The effect of atmospheric nudging on the stratospheric residual circulation in chemistry-climate models

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Figure S1: MMM \overline{w}^* from annual means latitude/height cross section of the stratosphere for the REF-C1 runs that have also run the REF-C1SD experiment. Apart from the upper stratosphere no real differences can be found between this MMM and the MMM from all the REF-C1 simulations (10).



Figure S2: Vertical profiles of climatological turnaround latitudes in the stratosphere for the MMM of the REFC1 runs (MMM REFC1), of the REF-C1 runs that have also run the REF-C1SD experiment (MMM SD subset REFC1) and of the REFC1SD runs for Southern Hemisphere (a) and Northern Hemisphere (b).



Figure S3. Tropical upward mass flux at 10 hPa (left bars) along with downward control calculations (right bars) showing contributions from EPFD (dark grey), OGW (mid-grey), and NOGW (light grey) for (a) REF-C1 and (b) REF-C1SD. For CMAM the NOGWD contributes negatively to TUMF and is indicated with two red horizontal lines inside the lighter grey bar.



Figure S4: MMM \overline{w}^* from annual means annual cycle of the stratosphere for the REF-C1 runs that have also run the REF-C1SD experiment.



Figure S5. Partial regression coefficients of each regressor ± 2 standard errors and R^2 values output from the MLR on the TUMF at 70 hPa for REF-C1 simulations.

w* MMM 70hPa REFC1 SD subset 1980-2009



Figure S6. Partial regression coefficients of each regressor ± 2 standard errors and R^2 values output from the MLR on the TUMF at 70 hPa for REF-C1SD simulations.



Figure S7. Regression coefficients of each regressor ± 2 standard errors and R² values output from the MLR on the TUMF at 70 hPa for all available REF-C1 CCSRNIES-MIROC3.2 ensemble members.



Figure S8. Regression coefficients of each regressor ± 2 standard errors and R² values output from the MLR on the TUMF at 70 hPa for all available REF-C1 CESM1-WACCM ensemble members.



Figure S9. Regression coefficients of each regressor ± 2 standard errors and R² values output from the MLR on the TUMF at 70 hPa for all available REF-C1 CMAM ensemble members. Note that CMAM does not simulate a QBO hence the QBO terms were omitted.



Figure S10. Regression coefficients of each regressor ± 2 standard errors and R^2 values output from the MLR on the TUMF at 70 hPa for all available REF-C1 NIWA-UKCA ensemble members.



Figure S11. Regression coefficients of each regressor ± 2 standard errors and R^2 values output from the MLR on the TUMF at 70 hPa for all available REF-C1 SOCOL ensemble members.



Figure S12. Regression coefficients of each regressor ± 2 standard errors and R² values output from the MLR on the tropical upward mass flux at 70 hPa for all available REFC1 ULAQ-CCM ensemble members.