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Global ocean oxygen decline as estimated from observations and current climate models

A global compilation of oxygen measurements over the past decades indicates that the global oceans were losing oxygen in a rate of nearly 1 Pmol per decade for the time period 1960-2015. The loss is non-uniform, as some areas show little to no significant loss in oxygen, while oxygen is dropping at rates of 4% per decade in other regions. A detailed analysis of oxygen changes shows a distinct impact of solubility changes due to ocean warming in the upper 1000m, as well as deep ocean changes most likely explainable by ventilation changes. The full set of CMIP5 climate models with oxygen is compared to the observations. While having the same order of magnitude for solubility changes, these are distributed differently to the observations. The overall oxygen decline is generally only half the size of the observed one, indicating substantial model deficiencies. An inter model comparison reveals significant spread and variability of the changes in the horizontal as well as in the vertical for the time period analyzed. We conclude that the CMIP5 climate model set analyzed here still has shortcomings in representing oxygen variations correctly. Nevertheless the correct magnitude of modeled solubility changes indicates that, overall, total oceanic heat uptake is simulated relatively well, while changes in oceanic circulation and/or biogeochemistry may be systematically underrepresented in the current set of climate models.

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