ALMOFRONT 91 : An interdisciplinary study of the geostrophic frontal jet in the Eastern Alboran Sea

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The ALMOFRONT-91 cruise of R. V. L'Atalante, during May 1991, was devoted to study the geostrophic front which lies between Almeria (Spain) and Oran (Algeria) in the eastern part of the Alboran Sea. The oceanic density front was found on the left side of the geostrophic jet which constitutes the atlantic water inflow into the Mediterranean. The main objectives which guided the strategy at sea were:

1/ to master the physical and dynamical parameters at a resolution that allows the calculation of vorticity and secondary (ageostrophic) circulation.

2/ to characterize the primary and secondary levels of the ecosystem in terms of stocks, production, growth rate, physiological stage or maturity .

3/ to evaluate the fluxes of matter in the frontal zone and the exports.

As revealed from the 83 CTD-rosette stations survey at synoptic scale (Fig. 1), the Atlantic jet was flowing along the Algerian coast with a 100 m thick, strong, horizontal density gradient and enhanced biomass along the flow (Fig.2). Phytoplankton composition as viewed by pigment analysis evidenced a strong upward supply of nutrients in the frontal zone. This upward flux was attributed to the secondary, ageostrophic circulation. The internal structure of the mass and velocity field was investigated by 4 CTD Tow-yo and ADCP sections through the main flow. A towed hydro-electric system (THES) which measured physical, biological and chemical variables by underwater probes and on pumped water, was operated between surface and 200m depth. This was repeated on three sections (Fig. 1) in order to reveal the nutrients, oxygen, biomass and pC02 fields as perturbated by the frontal zone. Subduction of dense water which is near surface north of the front below the light water of the jet is clearly signed, by anomalous vertical profiles of these chemical and biological variables.

A second, 15-day long leg was devoted to fluxes measurements in 6 sites representative of the frontal structure. The export of organic matter inside the frontal zone towards deep water is dramatically marked by the amount of matter found in drifting sediment traps. An subduction of water is also inferred from results obtained in 1990 inside a meander of the Ligurian Sea jet where mass and velocity fields are similar to those encountered in the Alboran sea jet.

The presentation corresponds to an overview of main results on the biophysical aspects of this study of which more 50 scientists participated.

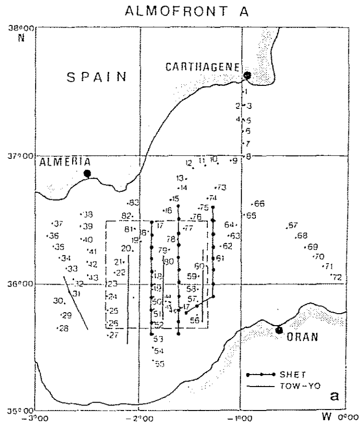

Fig. 1.- Map of Almofront stations and Tow-yo transects for Leg A, April 26 - May 12, 1992. Dots with numbers indicate the position of the 83 CTD casts of the synoptic survey. The four lines correspond to the 4 Tow-yo transects across the frontal jet structure. Dots linked by thick line indicate the 31 THES stations.

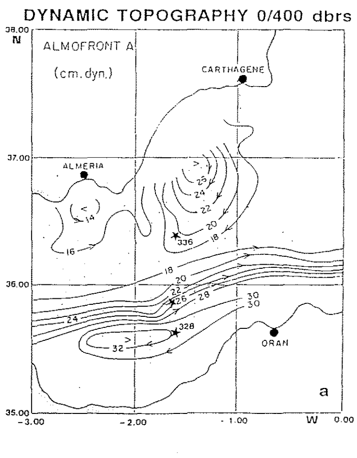

Fig. 2.- Results from the 83 stations of synoptic survey: Dynamic topography of the surface level relative to the 400 dbars level. The south position of the jet and two eddies at north are clearly shown. The stars indicate the positions of the 3 THES stations which will presented to evidence the subduction of the water, North of the jet front, southward and below the core of the jet.

Remote sensing of the generation and propagation of internal waves in the Strait of Gibraltar

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During the international GIBRALTAR EXPERIMENT, in 1985-1986 (KINDER and BRYDEN, 1987), we realized from an aircraft equipped with a Synthetic Aperture Radar, a survey of the strait of Gibraltar, during two semidiurnal tidal cycles (RICHEZ and KERGOMARD, 1990 and RICHEZ, 1992).

The SAR images clearly illustrate the generation and evolution of an internal structure, at the sill of Camarinal, during the westward phase of the tidal cycle. Its relation to a detailed topography of the sill is in agreement with the theoretical work of HIBIYA (1990). When the westward tidal current relaxes, this structure, moving east over the sill crest, transforms into an eastward propagating internal bore. At the same time, a lee-wave appears on the eastern side of the sill of Camarinal, as observed and explained by ARMI and FARMER (1988). It is obvious that the diurnal component of the tide plays a major role in determining the type of nonlinear wave train travelling along the strait and its speed of propagation. Two solitons with the same amplitude propagated at a mean speed of 2.1 to 2.6 m/s, during the first flight, while during the following tidal cycle, a train of dispersive nonlinear internal waves appeared in the Tarifa Narrows and the speed of propagation of the leading wave was about 1.9 m/s.

The ARMI and FARMER (1988) echosounder and mooring in situ observations helped the interpretation of the SAR images, and are quite in agreement with them.

Some images from the french satellite SPOT, taken at different tidal coefficients give an idea of the variability of the occurrence of this phenomenon in the strait of Gibraltar. At neaps, with weak tidal coefficient, we cannot detect any clear generation of internal structure at the sill of Camarinal. At springs, an other solitary wave event can be detected at the eastern end of the strait of Gibraltar, 2H:30 to 4H after the passage of the principal bore. We give a tentative explanation of this feature, already observed by ZIEGENBEIN (1969, 1970).

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