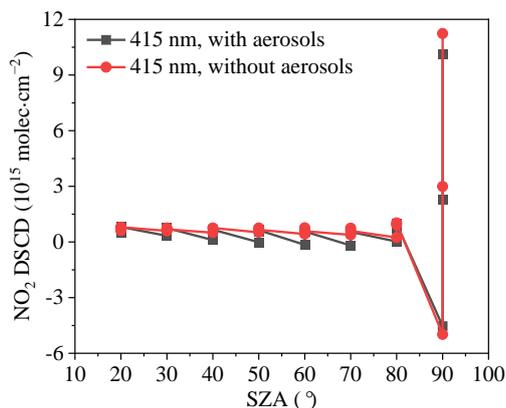
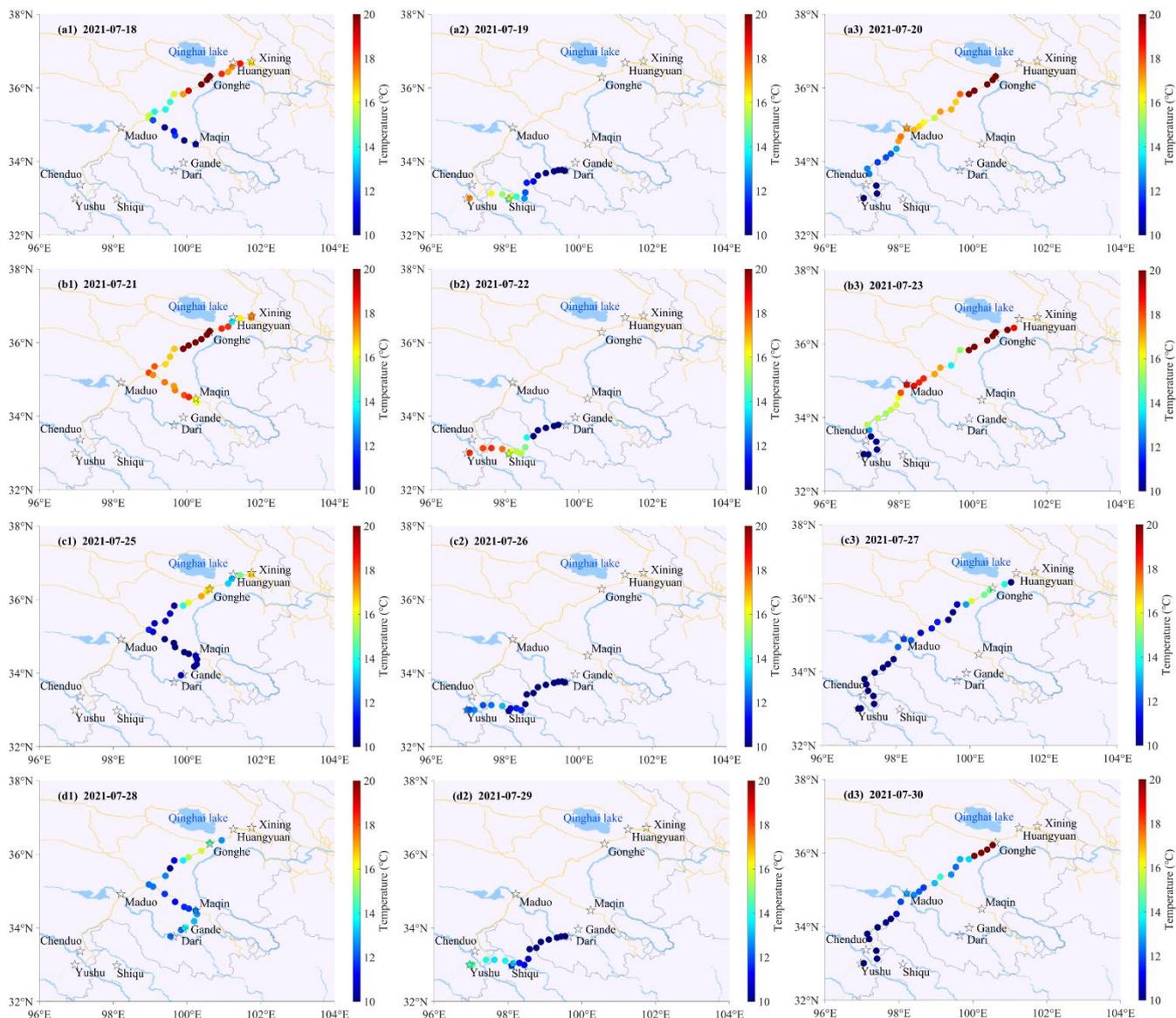


5 **Figure S1.** Corresponding to HCHO, (a) day-to-day variations of mean air temperature at 2 m above the land surface (black curves with squares) and downward solar radiation at the surface (SSRD, red curves with dots) as well as (b) linear fits between the two parameters and the daily averaged HCHO VCDs over the mobile observation routes. The error bars denote the standard deviations of air temperature and SSRD in figure (a). The lines denote the results of the regression analyses, and the corresponding equations and correlation coefficients are displayed in the figure (b).



10 **Figure S2.** Simulated apparent tropospheric NO₂ DSCDs at different SZAs, introduced by the stratospheric NO₂ absorption. The conditions during radiative transfer simulations include: (1) Simulation wavelength and elevation angle are set as 415 nm and 15° at an altitude of 4 km for three relative azimuth angles (0°, 90°, 180°), respectively; (2) The stratospheric NO₂ VCD is assumed to be 4 × 10¹⁵ molec cm⁻²; (3) The simulations are performed either without aerosols or with aerosols (aerosols from the surface to 1 km above the surface, AOD=0.1, HG phase function with asymmetry parameter=0.68, single scattering albedo=0.95). The DSCDs represent the differences of the SCDs at 15° and 90° elevations.



15 **Figure S3.** Spatial distributions of ERA5 hourly air temperature at 2 m above the land surface, corresponding to gridded HCHO VCDs with $0.25^\circ \times 0.25^\circ$ resolution for three segments (1, 2, 3) of four circling journeys (a, b, c, d). The main cities and counties on the driving routes are marked by the black stars. On the background map, the light blue lines and areas represent rivers and lakes (such as, Qinghai Lake), the yellow lines denote the roads, and the grey lines indicate the administrative boundaries.