CIRCULATION VARIABILITY IN THE CHANNEL OF SARDINIA OBSERVED FROM IN SITU AND ALTIMETRIC DATA

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Abstract

The channel of Sardinia is one of the less known areas of the Western Mediterranean sea and the circulation paths of the different water masses in this wide passage are still debated. *In situ* data from the PRIMO-1 experiment and merged TOPEX/Poseidon plus ERS-1 altimetric maps have been used to verify hypotheses about the possible migration of deep mesoscale eddies from Algeria to Sardinia and their effect on the circulation. Current meters were deployed on the Sardinian slope, Tunisian slope and central part of the channel from November 1993 to October 1994. No seasonal variations have been clearly detected, but the mesoscale variability is large in the western part of the channel and has a deep signature. A CEOF analysis of the Sea Level Anomaly maps (derived from altimetric data) has been used to see the correlation of the different dynamical features of the observed variability.

Key-words: mesoscale phenomena, currents, straits and channels, remote sensing, western Mediterranean

Introduction

The Algerian basin is characterized by a large mesoscale turbulence and acts as a buffer zone which partially disconnects the flux coming in at Gibraltar from the flux going out in the channel of Sardinia (1,2). The channel of Sardinia is the passage between the Algerian basin, on the west side, and the Tyrrhenian basin and the channel of Sicily on the east side, limited by the Sardinia island and the northern Tunisian coast. The sill is at about 2000 m near 9°E. Four different water masses have been identified by previous studies in the area: the Modified Atlantic Water (MAW), the Levantine Intermediate Water (LIW), the Tyrrhenian Deep Water (TDW) and the Western Mediterranean Deep Water (WMDW), but the circulation paths of these water masses in this wide passage are still debated. Recent XBT data (3) confirm that anticyclonic eddies, generated by instability of the Algerian current, are advected toward the channel and, before reaching it, they deviate northward and westward following the deep bathymetry. They can strongly interact with the current and influence the circulation in the channel at different depths.

In this presentation we summarize the results of two recent papers on the circulation variability in this region, one based on *in situ* measurements (4) and the other on satellite altimetry (5).

As part of the PRIMO-1 experiment, hydrological data were collected with a CTD probe at 13 stations along a cross section of the channel near 8.9°E (Fig. 1) in November 1993. Deployment and recovery of current meters was done in several times between November 1993 and October 1994 at four different points called N, O, S and E (Fig. 1). During the first deployment period a lot of instruments were lost due to a material failure, and as a consequence the recorded data were only partial: N (100 m - 8 months, 300-8, 1000-11, 2000-11), O (200-5, 2700-5), S (450-5, 1000-1, 2500-6), E (1800-6).

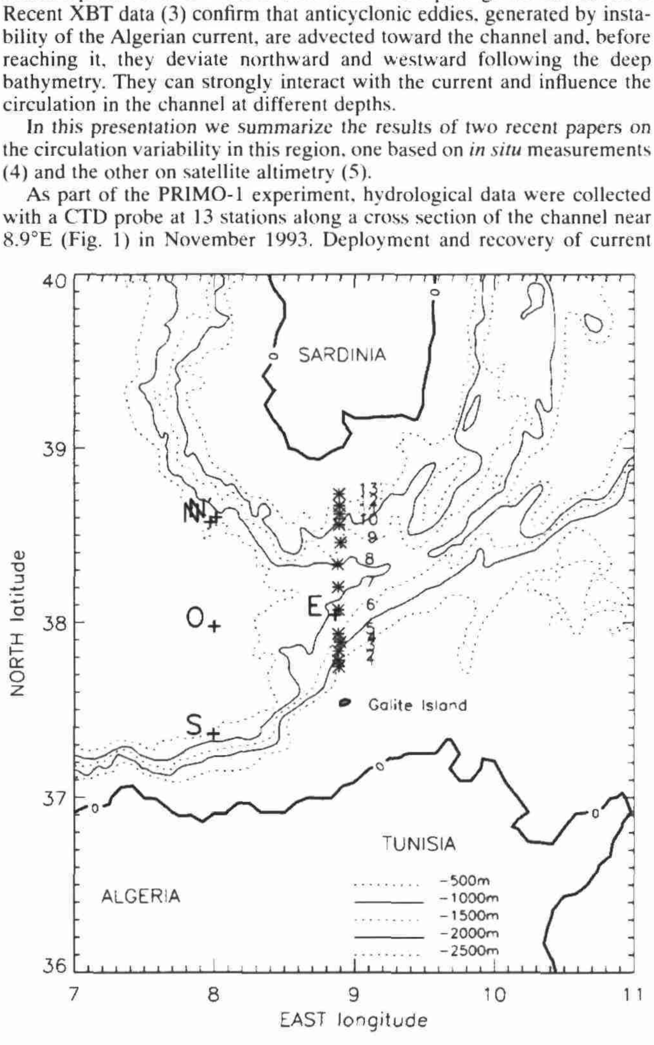

Figure 1: Location of the 13 CTD casts (*) in November 1993 and the 4 mooring points (+) of PRIMO-1 in the channel of Sardinia.

The TOPEX/Poseidon and ERS-1 altimeters provide complementary space and time sampling of the oceanic circulation. The data of both satellites have been merged on a common period, from October 1992 to December 1993, by CLS Toulouse (6). The lack of knowledge of the geoid impedes the use of the absolute heights of the sea level. So, the Sea Level Anomalies (SLA) relative to the annual mean have been calculated, and gridded every 10 days with a spatial resolution of 0.2° using an objective analysis scheme. For the present study, the data in the area of 0-15°E and 35-40°N have been extracted, to focus on the MAW flow until its entry in the eastern Mediterranean sea. The resulting 44 maps that are regular in time and space have been used to perform a Complex Empirical Orthogonal Functions (CEOF) analysis in order to extract the information on the variability of spatially correlated signals.

Results : *in situ* data

The in November 1993 hydrological section presents the low salinity MAW flowing eastward at the surface on the Tunisian slope (Fig. 2, left). This situation could correspond to an unperturbed alongslope vein crossing the channel of Sardinia in its path to the Tyrrhenian Sea and strait of Sicily, according to the classical schemes for the western Mediterranean surface layer circulation. Unfortunately, no current meter record was obtained within the surface layer in this southern part to account for the time evolution of the current. A secondary salinity minimum found in the northern part of the CTD section, together with westward geostrophic velocities (Fig.2, right), indicate that old MAW is re-introduced in the Algero-Provençal basin along the continental slope of Sardinia, after having circulated in the Tyrrhenian sea. Below it, a temperature minimum at 100-150 m identifies another water mass also flowing in the same direction, well separated from the vein of subsurface Winter Intermediate Water (WIW) circulating eastwards at the same depth in the southern half of the channel.

The current meter mooring situated on the Sardinian slope in the western opening of the channel shows an intense and very variable circulation at 100 m, while below the surface layer the motion is predominantly along the slope, although also affected by significant mesoscale variability. In spite of the low correlation between the records at 100 and 300 m, an Empirical Orthogonal Function analysis has shown that more than 90% of the variability at both levels can be explained by one single statistical mode. This means that the flow can be strongly perturbed by mesoscale events at least in the whole surface and subsurface layers. The stick diagrams show that in most occasions these events have an anticyclonic nature. Following the lag in the correlation between the records in the center and the north of the channel, they are usually propagating northwards with intense southward currents. These could be associated with the eastern edge of anticyclonic eddies being detached from the Algerian current region maybe due to topographic constraints. In the centre of the channel, no clear geostrophic motion (Fig. 2) is associated with the intermediate layer LIW core (250-400 m), so that the "coming from" or the "going to" of this water mass cannot be specified. Nevertheless, the important mesoscale activity that prevails in the surface layer could have a considerable influence on the intermediate circulation. Anticyclonic eddies, as described by Benzohra *et al.* (7), can reach the channel with a deep conical extension and can strongly interact with the surrounding superficial and intermediate waters. At the intermediate layer the currents recorded near the slopes at the western opening of the channel (S 450 m and N 300 m) indicate a cir-