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Oceanography of Eastern Mediterranean and Black Sea

Similarities and Differences of Two Interconnected Basins

Cyclops project : the hydrodynamics of the warm core eddy south of Cyprus, SE Levantine Basin

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Abstract- The Levantine Basin circulation pattern as obtained during April-May and August 2001, within the frame of the EU CYCLOPS project, showed that the dominant flow feature in the region south of Cyprus is the warm core eddy, known as the Cyprus eddy. Its centre was found to be located about 80 km west of its previous location during the 80s and late 90s, and the eddy was quite strong with geostrophic currents around the rim as high as 30-40 cm/s in the near surface layers. The salinity and temperature signals of the eddy were discernible down to 350 m. The computed geostrophic velocities of the eddy were comparable to the values estimated from the displacement of a subsurface buoy deployed by the PML group during the May 2001 CYCLOPS cruise. The post cruise model simulations also showed similar velocity values in the jet.

Keywords- Eastern Mediterranean, Levantine Basin, CYCLOPS project, general circulation, warm core mesoscale eddies, satellite imagery.

Introduction

The general features of the hydrodynamic conditions of the Levantine Basin have been known for some time (Ovchinnikov et al. 1976). During the second half of the 80s and the beginning of 90s, a more detailed picture of the water masses distribution and the general circulation has emerged (Ozsoy et al. 1991, POEM group 1992; Malanotte-Rizzoli et al., 1999). The general circulation of the Levantine Basin consists of a complicated flow pattern, with strong currents and several multi-scaled eddies, dominated to the west by the sub-basin multilobe cyclonic Rhodes gyre. This is flanked to the north by the westward meandering Asia Minor Current (ACM) and the south by the eastward mid-Mediterranean jet (MMJ). The Rhodes gyre extends eastward towards the western coast of Cyprus, thereby forming a secondary eddy center, known as the Western Cyprus Cyclonic eddy. Another important but not permanent dynamic feature in the SE Levantine Basin is the Shikmona gyre, consisting of several eddies (POEM group 1992). During late 80s an anticyclonic eddy, the Cyprus eddy, was activated south of Cyprus (Brenner 1989). During the Physical Oceanography of the Eastern Mediterranean (POEM) project this eddy was considered as the northernmost eddy

constituent of the Shikmona gyre. In late 90s, based on several seasonal field experiments carried out in the frame of the CYBO-Cyprus Basin Oceanography project, it was conclusively shown that the Cyprus eddy is permanent, dominating the general circulation of the entire SE Levantine Basin, particularly the eastward movement of the MMJ south of Cyprus and the bifurcation of the MMJ SW of Cyprus (Zodiatis et al. 1998).

The Cyprus eddy, whose influence extends to depths of about 400m, constitutes the most intense (up to 30-35 cm/s) dynamic feature of the SE Levantine Basin. The seasonal fluctuation of the Cyprus eddy shows that the baroclinic instability of the eastward flow along the periphery of the Cyprus eddy causes the formation of a secondary, smaller anticyclonic eddy, which circulates west of the main eddy center, contributing to an even more complicate meandering flow path of the MMJ. Moreover, the XBTs data collected bi-weekly, within the frame of the EU Mediterranean Forecast System Pilot Project (MFSPP) along the track Limassol–Port Said, showed the quasi-synoptic evolution of the temperature associated with the Cyprus eddy center (Zodiatis et al 2001).

This manuscript provides new evidence on the strong variability of the Cyprus eddy, during the first cruise of the EU CYCLOPS project in 2001. The principal goal of the EU-CYCLOPS project is to investigate the role of phosphorous as a growth-limiting nutrient factor in the oligotrophic Levantine Basin. The role of the physical oceanographic investigations in this project, is to study the hydrodynamic regime of the warm core eddy south of Cyprus in support the in-situ biogeochemistry experiments during the infusions of P and an inert tracer, SF_6

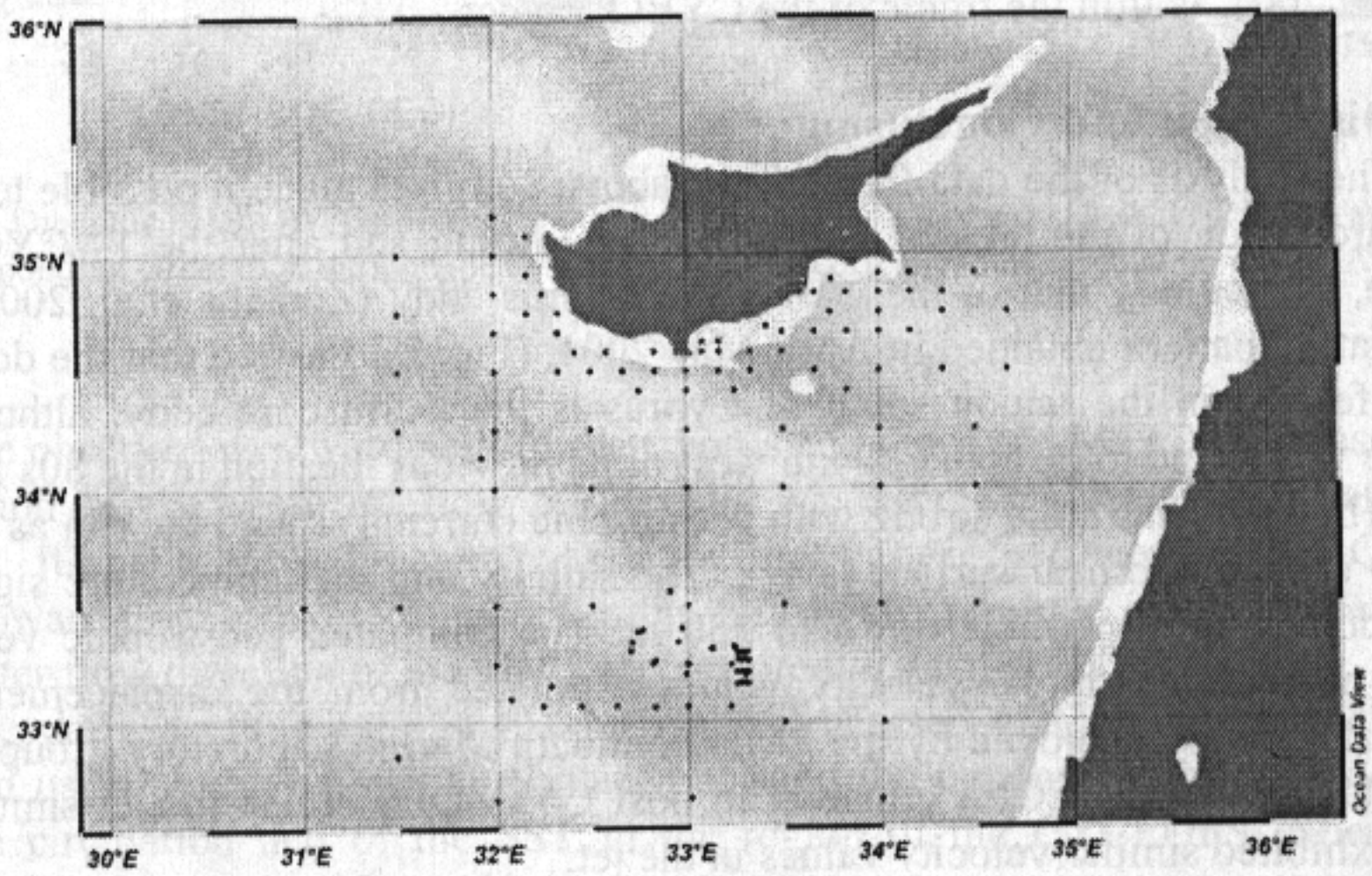

Fig. 1. Stations sampled during the April-May and August 2001 cruises

Data and Methods

The circulation regime is described on the basis of new in-situ data collected in the SE Levantine Basin in April, May and August 2001, on board the R/V AEGAEO. In order to complement the hydrographic patterns obtained from above cruise data, a corresponding time series of NOAA-AVHRR images and Topex/Poseidon and ERS-2 dynamic topography data of the Levantine Basin was utilised. In addition, short term high resolution model simulations were performed to assess the eddy's time variability during the biogeochemistry cruise in May 2001.

During the 1st CYCLOPS cruise, CTD data were collected from 69 casts in the centre of the Cyprus eddy, between 5-17 May 2001. The data were gathered using the Sea Bird Electronics (SBE911plus) CTD profiler, furnished with oxygen and fluorometer sensors. The measurements were sampled at a rate of 24 scan/s and they were averaged in-situ over 1 s intervals. Most of the casts during the first CYCLOPS cruise were shallower than 200 m. The shallow casts were carried out primarily for water sampling within the upper water layer, while mostly of the deep casts were done in order to define the exact location of the eddy center.

In order to define the prevailed dynamic features of the area under investigation, particularly that of the Cyprus eddy, the data from the first CYCLOPS cruise, collected from the deep casts, were used together with the data (more than 80 deep stations) of the CYBO-Cyprus Basin Oceanography project, which were collected in April 2001 in the broader sea area of the Cyprus eddy, south of Cyprus, SE Levantine Basin (Fig. 1).

After the 1st CYCLOPS cruise, the area of interest was re-surveyed in late August 2001, within the frame of the CYBO project.

Discussion and Conclusion

The analysis of the data from all the above 3 cruises made it possible to define the circulation of the area of interest before, during and after the 1st CYCLOPS cruise, particularly that of the warm core Cyprus eddy (Zodiatis et.al. 2001). The circulation pattern obtained in April-May 2001, (Fig. 2), showed that the dominant flow feature in the region south of Cyprus is the warm core eddy, although its centre was found to be about 80 km west of its previous location in the 80s and late 90s. The eddy was quite strong with geostrophic currents around the rim as high as 30-40 cm/s in the near surface layers. The salinity and the temperature signals of the eddy were discernible down to 350 m. The computed geostrophic velocities were comparable to the velocity values estimated from the displacement of a subsurface buoy deployed by the PML-Plymouth Marine Laboratory group during the May 2001 CYCLOPS cruise. The post CYCLOPS cruise model simulations also exhibited similar velocity values in the jet.

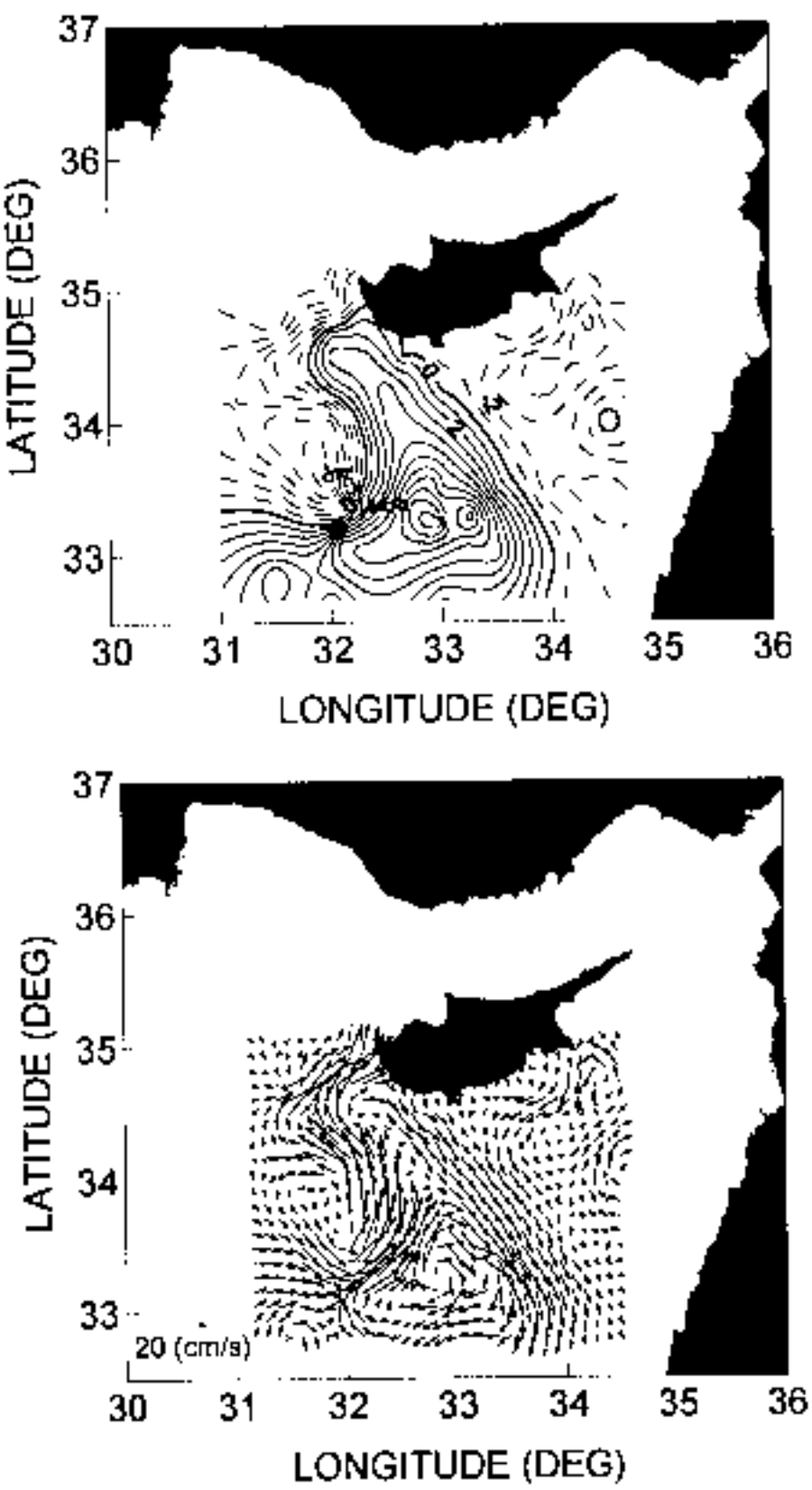

Fig. 2. Dynamic height (0/700m) and corresponding circulation during April –May 2001.

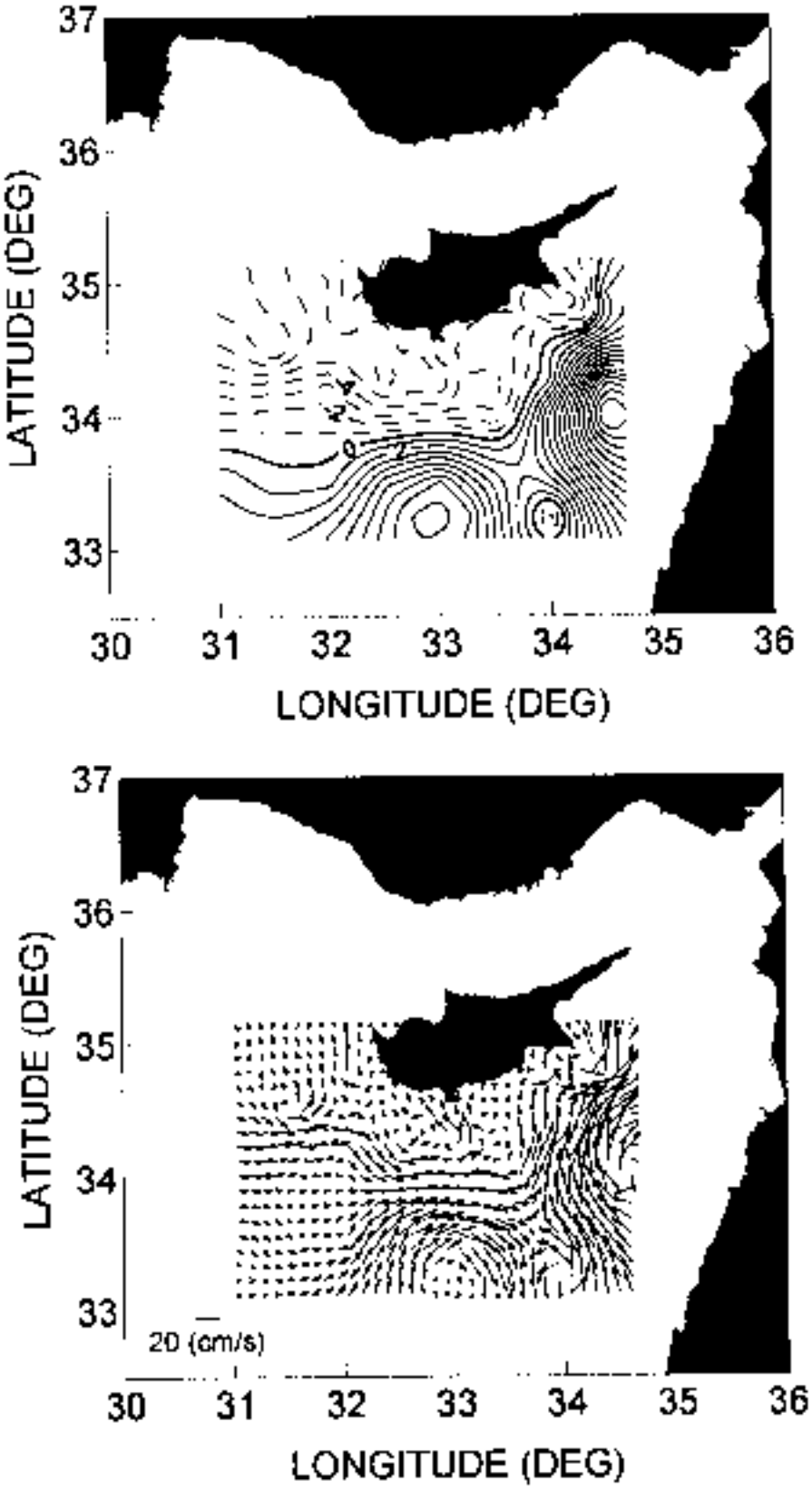

Fig. 3: Dynamic height (0/700m) and corresponding circulation during August 2001.

The observed westward shift of the Cyprus eddy in April-May 2001 caused the restriction of the eastward flow of the Mid Mediterranean Jet (MMJ) south of Cyprus. Its main flow direction was along the western periphery of the Cyprus eddy toward the north, as compared to the historically reported eastward meander. The latter flow direction of the MMJ was restored in August 2001 (Fig. 3).

The daily satellite images obtained and processed at OC-DFMR and PML allowed us to study the spatial displacement and the temporal fluctuations of the surface circulation and of the SST in the region of the CYCLOPS experiment (Figs. 4, 5).

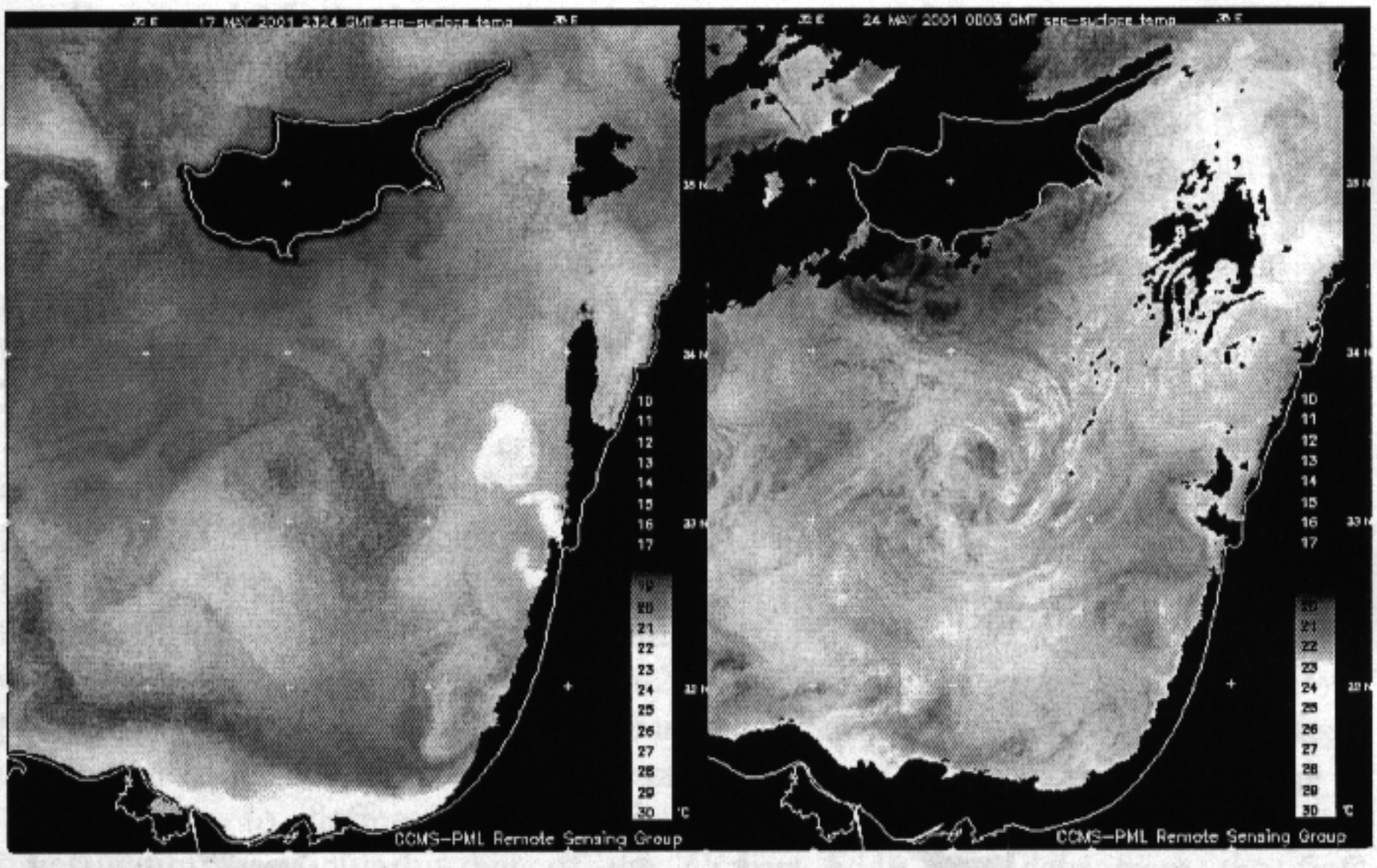

Figure 4: Sea surface temperature (AVHRR images) during 17 and 24 May 2001

Fig. 5. Sea WIFS Chlorophyll concentration on 19 of May 2001

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