SciMedCentral

JSM Environmental Science & Ecology

Editorial

Severe Aerosol Pollution Derived from Fireworks: A Case in Jinan, China

Liang Wen[1] and Jianmin Chen[1,2]*

[1]*Environment Research Institute, School of Environmental Science and Engineering, Shandong University, Jinan, China*
[2]*Shanghai Key Laboratory of Atmospheric Particle Pollution and Prevention (LAP3), Department of Environmental Science & Engineering, Fudan University, Shanghai, China*

***Corresponding author**
Jianmin Chen, Environment Research Institute, School of Environmental Science and Engineering, Shandong University, Jinan 250100, China, Email: jmchen@sdu.edu.cn; jmchen@fudan.edu.cn

Submitted: 30 August 2013

Accepted: 31 August 2013

Published: 02 Septemb er 2013

Fireworks were frequently displayed during ceremonies or festivals [1-5], which could cause both local and regional air pollution [6,7]. The concentration of atmospheric pollutants [8-10] and inhalable aerosol with a wide size range [11] would increase significantly, and has very obvious impact on air quality. However, the hourly-averaged concentration of inorganic pollutants synchronized to the particle size distribution related to firework events is not well studied. Here a case is shown the crucial impact of fireworks events on air quality with the rapid increases of chemical compositions and size concentration of aerosol derived from fireworks on the 2013 Chinese New Year and the Lantern Festival in Jinan, China.

EXPERIMENTAL

The sampling site was located on the ground monitoring station in the center campus of Shandong University (36.67ºN, 117.05ºE) in an urban area in Jinan. A MARGA ADI 2080 (Applikon-ECN, Netherlands) was used to monitor the hourly-averaged concentration of SO_2 and inorganic water-soluble ions in $PM_{2.5}$. A Particulate Monitor 5030 (Thermo Scientific, USA), and CO analyzer 300E (Teledyne Technol., USA) were used to monitor the concentration of $PM_{2.5}$ and CO, respectively. A Wide-Range Particle Spectrometer (Model 1000XP, MSP, USA) can on-line record the aerosol size distribution in the range of 5 nm ~10 μm. The ambient temperature and relative humidity were measured by a portable automatic meteorological station. The visibility was obtained from visibility instrument. The average temperature and RH were both blow 10°C and 60% during this field measurement, respectively.

THE MASS CONCENTRATION OF ATMOSPHERIC POLLUTANTS AND VISIBILITY

As KNO_3 is the important composition in black powder of fireworks, K^+ can be used as tracer of fireworks events. As shown in (Figure 1), the high concentration of K^+ have been found during four serious fireworks events on Feb. 9 and Feb.10 (the Chinese New Year), and Feb. 24 (the Lantern Festival), respectively.

The hourly-averaged mass concentration of $PM_{2.5}$ and the hourly-averaged visibility were 100.8 μg m^{-3} and 7.43 km within 6 h before 16:00 on Feb. 9, respectively. After a few hours, the values of $PM_{2.5}$ and visibility rapidly changed to 873.6 μg/m^3 and 1.1 km, respectively. The concentration of $PM_{2.5}$ in the second event closed to the value at the first time, higher than that in the third and forth events and the visibility dropped sharply during each event. In addition, inorganic water-soluble ions can account for 69% of the total mass concentration of $PM_{2.5}$ before the fireworks events, since then the value rose to 89% during the first event. The proportion of Cl^- and metal ions in $PM_{2.5}$ increased very obviously among them.

The mass concentration of K^+ were used to do linear regression with pollution gas and $PM_{2.5}$, water-soluble inorganic ions in the period of Feb. 9 10:00~16:00 and Feb. 24 14:00~18:00 (before the fireworks events), Feb. 9 18:00~Feb. 10 8:00 and Feb. 24 18:00~Feb. 25 0:00 (during the fireworks events), respectively. The values of R^2 between K^+ and SO_2, $PM_{2.5}$ and Cl^-, NO_2^-, SO_4^{2-}, Mg^{2+} in $PM_{2.5}$ were all above 0.85. Compared with the 6 h average data before 16:00, their mass concentration between 21:00 and 23:00 increased 184, 11.1, 9.19, 226, 33.5, 9.52 and 169 times, respectively. The R^2 between K^+, CO and Na^+ were in range of 0.6~0.8, that multiple of CO and Na^+ was 4.37 and 4.96, respectively.

AEROSOLS SIZE DISTRIBUTION

The number size distribution on Feb. 24 and 25 is shown in (Figure 2) as a contour plot. The most obvious characteristic of this plot is the high number concentrations of aerosols in range of 20~100 nm (Aitken nuclei modal) during the fireworks event (Feb. 24 18:00~Feb. 25 0:00), this period corresponded to the the event (Feb. 24 18:00~ Feb. 25 0:00) in (Figure 1). Compared with the 6 h average data before 17:00, the number concentration in range of 20~100 nm during the event increased 1.14 times, and then reduced rapidly after the event. So the results demonstrate that these aerosols in the Aitken nuclei modal were from firework events significantly changed the modal structure of aerosols size distribution, and can cause serious air pollution.

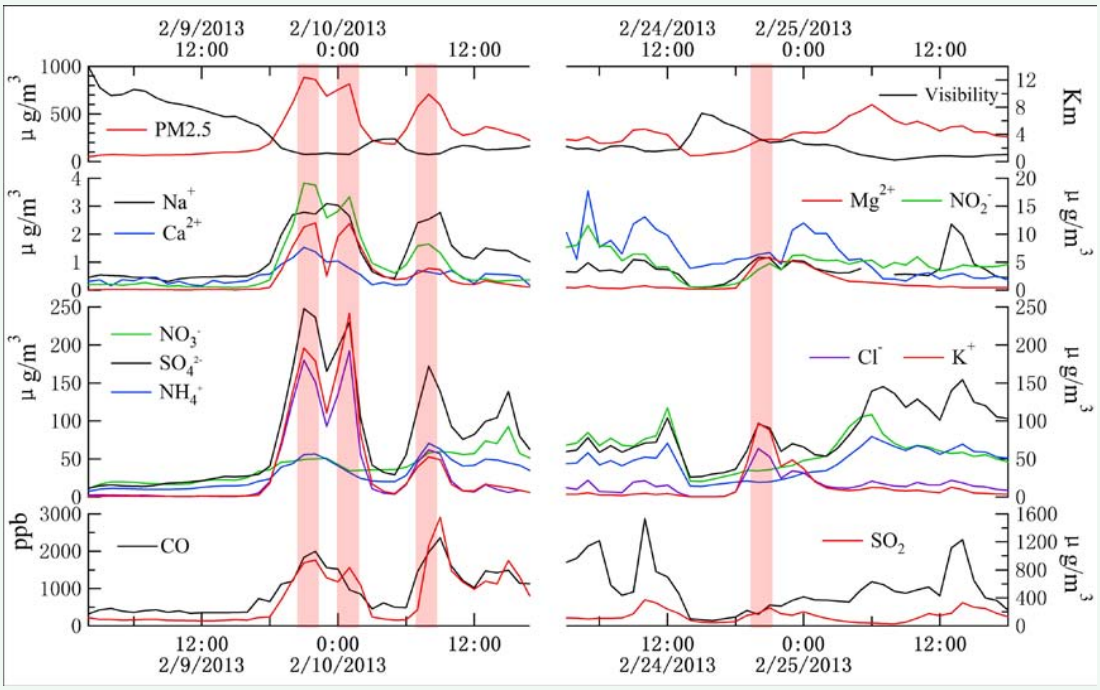

Figure 1 Hour average concentration of inorganic pollutants and visibility on Feb. 9, 10, 24 and 25, 2013.

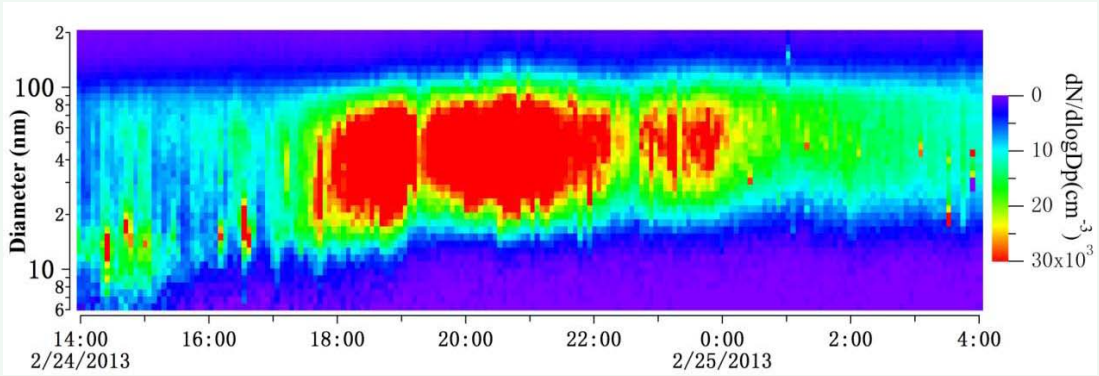

Figure 2 Contour plot of the number size distribution on Feb. 24 and 25, 2013.

ATMOSPHERIC IMPLICATIONS

The hourly average mass concentration of inorganic air pollutants and aerosols size distribution were measured during the two Chinese traditional festivals (the Chinese New Year and the Lantern Festival) in 2013 in Jinan, China. The mass concentration of $PM_{2.5}$ could rapidly increase during fireworks events. SO_2, CO and Cl^-, NO_2^-, SO_4^{2-}, Na^+, K^+, Mg^{2+} in $PM_{2.5}$ were primary emissions of combustion of black powder,these primary aerosols mainly concentrated in range of 20~100 nm (Aitken nuclei modal). The results demonstrate that firework events would aggravate the air pollution and changed the directly modal structure of aerosol size distribution, and lower the atmospheric visibility quickly.

Fireworks events can produce a large number of containing sulfur pollutants and containing nitrogen pollutants, these pollutants may occur to a series of chemical reactions in atmosphere. The fireworks events can cause serious air pollution, so it is necessary to take some measures to reduce fireworks displays.

ACKNOWLEDGMENTS

This work was funded by the Taishan Scholars Grant (No. ts20120522), National Natural Science Foundation of China (Nos. 21190053, 21177025), Strategic Priority Research Program of the Chinese Academy of Sciences (Grant No. XDB05010200) and FP7 project (AMIS, No.PIRSES-GA-2011). We are grateful for the help from Dr. Weijun Li for minor revision.

REFERENCES

1. Wang Y, Zhuang GS, Xu C, An ZS. The air pollution caused by the burning of fireworksduring the lantern festival in Beijing. Atmos. Environ. 2007; 41: 417–31.

2. Li W, Shi Z, Yan C, Yang L, Dong C, Wang W. Individual metal-bearing

particles in a regional haze caused by firecracker and firework emissions. Sci Total Environ. 2013; 443: 464-9.

3. Liu DY, Rutherford D, Kinsey M, et al. Real-time monitoring of pyrotechnically derived aerosol particles in the troposphere. Anal Chem. 1997; 69: 1808–1814.

4. Joly A, Smargiassi A, Kosatsky T, et al. Characterisation of particulate exposure during fireworks displays. Atmos Environ. 2010; 44: 4325–4329.

5. Sayantan S, Pandit SK, Darpa SJ, et al. Chemical speciation of respirable suspended particulate matter during a major firework festival in India. Journal of Hazardous Materials. 2010; 184: 321–330.

6. Shen Z, Cao J, Arimoto R, et al. Ionic composition of TSP and PM2.5 during dust storms and air pollution episodes at Xi'an, China. Atmos Environ. 2009; 43: 2911-8.

7. Steinhauser G, Sterba JH, Foster M, et al. Heavy metals from pyrotechnics in New Years Eve snow. Atmos Environ. 2008; 42: 8616-22.

8. Tan PH, Chou C, Liang JY, et al. Air pollution "holiday effect" resulting from the Chinese New Year. Atmos. Environ. 2009; 43: 2114–2124

9. Sayantan S, Pandit SK, Darpa J. Chemical speciation of respirable suspended particulate matter during a major firework festival in India. Journal of Hazardous Materials. 2010; 184: 321–330

10. Feng JL, Sun P, Hu XL, et al. The chemical composition and sources of PM2.5 during the 2009 Chinese New Year's holiday in Shanghai. Atmos. Res. 2012; 118: 435–444

11. Zhang M, Wang XM, Chen JM, et al. Physical characterization of aerosol particles during the Chinese New Year's firework events. Atmos Environ. 2010; 44: 5191-5198.

Cite this article

Wen L, Chen J (2013) Severe Aerosol Pollution Derived from Fireworks: A Case in Jinan, China. JSM Environ Sci Ecol 1(1): 1004.