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Black Sea spectral bio-optical models based on satellite data and their applications for assessment of spatial and temporal variability in waters transparency, chlorophyll a content and primary production

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Satellite observations of ocean color provide a unique opportunity in oceanography to assess productivity of the sea on different spatial and temporal scales. However it has been shown that the standard SeaWiFS algorithm generally overestimates summer chlorophyll concentration and underestimates pigment content during spring phytoplankton bloom in comparison with in situ measurements. It is required to develop regional algorithms which are based on biooptical characteristics typical for the Sea and consequently could be used for correct transformation of spectral features of water-leaving radiance to chlorophyll a concentrations (Chl), light absorption features of suspended and dissolved organic matter (CDM), downwelling light attenuation coefficient/euphotic zone depth (PAR1%) and rate of primary synthesis of organic substances (PP).

The numerous measurements of light absorption spectra of phytoplankton, non-algal particles and coloured dissolved organic matter carried out since 1996 in different seasons and regions of the Black Sea allowed to make a parameterization of the light absorption by all optically active components. Taking into account regional peculiarities of the biooptical parameters, their difference between seasons, shallow and deep-waters, their depth-dependent variability within photosynthetic zone regional spectral models for estimation of chlorophyll a concentration (Chl Model), colored dissolved and suspended organic matter absorption (CDM Model), downwelling irradiance (PAR Model) and primary production (PP Model) have been developed based on satellite data. Test of validation of models showed appropriate accuracy of the models.

The developed models have been applied for estimation of spatial/temporal variability of chlorophyll a, dissolved organic matter concentrations, waters transparency, euphotic zone depth and primary production based on SeaWiFS data. Two weeks averaged maps of spatial distribution of these parameters have been composed for period from 1998 to 2009 (most of them presented on site http://blackseacolor.com/browser3.html). Comparative analysis of long-term series (since 1998) of these parameters with subsurface water temperature (SST) and solar radiance of the sea surface (PAR-0m) revealed the key factors determining the seasonal and inter-annual variations of Chl, PAR1%, CDM, PP. The seasonal dynamics of these parameters were more pronounced compared with inter-annual variability. The later was related to climate effect. In deep-waters region relatively lower SST during cold winters were forcing more intensive winter-spring phytoplankton bloom. In north-western shelf inter-annual variability in river (Danube) run off, which was related to climate change as well, determined year-to-year changing in Chl, CDM, PAR1%, and PP.