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Hydrographic conditions and size-fractionated mesoplankton distribution in the Bay of Biscay shelf during spring 2005

Benjamin Planque[1], Gonzalo González-Nuevo [2], Nicolas Dupont [3] and Enrique Nogueira [4]

[1]PhD, IFREMER, rue de l'île d'Yeu 44311 Nantes Cedex 3, France, benjamin.planque@ifremer.fr
[2] PhD student, Marine Environment / Instituto Español de Oceanografía, gonzalez_nuevo@gi.ieo.es
[3]Master, nicolas_dupont7@yahoo.fr
[4] PhD, Marine Environment/ Instituto Español de Oceanografía, enrique.nogueira@gi.ieo.es

Abstract

A general description of the hydrography and the distribution of size-fractionated mesoplankton bio-volume in the Bay of Biscay shelf (from 41° up to 47° 30' N) during spring (April-May) 2005 is presented. Different hydrographic features, such as the Iberian Poleward Current, continental inputs and associated river plumes, thermohaline fronts or the progression of the seasonal thermocline, were noticeable. Mesoplankton biomass was generally low, except in a narrow coastal fringe along the Spanish shelf and in a relatively extensive area in the inner part of the French shelf, where the seasonal thermocline was already established. The size-structure of the mesoplankton community presented a patchy distribution and significant differences between the surface and sub-surface layers of the water column. The size-fractionated distribution of mesoplankton is discussed in the frame of the observed hydrographic structures.

1. Introduction

A miscellany of physical processes occur in the Bay of Biscay (Koutsikopoulos and Le Cann 1996, Planque et al. 2004). Most of them exhibit a strong seasonality (OSPAR 2000 a) and have a marked effect on biological processes and distributions that concern all ecosystem components (e.g. Calvo-Díaz et al., 2004; Sánchez & Gil 2000). Thus, it is important to characterise these physical structures in order to understand ecosystem functioning and dynamics.

Mesoplankton (i.e. 0.2-2 mm) constitutes an important ecosystem component since it plays a pivotal role channelling matter and energy from the lower (e.g. phytoplankton) towards higher trophic levels, such as the pelagic fish stocks which are economically important in the Bay of Biscay (i.e. sardine and anchovy, OSPAR 2000 b).

Here we present a general description of the main hydrographic features and mesoplankton distribution in the Spanish and French Atlantic shelves during spring 2005. The hydrographic and mesoplankton data where obtained by means of a CTD (conductivity-temperature-depth) coupled with an LOPC (laser optical plankton counter) (Herman et al. 2004), during the Spanish and French cruises *Pelacus05* and *Pelgas05* which took place during April and May respectively.

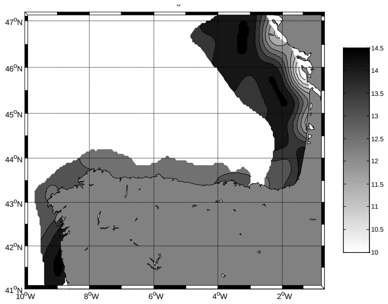
2. Results and discussion

The warm and salty waters characteristic of the Iberian Poleward Current (IPC) were noticeable in the western Iberian Peninsula (Fig. 1a-b). Off the Rías Baixas, continental inputs generate a sharp across-shelf haline front (Fig. 1b). The influence of the IPC is perceptible up to the West Cantabrian (WC) Sea (Fig. 1b, d). The interaction of the IPC with the colder and less saline waters present in the Central Cantabrian (CC) defines an along-shore front around 8° W (off Cape Ortegal). This front could be related to the Galician front (Peliz and Fiúza 1999), which separates Eastern North Atlantic Central Water (ENACW) from subtropical or subpolar origin (Ríos et al. 1992) (Fig. 1c-d). The CC presents high thermohaline variability due to the influence of the continental inputs at the coast and the presence of the IPC offshore, giving rise to the formation of a sharp cross-shore front over the coastal transition zone. The East Cantabrian (EC) is under the influence of the continental inputs from the Adour in the French coast and the progressive warming of the surface layer as the season progresses.

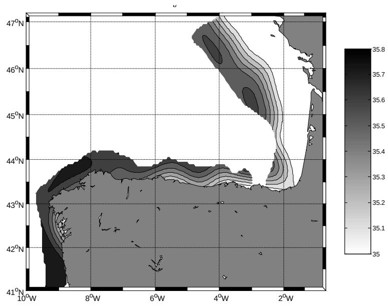
In the French sector, the main hydrographic features are strongly determined by the influence of continental inputs from the Adour, Gironde and Loire rivers (Fig. 1b) and the process of surface warming that give rise to the consolidation of the seasonal thermocline (Fig. 1a and Fig. 2). The presence of a sub-surface cold water pool in the inner shelf is also noticeable (Fig. 1c) (Vincent and Kurc, 1969) This results from sub-picnocline isolation of cold water formed during winter. These processes promote strong thermohaline vertical stratification in the inner part of the shelf (Fig. 2), and the presence of a marked across-shelf front which separates the inner and outer shelf (Fig. 1b-d).

Mesoplankton bio-volume in the small and middle size-fractions (200-400 and 400-800 µm respectively) was relatively low and restricted to a narrow coastal fringe in the Spanish sector (Fig. 3a-b). In the French sector, it was higher and occupied the inner part of the shelf, where the seasonal thermocline was well developed. Besides, mesoplankton in the large size-fraction (800-1200 µm) was only noticeable in the vicinity of the mouths of Arcachon Bay and the estuary of La Loire (Fig. 3c). The size-structure of the mesoplankton community, derived from the slope of the linear regression model fitted to a Pareto function of the size spectra (1), presented a patchy distribution (Fig. 4). The slope presented high values (b>-0.9), indicative of a relative predominance of the larger size-fractions, in frontal areas over the Spanish shelf: at the along-shore front at 8°W and at the cross-shore front located in the Central Cantabrian. In the French shelf, these high values of the slope were observed in front of Arcachon Bay and off La Gironde estuary.

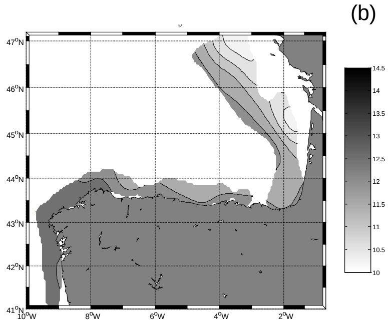
2.1. Figures



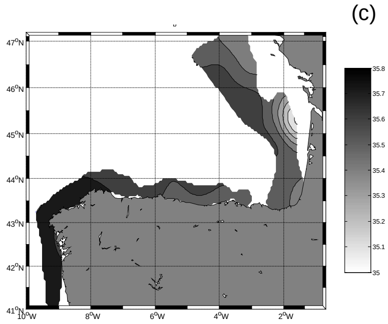
(a)



(b)



(c)



(d)

Figure 1. Spatial distributions of temperature and salinity at 10 m depth (a and b) and at 70 m depth (c and d).

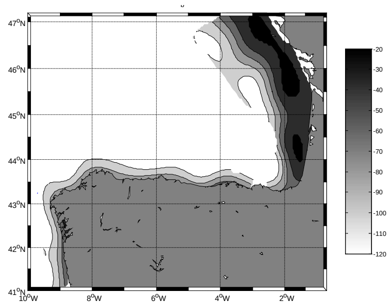
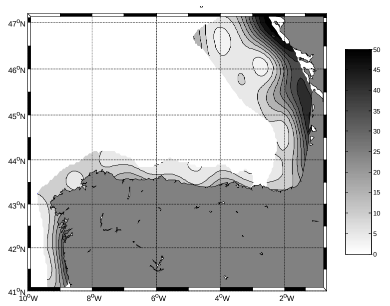
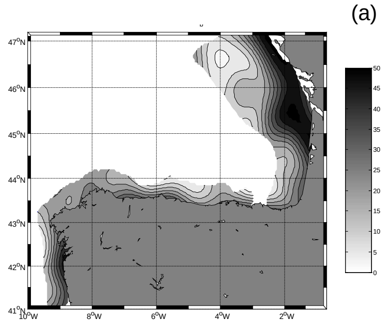


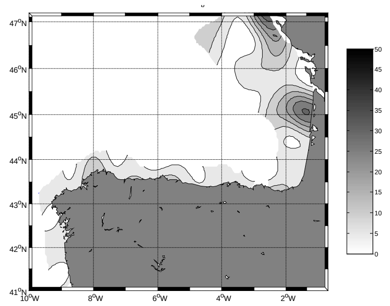
Figure 2. Spatial distribution of mixed layer depth (MLD) calculated following the expression $|\sigma_S - \sigma_{MLD}| > 0.04 \cdot \sigma_S$ (Durbin 2003) where, σ_S is surface density and σ_{MLD} is the density at the MLD.



(a)



(b)



(c)

Figure 3. Spatial distribution of the average size-fractionated biovolume ($mm^3 \cdot m^{-3}$) in the water column for size-fractions (a) 200-400, (b) 400-800 and (c) 800-1200 µm ESD (equivalent spherical diameter).

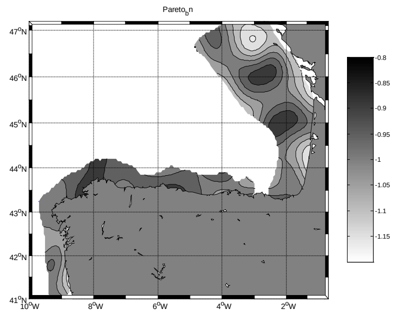


Figure 4. Spatial distribution of the slope of the linear regression model fitted to a Pareto function.

2.2. Equations

The Pareto function was calculated following Vidondo methods (Vidondo et al, 1997).

$$P(V \geq v_i) = \frac{N_{V \geq v_i}}{N_{tot}} \qquad (1)$$

Where $P(V \geq v_i)$ is the probability of finding a particle with a size equal or greater than the size of the class *i*, $N_{V \geq v_i}$ is the number of particles with a size equal or bigger than the size of the class *i* and N_{tot} is the total particles in the sample.

3. Conclusions

Distinct hydrographic processes take place along the Bay of Biscay shelf. In the Spanish sector, the presence of the IPC, the water masses characteristics and the restricted influence of continental inputs generate various along- and across-shelf fronts. In the French sector, the major influence of continental inputs from large rivers promote the isolation of cold water (cold pool) and the existence of a notorious across-shelf front all over the shelf. Besides, vertical stratification is stronger since the cruise took place later in the spring.

Despite the different physical processes occurring in the Spanish and French shelves, the distribution of mesoplankton is associated with frontal zones and/or the development of vertical stratification. The mesoplankton community in those zones is dominated by relatively large organisms.

4. Acknowledgments

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