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Multi-Resolution Ocean Color roducts to support the Copernicus Marine High-Resolution Coastal Service

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High-quality satellite-based ocean colour products can provide valuable support and insights in the management and monitoring of coastal ecosystems. Today's availability of Earth Observation (EO) data is unprecedented including traditional medium resolution ocean colour systems (e.g. Sentinel-3/OLCI) and high-resolution land sensors (e.g. Sentinel-2/MSI). Each of these sensors offers specific advantages in terms of spatial, temporal or radiometric characteristics, enabling the provision of different types of ocean colour products. This is also reflected in the portfolio of the Copernicus Marine service providing a number of different OC products to support different types of end users. While "traditional" ocean colour sensors like Sentinel-3 OLCI provide daily temporal resolution, the sensors onboard these satellites do not measure at the necessary high spatial resolution to resolve complex coastal dynamics. High spatial resolution sensors, like MSI onboard Sentinel-2 (10m - 60m resolution), are able to resolve these small scales, but their temporal revisit time is far from optimal (about 5 days considering the Sentinel-2 A & B constellation). Additionally, both high spatial resolution datasets and traditional ones are hindered by the presence of clouds, resulting in a large amount of missing data.

Given the high complementarity of these two measurement strategies, we present a methodology to derive daily cloud-free multi-resolution ocean colour products from the synergistic use of Sentinel-2 and Sentinel-3 data by applying DINEOF (Data Interpolating Empirical Orthogonal Functions). A key processing step in the gap-filling procedure is the harmonization between the ocean colour products (e.g. chlorophyll-a concentration -CHL-, Turbidity -TUR-) between the Sentinel-2/MSI and Sentinel-3/OLCI sensor. Due to differences between the sensors regarding spectral band sets and viewing geometry, CHL algorithms used for Sentinel-3/OLCI cannot be directly transferred to Sentinel-2/MSI resulting in the chlorophyll-a products often having diverging values between both sensors. To increase the coherency between the Sentinel-2/MSI and Sentinel-3/OLCI CHL products, a machine learning technique (LightGBM) was used to transfer the more complex CHL algorithms (e.g. band ratio algorithms, switching algorithms, other machine learning algorithms) from Sentinel-3/OLCI to Sentinel-2/MSI. Subsequently, DINEOF is used to generate the daily multi-resolution products by using the daily OLCI products to support gap-filling in the high-resolution 5-daily coastal products and retaining the high spatial resolution of Sentinel-2/MSI data and the high temporal resolution of OLCI data in the final product.

The machine learning and multi-resolution gap-filling approach will be demonstrated and validated in different regions (e.g. North Sea, North Adriatic Sea) to ensure suitability of the approach for integration into the operational high resolution COPERNICUS Marine Service. An analysis of TUR and CHL daily products at 100m resolution will be presented, alongside an analysis of the spatial and temporal scales retained by the approach. This work was performed in the Copernicus Marine Service Evolution Project MultiRes (21036-COP-INNO-SCI)