

Support Information

Rapid formation of intense haze episode in Beijing

Yonghong Wang^{1,2}, Yuesi Wang^{1,5}, Guiqian Tang¹, Tao Song¹, Putian Zhou², Zirui Liu¹, Bo Hu¹, Dongsheng Ji¹, Lili Wang¹, Xiaowan Zhu¹, Chao Yan², Mikael Ehn², Wenkang Gao¹, Yuepeng Pan¹, Jinyuan Xin¹, Yang Sun¹, Veli-Matti Kerminen², Markku Kulmala^{2,3,4} and Tuukka Petäjä^{2,3,4}

¹State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry (LAPC), Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, China

²Institute for Atmospheric and Earth System Research / Physics, Faculty of Science, P.O.Box 64, 00014 University of Helsinki, Helsinki, Finland

³Joint international research Laboratory of Atmospheric and Earth System sciences (JirLATEST), Nanjing University, Nanjing, China

⁴Aerosol and Haze Laboratory, Beijing Advanced Innovation Center for Soft Matter Science and Engineering, Beijing University of Chemical Technology (BUCT), Beijing, China

⁵Centre for Excellence in Atmospheric Urban Environment, Institute of Urban Environment, Chinese Academy of Science, Xiamen, Fujian 361021, China

Corresponding authors: Yuesi Wang and Markku Kulmala

E-mail: wys@mail.iap.ac.cn; markku.kulmala@helsinki.fi

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1. Synoptic conditions during this intense haze episode

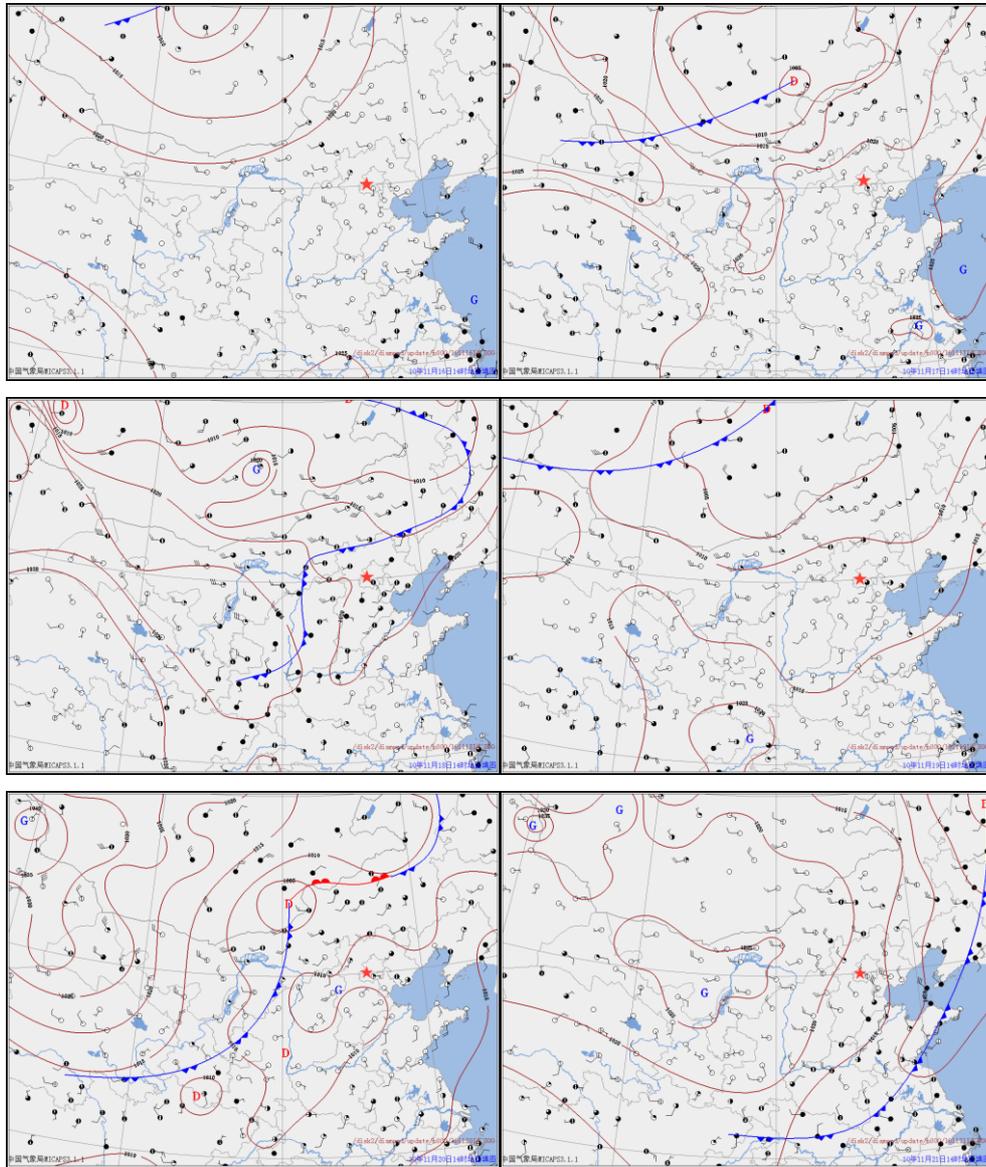


Figure S1. Synoptic weather situation during the air pollution episode. Figures are produced from MICAPS software. The red five star represents the observation site. The meteorology conditions on the surface were characterized as high solar radiation and high ultraviolet radiation, which results in a warm temperature around 0-10 degree Celsius. The synoptic weather situation was characterised by a cold front during 16th and 17th of November in Mongolia so the surface wind speed is quite small and the wind direction is unregularly. (Figure S1). As shown in figure S5, the variation of mixing layer height can be explained mostly by variation of buoyancy flux carried out on 47m observation platform during this air

pollution episode.

2. Characteristic of air pollutants vertical distribution in Beijing

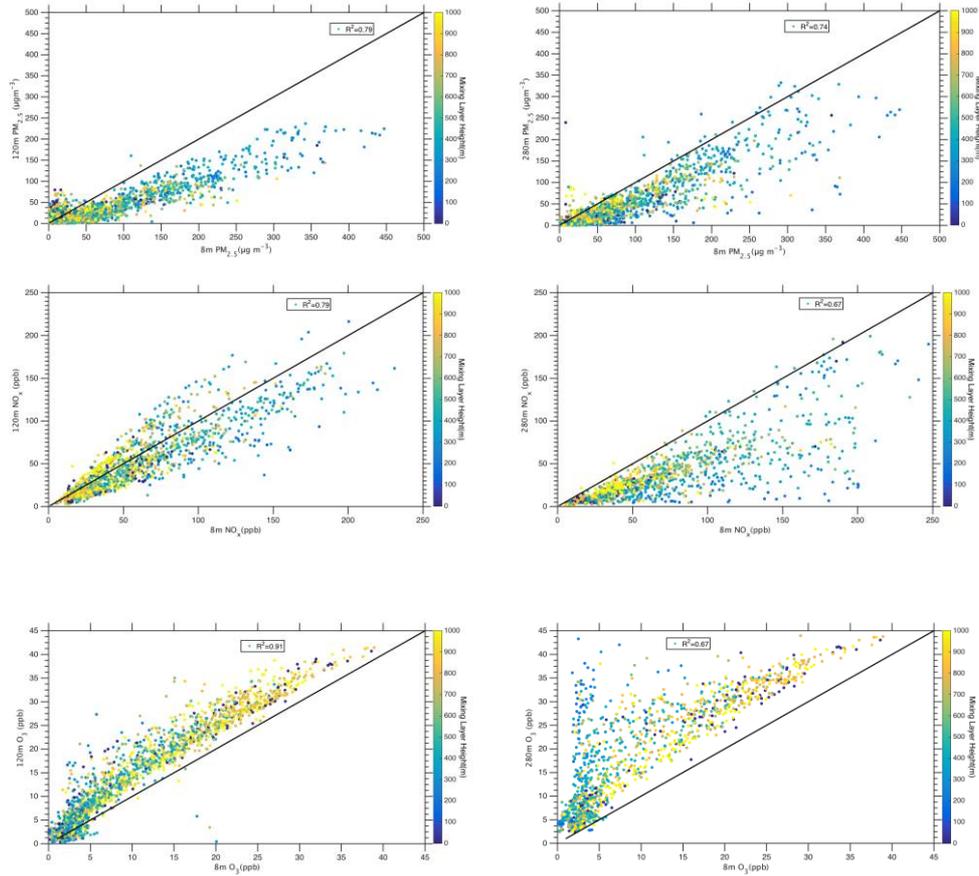
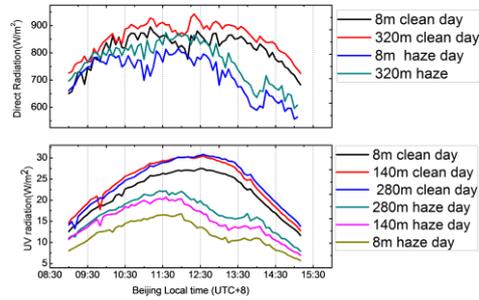
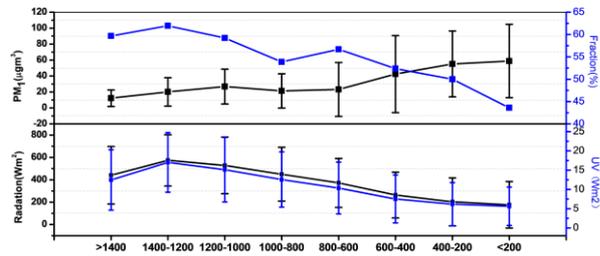


Figure s2. Vertical distribution and correlation of $PM_{2.5}$, ozone and NO_x in 8m, 120m and 280m Beijing meteorology tower during day time (10:00~17:00) with solar radiation values. The rainy hours were deleted.

3. Decreased solar radiation and increased $PM_{1-2.5}$ with decreased mixing layer height



(a)



(b)

Figure s3. (a) Vertical variation of direct radiation and UV radiation during a clean day and haze day. The direct radiation measurements were conducted at 8 m and 320m height of the tower. The UV radiation measurements were carried out at 8m, 140m and 280 observation platforms, respectively. (b) variation of PM_1 mass concentration and mass fraction of PM_1 in $PM_{2.5}$ with decreased mixing layer height (up figure) in winter, variation of net radiation and UV radiation during daytime in winter

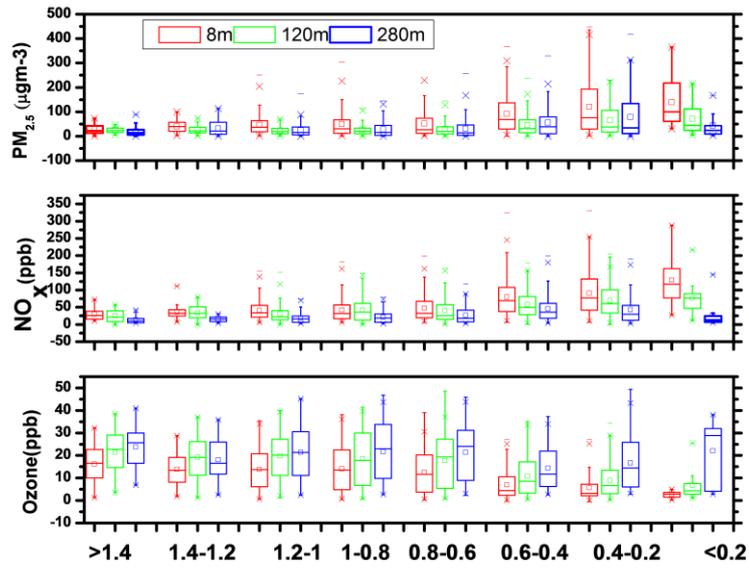


Figure s4. Statistics of variation of air pollutants at 8m, 120m and 280m with mixing layer height.

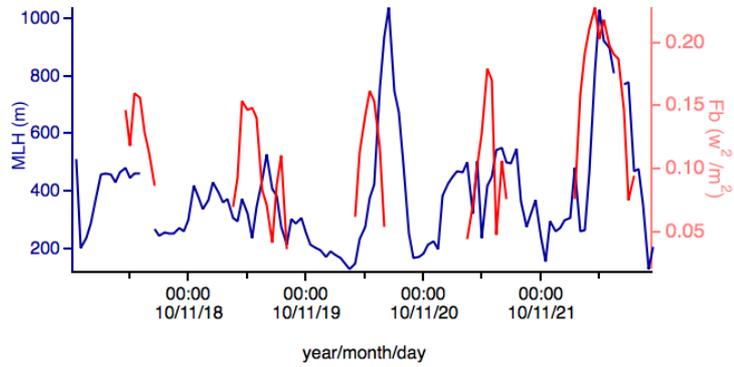
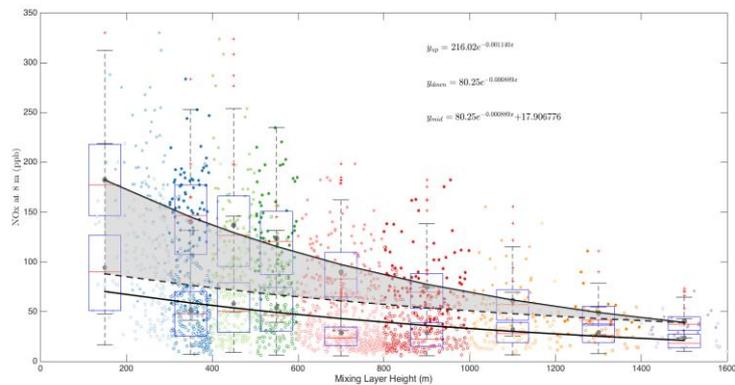


Figure s5. variation of observed mixing layer height compared with calculated Fb during the intense haze period.



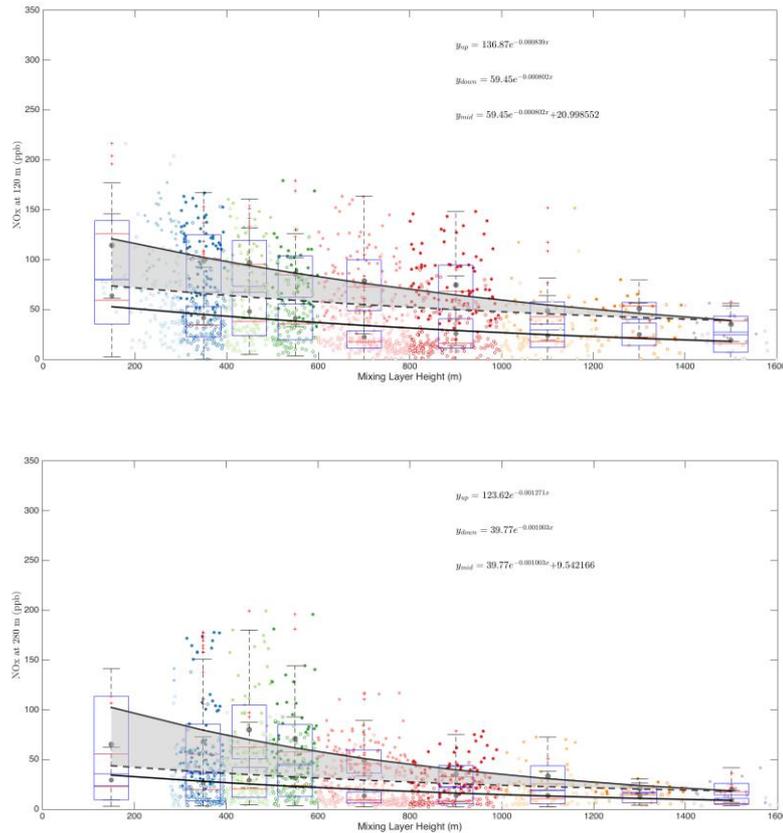


Figure s5. The variation of NO_x mixing ratios with variation of mixing layer height at 8m, 120 m and 280m observation platform. The concentration of NO_x was divided into each bins according to corresponded PM_{2.5} concentrations. The solid points represent NO_x concentrations as the corresponded PM_{2.5} concentrations large than 75 $\mu\text{g m}^{-3}$ under a fixed mixing layer height. The grey points represent mean values; the red line represents medium values. The shadow area corresponding to increased amount of NO_x with decreased mixing layer height.

4. Increase of secondary aerosol formation with decreased mixing layer height

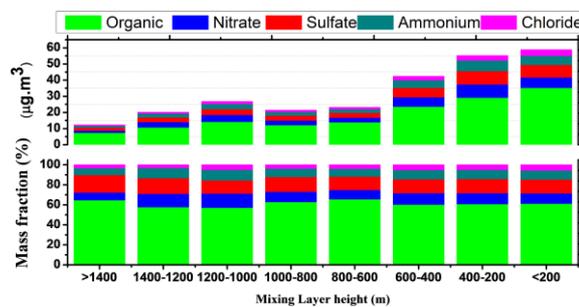


Figure s6. Chemical composition of organic, nitrate, sulfate, ammonium and

chloride with decreased level of mixing layer height. The mass fraction of each composition with variation of mixing layer height are also presented. The mass fraction of nitrate, sulphate and ammonium increased, as mixing layer height decreased from over 1400m to 1000~1200m. However, the mass fraction of organic also increased with decreased mixing layer height from 1000m to less. The data was selected during daytime (10:00~17:00).

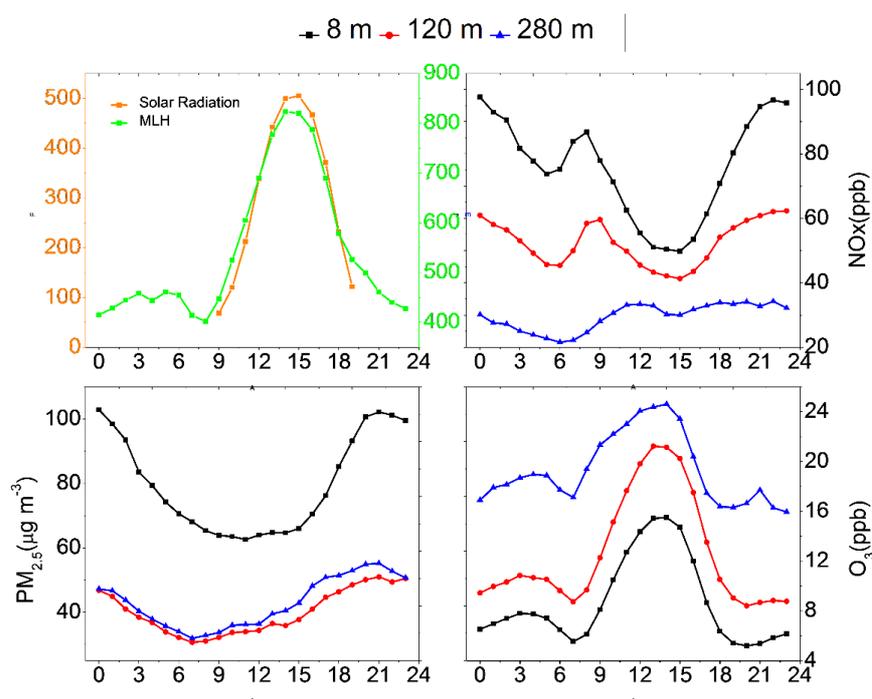


Figure s7. Diurnal variation of solar radiation, mixing layer height observed at 8 m observation platform, volume mixing ratio of NO_x, mass concentration of PM_{2.5} and volume mixing ratio of ozone simultaneous measured at 8 m, 120 m and 280 m observation platform at Beijing 325 m meteorology tower.