A radio-tracked drifting buoys system for the study of mesoscale near surface currents in the Mediterranean

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The use of radio-tracked drifting buoys in the study of near surface currents has been introduced in different ocean regions in the last ten years (Davis et. al., 1982). The tracking from a ship of current dragged buoys, by means of directional reception of individual radio signals, allows an almost continuous positiong of several buoys in a relatively large area. An oceanographic vessel equiped with a calibrated rotating antenna and a radio direction finding system, can simultaneously follow the trajectory of a set of buoys while performing other research work. Fig. 1 is an example of a trajectory calculated from 59 different bearings of a surface buoy released on June 1989 in the area of the Balearic current. The successive triangulations are corrected from the error introduced by the time lag between consecutive bearings.

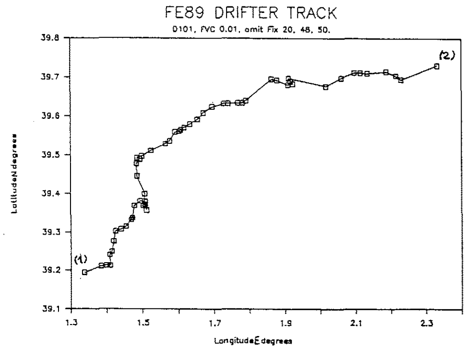

Fig. 1 Drifter trajectory obtained during FE89 cruise. Each calculated position is represented by a small square. Released (1) on June 14th 1989 at 12.49h and recovered (2) on June 18th at 12.52h

Our group (FEPOG) has been using this method in four different cruises since 1986 in the Catalan Sea (NW Mediterranean) where it has shown to be very useful in the study of mesoscale near surface phenomena, as frontal filaments (Wang et al., 1988) or inertial oscillations (Font et al., 1988; Salat et al., 1989). The space (few tenths of kilometers) and time (few days) scales typical of mesoscale processes in the Mediterranean make the system very suitable for such kind of studies in the region.

In the first two cruises, in cooperation with the Marine Sciences Research Center of the State Univ. of New York, we used drifters constructed by Lunar Electronics Co. (San Diego, U.S.A.), based on an original prototype by Russ E. Davis, and a receiving system developped in the Scripps Institution of Oceanography. Since 1988, in the frame of a Spanish research project (CAICYT PB86-0628), we have been developing a new system based on the same antenna commutation circuit structure, and used it in 1989 with a modified buoy model that kept the initial operating frequency band but introduced simplifications in the servicing of the buoy body.

Due to the fact that the original buoys were designed to operate in the 216 Mhz band, important interference problems can appear when using them in Europe, where that band is reserved to aircraft communications and navigation beacons. To have a system adequate for mesoscale studies in the Mediterranean, we have designed a complete new transmiter and direction finder that operates in the 430 Mhz band.

The new buoys, that have the same external shape and size in order to keep their dynamic characteristics, have been essayed during a cruse in 1990 with excelent results. Since the frequency of operation of the new system is aproximatively the double of the early one, the size of the direction finding antennas has been reduced to the half, allowing a more easily installed on board. We also took benefit from two other facts: First, the receiver noise level at 430 Mhz is lower than the corresponding at 216 Mhz. Second, since the size of the transmiter antenna is also the half of the one used at 216 Mhz, we have been able to design an antenna with higher efficiency without significative increase in its length. The result has been a very important increase in the signal to noise level for the same power consumption of the buoys. The effective range is actually limited by the Earth shape to 25 to 30 Km.

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On eddies formation in the Northwestern part of the Main Black Sea Current

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The investigations of the different scales eddies are of considerable importance in modern oceanography. It is due to the important role which they play in oceanic processes. According to recent data the eddies formation in the region of the Main Black Sea Current(MBSC) by its meandering is a remarkable feature of the Black Sea circulation. Analysis of a large set of hydrographic data has identified the regions with intensive meandering of MBSC, which have the largest probability of eddies formation. One such region is the part of MBSC over the continental slope of the northwestern part of the Black Sea. It is known that there is a quasi-stationary anticyclonic eddy in this region. This eddy can be seen on AVHRR-IR images.

This paper describes the thermo-haline structure of the anticyclonic eddy and its main parameters in detail, based on data from three hydrographic surveys in the northwestern part of the Black Sea (October-December, 1987). The distance between the hydrographic stations was 20' at the latitude and 30' at the longitude. The time interval between the surveys was approximately one month. All dynamic computations were based on a common reference level of 300 m.

The anticyclonic eddy was observed in the first and the third surveys; it was not observed in the second survey. Data of most interest were obtained in the third survey. These are described below.

On the dynamical topography map the stream of MBSC and the large anticyclonic eddy (AE), extending approximately 50 n miles at the longitude and 30 n miles at the latitude, are seen clearly. Geostrophic velocities of MBSC are upto 38 cm/sec and those of the AE upto 30 cm/sec. The stream of MBSC was displaced to the south. The AE penetrated from the surface to a depth of 300 m.

The sinking of the water inside the AE was considerable. The depth of the 8°C isotherm at the center of the AE was 170 m , and 90 m at the periphery. The depth of the 21 ppt isohaline was 190 m at the center and 100 m at the periphery, while the corresponding depths of the 16 sigma-t isopycnal were 170 m and 80 m respectively.
The difference between the temperatures at the center of the AE and its periphery changed sign with depth, due to the existence of the Cold Intermediate Water Layer (CIWL). Therefore the same eddy had both a warm core and a cold core, depending on the depth.

In our case the temperature was higher from the surface to a depth of 70 m at the center of the eddy than at the periphery. From 70 m to 300 m (depth of AE penetration) the temperature was lower in the center than at the periphery. The lens of the coldest water with temperature less than 6.5°C was found at the layer 80 - 110 m at the center of the AE.

Our observations show that the AE does not exist continuously in this region of the Black Sea.

The mechanism, the conditions of generation and development of anticyclonic eddies are the subjects of future investigations. However, it is clear that the meandering stream of MBSC is the main cause of the generation of these eddies. Possibly, the meridianal displacement of the MBSC plays an important role. The stream, moving across the continental slope, is situated sometimes in the shallow waters and sometimes in the deep waters. The maximum of the AE development will be at the deep waters, when the MBSC stream is situated at its southern-most location, and the minimum of AE development will be at the shallow waters, when the stream is situated at its northern-most position. In the latter case the AE may vanish.

The result of our present investigation is in agreement with earlier observations of the existence of the quasi-stationary AE in the continental slope region of the Black Sea north-western part.

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