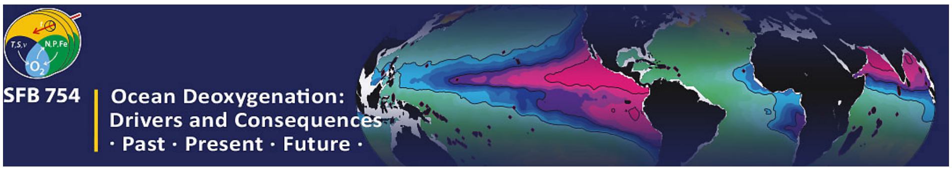

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Mechanisms that determine the dynamics of oxygen in the eastern equatorial Pacific in an Earth system model

Until now, biogeochemical ocean models have generally failed to reproduce the observed oxygen decline in the eastern equatorial Pacific (EEP) over the last decades. We here give an overview about mechanisms that determine the sensitivity of oxygen dynamics in an Earth system model of intermediate complexity in the EEP to climate change.

Earth System Climate Models generally overestimate nutrient concentrations in the deep eastern equatorial Pacific. This problem, dubbed "nutrient trapping" by Najjar (1993) already, causes spurious suboxia in the tropical oceans of typical coarse-resolution models. Parameterizing the effect of the unresolved Equatorial Intermediate Current System (EICS) by an (anisotropically) increased zonal isopycnal diffusivity in the tropics improves the simulation of oxygen and nutrients globally. Notably "nutrient trapping" and associated model deficiencies are reduced. Climate projections of low-oxygenated waters change sign and become more plausible if the effect of the EICS is parameterized.

In addition to the effects of the EICS we elucidate the effects of changing winds on oxygen levels in the tropical Pacific: Investigating the impact of observed past and anticipated future wind changes in the Southern Hemisphere, we distinguish effects due to a strengthening of the westerlies from effects of a southward shift of the westerlies that is accompanied by a poleward expansion of the tropical trade winds. The poleward shift of the trade-westerlies boundary triggers a significant decrease of oxygen in the tropical oxygen minimum zone. In a business-as-usual CO_2 emission scenario, the poleward shift of the trade-westerlies boundary and warming-induced increase in stratification contribute equally to the expansion of suboxic waters in the tropical Pacific. Further we apply different wind climatologies (NCEP/NCAR and CORE-normal-year) and observed wind fields (CORE, 1947-2007) to a coupled biogeochemistry circulation model. The Equatorial Undercurrent (EUC) shows significant differences in strength and structure depending on the applied wind forcing. On multi-decadal time scales, changes in oxygen concentrations in the upper 1000m of the EEP are predominantly forced by wind driven changes of the EUC, whereas preconditioning of the oxygen fields during the model's spin up plays a minor role. For future projections of the oxygen deficient water volume in the EEP the reliability of projected wind fields are of key importance.

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