Effect of contrail overlap on radiative impact attributable to aviation contrails

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Supplementary Information

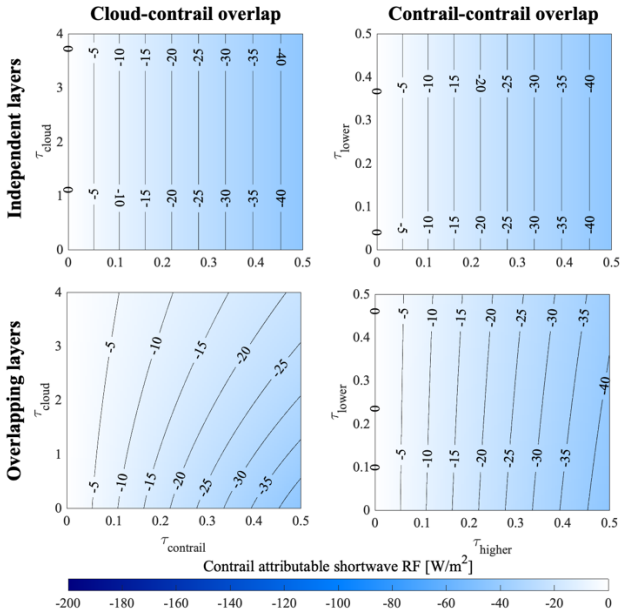

Figure S1. Effect of overlaps on contrail-attributable RF_{SW} as a function of the optical depth τ of each layer. Left: system contrail-contrail; right: system cloud-contrail. Negative RF is shown in blue and positive RF is shown in red. Lower and upper contrail properties are the following: asymmetry 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.

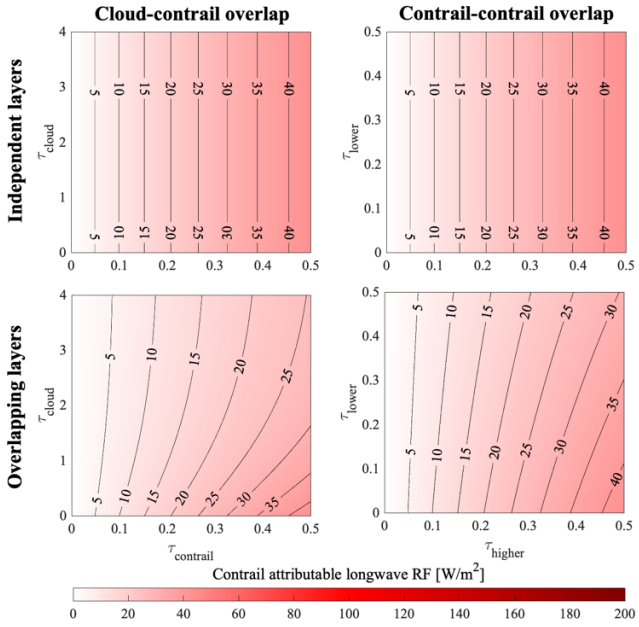

Figure S2. Effect of overlaps on system RF_{LW} varying with optical depth τ. Same properties as Fig. S1.

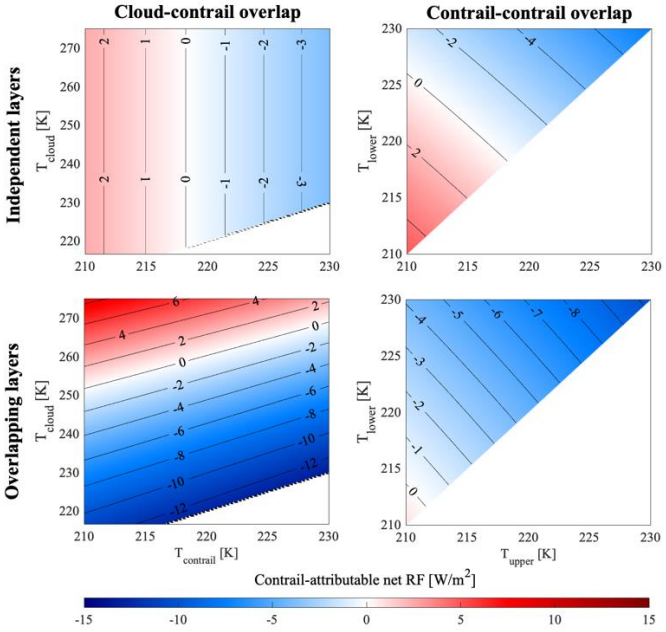

Figure S3. Effect of overlaps on system net RF varying with layer temperature. Left: system contrail-contrail; right: system cloud-contrail. Negative RF is shown in blue and positive RF is shown in red. Lower and upper contrail properties are the following: asymmetry parameter of 0.77, optical depth of 0.3. Cloud properties are the following: asymmetry parameter of 0.85, optical depth of 3. Fixed θ = 45°. Cases where the upper layer is warmer than the lower are not shown.

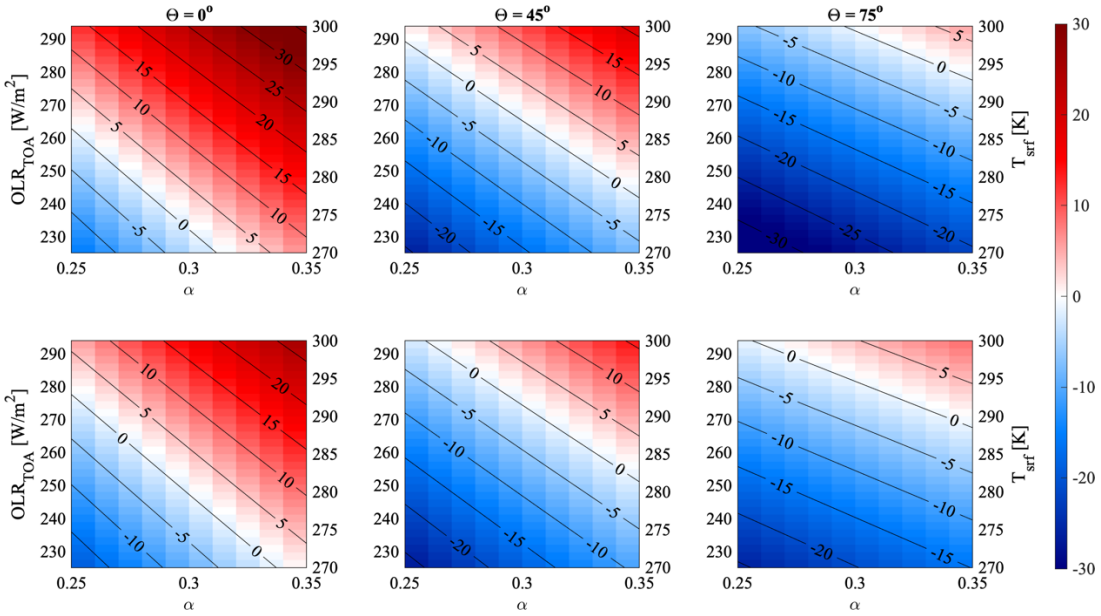

Figure S4. System contrail-contrail net RF in W/m^2, varying with local conditions (solar zenith angle θ increasing from left to right, outgoing longwave radiation and Earth surface temperature T_{srf} (based on Corti and Peter, 2009) and albedo α). Upper row: system RF when contrails considered independent. 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.

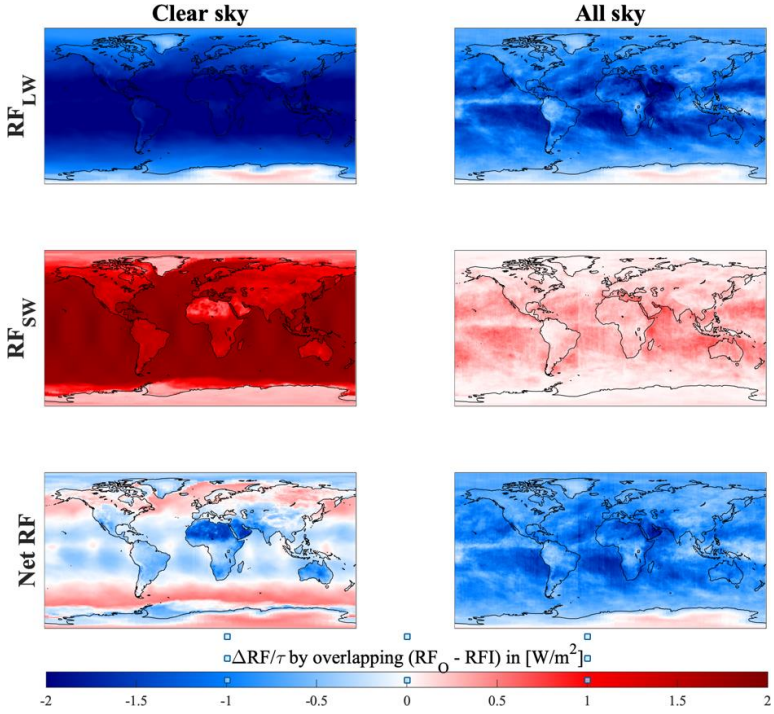

Figure S5. Global sensitivity to contrail-contrail overlap (RF = RF_O – RF_I)