



Supplement of

Stratospheric ozone projections under sulfur-based stratospheric aerosol injection: Insights from the multi-model G6-1.5K-SAI experiment

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	CESM	MIROC	UKESM
$\text{N}_2\text{O}_5 + \text{H}_2\text{O} \rightarrow 2 \text{HNO}_3$	X	X	X
$\text{ClONO}_2 + \text{H}_2\text{O} \rightarrow \text{HOCl} + \text{HNO}_3$	X	X	X
$\text{ClONO}_2 + \text{HCl} \rightarrow 2 \text{Cl} + \text{HNO}_3$	X	X	X
$\text{N}_2\text{O}_5 + \text{HCl} \rightarrow \text{Cl} + \text{NO}_2 + \text{HNO}_3$		X	
$\text{HOCl} + \text{HCl} \rightarrow 2 \text{Cl} + \text{H}_2\text{O}$	X	X	X
$\text{HOBr} + \text{HBr} \rightarrow 2 \text{Br} + \text{H}_2\text{O}$		X	
$\text{HOBr} + \text{HCl} \rightarrow \text{BrCl} + \text{H}_2\text{O}$	X	X	
$\text{HOCl} + \text{HBr} \rightarrow \text{BrCl} + \text{H}_2\text{O}$		X	
$\text{BrONO}_2 + \text{HBr} \rightarrow 2 \text{Br} + \text{HNO}_3$		X	
$\text{BrONO}_2 + \text{HCl} \rightarrow \text{BrCl} + \text{HNO}_3$		X	X
$\text{ClONO}_2 + \text{HBr} \rightarrow \text{BrCl} + \text{HNO}_3$		X	
$\text{BrONO}_2 + \text{H}_2\text{O} \rightarrow \text{HOBr} + \text{HNO}_3$	X	X	X
$\text{N}_2\text{O}_5 + \text{HBr} \rightarrow \text{Br} + \text{NO}_2 + \text{HNO}_3$		X	

Table S1. Summary of the heterogenous reactions occurring on stratospheric sulfate aerosols in each model.

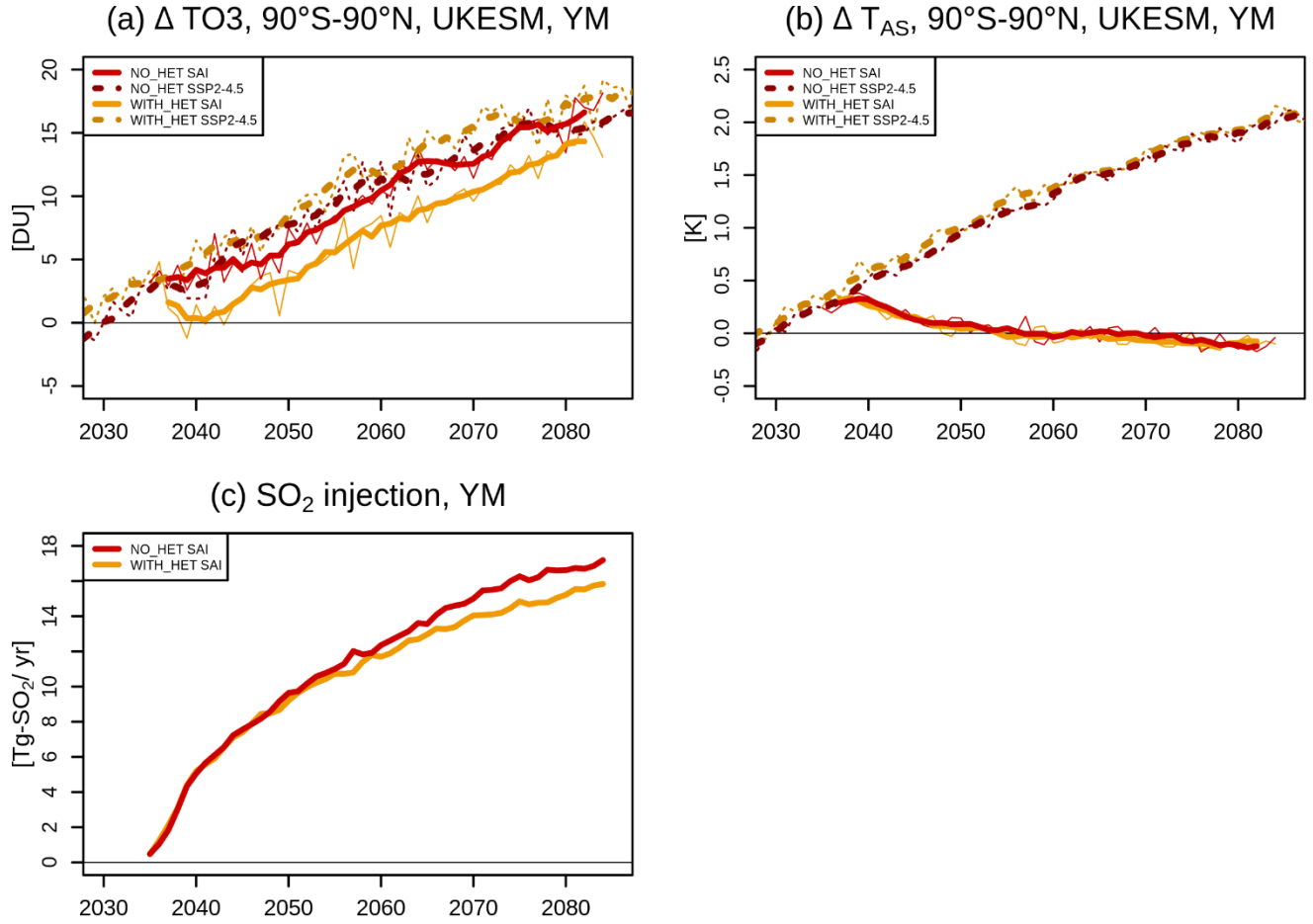


Figure S1. Timeseries of ensemble mean changes in annual mean (‘YM’) global mean (a) total column ozone (TO3) and (b) near-surface air temperature (T_{AS}) in the UKESM G6-1.5K-SAI (solid) or SSP2-4.5 experiment (dashed). Orange lines are for the fully coupled simulations with heterogenous chemistry on SAI sulfate aerosols included (WITH_HET, as discussed in this paper), and red lines are for the analogous simulation without it (NO_HET, i.e. the original UKESM simulations discussed in Lee et al. 2026). In both cases, the changes are calculated relative to the same baseline, i.e. 2020-2039 ensemble mean of the SSP2-4.5 NO_HET simulation. Thin lines denote the ensemble mean changes and thick lines denote their 5-year running means. (c) Timeseries of the corresponding ensemble mean annual mean SO_2 injection rates in the G6-1.5K-SAI simulation (colors).

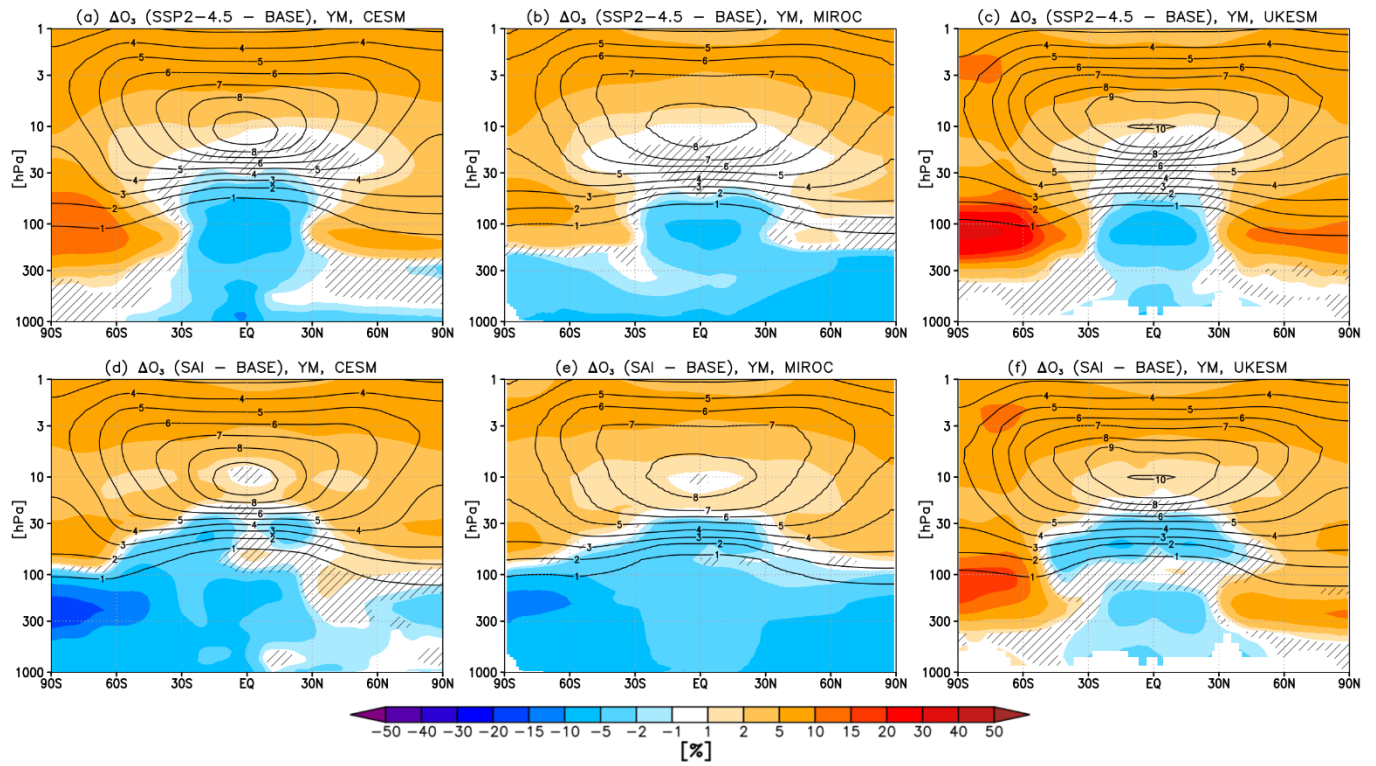


Figure S2. Shading: Annual 2045-2064 mean changes in ozone volume mixing ratios in each model (columns). Top row (a-c) is for changes in SSP2-4.5 between the future (2045-2064) and the baseline (2020-2039) periods, and bottom row (d-f) is for changes between the G6-1.5K-SAI simulations (2045-2064) and the baseline (2020-2039 mean of SSP2-4.5). Contours show the corresponding climatological ozone volume mixing ratios (in ppm) in the SSP2-4.5 runs for reference. Hatching marks the region where the response is not statistically significant (taken as smaller than ± 2 standard errors in the difference in means)

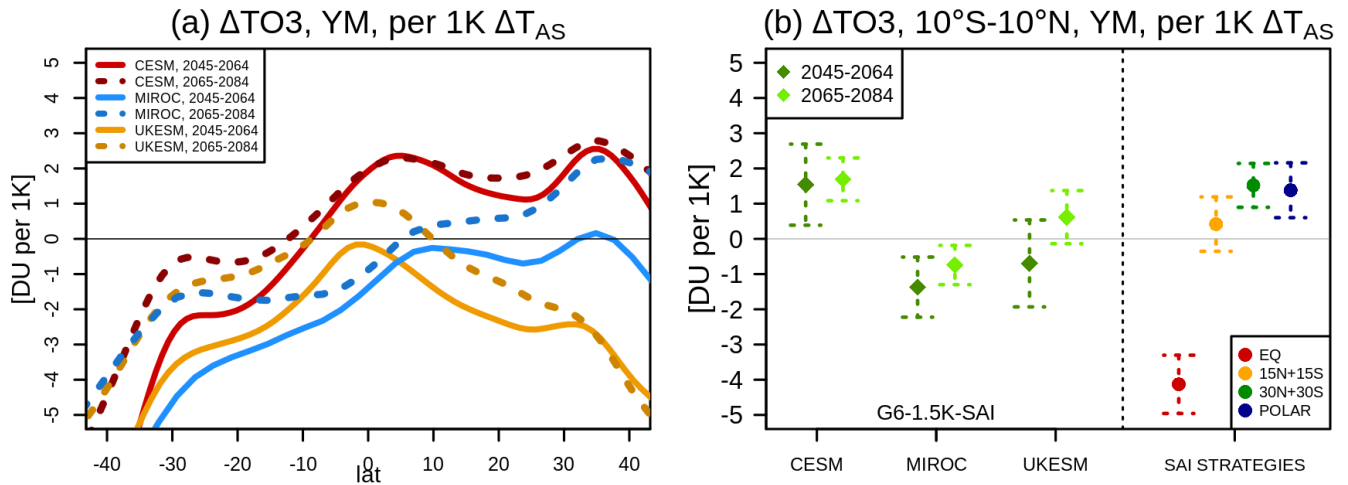


Figure S3. (a): Normalized annual mean total column ozone response per 1 K global mean near-surface air cooling in each model (colors) for 2045-2064 (solid) and 2065-2084 (dashed) as a function of latitude (between 40°S and 40°N). (b): As in Figure 3(c) in the main text but for the changes in total ozone column averaged over the deep tropical 10°S-10°N region.

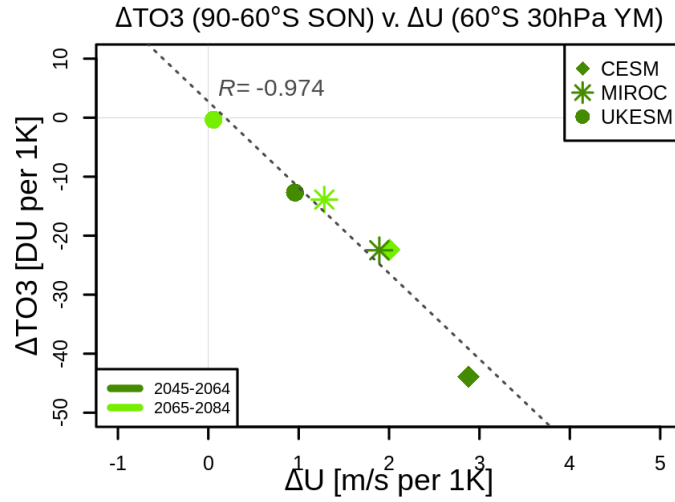


Figure S4. As in Figure 11(c) in the main text but for the correlation between the normalized changes in the springtime Antarctic total column ozone and annual mean polar vortex strength.

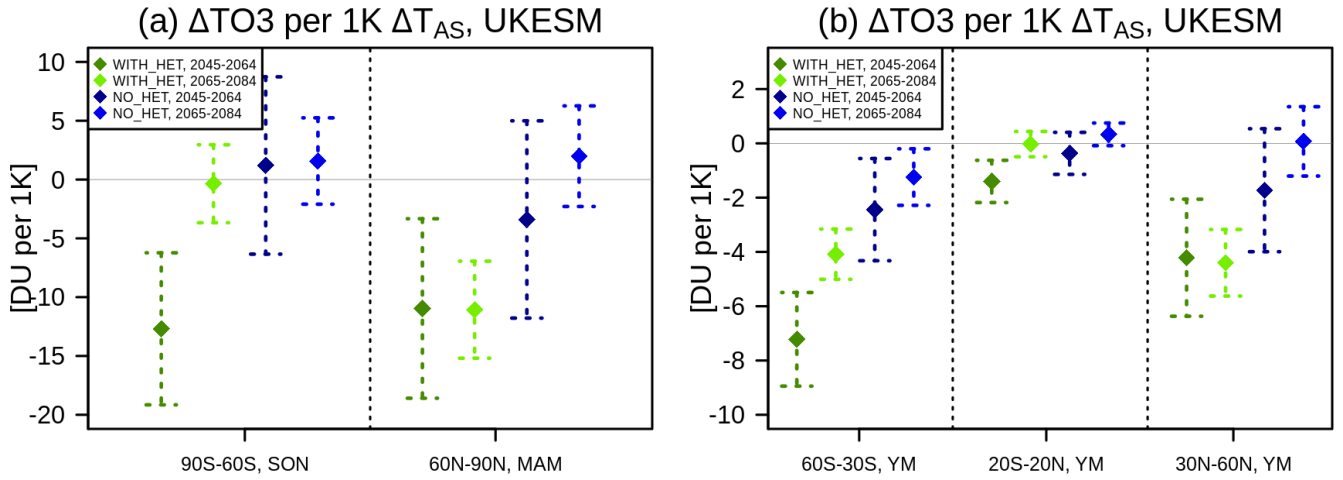
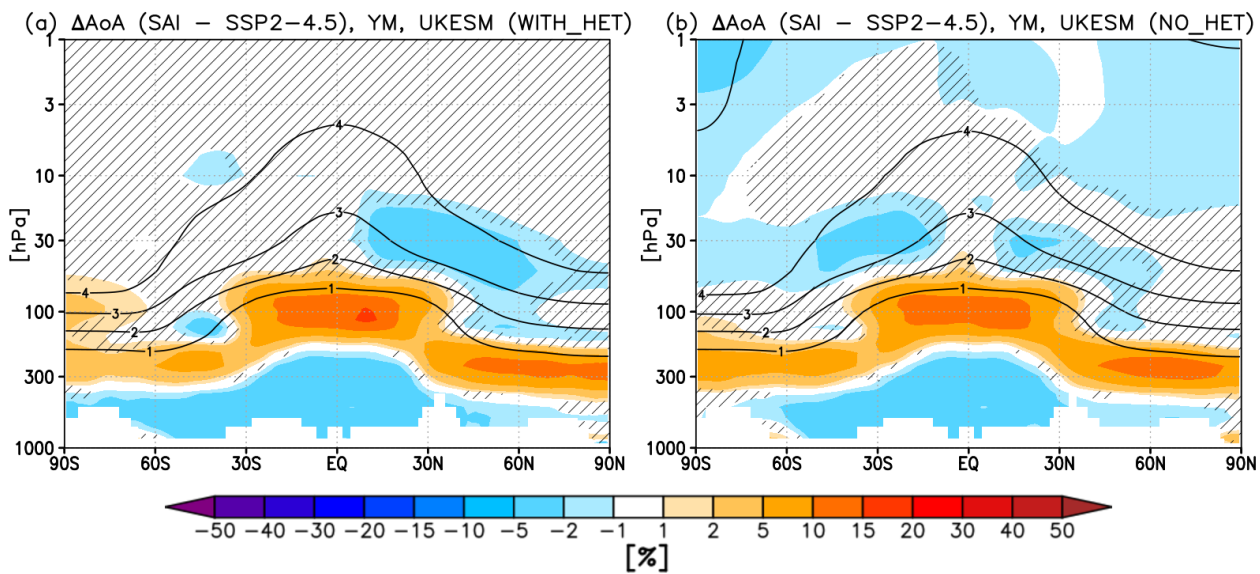


Figure S5. Normalized total column ozone changes between the UKESM G6-1.5K-SAI and SSP2-4.5 simulations averaged over either 2045-2064 or 2065-2084 periods and scaled with the corresponding global mean near-surface air temperature change. Green points are for the ozone responses in the fully coupled simulations with heterogeneous chemistry on SAI sulfate aerosols included (WITH_HET), and blue points are the analogous simulations without it (NO_HET). Panel (a) shows the responses in springtime Antarctic and Arctic ozone, and panel (b) shows annual mean responses in the SH mid-latitudes, tropics and NH mid-latitudes. The error bars represent +/- 2 standard errors in the difference in means.

2045-2064



2065-2084

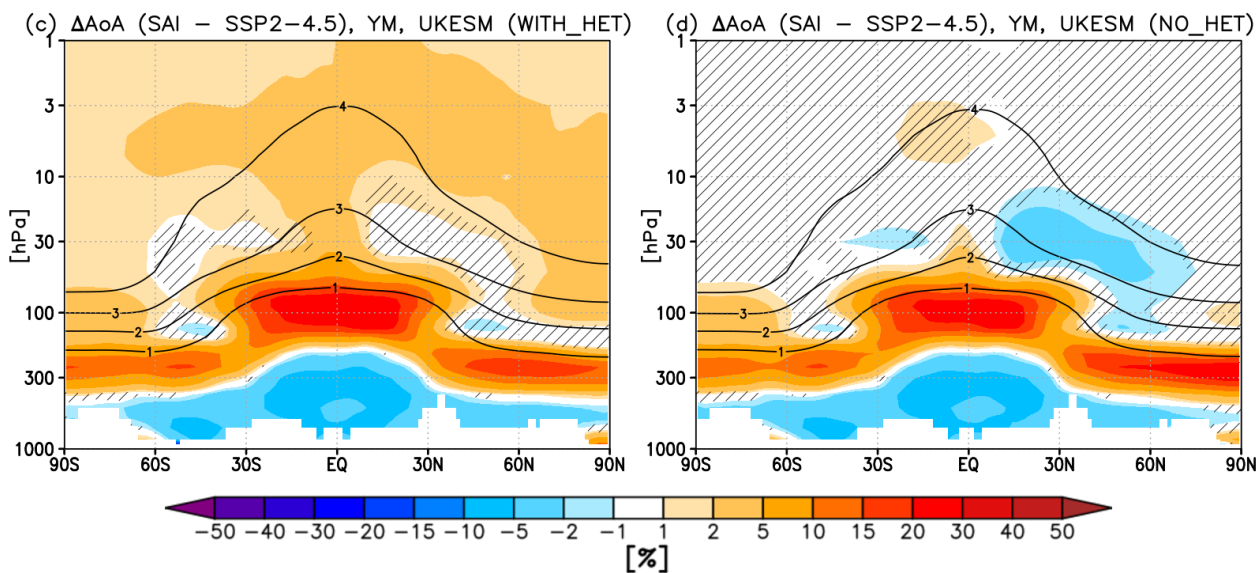


Figure S6. Shading: Annual (top, a-b) 2045-2064 mean and (bottom, c-d) 2065-2084 mean changes in age-of-air between the UKESM G6-1.5K-SAI simulations and the SSP2-4.5 simulations over the same period. Left column (a,c) is for the default simulations discussed in the paper, right column (b,d) is for the analogous simulation without heterogeneous chemistry on SAI sulfate aerosols (i.e. original G6-1.5K-SAI run). Contours show the corresponding climatological values (in units of years) in the SSP2-4.5 runs for reference. Hatching denotes regions where the response is not statistically significant (defined as in Fig. 1)

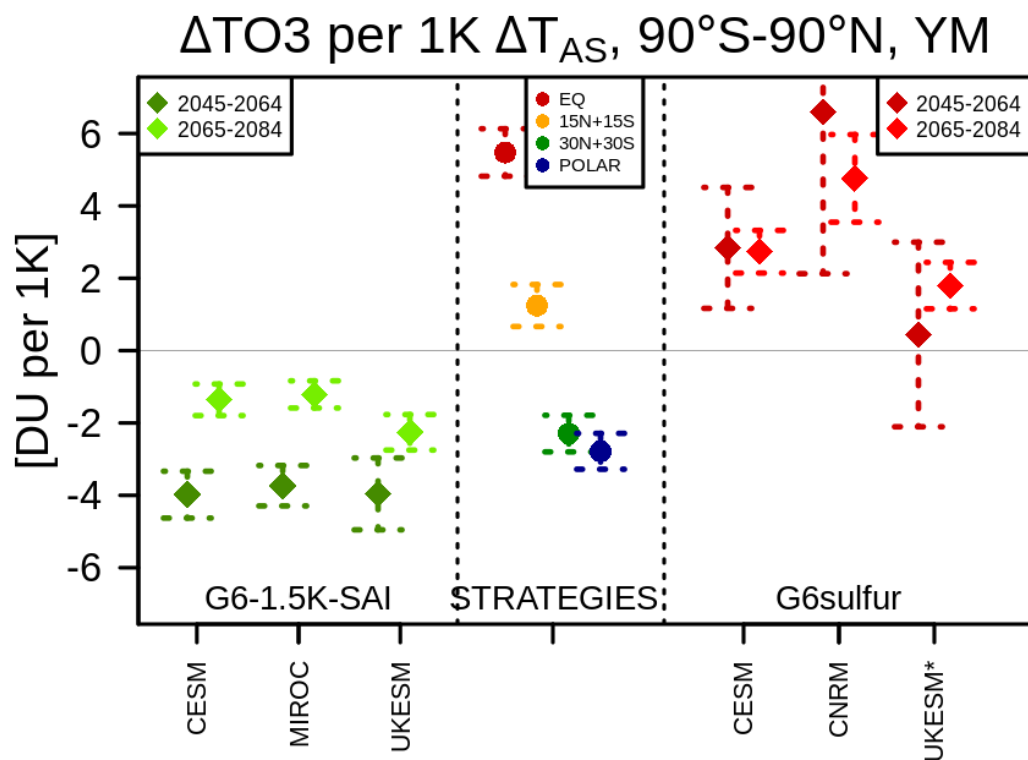


Figure S7. Normalized annual and global mean total column ozone changes between the G6-1.5K-SAI and SSP2-4.5 simulations averaged over either 2045-2064 or 2065-2084 periods and scaled with the corresponding global mean near-surface air temperature change. Shown also are the corresponding changes (2050-2069) in the different SAI strategies with CESM2(WACCM6-MA) discussed in Bednarz et al. (2023a) as well as the corresponding 2045-2064 or 2065-2084 total column ozone changes diagnosed from the G6sulfur models discussed in Tilmes et al. (2022): CESM2(WACCM), here denoted “CESM”; CNRM-ESM2-1, here denoted “CNRM”, and UKESM1-0-LL, here denoted “UKESM*” (note UKESM* does not include heterogenous chemistry on SAI sulfate aerosol). The error bars represent +/- 2 standard errors in the difference in means, calculated from the annual mean values (20 per ensemble member).