

Figure S1. Steady-state annual zonally averaged percent changes (experiment minus control) in (a) depth-integrated net primary productivity (NPP) and (b) particulate organic carbon flux at 2000 m for the UVic (black dashed line) and the ECCO-BUR (grey dotted line) simulations.

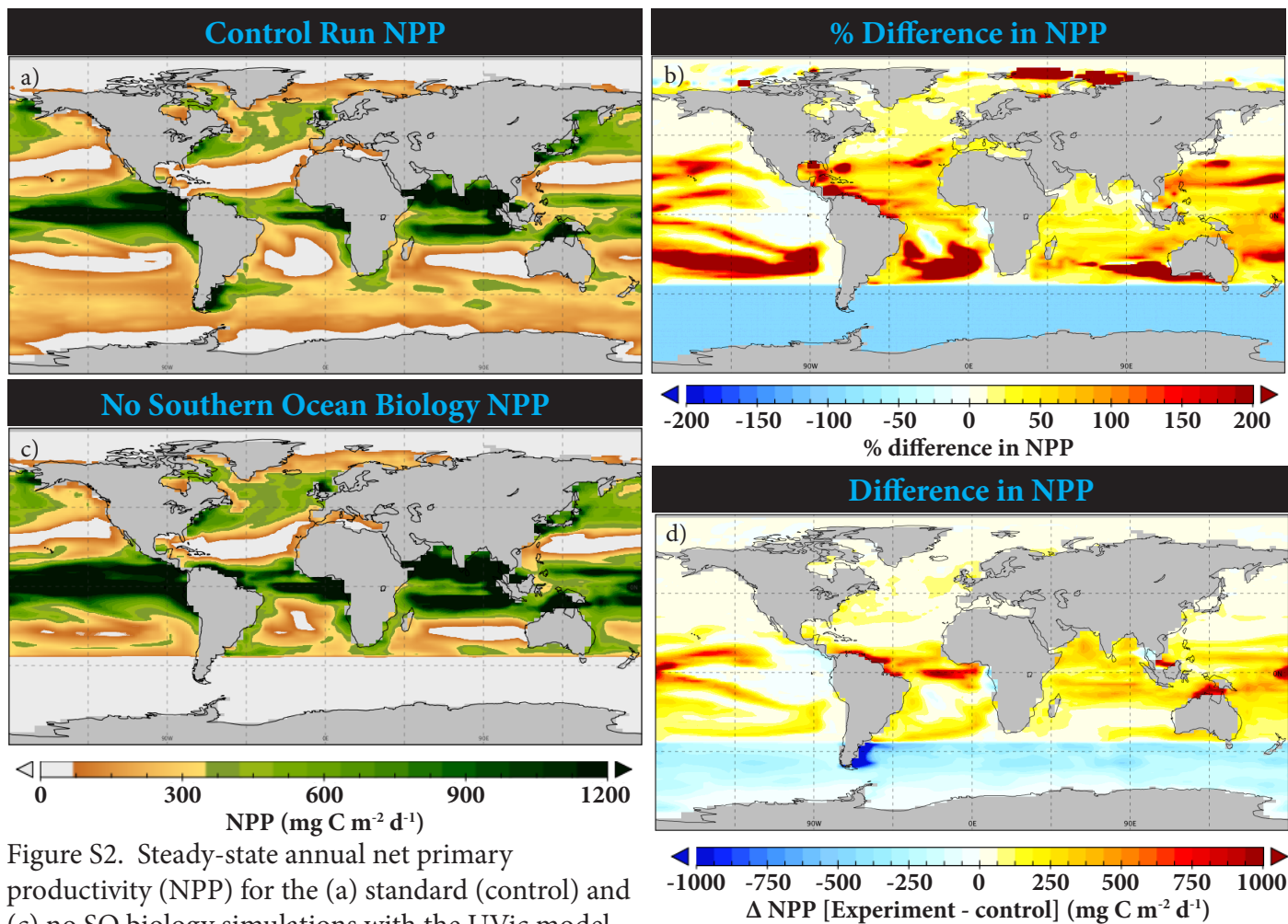


Figure S2. Steady-state annual net primary productivity (NPP) for the (a) standard (control) and (c) no SO biology simulations with the UVic model. The percent (b) and absolute (d) differences between the simulations are also shown.

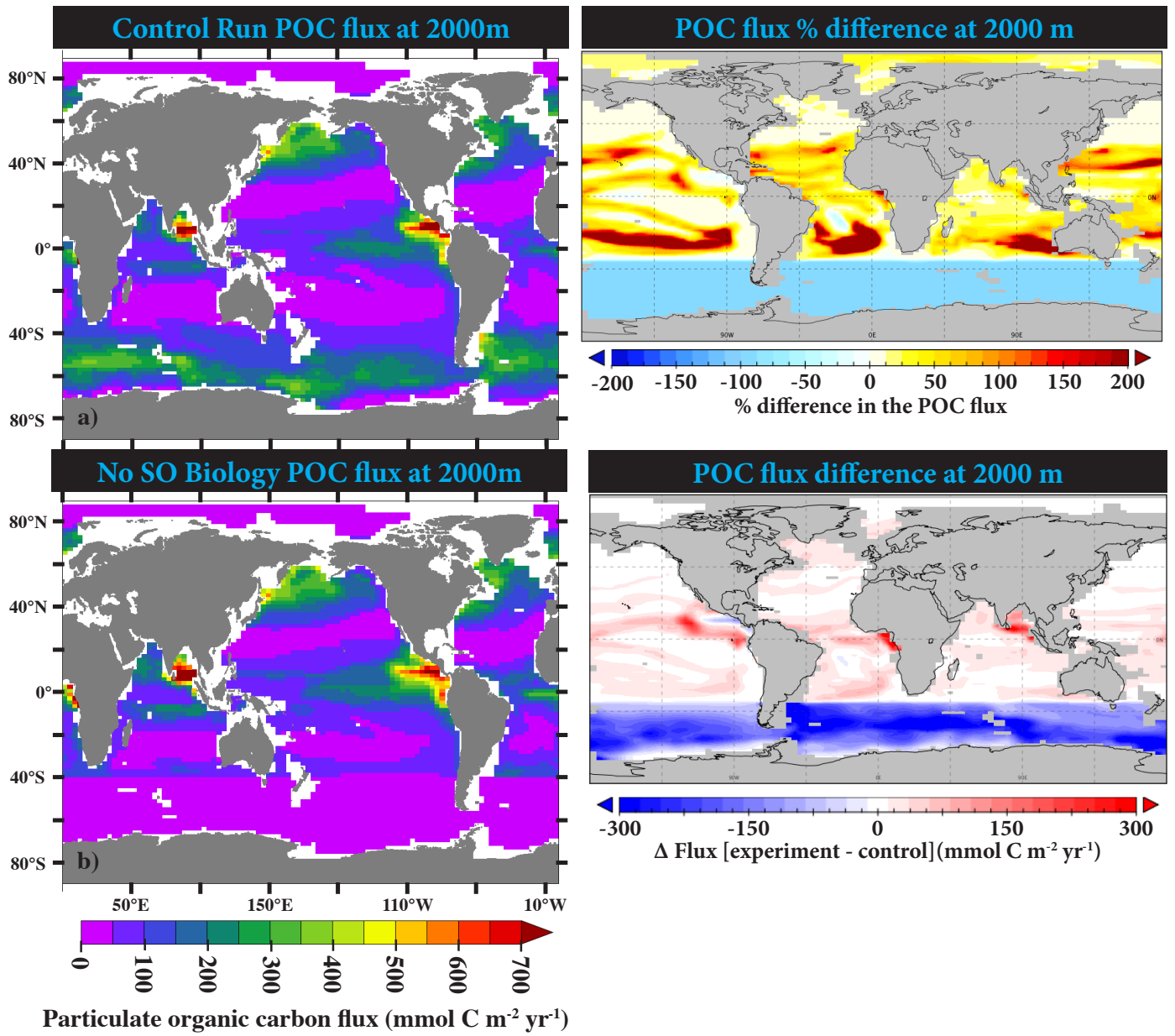


Figure S3. Steady-state annual particulate organic carbon flux at 2000m for the (a) standard (control) and (c) no SO biology simulations with the UVic model. The percent (b) absolute and (d) differences between the simulations are also shown.

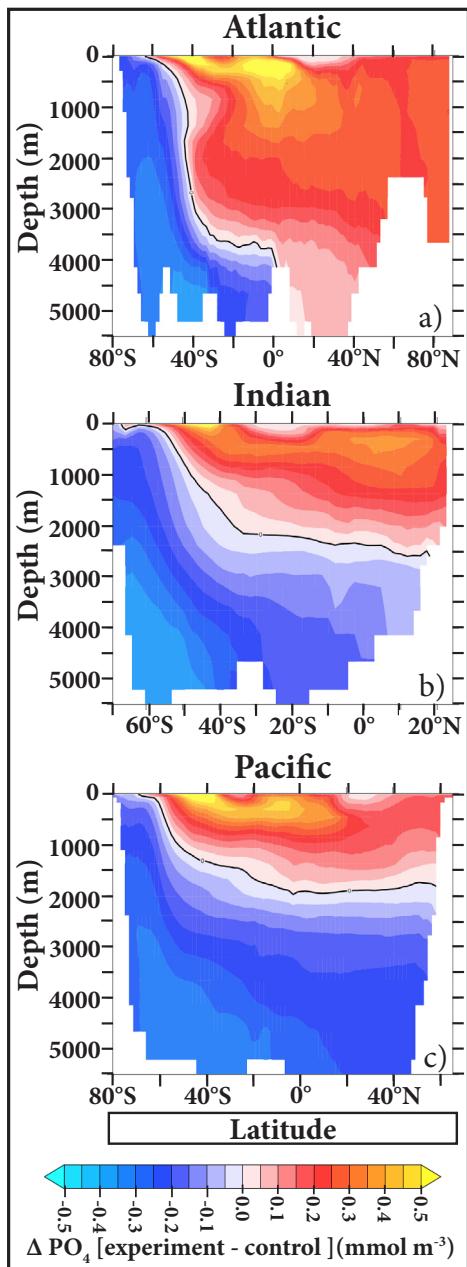


Figure S4. Steady-state annual zonally averaged differences (experiment minus control) in phosphate in the Atlantic, Indian, and Pacific Ocean basins for the UVic simulation.

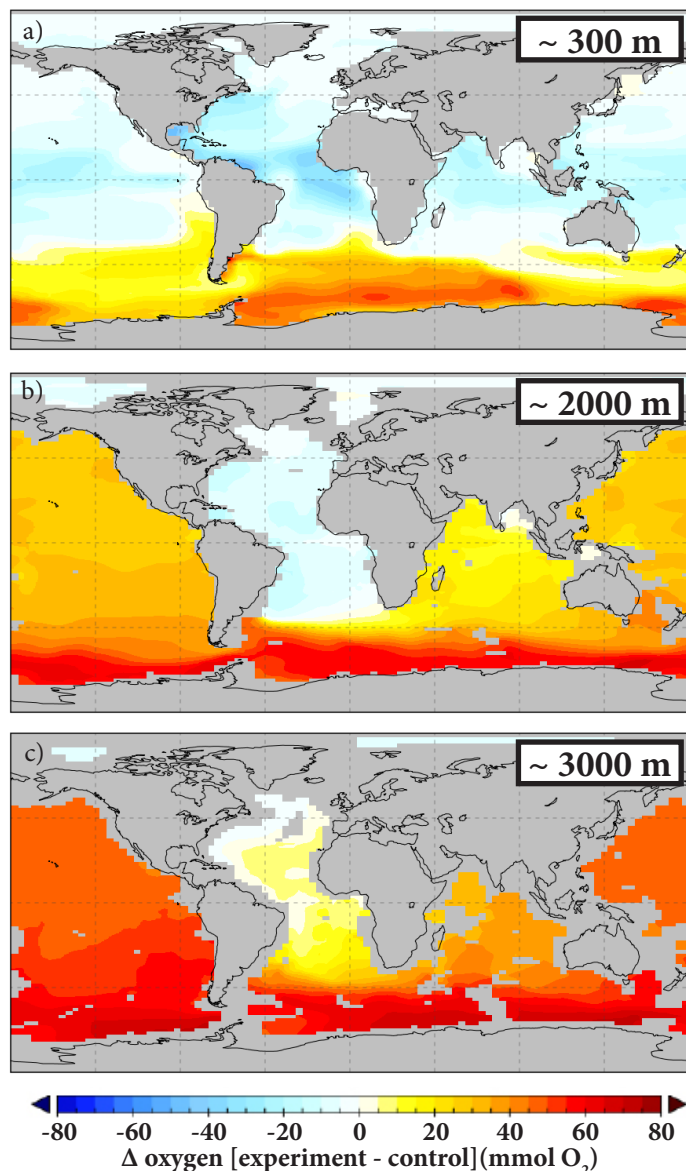


Figure S5. Steady-state annual differences (experiment minus control) in oxygen at ~ 300 m, 2000 m, and 3000 m for the UVic simulation.

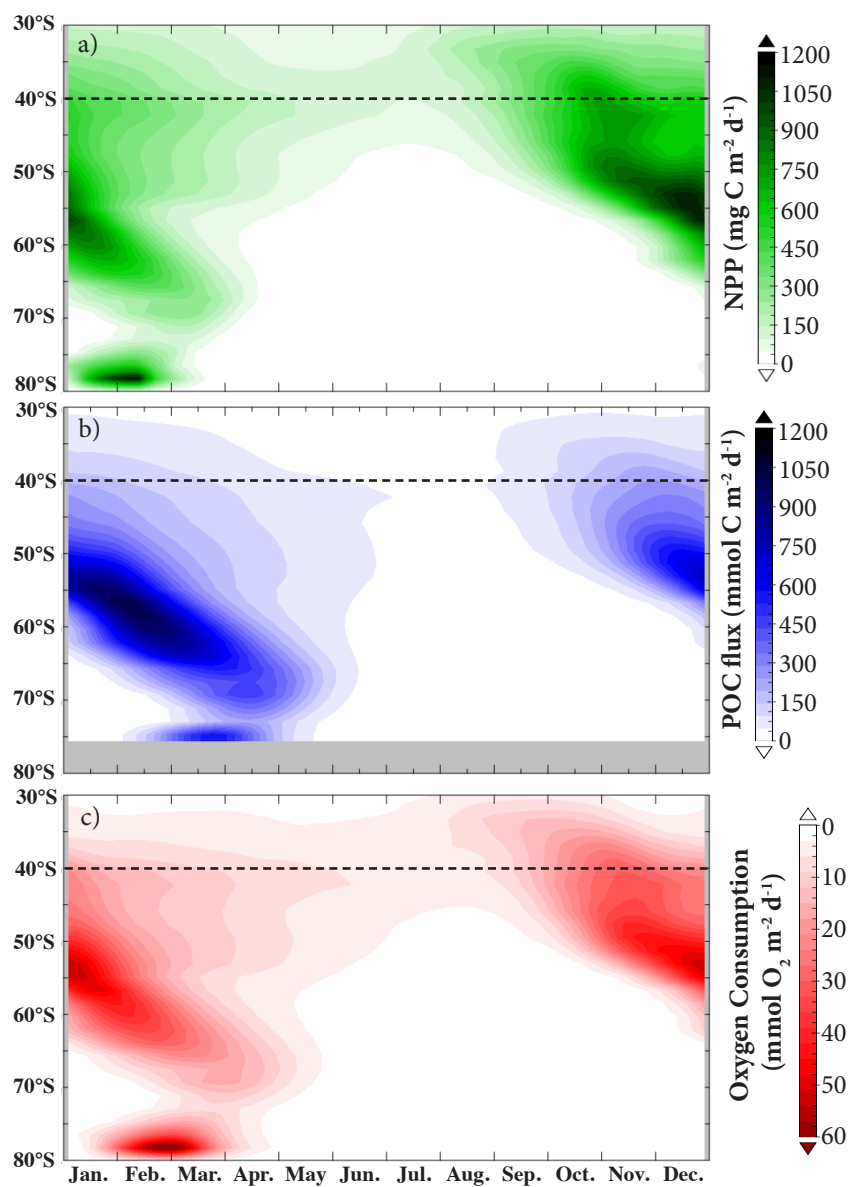


Figure S6. Zonally averaged Hövmoller plots of control run steady-state seasonal (a) net primary productivity, (b) particulate organic carbon flux at ~2000 m, and (c) the biological consumption of oxygen from 50 to 5000 m.

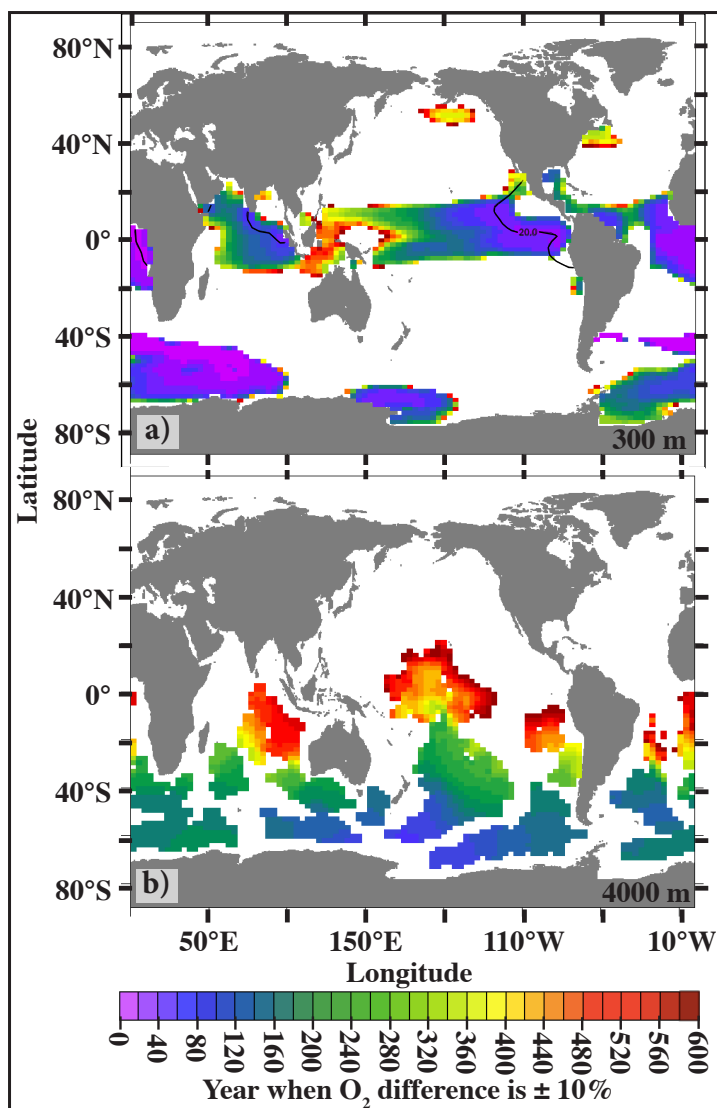


Figure S7. The year when oxygen first changes (experiment minus control) by  $\pm 10\%$  at (a) 300 m and (b) 4000 m. The black contour line in (a) indicates where oxygen equals 20 mmol m<sup>-3</sup> in the control run. White regions in a and b indicate that either oxygen changes are less than  $\pm 10\%$  or that bathymetry is shallower than the depth level.

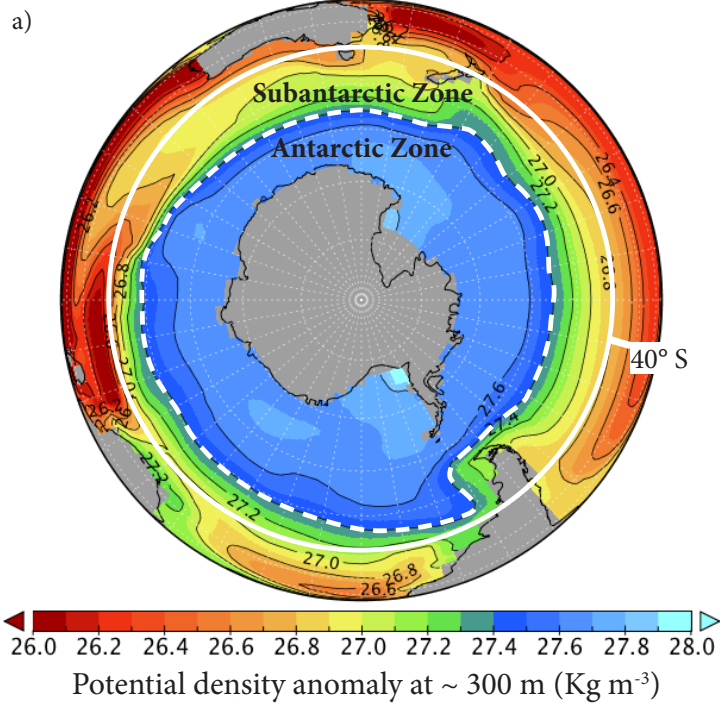
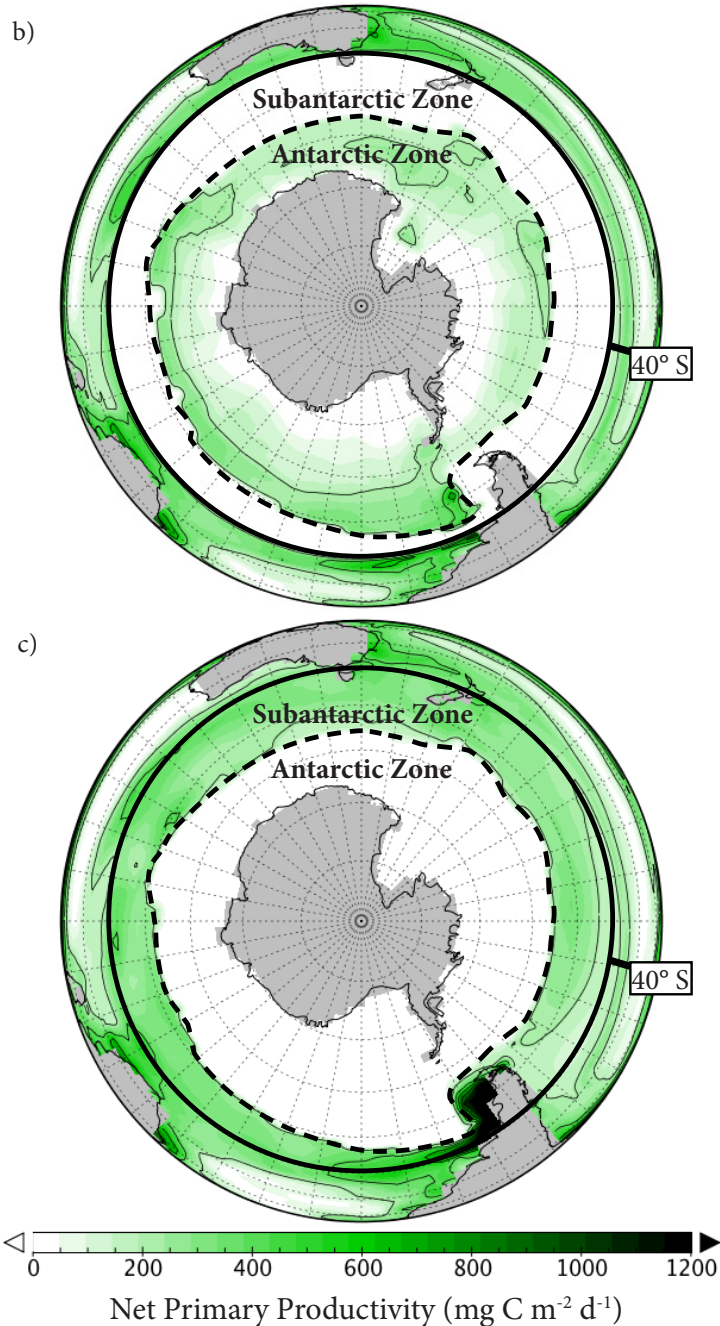


Figure S8. The Southern hemisphere annual mean potential density anomaly in the UVic model at ~300 m (a) that is used to separate (at  $27.4 \text{ Kg m}^{-3}$ ) the Southern Ocean into Subantarctic and Antarctic regions for experiments where biology is separately shut off in each. Net primary productivity when biology is shut off in the Subantarctic zone (b) and the Antarctic zone (c).



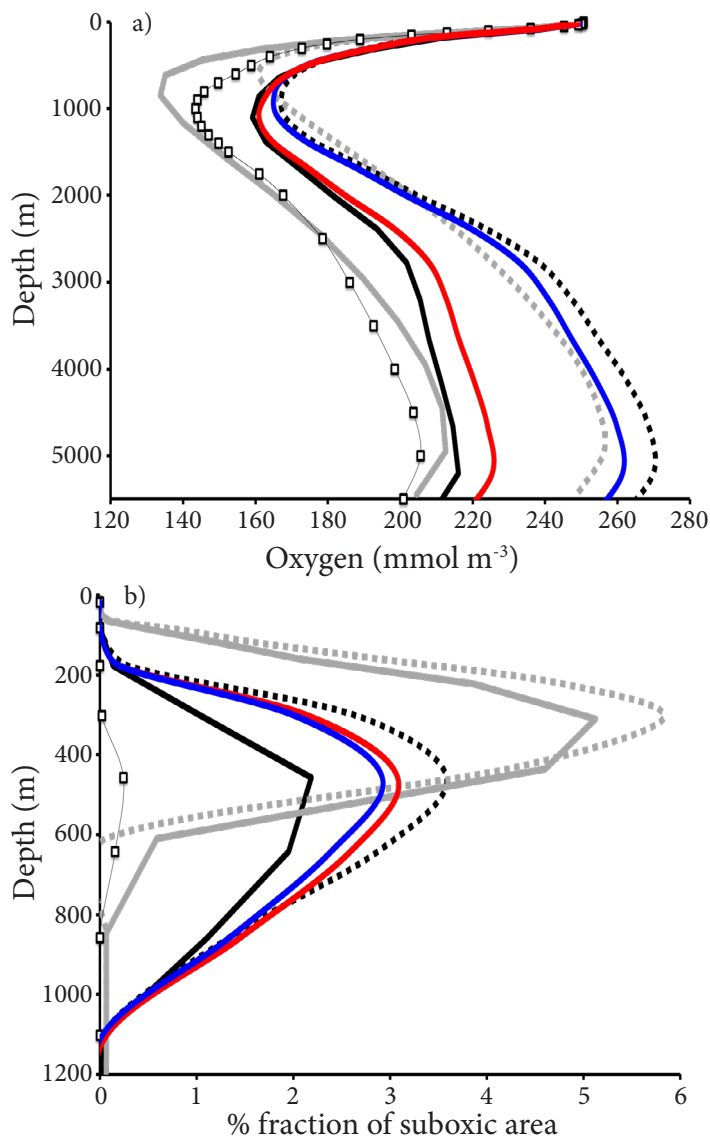


Figure S9. Steady-state annually averaged global (a) oxygen concentrations and (b) percent fraction of the ocean that is suboxic for the standard (i.e., control) UVic (black lines) and ECCO-BUR (grey lines) simulations, the experiments with no Southern Ocean biology (UVic – black square dots, ECCO-BUR – grey square dots), and the UVic experiments with no biology in the Subantarctic (red lines) and Antarctic (blue lines) portions of the Southern Ocean. World Ocean Atlas 2009 (WOA09) data is also shown (open square symbols).

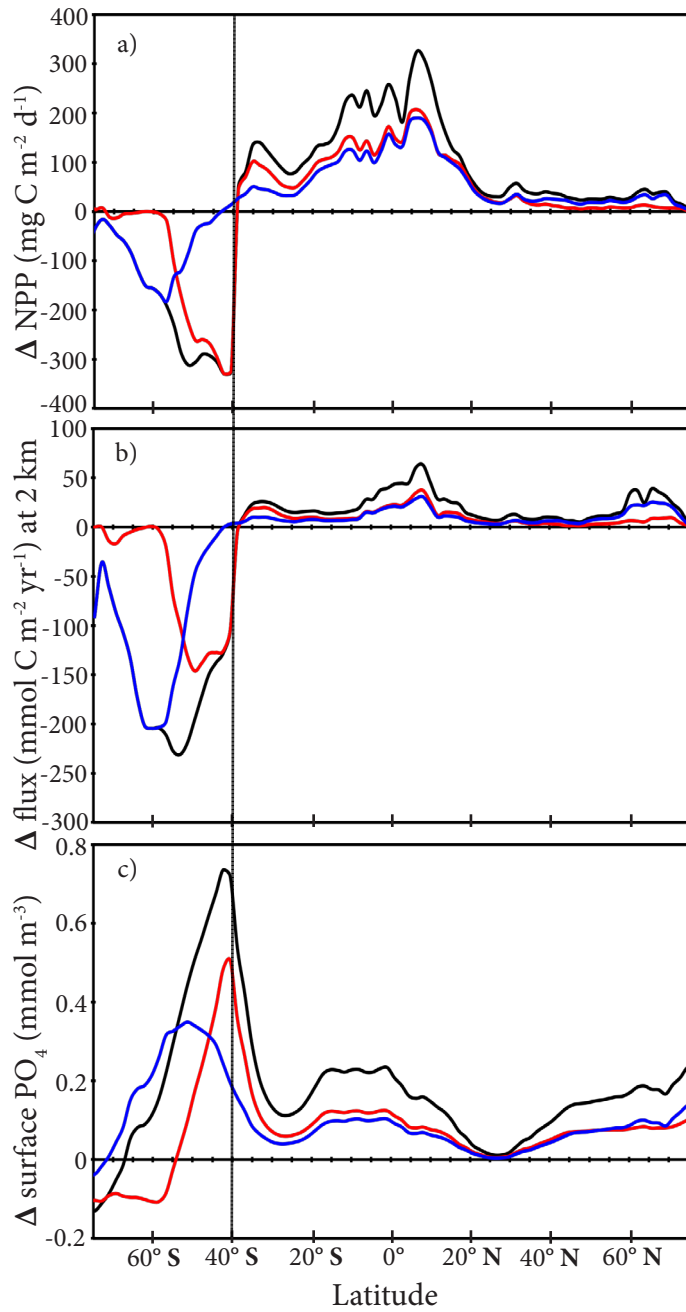


Figure S10. Steady-state annual zonally averaged differences (experiment minus control) in (a) depth-integrated net primary productivity (NPP) (b) particulate organic carbon flux at 2000 m and (c) the average surface  $\text{PO}_4$  concentration for UVic simulations with no biology in the whole Southern Ocean (solid black lines), only the Antarctic region (blue lines), or only the sub-Antarctic region (red lines).