

Supporting Information for ”Can oxygen utilization rate be used to track the long-term changes of aerobic respiration in the mesopelagic Atlantic Ocean?”

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Text S1

The schematic plot of the experiment setup is shown in Figure S1. We refer the details for the experiment set-up used in this paper to Chien et al. (2022). The coupled ocean-biogeochemical model was simulated for 500 years under prescribed pre-industrial atmospheric partial pressure of CO_2 (and other greenhouse gases) and hence climate (piControl-spinup), followed by a 250 years (drift) period with zero carbon dioxide emissions in which atmospheric carbon dioxide concentrations are computed prognostically (esm-piControl-spinup). Afterwards, three transient and pre-industrial control (esm-piControl) simulations were carried out, starting from 230th, 240th, and 250th year of

esm-piControl-spinup, respectively (for brevity's sake simply referred to as ensemble members 1, 2, 3, respectively in this paper). The transient simulations include 165 years (1850 to 2014) historical (esm-Hist) simulation and 85 years (2015 to 2099) projection under the Shared Socioeconomic Pathways 585 (SSP-585) scenario (esm-ssp-585 Eyring et al., 2016).

Text S2

The vertical integral is obtained as the sum of the grid-box thickness times the variable (OUR or mean true respiration rate) at each grid point, as shown in equation 1:

$$X_{int} = \sum_{k=1}^n (X_k \times thickness_k \times f_k) \quad (1)$$

in which, subscript k corresponds to the grid-box, and X_{int} corresponds to integrated variables (OUR or true respiration rate). The grid-box thickness is simply defined as from 0.5 times (z-depth of grid point $k - 1$ plus z-depth of grid k) to 0.5 times (z-depth of grid point k plus z-depth of grid $k + 1$). f_k is the fraction of the grid box that falls within the integration interval.

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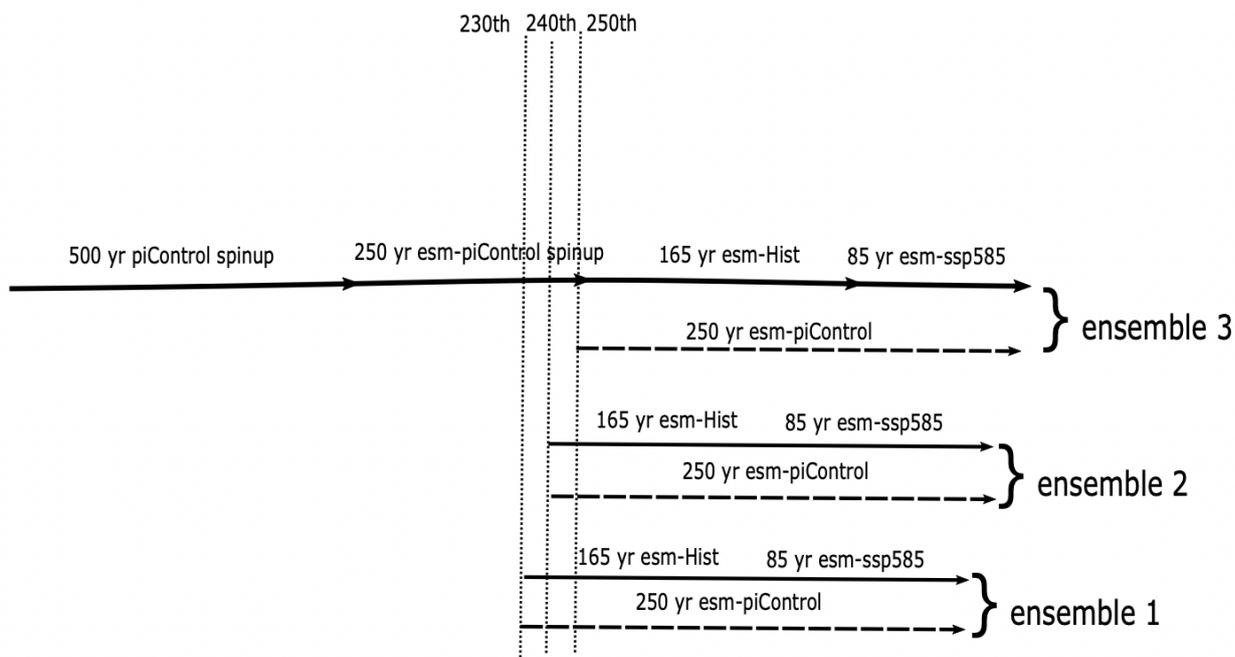


Figure S1. Schematical plot of the experiment set-up (modified from Chien et al., 2022). The piControl spin-up simulation uses the prescribed atmospheric partial pressure of CO_2 , and the esm-piControl spin-up uses the zero-emission CO_2 as the forcing.

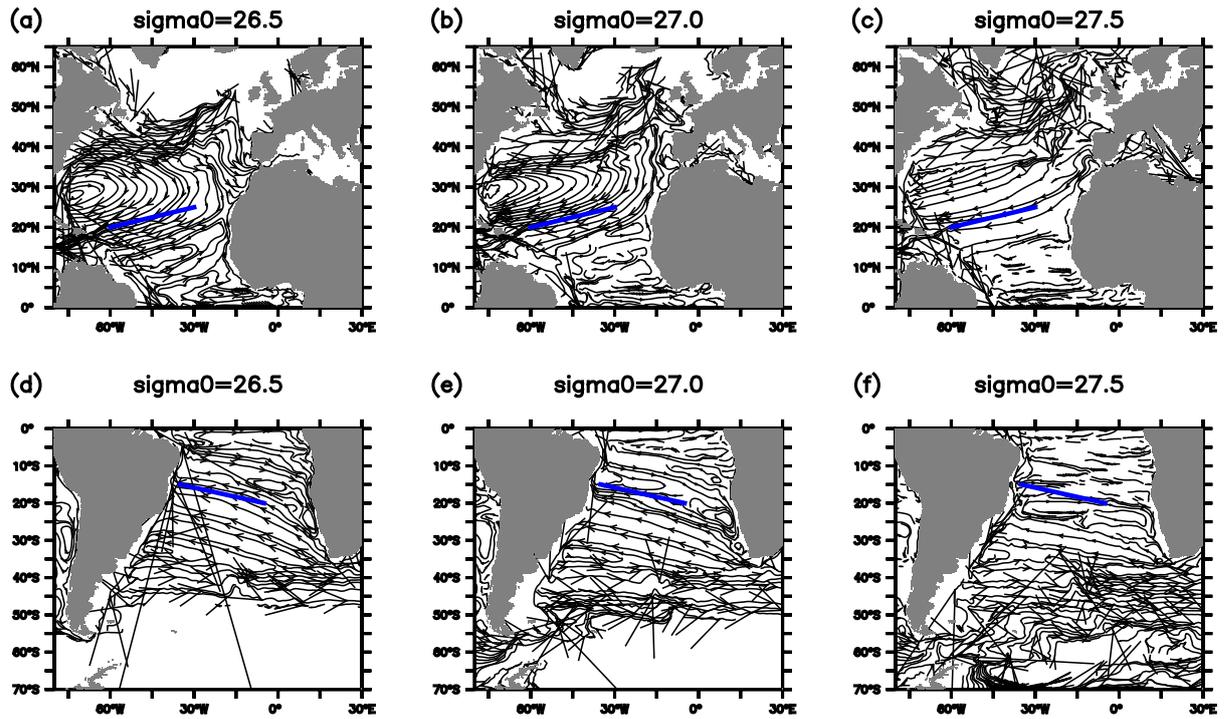


Figure S2. The ocean current streamlines and the chosen study sections at different density surfaces.

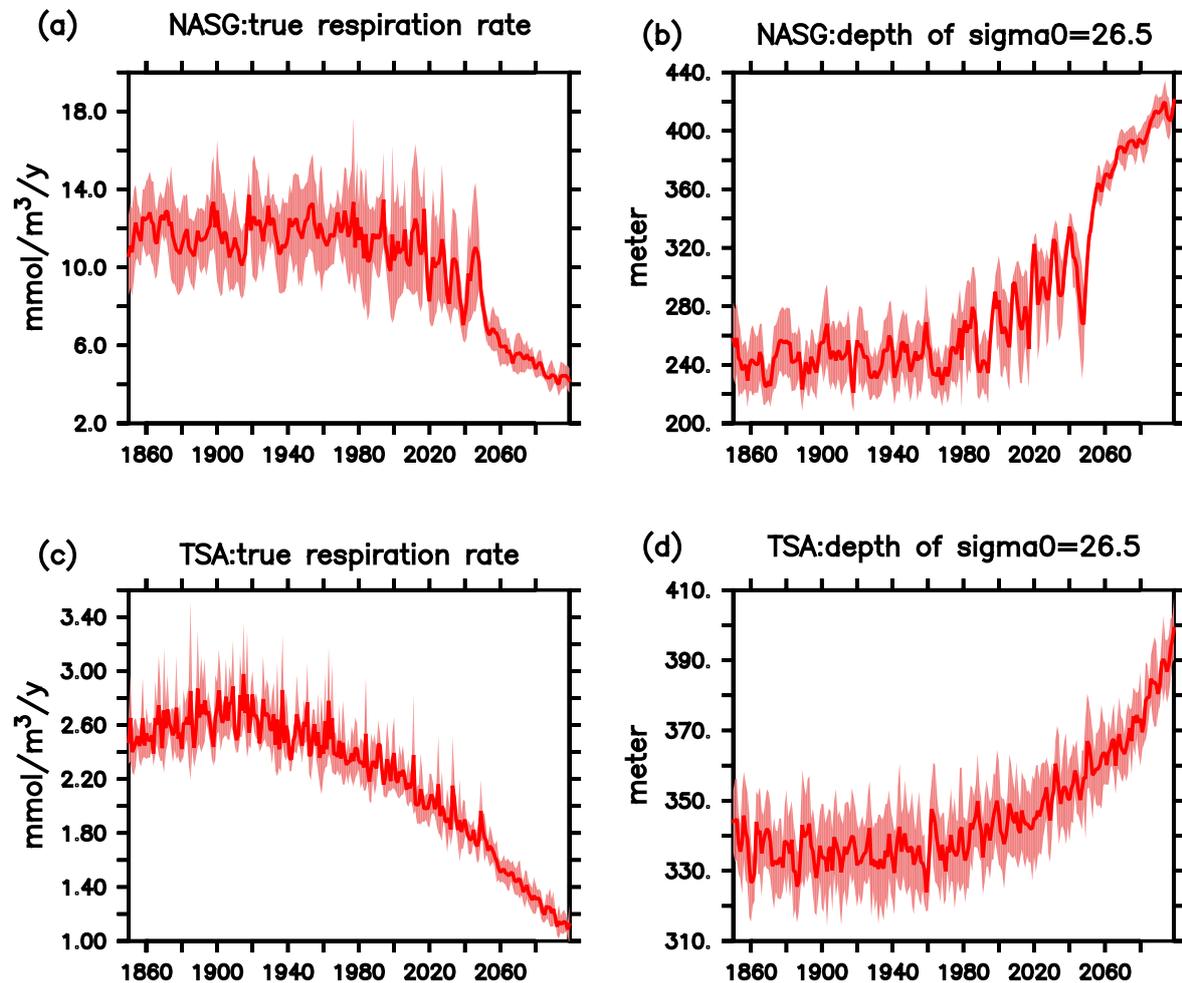


Figure S3. The true respiration rate and the mean depth at density surface $26.5 \text{ kg}/\text{m}^3$ in transient simulations of the ensemble member 1. The shading indicates one standard deviation.

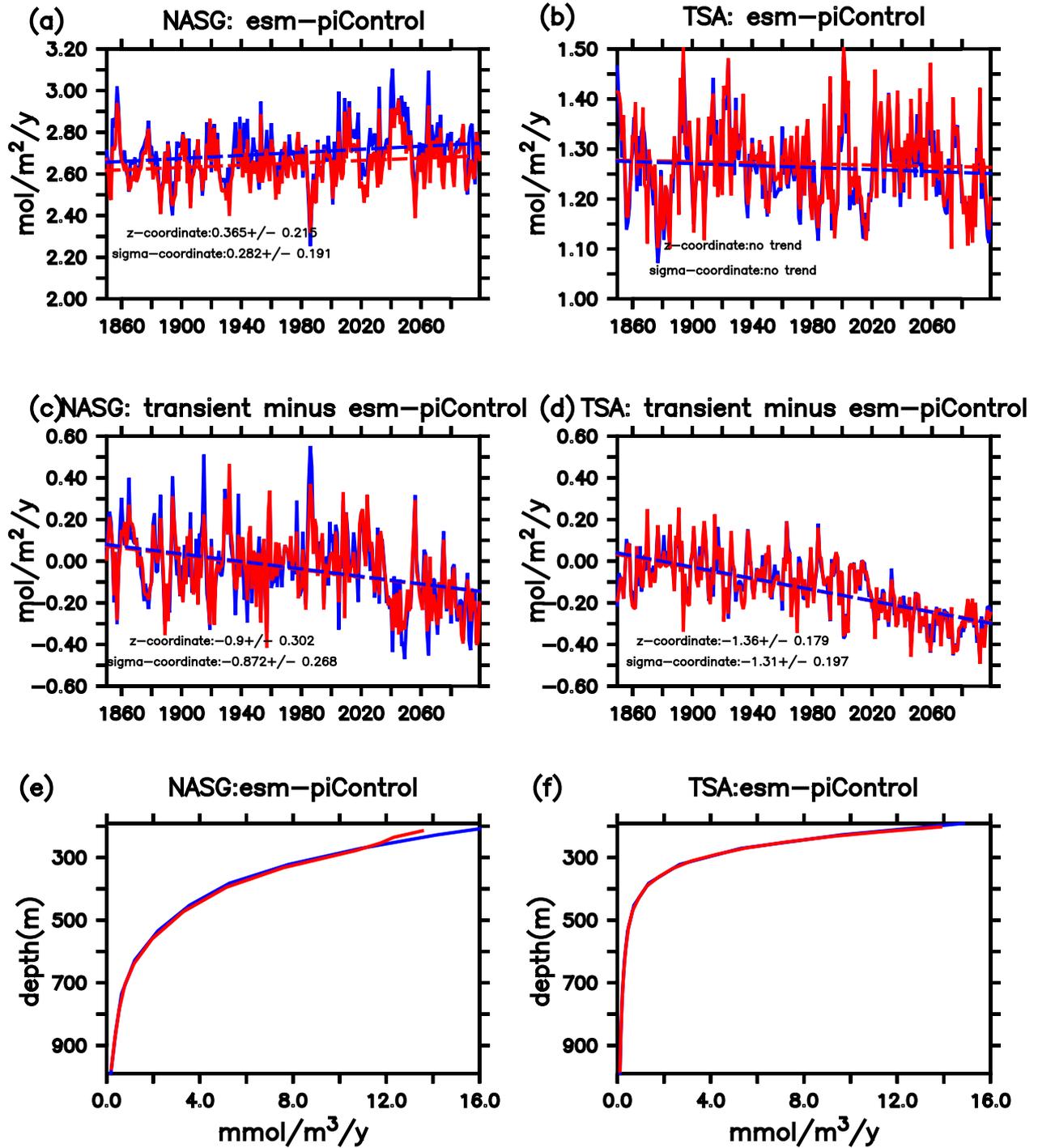


Figure S4. The comparison of original true respiration (blue) and processed true respiration (red) in the NASG (a,c,e) and TSA section (b,d,f). We use 2099 model year output in esm-piControl simulation in the panel (e) and (f). The significant trends (P-value below 0.05) of true respiration are shown in corresponding panels with units of mmol/m²/y².

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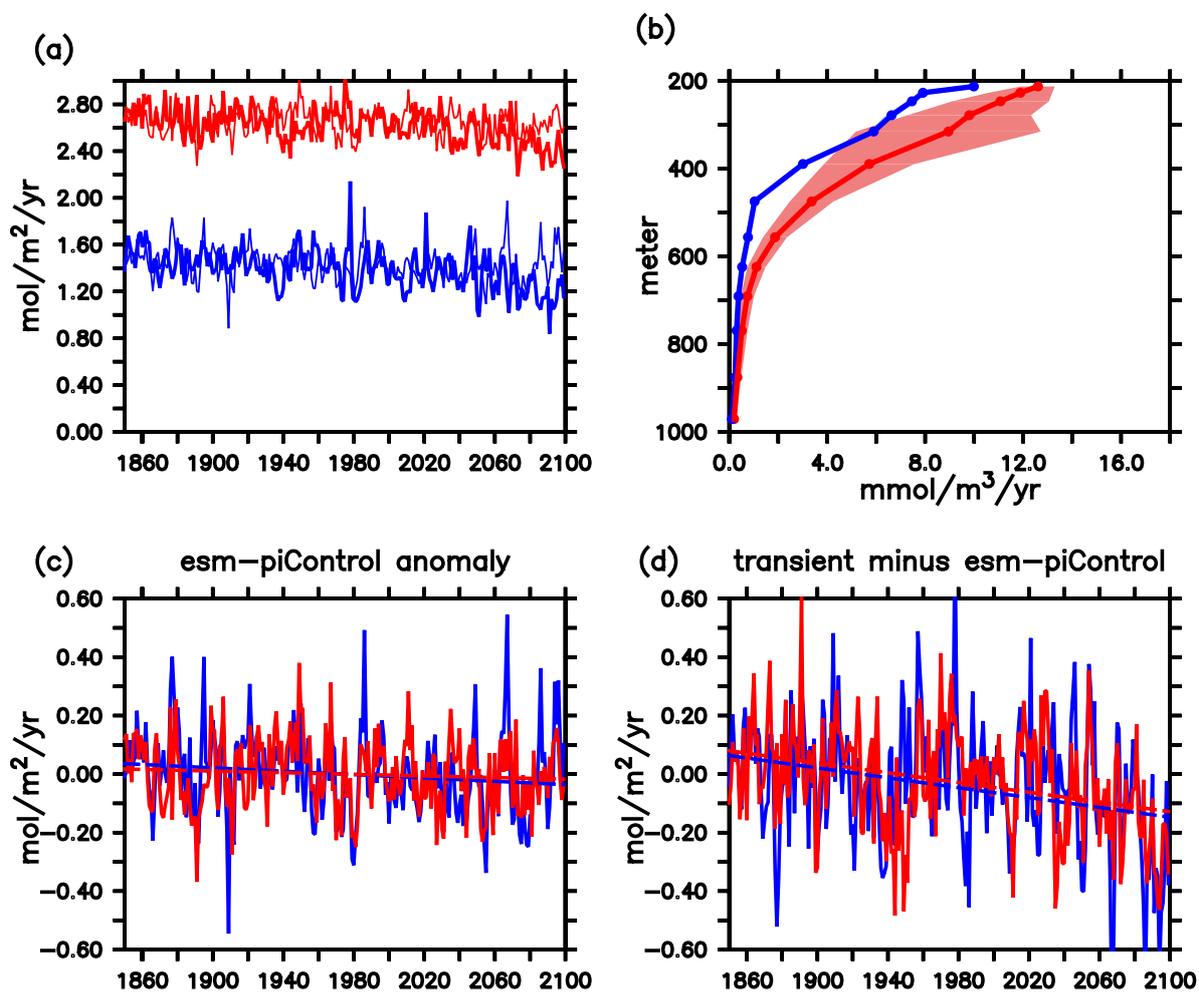


Figure S5. As Figure 2, but for the simulation ensemble member 2 that starts from 240th year of esm-piControl-spinup. In the panel (b), the individual r^2 of the AOU versus age regression are all above 0.77 in this section.

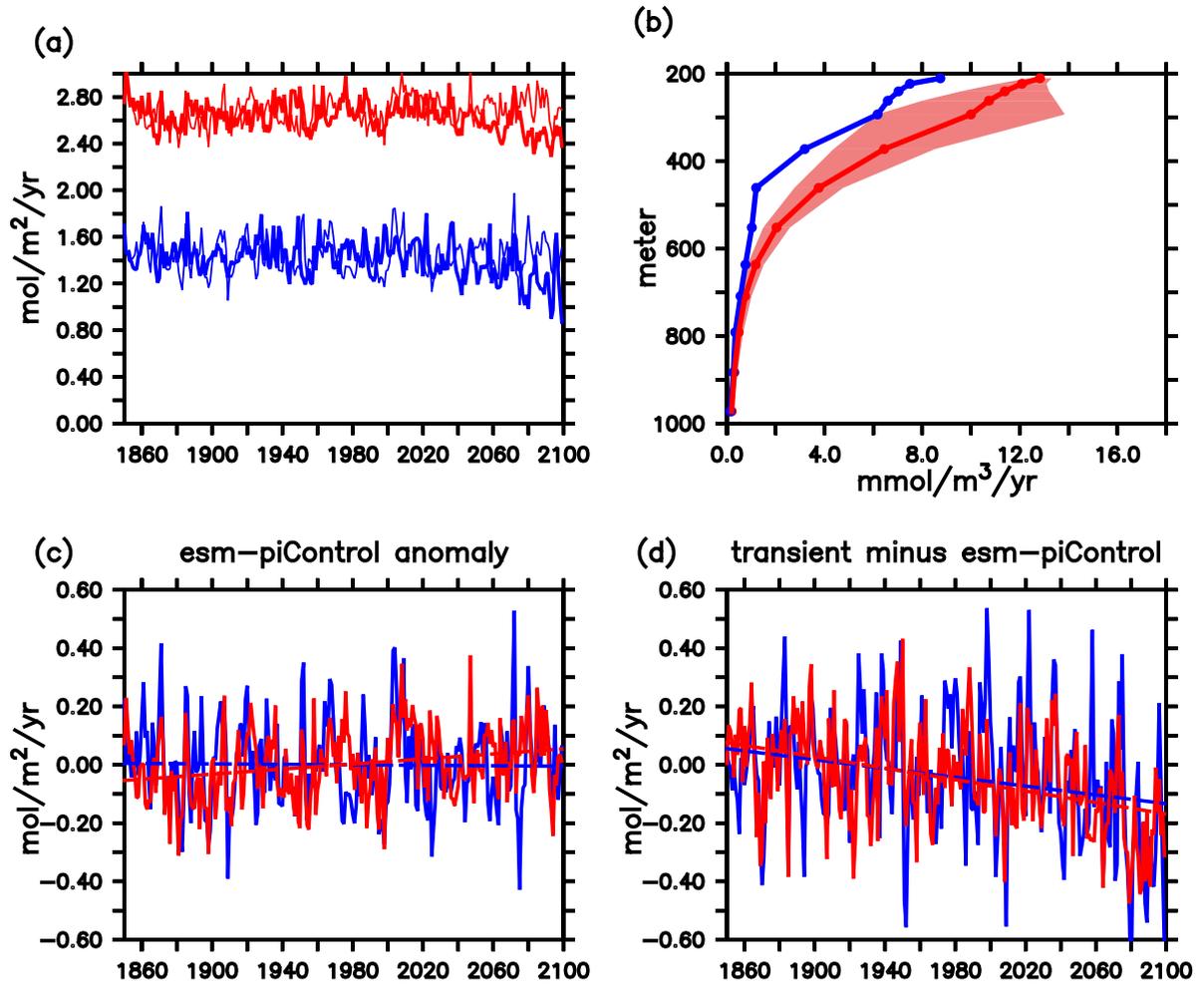


Figure S6. As Figure 2, but for the simulation ensemble member 3 that starts from 250th year of esm-piControl-spinup. In the panel (b), the individual r^2 of the AOU versus age regression are all above 0.79 in this section.

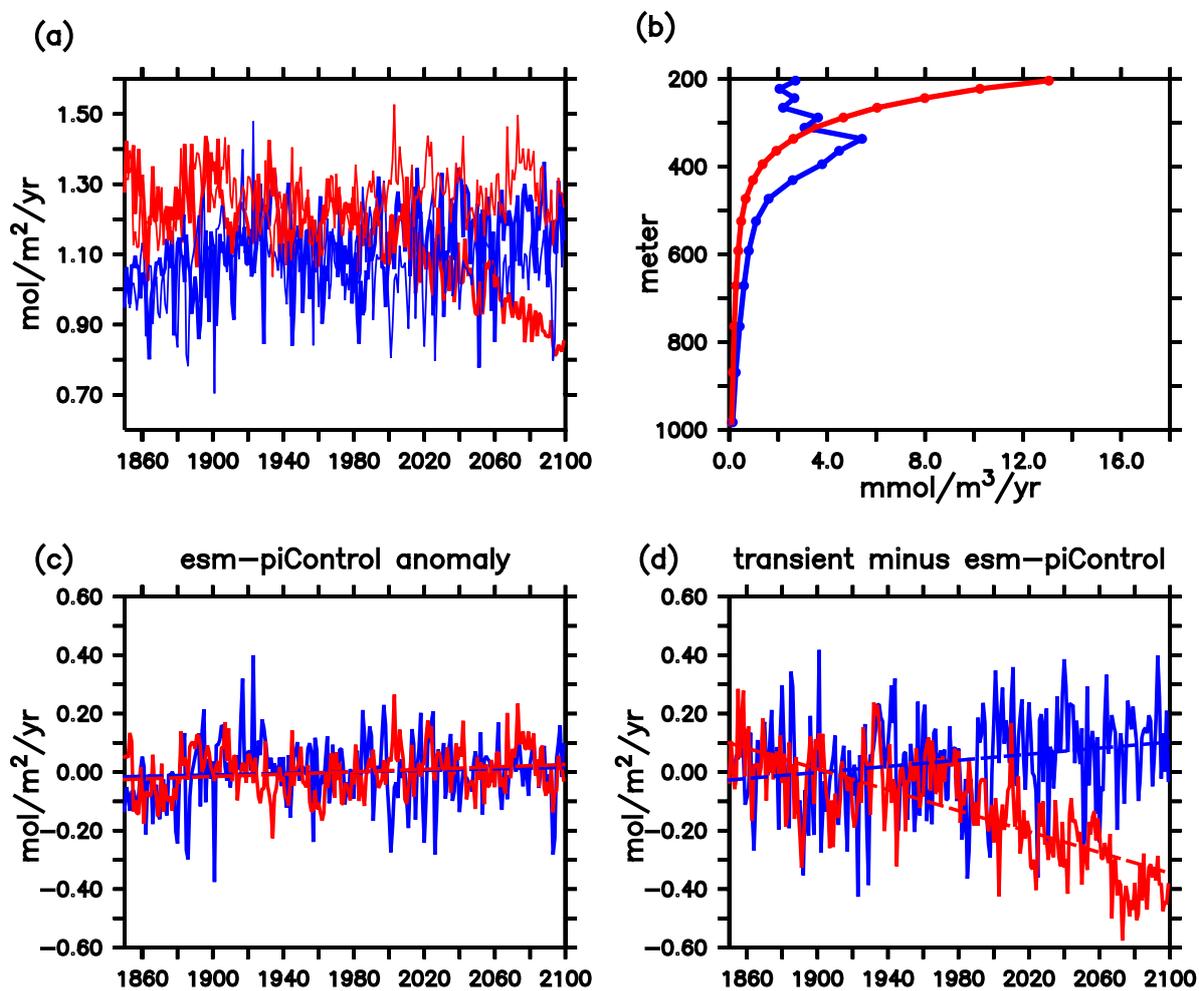


Figure S7. As Figure 3, but for the simulation ensemble member 2 that starts from 240th year of esm-piControl-spinup. In the panel (b), the individual r^2 of the AOU versus age regression are all above 0.85 in this section.

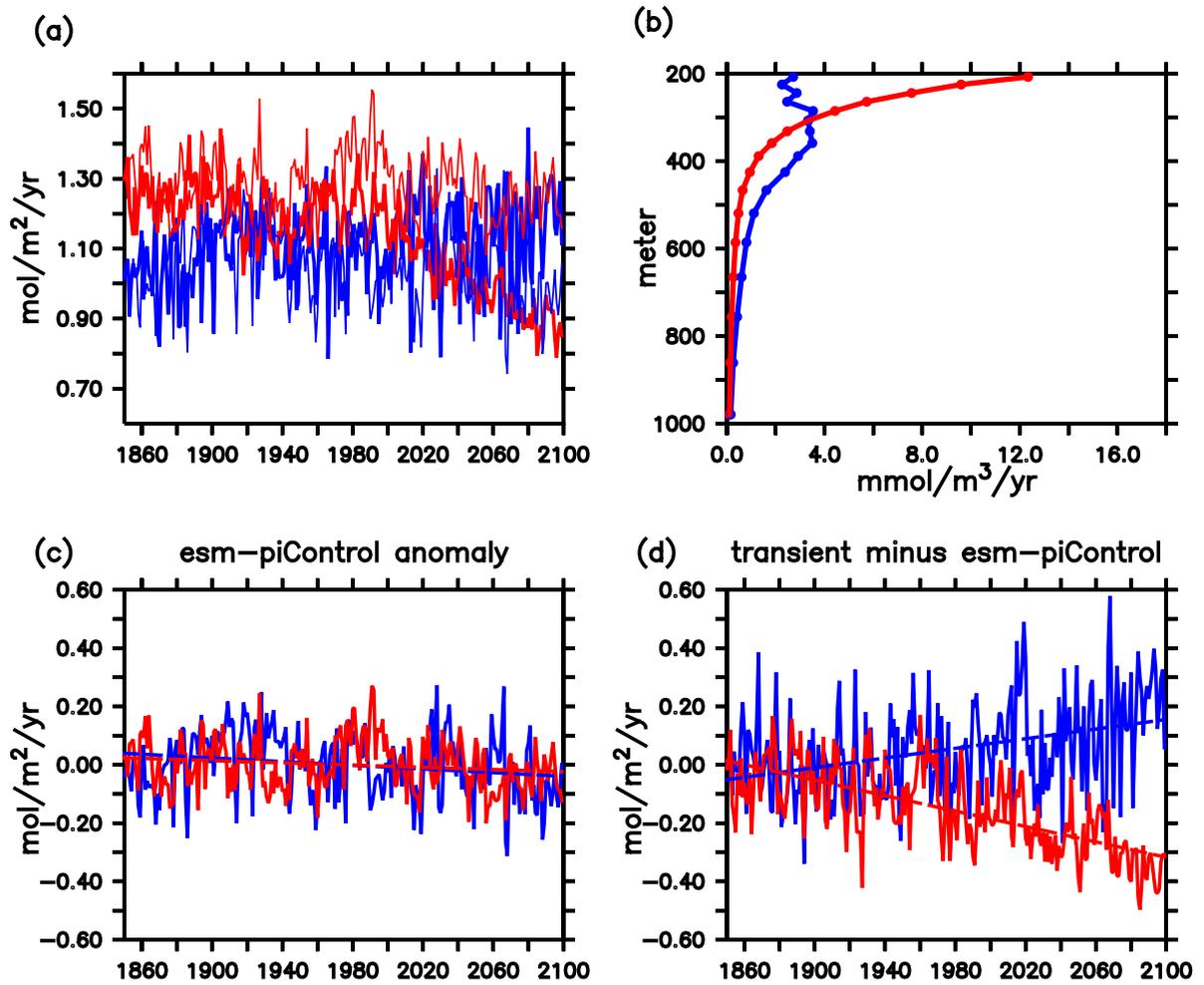


Figure S8. As Figure 3, but for the simulation ensemble member 3 that starts from 250th year of esm-piControl-spinup. In the panel (b), the individual r^2 of the AOU versus age regression are all above 0.93 in this section.

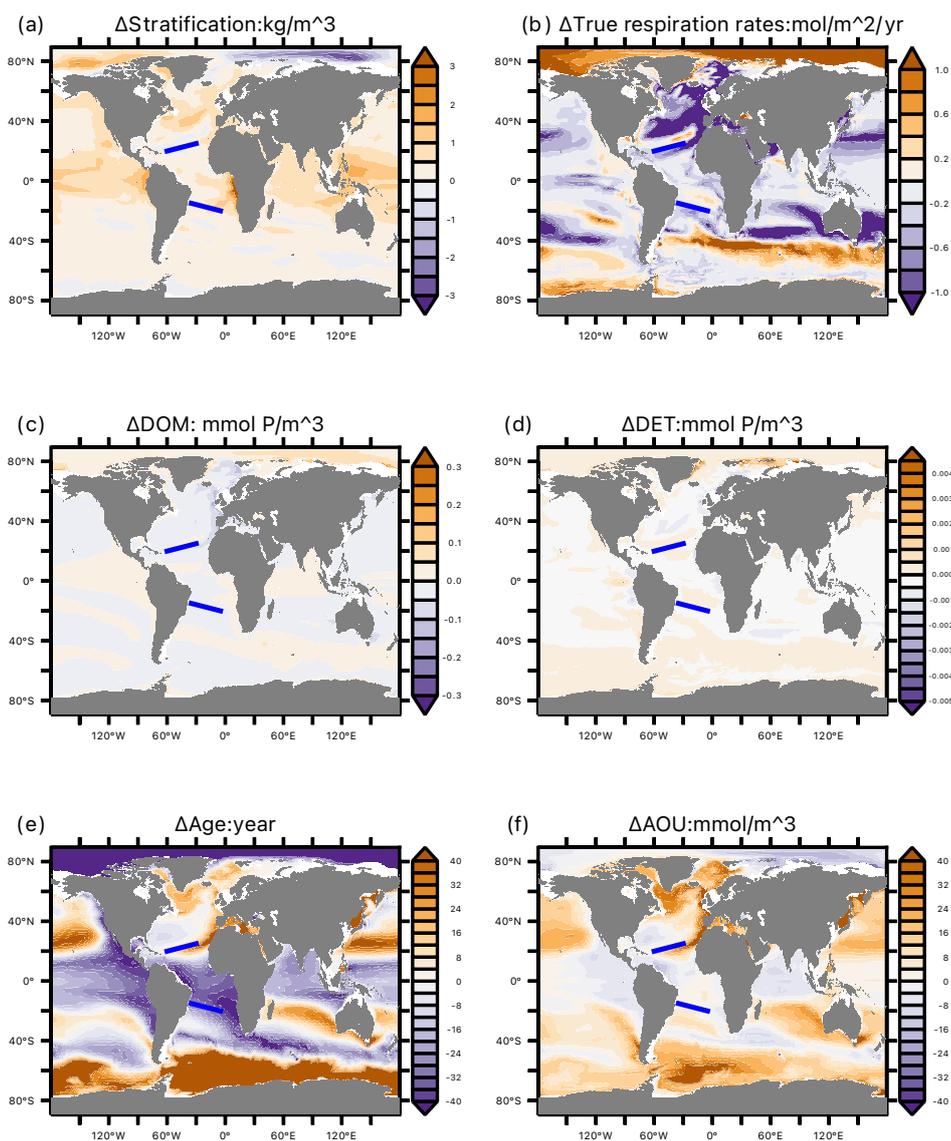


Figure S9. Transient minus esm-piControl (a) stratification, (b) 200m-1000m vertically integrated true respiration rates, (c) 200m-1000m averaged DOM, (d) 200m-1000m averaged DET, (e) 200m-1000m averaged ideal age, and (f) 200m-1000m averaged AOU distributions. We use the last decade's mean in the transient and esm-piControl simulations. The stratification is calculated as the density at 200m minus density at 0m (Behrenfeld et al., 2006; Kwiatkowski et al., 2020). The thick blue bars are study sections.