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A case study on bio-optical and radiometric quantities in northwest European shelf seas

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Colour of seawater has become an integral tool in understanding surface marine ecosystems and processes. Additionally, operational oceanographic observatories are becoming more prominent these days while at the same time hyperspectral radiometric sensors are becoming increasingly affordable. This has driven a wide spread use of these hyperspectral sensors to measure reflectance above the water surface from stationary and mobile platforms alike. As enormous amounts of data are produced and favourably processed in real-time, effective quality control procedures become more than just supporting tools, but a crucial prerequisite for trustworthy and manageable information. Here, we use bio-geophysical and hyperspectral radiometric measurements from German Bight (GB), North Sea (NS), Inner Seas (ISS), Irish Sea (IS) and Celtic Sea (CS) to identify and establish relationships between colour producing agents (CPAs) and perceived colour of seawater. In order to obtain valid optical measurements, meteorological and sunglint contamination were mitigated using state-of-the-art quality control protocols. The remote sensing reflectance measured is transformed into discrete Forel-Ule numerical indices (FUI), 1 (indigo-blue, oligotrophic) to 21 (cola brown, hyper-eutrophic). We present a novel approach of estimating which of the three main CPAs of seawater control perceived colour of seawater. Our bio-optical models for estimating FUI for measured CPAs; chlorophyll (Chl-a), coloured dissolved organic material (CDOM) and suspended particulate material (SPM) had correlation coefficients, R^2 (GB = 0.98, NS = 0.23, ISS=0.99, IS=0.63, CS = 0.16). It was also observed that salinity can be estimated from coloured dissolved organic matter with good accuracy, R^2 (GB = 0.94, NS = 0.44, ISS=0.90, IS=0.85, CS = 0.51). We show that ocean colour products i.e. reflectance and perceived colour of seawater can be used to infer, with good accuracy, environmental parameters e.g. Chl-a, CDOM, SPM, salinity and Secchi depth of the investigated waters providing an effective and affordable tool for operational marine observations. Improved and extensive field investigations are required to further enhance the sensitivity/accuracy of such region specific bio-optical models.