Dependence of Ocean Remote-Sensing Reflectance on the Solar Zenith Angle

L. A. Stefantsev, *Cand. Sci. (Phys.-Math.), steph2000@mail.ru*
Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences (GEOKHI RAS)
Moscow, Russian Federation

A. P. Vasilkov, *Cand. Sci (Phys.-Math.), alexander.vasilkov@ssaihq.com*
Science Systems and Applications Inc., Mariland, 20706, USA

Abstract. We consider an important feature of passive remote sensing of the ocean reflectance — its dependence on illumination conditions, namely on the solar zenith angle (SZA). In the context of the so-called quasi-single scattering approximation of the radiative transfer theory, the dependence of the remote-sensing reflectance of the ocean and the diffuse reflection on the solar zenith angle is calculated. Calculations show that the ocean surface effects on the remote-sensing reflectance are small even for high SZAs provided the absence of ocean foam on the surface.

This is explained by that the rough ocean surface weakly affects the fraction of diffuse solar radiation penetrating into the ocean. Spectroradiometer data were collected in different regions of the tropical Atlantic which are distinct in optical properties of ocean waters. Measurements of the remote-sensing reflectance were carried out by a three-channel spectroradiometer that simultaneously measured solar irradiance, sky radiance in the zenith, and water-leaving radiance at nadir in the spectral range of 400–650 nm with a spectral resolution of 2.5 nm. The remote-sensing reflectance is calculated from those measurements (assuming the Fresnel reflection from the surface and the surface transmittance of incident solar radiation are known). The spectroradiometer was installed on a research vessel in such a way as to avoid any interference that could be caused by the vessel body. Comparisons of the measured and calculated remote-sensing reflectance shows good agreement. An analysis of the measured and calculated data demonstrates that the SZA effect on the ratio of remote-sensing reflectance at two wavelengths is small.

This conclusion is important for remote sensing of oceanic chlorophyll because most existing chlorophyll algorithms are based on the spectral ratios of remote-sensing reflectance.

Keywords: passive remote sensing of the ocean, remote-sensing reflectance, solar zenith angle, quasi-single scattering approximation