RESULTS FROM ECOMALAGA PROJECT: HYDROLOGICAL AND BIOLOGICAL SEASONAL CYCLES AND TRENDS IN THE MALAGA BAY AND ALBORAN SEA.

M. Vargas-Yáñez[1*], T. Sarhan, E. Abad[1], T. Ramírez[1], D. Cortés[1], F. Plaza[2]

[1] Instituto Español de Oceanografía. Centro Oceanográfico de Málaga, [2] Dpto. Física Aplicada II. Universidad de Málaga, Fuengirola, Málaga. Spain - manolo.vargas@ma.ieo.es.

Abstract

From October 1992 to the present, the IEO has collected systematically (one survey each season of the year), hydrological (CTD profiles) and biological data (nutrients, oxigen, chlorophyll and zooplanktonic biomass) in the Málaga Bay. Preliminary results dealing with the possible existence of seasonal cycles and trends are presented. Short time scale variability superimposed on these cycles can be considered as a white noise due to the sampling interval (around 3 months). This noise presents as much variance as the low frequency variability we want to study, diminishing the significance of our results. We try to improve these results through the use of EOFs, as spatial structures are expected to have lower variance than single stations. To the view of our preliminary results we try to find the average distribution patterns of the variables analysed and, if existing, the relation between their variability and that of the whole Alboran Sea.

Introduction.

Málaga Bay is located in the northern shore of the Alboran Sea which is the first Mediterranean basin receiving the Atlantic waters coming from the Strait of Gibraltar.

The upper layer of the Alboran Sea is filled by Atlantic low salinity (S<36.6) waters, extending over the more saline Mediterranean waters. This water mass is more or less modified and extends to a different depth depending on the geographical location within the Alboran Sea. The classical circulation pattern shows the Atlantic current surrounding and feeding two anticyclonic gyres in both the western and eastern basins. Due to the geostrophic adjustment of these structures, isopicnals sink toward the centre of the gyres, where the Atlantic layer reaches its maximum depth (around 200m), and slope up toward the edge of the gyres, decreasing the thickness of this layer. As a consequence, the Atlantic current is associated to an intense thermohaline front that makes it clearly visible in infrared satellite images (1). Figure 1a shows a scheme of this circulation pattern, a more detailed description of the water masses and circulation of the Alboran Sea can be found in (2). Figure 1b is a zoom of figure 1a showing our area of study.

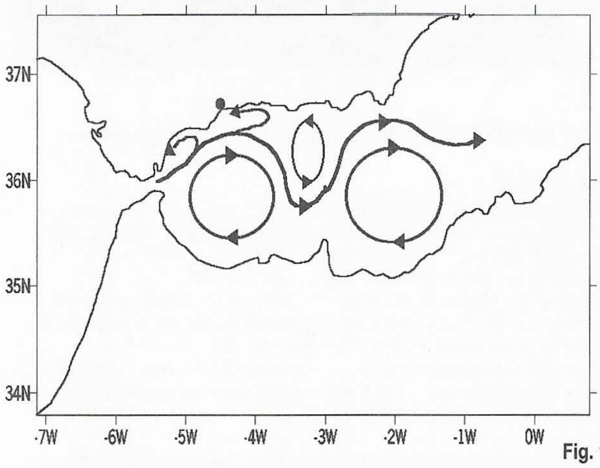

Fig. 1 a

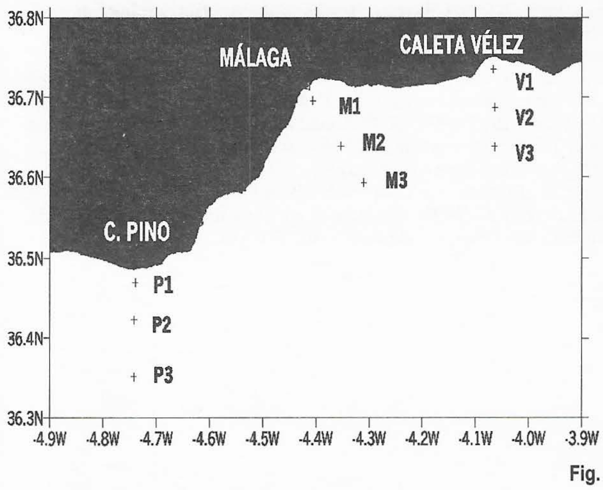

Fig. 1 b

According to this scheme, hydrological conditions in the Málaga Bay, depend on the dynamics of the Alboran Sea and will be very sensible to its time variability. If we accept, as a starting point, the scheme of figure 1a, the Atlantic current will flow through our westernmost transect (see fig. 1b, stations P1-3), and the rest of Málaga Bay (transects M and V) will keep out of the direct Atlantic influence and under a cyclonic circulation. An increase in size of the western Alboran gyre (WAG), will leave the whole Bay under Atlantic conditions, while a southward drift of the Atlantic jet will have the opposite effect. The study of the time variability in our area can also be an indicator of that of the whole basin.

In order to study the long term variability of the hydrological conditions (ranging from seasonal to inter-annual), as well as different biological and enviromental variables within the Málaga Bay and its relation with the dynamics of the Alboran Sea, the Instituto Español de Oceanografía (IEO) has supported the project ECOMALAGA since October 1992 to present (and still going on). For this propose, nine stations distributed along three transects (P,M and V in figure 1b) are systematically sampled four times each year (spring, summer, autumn and winter surveys). During each surveys, we accomplish CTD profiles and take sediment samples, water samples to evaluate nutrient and chlorophyll concentrations, and oblique trawls with Bongo net.

Preliminary results.

Our initial hypothesis is that most of our time series contain time variability at different time scales. The length of them (6 years for biological variables, and 8 for hydrological ones) do not aloud for the moment to study (in a statistically significant way) inter-annual variability. For this reason we focus our attention on the seasonal cycles plus shorter time scales. We propose a model in the form of a mean value a linear trend and a seasonal signal plus a noise containing the shorter time scale variability. Hypothesis about the noise superimposed on the deterministic part of the model are usually important in order to establish the significance of the model fit. We assume that differences between the values predicted by the deterministic part and the actual value (noise) are due to phenomena such as upwelling (wind driven or due to southward drifting of the Atlantic current), or to the instabilities associated to the Atlantic jet. Non of these phenomena are expected to have a time scales larger than several days or weeks, and so we suppose that deviations from the model are statistically independent. This is quite reasonable if we consider that in the best cases we have four samples per year. Our results evidence that the short time scale is likely to present as much variance as that associated to the low frequency (mainly seasonal) so diminishing drastically the significance of our estimates. A possibility of reducing variance in our time series is not to study the time series arising from each of the stations. Instead of this, we study the variability linked to spatial structures arising from EOF analysis.

Though in some cases it is possible to establish the seasonal cycles unambiguously (temperature and salinity) it is not so clear in others as chlorophyll concentrations. Surface temperature exhibit a clear cycle with maximum values at mid August. This maximum is delayed around a month at 50m, reflecting the heat diffusion into the sea. More interesting is a minimum of salinity found in autumn, which could be linked to the instability of the Alboran circulation in this season.

Nutrient concentrations are maximum in winter surveys. Chlorophyll, on the other hand, does not have a clear behaviour, and we will have to wait until new data are collected to establish if maximum values are found in winter or spring. The possibility of a winter bloom has already been suggested by (3) using pigment satellite data.

References

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