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Relation between Oceanographic parameters and Optical properties in five coastal areas of Southern Italy

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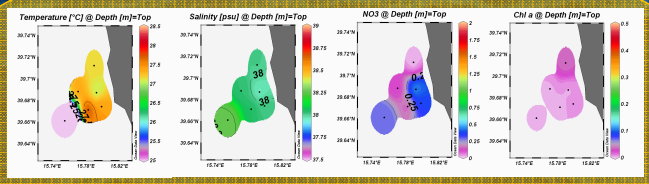
Introduction

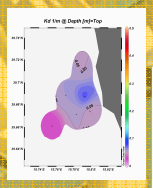
In the framework of the CLAM-PHYM (Coasts and Lake Assessment and Monitoring by PRISMA-Hyperspectral Mission) project it was carried out an oceanographic cruise (27/08-13/09/2010) along the coasts of southern Italy in order to analyze the physical, biochemical and optical properties of some coastal areas. The sampling areas are: the Gulf of Taranto, the Policoro area, the Cetraro Bay, the Gulf of Augusta and the Gulf of Gela.
At each site CTD profiles (temperature, salinity, turbidity, fluorescence and dissolved oxygen) and reflectance measurements of the sea surface and along the water column with portable field spectroradiometers were collected. Water samples at the surface and at 10 m depths were also collected for the analysis of nutrients, chlorophyll *a*, TSM (Total Suspended Matter) and CDOM (Colored Dissolved Organic Matter). These optically active substances interact with solar radiation along the water column through absorption and scattering processes. Furthermore, the CDOM regulates the penetration of UV light throughout the water column and mediates photochemical reactions, playing an important role in many marine biogeochemical processes.
In the present work has been taken into account the spectral diffuse attenuation coefficient (Kd(λ)), which describes the attenuation of the planar irradiance along the vertical due to absorbing and scattering substances. It is an important parameter able to describe the quality of sea water. The Kd can be used to classify the types of water and it is a critical parameter for an accurate estimate of the intensity of light at different depths.
The collected data were analyzed to identify the relationship between the bio-optical concentrations of optically active substances and the surface reflectance spectra measured in situ; this relation, if reversed, can be used to map the concentrations of optically active substances from hyperspectral satellite data.

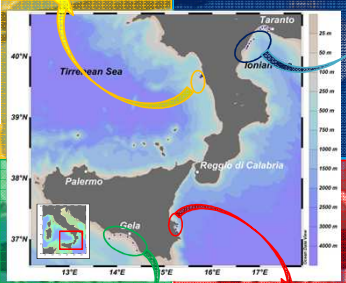
Results and Discussions



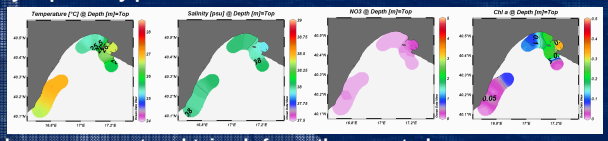
The area of Cetraro is characterized by surface salinity that ranges between 38 and 38.5 and high inshore values of temperature that are characteristic of the period (27-28 ° C). The low concentration of nutrients in the area shows that there is a probably lack of biological activity. In particular, the low values of chlorophyll *a* confirm that, probably, uptake processes by phytoplankton groups are not occurred.
The values of Kd (490), obtained by the solar irradiance profiles along the water column measured with the hyperspectral radiometer RAMSES-TRIOS, have been correlated with the different optical parameters measured (fluorescence, chlorophyll, turbidity and CDOM).

The low Kd values (0.03 - 0.07 m^{-1}) indicate a high transparency of the water body and consequently a probably paucity of organic and inorganic matter. The area does not show significant correlations between Kd and optical parameters measured.

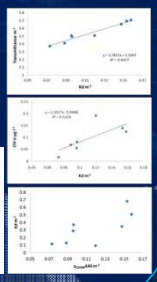


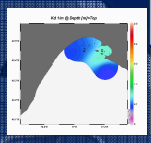


The Gulf of Taranto and the coastal area in front of Policoro have a homogeneous salinity between 37.8 and 38.1. The temperature shows different values between the two areas with values highest of 1-2 ° C in the area of Policoro. Both areas show low concentrations of nitrates. Low concentrations of Chlorophyll *a* in front of Policoro (0.02-0.1 µg l^{-1}) are observed. The opposite trend is observed in the Gulf of Taranto where the chlorophyll *a* shows values of 0,2-0.5 µg l^{-1}. In this area a higher biological activity is probably present.

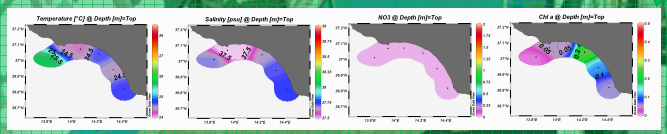


The Kd measurements obtained from the spectral curves made with the spectroradiometer in the Gulf of Taranto range between 0.07 and 0.16 m^{-1}. The area of "Mar Grande" of Taranto is the one with the highest values. In this area there are also the highest concentrations of chlorophyll *a* and suspended particulate matter. The regression curves indicate that the Kd shows significant correlations with the optically active parameters measured. The significance is 99% for transmittance and fluorescence (not shown) and 95% for chlorophyll *a* e $a_{cdom}(440)$.

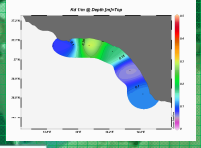


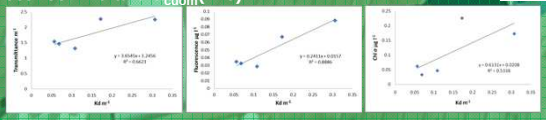


The Gulf of Gela shows values of surface temperature and salinity of 24-26 °C and 37.4-37.8, respectively. The nutrients detected throughout the area are generally low. The highest concentrations of chlorophyll *a* are detected at the central station of the bay (0.1- 0.2 µg l^{-1}).

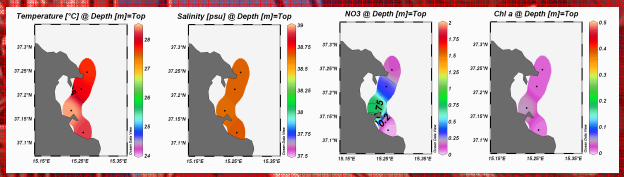


The Kd measures show values ranged between 0.06 and 0.31 m-1. The highest values are found at the south-east of the Salso River mouth as highlighted by low surface salinity.
The correlation between Kd and optical active substance seems to be good for chlorophyll *a*, fluorescence and transmittance. Unfortunately we have few data in order to consider these correlations significant. There are not correlation between Kd and $a_{cdom}(440)$.

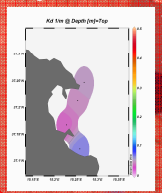




The Gulf of Augusta shows surface water warmer (27.6 - 28.5 °C) and salty (38.6 - 38.7) compared to the other investigated areas. The concentrations of nutrients are low as well as the concentrations of chlorophyll *a*. The biological activity is low and it is likely to be due to the presence of oligotrophic waters.



The measures of Kd are low throughout the area and ranged between 0.04 and 0.06 m^{-1}. This feature is an index of seawater with a high penetration of sunlight confirmed by low values of turbidity (not shown).



The regression curves between Kd and the optically active parameters do not show significant correlations. The concentrations of chlorophyll a and $a_{cdom}(440)$ are often close to the instrumental detection limit and this, probably, makes difficult the correlation due to the presence of possible errors during the sampling and the analysis that, at these very low concentrations, become non-negligible.

Remarks

- ✓ The five investigated areas show the physical, chemical and biological characteristics of oligotrophic waters with low productivity. Only the Gulf of Taranto and the Gulf of Gela show a weak trophic enrichment probably due to the presence of the iron and steel industries in Taranto and the Salso river mouth in the Gulf of Gela.
- ✓ The correlations found in the Gulf of Taranto among Kd, chlorophyll a and $a_{CDOM}(440)$ (not with salinity) would suggest that the origin of CDOM is mainly due to phytoplankton production rather than river discharge.
- ✓ The Gulf of Taranto shows to be the best site to identify the bio-optical relationships between the concentrations of optically active substances and reflectance spectra measured in situ.