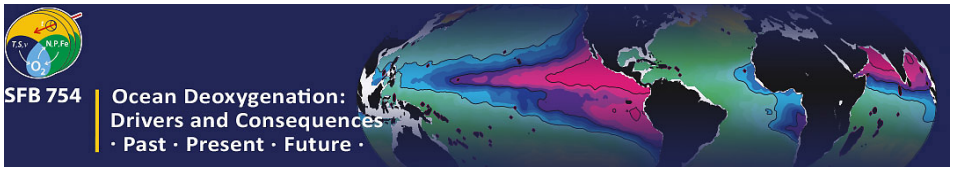

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Drivers and mechanisms of thermocline oxygen changes in the eastern tropical North Atlantic

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The tropical thermocline that covers the strongly stratified region below the oceanic mixed layer accommodates extended oxygen minimum zones (OMZs). The subtropical-tropical circulation of the Pacific and Atlantic oceans characterized by the wind-driven equatorward and westward flow of newly subducted water masses sets the poleward boundaries of the OMZs in both oceans. Energetic circulation along the equator results in enhanced oxygen supply to the eastern basins from the well-ventilated western boundary thereby separating the OMZs of both hemispheres by an equatorial oxygen maximum.
Observations indicate a significant and broad-scale decrease of oxygen levels and associated increase in the volume of oxygen deficient waters of the eastern tropical North Atlantic (ETNA) during the past 50 years, which is part of the widespread deoxygenation of the global ocean's thermocline. During the recent decade covered by enhanced observations in the framework of the German collaborative research centre SFB754 a more distinct pattern emerges consisting of regions with decreasing and increasing oxygen along the 23°W repeat section cutting through the ETNA OMZ. The observed spatial variations in the obtained ten-year trend may help to understand the underlying drivers and mechanisms of long-term oxygen changes. Current models do not reproduce observed patterns of oxygen changes in the ocean's thermocline. Nevertheless, they reveal a close correlation between declining oxygen levels and increases in water age on isopycnal surfaces in the thermocline suggesting decreasing ventilation as the dominant driver of thermocline deoxygenation whereas changes in respiration seem to play only a minor role. Here we investigate and review possible drivers and mechanisms of the observed oxygen changes in the tropical thermocline including changes in the wind-driven and eddy-driven circulation, alterations of ventilation pathways, and changes in stratification by taking into account a large data base of hydrographic, oxygen and current data as well as idealized process and realistic models.

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