Hijacking other thematic satellite sensors for ocean colour application.

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For more than 40 years traditional ocean color remote sensing has been employing multispectral satellite sensors' data that have a small number of broad incoherent spectral bands measuring portions of the visible electromagnetic spectrum. These bands were placed at key wavelength regions to detect the concentration of the primary pigment in phytoplankton, chlorophyll a, and but also to avoid high uncertainty in water leaving radiances caused by strong atmospheric absorption. The selection of the few spectral bands was further enabling high enough sensitivity (signal to noise ratio, SNR) over the mostly very dark ocean waters at a resolution sufficient for the observation of the temporal and spatial dynamics of phytoplankton growth and its degradation products. Satellite sensors with fine spectral resolution (~0.5 nm) and high signal SNR (>1000) which were originally designed for atmospheric application provide additional opportunities for distinguishing and quantifying various innovative descriptors of the surface water biogeochemistry and the underwater radiation field. This presentation focuses on innovative information gained within the last twenty years by exploiting these optical satellite sensors.

Information on major phytoplankton groups, the spectral underwater light, and the fluorescence by chlorophyll a (Chl) for the global ocean is retrieved from these sensors mostly by the inverse method called Differential Optical Absorption Spectroscopy (DOAS). With DOAS the absorption spectra representative for major phytoplankton groups, and the so called "pseudo-absorption" spectra caused by Vibrational Raman Scattering (VRS) and Chl fluorescence are fitted. The later spectra are derived using coupled ocean-atmosphere radiative transfer modelling (RTM) to simulate the Filling in of Fraunhofer Lines by these inelastic scattering processes. RTM is also used to construct Look-Up Tables which transfer the specific targets' fit factors to geophysical quantities, such as phytoplankton groups Chl concentration, the diffuse attenuation coefficient (in the UV and blue) or the Chl fluorescence line height while accounting for the influence of solar zenith angle, observation geometry and atmospheric transmissivity altering the fit factors. The final global products show good agreement to in situ matchups and similar multispectral products. Older sensor's products have been limited by low spatial resolution and coverage, but their application is enhanced by synergistic use with high coverage, but empirically based, multispectral data products. In addition, the recent sensor's provide much improved spatial and temporal resolution data which enable higher retrieval sensitivity for oceanic products. In future, these innovative data sets from the different sensors should be combined into a long-term data so that they can be used as input or for evaluation of modeling focusing on, e.g., marine biodiversity, primary productivity, photochemical reaction rates and short-wave radiation.

Recent results from employing spectral decomposition to such atmospheric sensor top of atmosphere radiance (UV to blue) data and then using machine learning for developing models for deriving bulk ocean color parameters are presented. These models are trained on matchups to MODIS ocean color products and then applied to top of atmosphere data under heavy aerosol loading, sun-glint and thin clouds which enables the prediction of these ocean color products in less-than-ideal conditions.

The presentation will end with a discussion how these achievements (may) pave the path for upcoming water color products from new hyperspectral “water” missions, such as PACE, SBG, CHIME or Next Generation Sentinel-3 OLCI, but also new atmospheric missions.