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Supplement of

Lower tropospheric distributions of O_3 and aerosol over Raoyang, a rural site in the North China Plain

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S1 Technical details of the UAV measurements

A newly delivered personal ozone monitor (POM, 2B Technologies, USA) was used in our UAV measurements of O_3 vertical profiles. The POM was calibrated in the factory just before delivery using a working standard (Model 205), which was calibrated against a transfer standard (TE 49i-PS, Thermo Electron, USA) traceable to the standard reference photometer #0 (SRP 0) at the US National Institute of Standards and Technology (NIST). We did not calibrate the POM again. However, we confirmed its proper working at the site using an O_3 calibrator (TE 49i-PS, Thermo Electron, USA).

The optical particle counters (OPC) used in our UAV flights were calibrated by the manufacturer Lighthouse following the procedures in accordance with key standards for particle counters including ISO 21501 (https://www.golighthouse.com/en/calibration-and-repairs). The calibration is NIST-traceable. We did not compare the OPC with other instruments at the site.

The sampling inlet that we used in the UAV measurements of aerosol is a stainless steel tube (300 mm, ID 5 mm) with a bullet-shaped head, which has a taper gas way (Figure S1). The sampling inlet was fixed at the front of the UAV nose, parallel to the inlet for airspeed measurement. The tip of the head has an ID of 2.1 mm. The OPC works at a flow rate of 2.83 l/min. These conditions cause an air velocity of about 14 m/s at the tip of the inlet head, which is close to the cruising speed of the UAV (22 m/s). This design of sampling inlet made sure that the aerosol number concentrations were measured under a nearly isokinetic condition. Since a battery-powered UAV was used, there was no interference from engine.

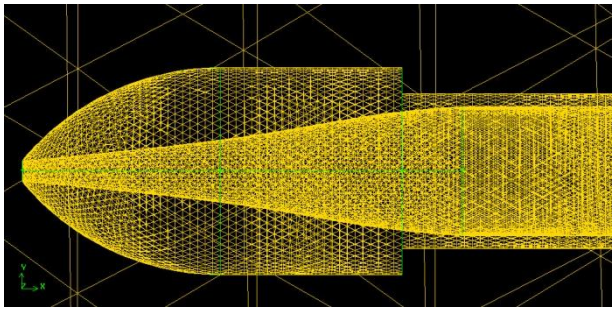

Figure S1. Schematic of the head of the sampling inlet used in the UAV measurements of aerosol.

S2 Airflow fields and air-mass backward trajectories

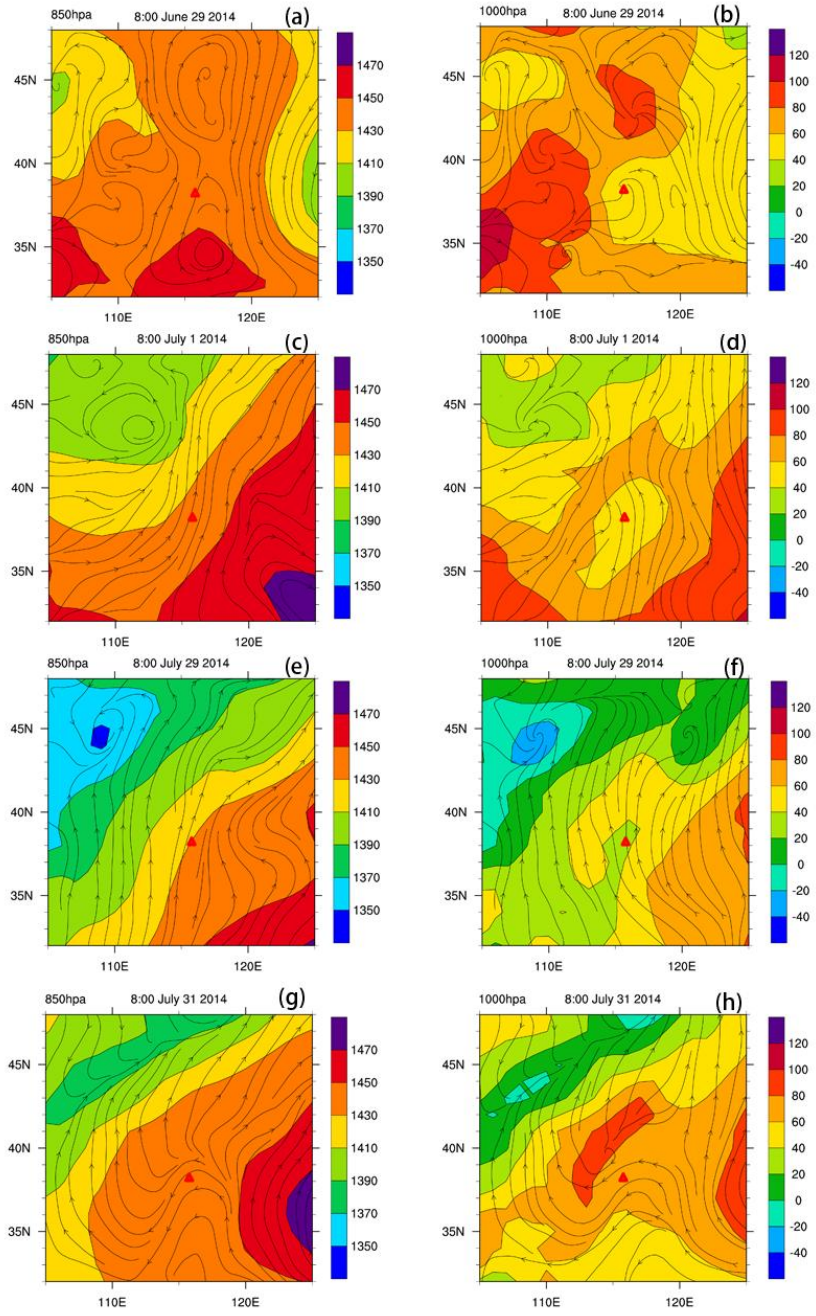

Figure S2. Geopotential heights (see color scale) and streamlines over the area surrounding Raoyang at 8:00 of June 29, 2014 at 850 hPa (a) and 1000 hPa (b); at 8:00 of July 1, 2014 at 850 hPa (c) and 1000 hPa (d); at 8:00 of July 29, 2014 at 850 hPa (e) and 1000 hPa (f); at 8:00 of July 31, 2014 at 850 hPa (g) and 1000 hPa (h).The reanalysis data from ECWMF were used to make these plots.

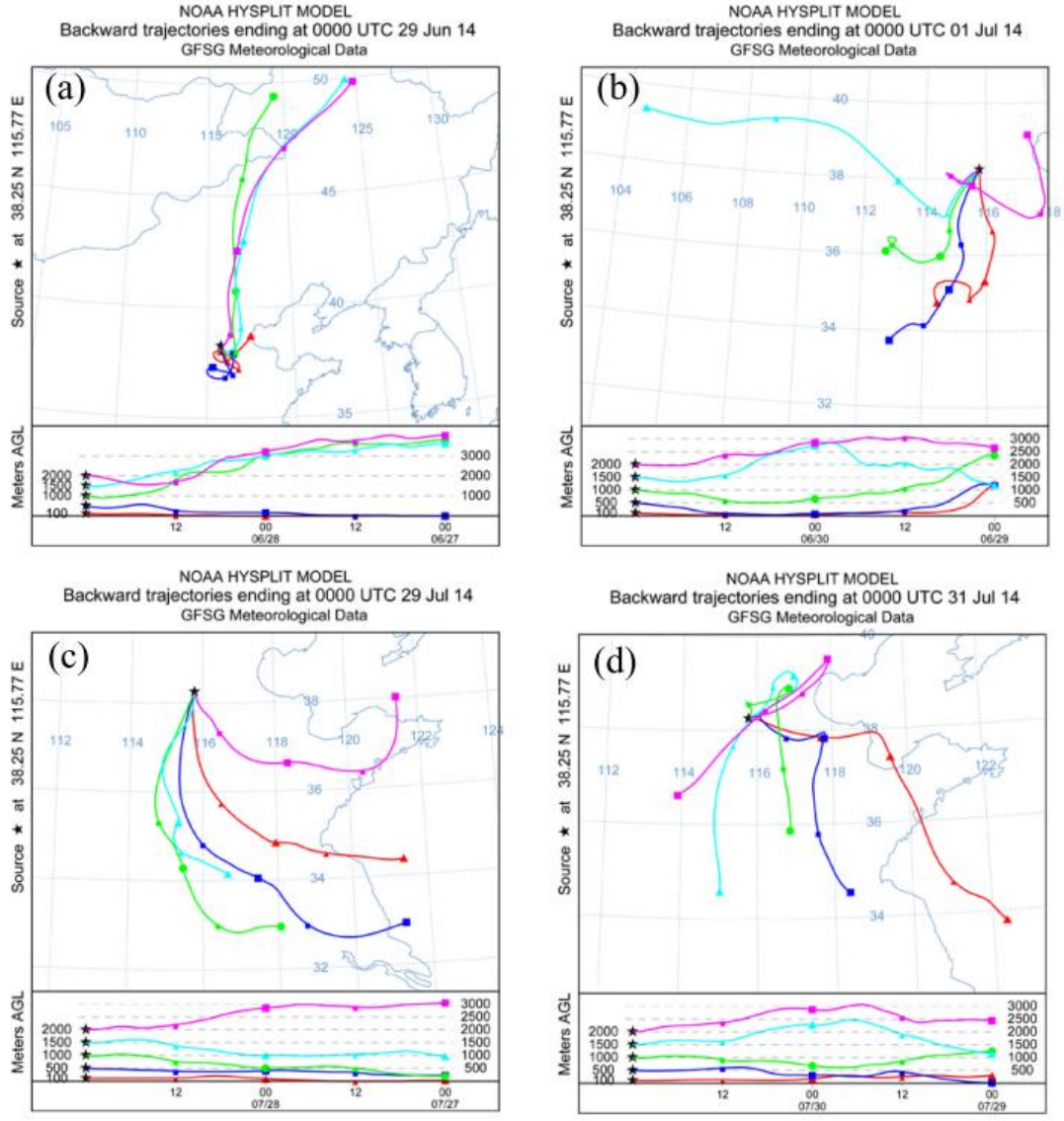

Figure S3. 48-h backward trajectories ending at 100 m, 500 m, 1000 m, 1500 m and 2000 m over Raoyang at 8:00 of June 29 (a), July 1 (b), July 29 (c) and July31 (d), 2014.

S3 Average diurnal variations of O_3 and NO

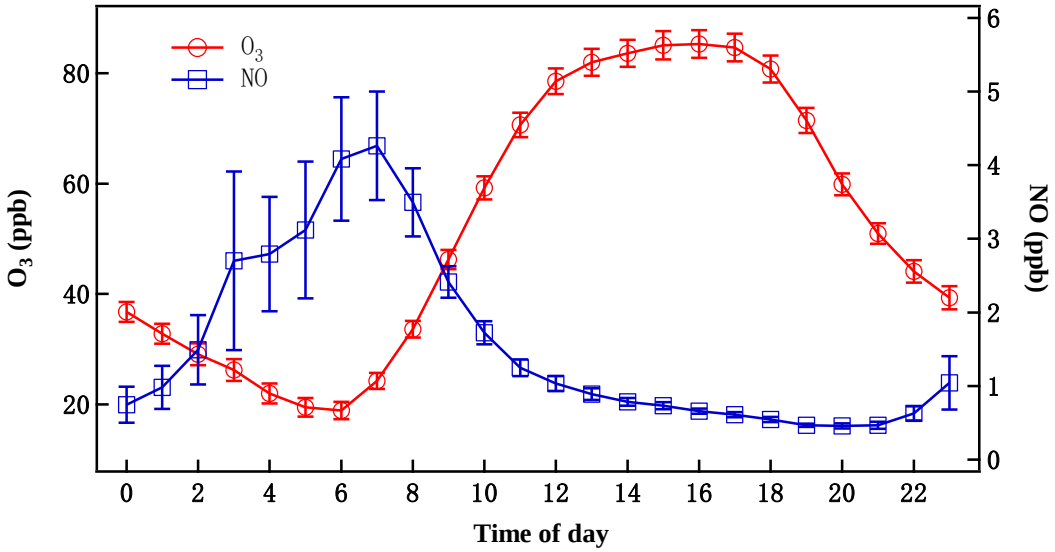

Figure S4. Average diurnal variations of surface O_3 and NO at Raoyang during the campaign in June-August 2014. The error bars represent one standard error of the mean.