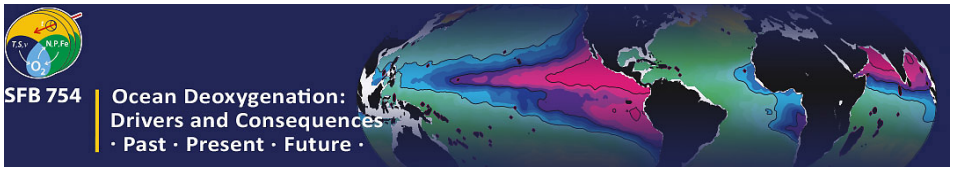


Contribution ID : **121** Type : **Oral**

# Shift in the Black Sea ventilation regime and decline of its oxygen inventory

*Wednesday, 5 September 2018 17:30 (15)*

Life in the Black Sea is confined in a thin surface oxygenated layer, bounded by a strong and permanent salinity gradient (halocline) that maintains the remaining 90% of the water column in euxinic conditions. We showed that from 1955 to 2016, the oxygen inventory in the Black Sea has decreased by 44 % and that the basin-averaged oxygen penetration depth has decreased from 140 m in 1955 to 80 m in 2016, which is the shallowest annual value recorded during that period [1]. Here, we discuss the physical/biogeochemical drivers of this deoxygenation trends.
In the 1970s-1980s, the Black Sea faced severe eutrophication. Enhanced respiration rates then reduced the thickness of the oxygenated layer. Following increase in the oxygen inventory (1985–1995) supported arguments in favor of the stability of the oxic layer. Concomitant with a reduction of nutrient loads, it also depicted a Black Sea recovering from eutrophication. However, this view neglected the variability in ventilation mechanisms.
Oxygenated conditions at intermediate depth (50-100m) are maintained by the annual formation of dense cold waters that brings oxygenated waters on top of the halocline, in the Cold Intermediate Layer (CIL). Recently, the lowest oxygen inventories were observed in concurrence with the lowest CIL cold content, suggesting a weakening of this ventilation mechanism.
To explore the long-term variability of Black Sea ventilation, we produced a composite time series for the CIL cold content using observations (ship casts, Argo), empirical (atmospheric predictors) and mechanistic (3D hydrodynamic) models. The agreement between independent data sources confirms the reliability of this description of the Black Sea CIL evolution during the last 60 years. A robust regime shift analysis highlights a strong ventilation period concomitant with the "recovery" period of the early 1990s. However, an anomalous restricted ventilation regime prevails from 2008 to present day, that can be attributed to warmer air temperature. This new regime is characterized by the sporadic absence of the annual cold water formation which lead to significant ageing of the intermediate waters, and thereby opens the way for a further upward migration of the oxycline depth.

[1] Capet et al. (2016) Biogeosciences, 13, 1287–1297.

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**Session Classification :** 03 Ventilation and Oxygen Supply

**Track Classification :** 03 Ventilation and Oxygen Supply