Effect of contrail overlap on radiative impact attributable to aviation contrails

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Supplementary Information

Figure S1. Effect of overlaps on contrail-attributable RFₜₜ as a function of the optical depth τ of each layer. Left: system contrail-contrail; right: system cloud-contrail. Negative RF is shown in blue and positive RF is shown in red. Lower and upper contrail properties are the following: asymmetry parameter of 0.77, temperature of 220 K and 215 K respectively. Cloud properties are the following: asymmetry parameter of 0.85, temperature of 260 K. The solar zenith angle (θ) is held at 45° for all cases.
Figure S2. Effect of overlaps on system RF$_{LW}$ varying with optical depth $\tau$. Same properties as Fig. S1.

Figure S3. Effect of overlaps on system net RF varying with layer temperature. Left: system contrail-contrail; right: system cloud-contrail. Negative RF is shown in blue and positive RF is shown in red. Lower and upper contrail properties are the following: asymmetry parameter of 0.77, optical depth of 0.3. Cloud properties are the following: asymmetry parameter of 0.85, optical depth of 3. Fixed $\theta = 45^\circ$. Cases where the upper layer is warmer than the lower are not shown.
Figure S4. System contrail-contrail net RF in W/m², varying with local conditions (solar zenith angle θ increasing from left to right, outgoing longwave radiation and Earth surface temperature $T_{srf}$ (based on Corti and Peter, 2009) and albedo $\alpha$). Upper row: system RF when contrails considered independent. Lower row: system RF when accounting for total overlap. Negative RF is shown in blue and positive RF is shown in red. Lower and upper contrail properties are the following: asymmetry parameter of 0.77, optical depth of 0.3, temperature of 220 K and 215 K respectively.

Figure S5. Global sensitivity to contrail-contrail overlap (RF = RF₀ – RF₁)