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Seasonal Hypoxia on the Shelf and Shoaling of the Permanent Oxycline in the Open Sea: Two Faces of the Black Sea Deoxygenation

Arthur Capet (1), Emil Stanev (2), Jean-Marie Beckers (3), and Marilaure Grégoire (4)

(1) CNR, OGS, Trieste, Italy, (2) HZG, Hamburg, Germany, (3) GHER, University of Liège, Belgium, (4) MARE, University of Liège, Belgium

The Black Sea is highly sensitive to external forcings and constitutes a natural laboratory to study the interplays of atmospheric warming and eutrophication on deoxygenation dynamics. Two decades of eutrophication were followed by a sudden reduction of nutrient loads in the late 1980s. Warm and cold air temperature cycles (5-10 years) follow atmospheric oscillation patterns, with a clear warming affecting the recent decades.

On the Black Sea north western shelf (<120m), which receives more that $\frac{3}{4}$ of the river runoff, seasonal hypoxia occurs when summer stratification prevents atmospheric fluxes to compensate for the respiration of organic matter accumulated in the lower water column and the sediments. A former multidecadal 3D model study (1) indicated that current monitoring do not provide a satisfactorily assessment of hypoxia, (2) revealed the inertia due to the benthic accumulation of organic matter during eutrophication period and (3) estimated the nutrient reduction effort required in adaptation to atmospheric warming.

In the open basin (120-2000m), the permanent interface between anoxic and oxic waters is subject to vertical migration as the ventilation ensured by dense water formation balances the respiration of sinking organic matter. The analysis of R/V casts and ARGO profiles revealed that the oxycline has shoaled from 140 to 90m between 1955 and present years, while the basin lost 36 % of its oxygen inventory.

While the interactions between seasonal hypoxia on the shelf and the shoaling oxic interface in the open basin are not clear, both dynamics will face atmospheric warming and new industrial development of the lower danube watershed.

We discuss the specific monitoring and modelling efforts required to assess the environmental and economical threat cast by further deoxygenation in the Black Sea.