Analysis on the characteristics of daily change of air environment quality in Tianhe District of Guangzhou

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Abstract. By extracting the diurnal variation trend, the air pollutant monitoring data series (such as the one-hour average for many years) are averaged by arithmetic at 24 hours per day, and the impact of air pollution sources on the environmental air quality in Tianhe District of Guangzhou is analyzed. The results show that the environmental air quality monitoring factors of each station are affected by moving sources in different periods, especially heavy vehicles. At the same time, some stations are affected by natural vegetation.

1 Introduction

Because of its distinct diurnal variation characteristics, the contribution of local pollution sources can be reflected by extracting the diurnal variation trend of air pollutant concentration. Through statistical method, the interference of seasonal variation and accidental pollution on monitoring data is shielded, thus highlighting the regular pollution effect of local pollution sources on a one-day cycle.

2 Data selection and method introduction

2.1 Data selection

The hourly average values of nitrogen dioxide (NO2), nitrogen oxides (NOX), carbon monoxide (CO), ozone (O3), sulfur dioxide (SO2), fine particulate matter (PM2.5) and coarse particulate matter (PM10) were selected from five automatic monitoring stations of environmental air quality in Tianhe District of Guangzhou from January 2018 to May 2019.

2.2 Method introduction

To extract the diurnal variation trend, the monitoring data sequence of air pollutants is used to calculate the average concentration of air pollutants at different time points according to the arithmetic average of 24 time points in a day.

3 Result analysis

3.1 Nitrogen dioxide（NO2）

It can be seen from the diurnal variation curve of NO2 (Fig. 1) that the diurnal variation law of NO2 at various monitoring stations in Tianhe District is similar except for the Fenghuangshan site.

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The common characteristics are that the concentration peaks occur around 7 am and 20 pm, and the valleys occur around 14 pm. In terms of the ranking of pollutant environmental concentration levels, the levels of sports, Olympics and Longdong are on the high side, followed by them. Wushan, Fenghuang Mountain is on the low side.

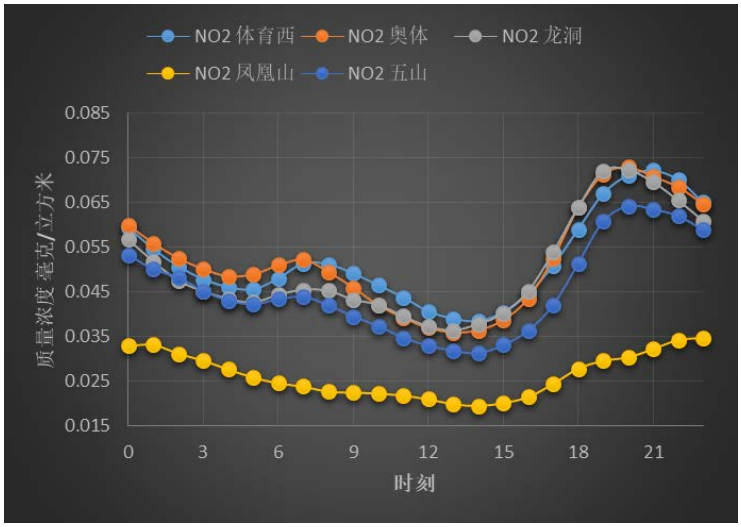

Fig. 1 Diurnal variation of NO2 concentration at each measuring point

3.2 Nitrogen oxide（NOX）

Combustion source is one of the main sources of NOX, which includes nitric oxide (NO) and NO2. In the initial stage of combustion source emission, NO is dominant in NOX, and then the dynamic equilibrium of NO and NO2 is gradually achieved in the ambient atmosphere, which is generally dominated by NO2. It can be seen from the diurnal variation curve of NOX (Figure 2) that the diurnal variation of NOX in Tianhe area is similar except for Fenghuang Mountain. The common characteristics are that there are concentration peaks around 7 am and 21 p.m., and valleys around 14 p.m. The highest level of pollutant environmental concentration is Austria, followed by Sports West, Wushan and Longdong, and the lower level of Fenghuang Mountain.

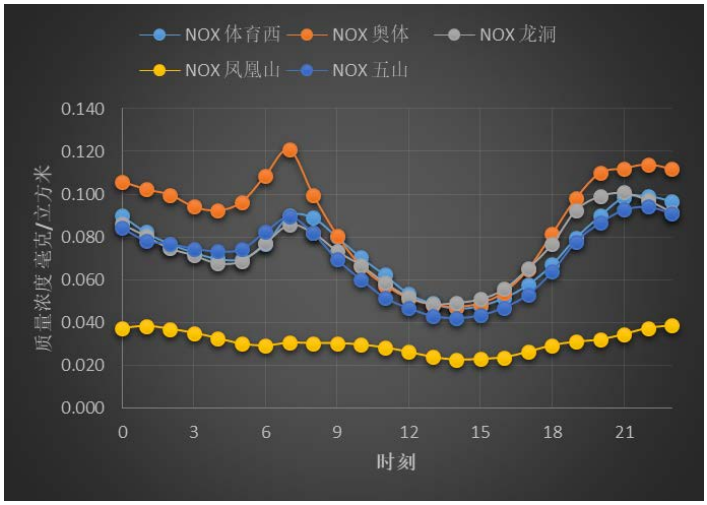

Fig. 2 Diurnal variation of NOX mass concentration at each measuring point

When the ratio of NO2 to NOX [NO2/NOX] is small, it indicates that NO is predominant, which may indicate that the measuring point is in the period of concentrated emission of combustion source. When [NO2/NOX] increases gradually, it may be that the intensity of emission of combustion source decreases or the quantity of emission decreases, the fresh emission of NO decreases. From the ratio of NO2 to NOX [NO2/NOX], the diurnal variation curve (Figure 3)

shows that the diurnal variation regularity of each measuring point in Tianhe District is similar, especially the four measuring points located in the urban area. The common characteristic is that they are high around 18 p.m. and low around 7 a.m. The difference between Fenghuangshan and other stations is slightly obvious, which is supposed to be related to the distance from the urban area. The level of [NO2/NOX] from high to low is generally Phoenix Mountain, Sports West, Longdong, Wushan and Olympic Sports. This phenomenon has a potential relationship with the oxidation of environmental air, and secondly is related to the characteristics of Phoenix Mountain far away from the city from traffic pollution.

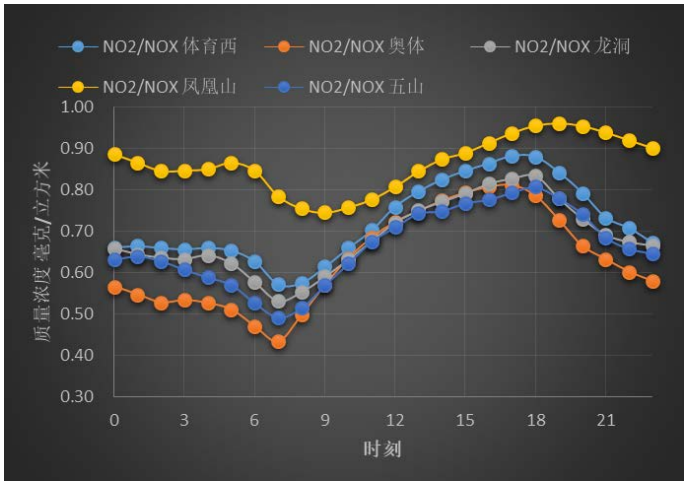

Figure 3 Diurnal variation of [NO2/NOX] mass concentration at each measuring point

3.3 Carbon monoxide（CO）

It can be seen from the diurnal variation curve of CO (Figure 4) that the diurnal variation of CO in Tianhe District is similar except for the Fenghuangshan station. The common characteristics are that the concentration peaks occur around 8 am and 20 pm, and the valleys occur around 14 pm. The time characteristics of pollutant sources around the western sports measuring point are related; the highest level of pollutant environmental concentration is in the west of sports, followed by Wushan and Longdong, while the Olympic and Phoenix Mountains are relatively low.

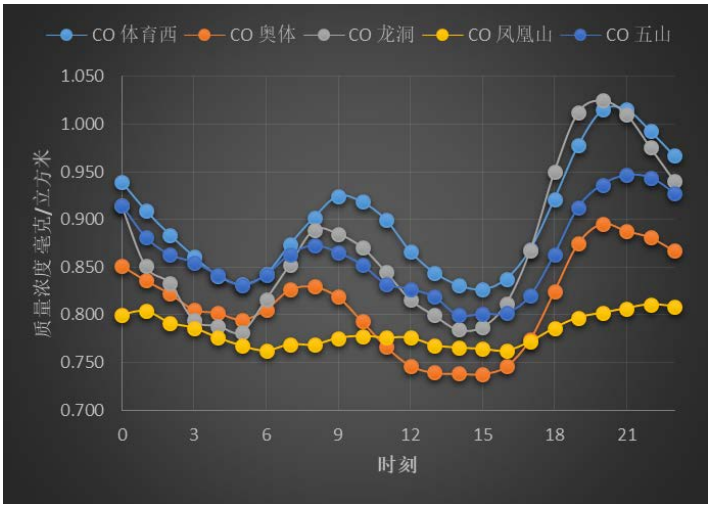

Fig. 4 Diurnal variation of CO mass concentration at each measuring point

Vehicle exhaust is the product of combustion of natural gas, gasoline and diesel. As far as the mainstream gasoline and diesel vehicles are concerned, according to the existing emission factors, the ratio of CO to NOX in the exhaust gas of gasoline vehicles [CO/NOX] is significantly higher

than that of diesel vehicles, in other words, the contribution of NOX emission of diesel vehicles is significantly higher than that of gasoline vehicles. From the diurnal variation curve (Fig. 5), we can see that the regularity of [CO/NOX] at other stations in Tianhe District is highly consistent except for the slight difference of Fenghuangshan survey points. The common characteristic is that it is low at 7 am and high around 14 p.m. [CO/NOX] is the highest in Fenghuangshan, followed by Sports West, Wushan and Longdong, and the Olympic sports is low. The low CO/NOX of the Olympic Sports indicates that the periphery of the measuring point is affected by more trips by diesel vehicles.

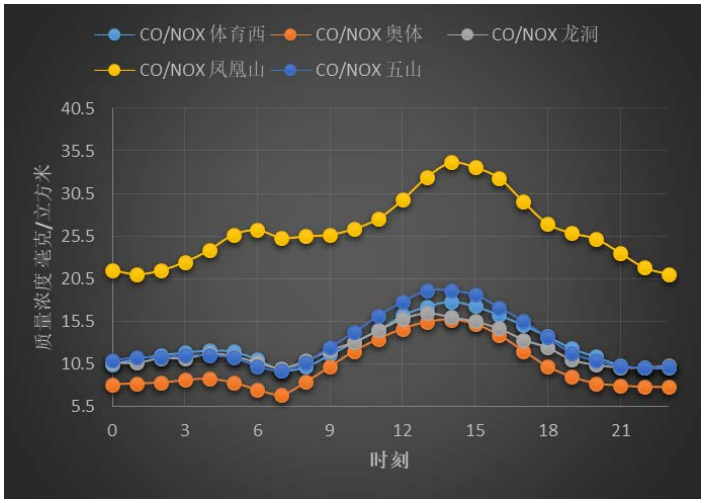

Fig. 5 Diurnal variation of [CO/NOX] mass concentration at each measuring point

3.4 Ozone（O3）

From the diurnal variation curve (fig. 6), it can be seen that the diurnal variation of O3 in Tianhe area is similar to that in other sites. The common feature is that the concentration peak appears around 15 p.m., while the concentration drops sharply at night. The highest concentration of pollutants is in Fenghuangshan, followed by Sports West, Wushan and Longdong, and the Olympic Games is relatively low. The anthropogenic emission of NOX and VOCs is the precursor of O3, and natural vegetation also emits a lot of VOCs. The Fenghuangshan site is likely to be affected by both man-made and natural sources, but the details need to be determined by the analysis of local volatile organic compounds.

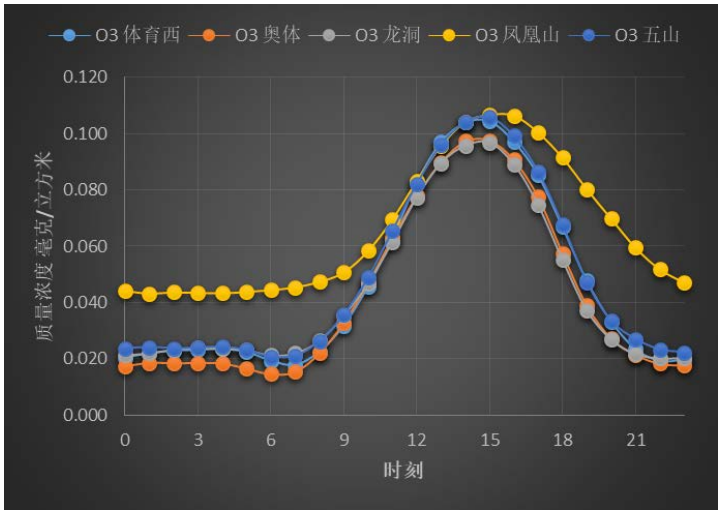

Fig. 6 Diurnal variation of O_3 concentration at each measuring point

3.5 Sulfur dioxide（SO2）

From the diurnal variation curve of SO2 (fig. 7), it can be seen that the diurnal variation of SO2 in Tianhe area is similar. The common characteristics are that the concentration peaks appear around 9 a.m. and the valleys appear around 18 p.m. The phenomena of SO2 increase in Wushan, Longdong and Fenghuangshan in the early morning are particularly noticed; the highest level of pollutant environmental concentration is in Sports West, followed by Wushan and Fenghuangshan. The Olympics and Longdong are on the low side.

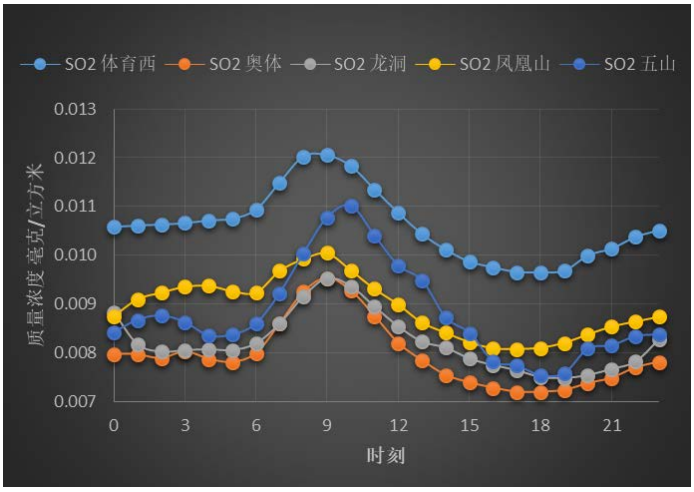

Figure 7 Diurnal variation of SO2 concentration at each measuring point

3.6 Fine particulate matter（PM2.5）

It can be seen from the daily variation curve of PM2.5 (Figure 8) that the daily variation trend of PM2.5 at each measuring point in Tianhe District is quite different, but there are still some common features, such as the high level of environmental concentration from noon and evening to night, forming two or three high value areas, with the highest concentration basically at 19-21; the high level of environmental concentration of pollutants in sports west and Longdong. Secondly, the Olympic Games and Wushan Mountains are on the low side, while the Phoenix Mountains are on the low side.

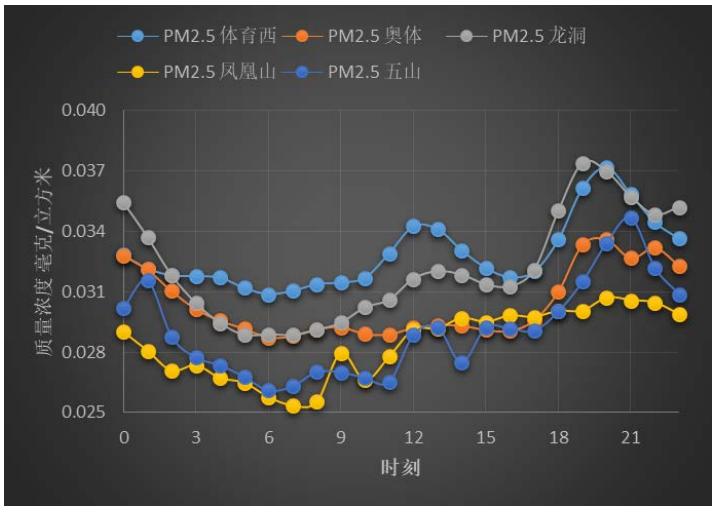

Figure 8 Diurnal Variation of PM2.5 Mass Concentration at Each Measuring Point

3.7 Respirable particles（PM10）

From the diurnal variation curve of PM10 (fig. 9), it can be seen that the diurnal variation characteristics of PM10 in Tianhe District are obviously different, but there are still some common

characteristics, such as the high environmental concentration level at 20-21 p.m. and 0-2 a.m. and the high value area formed; the high environmental concentration level of pollutants in Wushan Mountain, followed by Sports West, Olympic Sports, Longdong and Fenghuang Mountain.

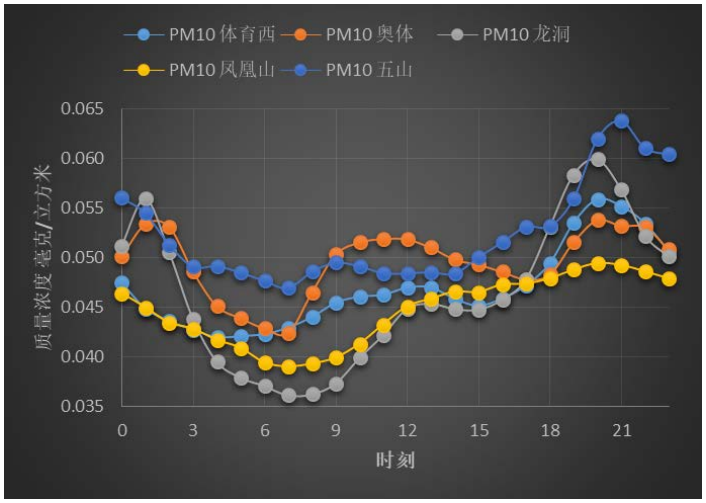

Figure 9 Diurnal variation of PM10 mass concentration at each measuring point

PM2.5 is a part of PM10, representing the smaller particle size groups, which mostly come from high temperature combustion and secondary transformation, while the larger particle size comes from mechanical crushing and dust. The ratio of PM2.5 to PM10 [PM2.5/PM10] is helpful to distinguish the size tendency of particles at the affected sites and to understand the source of particles. From the diurnal variation curve of [PM2.5/PM10] (Fig. 10), it can be seen that there is no uniform law among the stations in Tianhe District. The fluctuation of [PM2.5/PM10] at Fenghuangshan and Wushan stations is relatively stable, and the changes of sports in West, Austria and Longdong are relatively strong. From the overall level, the [PM2.5/PM10] of Sports West and Longdong is larger, which indicates that the particulate matter pollution tends to be smaller, with peaks in Sports West at 04 am and 12 noon, Longdong at 00 am and 08 am, and the Olympic and Phoenix Mountains at medium levels, with peaks at 00, 07 and 19 o'clock, and peaks in Phoenix Mountains at 09 am. On the whole, the [PM2.5/PM10] of Wushan is low and the diurnal variation regularity is not obvious.

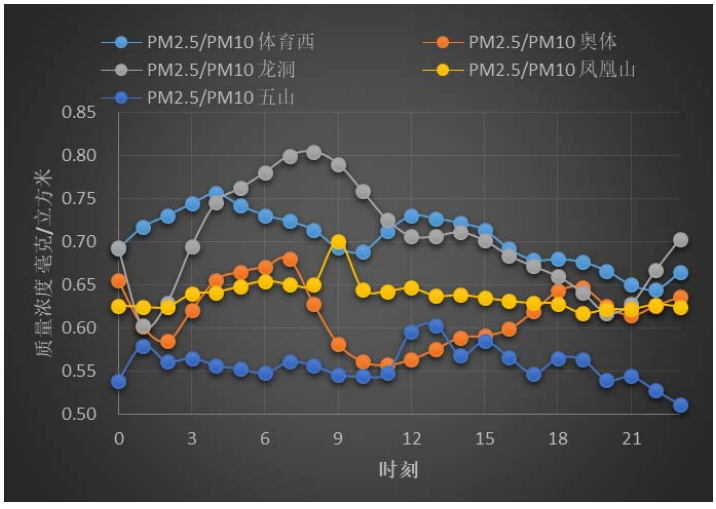

Fig. 10 daily change of mass concentration of each measuring point [PM2.5 / PM10]

4. Conclusion

In summary, except SO2 and O3 concentration level in Fenghuangshan, other environmental concentration levels such as NOX, NO2, PM10, PM2.5 and CO are basically the lowest in the whole region. In addition to the influence of regional ozone pollution, the higher concentration of O3 in Fenghuangshan is supposed to be related to the natural sources of volatile organic compounds (VOCs) brought by vegetation. Therefore, the situation of Fenghuangshan survey site basically satisfies the functional positioning as a clean control point in the whole region, and will not be discussed in the following further discussion on pollution sources.

On the other hand, without taking Fenghuang Mountain into statistical analysis, the concentration levels of pollutants in Sports West are mostly on the high side of the region, such as SO2, NOX, PM2.5, CO, etc. The high concentration levels of these pollutants are closely related to the urban traffic exhaust, which basically corresponds to the geographical characteristics of Sports West Station located in the central area of the city, especially the SO2 level is far higher day and night. In other sites, the contribution of combustion sources to the Western Sports Station is more fully revealed. For highly urbanized and densely populated areas, combustion sources often include road mobile sources, off-road mobile operating machinery and fuel combustion from residents'lives.

The situation of Austrian test points is very characteristic. The high NOX from night to morning and the low [NO2/NOX], [CO/NOX] imply the impact of diesel vehicle intensive travel. The higher PM10 and the lower [PM2.5/PM10] may be related to the dust caused by heavy vehicle travel.

Longdong site is characterized by the high SO2, NOX, CO, PM2.5, PM10 and [PM2.5/PM10] phenomena from late peak to midnight, especially the small peak of SO2 at midnight and the high concentration of PM2.5 and PM10. It is suspected that there is often some combustion source in this period, but the combustion source is not necessarily a motor vehicle. Together with the Olympic site, Longdong site needs to conduct more detailed observation and analysis of the causes of air quality deterioration around midnight, and then carry out "peak cutting" operations.

Compared with the other three measuring points located in urban areas, Wushan has its own unique situation. It can be seen that the levels of NO x, CO, PM2.5, [PM2.5/PM10] are low, but SO2, PM10 and O3 are high. This phenomenon implies that the sources of air pollution around Wushan measuring point are special.

References

[1] Pan Xiaochuan, Li Guoxing, Gao Ting. Assessment of health hazards and economic losses of PM2.5 in dangerous breathing [M]. Beijing: China Environment Press, 2012.

[2] Ministry of Environmental Protection, National Bureau of Quality Supervision, Inspection and Quarantine GB 3095-2012 Environmental Air Quality Standard [S] Beijing: China Environmental Science Publishing House, 2012.

[3] Ministry of Environmental Protection. Technical Regulations for HJ 633-2012 Environmental Air Quality Index (AQI) [S] Beijing: China Environmental Science Publishing House, 2012

[4] Li Lingjun, Li Jinxiang, Xin Lianzhong, et al. Air pollution analysis during the Spring Festival in Beijing [J]. China Environmental Science, 2006, 26 (5): 537-541.

[5] Analysis of the characteristics of ozone pollution in the central area of Dalian City [J]. Journal

of China Environmental Management Cadre College, 2009, 19 (2): 76-77, 84.

[6] Shi He Jun, Zhang Li and Zhang Lijie. Comparative analysis of haze characteristics in Shenzhen based on automatic station data [J]. China Environmental Monitoring, 2013, 29 (6): 39-43.