

1 **Enhanced hydrological cycle increases ocean heat uptake and moderates**
2 **transient climate sensitivity**

3 Maofeng Liu^{1*}, Gabriel Vecchi^{2,3}, Brian Soden¹, Wenchang Yang², Bosong Zhang¹

4 ¹Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL

5 ²Department of Geosciences, Princeton University, Princeton, NJ

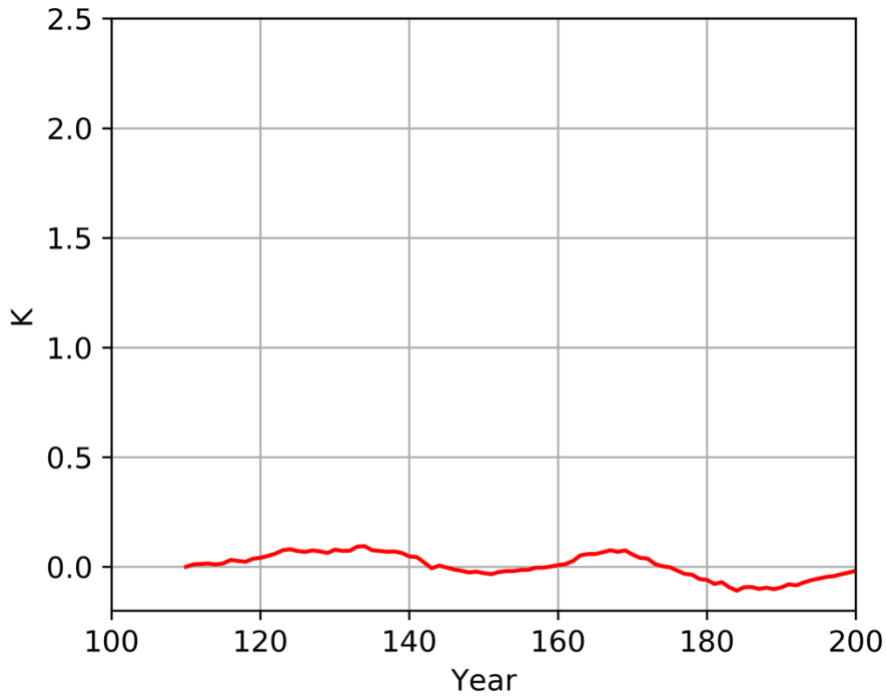
6 ³Princeton Environmental Institute, Princeton University, Princeton, NJ

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9 *Corresponding Author: Maofeng Liu (mx11744@miami.rsmas.edu; maofengliu2012@gmail.com)

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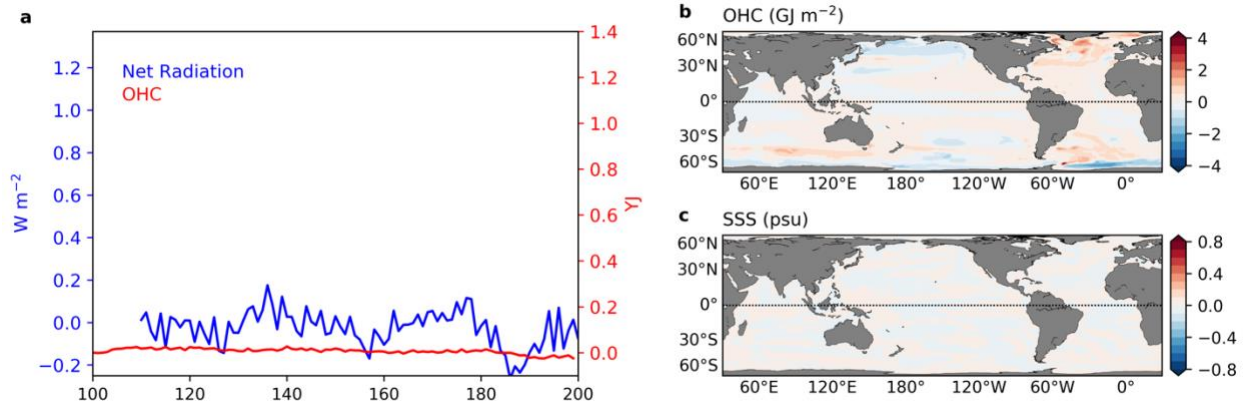


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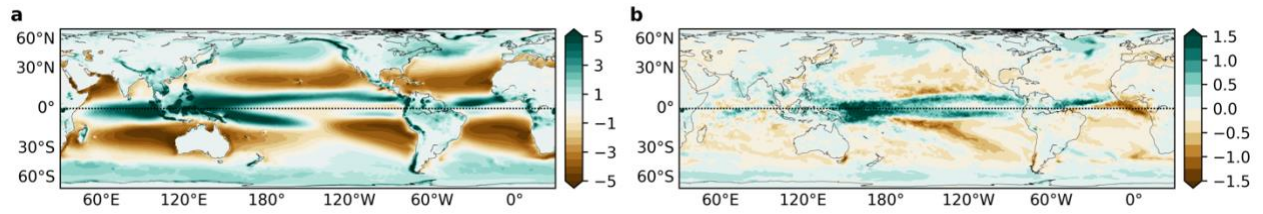
13 Supplementary Fig. 1. Time series of difference in global mean surface temperature (K) between
14 the control run of the STD and fixed-SSS-GL version. Data are plotted as 20-year running mean.

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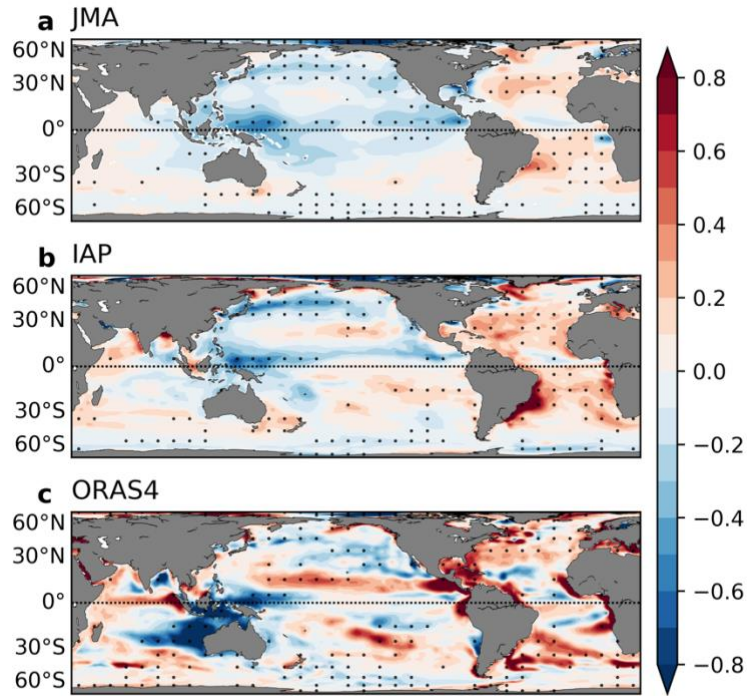
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 18 Supplementary Fig. 2. **a.** Time series of difference in global-mean the top-of-atmosphere net
 19 radiation (blue) and global-total ocean heat content change (OHC; red) between the control run
 20 of the STD and fixed-SSS-GL version. **b.** Difference in OHC climatology (GJ m^{-2} or 10^9 J m^{-2})
 21 between the STD and fixed-SSS-GL version from the 100-year control run. **c.** the same as **b.**
 22 for SSS (psu).
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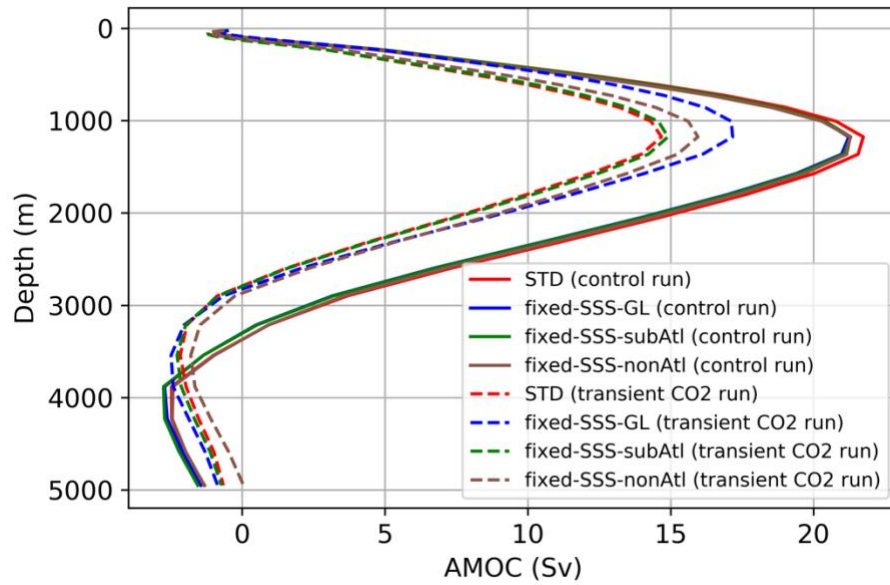
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25 Supplementary Fig. 3. **a.** The climatology of P-E (mm day⁻¹) from the STD version from the
26 100-year control run. **b.** Change in P-E in response to the transient CO₂ increase for the STD
27 version.
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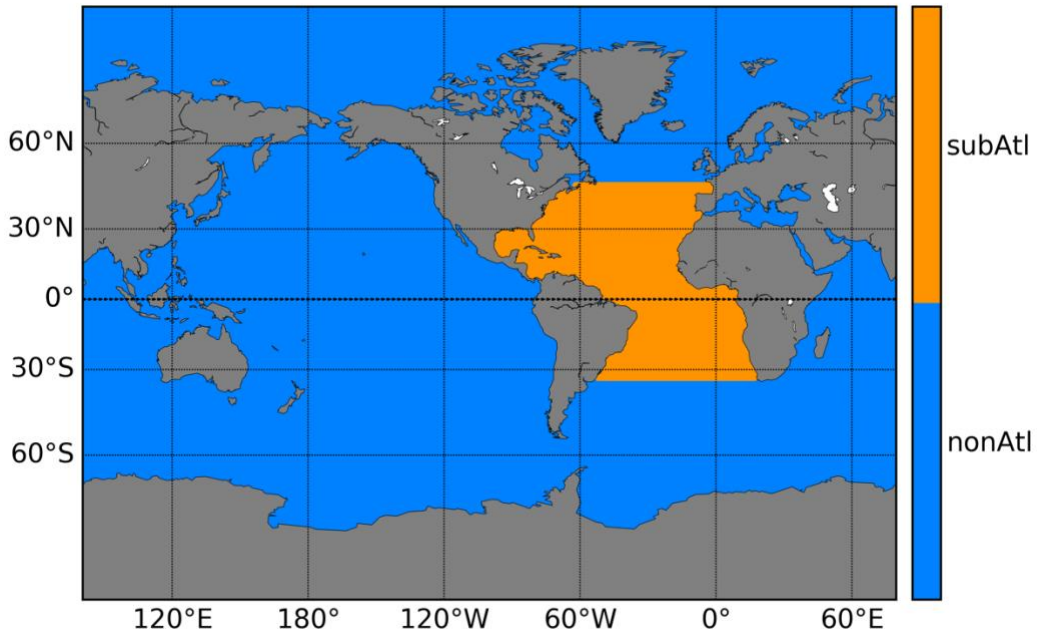
Supplementary Fig. 4. **a**. The linear trend (psu/50yr) of sea surface salinity over the period of 1968-2017 from **a** JMA, **b** IAP, and **c** ORAS4 data. The trend is tuned by the ratio of CO₂ concentration at CO₂ doubling in FLOR to that in 2017 from observations. The area with statistical significance ($p < 0.05$) is stippled.

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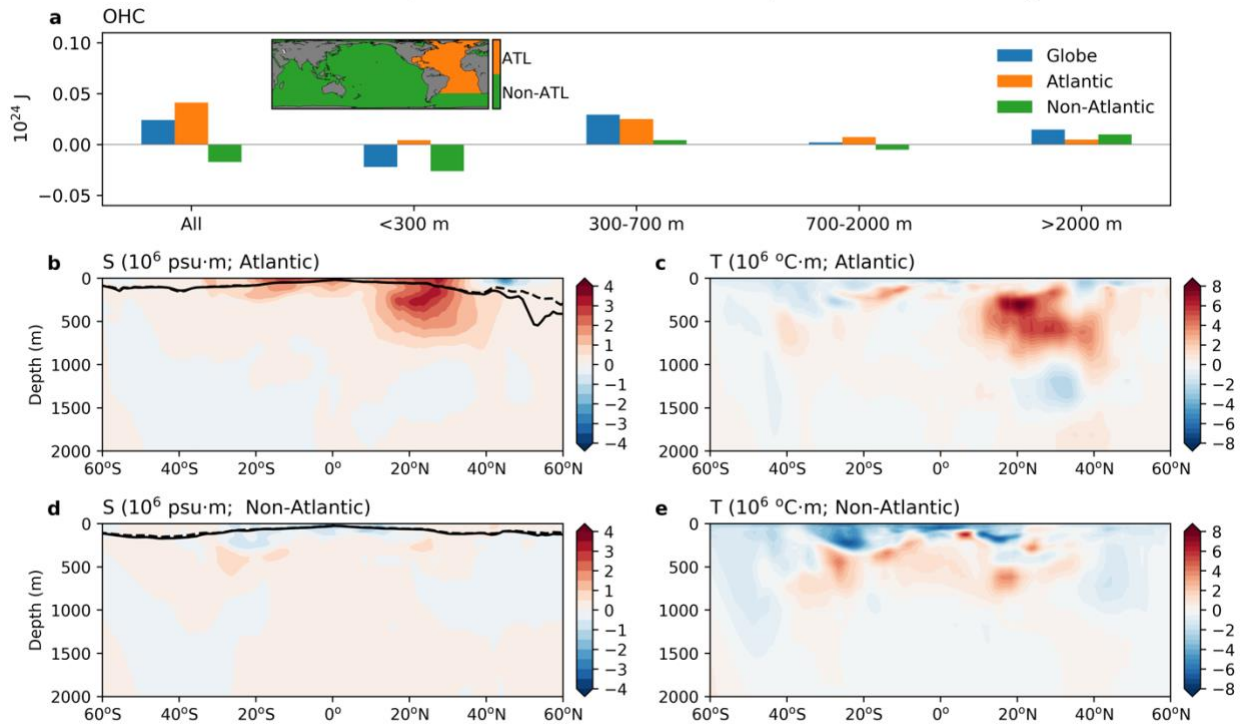
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Supplementary Fig. 5. The streamfunction of AMOC (Sv) as a function of depth at 40°N for all FLOR runs. The control runs use model year 101-200 while the transient CO₂ runs use model years 161-180 centered on the year with CO₂ doubling (year 170).



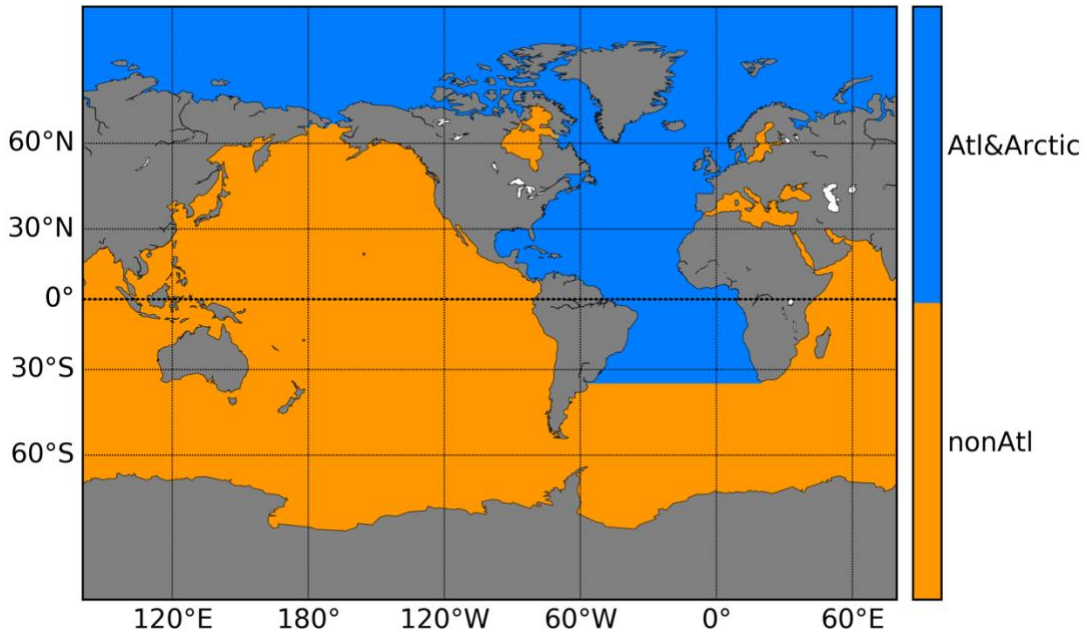
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42 Supplementary Fig. 6. The subtropical Atlantic Ocean (masked in orange) used for the fixed-
43 SSS-subAtl experiment.
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The impact of fixed SSS in model response to CO2 doubling



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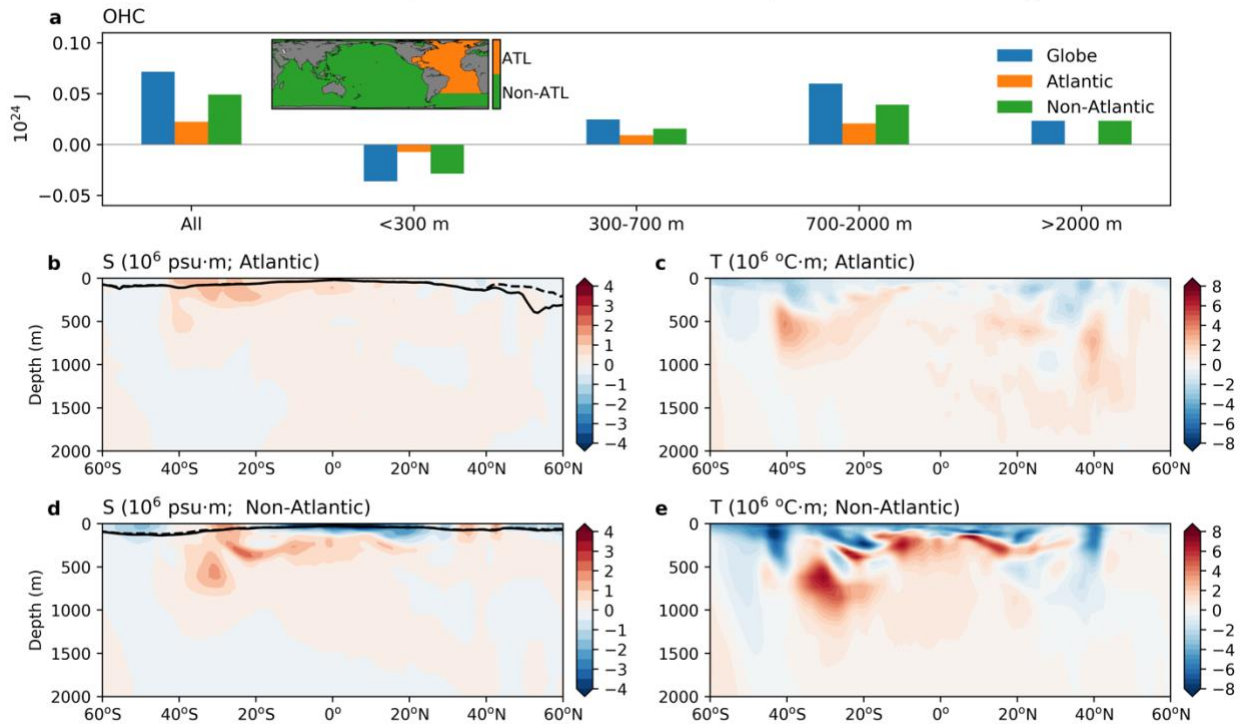
Supplementary Fig. 7. As in Fig. 3, but using the FLOR experiments with fixed SSS in the subtropical Atlantic as indicated in Supplementary Fig. 6 (the fixed-SSS-subAtl version).



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Supplementary Fig. 8. The non-Atlantic Oceans (masked in orange) used for the fixed-SSS-nonAtl experiment.

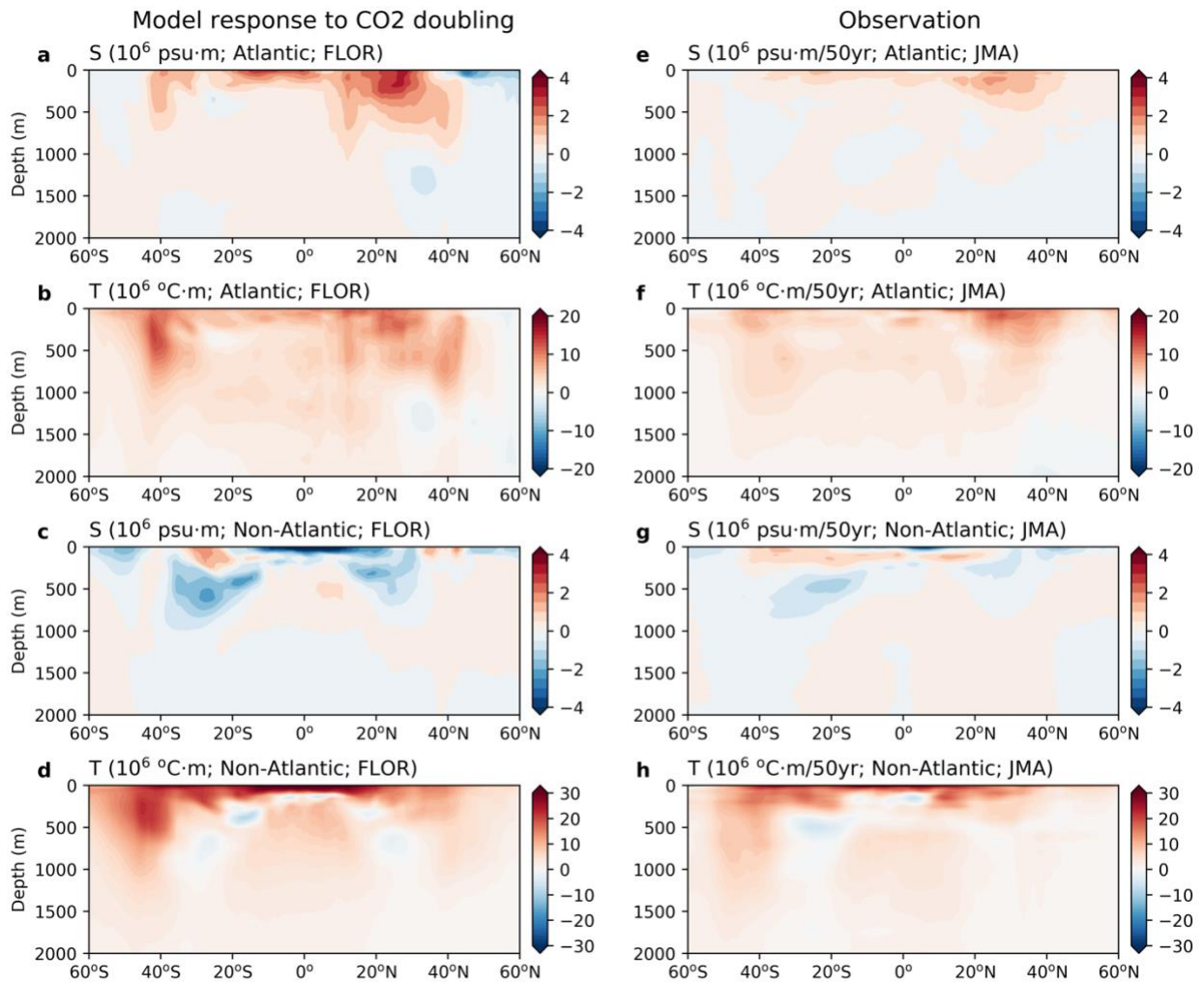
The impact of fixed SSS in model response to CO2 doubling



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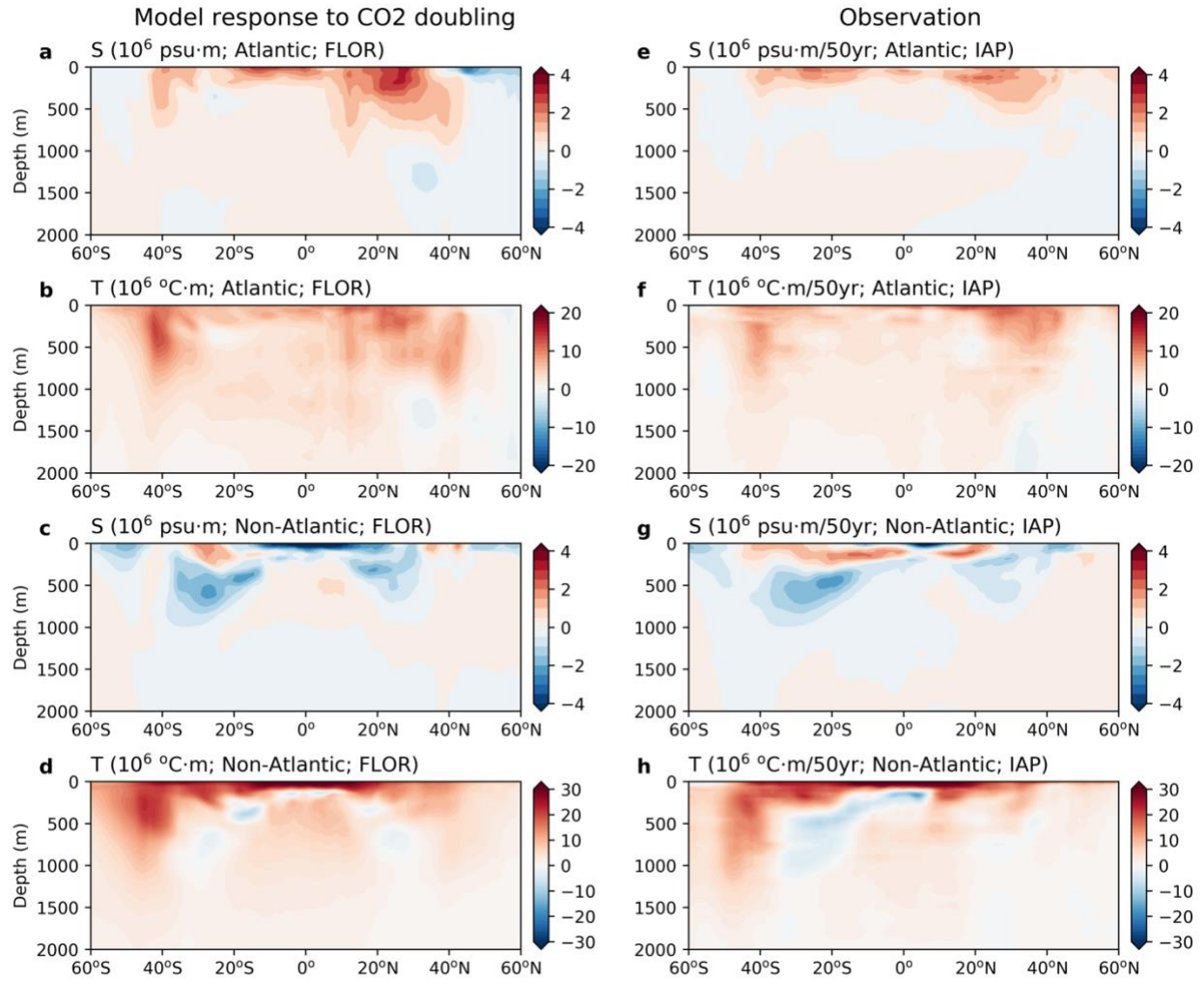
Supplementary Fig. 9. As in Fig. 3, but using the FLOR experiments with fixed SSS in the non-Atlantic as indicated in Supplementary Fig. 8 (the fixed-SSS-nonAtl version).

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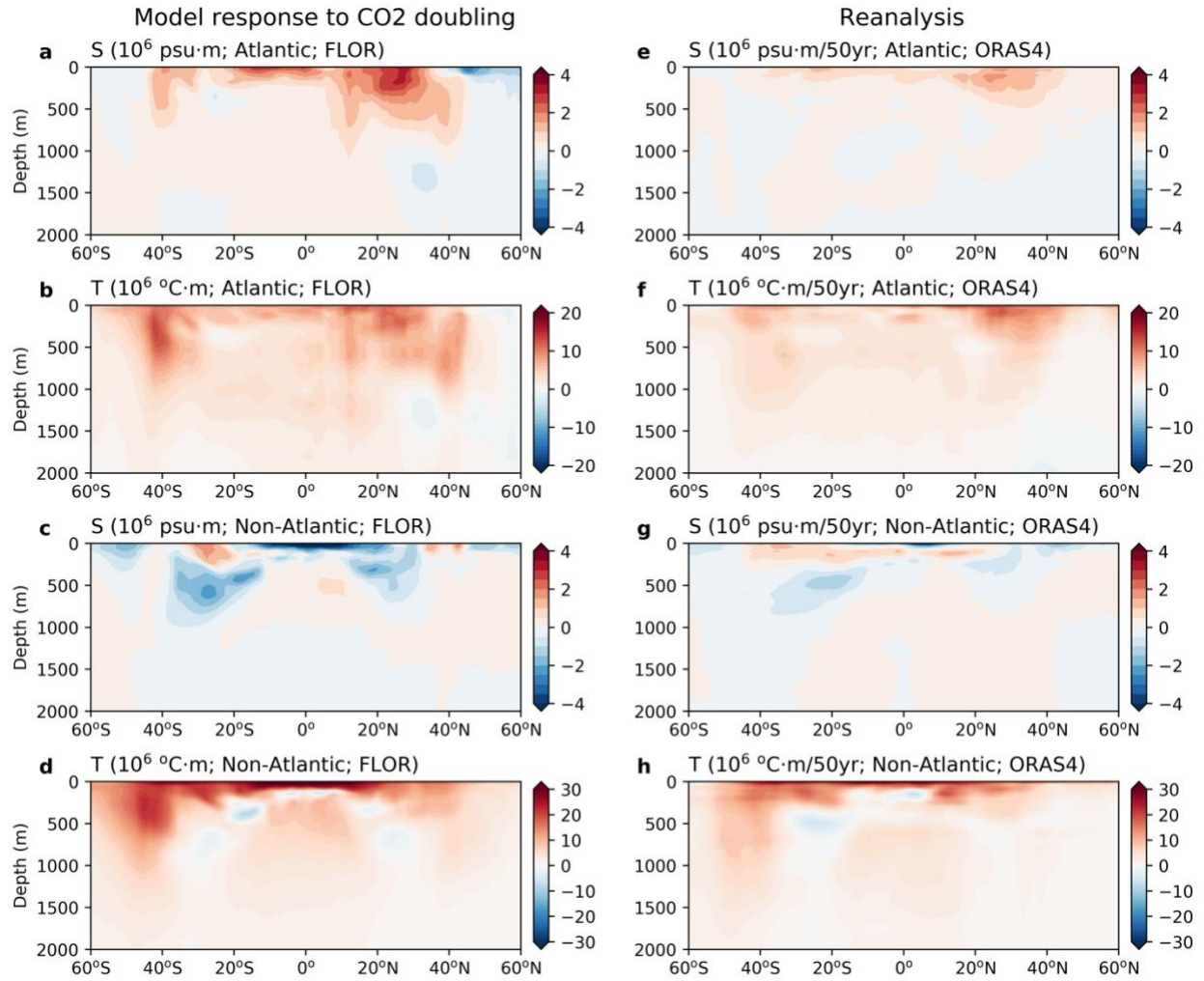
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Supplementary Fig. 10. As in Fig. 4, but using JMA data.



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Supplementary Fig. 11. As in Fig. 4, but using IAP data.



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Supplementary Fig. 12. As in Fig. 4, but using ORAS4 data.