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On the recent interannual changes of the Black Sea nutrient regime and oxic/anoxic boundary position

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In the present paper, we summarize recent assessments of the recent decadal changes of oxygen and nutrients (phosphate, total inorganic nitrogen, and silicate) in the oxic layer of the Black Sea and the characteristics of the oxic/anoxic interface and discuss the role of the climatic and anthropogenic forcing.
We found that the interannual variability of dissolved oxygen during the last decades was mainly determined by decadal climatic variations of physical forcing (thermal regime, and winter mixing). Dissolved oxygen concentration in the surface layer and in the Cold Intermediate Layer (CIL) decreases in warm periods and increases in cold periods, which is well related with the North Atlantic Oscillation (NAO) index variation.
Interannual variability of main nutrients (P, N, Si) in larger degrees is connected with the anthropogenic factor and the coastal discharge mainly from Danube. During the last decades, the main nutrient temporal trends show a negative anomaly in the surface layer (especially for P and DIN) well correlated in the W and NE parts. Nutrient concentrations are 3-5 – fold lower in W and NE parts of the sea than in the coastal zone of the NW part. The NW part is characterized by an increase of N content, while in the W and NE regions of the sea N concentrations decrease. Silicate decreases only in the coastal zone.
No connection was revealed between nutrient dynamics and oxygen that might testify to an absence of an intensive eutrophication during the last decades.
Recent years were characterized by a decrease in anthropogenic loads of nutrients, and this should lead to further positive changes in the Black Sea ecosystem. The changes in Si, N, and P content and ratios should result in qualitative changes of the ecosystem (i.e. changes of shares of diatoms and coccolithophores, the restoration of the traditional domination of diatoms in the Black Sea, possible recovery of N-fixation, consequent recovery of the plankton community, etc.).
Our studies showed that the biogeochemical system of the oxic-anoxic interface is subjected to interannual mean winter SST and CIL temperature forced changes. Surface layers ventilation with dissolved oxygen down to the depth of the CIL occurs in winter from a combination of the cold water advection from NW shelf and convective mixing in the central parts of the circulation gyres. The intensity of ventilation is determined by climate forcing which might be expressed by large-scale climate indicators like NAO. This ventilation sets the upper boundary conditions for the downward transport of oxygen. Therefore, the position of the hydrogen sulfide boundary in the density field is related to the climate variability and the NAO index.
It is necessary to underline that the direct result of the observed anoxic boundary oscillations by 10-20 m exhibits in the change of the volume of the oxic waters by approximately 5-10%, where the Black Sea aerobic ecosystem presents. Such oscillations might be vitally significant and should be studied in detail.
All present assessment studies indicate some gaps in our knowledge due to the absence of sufficiently comprehensive monitoring data. Especially in the present period of changing climate and variable anthropogenic load, the data on the biogeochemical parameters distribution in the Black Sea need to be regularly collected and analyzed. It should be frequently updated in order to reach a more definite identification whether the Sea does really improve in a sustainable manner or not.