SEASONAL AND INTERANNUAL CHLOROPHYLL A VARIABILITY IN THE BLACK SEA FROM SATELLITE AND BIOARGO MEASUREMENTS

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Abstract
Vertical distribution of the concentration of the chlorophyll A in the Black Sea and its interannual variability is investigated using combined satellite measurements of SeaWIFS and MODIS and recently deployed two Argo floats with biogeochemical sensors.

Keywords: Black Sea, Chlorophyll-A, Phytoplankton, Blooms

The variability of chlorophyll A concentration (Ca) in the Black Sea is investigated on the base of 15 years satellite optical measurements and recently deployed two Argo floats with biogeochemical sensors. Analysis of surface chlorophyll A is carried using blended array of SeaWiFS and MODIS-Aqua measurements for 1999-2015 years. According to satellite data surface Ca in the central part of the basin have prominent seasonal variability with the maximum in early winter and minimum in summer months (fig. 1a). Peak of the surface Ca in the deep part (depths more than 500 meters) is triggered by the beginning of winter convection [1,2] and is in counterphase with sea surface temperature on seasonal time scales. The surface maximum is detected first in the central eastern and western gyres of the Black Sea, where the convection is most intensive, and in the northwestern part of the continental slope (due to effect of slope convection). After ~1 week the maximum is observed in the periphery of the basin.

At the same time in the several areas of the Black Sea shelf the peak of surface Ca is detected in late spring-early summer, which is related to the intensification of river discharge. This effect is seen in the large part of the north-western shelf near the mouth of Danube, and in the coastal south-western and south parts, where smaller Caucasian and Turkish rivers outflow.

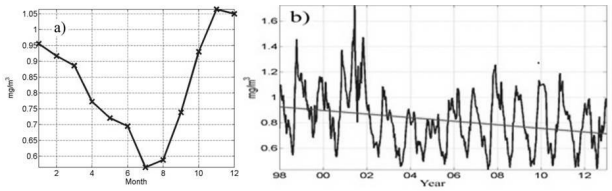

Fig. 1. Seasonal(a) and interannual (b) variability of the Ca in the deep part of the basin (depths >500 meters).

The most noticeable feature of interannual variability is an abrupt decrease observed in 2002, which coincide in time with the sharp intensification of the Black Sea basinscale circulation [3]. The averaged over the deep basin Ca changes from mean values of about 1 mg/l in 1998-2001 (period of "weak" currents) to 0.73 mg/l in 2002-2013 (period of "intense" currents). This decrease can be caused by the reduction of the number of eddies that is related to the Rim current intensification [4, 5]. As a result eddy-induced horizontal transport of the nutrient-rich coastal waters to the deep part of the basin declines [3].
The measurements of two Bio-Argo floats in 2013-2015 were used to investigate the vertical distribution of the Ca and its seasonal evolution. Computed seasonal time-depth diagram and column-averaged over 0-100 meters Ca is shown in fig.2 . Maximum of the layer-averaged Ca is observed in March when the Ca in the whole 0-55 meters is ~ 1-1.5 mg/m3. In April-May Ca peaks at 40-50 meters depth and is lower in upper layer. Subsurface summer maximum develops from June to October at 20-40 meters depth in agreement with [6]. Chlorophyll A concentrations in this layer in summer are even higher than in winter period. From October to February with the start of winter mixing large values of Ca are observed in surface layer and can be detected by satellite.
The comparison of Argo buoys with MODIS-Aqua surface Ca shows reasonable coincidence with correlation 0.7. Satellite data overestimate Argo measurements in 1.3-1.5 times.

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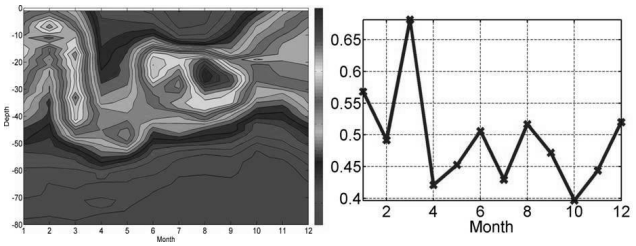

Fig. 2. Seasonal(a) and interannual (b) variability of the Ca in the deep part of the basin (depths >500 meters).

References
1 - Yunev, O. A., Vedernikov, V. I., Basturk, O., Yilmaz, A., Kideys, A. E., Moncheva, S., & Konovalov, S. K. (2002). Long-term variations of surface chlorophyll a and primary production in the open Black Sea. Marine Ecology Progress Series, 230, 11-28.
2 - Finenko, Z. Z., Suslin, V. V., & Kovaleva, I. V. (2014). Seasonal and long-term dynamics of the chlorophyll concentration in the Black Sea according to satellite observations. Oceanology, 54(5), 596-605.
3 - Kubryakov A.A, Stanichny S.V., Zatsepin A.G, Kremenetskiy V.V. Long-term variations of the Black sea dynamics and its impact on the marine ecosystem. Journal of Marine Systems, 2016 (in press).
4 - Kubryakov, A. A., & Stanichny, S. V. (2015a). Seasonal and interannual variability of the Black Sea eddies and its dependence on characteristics of the large-scale circulation. Deep Sea Research Part I: Oceanographic Research Papers, 97, 80-91.
5 - Kubryakov, A. A., & Stanichny, S. V. (2015b). Mesoscale eddies in the Black Sea from satellite altimetry data. Oceanology, 55(1), 56-67.
6 - Finenko, Z. Z., Churilova, T. Y., & Sosik, H. M. (2004). Vertical distribution of phytoplankton photosynthetic characteristics in the Black Sea. Oceanology, 44(2), 205-218.