remote sensing

Editorial

An Overview of the Special Issue on Seawater Bio-Optical Characteristics from Satellite Ocean Color Data

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Satellite ocean color data provide an opportunity to effectively observe possible changes in the state of marine ecosystems. The data on bio-optical characteristics obtained as a result of ocean color data processing depend on qualitative and quantitative compounds of dissolved and suspended matter contained in seawater. Its structure is extremely changeable and diverse: colored organic matter, phytoplankton, bacteria, detritus and suspended particles carried out to the sea by rivers and wind. The component's content and variability allow one to estimate the ecosystem's state and perform monitoring. These tasks can be executed successfully with the help of remote sensing methods.

The 'Seawater Bio-Optical Characteristics from Satellite Ocean Color Data' Special Issue aims to present the results of new studies on seawater bio-optical characteristics from satellite ocean color data with the possible implementation of other available remote sensing instruments such as drones and contact measurements, including autonomous drifting buoys. Under the conditions of frequent and dense cloudiness in the Arctic seas, the combined use of continuous measurement data on the ship's flow-through system and satellite observations also proved quite useful [1]. The results of remote and direct measurements can be used in hydro-optical models, statistical methods and various data processing algorithms, including atmospheric correction. Special attention is paid to the development and application of regional algorithms for the retrieval of the seawater's bio-optical characteristics from satellite ocean color data. The introduced above set of instruments and approaches will provide us with an opportunity to study the spatial and temporal changes in bio-optical characteristics values in the wide range of scales and let us monitor the ocean and seawater areas. These 10 articles collected in this Special Issue are, to one degree or another, devoted to the mentioned problems. The brief information about the content of each of them is given below.

Half of the articles are devoted to the bio-optical characteristics of East China, Yellow and Bohai seas. It is a region of the complex hydrodynamic environment that has strong influences from the large amounts of freshwater and sediments from the Yellow River and the Yangtze River. The study of these water areas is of great interest as far as the complexity of its optical characteristics is concerned and necessary due to the importance of marine ecological environment monitoring taking into account the intense anthropogenic pressure, particularly marine traffic. The variability of different seawater surface layer parameters was studied in the series of works in the scales from long-term to diurnal. The high temporal resolution research is possible due to the availability of Geostationary Ocean Color Imager (GOCI) data in this region.

In [2], the variations in water transparency in the Bohai and Yellow Seas from MODIS remote sensing reflectance data are considered. According to these data with the use of model [3], the Secchi disk depth (SDD) values, which characterize the water optical properties, were calculated. The results of this value's trend calculations for the period from 2003 to 2019 display an increase in water transparency from 2017. This can be estimated as a result of water quality improvement. With the help of empirical orthogonal function analyses, the authors show the connection of SDD with the total suspended matter concentration, as well as colored dissolved organic matter content. Taking into consideration the strong influence of river runoff in this region, no correlation with chlorophyll-a concentration (Chl) was registered. As a result, it was shown that the water transparency data on a long-term scale can be used as an effective parameter for monitoring water quality and marine ecosystem protection.

The long-term dynamics of particulate organic carbon (POC) in the East China Sea are studied in [4]. The obtained results provide an opportunity to clarify the models that describe the carbon cycle. To obtain information on POC concentrations, the hybrid model was developed with the help of field measurement data. Its implementation of the MODIS ocean color data provided a seventeen-year observation (from 2003 to 2020) of POC concentrations. Different factors influencing POC concentrations were revealed: river runoff, phytoplankton blooms, wind and currents impact. The results of this research can be also applied for other water areas.

Hourly data of the Geostationary Ocean Color Imager provide an opportunity to specify the particularities of different bio-optical characteristic diurnal variations in coastal waters: $K_d(490)$ in the East China Sea [5] and Chl, total suspended matter and $a_g(440)$ in Yellow and East China Seas [6]. It is important to note that the data of the buoys are considered in both papers: a moored marine optical buoy (the results of which are necessary for the validation of $K_d(490)$ GOCI L2 data) in the first one, and a drifting buoy (tracking the position of which made it possible to study the bio-optical characteristics transformation of water volume that moves this buoy) in the second work. The results of both articles can be used in a broad implementation with respect to water quality estimations in the coastal zone.

One more GOCI implementation can be found in [7], where the authors worked out the algorithm for obtaining the fluorescence line height (FLH) of chlorophyll. This algorithm uses 660, 680 and 745 nm GOCI bands and implies further band conversion for reducing the number of negative FLH values. The obtained results correspond to the data of field measurements and MODIS standard product well. The authors pointed out the possibility of their product merging with the data of other ocean color scanners for improving data coverage and extending the time series' span.

Besides works where high temporal resolution data were considered, there are also two articles in this Special Issue containing data on high spatial resolution images. The given data allows one to study comparatively small-sized objects thoroughly: Lake Villarrica (surface area 173 km^2) located in south–central Chile [8] and even the lateral border of a small river plume in the Black Sea [9]. In the first paper, the data of Landsat 8 OLI and Sentinel-2A/B MSI were processed in the ACOLITE processor with the help of different algorithms to obtain photosynthetic active radiation attenuation coefficient values. Their comparison to the data of field measurements shows the dependence of the most exact algorithm choice on the season. According to the calculation results, the classification of lake water types was suggested. The second paper is not connected with the quantitative definition of seawater bio-optical characteristics values on the ocean color data. It stands out due to its authors' approach to using optical contrast, which is generated by suspended mater income from the river runoff, to study plume dynamics.

One more work is dedicated to the Black Sea region [10]. Its authors specify the results of MODIS and VIIRS ocean color data atmospheric corrections in non-typical Saharan dust transfer conditions. The algorithm for additional data correction is recommended. Its implementation significantly reduces the discrepancy between in situ and retrieved remote-sensed reflectance, especially in short-wave spectral bands.

The two last papers represent the results of regional satellite algorithms development, used for the seawater bio-optical characteristics values estimation in the Arctic seas. The first one is focused on the analysis of the chlorophyll retrieval algorithm's accuracy in the Barents Sea and its influence on the exactness of the absorbed solar radiation estimation [11]. Based on the numerical calculations of the absorbed thermal energy in the visible spectral range in the seawater column results, it is shown that differences in chlorophyll-a concentrations due to the accuracy of satellite bio-optical algorithms (30–50%) have little effect on the vertical distribution of absorbed solar energy. The other work besides the representation of worked out regional empirical bio-optical algorithms for the estimation of chlorophyll-a concentrations and colored dissolved organic matter content in the western part of the Bering Sea in the late summer period provides information on the applicability of global bio-optical algorithms [12]. Recommendations on the choice of the most accurate algorithm are given in terms of the dependence on the quality of atmospheric correction.

Despite the wide diversity of hydro-optical problems gathered in this Special Issue, its theme is much wider. Unfortunately, no attention was paid to research directions such as the analysis and application of the data on airborne remote sensing, lidars, autonomous profiling biogeochemical Argo buoys and underwater gliders; in addition, seawater polarization characteristics were ignored. The editorial board hopes that gaps in these directions will be filled with worthy articles in the following part of the Special Issue.

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