Commentary

Remote Sensing the Coast: Atmospheric Techniques for Accurate Ocean Color Retrieval

Alireza Guan*

Department of Hydrology and Atmospheric Sciences, University of Arizona, Tucson, Untied States of America

DESCRIPTION

Remote sensing involves the measurement of sunlight reflected from the ocean surface to infer properties such as chlorophyll-a concentration, suspended particulate matter, and water transparency. These properties serve as indicators of phytoplankton productivity, sediment transport, and overall water quality. Satellite-based sensors, such as National Aeronautics and Space Administration (NASA's) Moderate Resolution Imaging Spectroradiometer (MODIS) and the European Space Agency's Sentinel-3, play a pivotal role in providing large-scale and synoptic views of ocean color dynamics.

Atmospheric aerosols, tiny particles suspended in the air, can significantly impact the quality of satellite ocean color data. Aerosols scatter and absorb sunlight, altering the radiative transfer processes that occur between the ocean surface and the satellite sensor. While non-absorbing aerosols are often assumed in atmospheric algorithms, the presence of absorbing aerosols, such as black carbon and dust, poses a complex challenge. These absorbing aerosols can exert a disproportionate influence on the retrieved ocean color signals, leading to inaccuracies in the estimation of water properties. Coastal waters are dynamic and complex environments where terrestrial and marine influences converge. The proximity of land introduces additional complexities in atmospheric due to variable aerosol types, sources, and optical properties. In coastal regions, the presence of absorbing aerosols can be particularly pronounced due to anthropogenic activities, such as industrial emissions, urban development, and shipping. Additionally, the intricate interplay between land, water, and atmosphere makes accurate atmospheric a formidable task.

Advancements in atmospheric techniques

Efforts to address the challenge of absorbing aerosols in satellite ocean color remote sensing have led to advancements in atmospheric algorithms. These advancements seek to improve the accuracy of ocean color retrievals over coastal waters.

Spectral information: Algorithms utilize multi-spectral observations to differentiate between the effects of aerosols and water color. By exploiting the spectral characteristics of absorbing aerosols, aim to isolate and correct their impact on the ocean color signal.

Aerosol models: Improved aerosol models that account for absorbing aerosols have been incorporated into atmospheric algorithms. These models consider aerosol size distributions, optical properties, and vertical profiles, enhancing the accuracy of radiative transfer simulations.

Sensitivity analysis: Sensitivity analysis assesses the influence of different aerosol types and their concentrations on the retrieved ocean color signal. This approach helps quantify uncertainties and establish robust strategies.

Data fusion: Integration of data from multiple satellite sensors with varying spatial and spectral resolutions enables the development of more accurate and comprehensive atmospheric methods.

Despite advancements, atmospheric for absorbing aerosols remains a complex and evolving field. Challenges include the dynamic nature of aerosols, uncertainties in aerosol properties, and the need for accurate atmospheric measurements. Additionally, the spatial and temporal variability of coastal aerosols requires tailored approaches for different regions. Future directions in atmospheric include the incorporation of machine learning techniques, increased use of high-resolution satellite data, and integration with in-situ measurements and models. Collaborative efforts between atmospheric scientists, oceanographers, and remote sensing experts are essential for advancing our understanding of absorbing aerosols and their impact on coastal ocean color remote sensing.

Applications and implications

Accurate atmospheric for absorbing aerosols holds far-reaching implications for marine and applications:

Correspondence to: Alireza Guan, Department of Hydrology and Atmospheric Sciences, University of Arizona, Tucson, Untied States of America, E-mail: alirezag@gmail.com

Ecosystem monitoring: Reliable ocean enables the assessment of phytoplankton productivity, harmful algal blooms, and overall marine ecosystem health.

Fisheries management: Accurate ocean color retrievals inform fisheries management by providing insights into nutrient availability and potential fishery productivity.

Climate studies: Precise Ocean contributes to climate studies by improving our understanding of carbon cycling, ocean-atmosphere interactions, and the Earth's radiative balance.

Environmental management: Informed decision-making in coastal zone management, pollution control, and conservation efforts relies on accurate ocean color information.

Satellite ocean color remote sensing has become a marine science, offering unprecedented insights into the dynamic processes of our oceans. However, the accurate retrieval of ocean color signals over coastal waters is contingent on robust atmospheric methods, especially in the presence of absorbing aerosols. Advancements in algorithm development, aerosol modeling, and data fusion are gradually unraveling the complexities associated with asorbing aerosols. By enhancing our ability to separate atmospheric and oceanic influences, accurate atmospheric contributes to a clearer and more precise understanding of coastal marine environments. As we continue to refine our methods and expand our knowledge, the combined power of remote sensing and atmospheric illuminates the coastal seas, on their intricate dynamics and vital role in our planet's health.