Supplementary Information for

Aerosol presence reduces diurnal temperature change: An interval when the COVID-19 pandemic reduced aerosols revealed the climate effect

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Model and experiments.

We further examine the role of aerosol reduction on the radiative forcing and DTR by employing the WRF-GC model (Lin *et al.*, 2020; Feng *et al.*, 2021). The model is a recent version of an online two-way coupling of the Weather Research and Forecasting model and the GEOS-Chem chemical model (http://wrf.geos-chem.org). The model domain covers the most regions of China (76.5°-133.5° E, 6.3°-44.5° N) at a grid resolution of 27 km × 27 km. All experiments are performed during January 5th to February 28th in 2020, and the results in February are used for analyses.

We design two comparable experiments forced by different anthropogenic emissions. In the control experiment, the monthly anthropogenic emission scenario is derived from the Multi-resolution Emission Inventory for China (MEIC; Zheng *et al.*, 2018) with a resolution of 0.25° × 0.25° at the year 2017, then scale to the emission level of 2019 based on Zheng *et al.* (2020). In the lockdown experiment, the anthropogenic emissions during the COVID-19 pandemic are estimated based on the reported reduction ratios from 2019 to 2020 (Zheng *et al.*, 2020).

The difference between the two experiments can represent the response of radiative forcing to the AOD change during the COVID-19 pandemic. We focus on the changes of shortwave radiation and long-wave radiation fluxes because they reflect the changes of daytime/nighttime radiation budget. The mean shortwave radiation and long-wave radiation over the locations of GSOD stations in China and the five regions are calculated for each experiment (Table S1).

Estimation of the temperature perturbations due to the radiation change.

The change in air temperature (T_a) can be roughly estimated using the following decompose equation (Zeng *et al.*, 2017):

$$\Delta T_a = \frac{1}{f}\left(- S\tau\Delta\alpha - \lambda\Delta E + S(1-\alpha)\Delta\tau + \varepsilon_s\sigma T_a^4\Delta\varepsilon_a + \frac{\rho C_d(T_s - T_a)}{r_a^2}\Delta r_a \right) + \Delta T_a^{cir}$$

The third term on the right attribute to the response of T_a to the changes in τ, which is the atmospheric shortwave transmissivity (the solar radiation reaching the land surface). f is an energy redistribution factor, f^{-1} represents the land surface air temperature sensitivity to 1 W m^{-2} radiative forcing at the land surface. Thus, the temperature perturbations due to the change of radiation can be estimated as follows:

$$\Delta DTR = (\Delta SW - \Delta LW)/f$$

f is given by:

$$f = \rho C_d/r_a + 4\varepsilon_s\sigma\varepsilon_a T_a^3$$

where ρ (=1.21 kg m^{-3}) is the air density; C_d (=1013 J kg^{-1} K^{-1}) is the specific heat of air at constant pressure; r_a is the aerodynamic resistance (in s m^{-1}), which can be estimated by wind speed ($r_a = 208/ws$); ε_s is land-surface emissivity, here we treat it as a constant of 0.95; σ (=5.67 $\times$ 10^{-8} W m^{-2} K^{-4}) is the Stephan-Boltzmann constant; ε_a is the atmospheric air emissivity, here we treat it as a constant of 0.8. The mean wind speed and the mean maximum air temperature during the February in 2020 are calculated based on the GSOD dataset (Table S1).

Table S1. Modelled shortwave radiation change and the estimated temperature perturbations in China and the five regions.

	China	Beijing	Chengdu	Wuhan	Shanghai	Guangzhou
ΔSW (W m^{-2})	3.81	7.04	9.77	12.17	7.57	8.78
ΔLW (W m^{-2})	-0.10	-0.22	-0.42	-0.40	-0.63	-0.47
Ws (m s^{-1})	2.54	2.43	1.94	2.37	3.11	2.42
Ta (K)	283.17	281.57	287.28	287.92	286.79	295.01
ΔDTR (K/°C)	0.21	0.40	0.66	0.70	0.37	0.50