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

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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 than2.5 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		Unit
		primary	secondary	
$PM_{2.5}$	Annual average	15	35	ug/m^3
	24hour average	35	75	
PM_{10}	Annual average	40	70	
	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 PM2.5 and PM10、PM2.5/PM10 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、Jan3, 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.

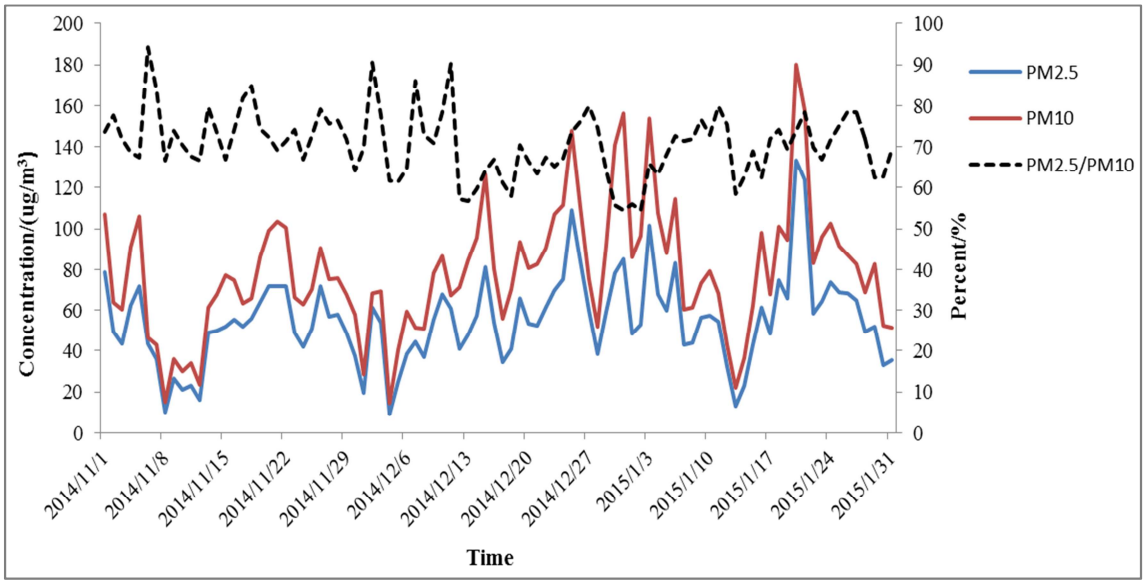

Figure 1. *Variation characteristic of $PM_{2.5}$、PM_{10}、and $PM_{2.5}/PM_{10}$.*

Throughout the values of PM2.5 and PM10, 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.

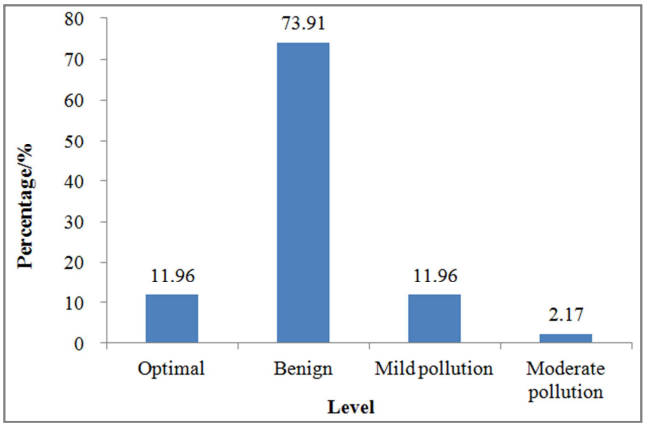

Figure 2. *The proportion of pollution levels.*

3.3. The Relationship Between $PM_{2.5}$ and PM_{10}

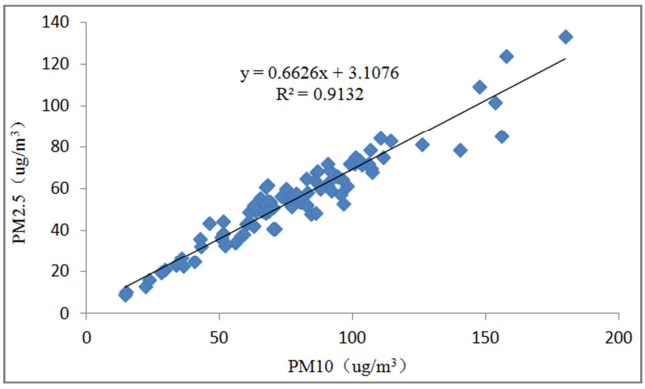

Figure 3. *Correlation of $PM_{2.5}$ and PM_{10}.*

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±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}. 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

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