**Supporting Information of:**

Opposing transient and equilibrium effective radiative forcing from aerosol-cloud interactions

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# Contents



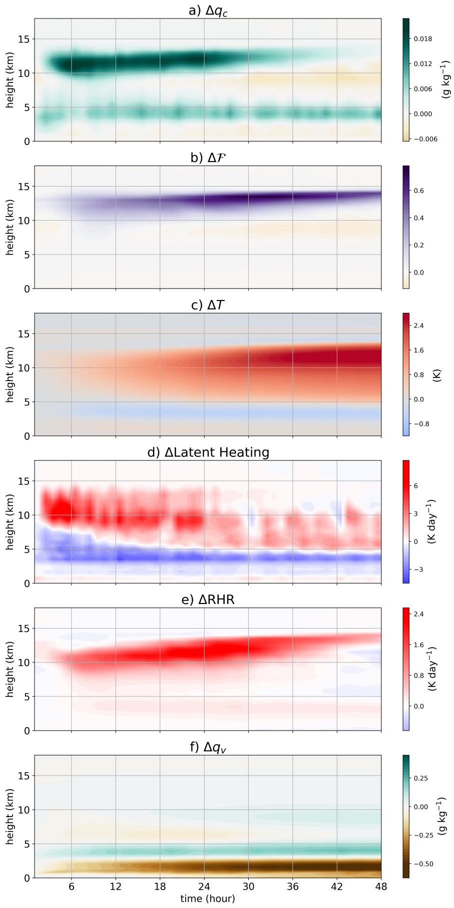


Figure S1: **Temporal-vertical evolution of domain-mean properties following an instantaneous aerosol perturbation.** Ensemble-mean Hovmöller diagrams of changes in cloud properties and environmental conditions following an aerosol perturbation. Presented are the domain-mean change in: (a) combined cloud water and ice mixing ratio, $\Delta q_c$, (b) cloud fraction, $\Delta\mathcal{F}$, (c) temperature anomaly, $\Delta T$, (d) latent-heating tendency, ΔLatent Heating, (e) radiative heating rate, ΔRHR, and (f) water vapor mixing ratio, $\Delta q_v$. All panels display the ensemble mean and therefore emphasize the robust, forced response rather than individual realizations. This Figure is similar to Fig. 2 from the main text but zoomed-in over the first 2 days.

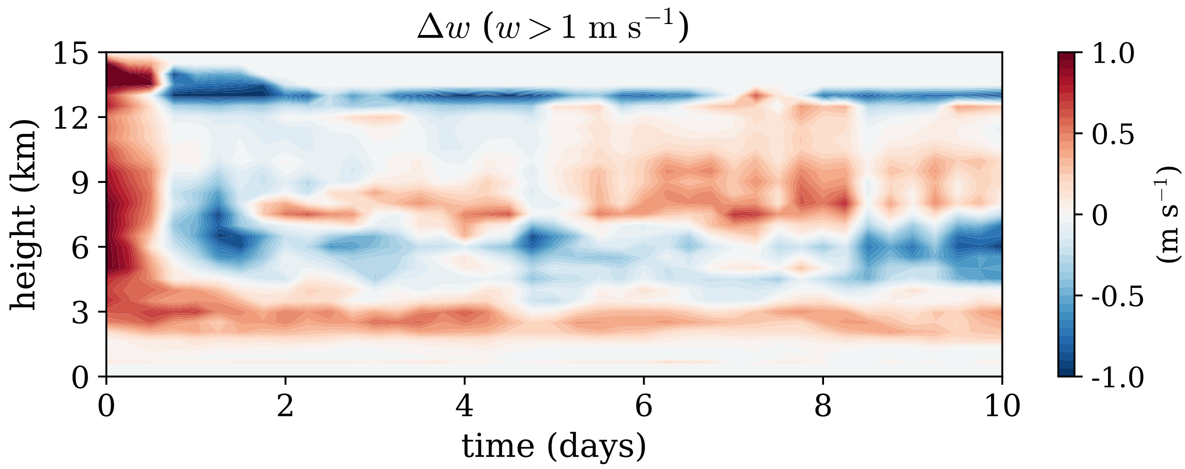


Figure S2: **Temporal-vertical evolution of domain-mean convective core vertical velocity response following an instantaneous aerosol perturbation.** Ensemble-mean Hovmöller diagrams of changes in convective core (defined as grid cells with vertical velocity exceeding 1 m s$^{-1}$ and total condensate $> 10^{-5}$ g g$^{-1}$) vertical velocity ($\Delta w$) following an aerosol perturbation. This figure presents the ensemble mean and therefore emphasize the robust, forced response rather than individual realizations.

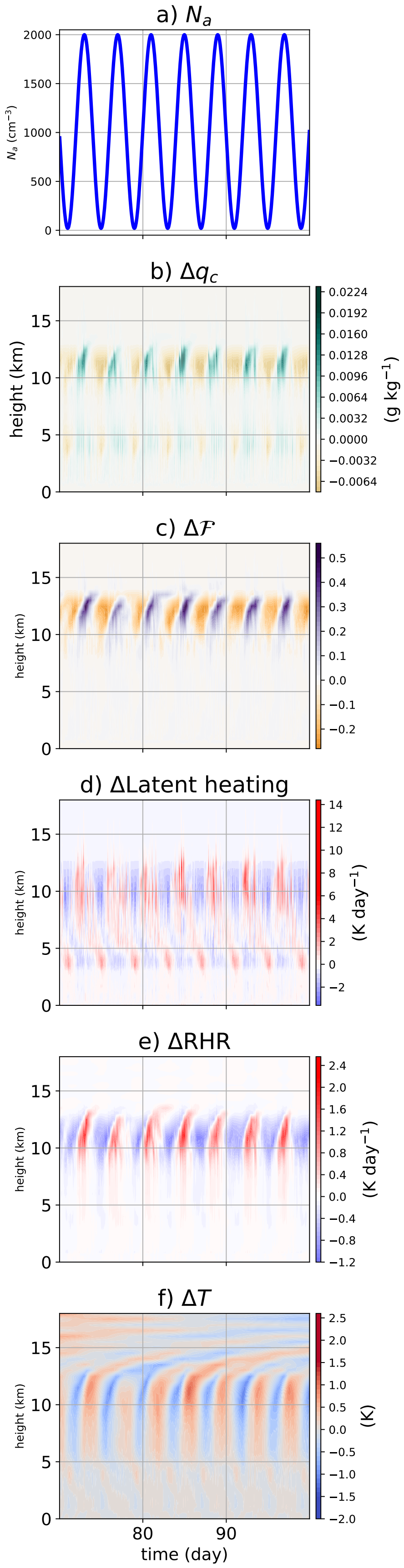


Figure S3: **Temporal-vertical evolution of domain-mean properties.** Hovmöller diagrams of cloud properties and environmental conditions in a simulation with continuously evolving aerosol conditions. Shown are the domain-mean: (a) imposed $N_a$ conditions; (b) changes in total condensate mixing ratio ($\Delta q_c$); (c) cloud fraction ($\Delta\mathcal{F}$); (d) latent heating tendency (ΔLatent heating); (e) radiative heating rate (ΔRHR); and (f) temperature anomaly ($\Delta T$). Panels (b)–(f) show deviations from the time-mean values.

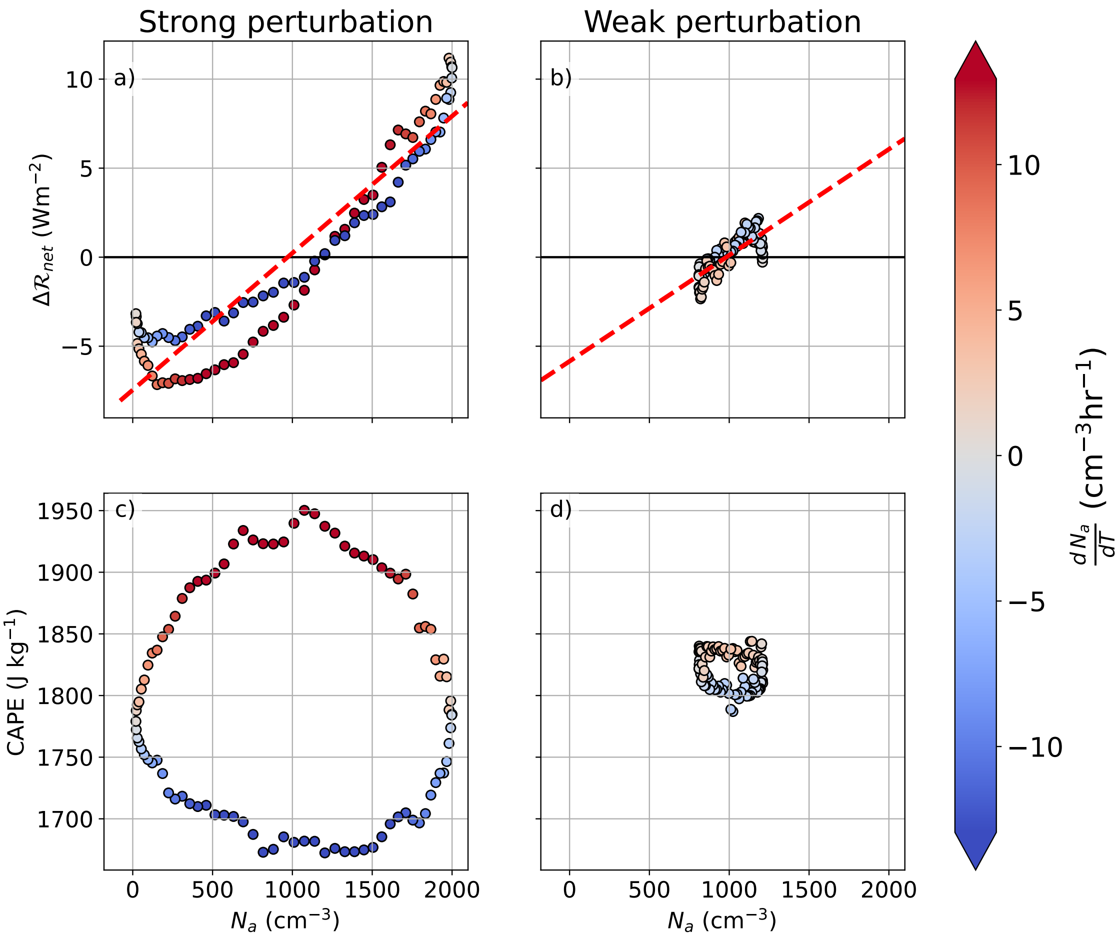


Figure S4: **Strong versus weak aerosol perturbations.** Evolution of $\Delta\mathcal{R}_{\text{net}}$ (a–b) and Convective Available Potential Energy (CAPE; c–d) versus $N_a$ for simulations with a 4-day $N_a$ oscillation period under high ($\sim$1000 cm$^{-3}$; a and c) and low (200 cm$^{-3}$; b and d) amplitude oscillations. The presented data are composited over all oscillations during the final 30 days of each simulation. Colors indicate the rate of change in $N_a$. In panels (a) and (b), the red dashed curves indicate linear regressions computed over all scatter points. $\Delta\mathcal{R}_{\text{net}}$ is calculated relative to the time-mean $\mathcal{R}_{\text{net}}$ over the last 30 days of each simulation.

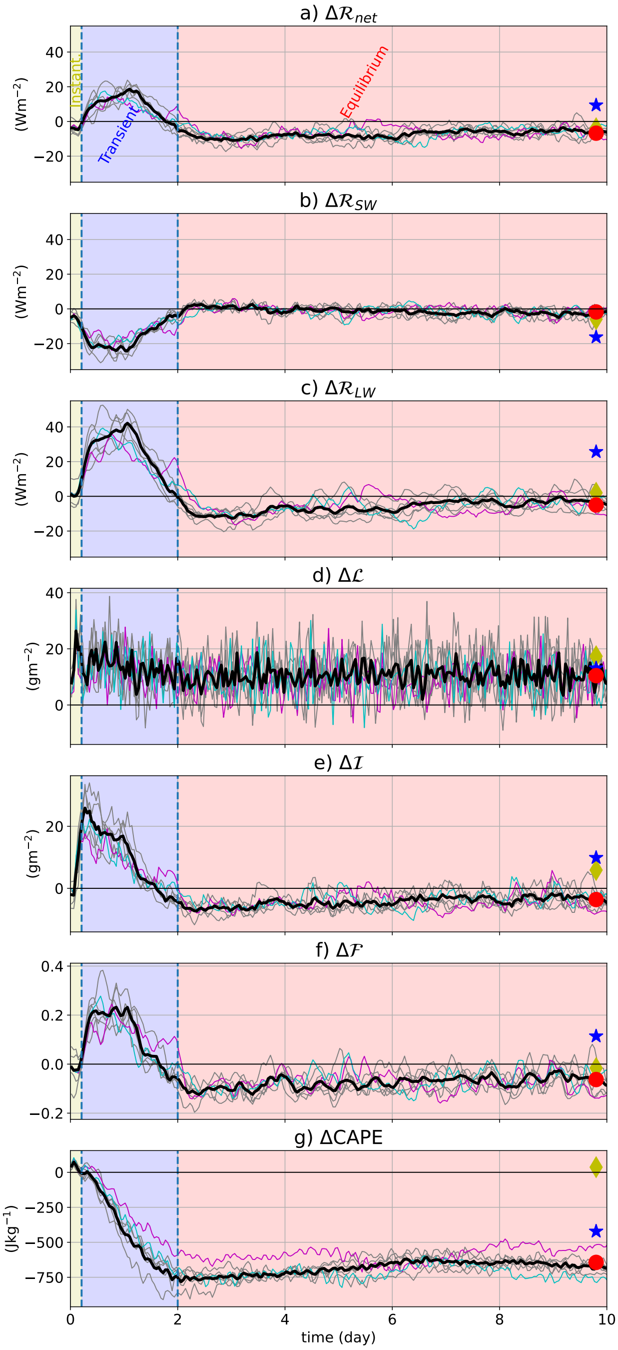


Figure S5: **Temporal evolution of domain-mean radiative and cloud properties following an instantaneous aerosol perturbation.** The ensemble members (gray curves) and ensemble-mean (black thick curves) change in domain-mean properties relative to equilibrium conditions in a clean simulation. Presented are the domain-mean change in: (a) top-of-atmosphere (TOA) net radiative energy gain, $\Delta\mathcal{R}_{net}$, (b) TOA shortwave radiative energy gain, $\Delta\mathcal{R}_{SW}$, (c) TOA longwave radiative energy gain, $\Delta\mathcal{R}_{LW}$, (d) liquid water path ,$\Delta\mathcal{L}$, (e) ice water path ,$\Delta\mathcal{I}$, (f) cloud fraction ,$\Delta\mathcal{F}$, and, (g) convective available potential energy ,Δ CAPE. Yellow diamonds on the right side of each panel represent the instantaneous response (averaged over the first five hours). Blue stars denote the transient time-mean response (from 5 hours to 2 days following the aerosol perturbation), and red dots indicate the equilibrium mean response (days 2–100). The figure focuses on the first 10 days of 100-day-long simulations. This figure is similar to Fig. 1 in the main text but presents two additional sensitivity simulations with $k = 1$ in the microphysical scheme (magenta) and with 1-minute radiative calculation resolution (cyan). See details in the main text.