater depths in the water column. In the lower layers, internal waves in the band of the inertial period prevail. Results from this analysis may also contribute to the definition of more effective strategies for monitoring the sea surface layer.

The anomalous warming period occurred during summer 2003, when the sea surface temperature of the Mediterranean Sea achieved the highest values of the last 50 years, is also considered. By comparing the temperature recorded in summer 2003 with the one acquired one year before, we deduce that surface heating was confined to the upper 10-15 m depth due to the presence of a strong stable stratification lasting several weeks thus preventing any relevant vertical mixing and consequently the heat redistribution along the water column. In fact, no relevant difference is detected below 15 m (Fig. 1). The persistence of calm weather conditions which did not allow vertical mixing processes lasted until the end of August when a strong storm was able to mix the whole layer.

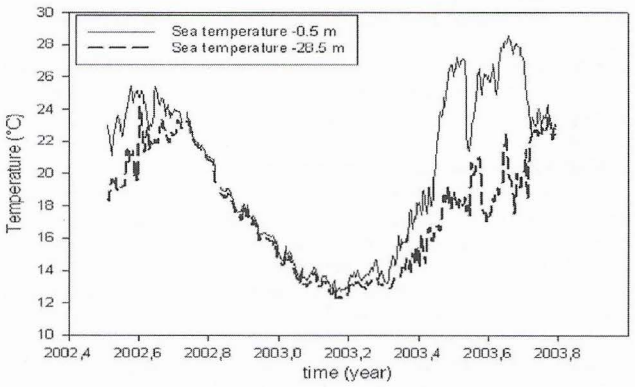

Fig. 1 Mean daily values of sea temperature at -0.5 m and -28.5 m depth from July 2002 to September 2003.

References

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