LIGHT ABSORPTION BY ALL OPTICALLY ACTIVE COMPONENTS IN THE BLACK SEA: APPLICATION FOR DEVELOPMENT OF REGIONAL ALGORITHMS OF PRODUCTIVITY INDICATORS ASSESSMENT

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Abstract
Application of satellite information for assessment of productivity indicators of the Black Sea requires development of the regional algorithms, which take into account bio-optical properties of the Black Sea waters. The parameterization of light absorption by all optically active components in upper mixed layer has been done and seasonal differences have been revealed.

Keywords: Absorption, Phytoplankton, Models, Organic matter, Black Sea

Application of satellite information for assessment of productivity indicators (chlorophyll a concentration, photosynthesis rate, primary production depth-resolved and depth-integrated) of the Black Sea requires development of the regional algorithms, which take into account bio-optical properties of the Black Sea waters. It has been shown for the Black Sea that spectral features of water leaving radiance are determined by optical properties of the upper mixed water layer (UML) because first optical depth located within UML depth almost for all year with the exception of the spring season when seasonal stratification of waters started forming. Analysis of the bio-optical data has revealed seasonal dynamics of chlorophyll a-specific light absorption coefficients of phytoplankton within UML caused by adaptive changes of composition and intracellular pigment concentration because of the different environment condition: light intensity averaged for UML increased from 2.2(±1) E m^{-2} d^{-1} in winter to 32 (± 6.5) E m^{-2} d^{-1} in summer. Parameterization of phytoplankton light absorption has been done for different season (Fig.1).

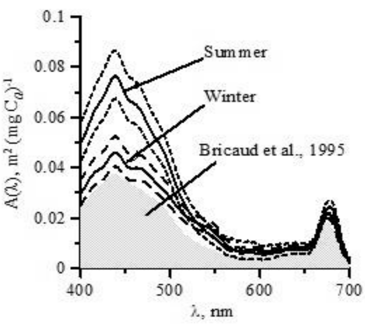

Fig. 1. Coefficient A(lambda) of the phytoplankton light absorption (aph (lambda)) parameterization: aph(lambda) = A(lambda) Chl^B(lambda), done for upper mixed layer of the Black Sea (grey – data [4]).

Parametrization of non-algal particles absorption (a_{NAP}(lambda)) showed that spectral slope S_{NAP} was equal 0.011 (± 0.002) nm^{-1} in averaged without seasonal differences. Relative contribution of $a_{NAP}(440)$ to total particulate absorption at 440 nm ($a_{NAP}(440)/a_p(440)$) was 20 (± 9) % in winter and 37 (± 16) % in summer and reached ~ 50 % after diatom blooms in yearly spring. The vertical distribution of $a_{NAP}(440)/a_p(440)$ within UML was uniform. Parametrization of colored dissolved organic matter absorption (a_{CDOM} (lambda)) showed pronounced seasonal differences in values and vertical distribution of S_{CDOM} and $a_{CDOM}(440)$ within UML. In winter S_{CDOM}(350-500) was 0.020 (± 0.008) nm^{-1}.The values $a_{CDOM}(440)$ were uniformly distributed within UML and equal 0.077 (± 0.040) m^{-1}. The contribution of $a_{CDOM}(440)$ and $a_{CDM}(440)$ (CDM=CDOM+NAP) to total light absorption at 440 nm was ~ 52 and 63 %, correspondently. In summer in UML S_{CDOM}(350-500) values were higher (0.025±0.0046 nm^{-1} in averaged) than in winter. The S_{CDOM}(350-500) values decreased, but $a_{CDOM}(440)$ increased from surface to thermocline (~ 10 m) due to photodestruction of dissolved organic matter (PAR (0m) ~ 45 E m^{-2} d^{-1}) (Fig.2).

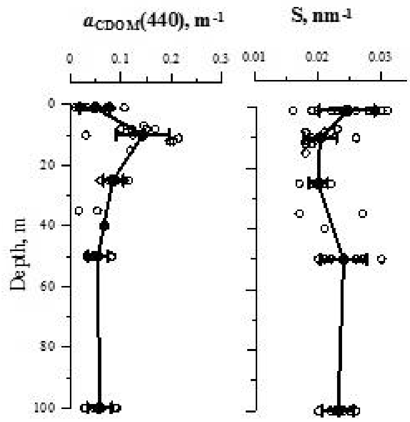

Fig. 2. Vertical distribution of colored dissolved organic matter light absorption coefficient at 440 nm (aCDOM(440)) and slope coefficient for 350 - 500 nm range (S) in deep-waters of the Black Sea in summer season.

The contribution of $a_{CDOM}(440)$ and $a_{CDM}(440)$ to total light absorption was ~ 56±11% and 71± 14 %, correspondently. Analysis of biooptical properties of the Black Sea coastal waters is to be done soon. Assimilation of these new seasonal bio-optical properties of the Black sea waters in the regional models of chlorophyll [1], downwelling radiance [2], primary production [3] will provide correct assessment of several indicators of water quality and productivity of the Black Sea because interannual variability in environmental conditions and relevant changes in bio-optics will be taken into account.

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