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The "Parade Blue": effects of short-term emission control on aerosol chemistry

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Contents

Introduction

- Aerosol particles are of great importance not only because of their direct and indirect radiative forcing on climate but also because of their adverse effects on health.

- Anthropogenic emissions of air pollutants in China are much greater than in European or North American countries, which intensifies China's severe air pollution.(Akimoto, H,2003) Therefore, it is essential to understand how anthropogenic sources affect the aerosol load before implementing clean-air measures.

- To improve the air quality for the 2015 Victory Day Parade, held on September 3, 2015, the Chinese government implemented a number of strict control measures to reduce anthropogenic emissions in Beijing and the surrounding areas. Consequently,the air quality in Beijing during the event was improved significantly and dubbed the "Parade Blue".

Methods

Sampling site: The campus of Tsinghua University (THU site: 40.0° N, 116.3° E)

Online instrumentation:

ACSM
(Arosol Chemical Speciation Monitor)

To measure the chemical concentrations of non-refractory species (organic, sulfate, nitrate, ammonium and chloride)

MAAP
(Multi-Angle Absorption Photometer)

To obtain the concentration of refractory black carbon (BC)

Other collocated instruments

To measure the gaseous species (CO, O_3, NO, NO_2 and SO_2) and monitor temperature, RH, precipitation, wind speed and wind direction

Data Analysis

The default relative ionization efficiencies (RIEs)

Organics： 1.4

Sulfate： 1.08

Nitrate： 1.1

Chloride： 1.3

Ammonium： 7.16

CE_{dry} = max (0.45, 0.0833+0 .9167 × ANMF)

The standard ACSM data analysis software (v.1.5.3.0)

PMF2.exe algorithm combined with the positive matrix factorization (PMF) Evaluation Tool (PET)

Results & Discussion

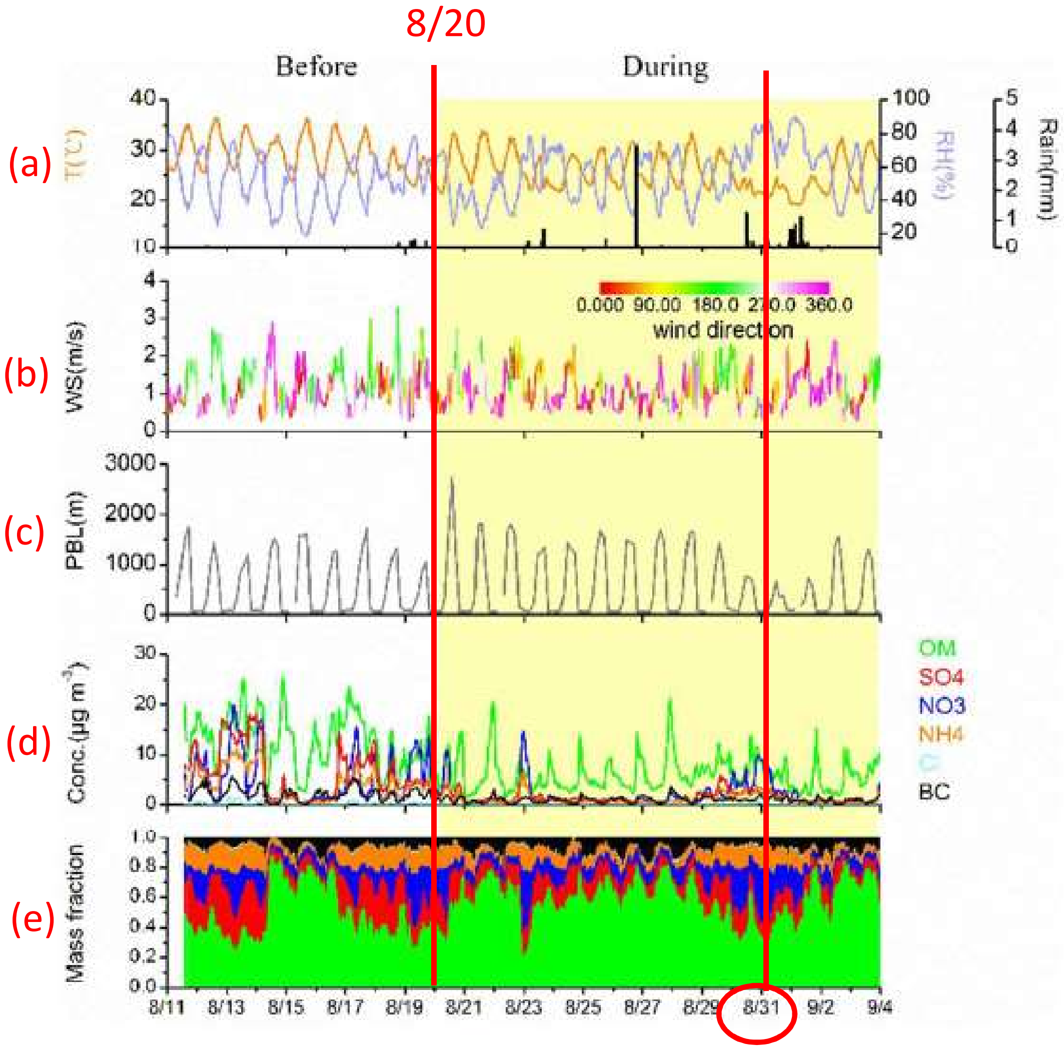

Figure 1. Temporal variations of (a) T, RH and precipitation, (b) WS and WD, (c) PBL, (d) mass concentrations, and (e) mass fractions of chemical species in PM_1.

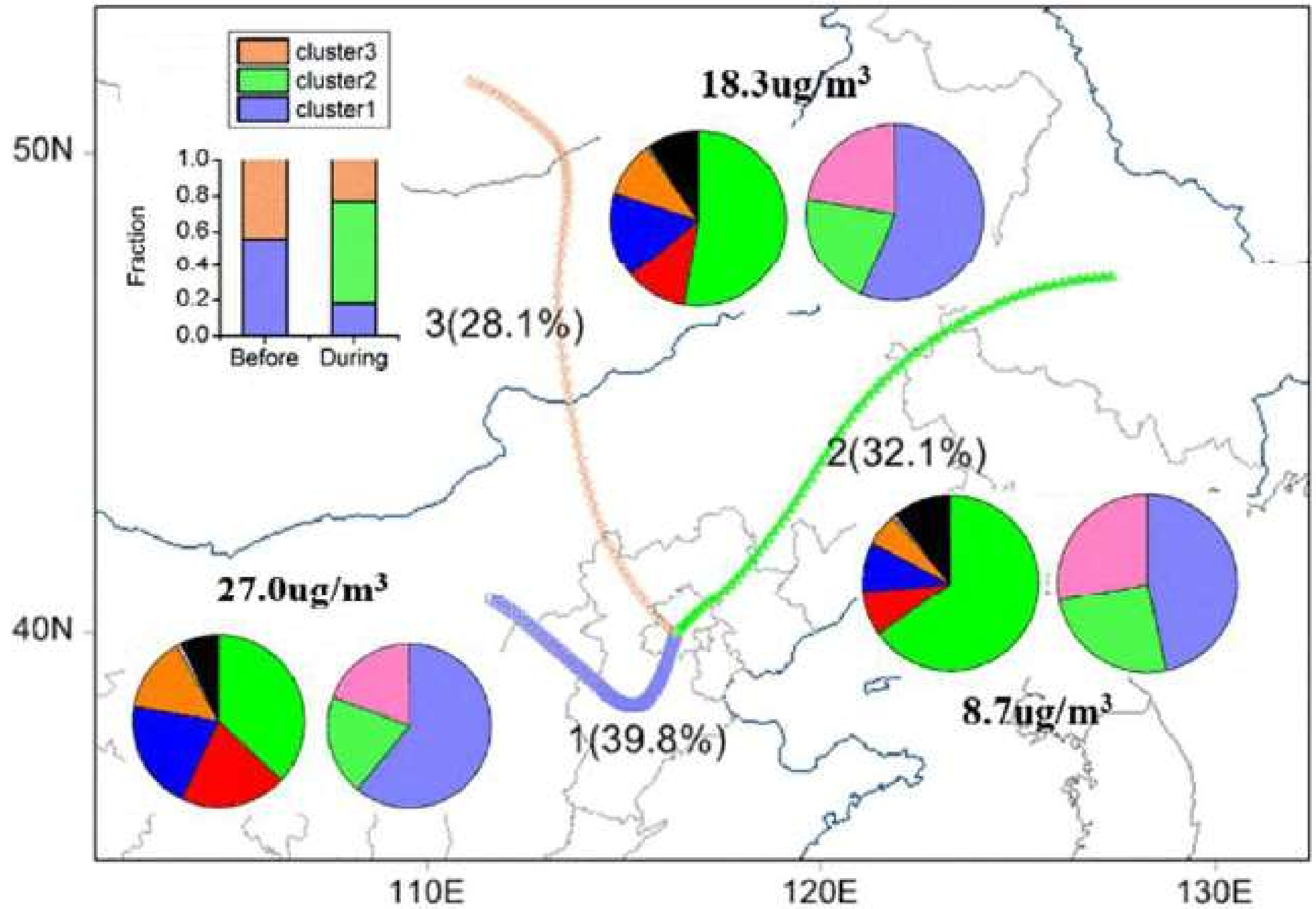

Figure 2. The back trajectory clustering analysis associated with the corresponding average PM1 mass and composition during the campaign.

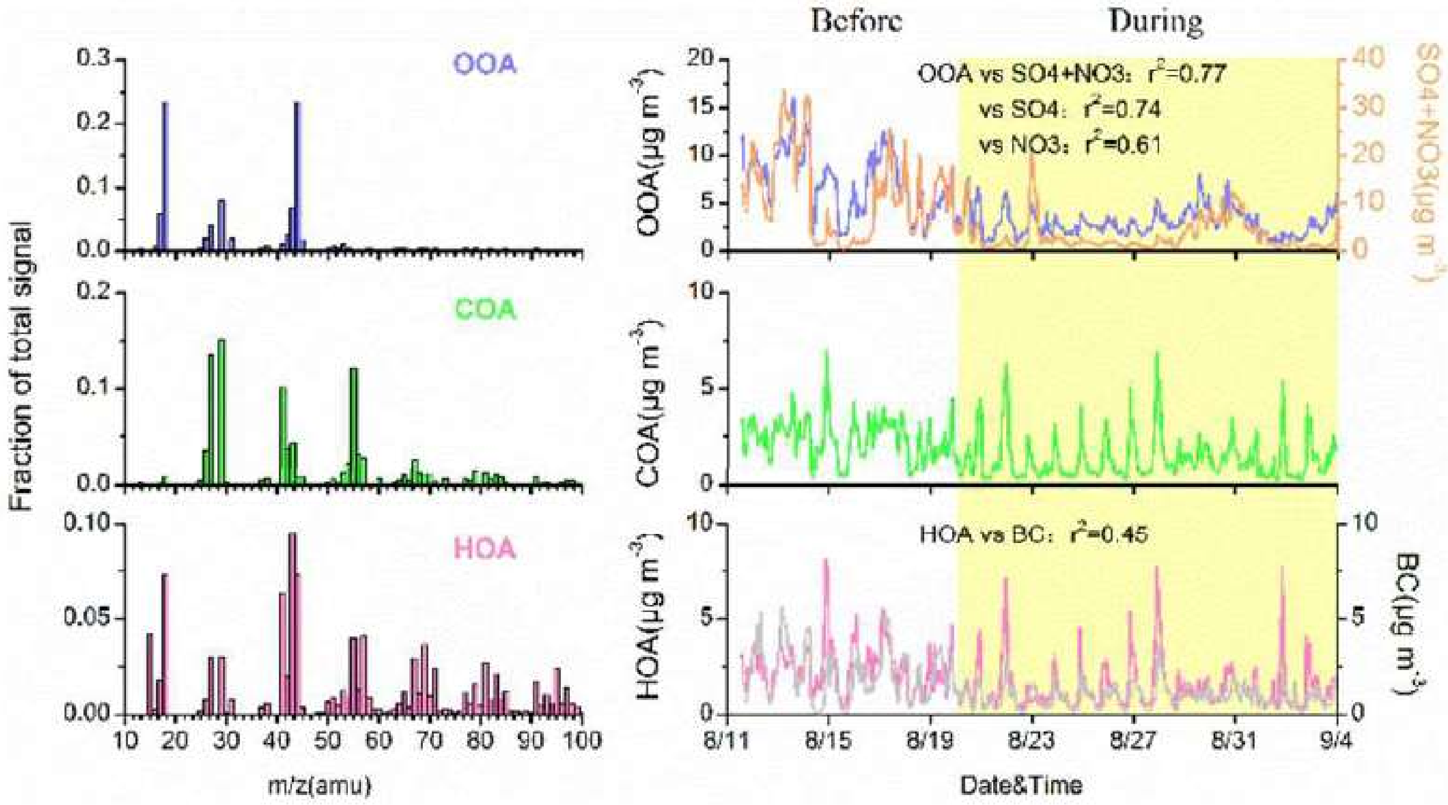

Figure 3. Mass spectra and time series of (a) HOA, (b) COA and (c) OOA. Also shown are the time series of external tracers and their correlation coefficients with OA factors.

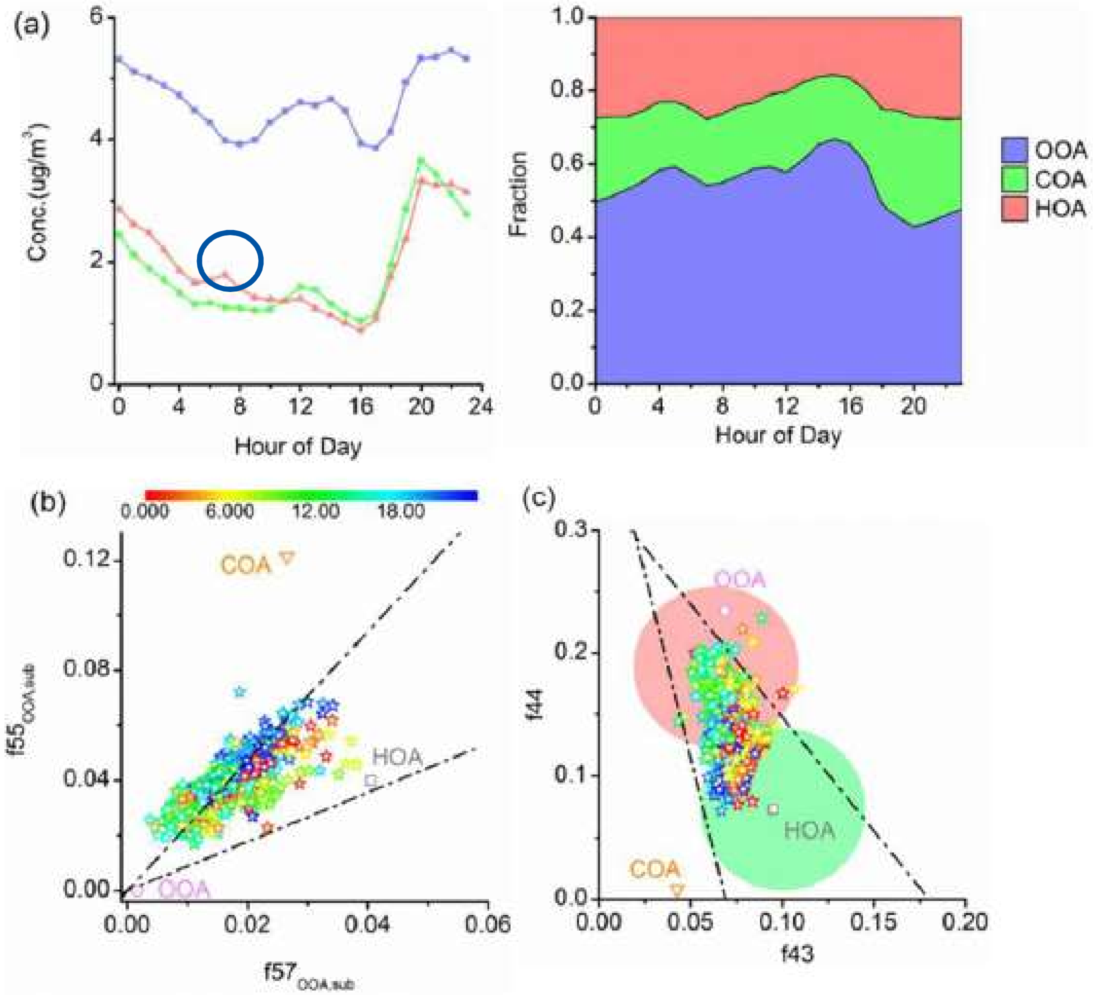

Figure 4. (a) Diurnal variations of mass concentrations and mass fractions of HOA, COA and OOA, Scatterplots of (b) $f55_{OOA, sub}$ vs. $f57_{OOA, sub}$, and (c) f44 vs. f43. The measured OA data points are colored by time of the day. And the shaded ovals indicate regions of LV-OOA and SV-OOA reported in Ng et al.

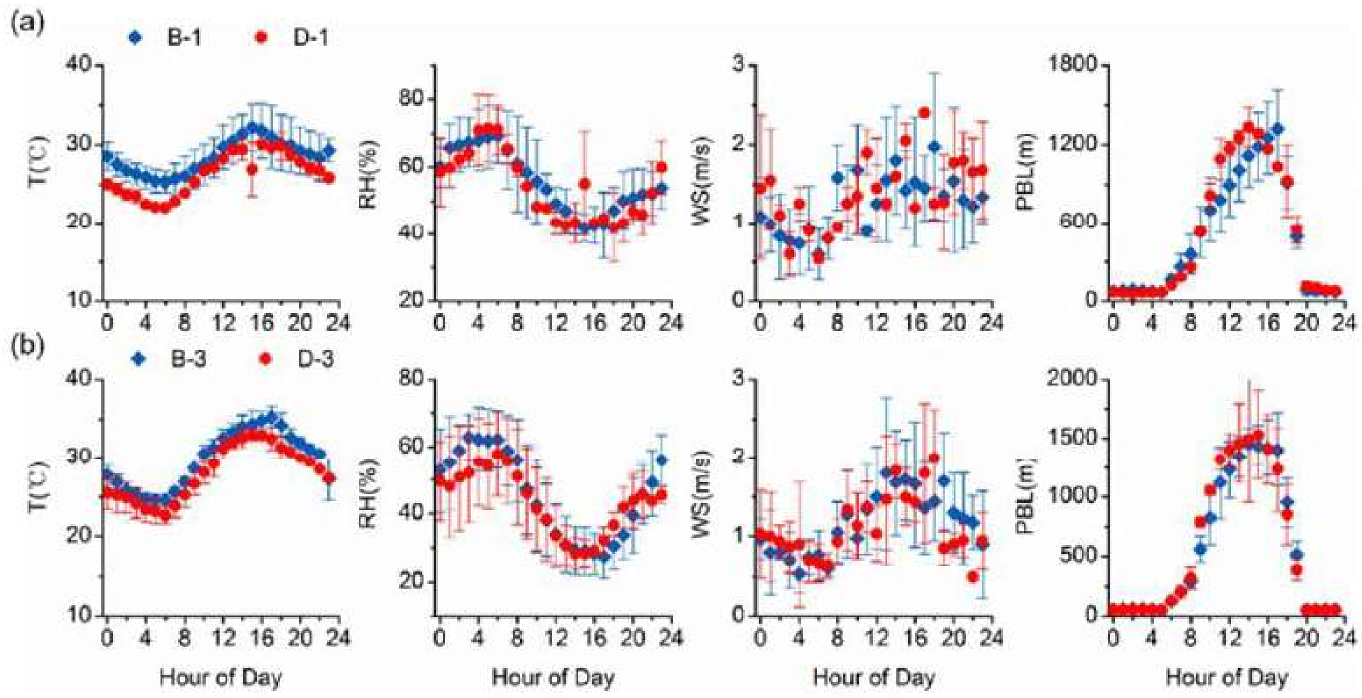

Figure 5. Diurnal patterns of T, RH, WS and PBL height before and during the V-day Parade for (a) cluster 1 and (b) cluster 3.

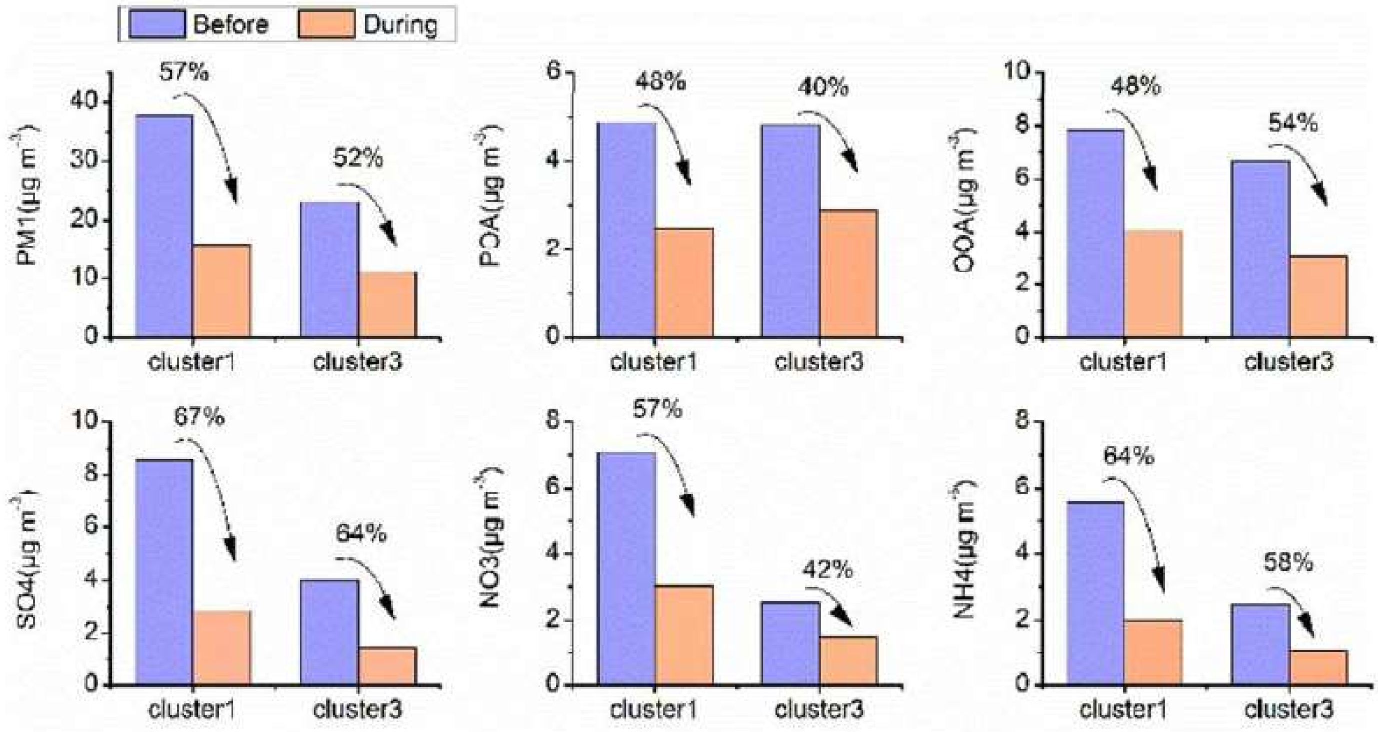

Figure 6. Estimated influence of emission controls on mass concentrations of PM_1 and its major chemical species.

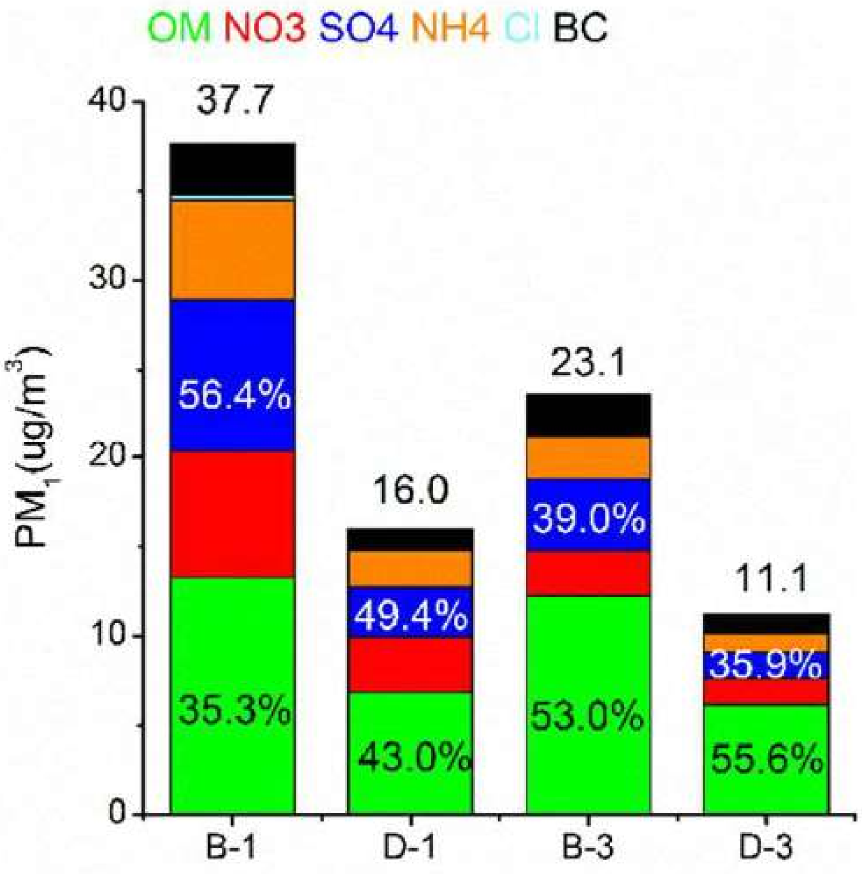

Figure 7. Average composition of PM_1 before and during the V-day Parade for cluster 1 and cluster 3 respectively. Also shown are the average mass concentrations of PM_1, and the average ratios of SNA and organics.

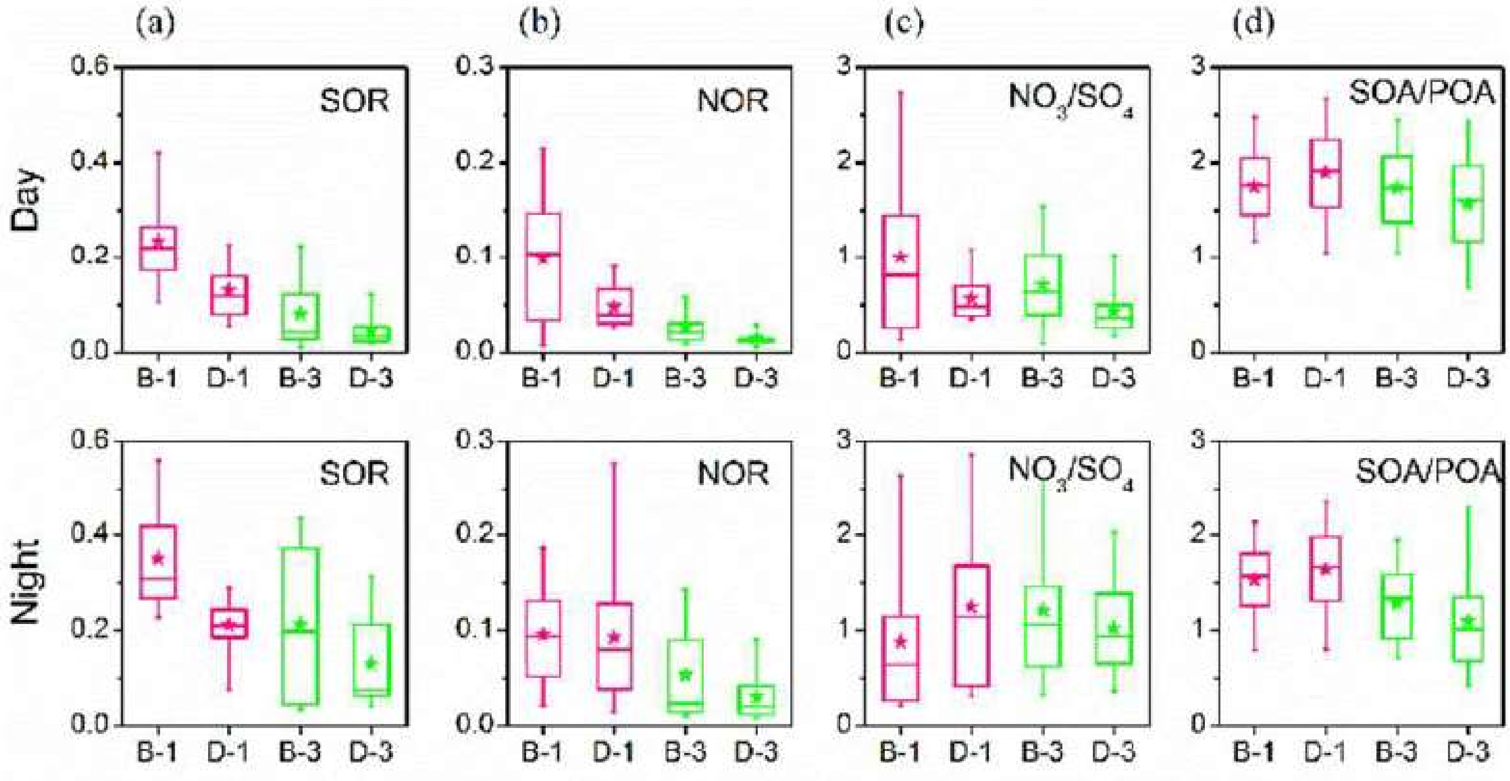

Figure 8. Daytime and nighttime (a) SOR, (b) NOR, (c) NO_3^-/SO_4^{2-} ,and (d) SOA/POA before and during the V-day Parade for cluster 1 and cluster 3 respectively.

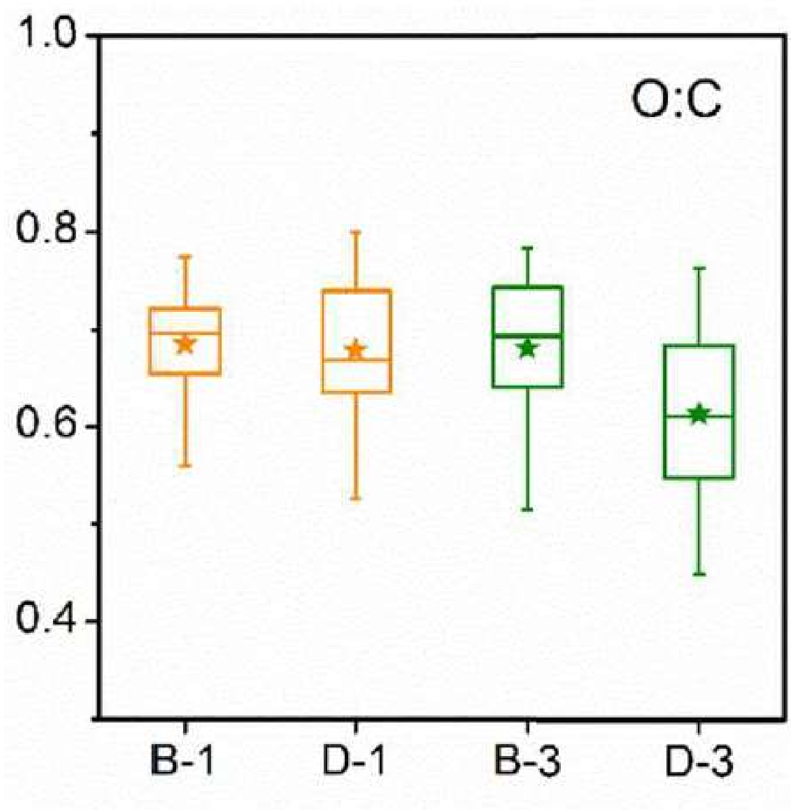

Figure 9. O: C ratios of OA before and during the V-day Parade for cluster 1 and cluster 3.

Conclusions

- The average PM_1 mass concentration was 11.3 (±6.7) μg/m^3 during the parade, decreased by 63.5% compared with that before the parade. Different from the relatively smaller decrease of organics (53%), secondary inorganic aerosols (sulfate, nitrate and ammonium) showed significant reductions of 65%–78% during the V-day Parade.

- Primary organic aerosol (POA) from traffic and cooking emissions decreased by 41.5% during the parade, whereas secondary organic aerosol (SOA) presented a much greater reduction (59%).

- The SOR and NOR decreased significantly during the control period both in daytime and nighttime, indicating the suppressed secondary formation of sulfate and nitrate because of emission restrictions.

- Northwesterly airflows, emission restrictions during the V-day Parade also reduced the oxidation degree of organic aerosol.

Thank you