1   **Supplementary Material for**

2   **Transient Climate Sensitivity Depends on Base Climate Ocean Circulation**

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24   Here, we show the spin-up process in the control runs (Figure S1) and discuss the

25   potential impact of climate drift on the implication of our results.

26   Our 1pctCO2 runs are initialized at year 101, when the ocean is not yet well spun

27   up. This results in drifts in the ocean circulation in both 1860-start and 1990-start runs.

28   Figures S2 and S3 show that the circulation difference between the 1990 and 1860

29   control runs largely persist till year 900. This indicates that the difference in the base

30   climate, which results in the different transient climate sensitivity, is dominated by the

31   difference in CO_2 levels instead of the difference in their deviation from the steady state.

32   Therefore, our results are likely robust even with additional spin-up. To further

33   demonstrate this point, we conduct additional 1pctCO2 simulations at year 501 of each

34   control run. In these simulations, CO_2 increases till quadrupling and is then held fixed for

35   20 years. As shown in Figure S4, the 1990-start run still warms faster than the 1860-start

36   run. The warming difference primarily develops during the first 100 years and saturates at

37   about 0.5K, consistent with the simulations analyzed in the main text.
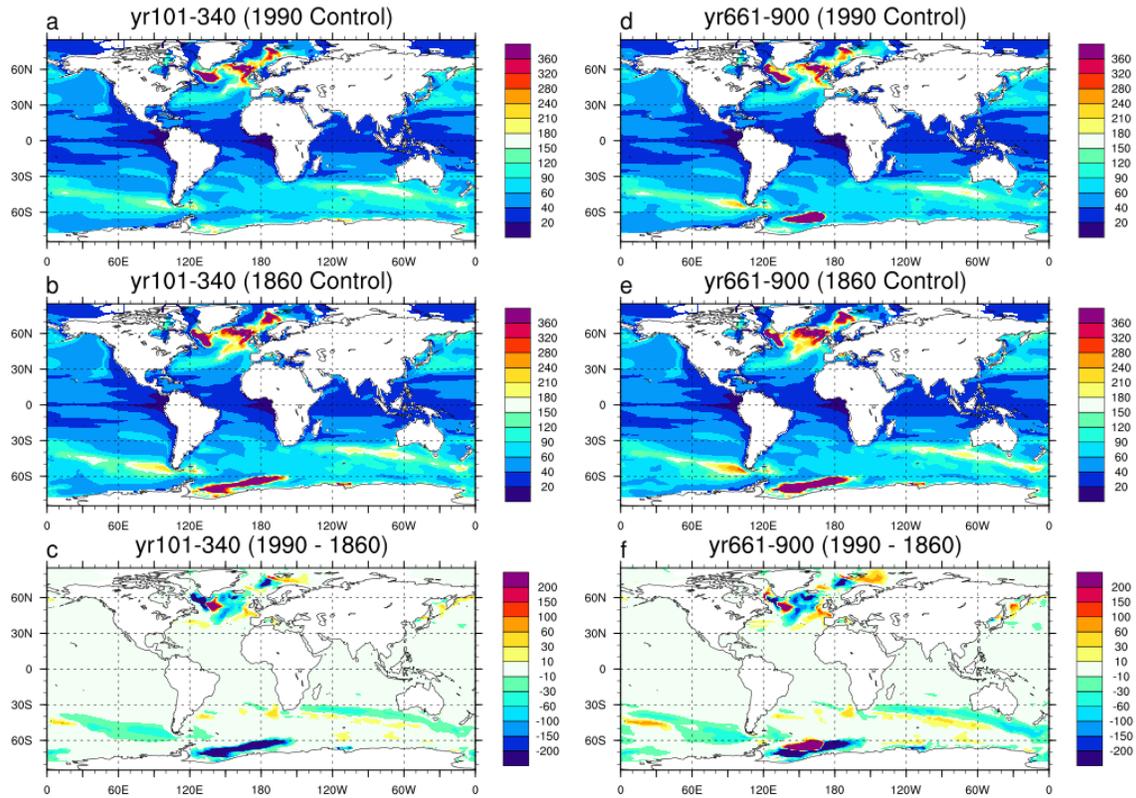
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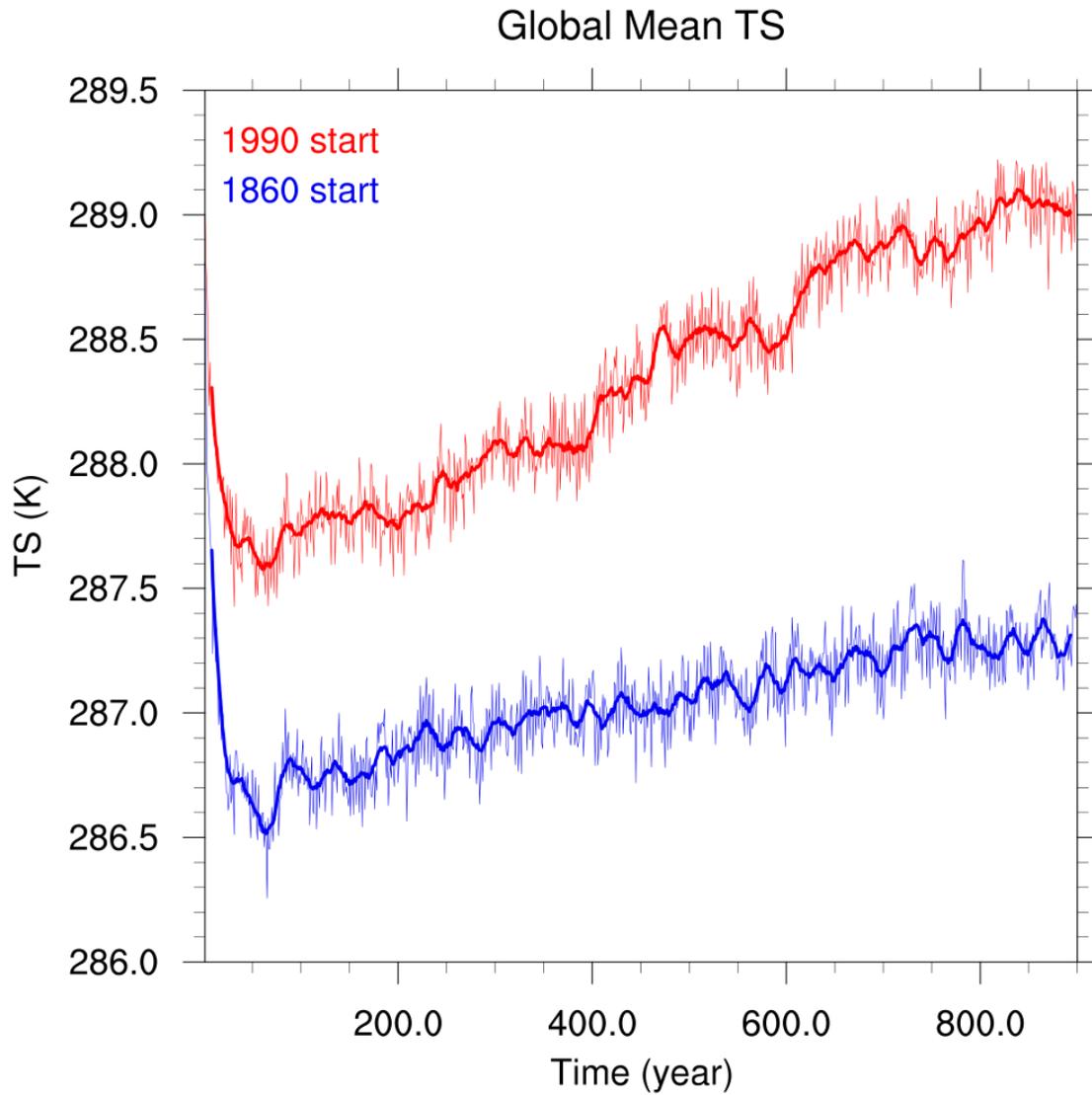
Global Mean TS

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41   Figure S1. Time series of global mean surface temperature from the 1860 and 1990

42   control runs. Thin lines show the annual mean changes, whereas thick lines show the 15

43   year running mean.
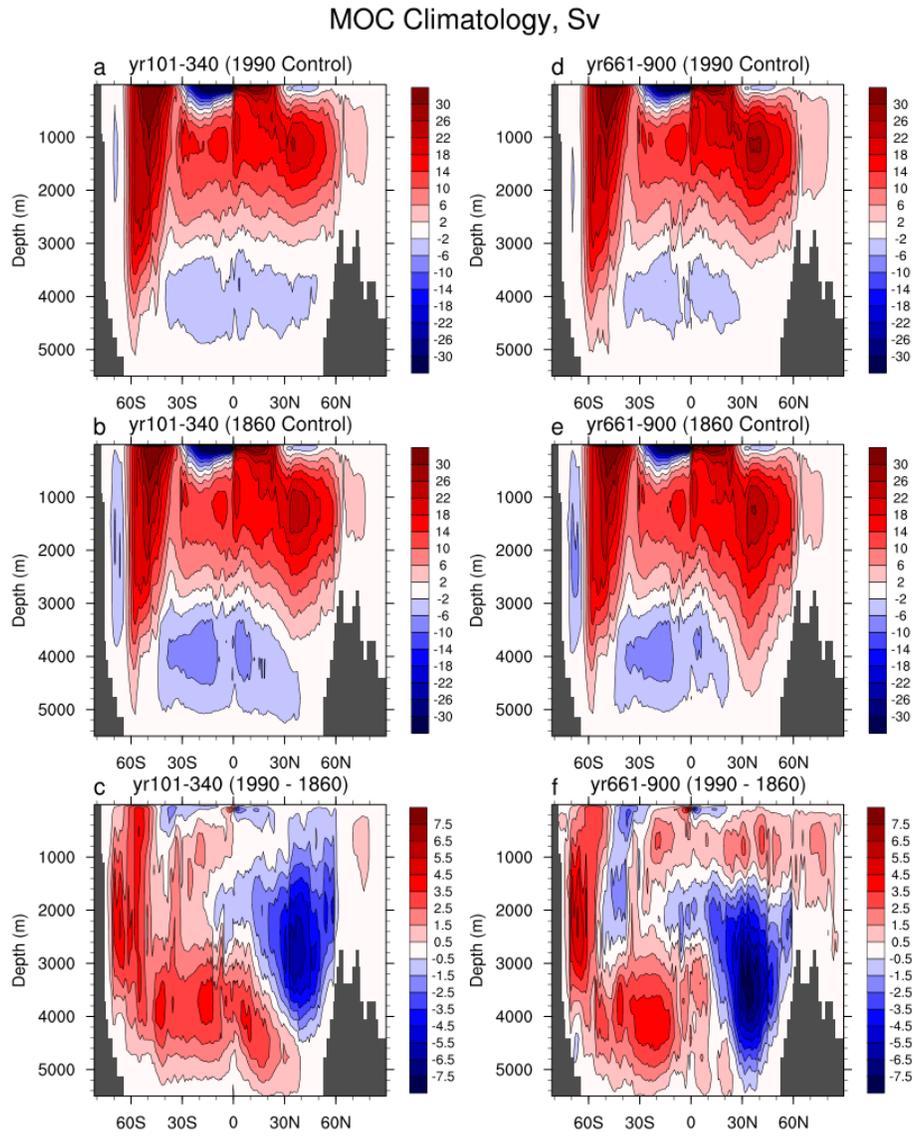
Mixed-layer depth Climatology, m

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45   Figure S2. Mixed-layer depth from the control runs averaged over year 101 to 340 (left

46   column) and year 661 to 900 (right column). Top and middle rows are results from the

47   1990-start and 1860-start runs, respectively. The bottom row is the difference between

48   the two.

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54   Figure S3. Same as Fig. S2, except for zonally integrated stream function.
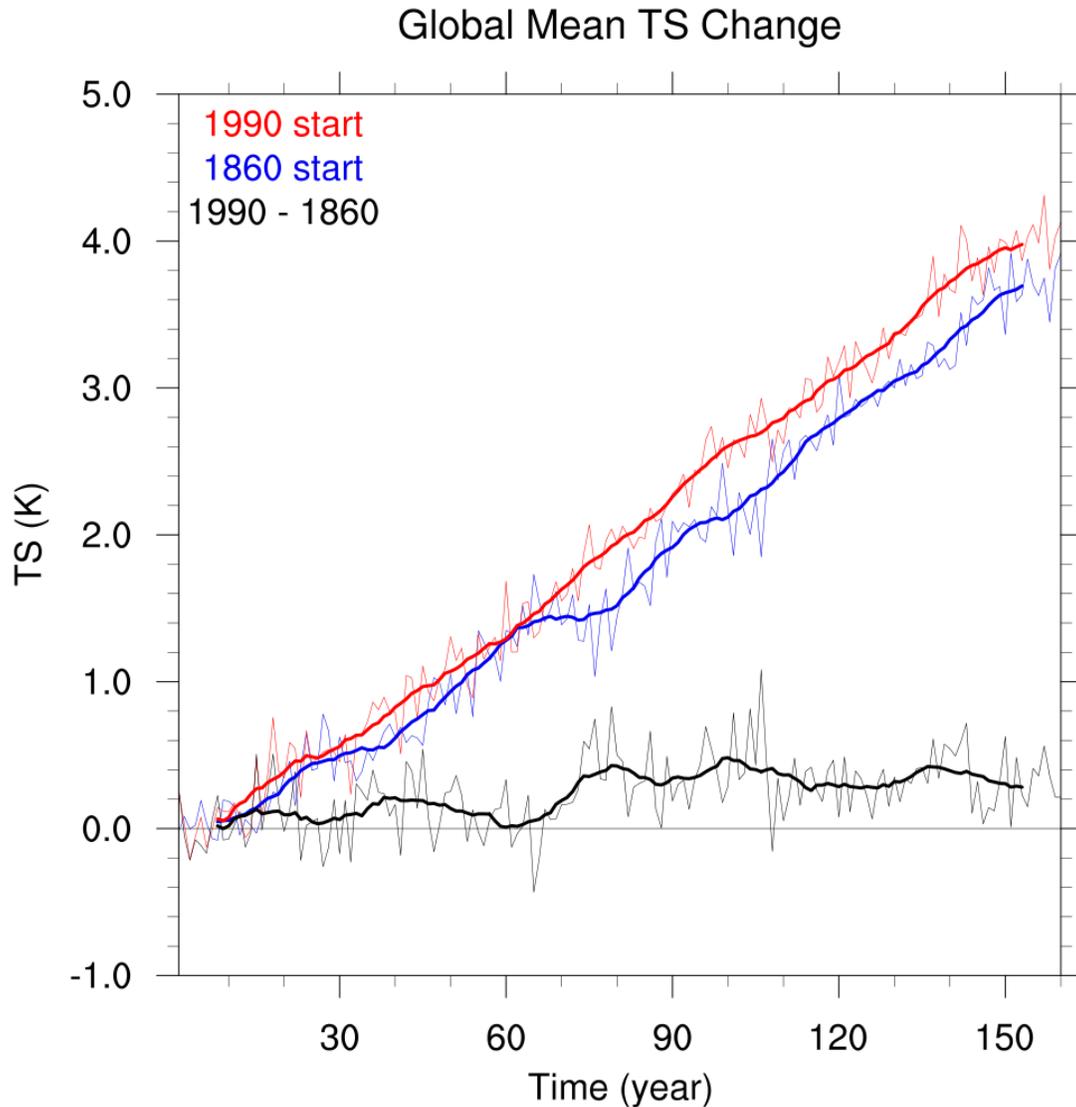
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Global Mean TS Change

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61   Figure S4. Global mean surface temperature change from the 1990 perturbation (red) and

62   1860 perturbation (blue) runs, which branch off year 501 of the respective control runs.

63   In both perturbation runs, CO_2 increases by 1 percent per year till quadrupling and is then

64   held fixed for 20 years. Black lines show the difference between the two perturbation

65   runs. Thin lines show the annual mean changes, whereas thick lines show the 15 year

66   running mean.

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