AN EMPIRICAL OCEAN COLOR ALGORITHM FOR ESTIMATING THE CONTRIBUTION OF COLORED DISSOLVED ORGANIC MATTER IN WESTERN ADRIATIC SEA

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Abstract
Empirical band ratio algorithms for the estimation of Colored Dissolved Organic Matter (CDOM) using MODIS ocean color sensor were developed for Western Adriatic Sea (Mediterranean Sea). Correlations between in situ measurements of CDOM absorption coefficients at 355 nm ($a_{CDOM}355$) with Modis remote sensing band ratios were examined. The best performance was obtained by linear regression using $R_{rs}(667)/R_{rs}(488)$ band ratio both for the entire pool of data (R^2=0.85) and for data with salinity <35 (R^2=0.89).

Keywords: Organic matter, North Adriatic Sea, Ocean colours, Remote sensing

Introduction
The Colored fraction of Dissolved Organic Matter (CDOM) plays various roles in physical and biogeochemical processes. CDOM absorption coefficient, $a_{CDOM}(lambda)$, has been shown to vary mainly with type and source of CDOM. It can dominate the inherent light absorption at the blue wavelengths in surface waters of the coastal and pelagic ocean/sea [1]. In many coastal areas, CDOM absorption is several times that of chlorophyll proving to be a useful tracer not only for carbon but also as a proxy for mixing in a wide variety of environments. The accurate retrieval of CDOM absorption is, however, a prerequisite for applying ocean color remote sensing data to separate it from other optically active ocean constituents such as chlorophyll *a* or rate processes such as phytoplankton productivity. Numerous bio-optical algorithms have been developed to retrieve CDOM absorption from ocean color satellite observations around the world.
As a part of several national and international projects (RITMARE, BALMAS, ECOSEE/A), oceanographic cruises in the Central and Northern Adriatic Sea were conducted between 2013 and 2015. This work aims to develop an empirical algorithm to retrieve CDOM from satellite remote sensing reflectance (R_{rs}) in Western Adriatic Sea, which is a complex system influenced by one of the largest Mediterranean rivers (Po).

Methods
The in situ measurements were performed in Western Adriatic Sea from December 2013 to May 2015 (Fig. 1).

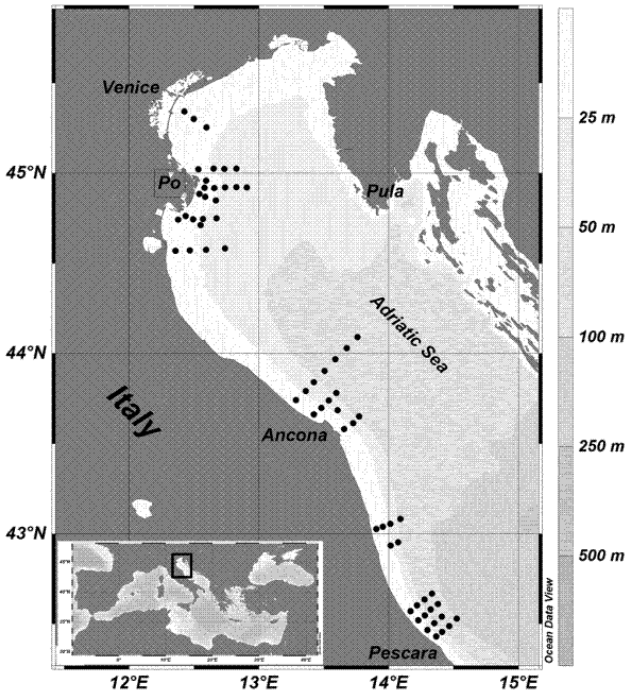

Fig. 1. Fig. 1 Map of all sampling stations in the Italian waters of the Adriatic Sea. Some stations were sampled more than once.

Sea surface water samples from different areas of the Adriatic Sea were collected in different seasons. A total of 91 samples corresponded to clear-sky days during which satellite Modis-Aqua acquired Rrs. For each of these samples, temperature, salinity (S) and $a_{CDOM}355$ were measured. The CDOM absorption coefficient $a_{CDOM}355$ was then correlated, using linear or exponential regressions, with the following MODIS R_{rs} band ratios: ($R_{rs}(412)/R_{rs}(547)$, $R_{rs(488)}/R_{rs}(547)$, $R_{rs}(667)/R_{rs}(412)$ and $R_{rs}(667)/R_{rs}(488)$).

Results and Discussions
The linear regression was proved to be most performing (i.e. higher R^2) with respect to the exponential regression. A linear relationship between $a_{CDOM}355$ and the different ratios of R_{rs} was observed but with different goodness of fit. The best linear regression between CDOM absorption and the in situ values were obtained by using the $R_{rs}(667)/R_{rs}(412)$ and $R_{rs}(667)/R_{rs}(488)$ band ratios with R^2 values of 0.79 and 0.85, respectively, whereas the use of the $R_{rs}(412)/R_{rs}(547)$ and $R_{rs}(488)/R_{rs}(547)$ band ratio generated lower R^2 values. A linear regression analysis was applied also to the split dataset for less salty waters (S<35) and salty ones (S>35). The optimal regression was obtained using the $R_{rs}(667)/R_{rs}(488)$ band ratio for S<35 (R^2=0.89). The use of $R_{rs}(667)/R_{rs}(488)$ band ratio resulted to be the best variate for the retrieval of $a_{CDOM}355$ in our test areas in Western Adriatic Sea that are characterized by high river discharges [2], [3]. Though CDOM does not adsorb strongly at 667 nm, riverine CDOM shows a significant absorption at 488 nm, a wavelength at which the chlorophyll absorption is rather low. Therefore, this ratio should be more sensitive to changes in CDOM rather than in chlorophyll. The algorithms (1) and (2) based on this relationship should be a good compromise for the retrieval of $a_{CDOM}355$ in North-Central Western Adriatic Sea:
(1) $a_{CDOM}355_{\text{ (ENTIRE DATASET)}} = 0.1165 + 1.9089*(R_{rs}(667)/R_{rs}(488))$
(2) $a_{CDOM}355_{\text{ (S<35)}} = 0.0262 + 2.202*(R_{rs}(667)/R_{rs}(488))$
Further work is ongoing in order to validate the proposed algorithms.

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