A MESOSCALE INDEX TO DESCRIBE THE REGIONAL OCEAN CIRCULATION AROUND THE BALEARIC ISLANDS

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Abstract

The formation of Western Mediterranean Intermediate Water (WIW) in the Gulf of Lions and its later presence in the Balearic Channels play a significant role in the regional circulation. The presence of WIW, given by the intermediate water temperatures in the Ibiza Channel, has been related to air temperature in the Gulf of Lions, providing a continuous and long index of regional circulation.

Keywords : Balear Sea, Circulation, Hydrography, Atmospheric Input.

The multidisciplinary IDEA project (www.ba.ieo.es/idea) has analyzed the population dynamics of demersal fishery resources in the Balearic Islands from an ecosystemic perspective (i.e. taking into consideration their natural fluctuations and the forcing factors). One of its objectives has focused on the study of how the inter-annual variability of abiotic factors (oceanographic structure and dynamics) could impact on the demersal ecosystems, and to be more concrete, on the population dynamics of two species exploited by bottom trawlers on deep shelf and slope bottoms: hake (*Merluccius merluccius*) and red shrimp (*Aristeus antennatus*).

Historical oceanographic surveys carried out around the Balearic Islands (western Mediterranean) suggest two different scenarios for the regional ocean circulation during late spring-summer. In one scenario, occurring after cold winters, cool water is formed at intermediate layers (100-300 m) in the Gulf of Lions. This Western Mediterranean Intermediate Water (WIW) usually moves southward reaching the Balearic channels at spring, deflecting the warmer Levantine Intermediate Water (LIW) coming from the eastern Mediterranean, and even stalling the Ibiza channel. On the other hand, during mild winters, less WIW is formed and then LIW flows through the channels, appearing at their characteristic depths. The oceanographic surveys around the Balearic Islands (1985-2004) have provided a qualitative index, indicating the presence or not of WIW in the Ibiza channel, based on the analyses of θ-S diagrams. A quantitative index based on mean water temperature between 100 and 300 meters depth in the channels may also be defined. Both indexes, the qualitative and the quantitative, are well correlated for the period 1985-2004, however, both are short in time and gapped.

In order to obtain a longer and continuous index of presence of WIW and then of regional ocean circulation, sea-air heat fluxes at the Gulf of Lions during winter months are obtained from the meteorological NCEP/NCAR reanalysis dataset and compared with other meteorological data as surface air temperature. The standardized air temperature anomaly at 1000 hPa in the Gulf of Lions during winter (December-March) has been shown to be the simplest and best indicator of absence/presence of WIW in the Balearic Islands channels in late spring.

In general, correspondence between heat fluxes and air temperatures is very high for the whole available period suggesting that surface air temperature is a strong contribution to heat fluxes variability in this region during winter (Fig. 1). Furthermore, it is particularly remarkable that significant discrepancies observed between heat fluxes and air temperature for the period when oceanographic data are available (1985-2004), are restricted to those years when heat fluxes seem not to reproduce later WIW presence in the Balearic Channels (1991 and 1993). Also the fact that no WIW was detected in 2001 seems to be better reflected in the air temperature anomaly than in the heat fluxes. This suggests that air sea temperature anomalies seem to be a better indicator for WIW generation than heat fluxes themselves. The reason is not clear but it could be related to the fact that heat fluxes involve many parameterizations and indirect measurements which could cause some bias in its determination. Air temperature is a variable much easier to compute in the reanalysis models and is less subjected to any source of error than an indirect data as heat fluxes. Results shown here seem then to suggest that WIW formation in the Gulf of Lions is basically controlled by the air surface temperature anomaly, at least for the interannual time scale. Other factors, obviously involved in the deep convection process, as surface water temperature and salinity, cloud covering or winds, among others, seem to play, at least, a secondary role in this formation.

Assuming that air temperature is the key factor for WIW formation in the Gulf of Lions, the comparison with WIW presence/absence in the Balearic Channels would suggest that an air surface temperature anomaly larger than its standard deviation would imply non presence of WIW in the channels the following spring. Standardized anomalies between 1.0 and 0.5 would suggest some uncertainty and values below 0.5 would indicate clear presence of WIW [1].

The estimation of this index has allowed the analysis of the influence of oceanographic scenarios on the population dynamics of hake and red shrimp, two of the most important demersal resources in the western Mediterranean. Recruitment of both species seems to be enhanced during low IDEA index periods, when colder-than-normal winters, producing high generation of WIW in the Gulf of Lions, which flow southwards, reach the Balearic Islands channels in spring and reinforce the Northern and Balearic slope currents, increasing the productivity in the area [2].

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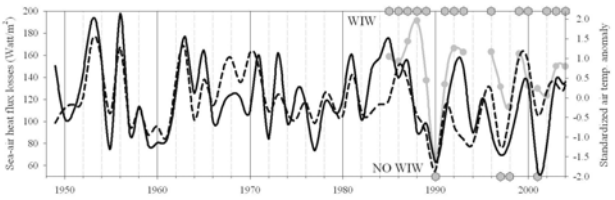

Fig. 1. Time series of air-sea heat flux losses from the NCEP/NCAR reanalysis data set averaged for the period December-March at the grid point closest to the Gulf of Lions (dashed dark line) and standardized winter (December-March) air surface temperature anomalies from the same data base and at the same grid point (solid dark line). Data of in-situ mean water temperatures at Ibiza channel region (grey line with small circles), computed for the period

References

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