



Supplement of

Aerosol–cloud interactions influence the climate response to AMOC weakening

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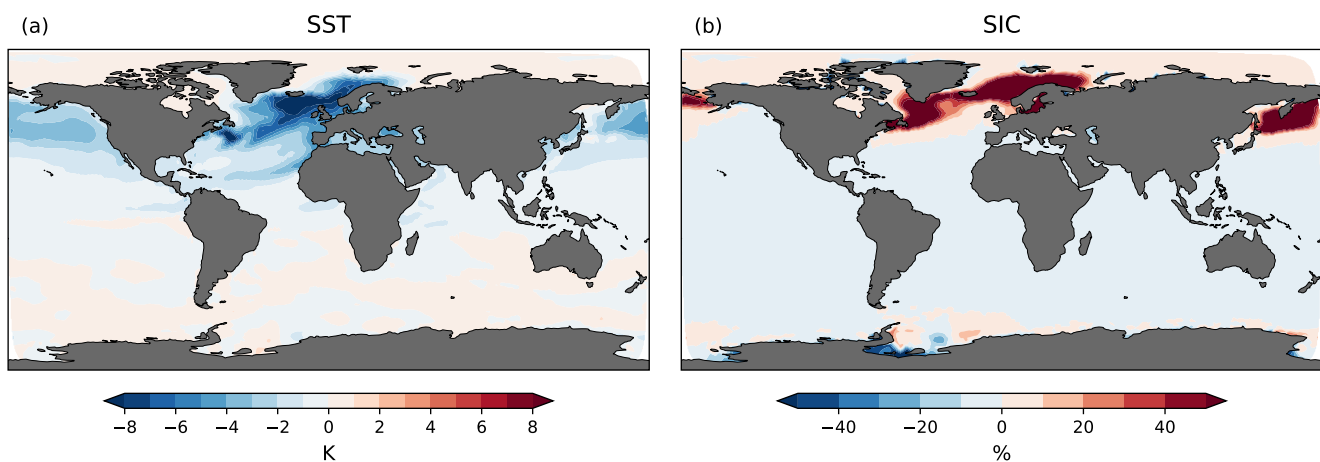


Figure S1. SST and sea-ice cover response to a 60% AMOC slowdown. Simulated annual mean changes in (a) Sea Surface Temperature (SST) and (b) Sea Ice Concentration (SIC). All changes represent the annual mean difference between the freshwater-hosing experiment and the control simulation performed with the EC-Earth3 climate model.

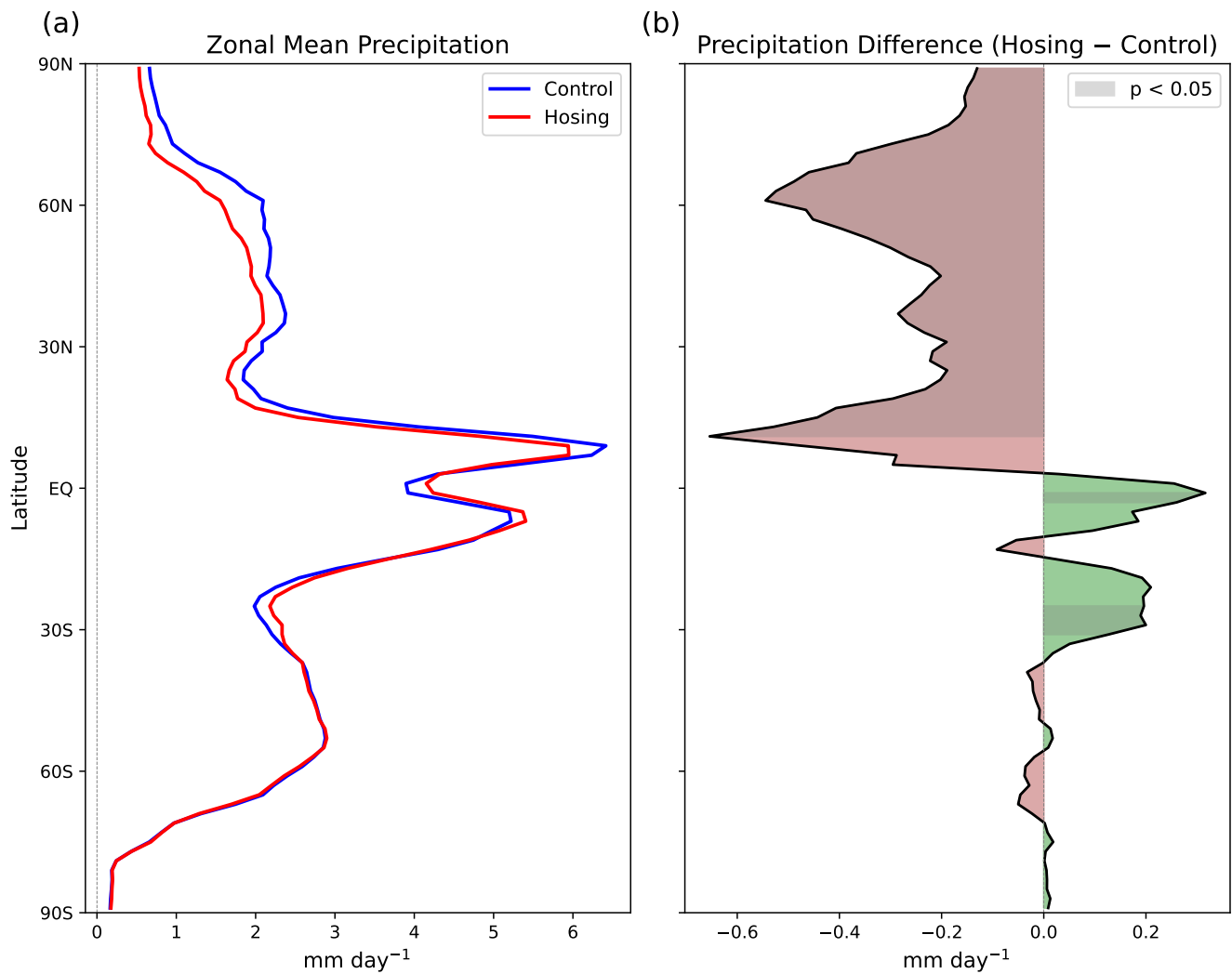


Figure S2. (a) Zonal mean precipitation as a function of latitude for the Control (blue line) and Hosing (red line) experiments. (b) Zonal mean precipitation difference (Hosing - Control). The shaded area under the curve illustrates the magnitude and direction of the change, with green and brown indicating positive and negative differences, respectively. The grey horizontal shaded bands denote latitudes where the precipitation difference is statistically significant ($p < 0.05$).

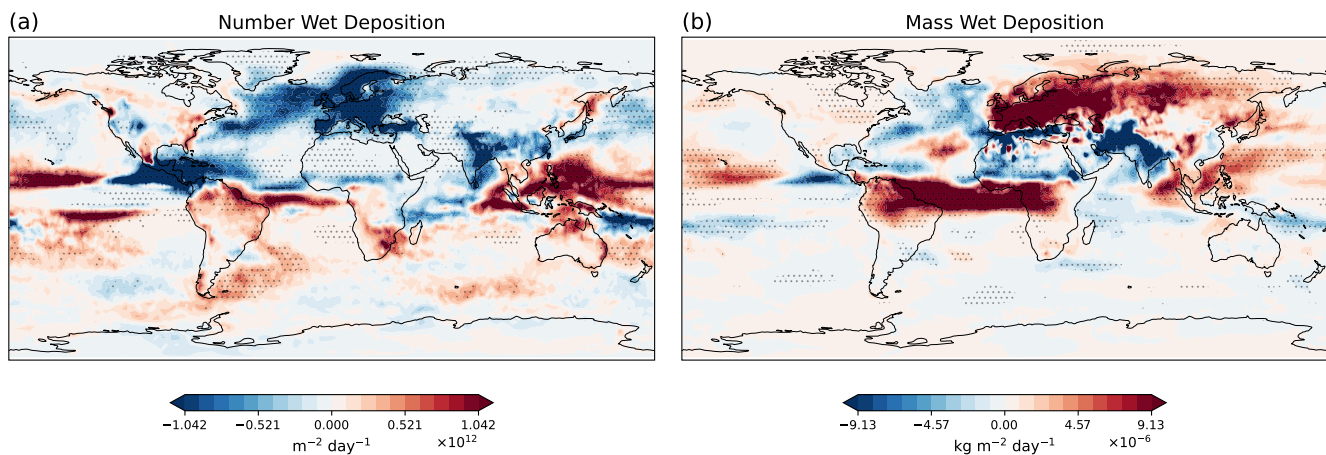


Figure S3. Global anomalies in (a) total aerosol number, and (b) aerosol mass wet deposition. Stippled regions indicate areas where the changes are statistically significant.

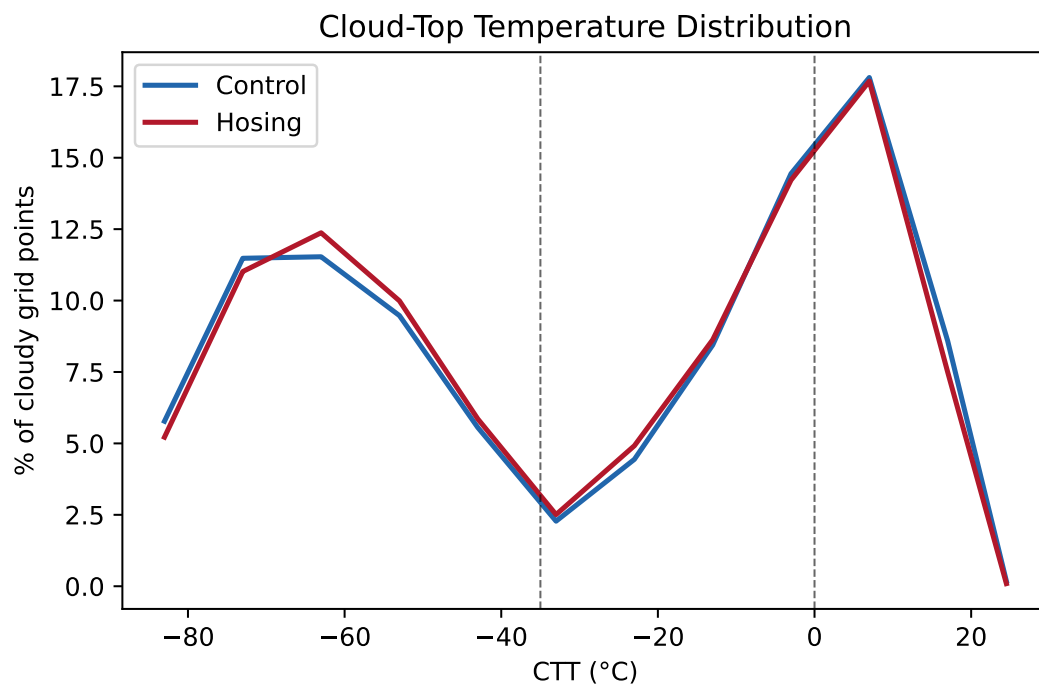


Figure S4. Normalised distribution of cloud-top temperature (CTT) for the Control (blue) and Hosing (red) simulations, expressed as a percentage of total cloudy grid points. Cloud-top temperature is diagnosed as the temperature at the highest model level where total water content exceeds $10^{-6} \text{ kg kg}^{-1}$. Data are binned in 5°C intervals from daily instantaneous output over 2000–2009.

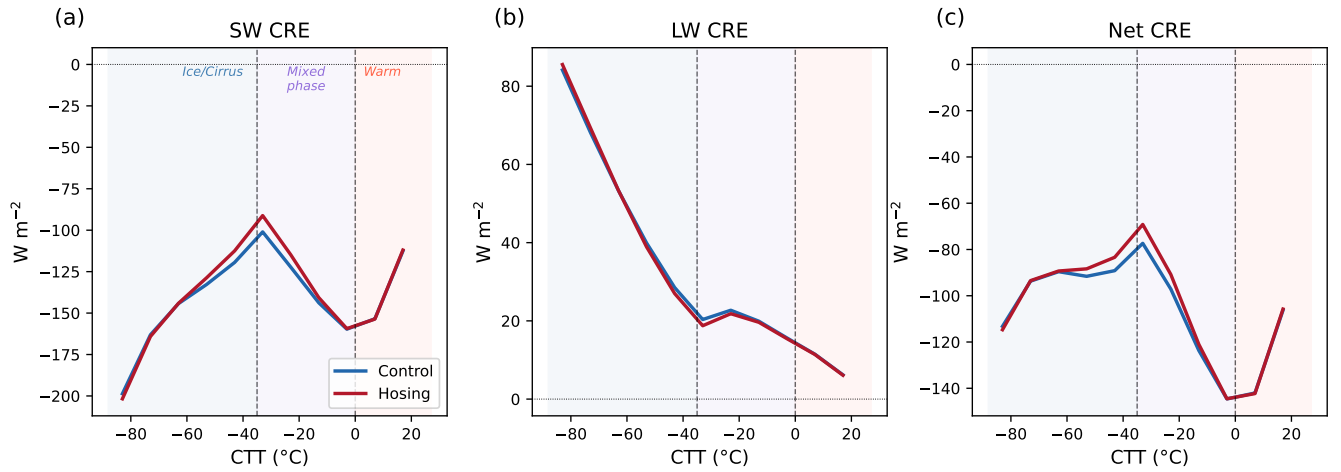


Figure S5. Absolute (a) shortwave (SW), (b) longwave (LW) and (c) net cloud radiative effect (CRE) as a function of cloud-top temperature (CTT) for the Control (blue) and Hosing (red) simulations, from instantaneous output sampled every six hours, with SW CRE restricted to daytime grid cells. Shading marks the ice and cirrus ($< -35^{\circ}C$), mixed-phase (-35 to $0^{\circ}C$) and warm ($> 0^{\circ}C$) regimes. The differences between the two simulations are shown in Fig. S6.

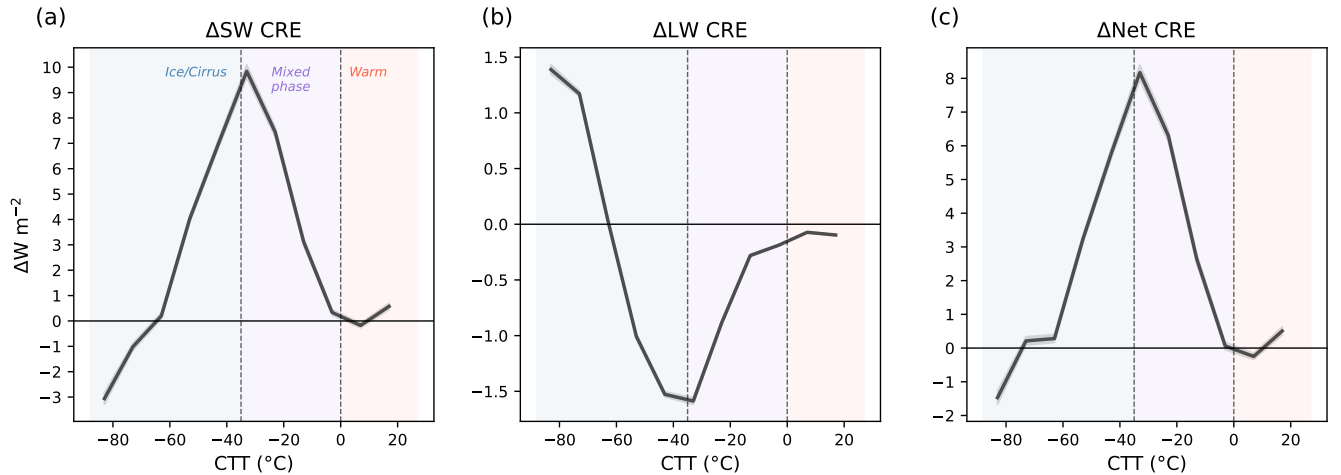


Figure S6. Differences (Hosing minus Control) in (a) shortwave (SW), (b) longwave (LW), and (c) net cloud radiative effect as a function of cloud top temperature, from instantaneous output sampled every six hours with SW CRE restricted to daytime grid cells. The anomalies are averaged over the columns that are cloudy in each bin and therefore describe the change per cloud, not per unit area. The corresponding absolute values for both simulations are shown in Fig. S5. Shading denotes ± 2 standard errors of the mean.

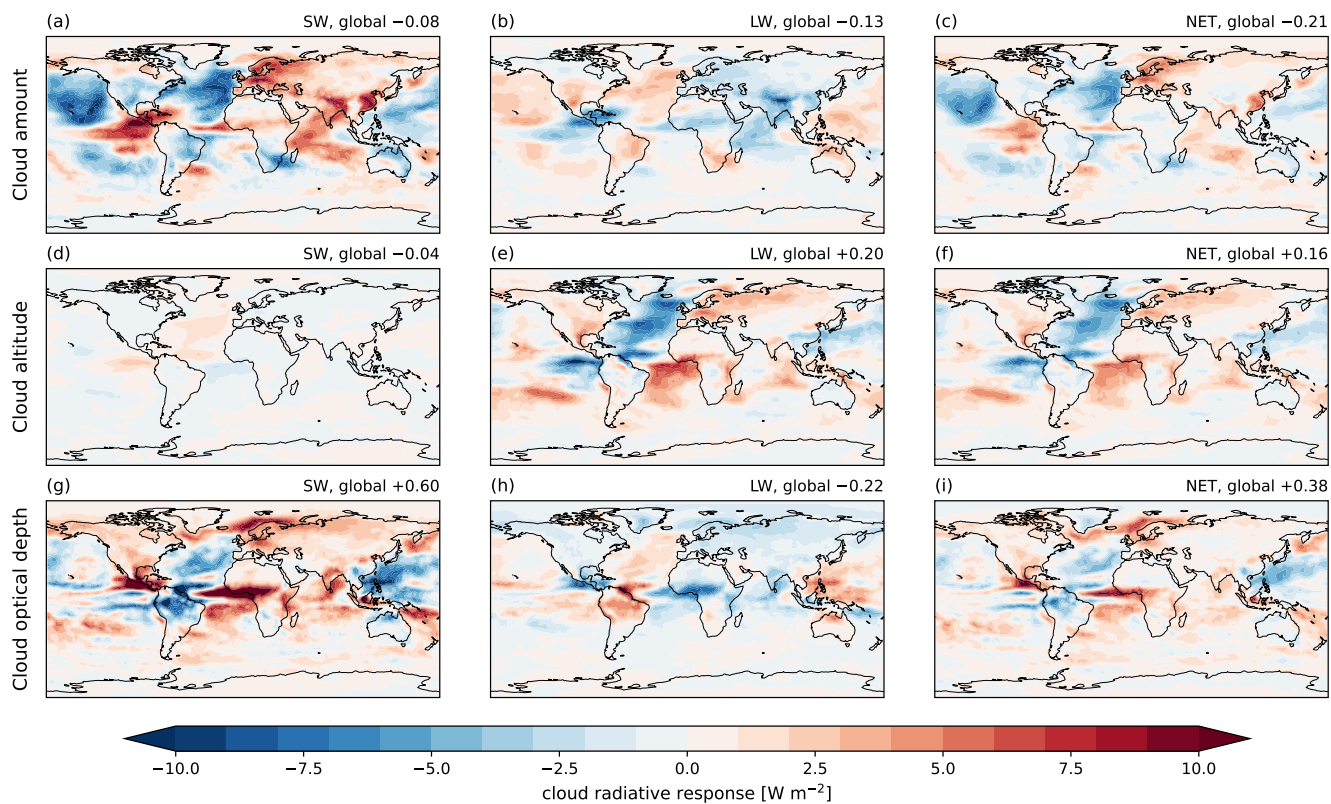


Figure S7. Maps of the cloud radiative response (Hosing – Control) decomposed with ISCCP simulator cloud radiative kernels into (a–c) cloud amount, (d–f) cloud altitude and (g–i) cloud optical depth components, for the shortwave (left), longwave (middle) and net (right). Global means in W m^{-2} are given above each panel. The kernel residual is not shown. The decomposition is applied to the 10-year monthly climatology of the ISCCP simulator histograms.

Table S1. Closure of the top of atmosphere shortwave response (Hosing – Control, W m^{-2} , positive downward, 2000–2009). The cloud term is from ISCCP simulator cloud radiative kernels, the surface albedo term from APRP, and the aerosol term is the all sky shortwave effective radiative forcing due to aerosol–radiation interactions (ERF_{ari}) from the aerosol free double radiation call. Term (4) is the APRP non-cloud term computed from the aerosol-free fluxes, attributed mainly to water vapour. The last row replaces the kernel cloud term by the APRP cloud term. Percentages give each sum relative to the simulated change. SPNA denotes the subpolar North Atlantic ($50\text{--}65^\circ\text{N}$, $60\text{--}10^\circ\text{W}$).

Term	Global	40–90°N	SPNA
Simulated ΔSW	–1.12	–5.06	–16.29
(1) Cloud, kernel	+0.50	+1.44	–1.15
(2) Surface albedo, APRP	–0.83	–4.60	–13.03
(3) ERF_{ari}	–0.28	–0.22	+0.27
Sum (1)–(3)	–0.61 (55 %)	–3.39 (67 %)	–13.91 (85 %)
(4) Clear atmosphere (mainly water vapour), APRP	–0.33	–0.61	–0.09
Sum (1)–(4)	–0.95 (85 %)	–4.00 (79 %)	–14.00 (86 %)
Residual	–0.17	–1.06	–2.29
Cloud, APRP	+0.34	+0.59	–3.01
Sum (1)–(4) with APRP cloud	–1.10 (98 %)	–4.85 (96 %)	–15.85 (97 %)