ALGERS'96 CRUISE, OCTOBER 1996: AN INTERDISCIPLINARY STUDY OF A MESOSCALE INSTABILITY OF THE ALGERIAN CURRENT (WESTERN MEDITERRANEAN SEA)

Jordi Font* and the ALGERS'96 Group
Institut de Ciències del Mar CSIC, Barcelona; Laboratoire d'Océanographie et de Biogéochimie COM-CNRS, La Seyne; Universitat de Barcelona; Universitat Autònoma de Barcelona; Universitat de les Illes Balears, Palma de Mallorca;
DCN Ingénierie Sud LSM, Ministère de la Défense, Toulon; Instituto Español de Oceanografía, Palma de Mallorca.

Abstract

ALGERS'96 was the first MATER (MAST 3 Mediterranean Targeted Project MTP II) campaign in the Algerian basin, carried out on board the Spanish R/V *Hesperides* in October 1996. A mesoscale meander of the Algerian current, developed near 1°E, was exhaustively sampled: ADCP, CTD and XCTD/XBT profiles and transects, multibeam echosounding, dissolved oxygen, nutrients, chlorophyll, suspended particulate matter, primary production, bacterial abundance and radioactive tracers, together with satellite-tracked surface drifters and real-time remote sensing. The detailed analysis of all this interdisciplinary data set is giving, for the first time, a three-dimensional characterisation of the phenomenon and allows gaining some important answers on the coupling of physical and biological dynamics in the Algerian basin.

Key-words: Algerian basin, circulation, density, fronts, primary production

Algerian current instabilities

Downstream from the Alboran Sea, the Modified Atlantic Water incoming into the Mediterranean forms a well defined flow along the African slope: the Algerian current. Due to complex hydrodynamical processes, baroclinic instability mainly, this alongslope current develops meanders as soon as 0°-1°E, creating an upwelling cell and an anticyclonic eddy inside (1). Sometimes a cyclonic circulation also develops, but it is superficial and short-lived: it will decay within few days. Only anticyclonic eddies are observed to grow up to 50-100 km in diameter, while translating eastwards along the slope at a few km/day. Large open sea anticyclonic eddies (100-200 km diameter), that are probably later stages of the coastal ones, can be quasi-motionless while still energetic for months. These mesoscale phenomena play a major role in the configuration of the general circulation and the distribution of the biogeochemical parameters and hence, of the ecosystems, in the Algerian basin (see a summary in 2).

ALGER'S 96 cruise

MATER (MAss Transfer and Ecosystem Response) is the second phase of the European Union Marine Science and Technology programme Mediterranean Targeted Project (MTP-II). The interdisciplinary study of the Algerian basin mesoscale instabilities is one of the MATER tasks, and ALGERS'96 on board the Spanish R.V. *Hespérides* was the first one in a series of oceanographic campaigns to be carried out in the region.

The main objective of the cruise was to exhaustively sample the three-dimensional structure of a mesoscale instability of the Algerian current from the dynamical, geochemical and biological points of view. An official authorization for the *Hespérides* to work in the Algerian waters was a unique opportunity to completely sample this alongslope current. From October 15 (Málaga) to October 21 (Cartagena), 1996, a series of sections perpendicular to the alongslope current upstream (A), in the middle (B, C, D) and downstream (E) of the instability, were performed from the outer boundary of the area influenced by the recent Modified Atlantic Water, to near the coast. The measurements included ADCP, CTD and XBT/XCTD profiles, multibeam echosounding (38, 120, 200 kHz), and underway surface analysis (T, S, fluorescence, meteorology). Water samples were taken at 22 depths for determination of dissolved oxygen, nitrite, nitrate, phosphate, aliphatic and aromatic hydrocarbons, total chlorophyll, pigment speciation, bacterial abundance, primary productivity, suspended particulate matter, and radioactive tracers (^{210}Pb, ^{210}Po, ^{226}Ra, ^{239}Pu, ^{247}Pu, ^{137}Cs, ^{90}Sr). Eighteen surface drifting buoys equipped with an ARGOS transmitter were released upstream of the instability in the core of the current (along section A), and across the cyclonic part of the meander (along section B). All of them had a 10-m long WOCE standard drogue.

Prior to and during the campaign, the region was monitored by satellite remote sensing. NOAA/AVHRR infrared images are well-known to be adequate in identifying coastal and offshore eddies in the Algerian basin (3). By the end of September, a mesoscale meander of the Algerian current was developed near 1°E. It was then continuously tracked with a portable NOAA/AVHRR satellite receiving station installed on board the *Hespérides* which acquired four passes a day. It appeared on images like an usual instability associating a coastal anticyclonic eddy with a well-marked secondary cyclonic circulation (offshore) (fig. 1). It was decided that this was the phenomenon to investigate, and daily updating the location of the main thermal gradients and hence the position of the boundaries of the evolving instability provided an efficient and detailed guidance of the *in situ* sampling.

First results

Figure 1 shows the location of several CTD stations, as well as the initial trajectories of the surface drifters, plotted on a satellite infrared image. The cyclonic and anticyclonic motions are clearly correlated with the surface thermal structures, although the latter are rapidly evolving: the trajectories at the end of the period indicate a growth and eastward displacement of the anticyclonic eddy, as well as a NW enlargement of the cyclonic one.

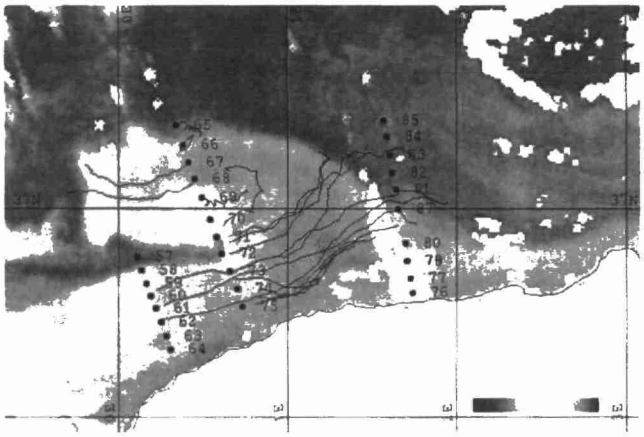

Figure 1. NOAA/AVHRR Sea Surface Temperature image of 16 October with location of CTD stations on sections A, B and D, and satellite-derived trajectories for the 18 surface drifters until 21 October.

The analysed vertical profiles of the hydrological data clearly depict the structure corresponding to the undisturbed yet alongslope current (section A), the offshore cyclonic eddy (northern part of section B, fig. 2) and the coastal anticyclonic eddy with the Algerian current displaced offshore around it (section D). The distribution of the maxima of chlorophyll in section B across the cyclonic eddy and coastal current (fig. 3) is correlated with the areas of strong velocity shear, i. e. on the current's edge (st. 73) and on the cyclonic eddy's edge (st. 71-70 and 67-66). Similar maxima

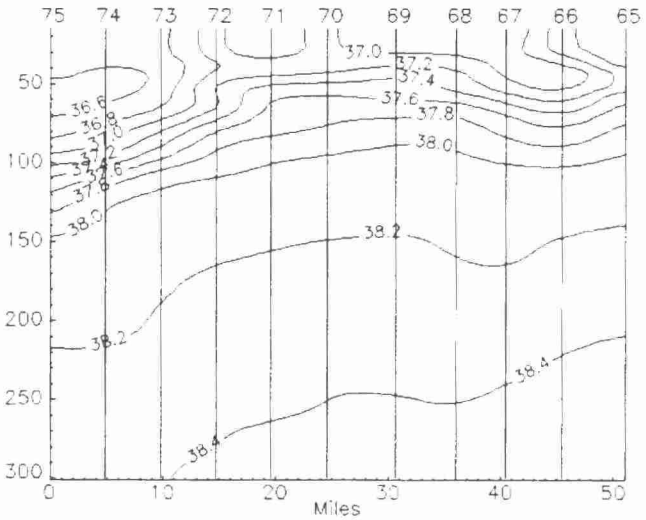

Figure 2. Salinity (in the surface and subsurface layers) along section B on 18 October. The sloping of the isohalines shows the presence of the Algerian current near the coast (left) and the cyclonic eddy centered on stations 70-68.