



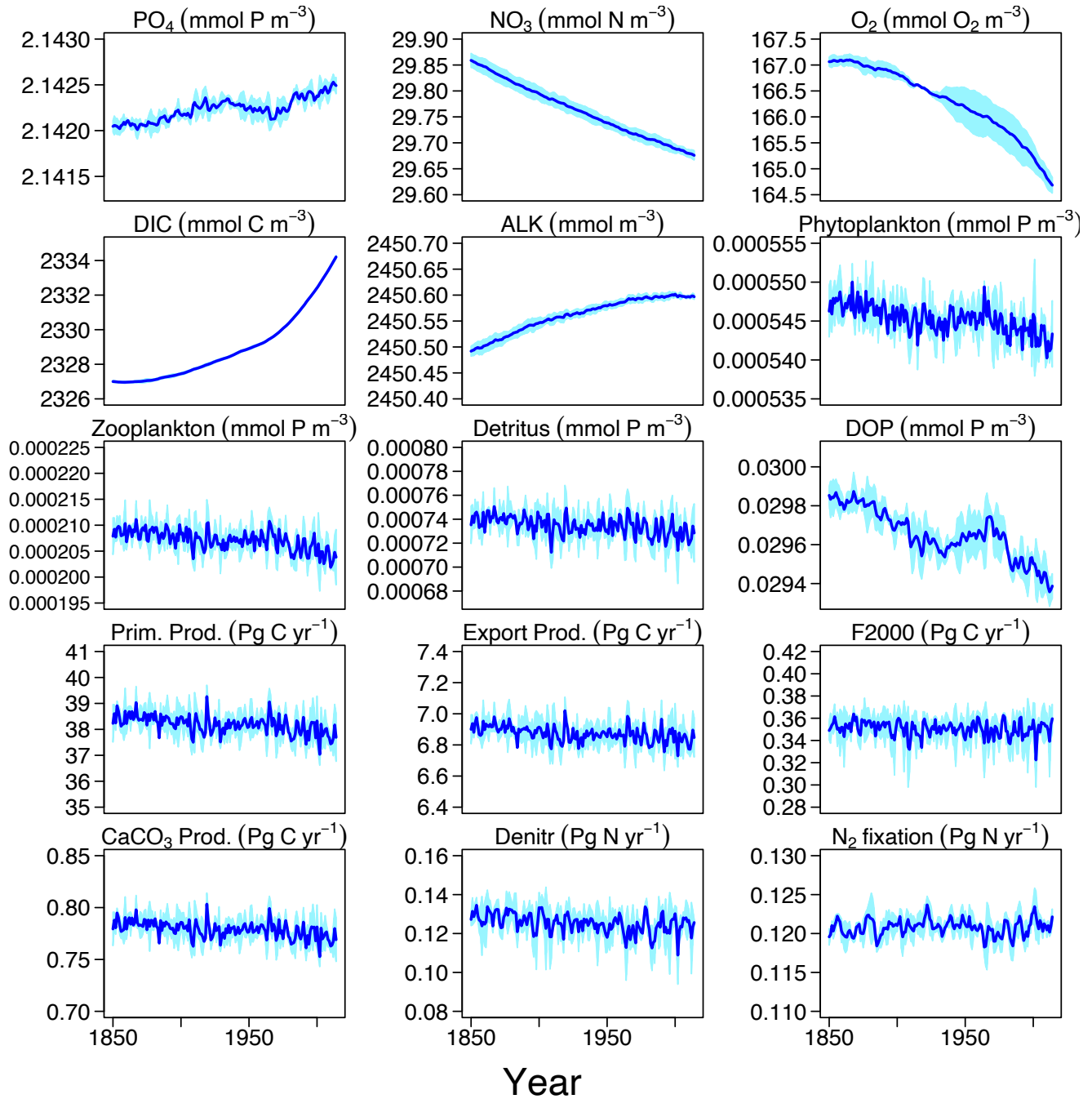
*Supplement of*

**FOCI-MOPS v1 – integration of marine biogeochemistry within the  
Flexible Ocean and Climate Infrastructure version 1 (FOCI 1)  
Earth system model**

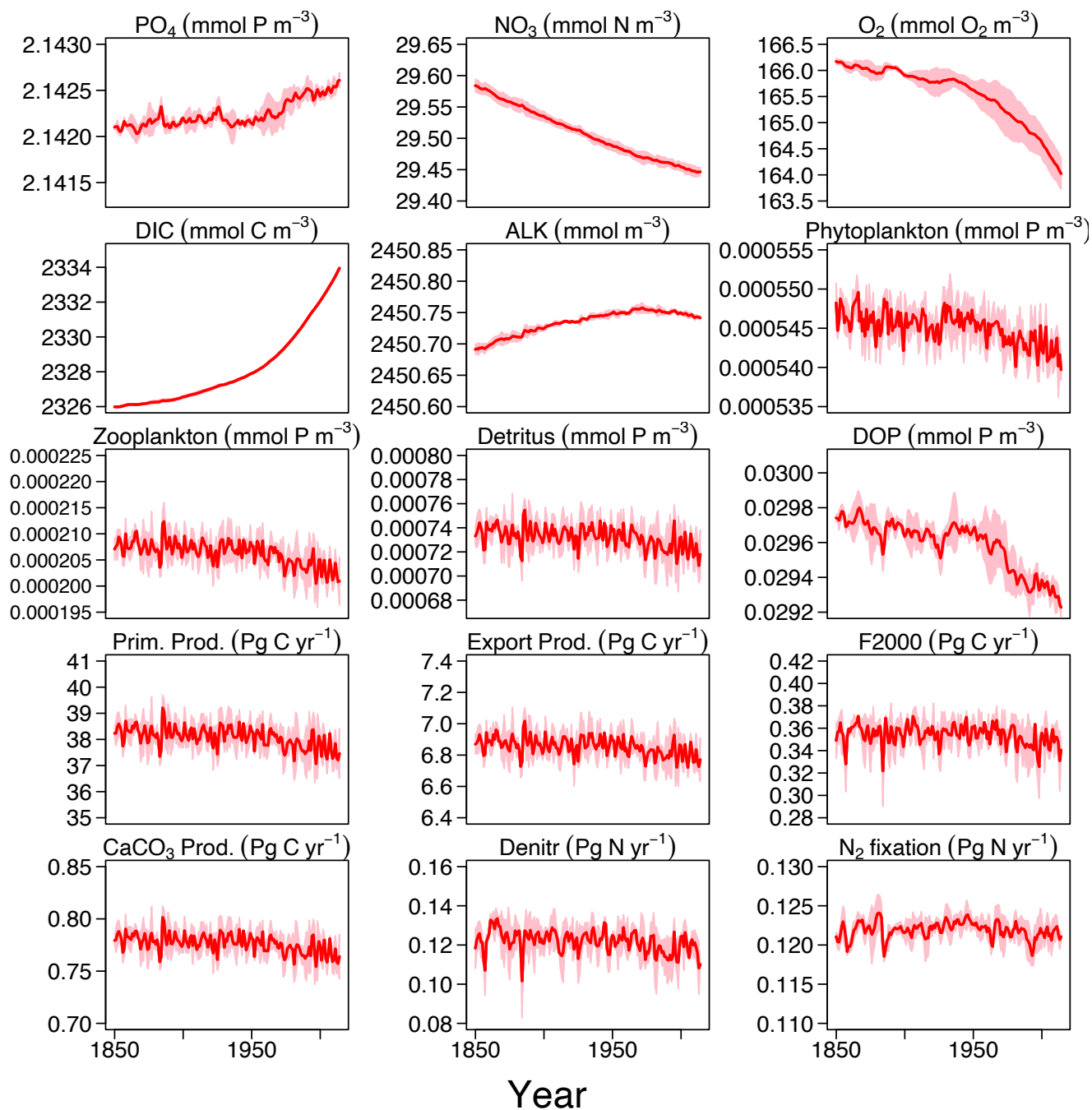
**Chia-Te Chien et al.**

*Correspondence to:* Chia-Te Chien (cchien@geomar.de)

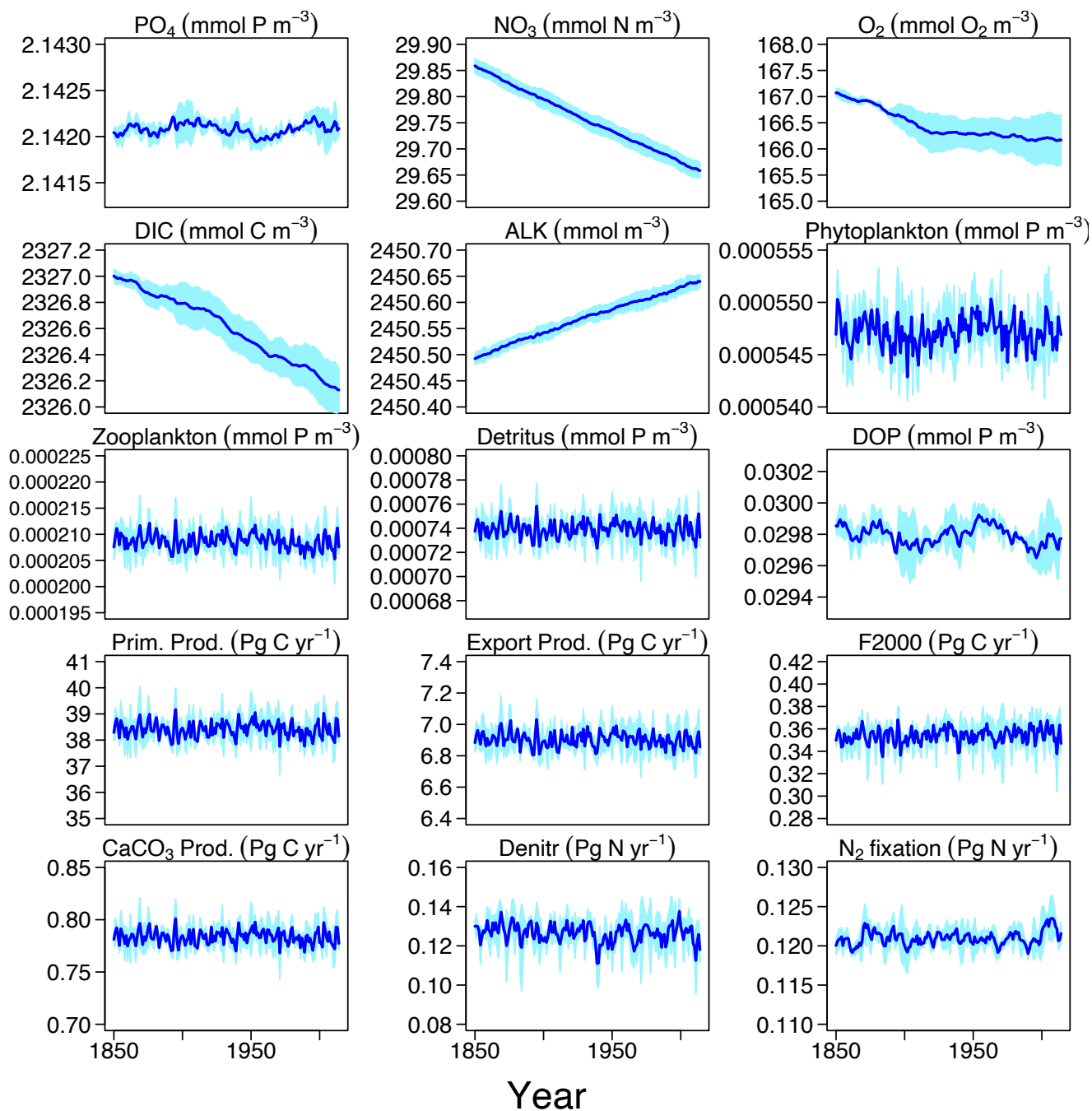
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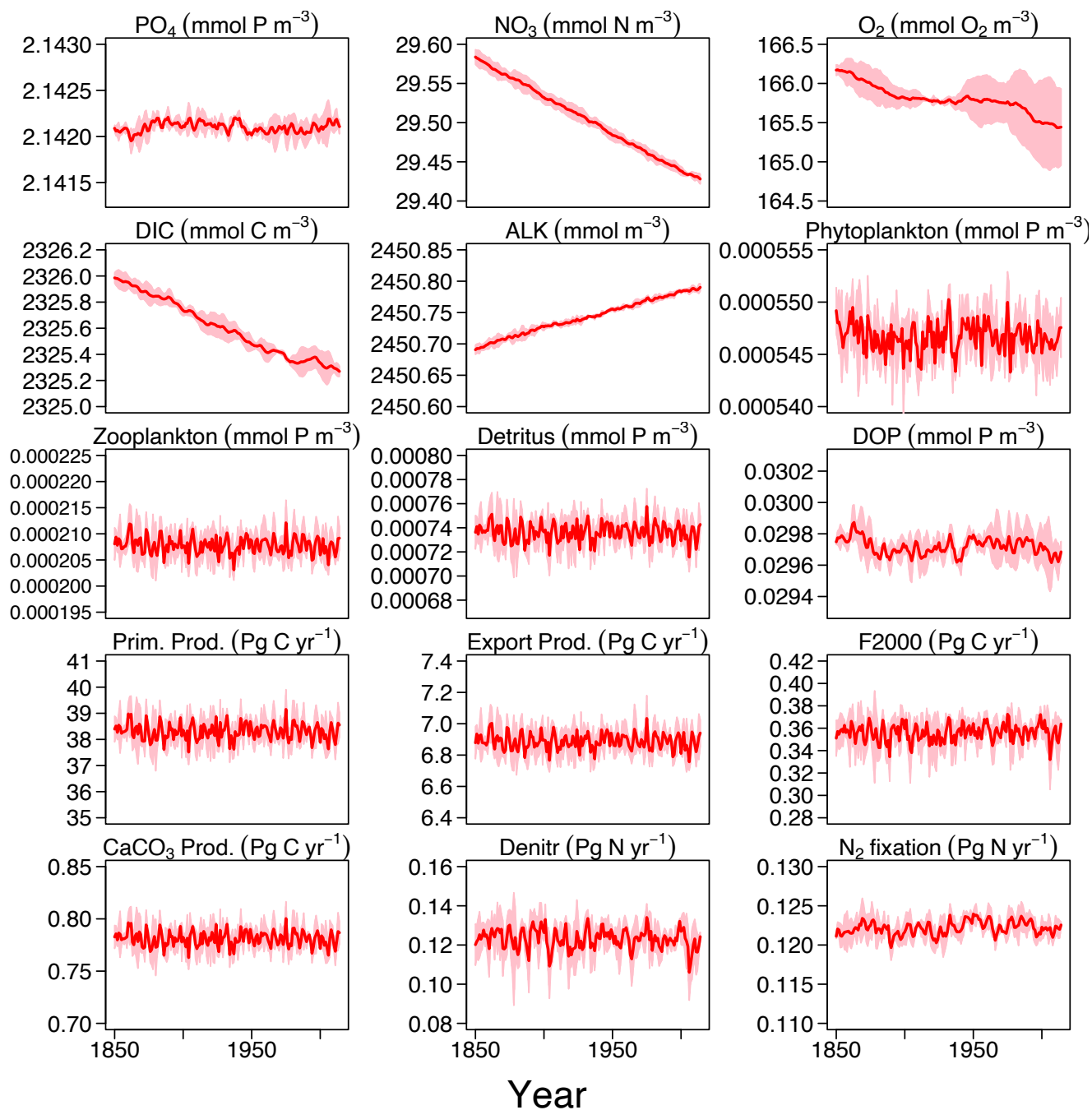
**Figure S1.** An ensemble of three *Hist* simulations. Dark blue lines stand for the means, and light blue shaded areas represent one standard deviation, respectively. Arrangement of sub panels are the same as in Fig. 2 in the main text



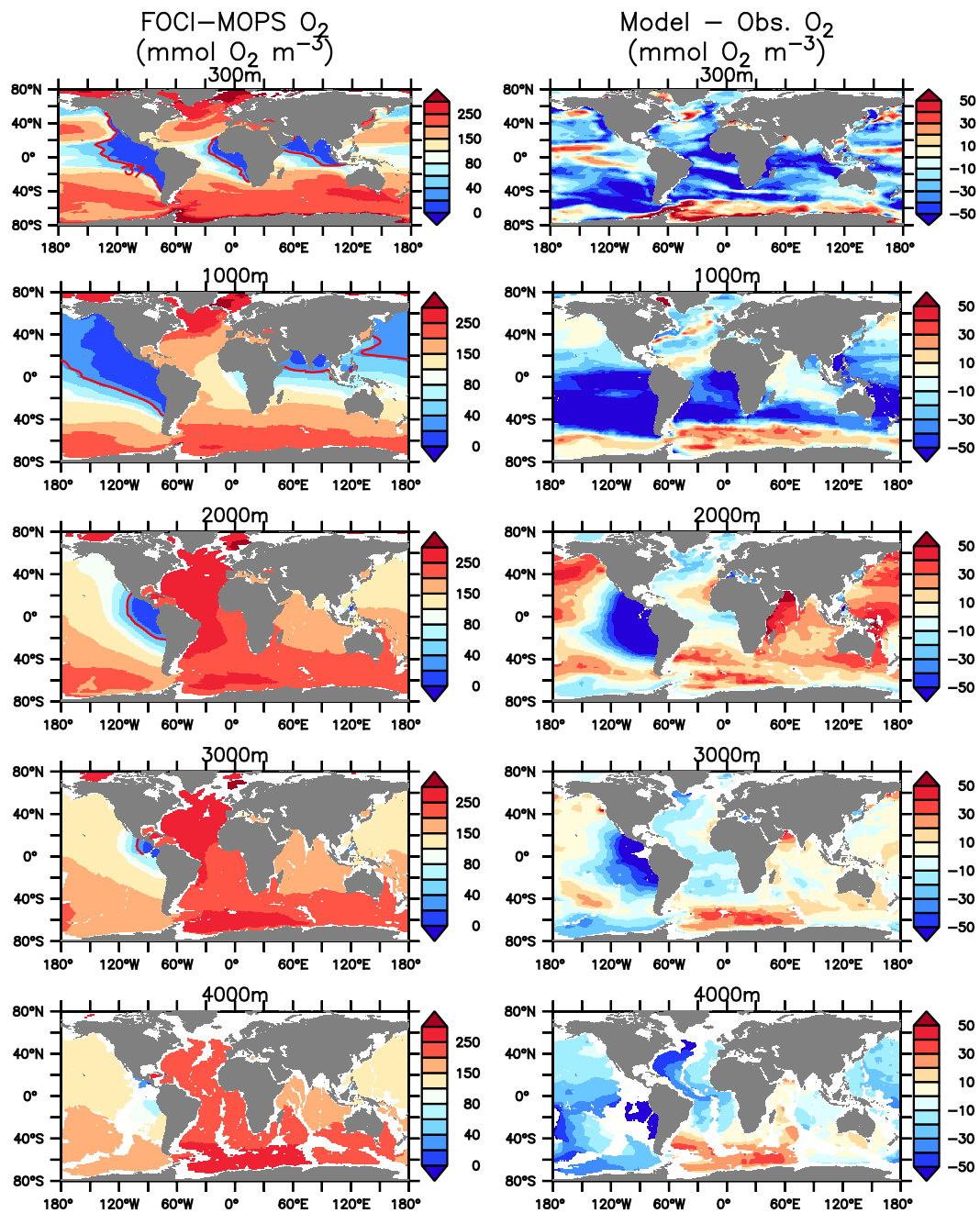
**Figure S2.** An ensemble of three *ESM-Hist* simulations. Dark red lines stand for the means, and light red shaded areas represent one standard deviation, respectively. Arrangement of sub panels are the same as in Fig. 2 in the main text



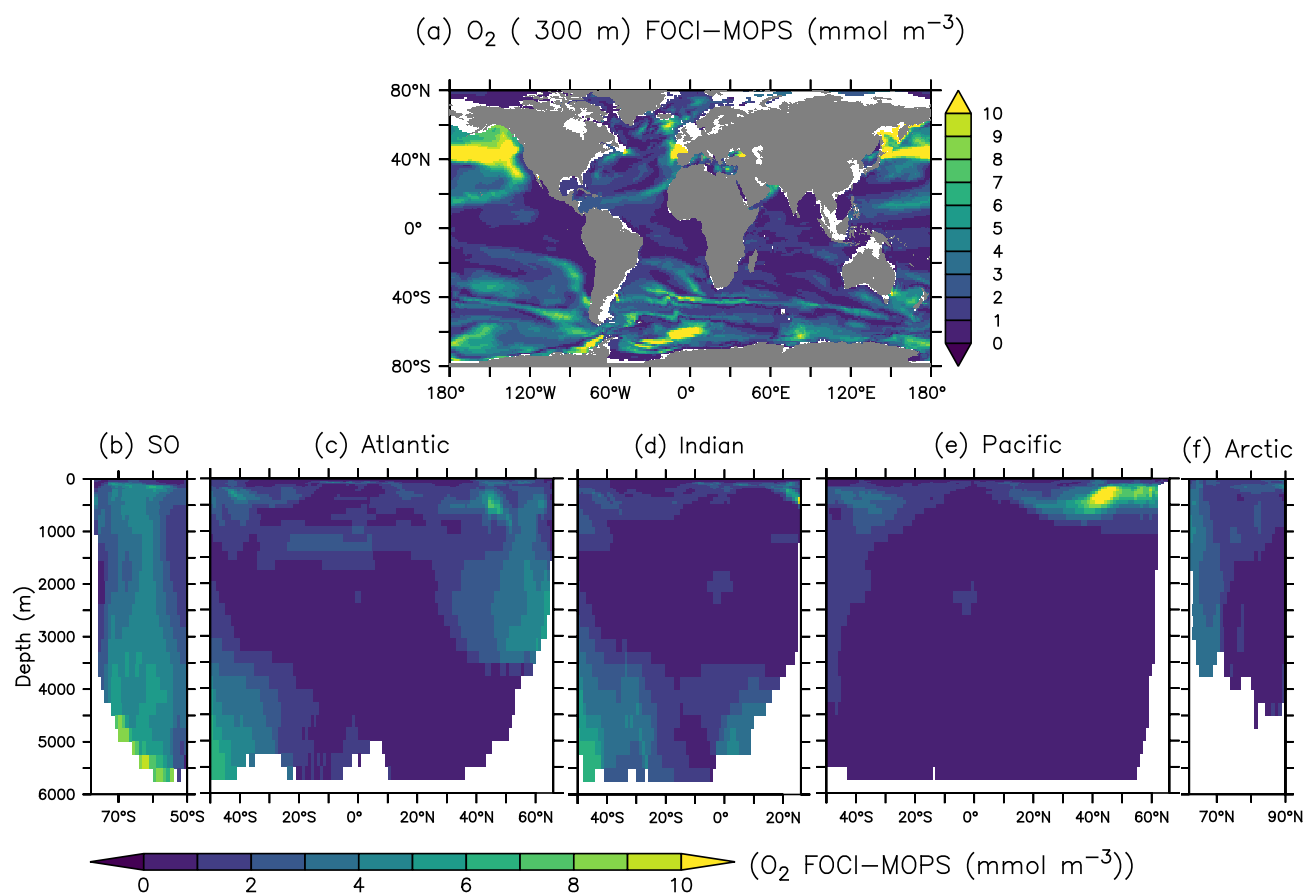
**Figure S3.** An ensemble of three *piControl* simulations. Dark blue lines stand for the means, and light blue shaded areas represent one standard deviation, respectively. Arrangement of sub panels are the same as in Fig. 2 in the main text



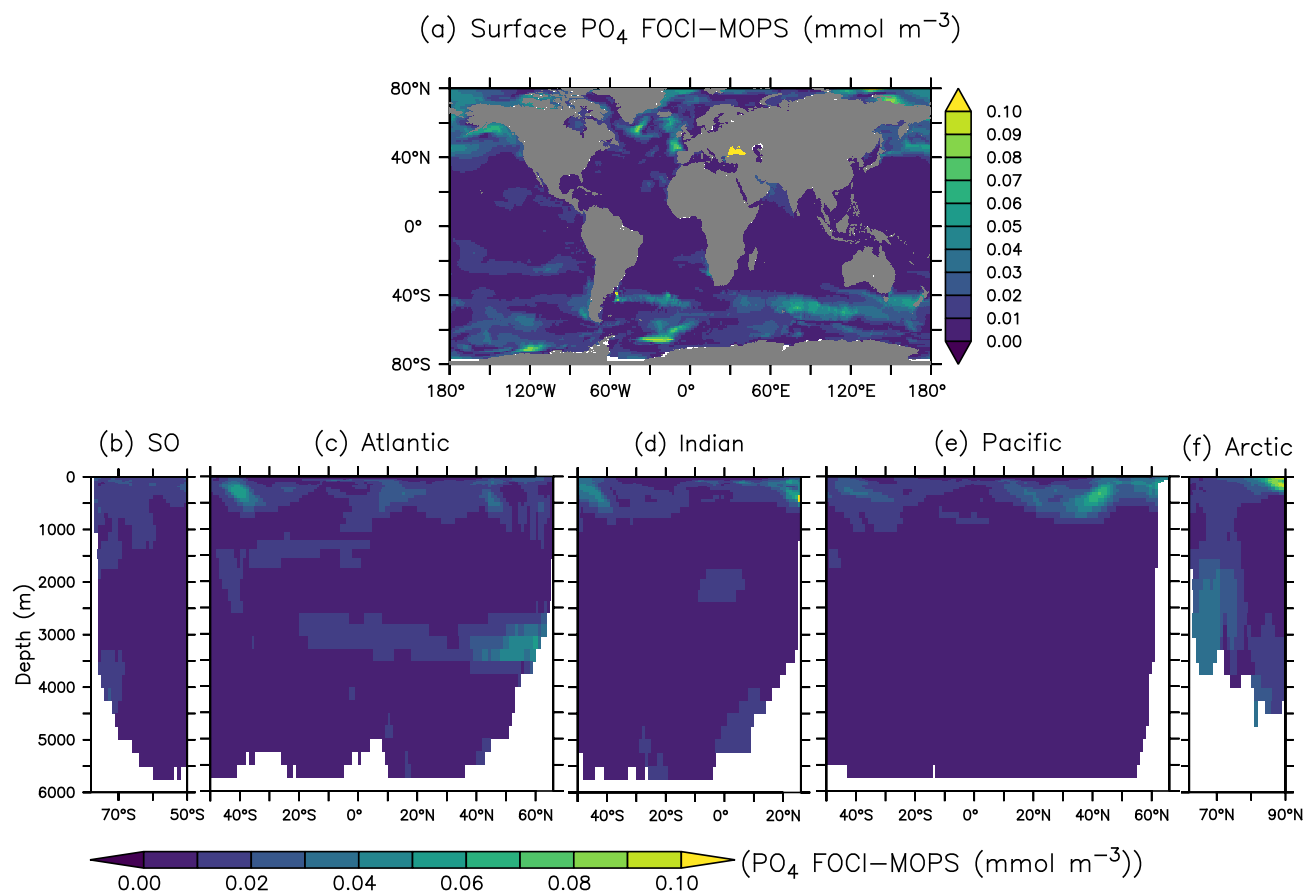
**Figure S4.** An ensemble of three *ESM-piControl* simulations. Dark red lines stand for the means, and light red shaded areas represent one standard deviation, respectively. Arrangement of sub panels are the same as in Fig. 2 in the main text



**Figure S5.** Hist model mean and model - observation of  $O_2$  at 300, 1000, 2000, 3000, and 4000 m. Red contours in model indicate  $O_2$  concentration at  $36 \text{ mmol m}^{-3}$ .

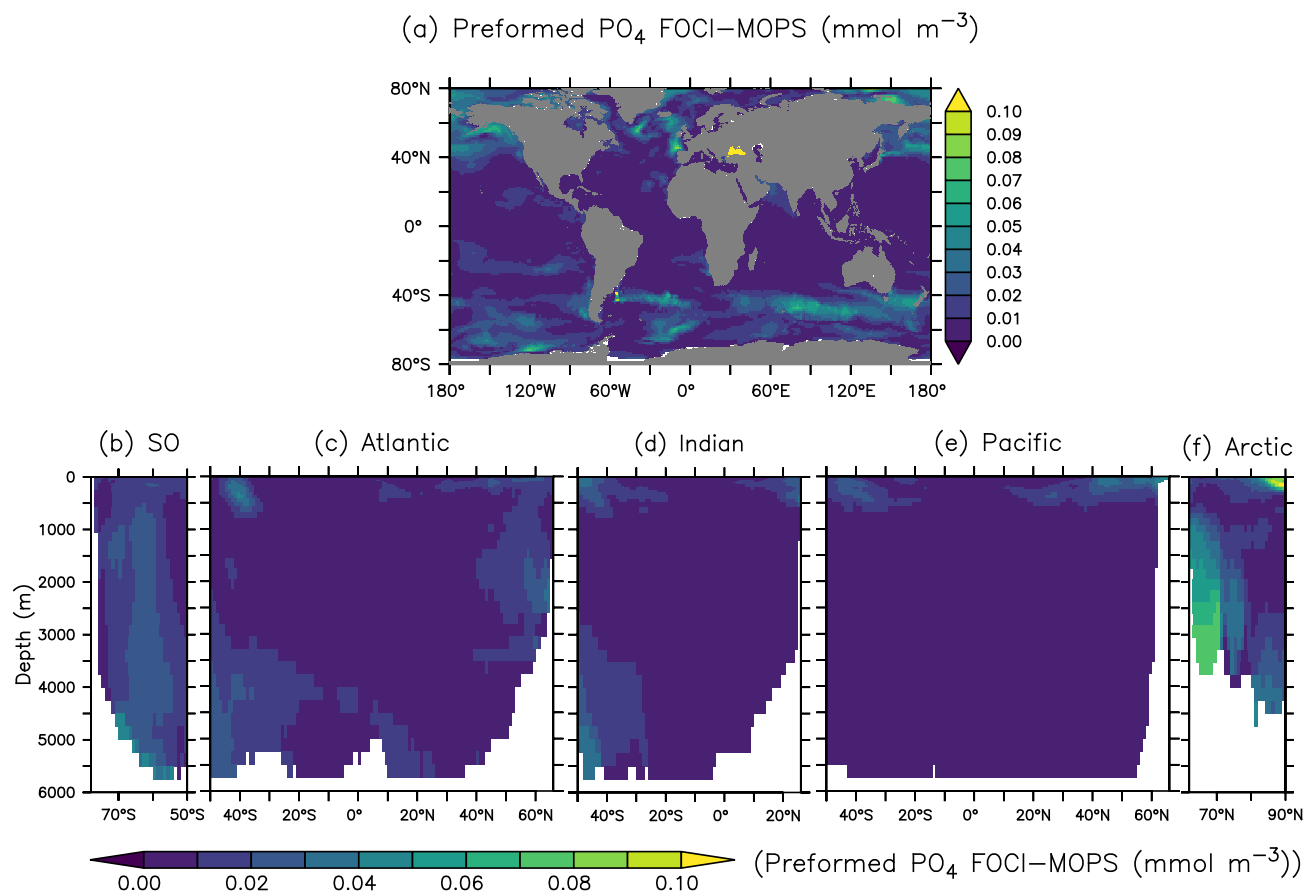


**Figure S6.** One standard deviation (sd) of the  $O_2$  climatology over 1972 – 2013 of the *Hist* simulations at (a) 300 m depth and zonally averaged across the (b) Southern Ocean, (c) Atlantic, (d) Indian, (e) Pacific, and (f) Arctic Ocean in FOCI-MOPS.

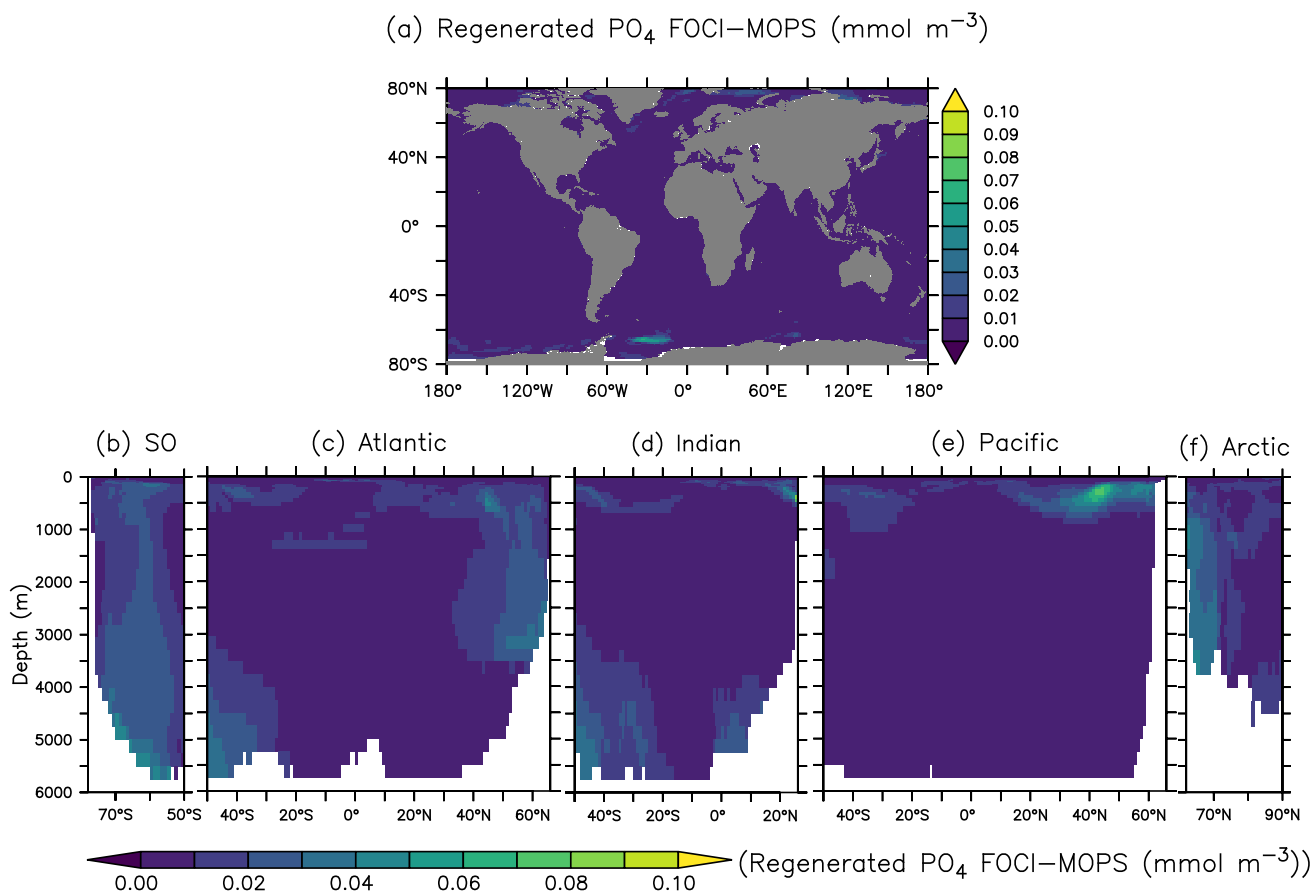


**Figure S7.** One standard deviation (sd) of the  $\text{PO}_4$  climatology over 1972 – 2013 of the *Hist* simulations at (a) 300 m depth and zonally averaged across the (b) Southern Ocean, (c) Atlantic, (d) Indian, (e) Pacific, and (f) Arctic Ocean in FOCI-MOPS.

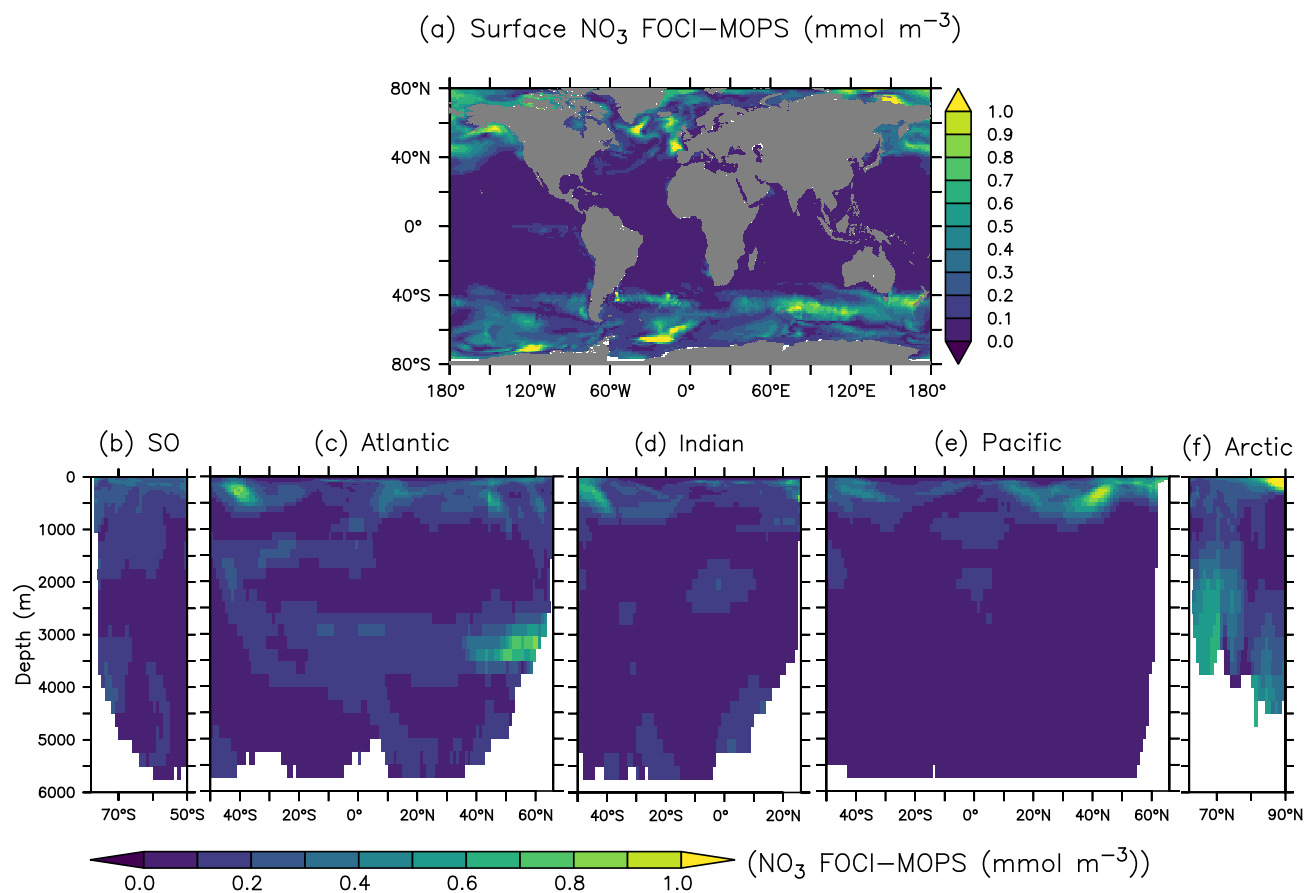




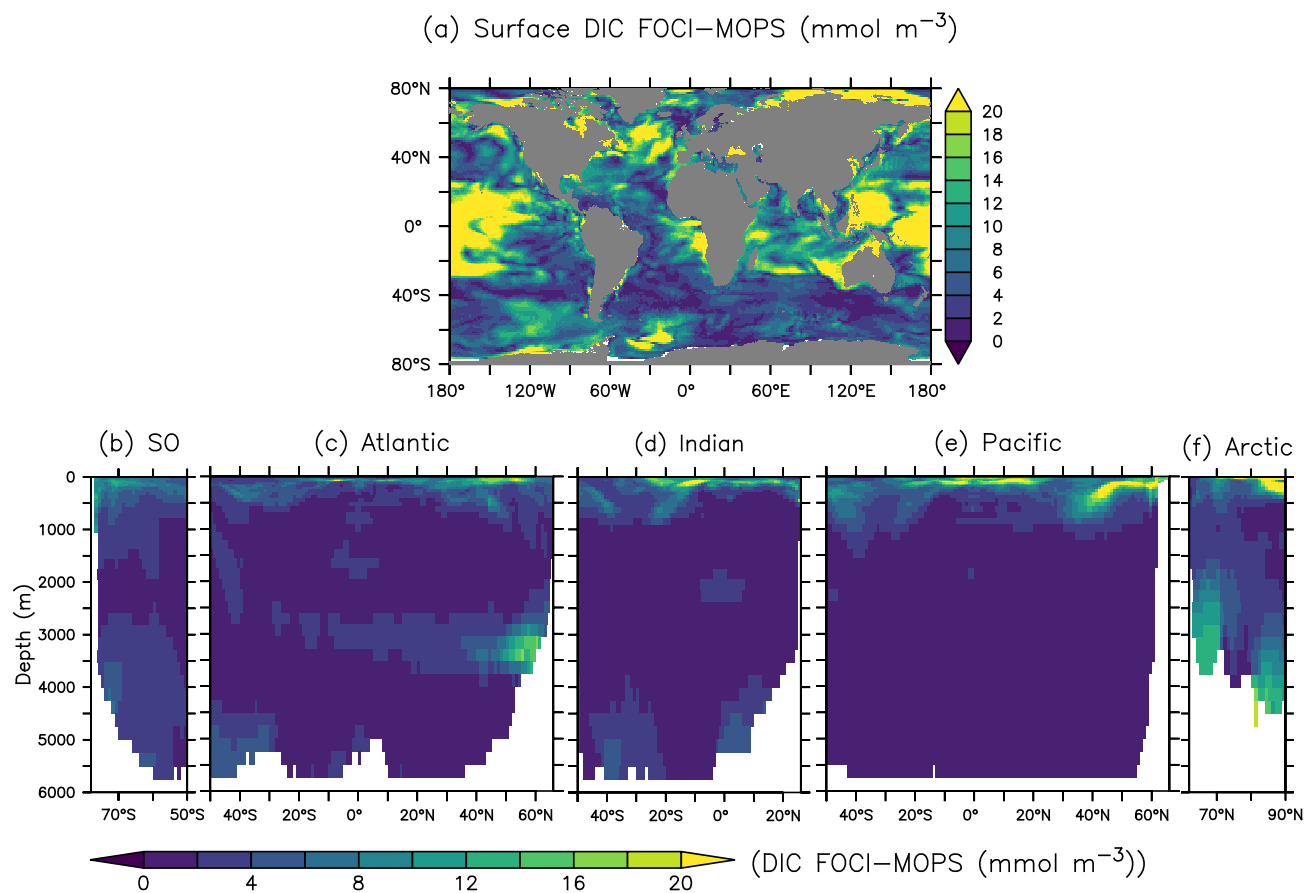
**Figure S8.** One standard deviation (sd) of the preformed  $\text{PO}_4$  climatology over 1972 – 2013 of the *Hist* simulations at (a) 300 m depth and zonally averaged across the (b) Southern Ocean, (c) Atlantic, (d) Indian, (e) Pacific, and (f) Arctic Ocean in FOCI-MOPS.



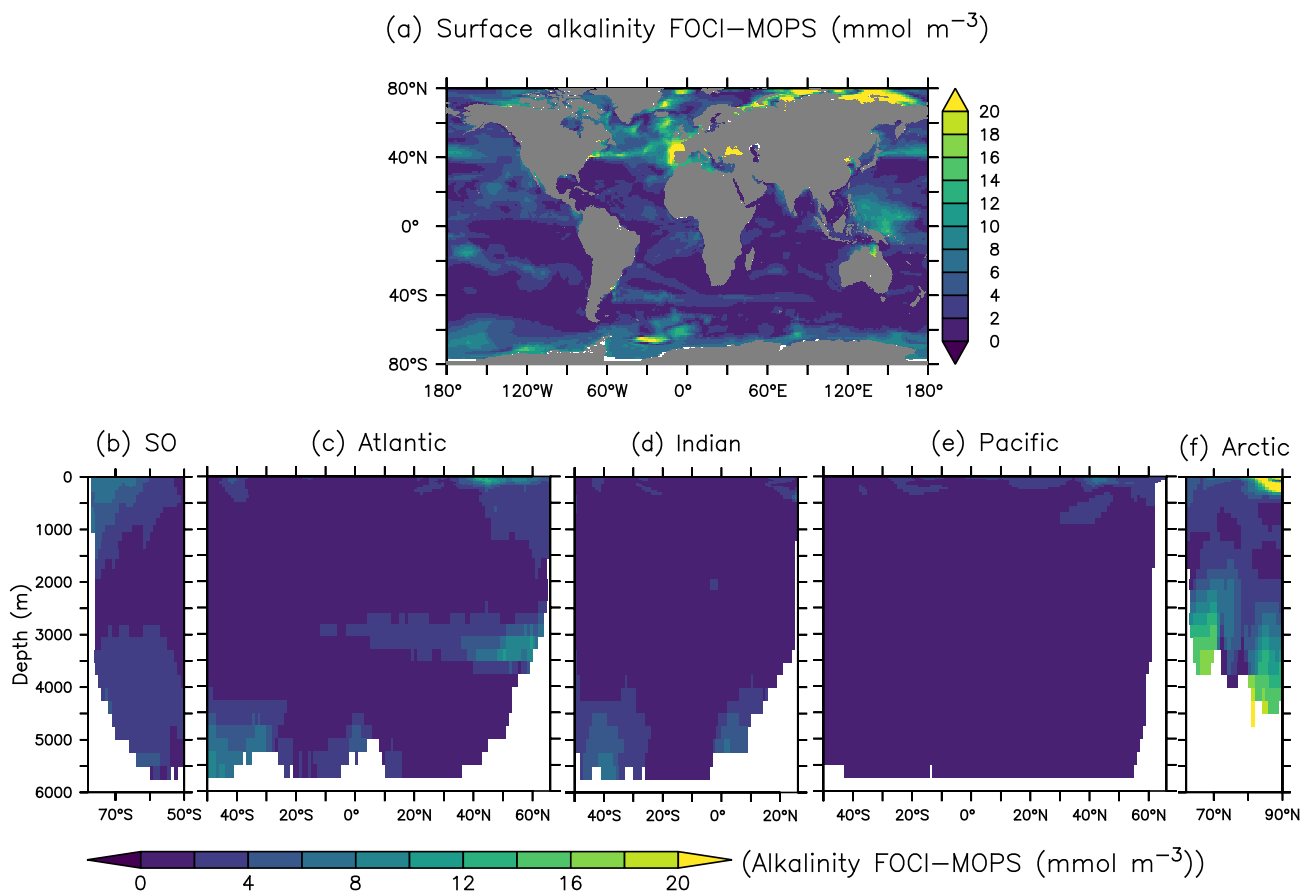
**Figure S9.** One standard deviation (sd) of the regenerated  $\text{PO}_4$  climatology over 1972 – 2013 of the *Hist* simulations at (a) 300 m depth and zonally averaged across the (b) Southern Ocean, (c) Atlantic, (d) Indian, (e) Pacific, and (f) Arctic Ocean in FOCI-MOPS.



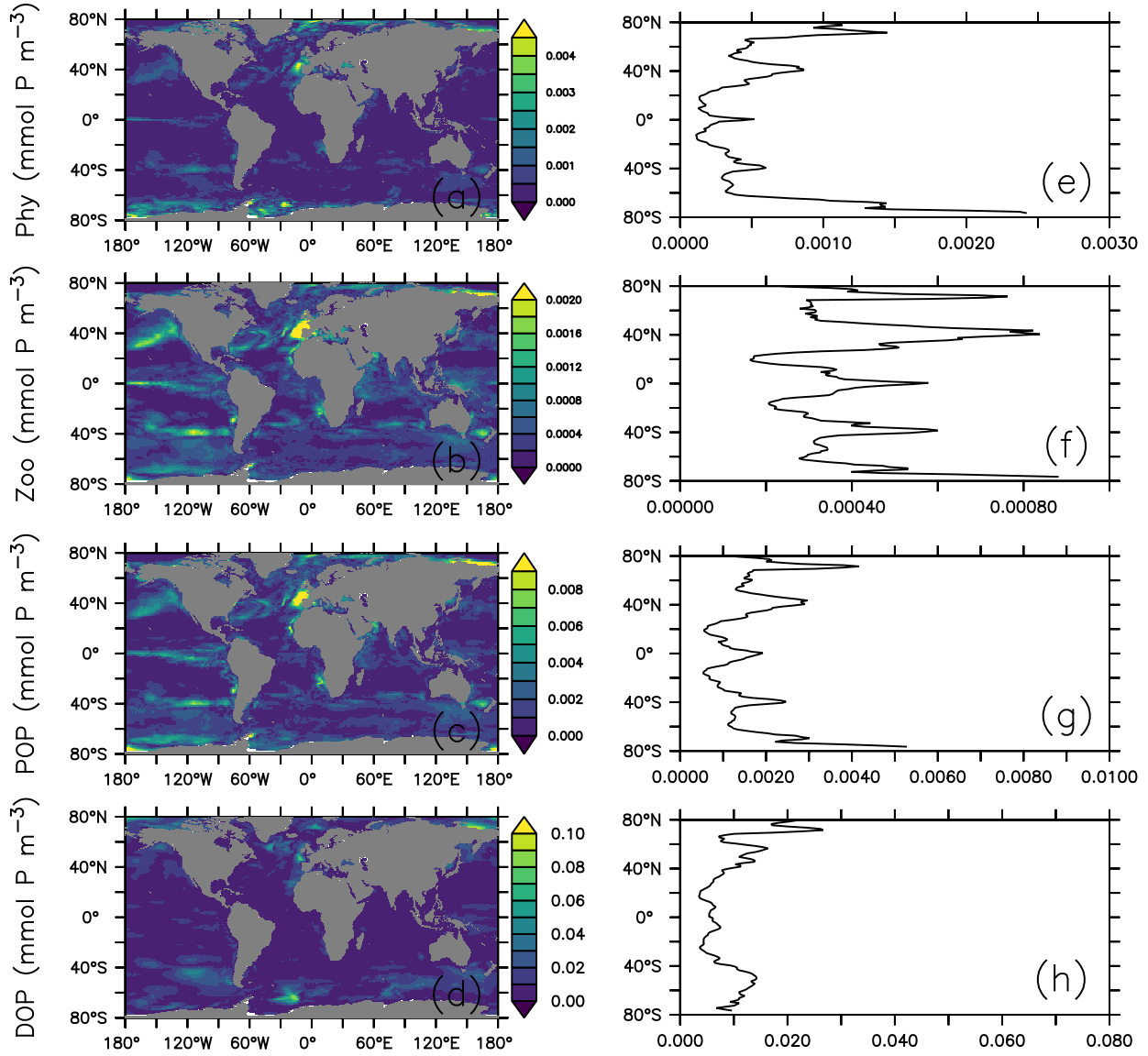
**Figure S10.** One standard deviation (sd) of the  $\text{NO}_3$  climatology over 1972 – 2013 of the *Hist* simulations at (a) 300 m depth and zonally averaged across the (b) Southern Ocean, (c) Atlantic, (d) Indian, (e) Pacific, and (f) Arctic Ocean in FOCI-MOPS.



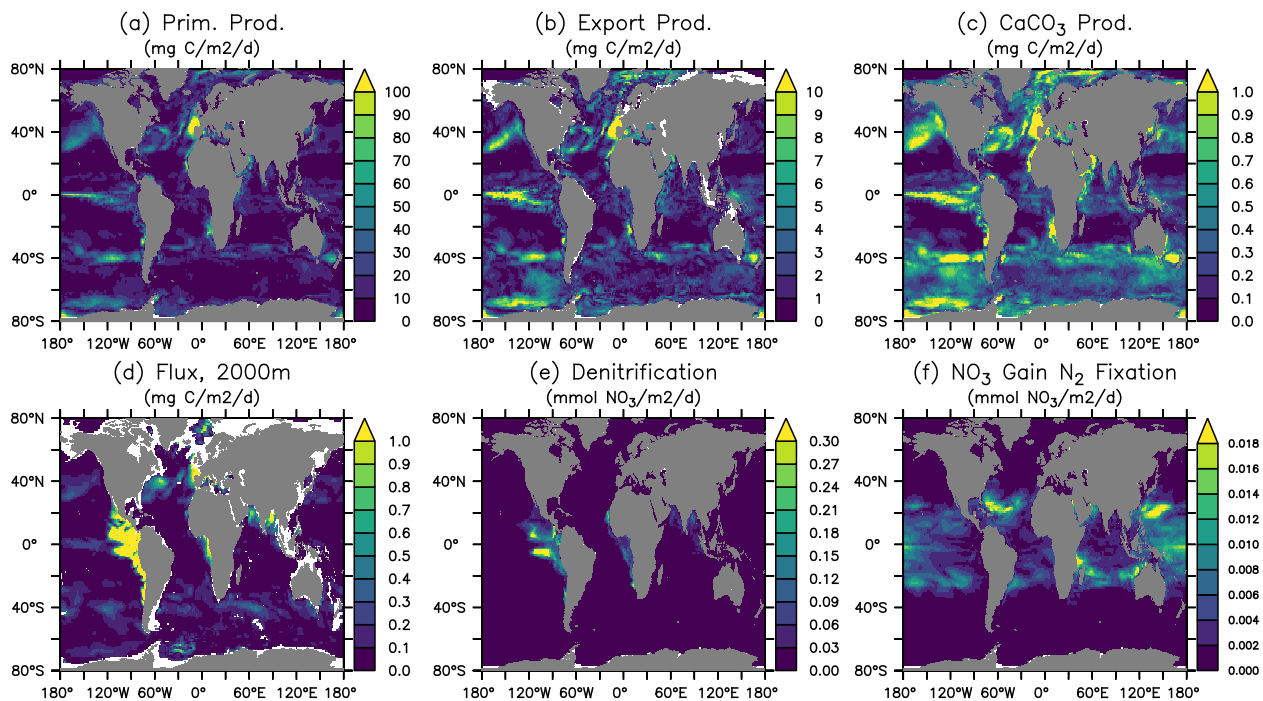
**Figure S11.** One standard deviation (sd) of the dissolved inorganic carbon (DIC) of year 2002 of the *Hist* simulations at (a) 300 m depth and zonally averaged across the (b) Southern Ocean, (c) Atlantic, (d) Indian, (e) Pacific, and (f) Arctic Ocean in FOCI-MOPS.



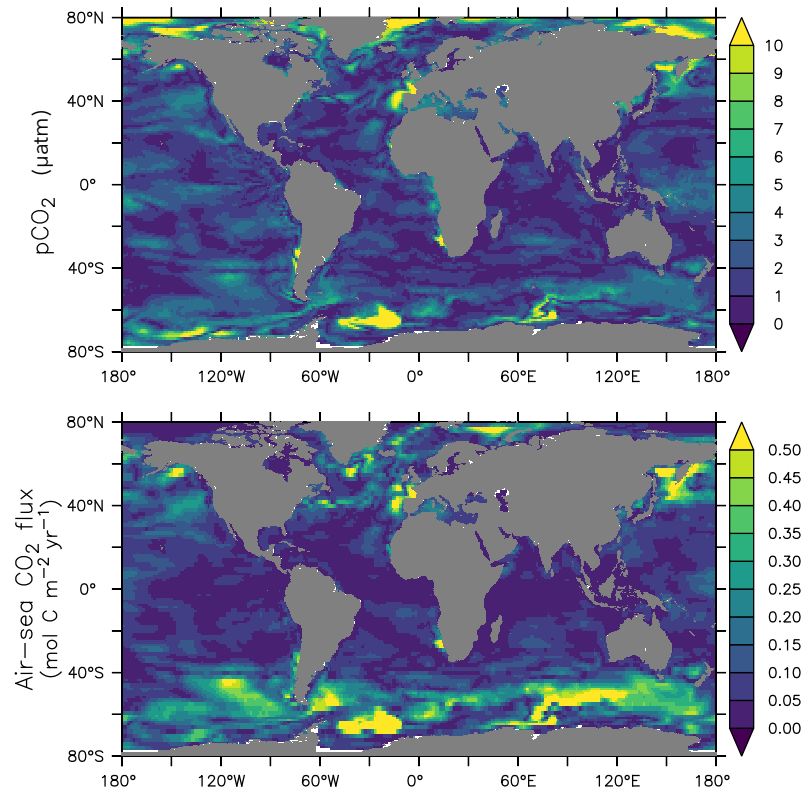
**Figure S12.** One standard deviation (sd) of the alkalinity (ALK) climatology over 1972 – 2013 of the *Hist* simulations at (a) 300 m depth and zonally averaged across the (b) Southern Ocean, (c) Atlantic, (d) Indian, (e) Pacific, and (f) Arctic Ocean in FOCI-MOPS.



**Figure S13.** One standard deviation (sd) of organic tracer concentrations (first layer (~6 m) of phytoplankton (Phy), 0–100 m of zooplankton (Zoo), particulate organic phosphorus (POP), and dissolved organic phosphorus (DOP)) climatology over 2005–2014 of the *Hist* simulations (a–d), and the zonally averaged values (e–h).

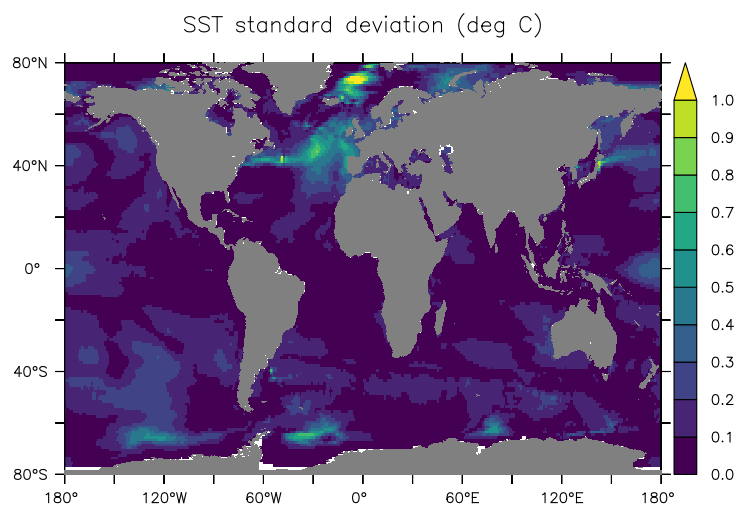


**Figure S14.** One standard deviation (sd) of primary production, export production at 100 m,  $\text{CaCO}_3$  production, flux of detritus at 2000 m, denitrification, and  $\text{N}_2$  fixation in the *Hist* simulations averaged over 2005–2014.

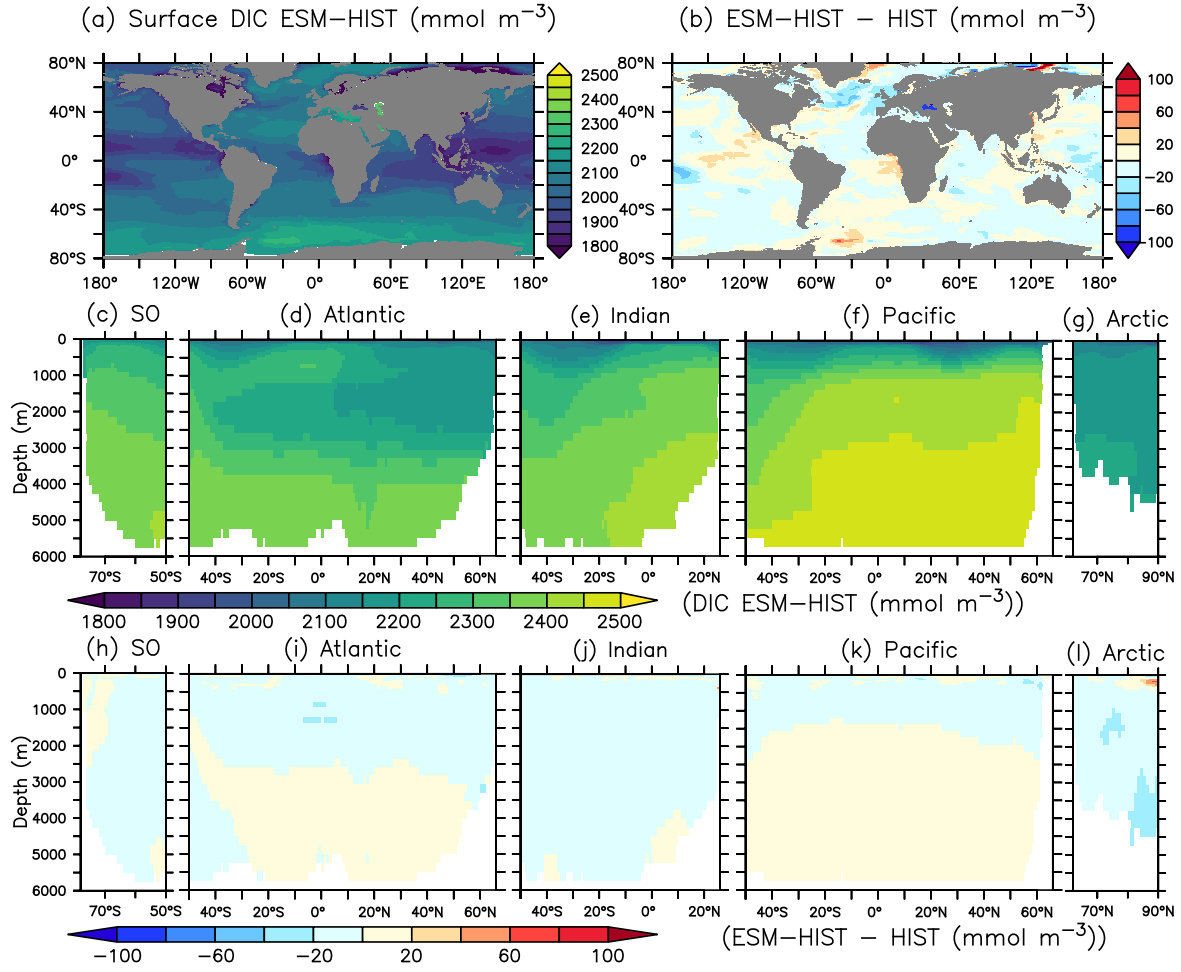


**Figure S15.** One standard deviation (sd) of (a) ocean pCO<sub>2</sub> and (b) air-sea CO<sub>2</sub> fluxes (positive downwards) in the *Hist* simulations averaged over 2005 to 2014.





**Figure S16.** One standard deviation (sd) of the sea surface temperature (SST) climatology over 2005 – 2014 of the *Hist* simulations in FOCI-MOPS.



**Figure S17.** Dissolved inorganic carbon (DIC) of year 2002 of the *ESM-Hist* simulations and the difference between *ESM-Hist* and *Hist* simulations. The order of panels is the same as in Fig. 10 in the main text