# OBSERVATIONS OF BIO-OPTICAL SURFACE FEATURES IN THE MEDITERRANEAN AND BLACK SEA

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**Abstract**

Optical observations of the Mediterranean and Black Sea have been used to assess water constituents' distribution and abundance. A set of SeaWiFS images (1998-2001) was processed to obtain chlorophyll-like pigment concentration, tracing coastal plumes and filaments, fronts, mesoscale eddies and gyres. Small (coastal) features are transient, while larger (basin-scale) patterns are recurrent, over longer periods. Although scales and structures are similar in the basins considered, the average concentration of water constituents presents high variability between different seasons or areas. This can be interpreted in terms of the known oceanographic traits of the observed basins.

*Keywords: Mediterranean Sea, Black Sea, bio-optical properties*

## Introduction

In the last three decades, orbital sensors have generated a novel view of the Mediterranean and Black Sea, expanding both synoptically and statistically the punctual information previously available from in situ data alone (1). Optical observations can be used to characterize basic ecological processes in the sea, over a wide range of space and time scales. In the following, the Sea-viewing Wide-Field-of-View Sensor (SeaWiFS) data set will be discussed, while analogous data, from the Coastal Zone Color Scanner (CZCS) historical archive, will be used to evaluate the SeaWiFS performance. An assessment of bio-optical features will be made, in terms of the known oceanographic traits of the observed basins.

## Historical data sets

Observations performed by the SeaWiFS, in the visible spectrum, have been used to detect optical properties of surface waters, which depend on the distribution and abundance of water constituents. About 1800 SeaWiFS Local Area Coverage (LAC) scenes, covering southern Europe and northern Africa, in the period 1998-2001, compose the time series. Each individual image, taken when favorable meteorological conditions occurred over at least part of the Mediterranean basin, was processed to apply sensor calibration, to correct for atmospheric contamination, and to estimate Chlorophyll-like Pigment Concentration (CPC). The whole data set was processed using the SeaDAS software package (2), with additional modifications (3) (4). The CPC images, with a resolution at nadir of 1.1 km, were re-mapped on an equal-area projection grid (pixel size 2 km), covering the whole Mediterranean region. Composite fields, at ten-day and monthly scales, were derived from the re-mapped images, using simple weighted averaging techniques. Image data originated by the CZCS were also used, for comparison with SeaWiFS. About 2500 individual full-resolution (0.825 km at nadir) CZCS scenes, from the period 1979-1985, compose the time series (5), from which climatological CPC images (annual and monthly means) were derived (6).

## Bio-optical features

The comparison of SeaWiFS images with those of the historical CZCS archive demonstrates a remarkable consistency of absolute values and bio-optical features, in the two periods considered. The SeaWiFS-derived CPC values are consistent with the CZCS-derived climatological means, even though they tend to be systematically lower in near-coastal areas. Such difference is due to the improved algorithms used for the SeaWiFS, with respect to those used for the CZCS – which tended to overestimate CPC within plumes and coastal waters, where the optical properties are influenced not only by planktonic pigments, but also by dissolved organic matter and suspended inorganic particles (7). The patterns in the SeaWiFS-derived CPC field are also similar to those in the CZCS climatology. In the Mediterranean Sea, complex structures (i.e. coastal plumes and filaments, frontal structures, mesoscale eddies, basin-wide gyres) can be found from local to basin scales. Normally, such patterns are traced by CPC higher than the background value, due to some event that produces mixing and/or enrichment of surface waters with nutrients coming from deeper layers or coastal margins. The result is a localized increase in pigments of bio-organic origin, which act as a marker of the event itself. A systematic analysis of the SeaWiFS archives suggests that small-scale (coastal) features, linked to local dynamical processes, are transient and appear only in individual images for a few days, while large-scale patterns, linked to basin-wide bio-geo-chemical processes, are recurrent and can persist over much longer time scales. Local transient structures, such as coastal filaments and eddies, develop along the shorelines, from pronounced headlands and over bathymetric relief interacting with the prevailing currents. The lifetime of such features varies from a few days to a few weeks. In the Black Sea, coastal plumes and fronts form similar structures, mostly as a result of interactions between river discharges over a shallow shelf and the basin's cyclonic circulation. The long-term CPC composites show large-scale features, with a lifetime of many months. This is the case of the main river plumes, of the surface inflow from the Atlantic Ocean, forming the gyre system in the Alboran Sea, and of the inflow from the Marmara Sea, forming a plume in the northern Aegean Sea. Other features appear to have a more pronounced seasonality, such as the blooming cycle in the Ligurian-Provençal Sea, the giant filament of Capo Passero, anchored at the southernmost headland of Sicily, and the Rhodes gyre in the eastern Mediterranean.

## Conclusion

The features traced by CPC, in the SeaWiFS images, can be used to differentiate between geographical provinces of the Mediterranean and Black Sea shaped by bio-geo-chemical and dynamical processes (8). Although scales and structures of bio-optical features are rather similar in the Mediterranean sub-basins and in the Black Sea, the actual concentration of water constituents presents high variability between different seasons (as in the north-western Mediterranean) or between different areas (as in the south-eastern Mediterranean, regularly displaying an oligotrophic nature, and in the Black Sea, always characterized by extremely high pigments). In future work, this should be interpreted in terms of different geographical setting and climate, freshwater input and nutrient supply, water circulation and exchanges.

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