THE CYPRUS WARM EDDY AND THE ATLANTIC WATER DURING THE CYBO CRUISES (1995-2009)

George Zodiatis [1]*, Dan Hayes [1], Isaac Gertman [2] and Yianna Samuel-rhoads [1]
[1] Oceanography Centre, University of Cyprus, Nicosia, Cyprus - gzodiac@ucy.ac.cy
[2] Israel Oceanographic and Limnological Research, Haifa, Israel

Abstract

In '80s, during the few seasonal POEM (Physical Oceanography of the Eastern Mediterranean) cruises in the SE Levantine Basin was first depicted a mutli-pole gyre, the Shikmona, formed by three eddies with the Cyprus one being most pronounced and an offshore cross basin current, the Mid Mediterranean Jet. A considerable much larger amount of seasonal in-situ data were collected from various observing platforms in the SE Levantine Basin from 1995-2009, mostly in the framework of the CYBO cruises and secondary by some other collaborative cruises and projects. These new in-situ data sets show a strong spatial and temporal variability of the Cyprus warm core eddy, of the Atlantic Water and of the associated MMJ displacement in the area.

Keywords: Levantine Basin, Circulation Models, Cyprus Arc, Currents

Preface

The general circulation in the Eastern Mediterranean as inferred from several cruises in 1960s and 70s [1], shows an anticlockwise flow with sub-basin features in the Levantine Basin, with the Rhodos gyre being the most well pronounced. In '80s, during the POEM international field experiments [2,3], a more detailed structure of the mesoscale circulation was defined to consist of several alternative cyclonic and anticyclonic gyres and eddies. Further, it was first shown that as a result of the interaction between these cyclonic (Rhodos) and anticyclonic (Mersa Matruh and Shikmona) gyres, an offshore cross basin jet is generated, named the Mid Mediterranean Jet (MMJ). In the SE Levantine the POEM group defined the Shikmona gyre as a multi-pole gyre, consisting of 3 eddies, of which the Cyprus one is the most well pronounced. Despite the fact that the Levantine Basin is characterised with the highest salinity at the surface and intermediate layers of the Mediterranean, less saline waters of Atlantic origin spread at the sub-surface layers, almost throughout the basin, as a results of the water volume compensation for the high rates of the sea water evaporation in the Levantine and of the outflow of the intermediate water into the North Atlantic [1].

Discussion and Results

The analysis of new in-situ datasets gathered in the SE Levantine during the period 1995-2009 from CYBO and CYCLOPS cruises, HaiSec cruises, NRT data of the CYCOFOS observing system, as well as extended use of satellite remote sensing data collected during the same periods, helped define in details not only the daily and seasonal, but also the inter-annual variability of the dominated mesoscale flow features and of the water masses displacement in the region.

These long term seasonally collected in-situ datasets reveal that the dominant and permanent flow feature in the SE Levantine is the Cyprus warm core eddy, that undergoes significant seasonal and inter-annual fluctuations in terms of its shape, size, intensity and location. Moreover, the establishment of a secondary warm eddy in the SE part of the study area was found during periods when the Cyprus eddy became weaker, as was shifted westward for about 80 nm away from Eratosthenes SM. Also during the long term CYBO campaigns it was found the re-establishment of the non permanent Shikmona gyre, when the co-existence of 2-3 warm eddies was observed. Particularly, during certain short periods related to the generation and destruction mechanism of the warm core eddies circulated within the Shikmona gyre, when it is present. The latter is recently evident from drifters trajectories, gathered by the NEMED project, which show that the instability of the strong northward current flowing along the Israel-Lebanese coast generated an anticyclonic eddy. The latter, detached away from this northward current towards the area of the secondary eddy, as observed by CYBO cruises.

These new data confirm the previous works [2, 3] that the MMJ enters the study area from the southwest, after crossing offshore the basin from the southwest. Furthermore during the CYBO cruises it was found that this jet meanders between Cyprus and the northern periphery of the Cyprus warm core eddy [4, 5]. The Cyprus warm core eddy, the Shikmona gyre (when appears), the smaller-scale non permanent cyclonic and anticyclonic eddies in the region, increase the complexity of the MMJ flow path and thereby of the AW transport in the SE Levantine.

The AW in the SE Levantine is very well pronounced during summer periods, mostly at the sub-surface depths, below the thermocline (~40 m) and down to the depth of ~80m, with salinity as low as 38.65-38.9. Periodically the AW was also defined at the surface, in the western part of the SE Levantine. During winter mixing processes the AW mostly is absent from the region, however, in winter periods with mild weather conditions all over the Mediterranean, the AW can be traced in the study area at the surface too. Throughout the study period the AW is well pronounced south and southwest of Cyprus. The MMJ is documented to transfer the AW eastward within the Levantine Basin. It was found that the MMJ transfers the AW along the periphery of the Cyprus warm core eddy, at the subsurface layers. AW has also been observed close to the Egyptian coast, as a result of a westward re-circulation, either of the MMJ or of a current flowing eastward along and closer to the Egyptian coast. During most of the examined periods the MMJ was found to be a main flow pathway for transferring the AW within the SE Levantine Basin.

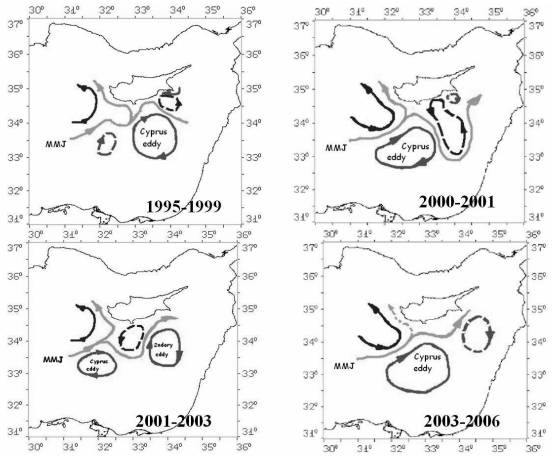

Fig. 1. Schematic of the general circulation in the SE Levantine showing the Cyprus eddy, the secondary eddy and the MMJ, as depicted from the CYBO cruises, 1995-2009.

References

1 - Ovchinnikov I.M, Plakhin A., Moskalenko L.V., Neglyad K.V., Osadchiy A.S., Fedoseyev A.F., Krivoscheya V.G. and Voytova K.V., 1976. Hydrology of the Mediterranean Sea. Gidrometeoizdat, Leningrad, 375 pp.

2 - Özsoy E, Hecht A., Ünlüata U., Brenner S., Oguz T., Bishop J., Latif M.A. and Rosentraub Z., 1991. A review of the Levantine Basin circulation and its variability during 1985-1988. *Dyn. Atmos. Oceans*, 15: 421-456.

3 - POEM group, 1992. General circulation of the eastern Mediterranean sea. *Earth Sci. Rev*., 32: 285-309.

4 - Zodiatis G., Drakopoulos P., Gertman I., Brenner S. and Hayes D., 2005. The Atlantic Water Mesoscale Hydrodynamics in the Levantine Basin. *In*: 37th CIESM Workshop Monograph-Strategies for understanding mesoscale processes.

5 - Zodiatis G., Drakopoulos P., Brenner S. and Groom S., 2005. Variability of the Cyprus warm core Eddy during the CYCLOPS project. *Deep-Sea Res. II*, 52: 2897–2910.