Retrieval of Biogeochemical Properties in Marine Waters Using a Newly Introduced Inversion of the Three-stream Irradiance Model

The emergence of satellites and the constant refinement of numerical algorithms used for optical and biogeochemical variables prediction have proven to be essential in improving light for better calculations both of physics and biogeochemistry in marine systems. Inversion models are useful tools to invert the ocean color observed by satellites into inherent optical properties IOPs. However, building an accurate inversion model is complex due the variations in the composition or optical properties of biogeochemical constituents. This study seeks to demonstrate the feasibility and efficiency of the implementation of an inversion of the three-stream irradiance model approach in one-dimensional water column configuration in the Boussole site in the Northwestern Mediterranean Sea. The inversion procedure is based on the minimization of a cost function in the form of a mean square difference depending on the concentrations of the biogeochemical elements.This model was applied to a multi-sensor satellite merging product of remote sensing reflectance (Rrs(λ)) at five wavelengths (412.5, 442.5, 490, 510 and 555 nm), acquired from Copernicus Marine Service CMEMS from January 2005 to December 2021 to retrieve IOPs such as absorption coefficients of phytoplankton (aphy), Colored Dissolved Organic Matter (acdom), Non-Algal Particles (aNAP), and particulate backscattering coefficient (bbp). Rrs used as an input for the inversion approach, as an extension, for data assimilation, was processed and quality checked using different filtering processes. The quality check procedure proposed in the present work proved to perform well for reducing noise in the model output while maintaining temporal and spectral variability. Several simulations were applied to identify a reference configuration (REF) with the parameters derived from literature data. To improve model's skills, we conduct a series of sensitivity experiments, by perturbing the parameters related to the bio-optical properties and phytoplankton physiology. The uncertainties of each specific perturbation were assessed using the standard statistical procedures BIAS, root mean square error (RMSE), and correlation (CORR). The model output of the starting REF configuration, and after optimization of the optical and physiological parameters, can reconstruct the seasonal variability of the optical constituents. The optimized model configuration (OPT) appears to better reconstruct Chlorophyll-a variability, mainly during vertical mixing with a reduction of RMSE by approximately 50%. Phytoplankton and CDOM absorption coefficients were better predicted by the OPT configuration with respect to observed data. Sensitivity analysis shows that parameterization of Chlorophyll-a to Carbon ratio has a major role in the performance of the inversion model.

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