Supplementary Material for The Emissions Model Intercomparison Project (Emissions-MIP): quantifying model sensitivity to emission characteristics

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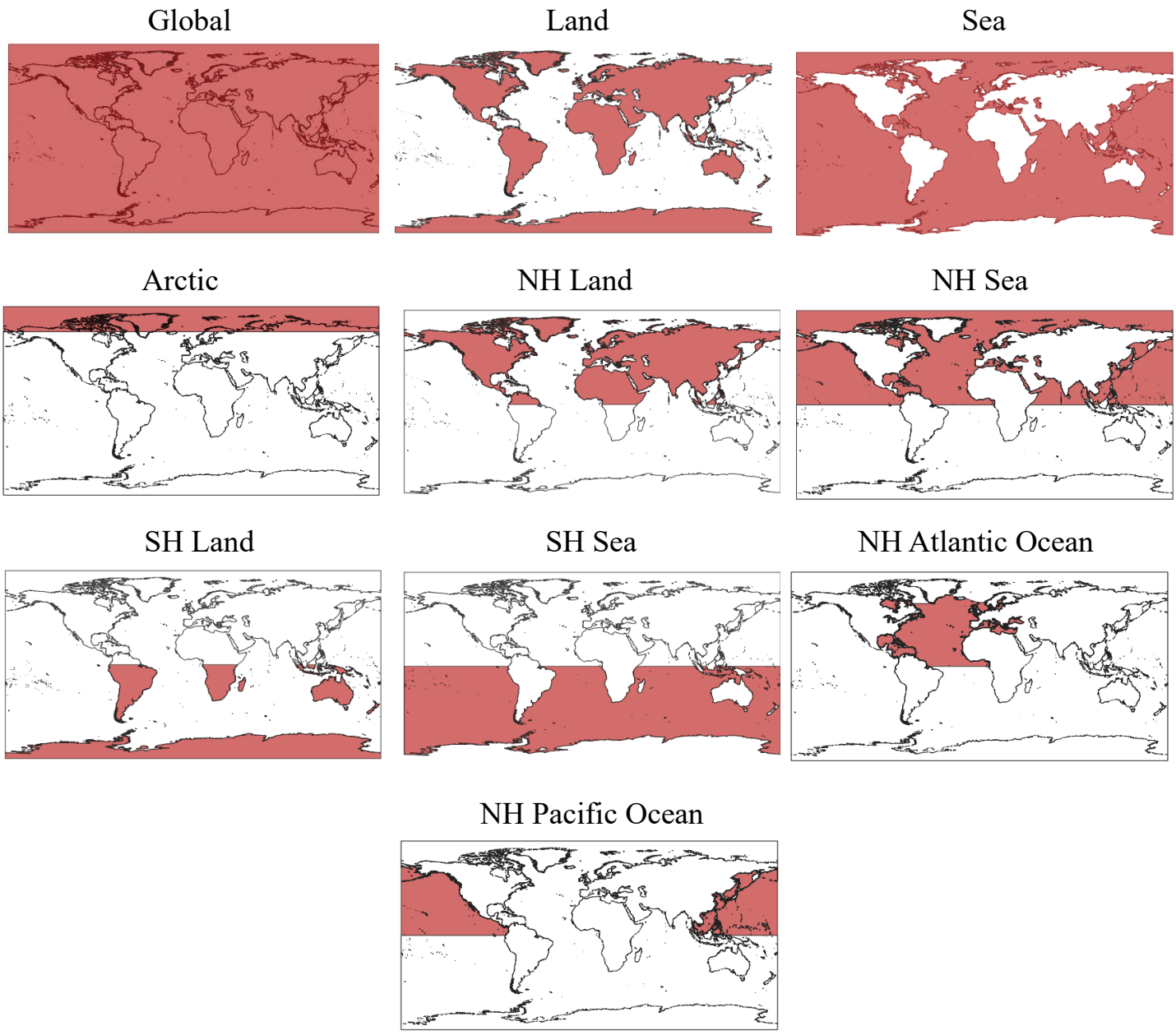

Figure S1: Global maps showing the various regions shaded in red for which diagnostics were calculated using ESMValTool.

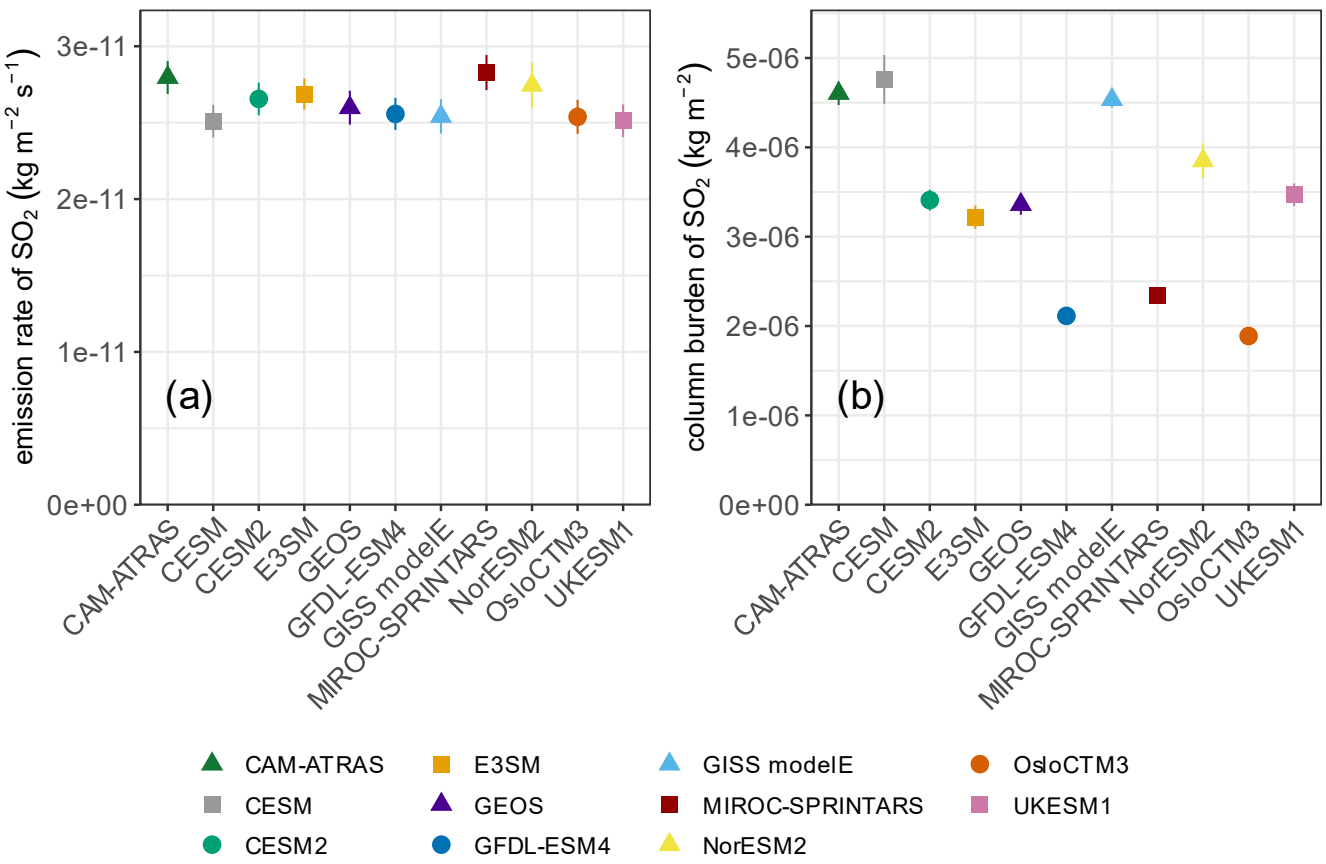

Figure S2: (a) Northern Hemisphere land SO_2 emission rate and (b) SO_2 column burden of the reference case model simulations. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The error bars represent interannual variability (± 1 σ).

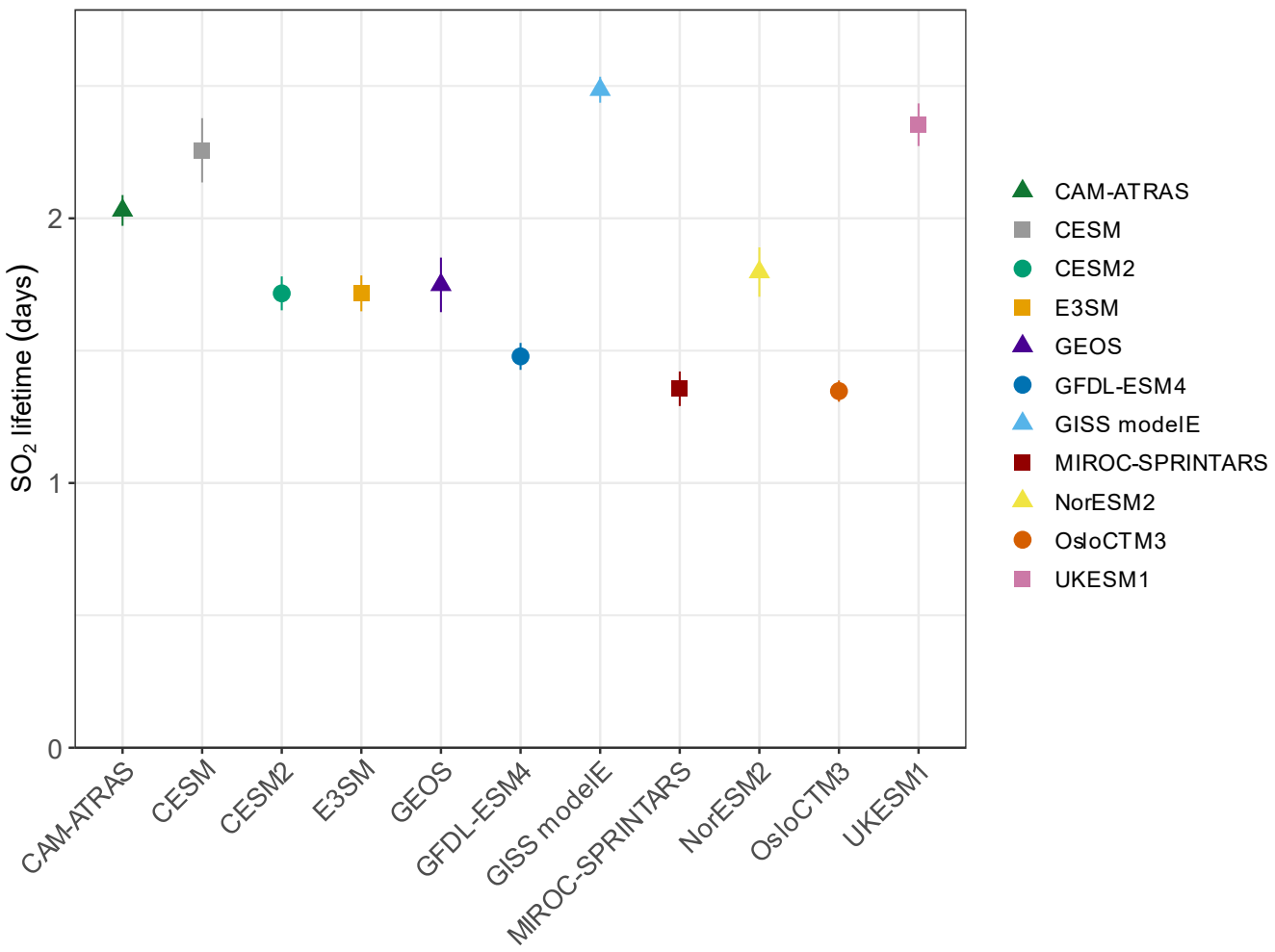

Figure S3: Global SO_2 lifetime of the reference case model simulations. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The error bars represent interannual variability (± 1 σ).

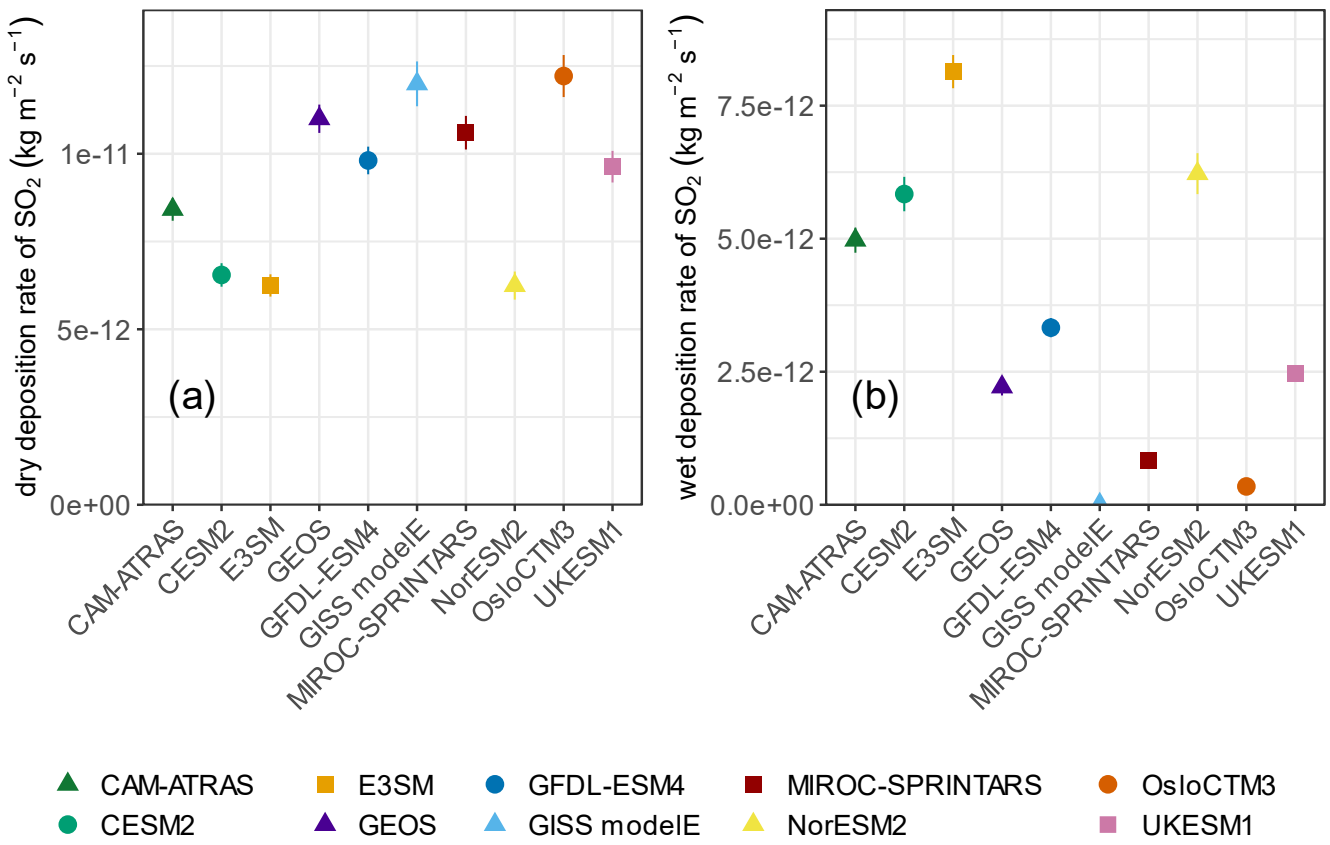

Figure S4: (a) Northern Hemisphere land dry SO_2 deposition rate and (b) wet SO_2 deposition rate of the reference case model simulations. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The error bars represent interannual variability (± 1 σ).

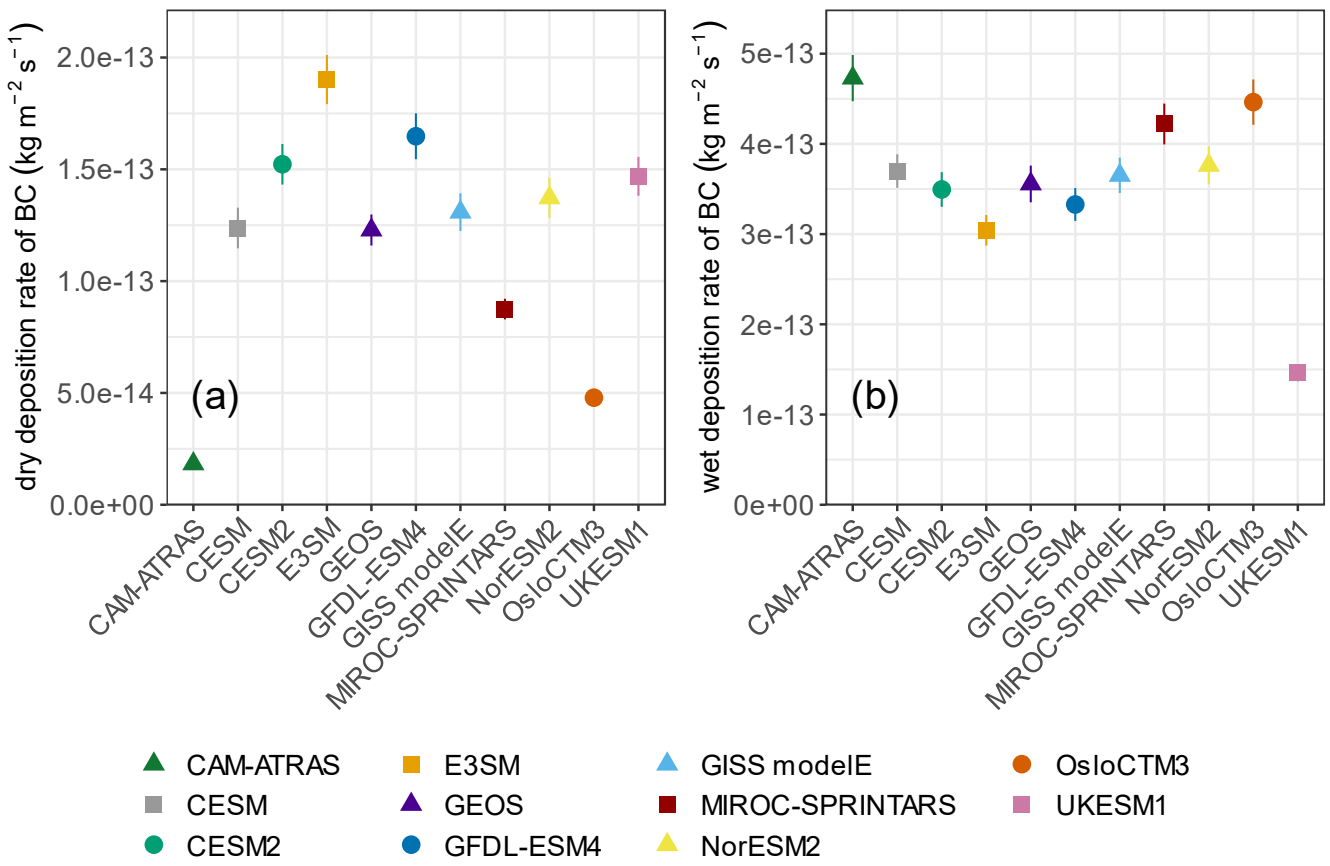

Figure S5: (a) Global dry BC deposition rate and (b) wet BC deposition rate of the reference case model simulations. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The error bars represent interannual variability (± 1 σ).

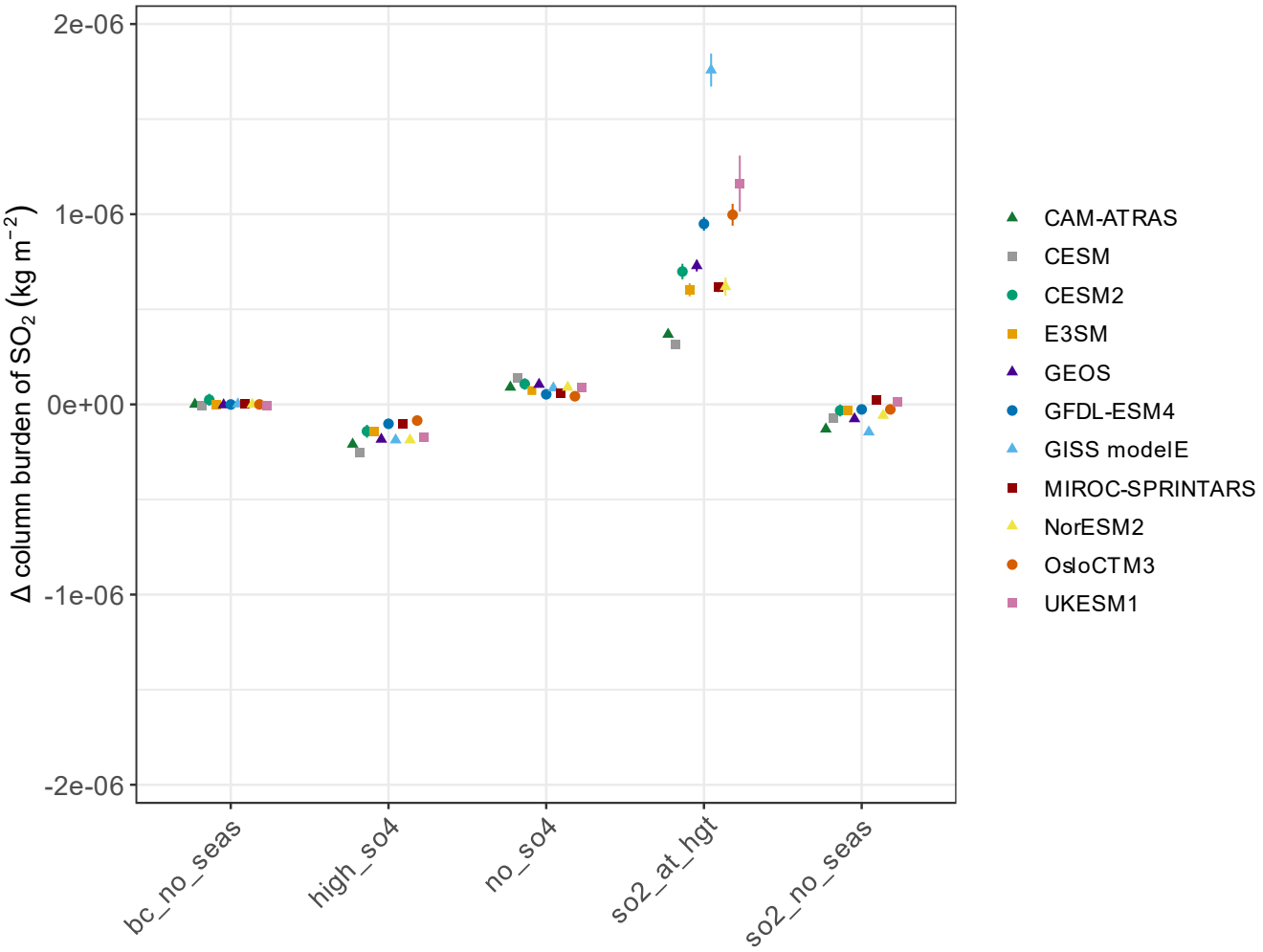

Figure S6: Absolute difference of Northern Hemisphere land SO_2 column burden for each perturbation. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The uncertainty bars represent interannual variability (± 1 σ).

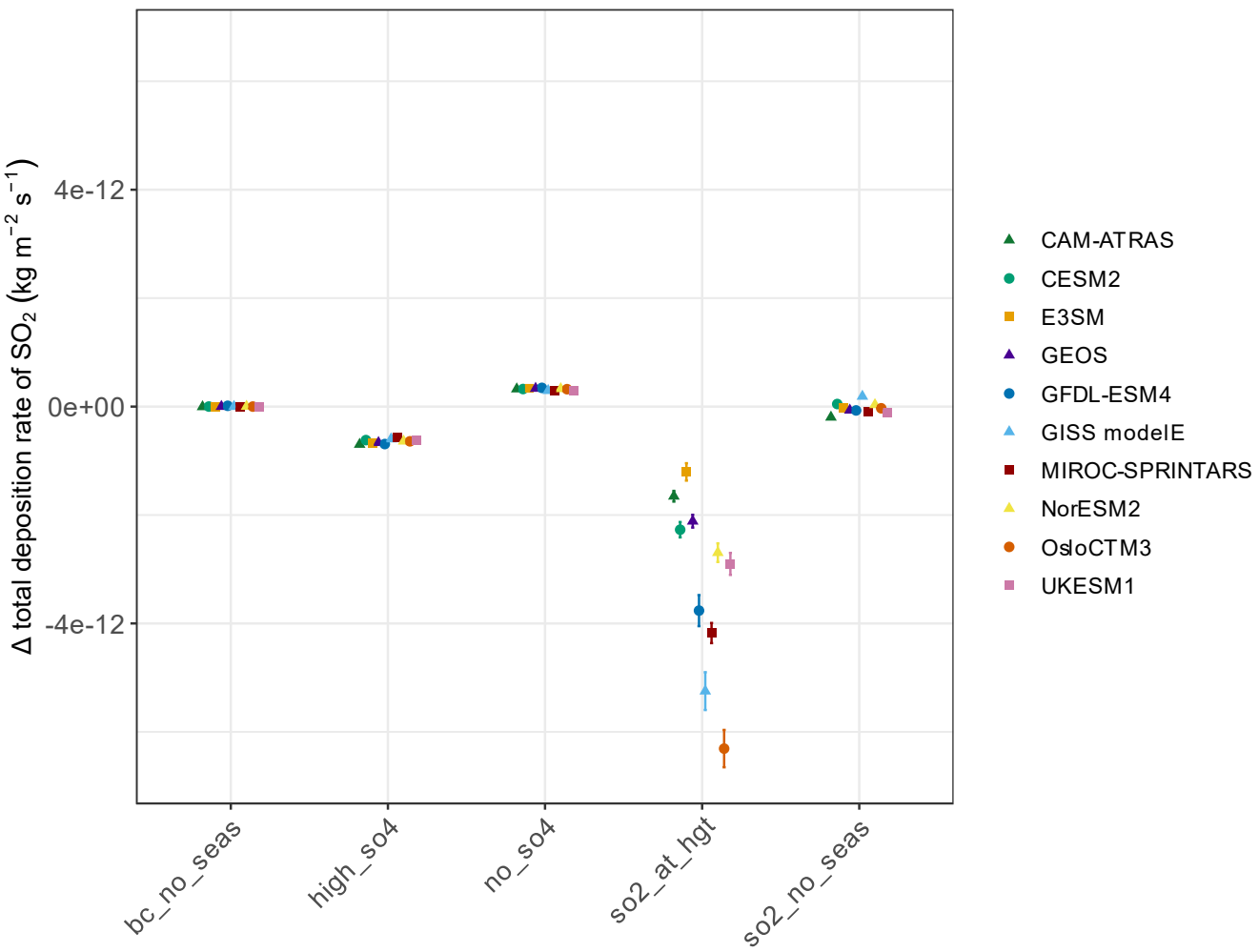

Figure S7: Absolute difference of Northern Hemisphere land total SO_2 deposition rate for each perturbation. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The uncertainty bars represent interannual variability (± 1 σ).

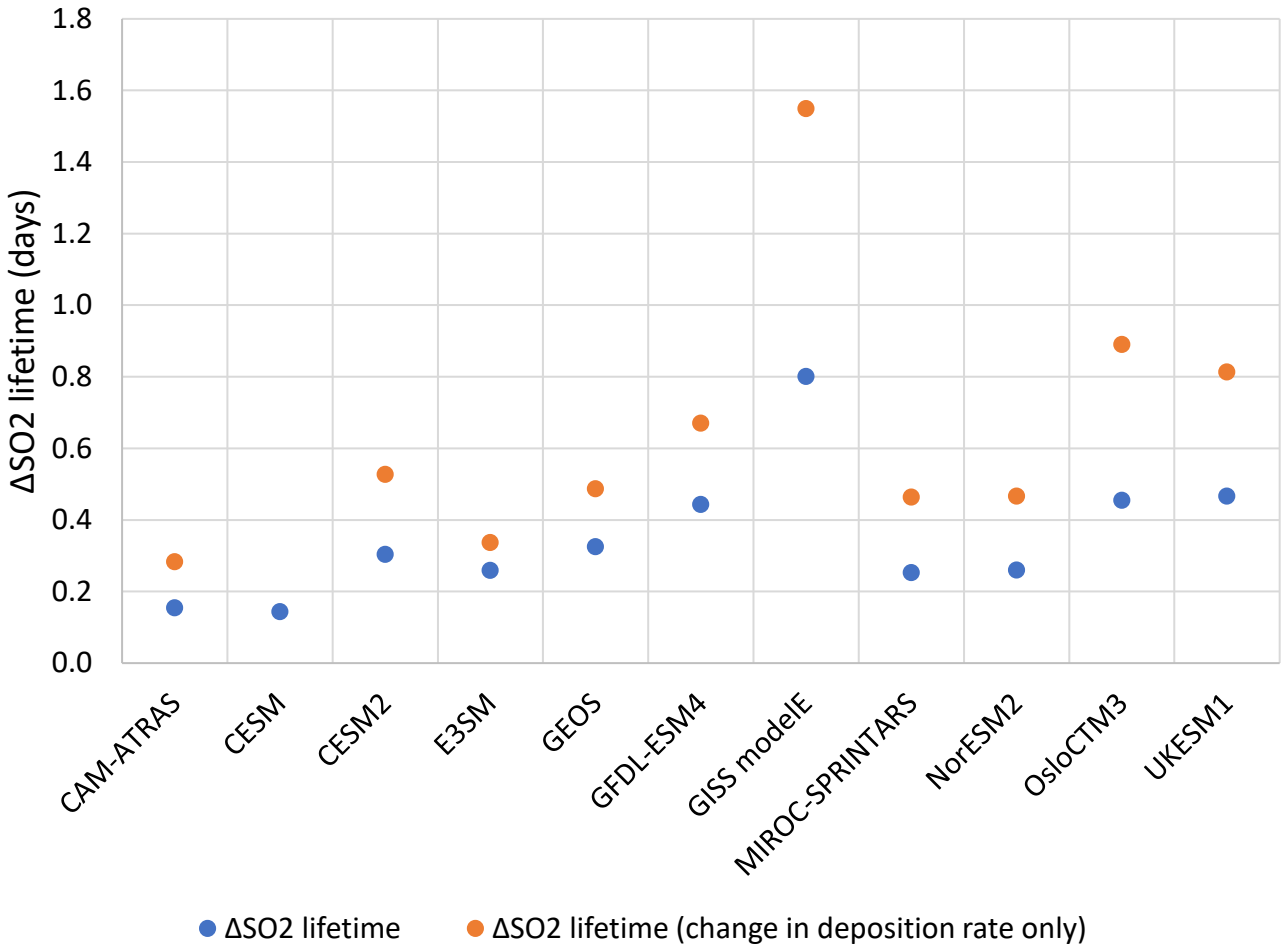

Figure S8: Absolute difference (emission at height – reference) of Northern Hemisphere land SO_2 lifetime, showing the relative impact of deposition vs chemical conversion. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005.

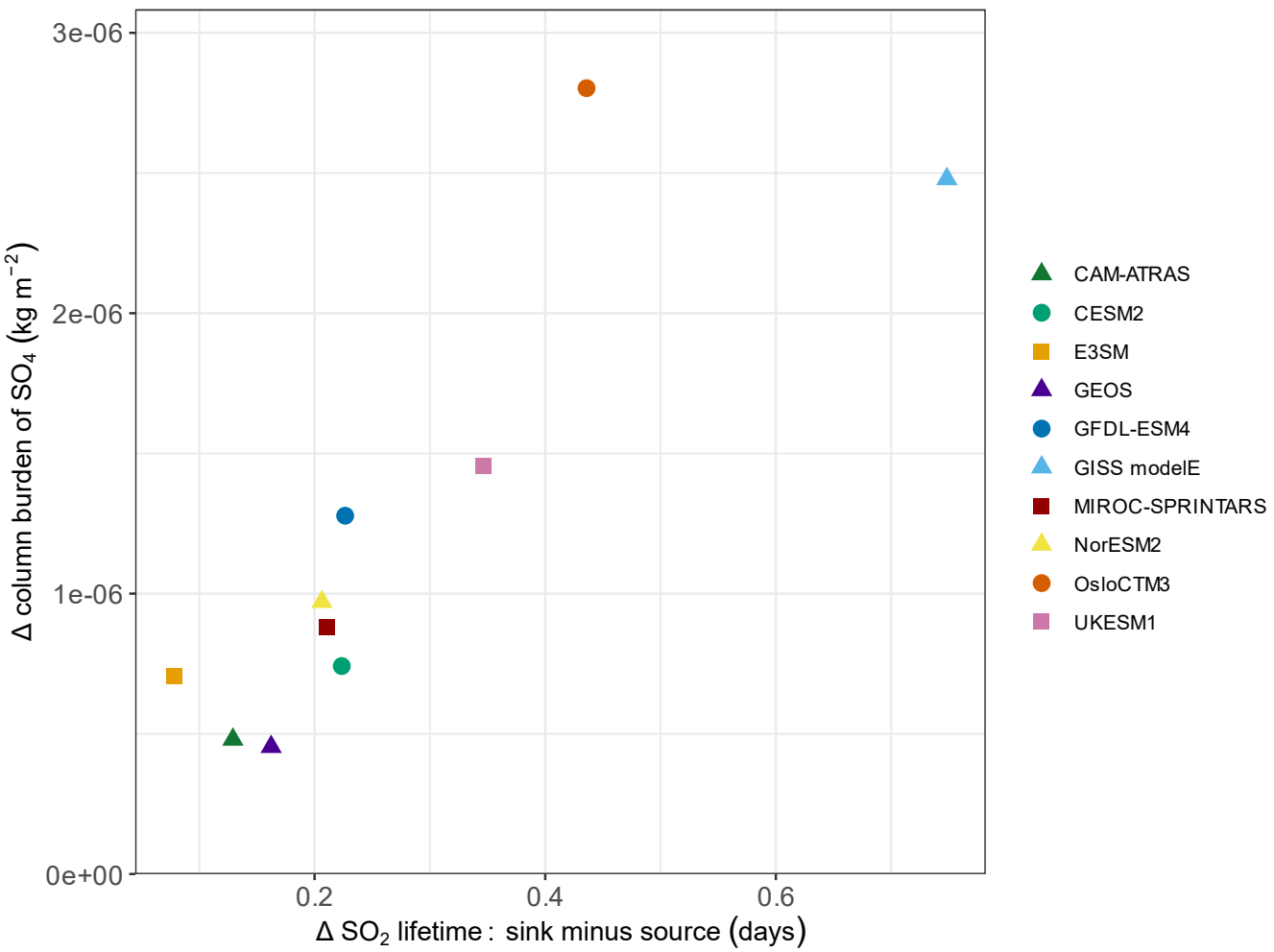

Figure S9: Absolute difference (emission at height – reference) of Northern Hemisphere land sulfate column burden vs SO_2 lifetime offset (sink minus source). All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005.

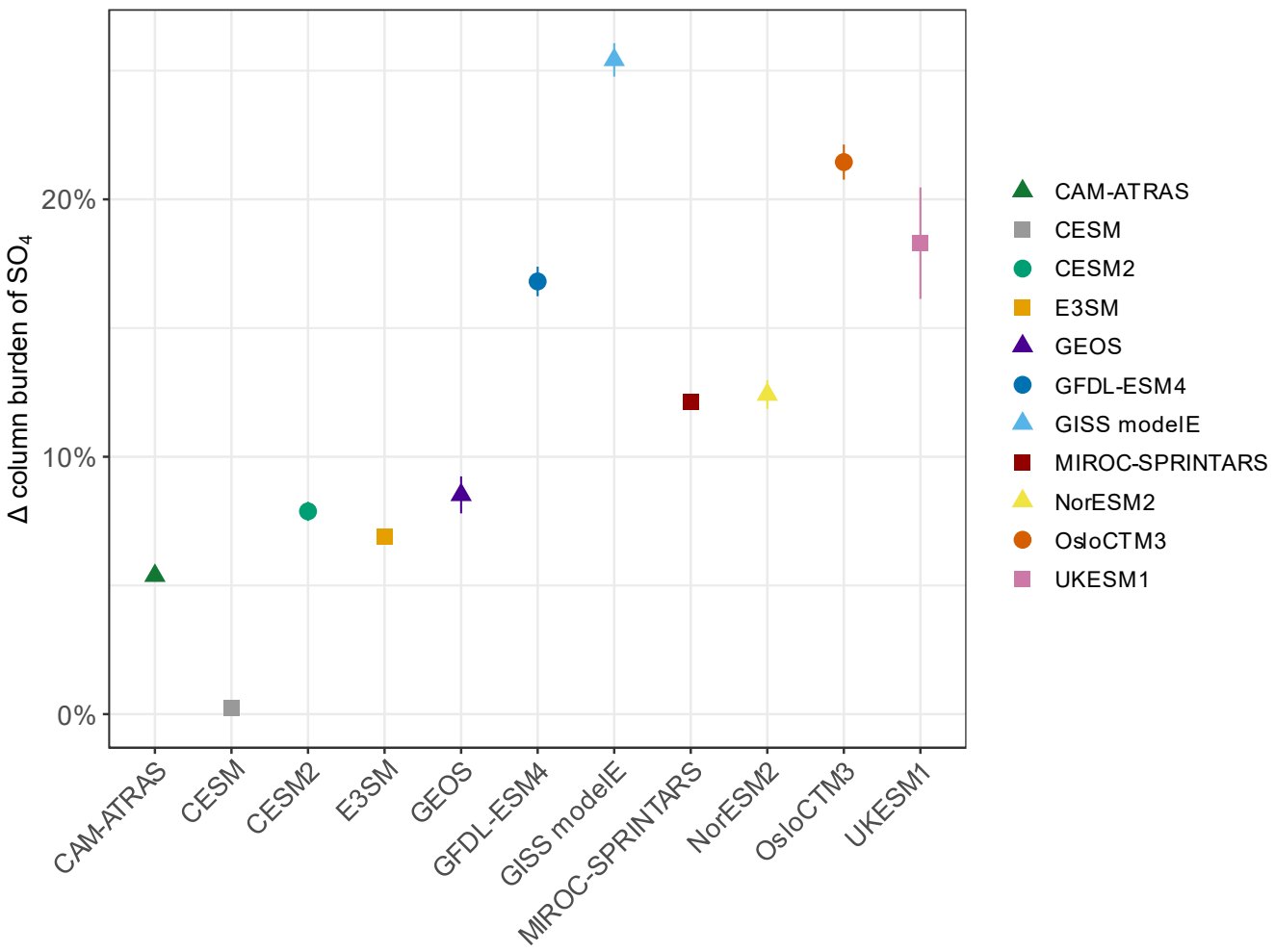

Figure S10: Percent difference (emission at height – reference) of global mean sulfate column burden. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The uncertainty bars represent interannual variability (± 1 σ).

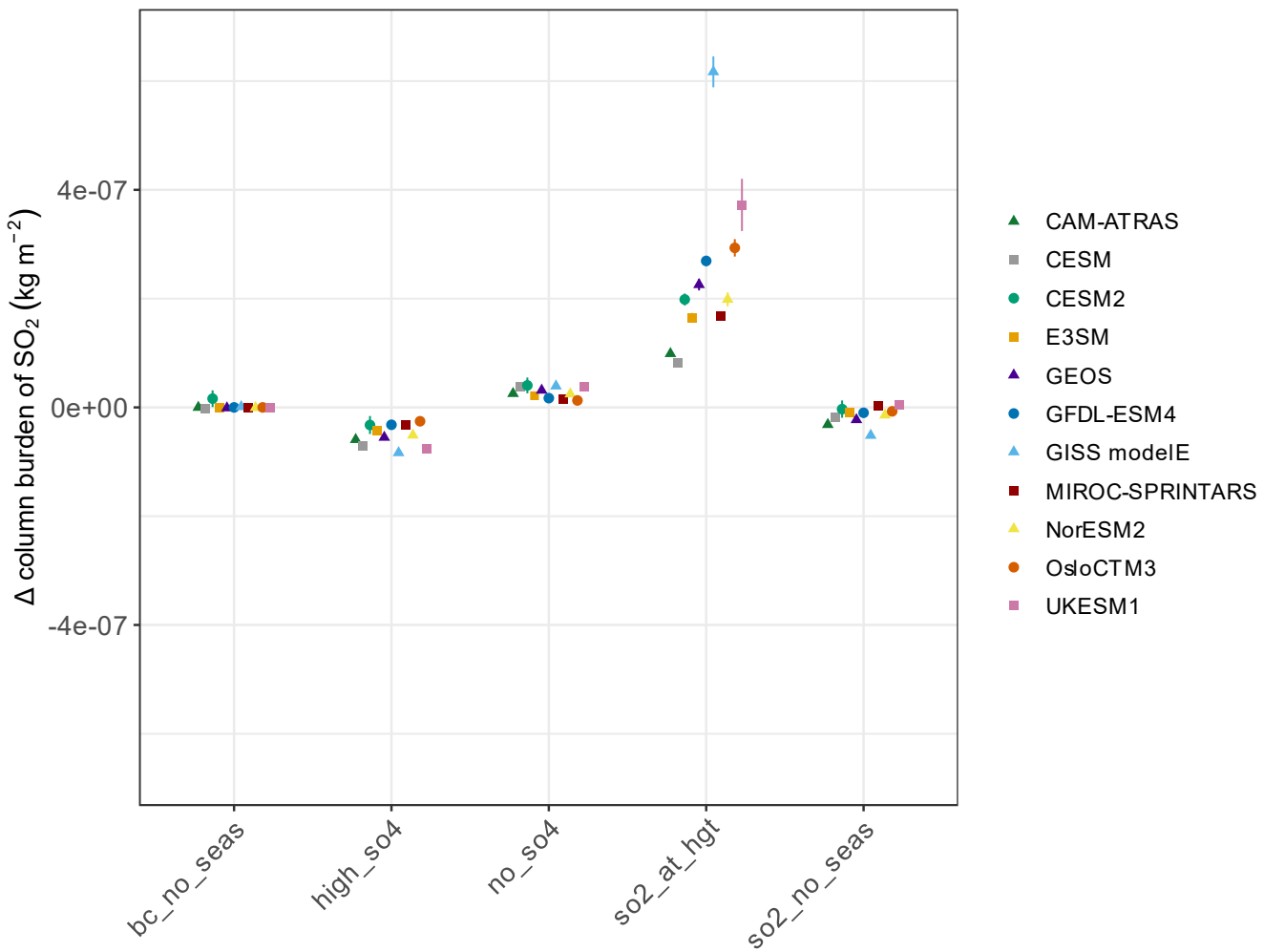

Figure S11: Absolute difference of global mean SO_2 column burden for each perturbation. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The uncertainty bars represent interannual variability (± 1 σ).

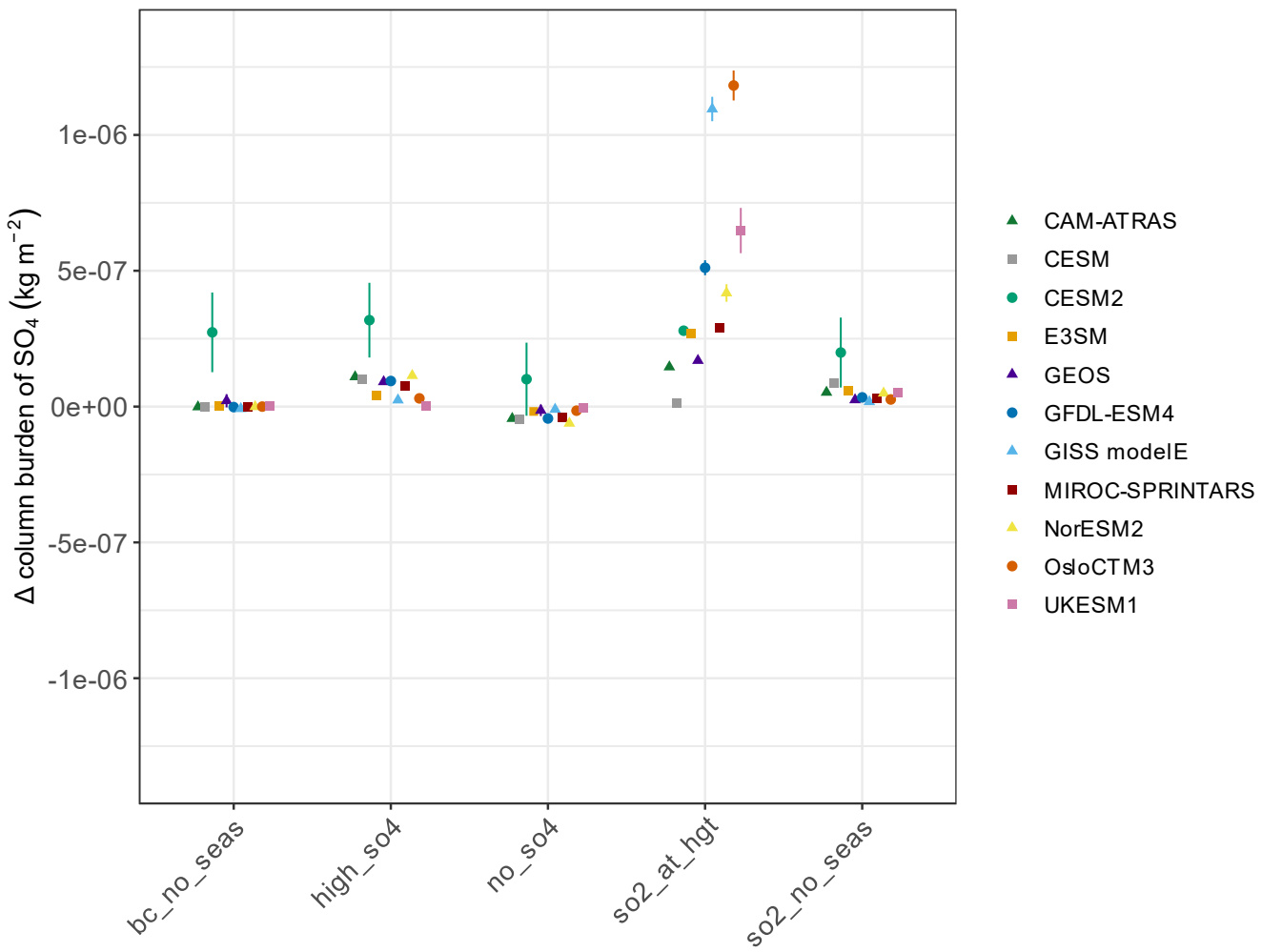

Figure S12: Absolute difference of global mean SO_4 column burden for each perturbation. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The uncertainty bars represent interannual variability (± 1 σ).

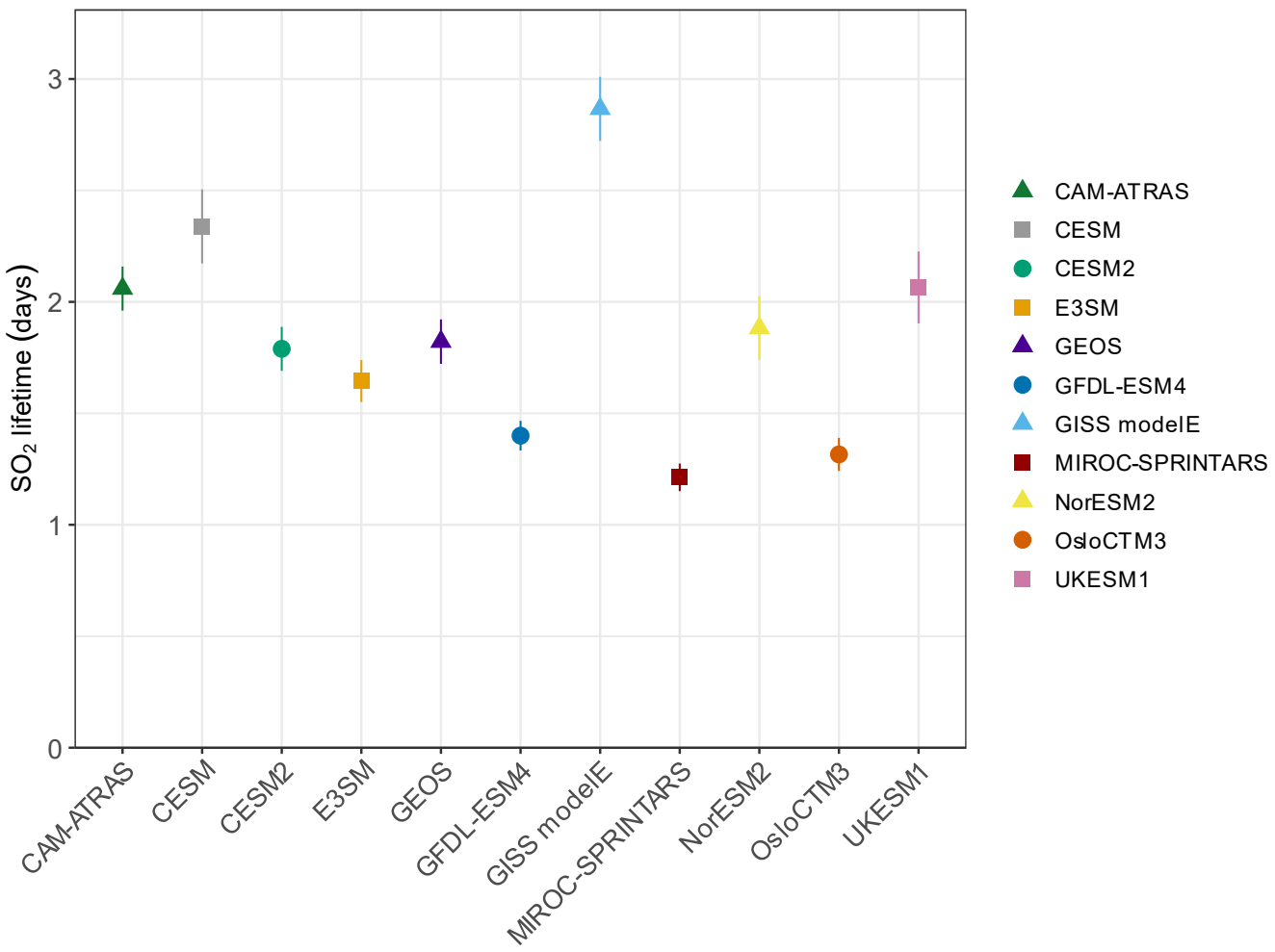

Figure S13: Northern Hemisphere land SO_2 lifetime of the emission at height perturbation simulations. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The error bars represent interannual variability (± 1 σ).

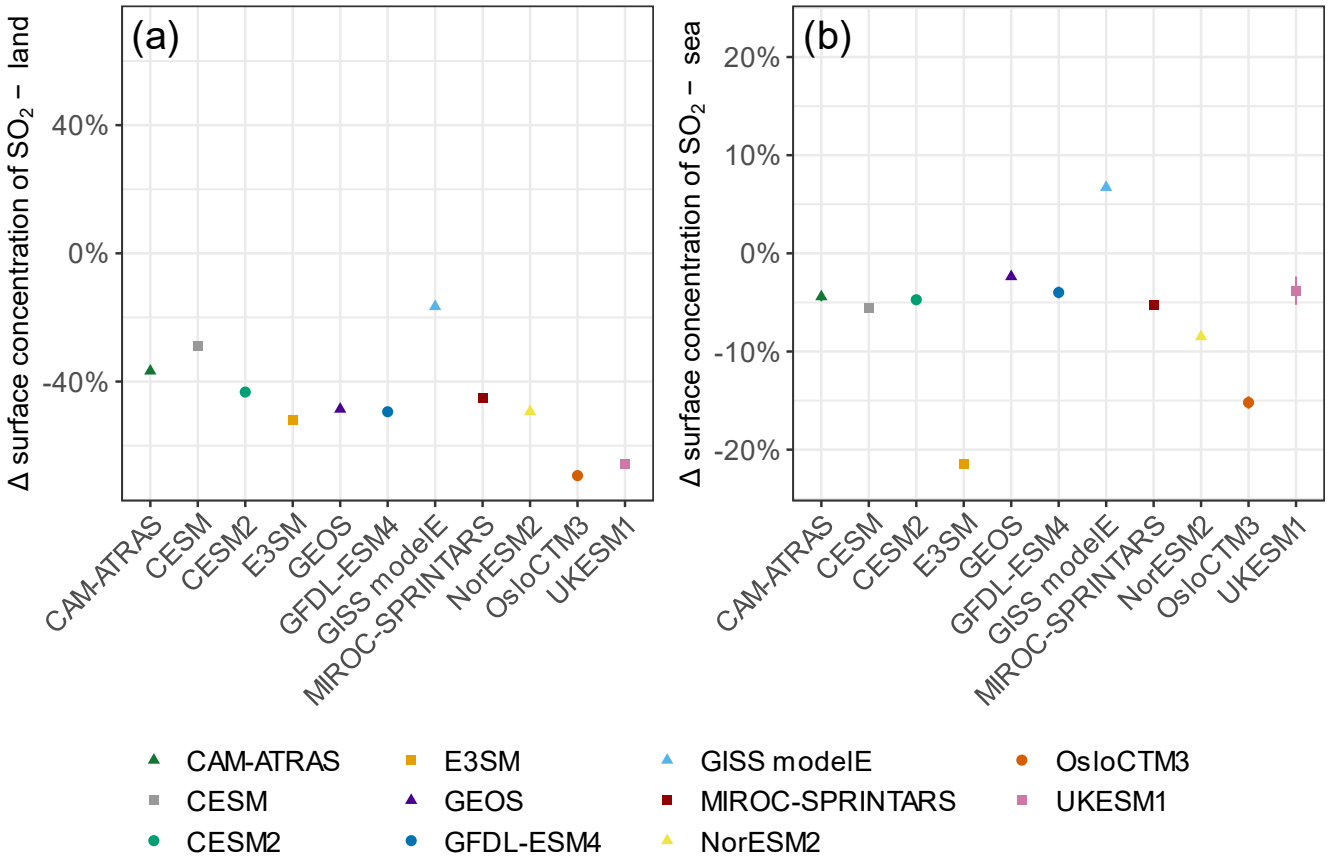

Figure S14: Percent difference (emission at height – reference) of (a) land surface concentration of SO_2 and (b) sea surface concentration of SO_2. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The error bars represent interannual variability (± 1 σ).

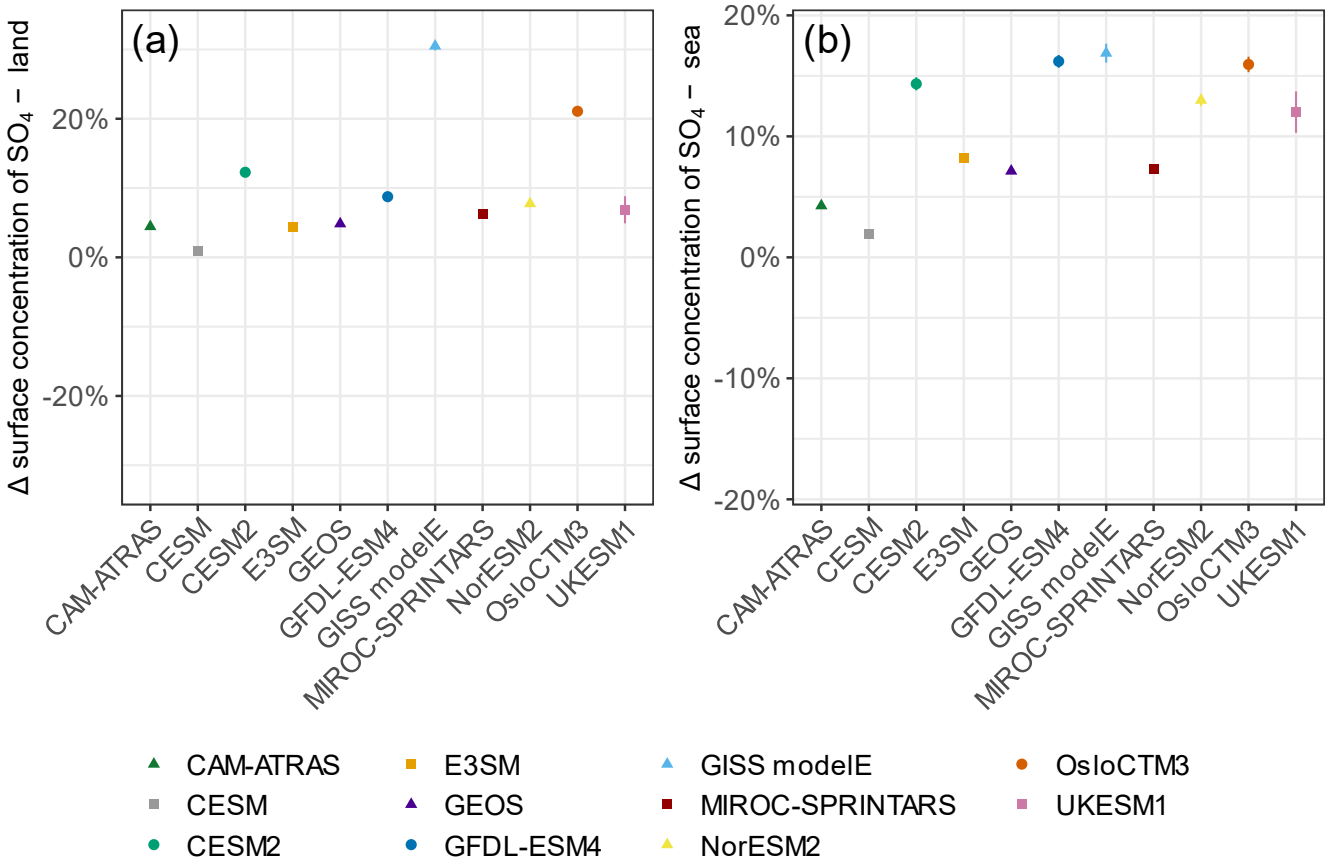

Figure S15: Percent difference (emission at height – reference) of (a) land surface concentration of SO_4 and (b) sea surface concentration of SO_4. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The error bars represent interannual variability (± 1 σ).

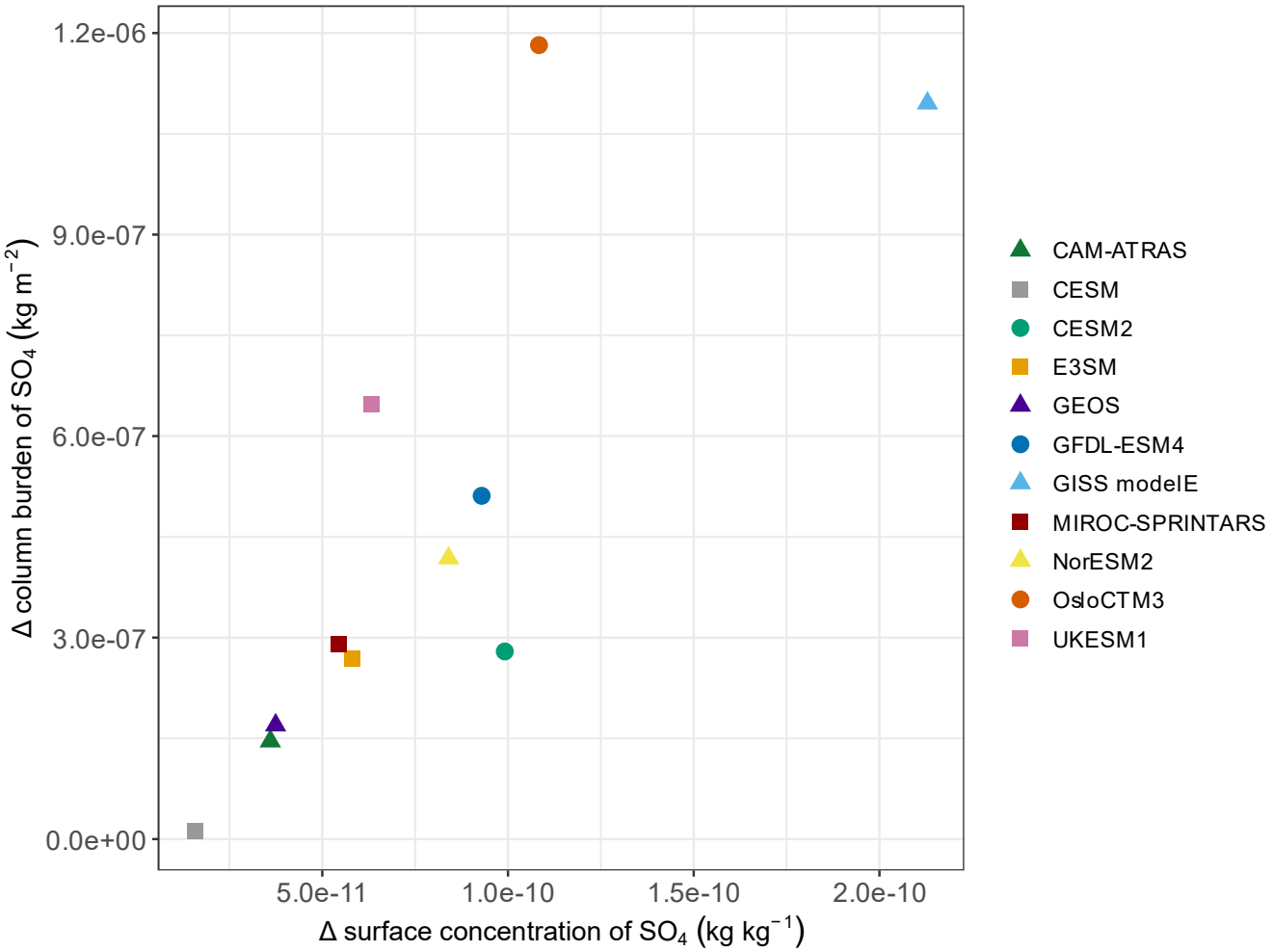

Figure S16: Absolute difference (emission at height – reference) of global mean sulfate column burden vs surface sulfate concentration. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005.

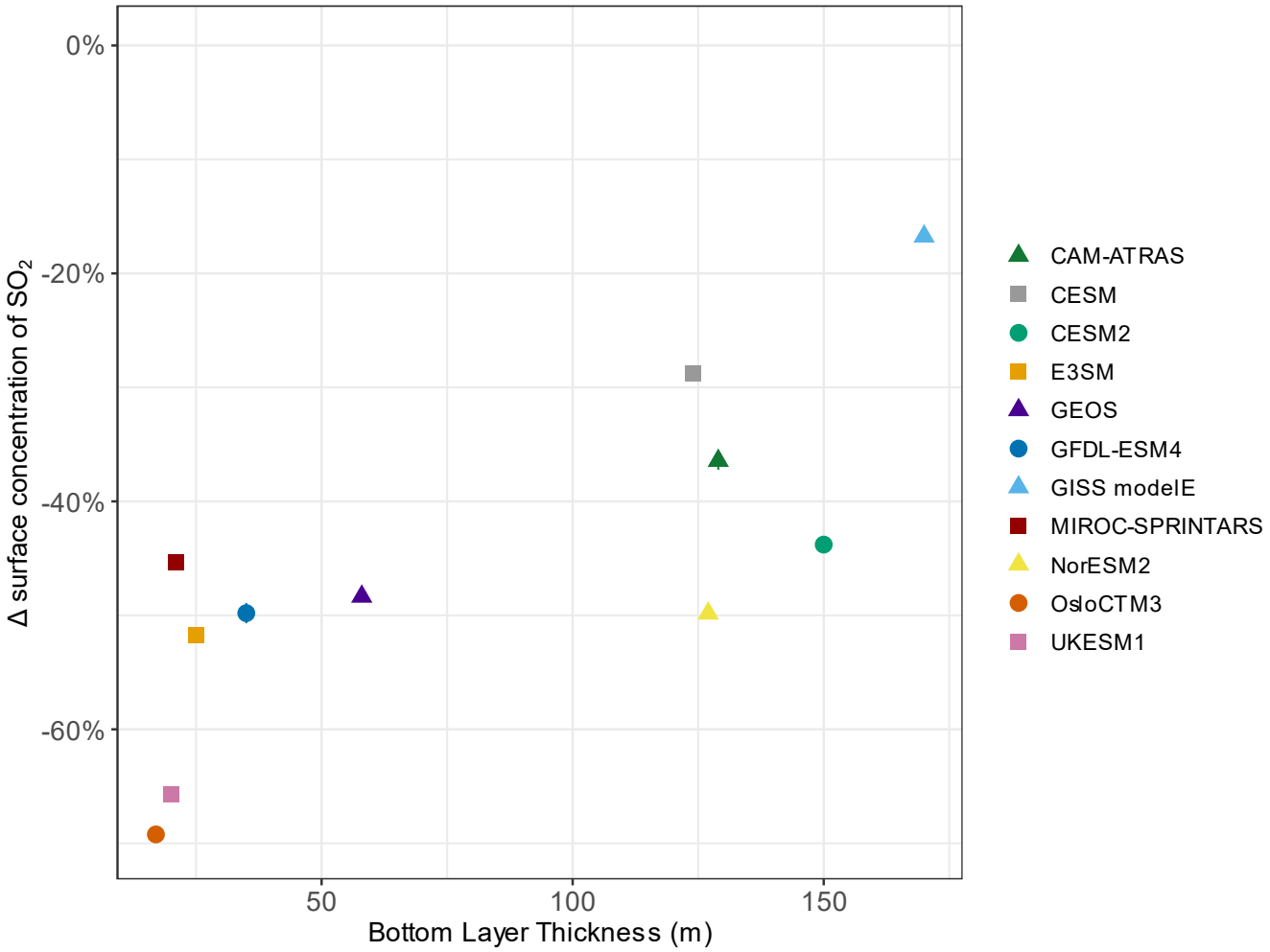

Figure S17: Percent difference (emission at height – reference) of Northern Hemisphere land SO_2 surface concentration vs bottom model layer thickness. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005.

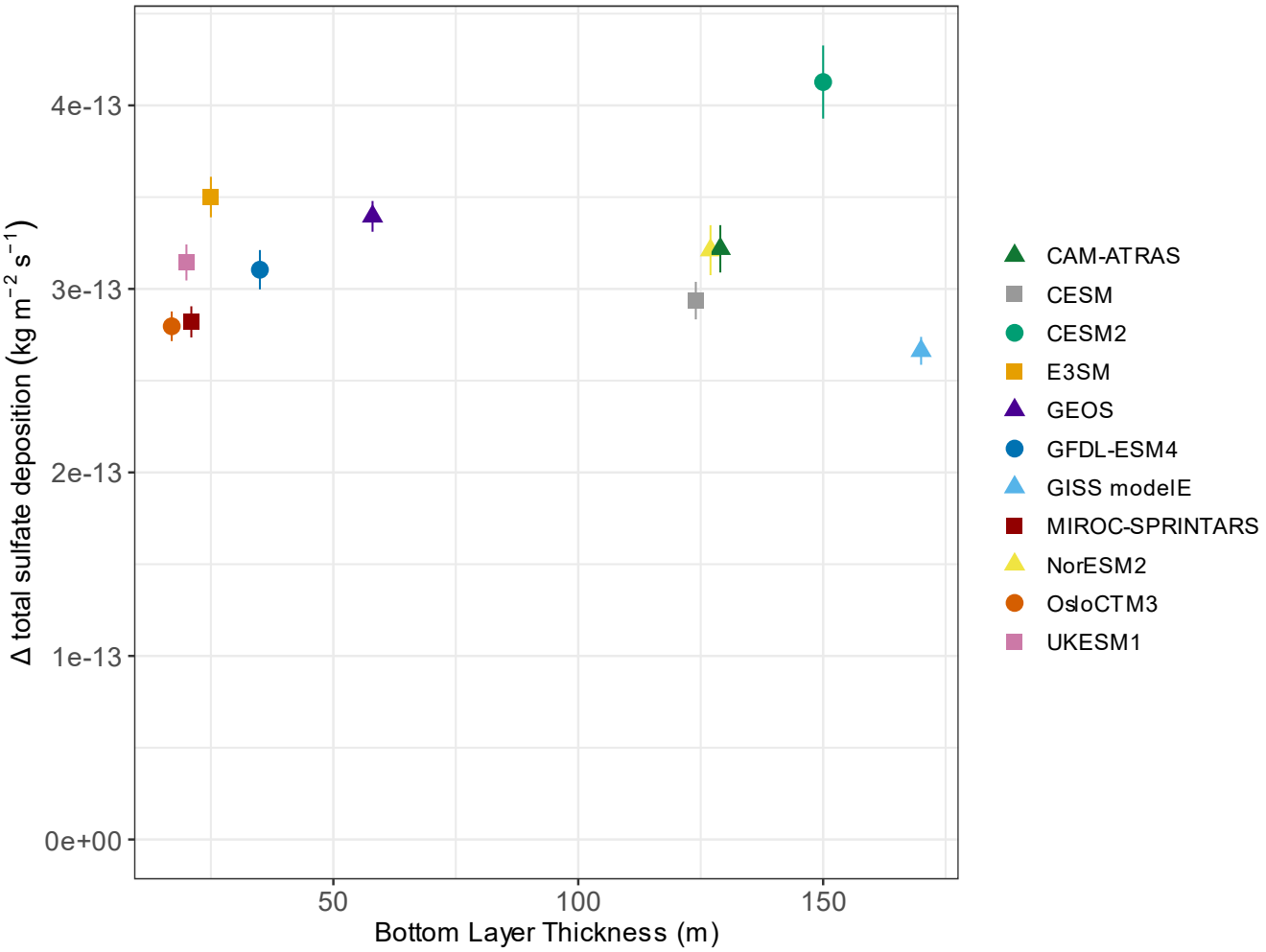

Figure S18: Absolute difference (high SO_4 – reference) of global mean total sulfate deposition vs bottom model layer thickness. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The error bars represent interannual variability (± 1 σ).

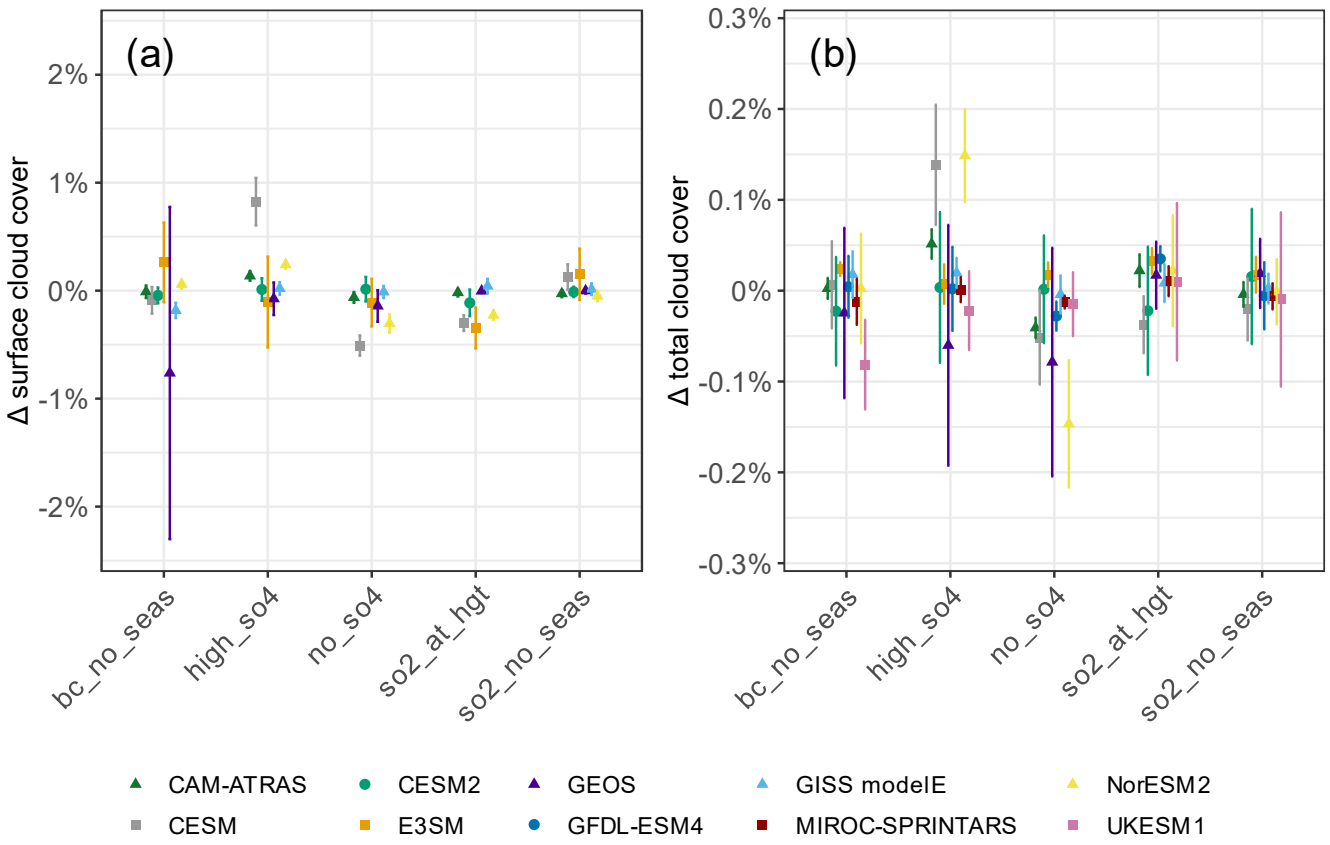

Figure S19: Percent difference of global mean (a) surface cloud cover and (b) total cloud cover for each perturbation. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The uncertainty bars represent interannual variability (± 1 σ).

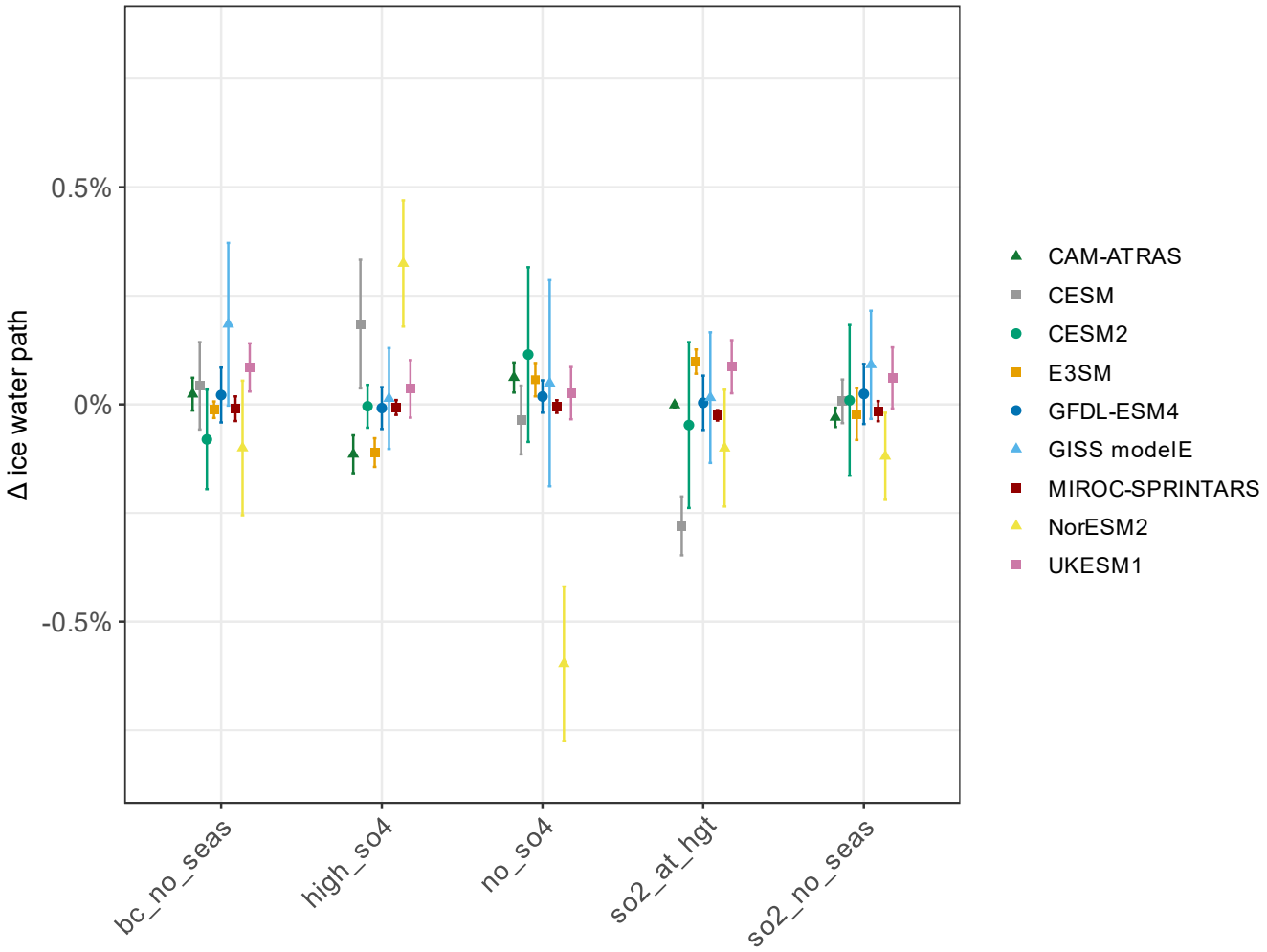

Figure S20: Percent difference of global mean ice water path for each perturbation. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The uncertainty bars represent interannual variability (± 1 σ).

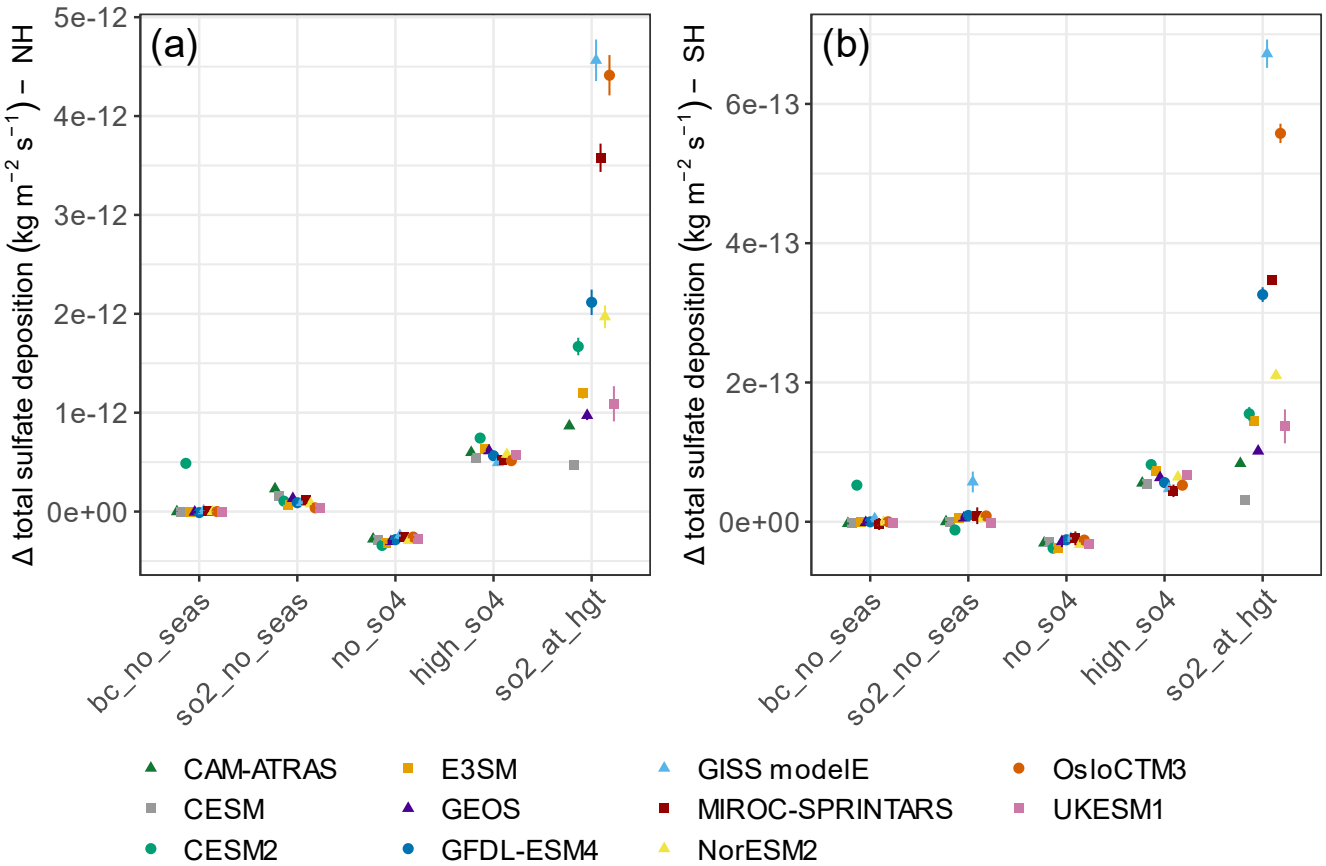

Figure S21: Absolute difference of (a) Northern Hemisphere total sulfate deposition and (b) Southern Hemisphere total sulfate deposition for each perturbation. All results are averaged over the years 2000 – 2004, except NorESM2 is averaged over 2001 – 2005. The uncertainty bars represent interannual variability (± 1 σ).

Table S1: Tabulated values of Figure S8 showing relative impact of deposition vs chemical conversion when estimating change in SO_2 lifetime over Northern Hemisphere land due to emission at height.

model	ΔSO_2 lifetime	ΔSO_2 lifetime (change in deposition rate only)	ratio
CAM-ATRAS	0.15	0.28	1.84
CESM	0.14		
CESM2	0.30	0.53	1.74
E3SM	0.26	0.34	1.30
GEOS	0.32	0.49	1.50
GFDL-ESM4	0.44	0.67	1.51
GISS modelE	0.80	1.55	1.94
MIROC-SPRINTARS	0.25	0.46	1.84
NorESM2	0.26	0.47	1.79
OsloCTM3	0.45	0.89	1.96
UKESM1	0.47	0.81	1.74
Avg	0.35	0.65	1.72
Avg (w/o GISS modelE)	0.31	0.55	1.69