Supplementary Material

Text S1:

The specific formula for calculating the analytical solution for diffuse transport in the target area of aircraft catalytic operations is as follows:

$$q(x,y,z,t) = \sum_{n=1}^{k} q_n(x,y,z,t) (\text{k: } t_{n=k} < t < t_{n=k+1})$$

$$q_n(x,y,z,t) = \frac{Q_n}{8\sqrt{\pi^3 k_H^2 k_v (t - t_n + t^*)^3}} \times e^{-\frac{[x-x_n-u(t-t_n)]^2}{4k_H(t-t_n+t^*)}} e^{-\frac{[y-y_n-v(t-t_n)]^2}{4k_H(t-t_n+t^*)}} e^{-\frac{[z-z_n-\omega(t-t_n)]^2}{4k_v(t-t_n+t^*)}}$$

$$\ln q_n = \ln Q_n - \ln 8 - \frac{3}{2}\ln \pi - \ln k_H - \frac{1}{2}\ln k_v - \frac{3}{2}\ln(t - t_n + t_0) - \frac{[x - x_n - u(t-t_n)]^2}{4k_H(t - t_n + t_0)} - \frac{[y - y_n - v(t-t_n)]^2}{4k_H(t - t_n + t_0)} - \frac{[z - z_n - \omega(t-t_n)]^2}{4k_v(t - t_n + t_0)}$$

where q is the diffuse material concentration; u, v, and ω represent the fractional wind speeds on the x, y, and z axes, respectively; k_H and k_v are the turbulence coefficients in the horizontal and vertical directions, respectively. t is time. The seeding volume is $Q_n = R\Delta t$, where R is the seeding rate in g/s. x_n, y_n, z_n, and t_n are the four-dimensional exact coordinates of the nth aircraft seeding point, which are input from the aircraft GPS real measurements.

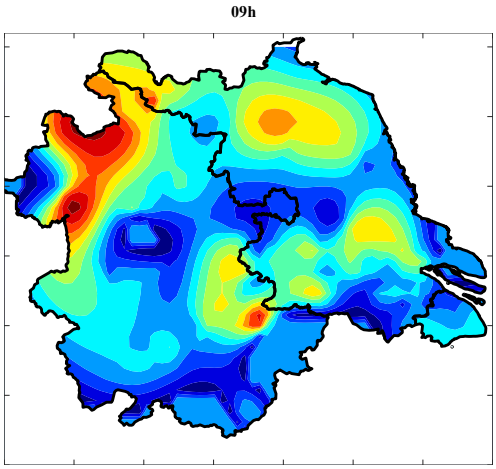

Figure S1. The spatial distribution of $PM_{2.5}$ mass concentration at 09:00 on November 01, 2020.

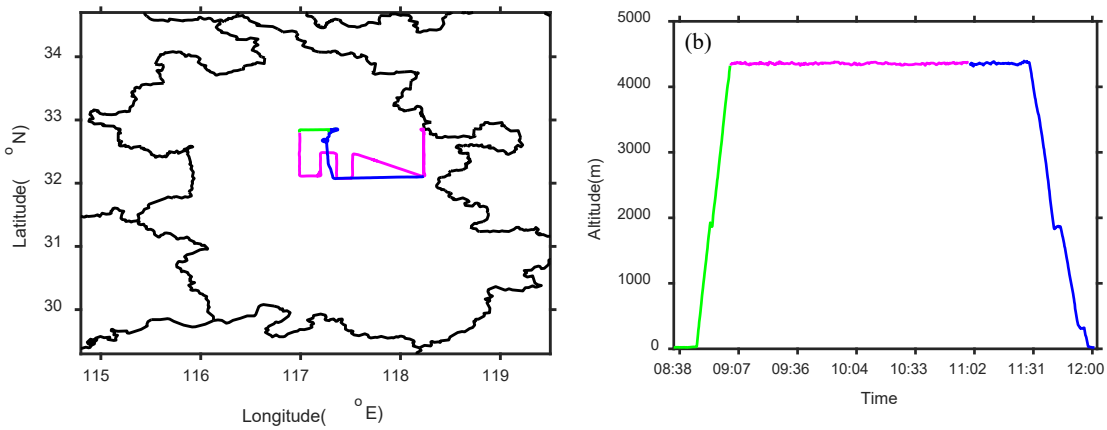

Figure S2. (a) Flight track and (b) altitude during the precipitation enhancement operation on November 1, 2020 (the green segment is the take-off and climbing stage, the purple segment (09:00-11:10) is the operation stage (AgI seeding), and the blue segment is the return stage after operation）

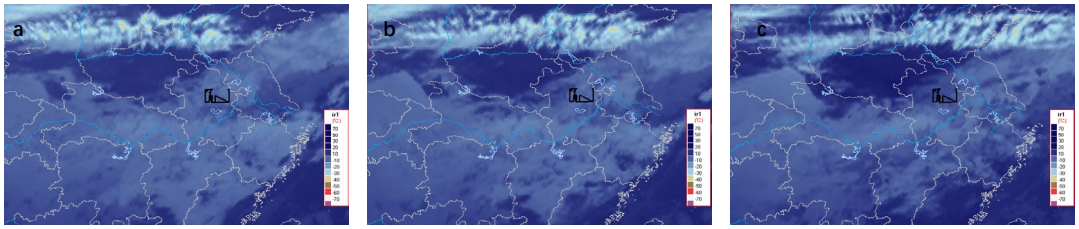

Figure S3. 10.8 μm infrared cloud image at 08:30 BT(a), 09:30 BT(b), 11:30 BT(c) on November 1, 2020 from the FY-4A satellite.

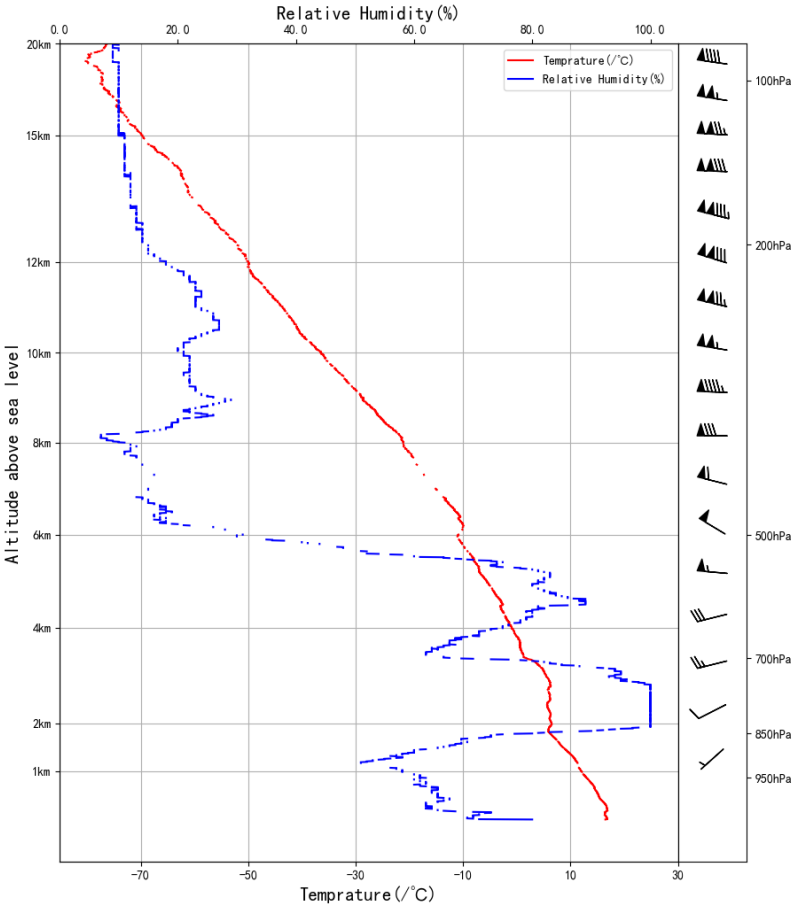

Figure S4. Temperature profile (red solid line), relative humidity profile (blue solid line), and wind speed and direction (black wind) from sounding data in Nanjing at 08:00 BT on November 1, 2020.

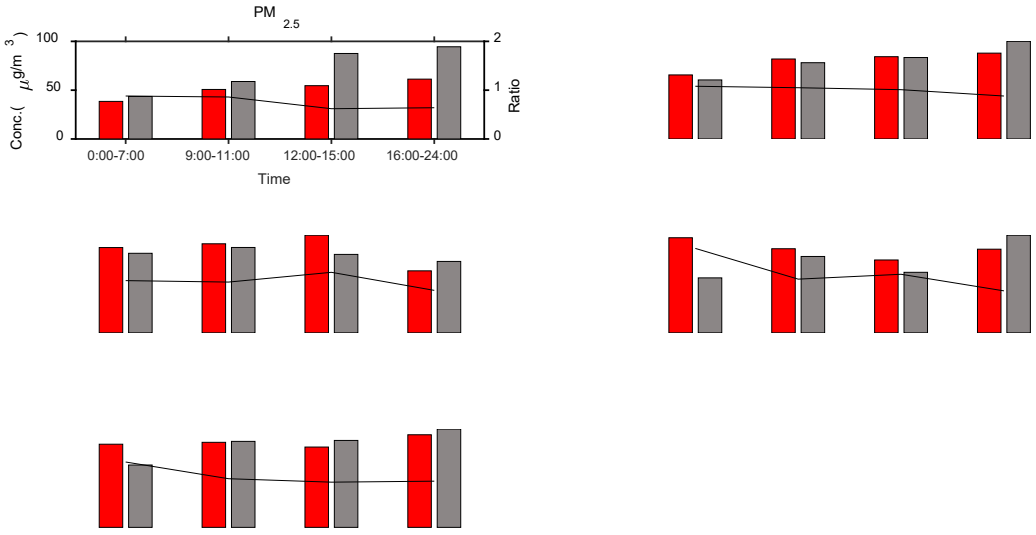

Figure S5. The mass concentrations of air pollutants in the target and contrast areas (bar plots) and their ratios (black lines).

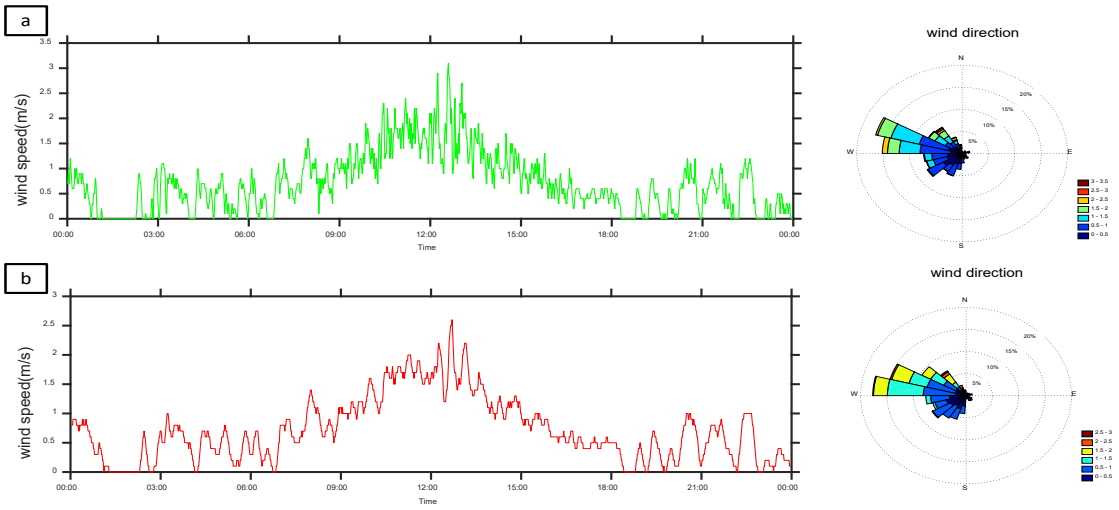

Figure S6. (a) 2-minute and (b)10-minute average wind speed and direction at NUIST on November 1, 2020