frontiers

Supplementary Material

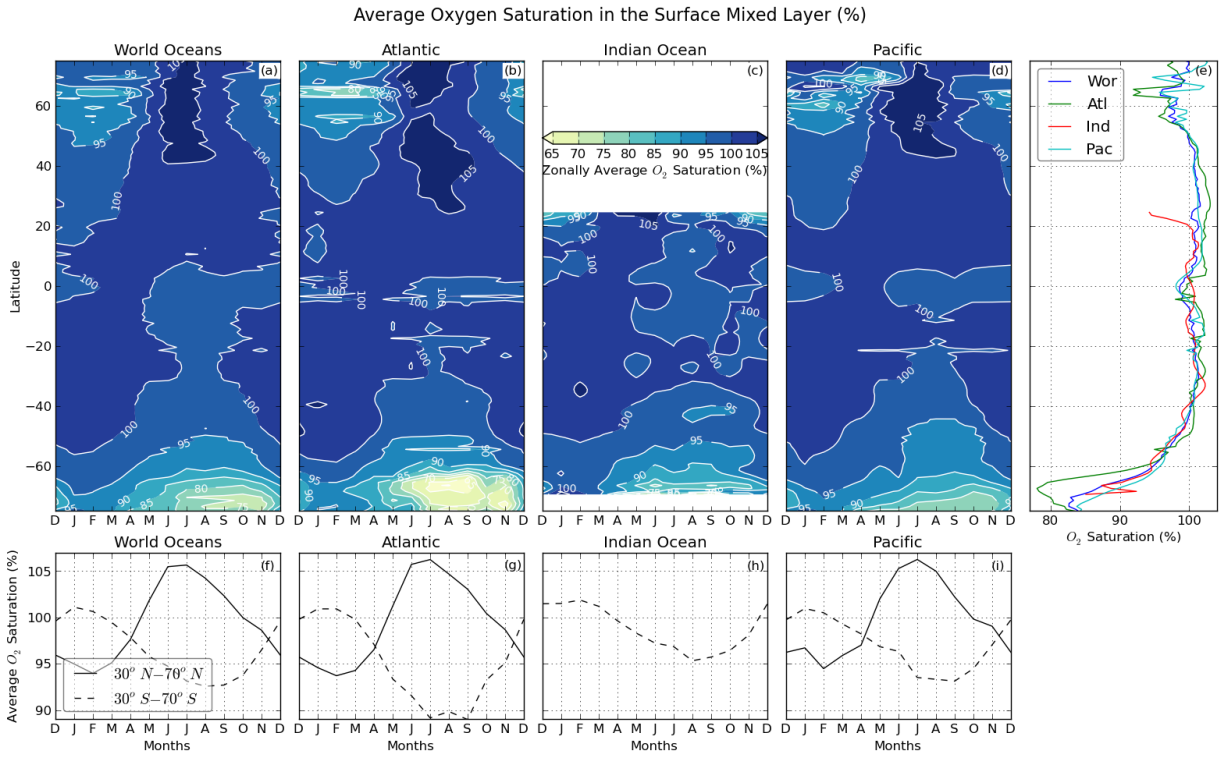
1 *O2C* Change with Time and Mass Balance Model

Based on the definition of O2C in the main text (Eq. (1)), the O2C change with time can be calculated as

$$\frac{\partial O2C}{\partial t} = \frac{A\partial(hO_{2m})}{\partial t} = \frac{Ah\partial O_{2m}}{\partial t} + \frac{AO_{2m}\partial h}{\partial t} \qquad \text{(S1)}$$

In Eq (S1), $\frac{\partial O2C}{\partial t}$ is separated into two terms. The first term $\frac{Ah\partial O_{2m}}{\partial t}$ shows the change of *O2C* related to oxygen concentration change with time, which is the term on the left-hand side of Eq (2) in the manuscript, but scaled by area *A*. *A* is skipped in Eq. (2) of our mass balance model to show the area-averaged mass balance at each grid. The second term $\frac{AO_{2m}\partial h}{\partial t}$ represents the oxygen content change related to mixed layer thickness change with time, $\partial h/\partial t$ (the entrainment effect). In the mass balance model, the second term in Eq. (S1) becomes part of the entrainment term in Eq. (3) in Appendix A. Eq (S1) shows how *O2C* is related to the mass balance model.

2 Average Dissolved Oxygen Saturation in the Surface Mixed Layer



Supplementary Figure 1. Average climatology of dissolved oxygen saturation (%) in the surface mixed layer. Zonally averaged monthly oxygen saturation in the surface mixed layer for the (a) World Ocean, (b) Atlantic, (c) Indian Ocean, and (d) Pacific Basins. Same colorbar used for panels (a)-(d) as shown in (c). (e) Average meridional oxygen saturation as a function of latitude for the world ocean and the three major ocean basins. Monthly time series estimate of the oxygen saturation for the subtropics and mid-latitudes between 30° and 70° for both northern hemisphere (solid black) and southern hemisphere (dashed black) for (f) World Ocean, (g) Atlantic, (h) Indian, and (i) Pacific Ocean, respectively.