Characterization on PM$_{2.5}$/PM$_{10}$ During Winter Period in Guangzhou, China

Tian Lixue

School of Geography Sciences, South China Normal University, Guangzhou, China

Email address:
li-xue.tian@m.scnu.edu.cn

To cite this article:
Tian Lixue. Characterization on PM$_{2.5}$/PM$_{10}$ During Winter Period in Guangzhou, China. International Journal of Environmental Monitoring and Analysis. Vol. 3, No. 5, 2015, pp. 331-333. doi: 10.11648/j.ijema.20150305.23

Abstract: With the rapid economic development and urbanization over the past several decades, air pollution and degradation of visibility are common in Guangzhou, especially in winter. Our objective is to generalize the variation characteristic of PM$_{2.5}$ and PM$_{10}$ during winter period in Guangzhou and provide some theoretical evidence for the government and the relevant administration to defend PM$_{2.5}$ and PM$_{10}$. This article collects the concentration data of PM$_{2.5}$ and PM$_{10}$ in the area of Guangzhou from 2014.11-2015.1 (the winter period), and the concentration of PM$_{2.5}$ and PM$_{10}$ were (55.01 ± 78.19)ug/m$^3$ and (78.34 ± 101.76) ug/m$^3$, respectively. The mean ratio of PM$_{2.5}$ to PM$_{10}$ was 70.59% and the PM$_{2.5}$/PM$_{10}$ value ranges from 54.61% to 94.37%, indicating that fine particle (PM$_{2.5}$) occupy high proportion in the PM$_{10}$. In addition, PM$_{2.5}$ has a good linear relationship with PM$_{10}$. All evidence provides us conclusions that fine particle has a higher proportion in the atmospheric aerosol, and make a major contribution in the air environmental pollution.

Keywords: PM$_{2.5}$, PM$_{10}$, PM$_{2.5}$/PM$_{10}$, Variation Characteristic, Guangzhou

1. Introduction

With the rapid economic growth and urbanization during the last several decades, air pollution has become a pressing environmental problem in China [1]. PM$_{2.5}$, the particulate matter with an aerodynamic diameter of less than 2.5um and PM$_{10}$, the particulate matter with an aerodynamic diameter of more than 2.5 um and less than 10 um, were increasingly emphasized [2]. The epidemiological studies have demonstrated that the PM exposure is associated with the occurrence of acute respiratory infections, lung cancer and chronic respiratory and cardiovascular diseases [3, 4, 5].

Compared to the foreign, the study of PM$_{2.5}$, PM$_{10}$ in China started relatively later, and the research is focused on a few big cities, such as Beijing [6], Shanghai [7], Hong Kong [8], Guangzhou [9]. Guangzhou (112°57′E - 114°03′E, 22°26′N - 23°56′N), the capital city of Guangdong Province in China, has a population of more than 10 million and is located in the northern Pearl River Delta (PRD). With the rapid economic development and urbanization over the past several decades, air pollution and degradation of visibility are common in the PRD region [10-11].

Big cities have more seriously haze phenomenon, even Guangzhou, the China’s most southern coastal city has also suffered. However, the research of large cities’ haze phenomenon especially in winter is rare. This paper focuses on the study of Guangzhou in winter and combines the PM$_{2.5}$ with PM$_{10}$. More importantly, this paper has a higher reference value owing to the use of the latest data.

2. Material and Methods

| Table 1. Ambient air quality standards (GB 3095-2012). |
| --- |
| Average time | Concentration limit primary | secondary | Unit |
| --- | --- | --- | --- |
| PM$_{2.5}$ | Annual average | 15 | 35 | ug/m$^3$ |
| PM$_{2.5}$ | 24hour average | 35 | 75 | |
| PM$_{10}$ | Annual average | 40 | 70 | |
| PM$_{10}$ | 24hour average | 50 | 150 | |

Our date are collected from the Guangdong Environmental Monitoring Center, which starts on Mar 8,2012, meanwhile the PRD region become the first city agglomeration that publish monitoring indicators and evaluate air quality after implementing the new «Ambient air quality standards» (GB3095-2012) (Table.1). There are thirteen monitoring stations in Guangzhou, and data used in this paper are from the average 24 hours concentration values of thirteen monitoring stations. PM$_{2.5}$ and PM$_{10}$ are measured by the Particle Analyzer.
based on the Tapered Element Oscillating Microbalance (TEOM) working principle.

3. Results and Discussion

3.1. PM$_{2.5}$ and PM$_{10}$

There are ninety-two samples during the winter period (from Nov 1, 2014 to Jan 31, 2015). The variations of the PM$_{2.5}$ mass concentration are shown in Figure 1. The mass concentration values of PM$_{2.5}$ range from 9.0 ug/m$^3$ to 133.2 ug/m$^3$ (Table 2). And the mean mass concentration of PM$_{2.5}$ was 55.01 ug/m$^3$. The highest concentration of PM$_{2.5}$ was 133.2 ug/m$^3$, in excess of 60 ug/m$^3$ than standard (75 ug/m$^3$) approximately, and the least values were 9.0 ug/m$^3$, which was favorable air environment for living. Among the total samples, 10 samples’ PM$_{2.5}$ mass concentration exceed standard (75 ug/m$^3$) (Table 2), occupying 10.87% of total sample number.

The variations of the PM$_{10}$ mass concentration are also shown in Figure 1, ranging from 14.6 ug/m$^3$ to 180.1 ug/m$^3$, and the average values was 78.34 ug/m$^3$. The peak of PM$_{10}$ mass concentration (180.1 ug/m$^3$) just a little more than the standard 150 ug/m$^3$, and this phenomenon is better than PM$_{2.5}$. There are 4 samples exceed standard, and they have a proportion of 4.35% in total samples.

| Table 2. Summary of PM$_{2.5}$ and PM$_{10}$, PM$_{2.5}$/PM$_{10}$ from Nov 2014 to Jan 2015. |
|----------------------------------|-------------------------------|-------------------------------|-------------------------------|-----------------------------------------------|
| **Mean/(ug/m$^3$)**              | **Max./(ug/m$^3$)**            | **Min./(ug/m$^3$)**            | **Total sample number/d**    | **Exceed standard number/d**     | **The percentage of exceed standard number to sample number/%** |
| PM$_{2.5}$                       | 55.01                         | 133.2                         | 9.0                          | 92                             | 10                             | 10.87                        |
| PM$_{10}$                        | 78.34                         | 180.1                         | 14.6                         | 92                             | 4                              | 4.35                         |
| PM$_{2.5}$/PM$_{10}$             | 70.59%                        | 94.37%                        | 54.61%                       | 92                             |                                |                               |

Seen from Figure 1, there are several peaks, such as Dec 15, 2014, Dec 24-26, 2014, Dec 30-31, 2014, Jan 3, 2015, Jan 20-21, 2015. By viewing historical weather data, during this peak period, the weather was dry and without or little wind and rain, which inhibits the dispersion of pollutants. Therefore, the PM$_{2.5}$ and PM$_{10}$ mass concentration were closely associated with weather conditions.

Throughout the values of PM$_{2.5}$ and PM$_{10}$, the author has come to the proportion of pollution levels in the winder period, as shown in Figure 2. The benign environmental condition has the largest proportion, that is 73.91%. The optimal and mild pollution have the same proportion, and the rest is 2.17%, proportion of moderate pollution. The percentage of exceed standard is 14.13% and the overall is good air quality.

3.2. PM$_{2.5}$/PM$_{10}$

The ratio of PM$_{2.5}$/PM$_{10}$ indicates the percentage composition of PM$_{2.5}$ fine particle in the PM$_{10}$. Shown from Table 2 and Figure 1, among the total ninety-two samples, the mean ratio of PM$_{2.5}$ to PM$_{10}$ is 70.59%. The PM$_{2.5}$/PM$_{10}$ value ranges from 54.61% to 94.37%. Compared with other domestic cities, such as Wuhan (61%), Lanzhou (52%), Chongqing [12] (65%) and Hong Kong [13] (82%), the ratio of PM$_{2.5}$ to PM$_{10}$ in Guangzhou during the sampling period is higher than some inner cities and the data of Guangzhou is closed to that of Hong Kong as probably they are both in the Pearl River Delta of China. This evidence provide us a conclusion that fine particle make a major contribution in the air environmental pollution. For example, in recent years, the increased number of hazy may have a close relationship with that in the region.
3.3. The Relationship Between PM$_{2.5}$ and PM$_{10}$

Figure 3 shows plots of PM$_{2.5}$ and PM$_{10}$ concentrations and the linear relationships between them. PM$_{2.5}$ has a good linear relationship with PM$_{10}$, with correlation coefficients ($R^2$) exceeding 0.9, and the regression equation is PM$_{2.5} = 0.66*PM_{10} + 3.1$ (Figure 3). In the study, PM$_{2.5}$ and PM$_{10}$ are closely correlated and there is an interaction relationship between PM$_{2.5}$ and PM$_{10}$. This evidence also indicates that higher percentage composition of PM$_{2.5}$ fine particle in the PM$_{10}$ and both of them make a combined contribution in the air environmental pollution.

4. Conclusion

The concentration of PM$_{2.5}$ and PM$_{10}$ in Guangzhou during the winter period was $(55.01 \pm 78.19) \mu g/m^3$ and $(78.34 \pm 101.76) \mu g/m^3$, respectively. The mean ratio of PM$_{2.5}$ to PM$_{10}$ was 70.59% and the PM$_{2.5}$/PM$_{10}$ value ranges from 54.61% to 94.37%, indicating that fine particle (PM$_{2.5}$) occupy high proportion in the PM$_{10}$. Compared with PM$_{10}$, PM$_{2.5}$ has higher percentage of exceeding standard number. In addition, PM$_{2.5}$ has a good linear relationship with PM$_{10}$. From the above, all evidence provides us conclusions that fine particle has a higher proportion in the atmospheric aerosol, and make a major contribution in the air environmental pollution. Therefore, government should aim to control fine particles for priority in the particulate matter control strategy.

Acknowledgments

The study was financially supported by the National Natural Science Foundation of China (41571187) for which the author is grateful. Thanks are giving to the Guangdong Environmental Monitoring Center for the sample data.

References

[1] Feng, J., et al., Characteristics and seasonal variation of organic matter in PM2.5 at a regional background site of the Yangtze River Delta region, China, Atmos, Environ, 2015, 1-10.

[2] Xu, L.L., et al., Seasonal variations and chemical compositions of PM2.5 aerosol in the urban area of Fuzhou, China, Atmos Res. 2012, 104-105: 264-272.

[3] Pope III, C.A., et al., Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution, J. Am. Med. Assoc. 2002, 287: 1132-1141.

[4] Kok, T.M.C.M., et al., Toxico-logical assessment of ambient and traffic-related particulate matter: a review of recent studies, Mutat. Res. 2006, 613: 103-122.

[5] Taus, N., et al., Respiratory exposure to air pollutants, J. Environ. Prot and Ecol. 2008, 9: 15-25.

[6] Zhao, X.J., et al., Seasonal and diurnal variations of ambient PM2.5 concentration in urban and rural environments in Beijing. Atmos. Environ. 2009, 43: 2893-2900.

[7] Huang K, et al., How to improve the air quality over mega-cities in China? Pollution characterization and source analysis in Shanghai before, during and after the 2010 World Expo. Atmos. Chem. Phys. 2013, 13: 3379-3418.

[8] Shi W Z, et al., Analysis of airborne particulate matter (PM2.5) over Hong Kong using remote sensing and GIS. Sensor. 2012, 12: 6825-6836.

[9] Garland R M, et al., Aerosol optical properties in a rural environment near the mega-city Guangzhou, China: implication for regional air pollution radiates forcing and remote sensing. Atmos. Chem. Phys. 2008, 8: 5161-5186.

[10] Wu, D., et al., An extremely low visibility event over the Guangzhou region: A case study, Atmos. Environ., 2005, 39: 6568-6577.

[11] Deng, X.J., et al., Long-term trend of visibility and its characterizations in the Pearl River Delta (PRD) region, China, Atmos. Environ, 2008, 42.1424-1435.

[12] Wei, F., et al., Ambient Concentrations and Elemental Compositions of PM10 and PM2.5 in Four Chinese Cities, Environ. Sci. Technol. 1999, 33: 4188-4193.

[13] Chan. L.Y., Spatial Variation of Mass Concentration of Roadside Suspended Particulate Matter in Metropolitan Hong Kong. Atmos. Environ, 2001, 35: 3167-3176.