



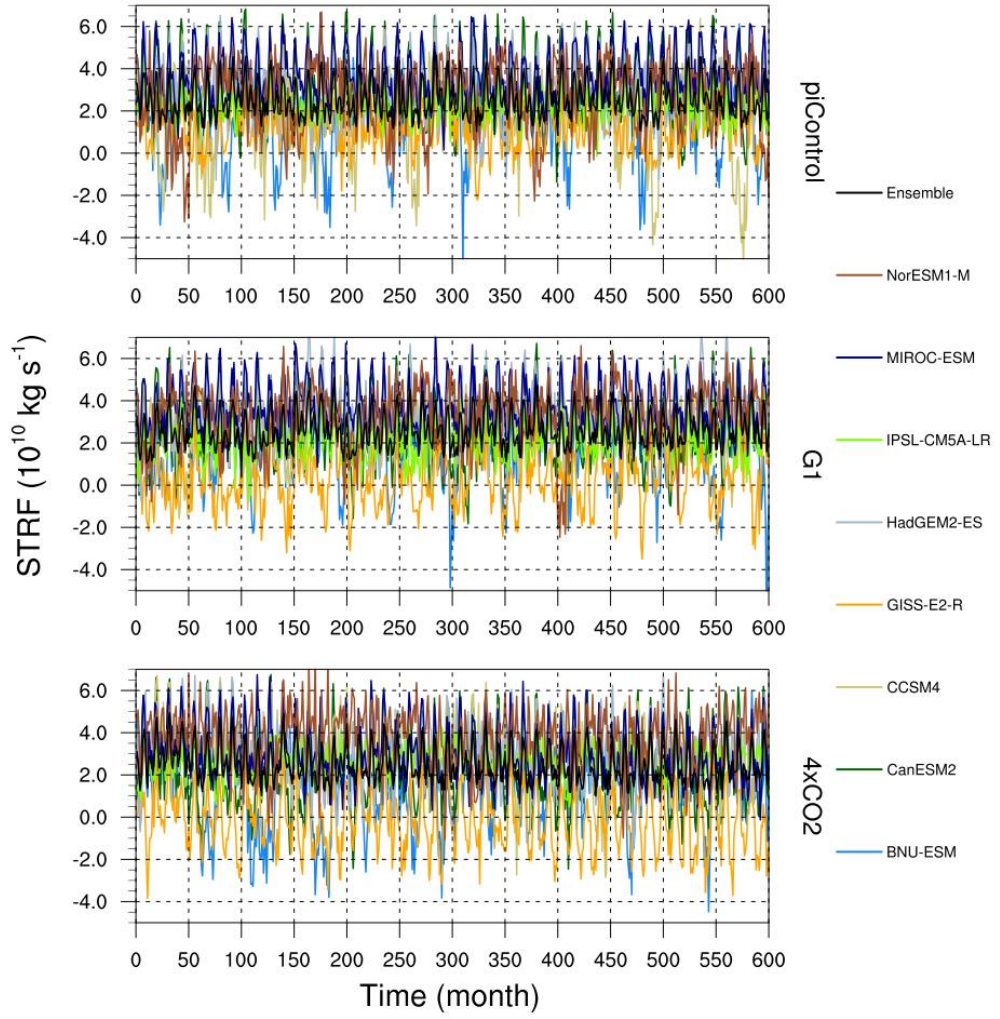
Supplement of

Tropical atmospheric circulation response to the G1 sunshade geoengineering radiative forcing experiment

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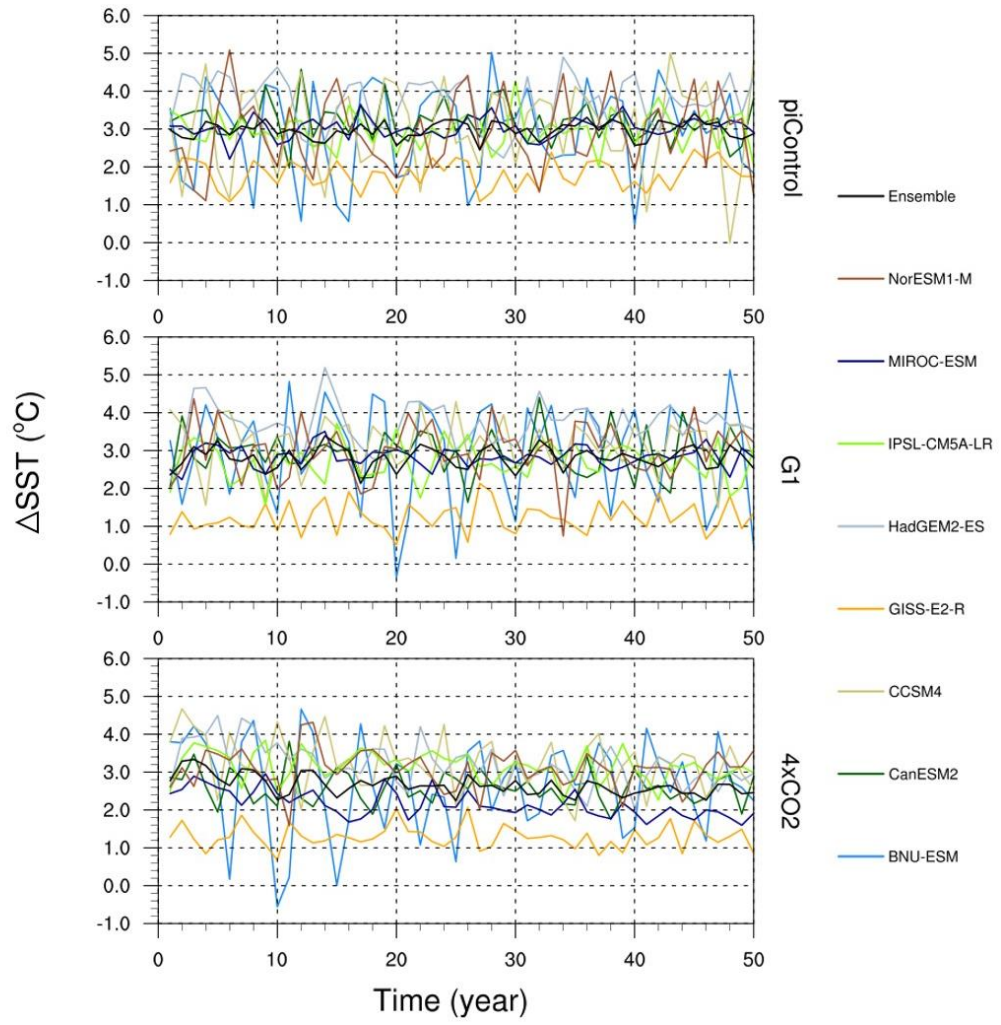
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2 **Figure S1.** Time series of the monthly Walker circulation intensity based on the STRF
3 index, that is the vertically averaged value of the stream function ψ_z over the western
4 and central Pacific ($150^\circ\text{E} - 150^\circ\text{W}$), and between 1000 – 100 hPa ($10^{10} \text{ kg s}^{-1}$).
5 Different colored lines represent different models. Note the lack of obvious transients
6 at the start of the simulations. Some models (BNU-ESM, CanESM2, GISS-E2-R,
7 MIROC-ESM, HadGEM2-ES) have strong annual variability in STRF, while others
8 show weak seasonality (CCSM4, NorESM1-M, IPSL-CM5A-LR).

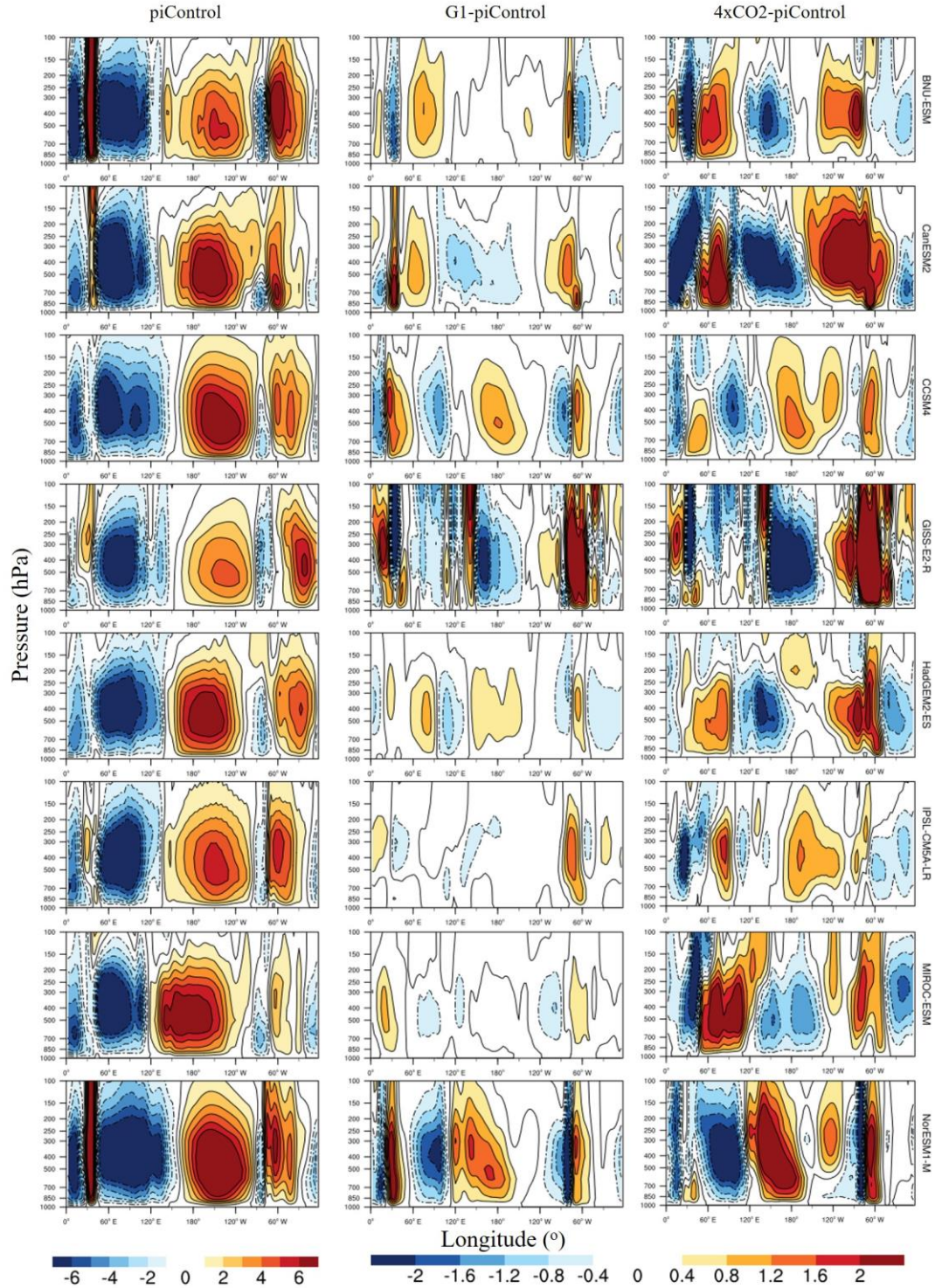
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11 **Figure S2.** Time series of the annual Walker circulation intensity indices based on the

12 ΔSST index. Different colored lines represent different models.



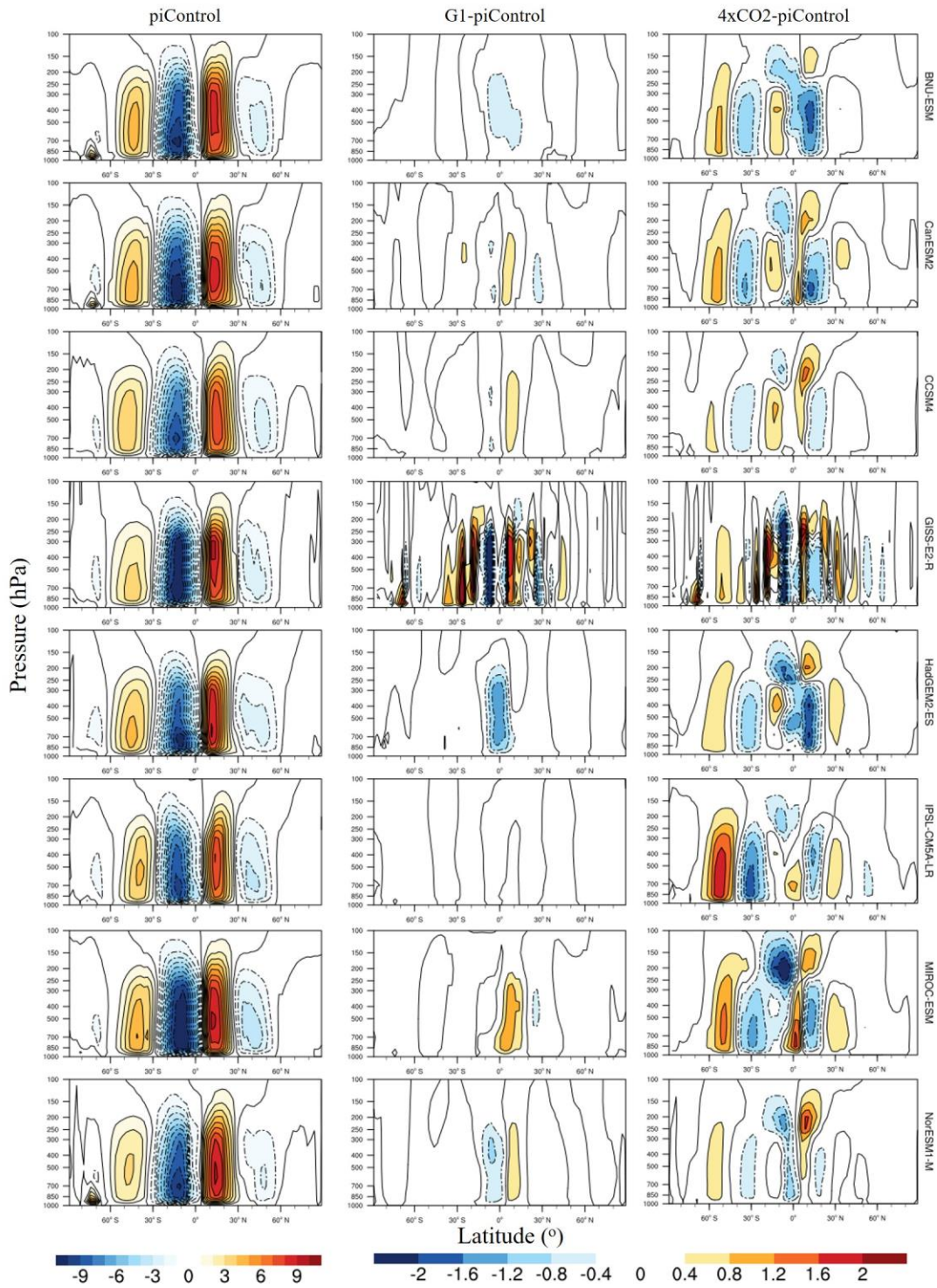
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14 **Figure S3.** The mean state of Walker circulation in three experiments for the 8
 15 models. Color bar indicates the value of averaged zonal mass stream-function (10^{10} kg
 16 s^{-1}). Left shows piControl, while center and right column respectively indicate the
 17 anomalies relative to piControl for G1 and abrupt4 \times CO $_2$ experiments. Warm color

18 (positive values) indicate a clockwise rotation and cold color (negative values)

19 indicate an anticlockwise rotation.

20



21

22 **Figure S4.** The mean state of Hadley circulation during 50 years in three experiments

for the 8 models. Color bar indicates the value of averaged meridional mass stream-function ($10^{10} \text{ kg s}^{-1}$). Left shows piControl, while center and right column respectively indicate the anomalies relative to piControl for G1 and abrupt4 $\times\text{CO}_2$ experiments. Warm color (positive values) indicate a clockwise rotation and cold color (negative values) indicate an anticlockwise rotation.

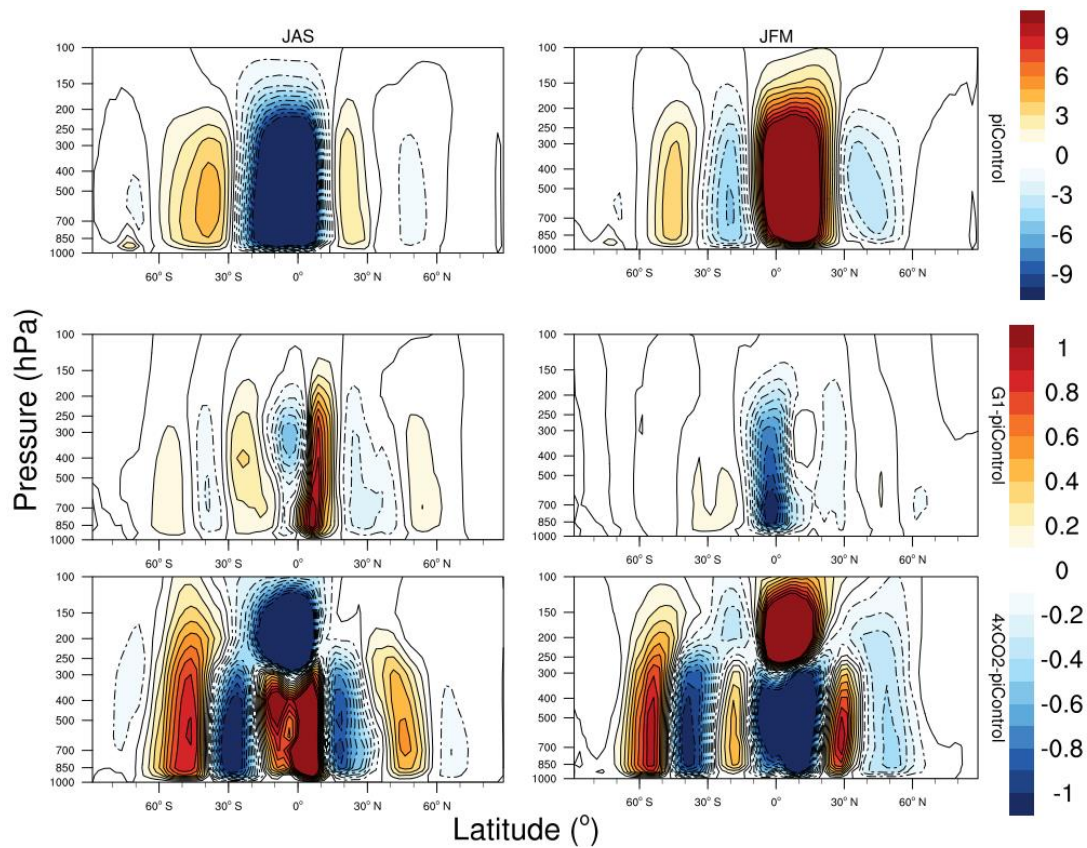
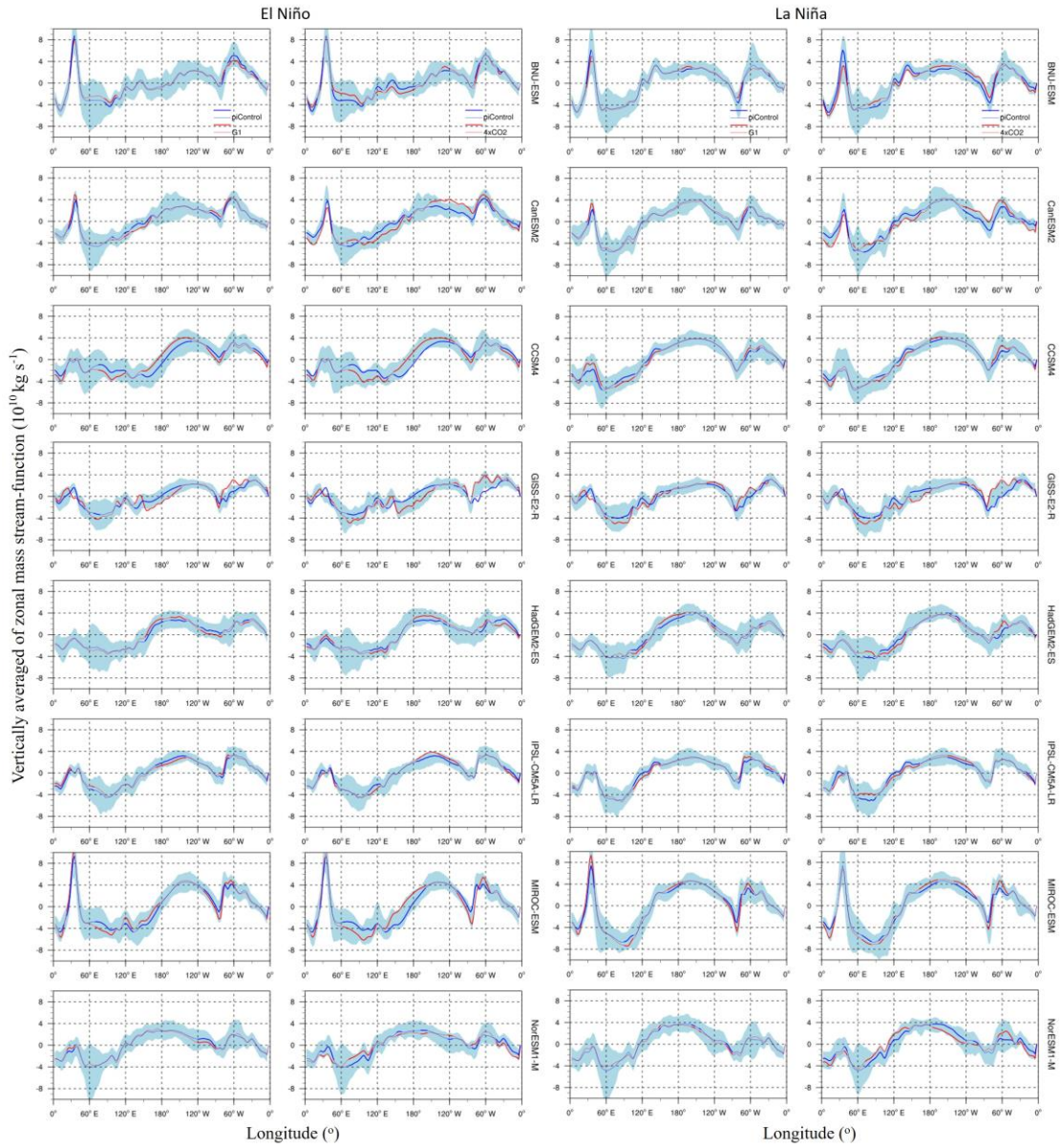
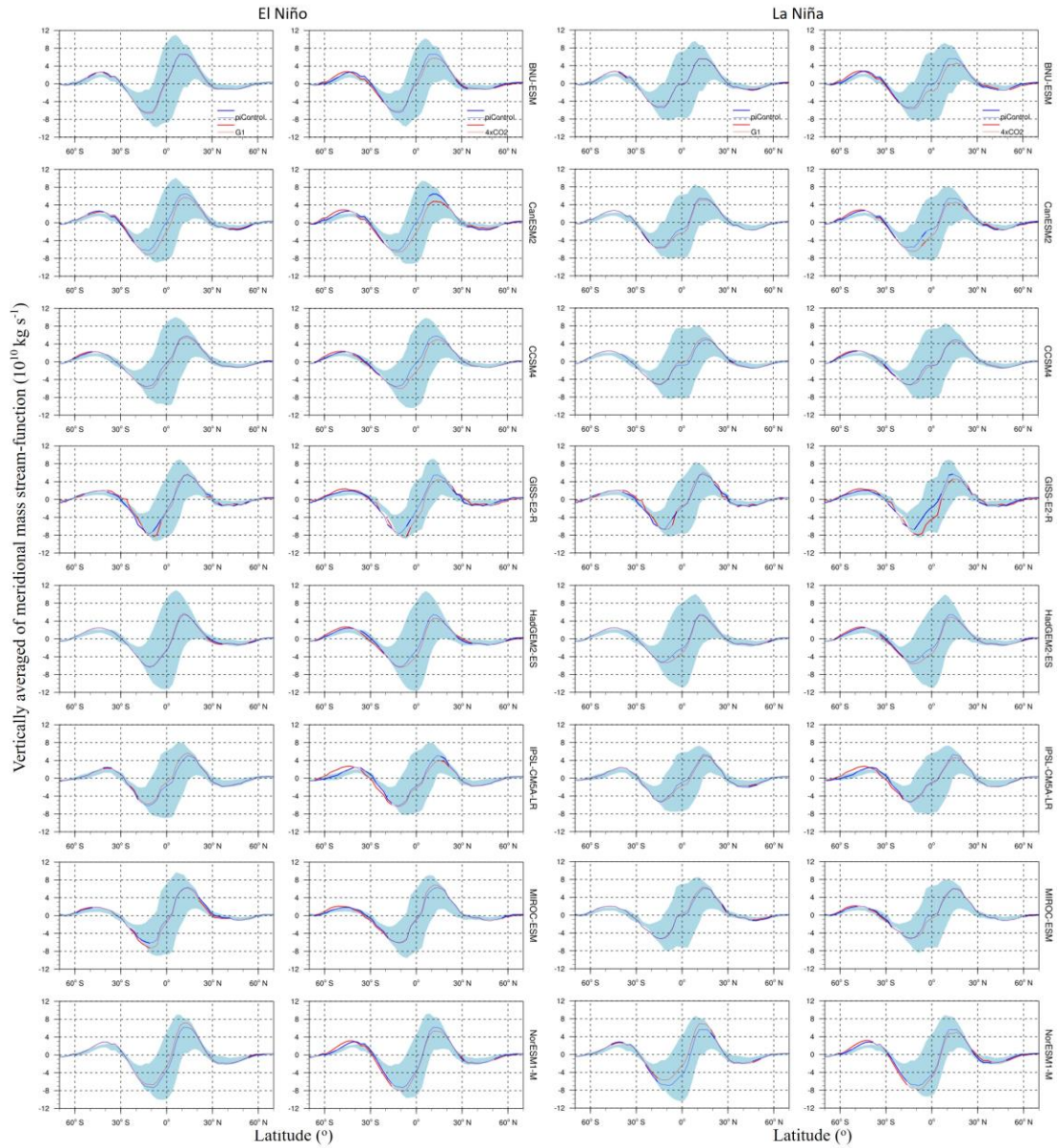


Figure S5. Model ensemble mean meridional stream-function without GISS-E2-R in JAS (left) and JFM (right). Top shows piControl, while center and bottom row respectively indicate the anomalies relative to piControl for G1 and abrupt4 $\times\text{CO}_2$ experiments. Color bar indicates the value of averaged meridional mass stream-function ($10^{10} \text{ kg s}^{-1}$). Warm colors (positive values) indicate a clockwise rotation and cold colors (negative values) indicate an anticlockwise rotation.



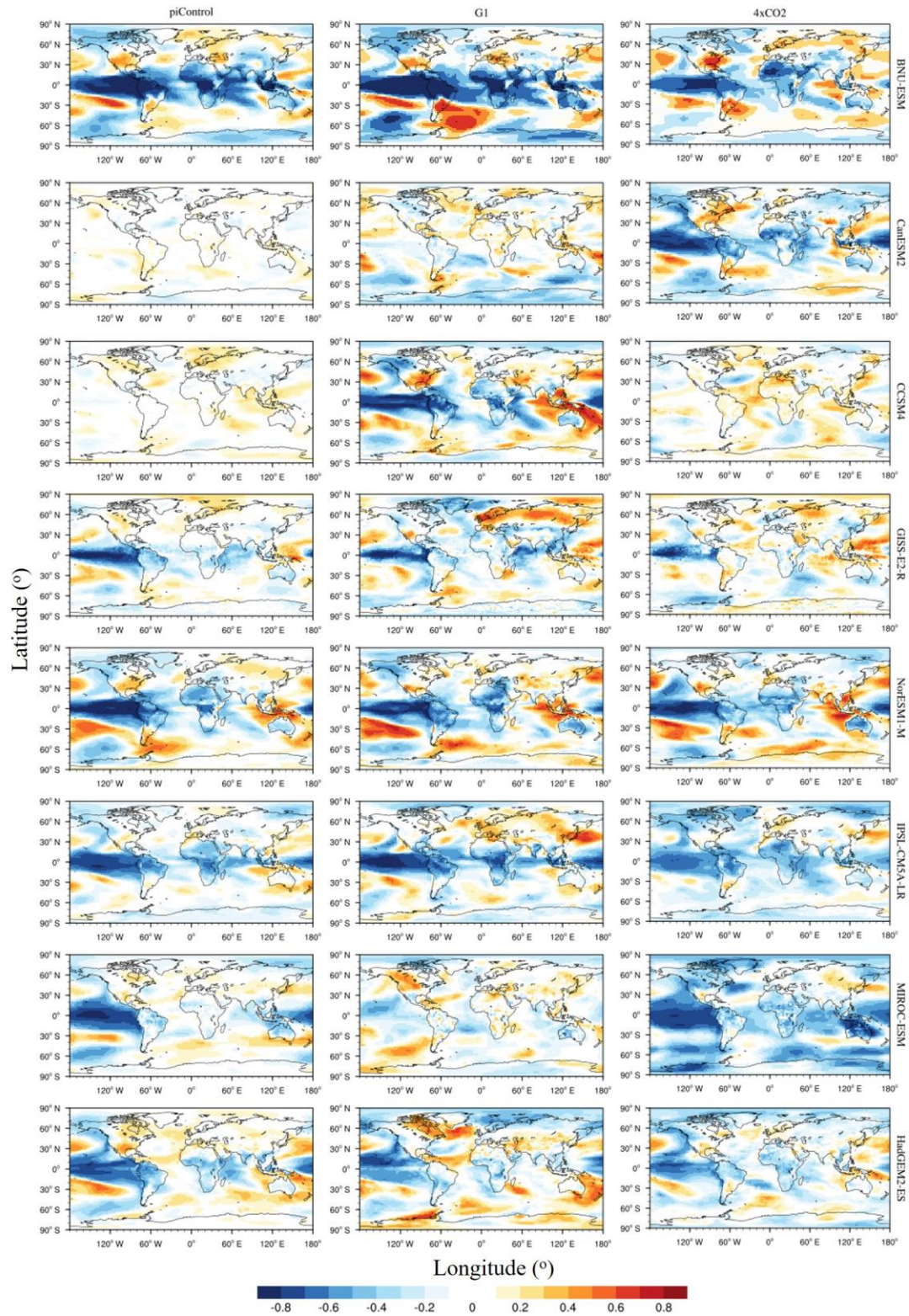
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Figure S6. The vertically averaged of zonal mass stream-function under ENSO. For El Niño or La Niña conditions, blue line in each panel represent the vertically averaged of zonal mass stream-function ($10^{10} \text{ kg s}^{-1}$) under piControl. Red line in left two column is G1 and right two column abrupt4xCO₂. Thick lines denote locations where circulation changes are significant at the 95% confidence level. The 16%-84% range across the 8 individual models are show by light blue shading.



46 **Figure S7.** The vertically averaged of meridional mass stream-function under ENSO.

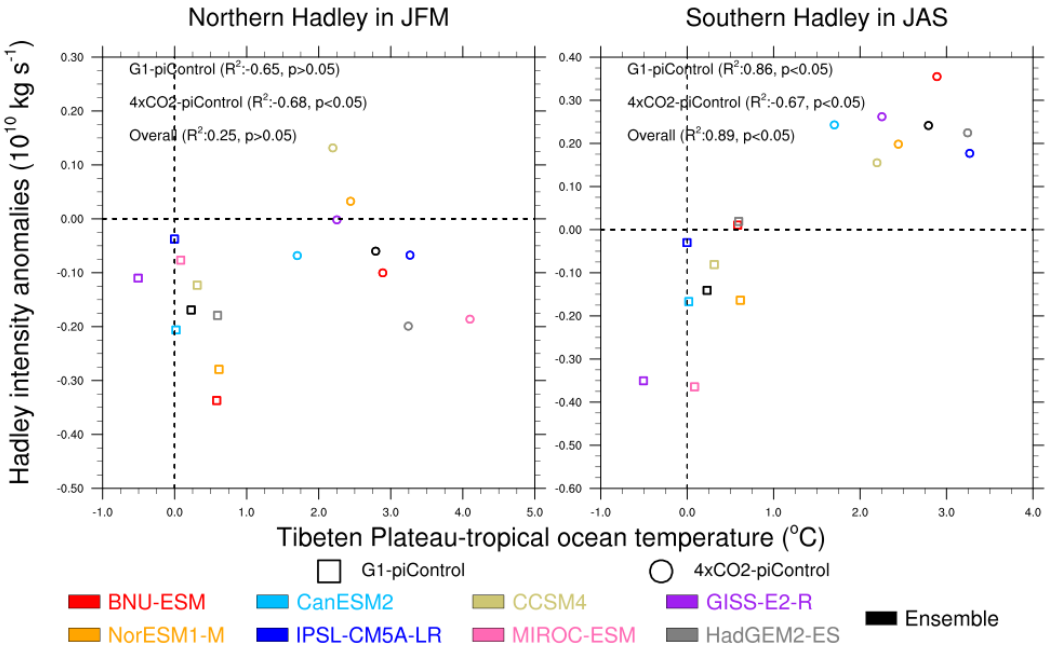
47 For El Niño or La Niña conditions, blue line in each panel represent the vertically
 48 averaged of zonal mass stream-function ($10^{10} \text{ kg s}^{-1}$) under piControl. Red line in left
 49 two column is G1 and right two column abrupt4 \times CO $_2$. Thick lines denote locations
 50 where circulation changes are significant at the 95% confidence level. The 16%-84%
 51 range across the 8 individual models are show by light blue shading.



54 **Figure S8.** Mean correlation between yearly STRF and global gridded 2 m
 55 temperatures for 100 years of piControl (left column), and 30 years of G1 (middle

56 column) and abrupt4×CO₂ (right column) experiments for 8 models.

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59 **Figure S9.** Hadley intensity mean model anomalies versus the Tibetan Plateau (26°N-
60 39°N, 73°E-104°E) minus tropical ocean (5°S-5°N, 180°W-180°E) temperature for the
61 northern Hadley cell (left) in JFM and the southern Hadley cell in JAS (right). Positive
62 value of Hadley intensity indicate Hadley circulation strengthening regardless of the
63 direction.

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