COMPARATIVE ANALYSIS OF THE METHODS USED FOR THE DETERMINATION OF THE OPTICAL PARAMETERS OF WATERS IN THE BLACK SEA ACCORDING TO THE DATA OF SATELLITE MEASUREMENTS

V. S. Suetin, S. N. Korolev, V. V. Suslin, and A. A. Kucheryavyi

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We demonstrate the possibility of determination of the spectral characteristics of absorption and backward scattering of light in the Black Sea according to the data of a SeaWiFS satellite device. We use specially selected data of observations obtained under favorable atmospheric conditions. It is shown that the results of calculations performed by using different methods are almost identical and weakly depend on the model parameters of the spectral course of the coefficients of absorption of light by yellow substance and its scattering by suspended particles.

Keywords: Black Sea, optical parameters, spectral characteristics, satellite measurements.

As one of the fields of application of the data of remote satellite observations, one can mention the determination of the optical characteristics of seawater. To solve this problem, it is possible to use various methods and algorithms available from the literature [1–4]. For the better comprehension of their possibilities and specific features, it is useful to perform the comparative analysis of the results obtained by using different methods on the basis of the data of actual satellite observations of the Black Sea.

In the present work, we consider some examples of testing the three algorithms from [2–4] used to compute the spectral coefficients of the total absorption and backward scattering of light in the upper layer of the sea. In what follows, these quantities are denoted by \( a_\lambda(\lambda) \) and \( b_\lambda(\lambda) \), respectively (\( \lambda \) is the length of the emitted wave). These data are necessary for the proper interpretation of the results of observations of various hydrophysical processes, modeling of the conditions of formation of the light field in the sea, etc.

A convenient practical procedure of determination of the quantities \( a_\lambda(510) \) and \( b_\lambda(555) \) at \( \lambda = 510 \) and 555 nm is proposed in [1]. The algorithms considered in the present work enable us to compute \( a_\lambda(\lambda) \) and \( b_\lambda(\lambda) \) for all basic spectral channels of the SeaWiFS (Sea-Viewing Wide Field-of-View Sensor) and MODIS (Moderate Resolution Imaging Spectroradiometer) devices under the conditions of independent multifactor variations of these quantities.

To perform test calculations, we used the results of satellite surveys of the Black Sea stored in the archive of the NASA Goddard Space Flight Center, USA (NASA GSFC) and available through the Internet. To process these data, we applied the SeaDAS software system [5]. As the input data, we took the values of the spectral normalized water leaving radiance \( L_{WN}(\lambda) \) obtained in the stage of taking into account the atmospheric distortions (atmospheric correction). The atmospheric correction is a serious problem and its detailed analysis lies far beyond the scope of the present work. It is known that the reliability of the results of determination of the parameter \( L_{WN}(\lambda) \) for the Black Sea is often doubtful [1, 6–8].
Comparative Analysis of the Methods Used for the Determination of the Optical Parameters of Waters

The main cause of the appearance of distortions in the evaluation of $L_{WN}(\lambda)$ is the presence of regional distinctions of the optical properties of the atmospheric aerosol from the model parameters used in the system for processing the data of satellite observations developed by the NASA. In the first turn, this system is aimed at the analysis of the results of observations accumulated in the open ocean and does not take into account the entire variety of the optical properties of actual atmospheric aerosols in the regions subjected to the influence of the dry land.

However, since the optical properties of the atmosphere in the Black-Sea region are characterized by significant variations, it is possible to assume that the accuracy of values of the quantity $L_{WN}(\lambda)$ could be, in some cases, acceptable. In view of the fact that the main purpose of the present work is the comparison of the results of calculations obtained by using different algorithms, the application, as examples, of the actual values of $L_{WN}(\lambda)$ determined in the course of satellite measurements and (possibly) containing some (not very evident errors) should be regarded as reasonable. In Fig. 1, we present the spectral dependences $L_{WN}(\lambda)$ obtained according to the data of surveys performed by the SeaWiFS device under supposedly favorable atmospheric conditions. The presented plots are constructed according to the values of $L_{WN}(\lambda)$ for $\lambda = 412, 443, 490, 510, 555,$ and $670$ nm. The indicated values of $L_{WN}(\lambda)$ are computed by averaging the data accumulated for various regions of the sea containing up to several tens of readings in the images represented in the form with a space resolution of 1 km.

In choosing these examples, we used the following main indications of the reliability of atmospheric corrections specified by the results obtained in [6–8]: sufficiently high levels of $L_{WN}(\lambda)$ and the absence of sharp chaotic fluctuations of $L_{WN}(\lambda)$ for all $\lambda$ in all studied regions of the sea. Moreover, some additional criteria supporting the reliability of values of the quantity $L_{WN}(\lambda)$ with regard for the specific atmospheric conditions were also taken into account.