

## Supporting Information for

### Evolution of continental temperature seasonality from the Eocene greenhouse to the Oligocene icehouse - A model-data comparison

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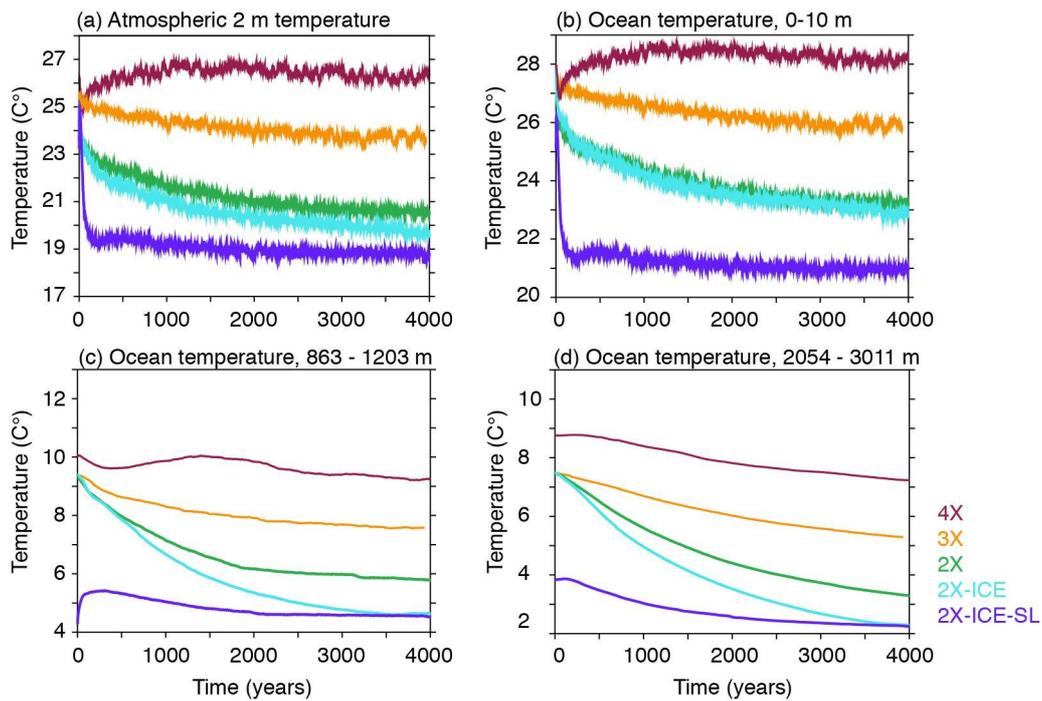
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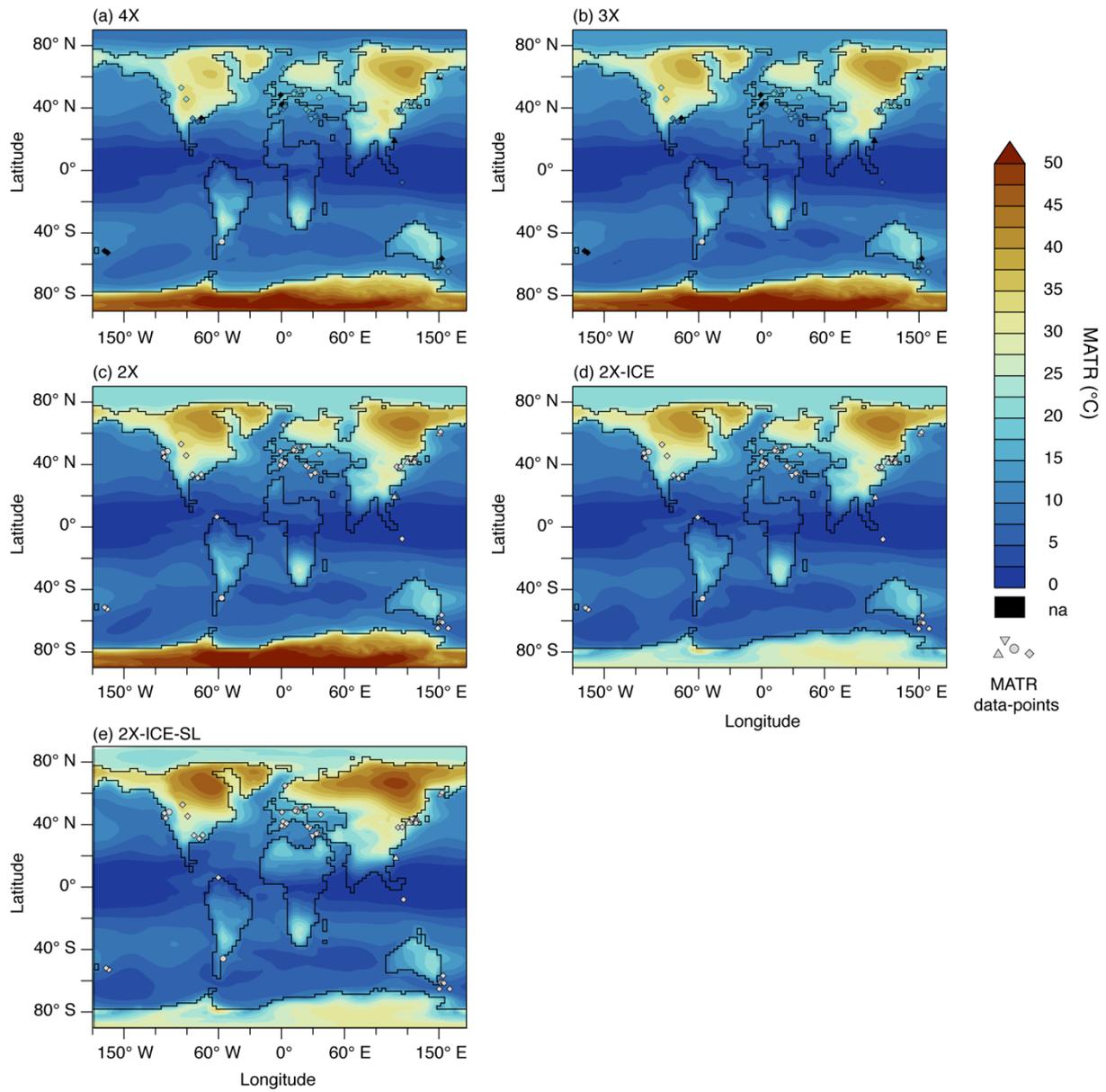
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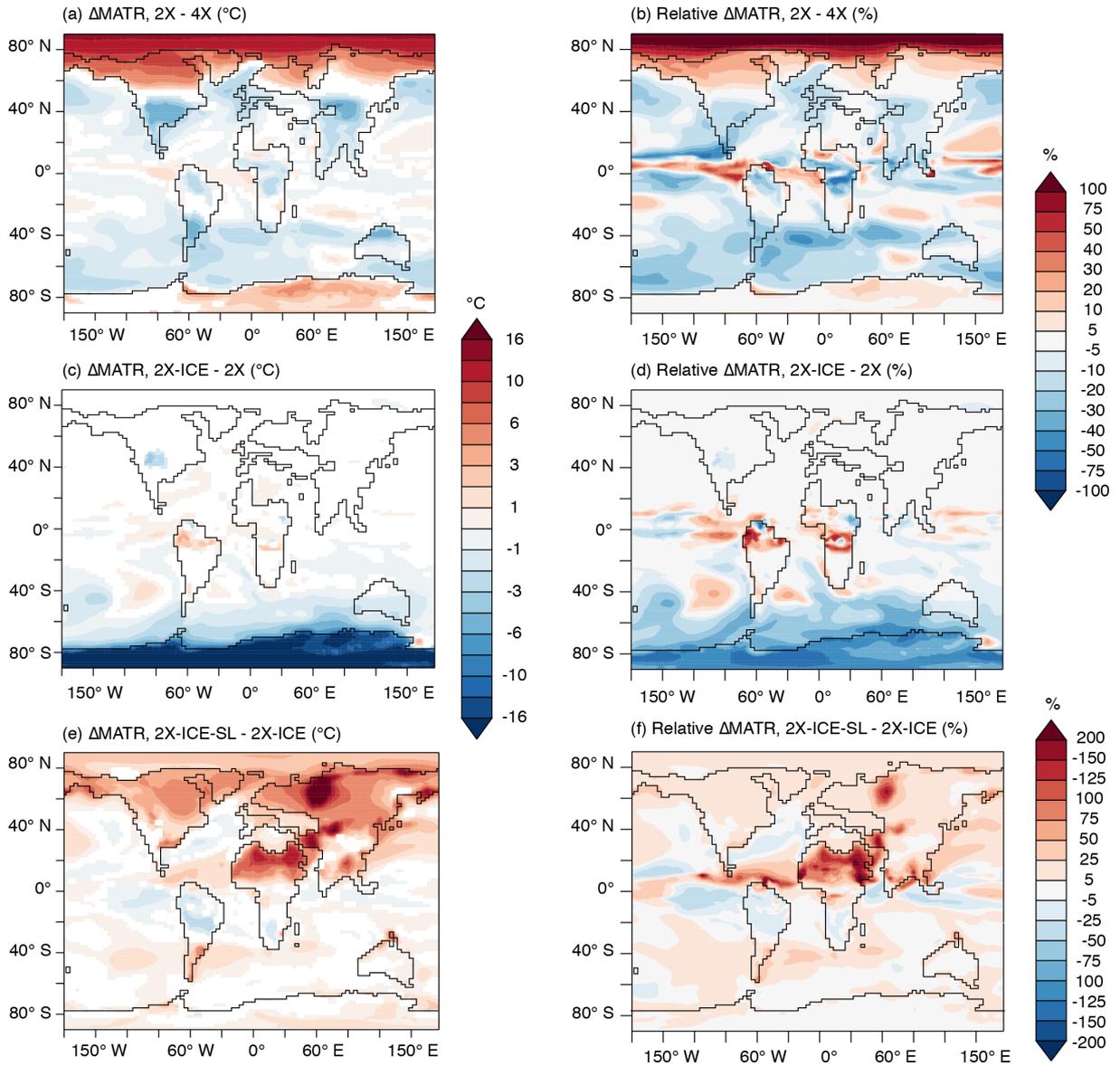
Figure S1: Atmospheric and ocean temperature evolution through spin-up time (°C)



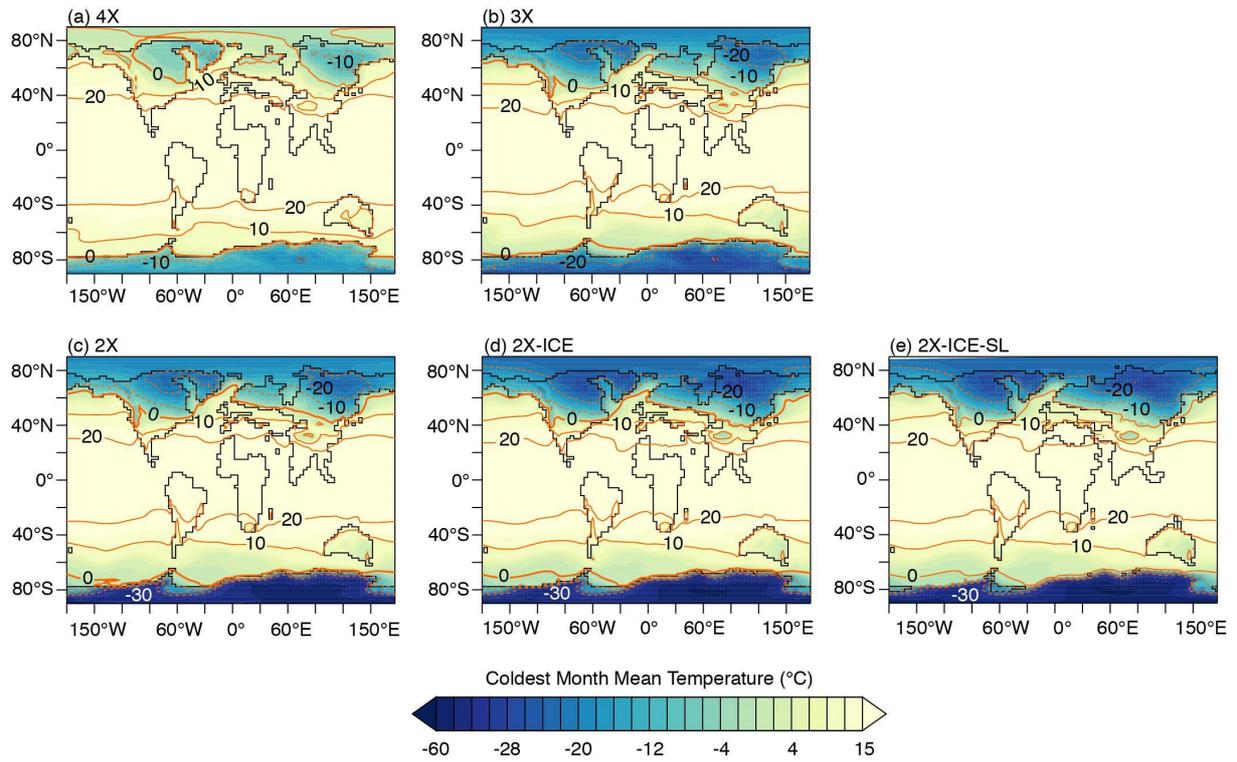
**Figure S2:** Absolute Mean Annual Range of Temperatures (°C).



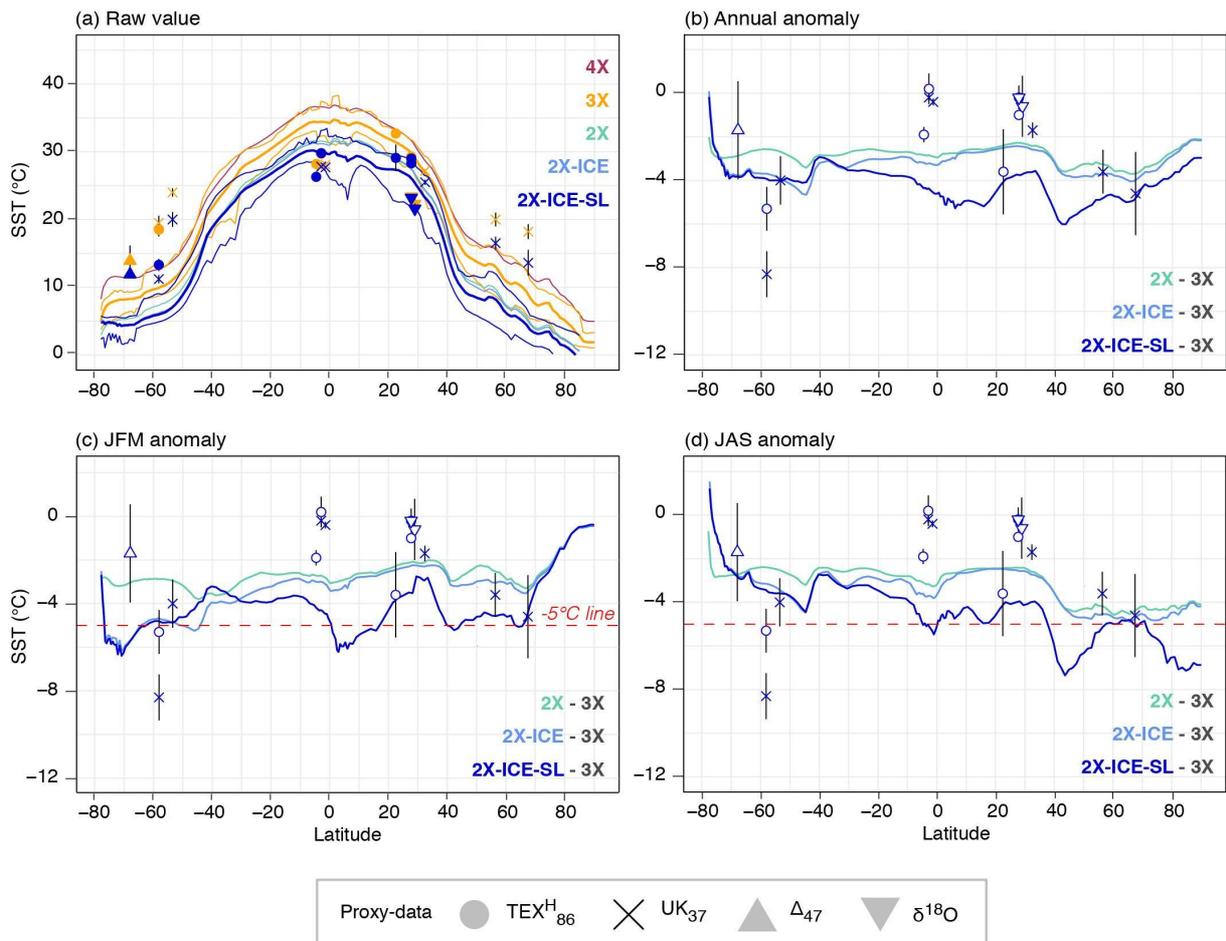
**Figure S3:** Additional MATR anomalies ( $^{\circ}\text{C}$ ). Left side maps (a,c,e) show absolute  $\Delta\text{MATR}$ , calculated from student test (95% confidence), right side maps (b,d,f) show relative changes (%).



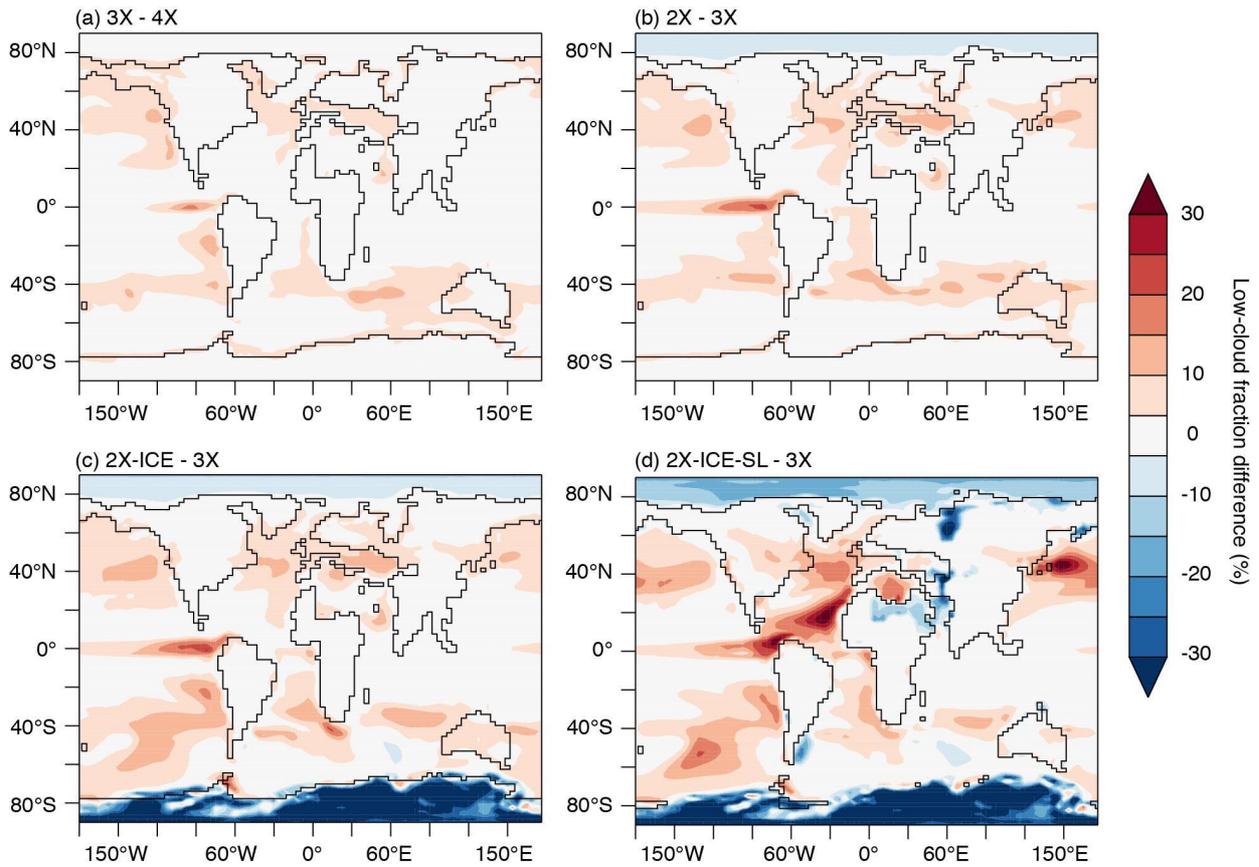
**Figure S4:** Coldest Month Mean Temperature (CMMT, °C). Orange lines are level contours every 10°C.



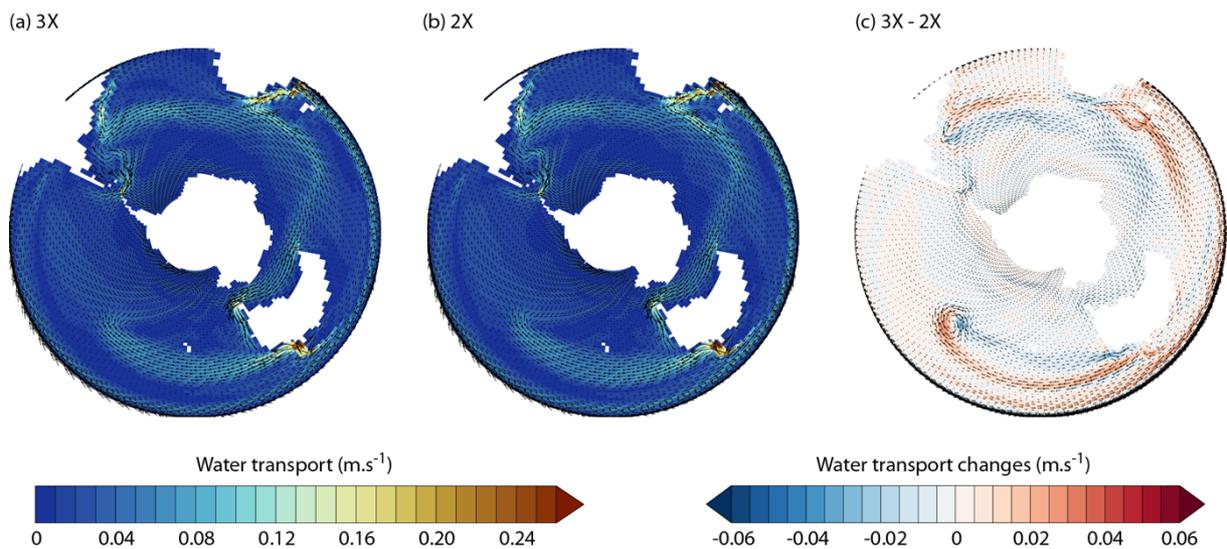
**Figure S5:** Latitudinal gradient of Atlantic Sea-Surface Temperatures (SST). (a). Mean annual values. Bold lines indicate the mean value of the SST gradient for the different simulations. Thinner lines indicate the minimum and maximum values for 3X (orange) and 2X-ICE-SL (dark blue). Symbols correspond to SST proxy-data estimates for the Atlantic Ocean (extracted from the compilation of Hutchinson *et al.*, 2021), orange symbols correspond to pre-EOT values (38-34.2 Ma), dark blue symbols are post-EOT values (33.7-30 Ma). (b-d). SST gradient anomalies annually (b), for Boreal winter, January to March (c), for Boreal summer, July to September (d). For (b-d), symbols are SST differences between pre- and post-EOT values given by Hutchinson *et al.*, 2021. All proxy-data error bars are those given by Hutchinson *et al.*, 2021. Line “-5°C” is purely indicative and aims at highlighting a stronger temperature decrease in the Northern part of the North Atlantic Ocean during Boreal summer as compared to Boreal winter.



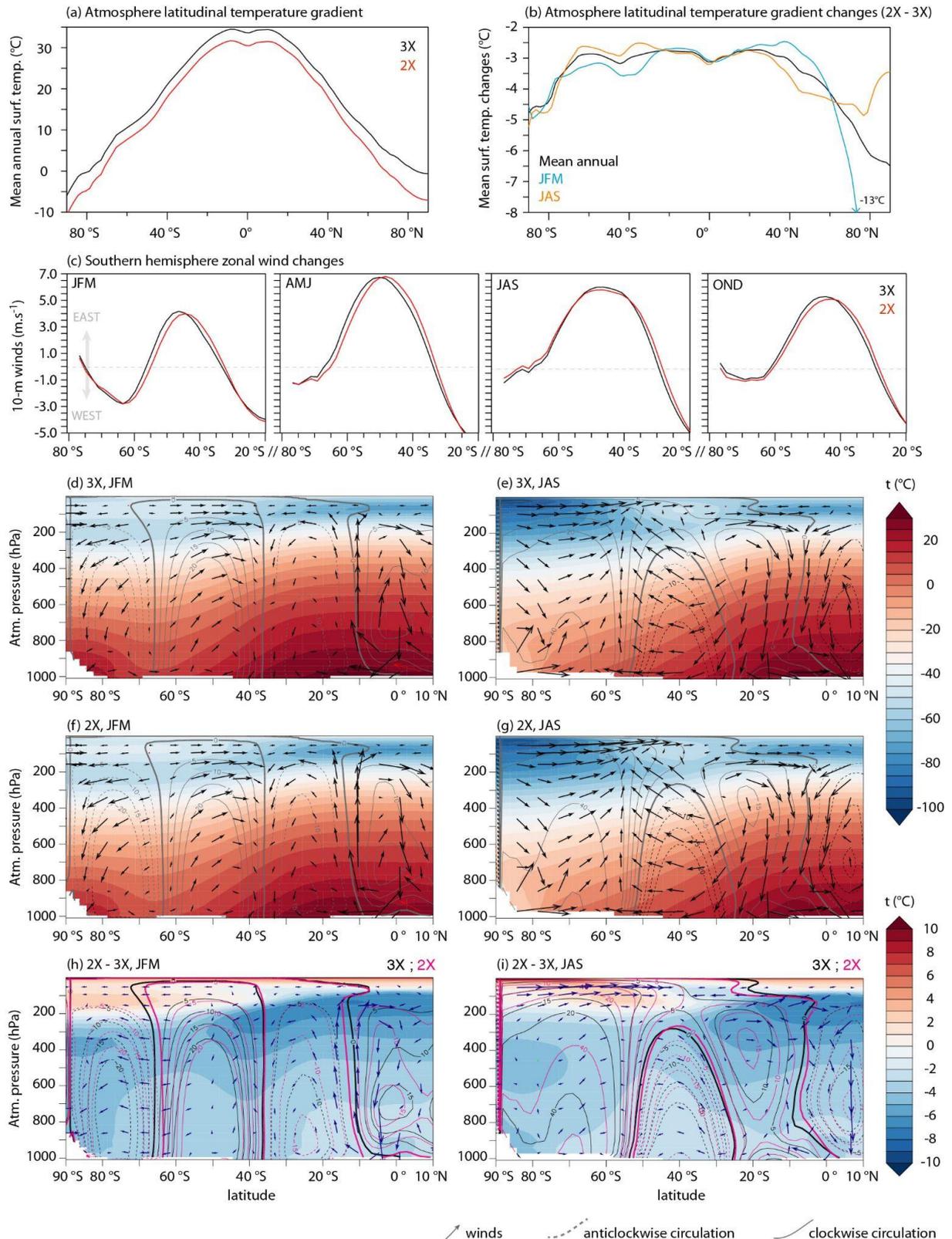
**Figure S6:** Global map of low-level clouds changes (%).



**Figure S7:** New Figure S5. Annually 0–300 m depth averaged current velocity through the Southern Ocean (annual average, m.s-1).



**Figure S8:** Atmospheric temperature dynamics changes between 3X and 2X in the Southern Hemisphere. (a,b) latitudinal surface temperature gradient; (c) zonal winds; (d-g) Air temperature (shaded), atmospheric cell extent (zonal mean streamfunction, lines) and vertical winds (arrows) in austral summer and winter for the simulations 3X and 2X. (h,i) Temperature, atmospheric cells extent and wind changes between the simulations 3X and 2X. The white arrow shows the northward migration of the polar/ferrel cell boundary. Dashed lines indicate anticlockwise circulation, solid lines, clockwise circulation. Arrows correspond to vertical winds. Atmospheric circulation was calculated over the pacific sector, between 180-30 °W.



**Figure S9:** Data-model comparison of  $\Delta\text{MATR}$  from the Priabonian to the Rupelian. Comparison of data estimates of Priabonian-Rupelian  $\Delta\text{MATR}$  (black diamonds, see Fig. 8 a for sites localization) to modelled  $\Delta\text{MATR}$  at same localities (colored circles, calculated over a  $3 \times 3^\circ$  area) from different pairs of simulations with 4X. Error bars are minimum and maximum data estimates of  $\Delta\text{MATR}$ . Dashed black line is the loess curve associated to data  $\Delta\text{MATR}$  estimates. Bold colored lines indicate the continental latitudinal gradient of  $\Delta\text{MATR}$  on lands (i.e., all longitudes averaged per degree of latitude); color-shaded intervals are the standard deviation around the average. Similar figure with pairs of simulations having 3X for the Priabonian stage is available in the manuscript, Fig. 8 b.

