

Characteristics of Ozone Concentration in Shangqiu City and its Countermeasures

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Abstract: This article uses the air quality monitoring data of Shangqiu City to statistically analyze the characteristics of O₃ concentration changes in the near-surface layer of Shangqiu City from 2016 to 2019. The characteristics of O₃ in the peak period of spring, summer, early autumn and daily 10: 00-18: 00, Put forward countermeasures for O₃ pollution prevention.

Introduction

Ozone is one of the important substances in the chemical composition of the atmosphere. Studies have found that high concentrations of O₃ near the ground can harm human health, affect plant growth and the quality of the urban atmospheric environment. Generally speaking, photochemical reactions are the dominant source of near-surface O₃, and high-concentration O₃, as a characteristic product of urban photochemical smog, has become one of the hot issues in the field of international atmospheric science research. Shangqiu City is located in the easternmost part of Henan Province, where the four provinces of Henan, Shandong, Jiangsu and Anhui Provinces meet. With the acceleration of industrialization and urbanization, the concentration of O₃ shows an upward trend, and the ozone pollution problem caused by it has become increasingly prominent. Therefore, it is of great significance to carry out ozone analysis and research.

1. Methods and Materials

The pollutant concentration data used in this paper are from the monitoring data of 4 stations in Shangqiu City from 2016 to 2019. O₃-8h is also called ozone 8-hour moving average, that is, the largest continuous 8-hour O₃ concentration in a day is used as a standard to evaluate the ozone pollution level on that day. The city-wide average refers to the average of 4 stations. The data is selected from data sources with at least 3 sites, that is, the values that form valid data. The seasons are divided into spring (March-May), summer (June-August), autumn (September-November), and winter (December-February). This paper uses the air quality monitoring data of Shangqiu City to statistically analyze the time variation characteristics of O₃ pollution near the ground layer in Shangqiu City, and proposes prevention measures.

2. Results and Analysis

2.1 Seasonal Change Characteristics

Table 1 Statistics of ozone concentration in Shangqiu City from 2016 to 2018

Years	Number of samples	Average/ ($\mu\text{g}/\text{m}^3$)	Max value/ ($\mu\text{g}/\text{m}^3$)	Exceeded days/ d	Excessive Days Ratio/%
2016	362	99	217	34	9.39

Year					
2017	364	108	244	56	15.38
Years					
2018	357	111	253	67	18.77
Year					
Total	1083	/	/	/	14.50

Table 1 summarizes the actual monitoring data of O₃ in Shangqiu City from 2016 to 2018. From January 1, 2016 to December 31, 2018, the annual average ozone concentration in Shangqiu City increased from 99 $\mu\text{g} / \text{m}^3$ in 2016 to 111 $\mu\text{g} / \text{m}^3$, and the average ozone concentration increased year by year.

From January 1, 2016 to December 31, 2018, the total number of monitoring days was 1083d, and the O₃-8h concentration exceeded the standard for 157d, which accounted for 14.50% of the total monitoring days. Among them, the number of exceeded days in 2016 was 34 days and the number of days in 2017 was 56d. In 2018, it was 67d, and the number of days with O₃-8h concentration exceeding the standard showed an upward trend year by year.

2.2 Seasonal Changes

The O₃ monitoring data of Shangqiu City from March 2016 to February 2019 were collected to obtain its seasonal change characteristics. Figure 1 shows that the seasonal concentration of O₃ is generally the highest in summer, followed by spring and autumn, and the lowest in winter, and the overall seasonal change trend over the three years is exactly the same. The difference between the highest and lowest spring averages of 1 $\mu\text{g} / \text{m}^3$ in the three seasons is not much changed; the highest and lowest difference in summer is 11 $\mu\text{g} / \text{m}^3$; the highest and lowest difference in autumn is 11 $\mu\text{g} / \text{m}^3$; Shangqiu City is in a temperate continental climate, with four distinct seasons, and has the characteristics of cold winter and hot summer. The small changes in the same season for the three seasons show that the ozone concentration in Shangqiu is closely related to the meteorological conditions.

According to the data analysis, the ozone concentration data points in the spring and summer are relatively concentrated in the three seasons, generally in high-concentration areas. The highest ozone concentration is basically in the early summer of June, the ozone concentration in the autumn is relatively scattered, and the ozone concentration in September is more. Distributed in high-concentration areas, the ozone concentration in October-November is basically in the low-concentration area, and the ozone concentration in winter is in the low-concentration area. The data are relatively concentrated. It shows that the sunshine and solar radiation in spring and summer are relatively strong seasons of the year, which are prone to photochemical reactions. When the precursors such as nitrogen oxides and VOCs are the same, high concentrations of ozone are likely to occur. With the development of the prevention and control of atmospheric pollution in 2016, the main pollutant PM_{2.5} weakened in summer and autumn, which led to the reduction of the aerosol optical thickness, enhanced the photochemical generation rate of O₃, and the O₃ concentration tended to increase. The solar radiation in spring and autumn is still sufficient, the hours of sunshine are long, and the ozone concentration is still at a high level. However, with the rapid decline of temperature, solar radiation, and sunshine hours from November to February, it is not conducive to photochemical reactions, so the ozone concentration in winter the lowest season.

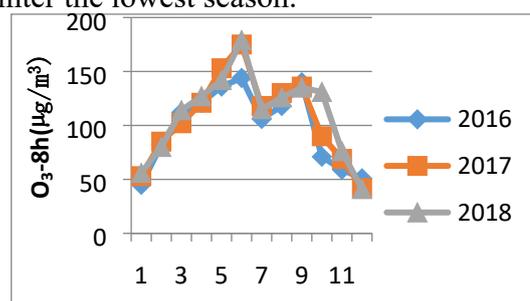
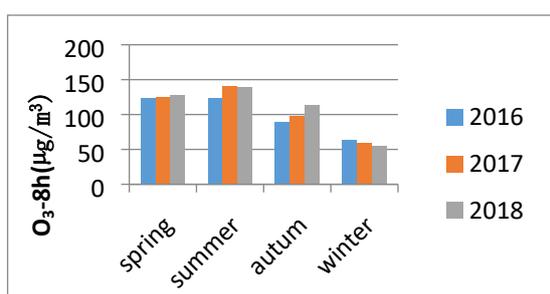


Figure 1: Seasonal variation of ozone

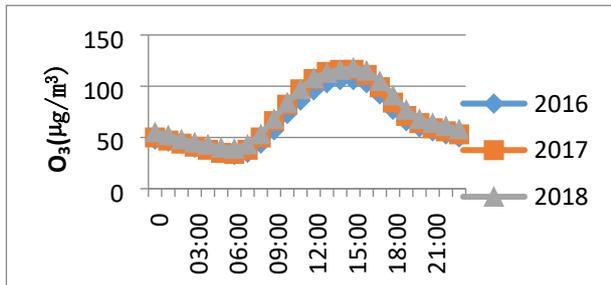


Figure 3: Diurnal variation of ozone

Figure 2: Monthly change of ozone

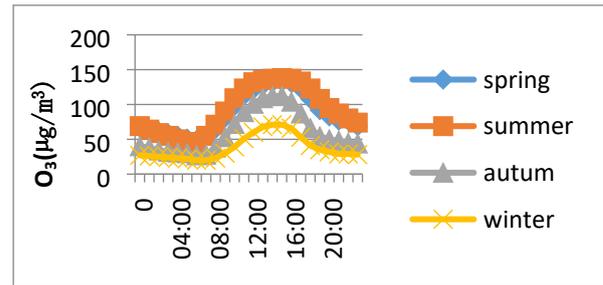


Figure 4: Diurnal chart of ozone season

2.3 Monthly Changes

Figure 2 Analysis and comparison of the ozone concentration changes in the 12 months of 2016-2018 in the city. It can be seen that the highest ozone concentration in June was $166 \mu\text{g} / \text{m}^3$, followed by May, September, August, and April. The lowest monthly concentration occurred in December, followed by January. On the whole, the monthly change trend from 2016 to 2018 is basically the same. The overall trend is gradually increasing from January to June, reaching the highest in June, slightly decreasing from July to August, then rising in September, and gradually decreasing from October to December. The reason has a greater relationship with the climate characteristics of Shangqiu City. From January to June, with the increase of temperature and the increase of sunshine time, the ozone concentration formed by the photochemical reaction gradually increased, reaching the highest in June, and the temperature and sunshine time of July-August were slightly lower than that of June. The concentration is slightly lower than in June. As September enters the first month of autumn, the autumn is high and the air is cool, and the aerosol optical thickness decreases. However, the temperature and light during the day will still strengthen the photochemical generation rate of O_3 , and the O_3 concentration will rise accordingly. 9- With the decrease of temperature and light in December, the ozone concentration gradually decreased.

Count the number of days of ozone exceeding the standard for eight hours per month from 2016 to 2018. None from January to February and November to December. It gradually increased from March to the highest in June, then decreased, and reached the second highest point in September. The number of days of ozone pollution was 7 days in October 2018, but both were zero days in October 2016 and October 2017. The number of days of pollution showed an increasing trend year by year, and the number of days exceeding the standard began to appear in March 2018 and continued to October.

2.4 Diurnal Characteristics

Statistics of daily variation characteristics of ozone in Shangqiu City from 2016 to 2018 and daily variation characteristics of four seasons are shown in Figure 3 and Figure 4, respectively. The daily changes of ozone show obvious single-peak characteristics, starting at 8:00 in the morning, gradually increasing, peaking at 14:00-16:00, and then gradually decreasing, gradually stabilized to 20:00-24:00, and the daily average value of O_3 -8h The largest appeared on June 1, 2018, at $253 \mu\text{g} / \text{m}^3$. The daily change pattern of O_3 is divided into three stages: the ozone and precursor accumulation stage, the O_3 actinic student generation stage and the consumption stage, which are consistent with the characteristics of O_3 daily change in many other cities. From midnight to early morning, the O_3 concentration in the urban atmosphere is in a low area, and there is no photochemical reaction at night, but the near-surface NO will continuously consume O_3 to gradually reduce it, but the change is not large. With the arrival of the morning peak, a large amount of O_3 precursors Continuously increasing, the intensity of ultraviolet radiation began to gradually increase, and the photochemical reaction gradually increased, leading to a gradual increase in O_3 concentration, reaching a peak from 14:00 to 16:00, and then with the decrease in sunlight intensity and temperature, and the emission of new O_3 precursors It has a depleting effect on the O_3 concentration, so that the O_3 concentration is gradually reduced to a lower region.

From the perspective of seasonal diurnal changes in Figure 5, the trend of the four seasons shows a clear single-peak characteristic. The peak interval appears between 14: 00-16: 00. The ozone concentration in spring and summer is significantly higher than that in autumn and winter. It is related to human activities, temperature, and sunlight. There is a clear relationship between intensity and so on.

2.5 Analysis of Ozone Prevention Countermeasures

Relevant research shows that under certain temperature and sunlight conditions, nitrogen oxides, VOCs, etc., will cause photochemical reactions to increase the ozone concentration. Based on the characteristics of ozone time changes in Shangqiu City for three years, it is recommended to take the following countermeasures for ozone prevention: in spring and summer Control the generation of local sources at the beginning of autumn and reduce the emissions of O₃ precursors, nitrogen oxides, VOCs, etc. ; Shangqiu City is located at the junction of the four provinces of Shandong, Henan, Anhui and Anhui, and belongs to the monsoon climate. External transmission from the west, north, and southeast This transmission channel transits and accumulates in Shangqiu City, causing the concentration of ozone-producing precursors to increase. Therefore, prior to the arrival of external transmissions, shift production of local sources should be implemented to reduce the cumulative effect of precursors; Taking active and effective prevention and control measures in the hot season plays a positive role in the prevention and control of ozone pollution.

Conclusion

From the three-year data statistics from 2016 to 2019, the annual average ozone value in Shangqiu City has been increasing year by year, and the number of days when the concentration of O₃-8h exceeded the standard has been increasing year by year. The seasonal concentration of O₃ is generally high in summer and low in winter. Meteorological conditions in the four seasons of the city are closely related; O₃ changes in a single peak feature in June, the highest in June, the second highest in September-October, and the other is lower; O₃ daily changes show a single peak feature, O₃ concentration peaks appear in April to October 10: 00-18: 00, need to do a good job of pollution prevention.

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