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Study on the Characteristics of Nitrogen Dioxide Pollution in the Atmospheric Environment of Zhenjiang City

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ABSTRACT

This paper mainly takes NO_2 in the ambient air of Zhenjiang urban area as the research object, collects and obtains the NO_2 monitoring data of the ambient air automatic monitoring station from 2016 to 2020, and studies the temporal and spatial emission characteristics of NO_2 in different regions. The main research results are as follows: In terms of time, the seasonal changes of NO_2 in five years are more obvious. The highest values of daily average concentration and over-standard rate appear in winter, and the lowest in summer. The overall trend of average concentration is: winter (45.4μg•m^{-3})>spring (39.2μg •m^{-3})>Autumn (37.6μg•m^{-3})>Summer (26.3μg•m^{-3}); The weekly change of NO_2 pollutant concentration is not obvious, and the average concentration of each day is basically the same; in terms of hourly changes , Reaching the lowest value in a day at 14 o'clock, and reaching the peak at 8 o'clock and 20 o'clock, which can basically be regarded as a positive "M" type change trend; the monthly change of NO_2 pollutant concentration basically occurs in the highest value of the annual NO_2 pollutant concentration. In winter, the lowest concentration of NO_2 pollutants mostly occurs in summer. In terms of space, the concentration of NO_2 in Zhenjiang urban area was significantly higher in 2016 and 2017, especially in the eastern part of the urban area, which is mainly related to the distribution of Zhenjiang's industry. The NO_2 concentration in the central part of Zhenjiang city has a slight increase trend, which may be related to the increase of private vehicles driven by economic development, which has led to an increase in vehicle exhaust emissions. However, the concentration of NO_2 in the environment of the western part of Zhenjiang has eased. On the whole, the NO_2 concentration in Zhenjiang urban area is low in the west and high in the east, which is inevitable related to the economic structure of the city.

Keywords : Zhenjiang; nitrogen dioxide; photochemical reaction; temporal and spatial changes

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INTRODUCTION

Nitrogen dioxide (NO_2) refers to a toxic and pungent brownish-red gas in the air. In addition to natural sources, it mainly comes from the combustion of fuel, the exhaust of urban cars and the emission of boiler exhaust. NO_2 is a significant source of pollution in the ambient atmosphere. It can not only produce the main precursor required for the photochemical reaction of ozone, but also generate nitrate aerosols through a series of photochemical reactions, which leads to a decrease in urban visibility and significantly aggravates urban pollution. It is one of the main substances that form haze [1~4]. It is easily soluble in water, and the water-soluble part generates nitric acid and nitric oxide, which leads to the formation of acid rain. After NO_2 is inhaled, it is strongly irritating and corrosive to lung tissue. Nitrogen oxides mainly damage the respiratory tract. There are only slight eye and upper respiratory tract irritation symptoms at the initial stage of inhalation, such as pharynx discomfort, dry cough, etc. Delayed pulmonary edema, adult respiratory distress syndrome, chest tightness, respiratory distress, cough, foamy sputum, cyanosis, etc. occur after a constant incubation period of hours to ten hours or more. Can be complicated by pneumothorax and mediastinal emphysema. Delayed obstructive bronchiolitis may occur about two weeks after the pulmonary edema subsides[5].

MATERIALS AND METHODS

1 Site distribution and instruments

There are a total of six monitoring stations in this research, of which four are directly controlled and managed by the state, namely the Municipal Center for Disease Control, Vocational Education Center, New District Office, and Dantu District Monitoring Station, followed by Zhenjiang Ambient Air Quality Monitoring. The two monitoring stations of Jiangsu University and the Haze Station in the New District are respectively. The national control point and the municipal construction point belong to the second-class environmental function zone. There is no obvious pollution source near the selected point, which can meet the continuous 24-hour continuous online monitoring of NO2 pollutants. Secondly, it also possesses meteorological elements such as temperature, humidity, wind speed and direction to be observed simultaneously.

Figure 1-1 Distribution of stations in Zhenjiang urban area

The principle of the nitrogen oxide analyzer is based on the chemiluminescence detection technology.[6~8]It is based on the chemiluminescence reaction of NO and O_3 to produce excited NO_2 molecules. When the excited NO_2 molecules decay to the ground state, they emit infrared light with a certain energy. The intensity of the emitted light is directly proportional to the concentration of NO. The nitrogen oxide analyzer uses the change in the intensity of the detected light to detect NO. The reaction process is as follows:

$NO+O_3 \rightarrow NO_2+O_2+ hv$

When measuring NO_2, the nitrogen oxide analyzer must first convert NO_2 into NO, and then measure it through chemiluminescence reaction. NO_2 gas is the conversion of NO_2 to NO in the converter of the molybdenum furnace, and the heating temperature required by the converter is about 325℃ (the heating temperature of the stainless steel converter is higher, about 625℃).

As shown in Figure 1-2, the ambient air sample gas is first filtered out of particulate matter through a filter cartridge equipped with a filter membrane, and then drawn into the nitrogen oxide analyzer through the air inlet marked Sample, and then reaches the manifold valve. The manifold valve selects whether the sample gas path directly reaches the reaction chamber (NO Mode), or first passes through the NO_2 to NO converter and then enters the reaction chamber (NO_X Mode). A limited flow capillary and a flow sensor must be installed before the reaction chamber to achieve the function of controlling and measuring the flow of the sample gas.

Dry air enters the nitrogen oxide analyzer through the air inlet marked Dry AIR. After passing the flow adjustment switch first, a certain amount of dry air passes through the discharge ozone generator. The ozone generator is used to generate the ozone required for the chemiluminescence reaction. In the reaction chamber, ozone reacts with NO in the sample gas to generate excited NO_2 molecules, and then the photomultiplier tube (PMT) detects the luminescence produced in this reaction. Exhaust starts from the reaction chamber, flows through the ozone scrubber under the suction of the pump, and finally exhausts through the exhaust port marked Exhaust.

The NO and NO_X concentrations calculated in the NO and NO_X mode are stored in the memory. The difference between the concentration of NO and NO_X can be used to calculate the concentration of NO_2. The nitrogen oxide analyzer outputs the concentration of NO, NO_2 and NO_X to the front panel display and analog output. At the same time, these data can also be read through the serial port protocol or the Ethernet interface linking the industrial computer.

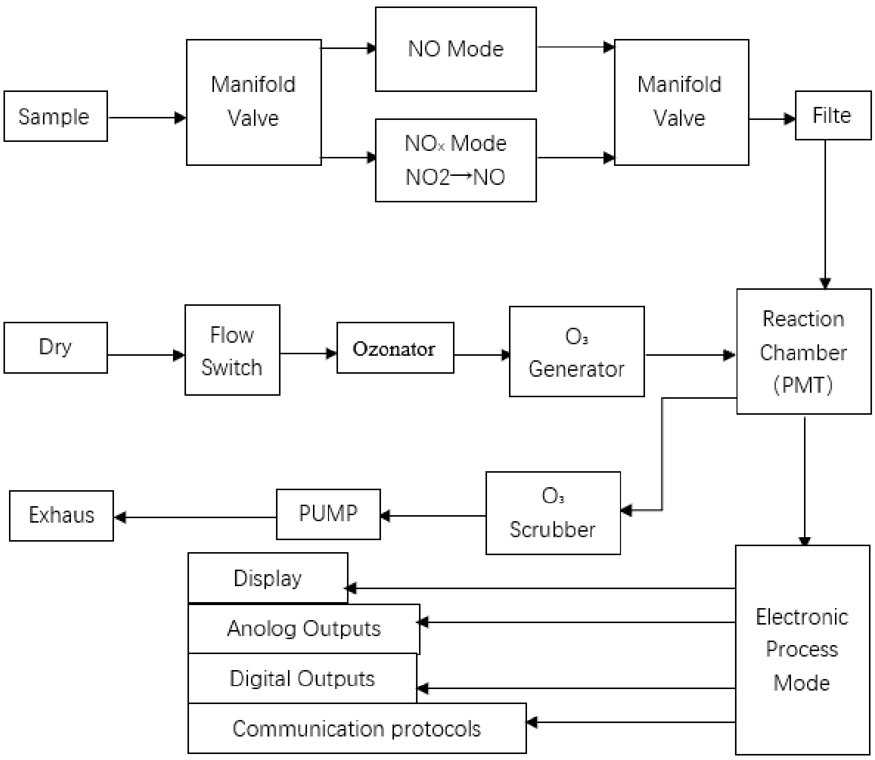


Figure 1-2 Detection principle of NO_X analyzer

2 Temporal and spatial variation characteristics of NO_2 pollutants

2.1Seasonal variation

Figure 2-1 is the time series of the daily average concentration of NO_2 at the six sites in Zhenjiang City from 2016 to 2020. It can be seen from the figure that the daily concentration of NO_2 at the six sites is basically the same. The overall trend of seasonal changes in NO_2 over the five years is: the highest in winter. Followed by spring, autumn, and finally summer. The seasonal changes of NO_2 are more obvious. The highest values of daily average concentration and over-standard rate appear in winter, and the lowest in summer. It is worth mentioning that the over-standard rate in summer is 0%, which is mainly due to the long distance from the urban monitoring points. The source of pollution is unclear and related to meteorological factors.

On the whole, the daily average concentration and over-standard rate of NO_2 pollution levels in Zhenjiang City from 2016 to 2020 reached the maximum in 2018. In 2020, the daily average concentration of NO2 pollution levels will be the lowest except for the new area haze station (coming into use in 2017) In the spring and summer of 2020, the NO_2 excess rate of the six stations is zero. The characteristics of the four seasons are as follows: the five-year average concentration trend is shown as winter (45.4μg•m^{-3})>spring (39.2μg•m^{-3})>autumn (37.6μg•m^{-3})>summer (26.3μg•m^{-3}) The trend of the five-year average over-standard rate is winter (8.1%)> autumn (2.2%)> spring (1.4%)> summer (0.0%).

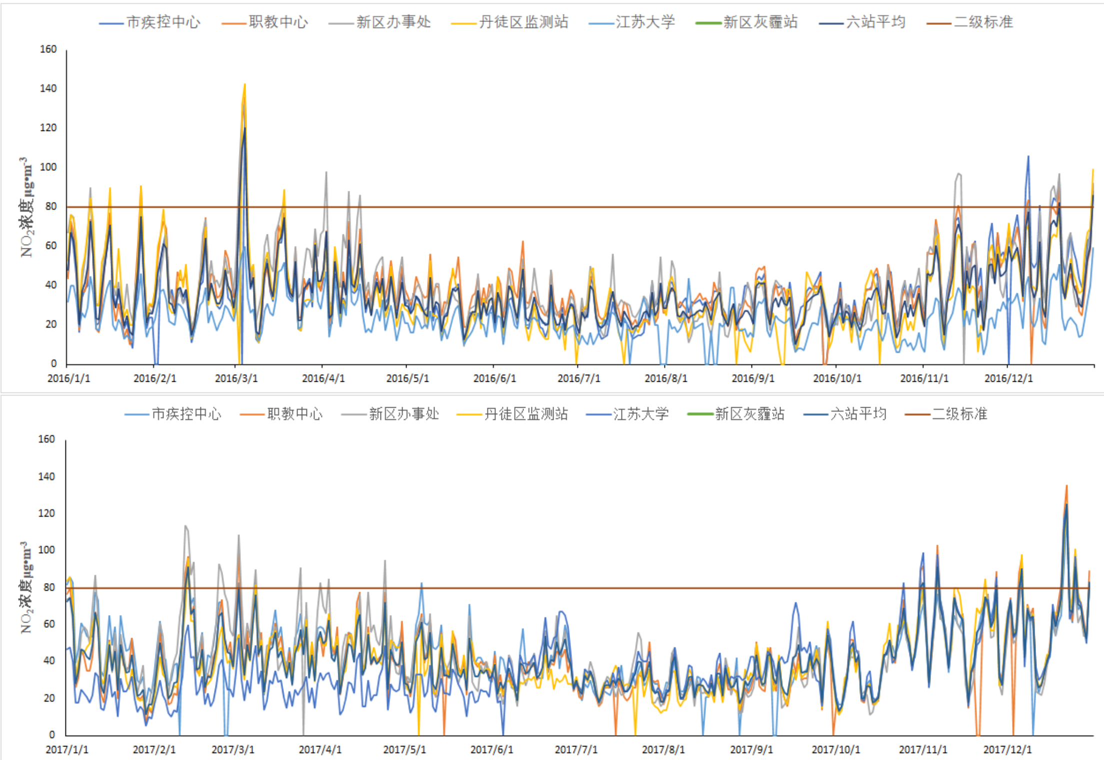


Figure 2-1 Time series of daily average concentration of NO_2 at six stations in Zhenjiang City

2.2 Weekly change characteristics

Figure 2-2 shows the daily average concentration of NO_2 pollutants in Zhenjiang City in a week from 2016 to 2020. It can be seen from Figure 2-2 that the weekly change of NO_2 pollutant concentration from 2016 to 2020 is not obvious, and the average concentration of each day is basically the same. Except for 2016, the daily average daily concentration of NO_2 in each week from 2017 to 2020 basically showed a decreasing trend. The concentration of NO_2 in 2017 was higher, and the concentration of NO_2 in 2020 was lower. On the whole, the concentration difference of NO_2 pollutants within a week is small (the relative standard deviation is not more than 10%), so the weekly change characteristics are not obvious. This may be related to the industrial structure of Zhenjiang City and the small and relatively balanced NO_2 emission sources. The factor is related.

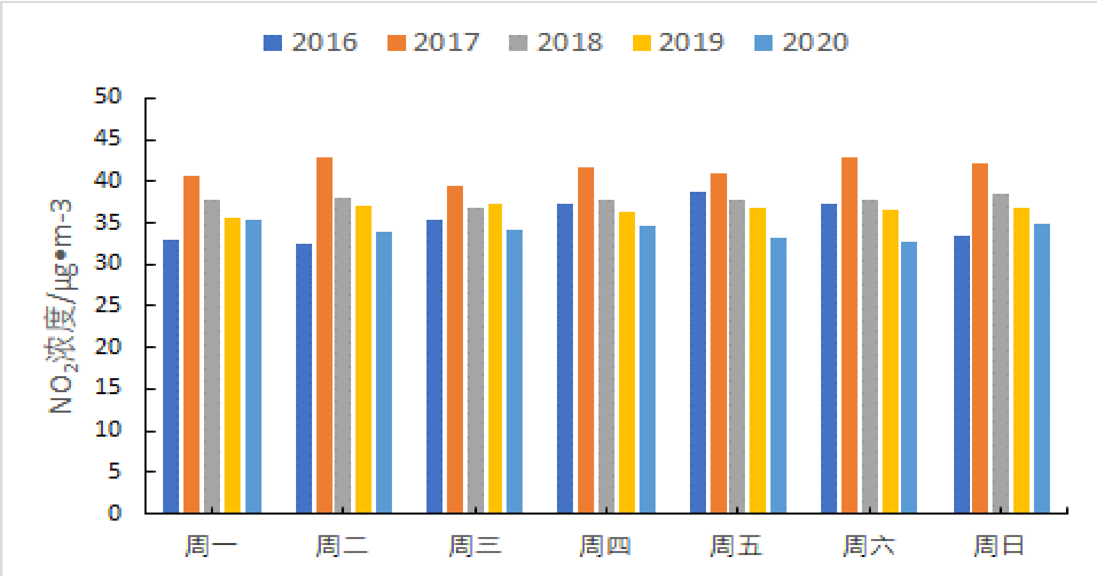


Figure 2-2 Weekly changes in NO_2 pollutant concentration

2.3 Time-varying characteristics

Figure 2-3 shows the changing trend of the hourly concentration of NO_2 pollutants in one day from 2016 to 2020. It can be clearly seen from the figure that it can basically be seen as a positive "M"-shaped change trend. The NO_2 pollutant concentration basically keeps a slight increase from 4 am to 8 am every day, reaching a peak at about 8 am, and then begins to drop significantly at a rate of about 14 micrograms per hour, and reaches the lowest level in the day at 2 pm (14:00) Afterwards, it began to rise significantly at a rate of about 14 micrograms per hour, and reached its peak again at about 8 o'clock in the evening (20 o'clock). It can be seen from Figure 4-3 that a "V"-shaped structural change pattern is formed from 8 am to 8 pm (20 pm) every day. After that, the concentration of NO_2 pollutants continued to decline slightly until about 4 o'clock in the morning the next day. It can be seen that the change trend of the hourly concentration of NO_2 pollutants in one day from 2016 to 2020 is in an "M"-shaped distribution.

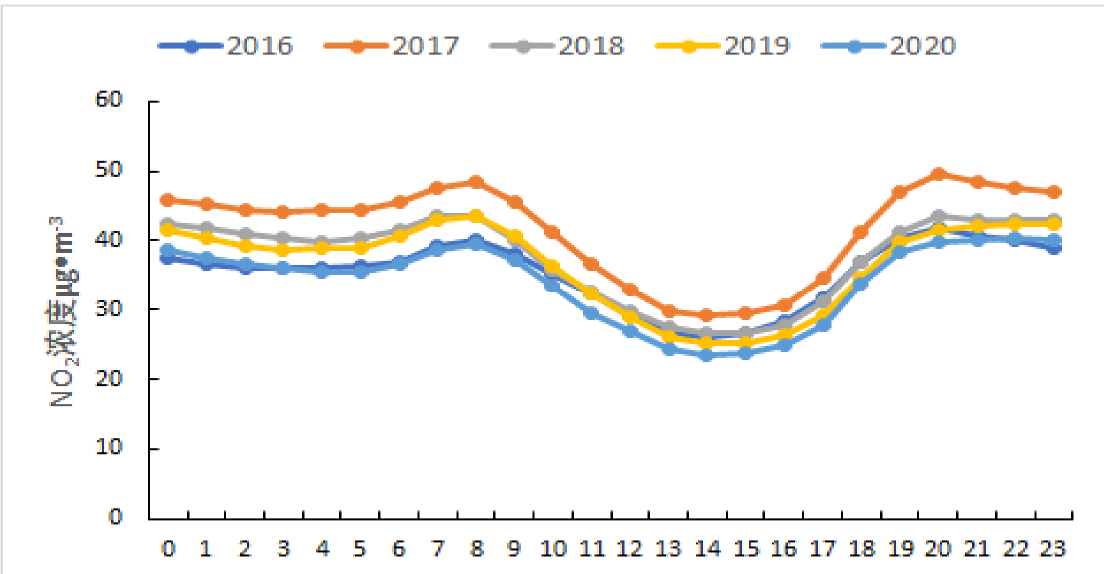
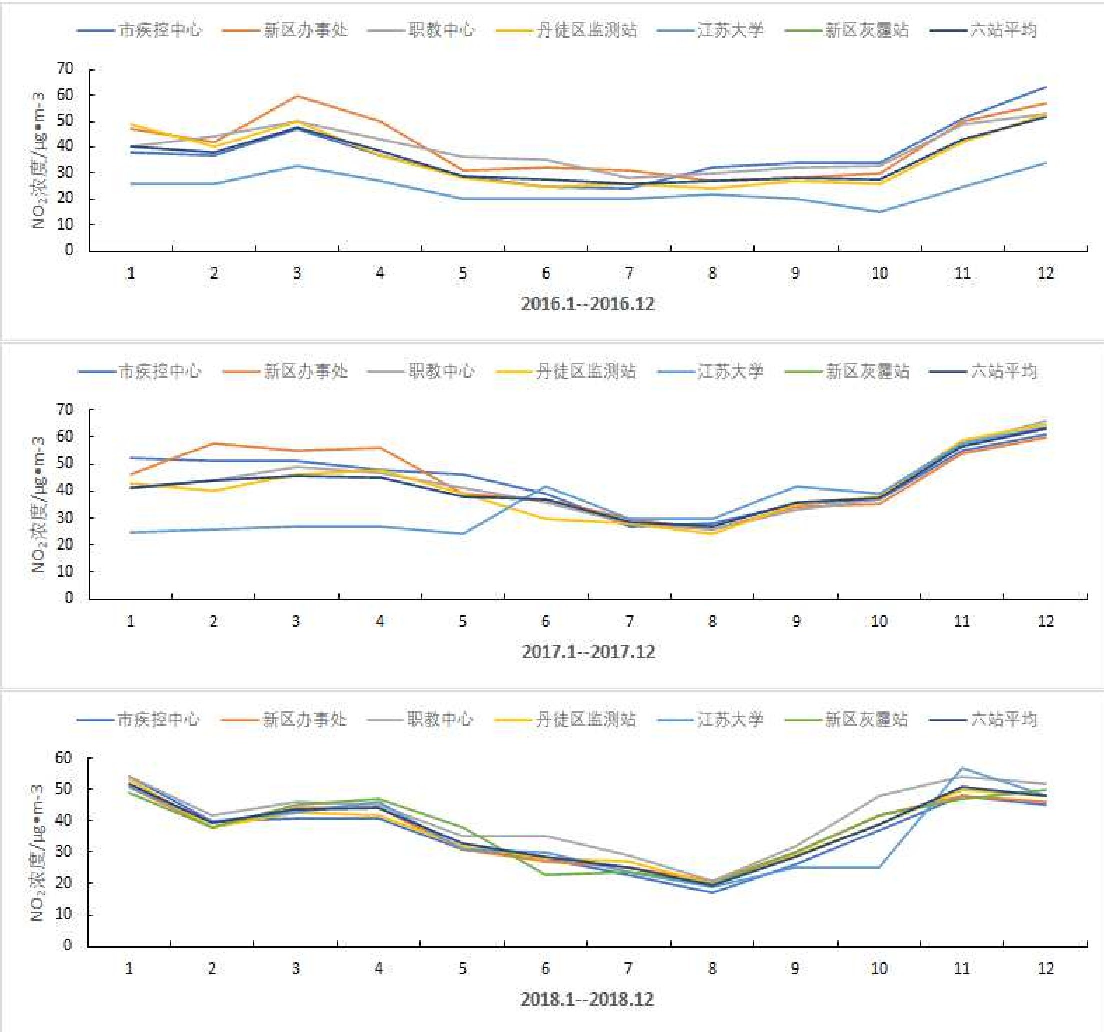


Figure 2-3 Changes in NO_2 pollutant concentration

2.4 Monthly change characteristics

The pollution monitoring data of NO_2 in the atmospheric environmental pollutants of the six monitoring stations in Zhenjiang City from 2016 to 2020 are summarized, and the monthly change trend of the NO_2 pollutant concentration in Figure 2-4 is analyzed and sorted out. Excluding the interference of abnormal conditions, basically the highest value of NO_2 pollutant concentration occurs in winter, mostly in December, while the lowest value of NO_2 pollutant concentration occurs in summer, mostly in August.



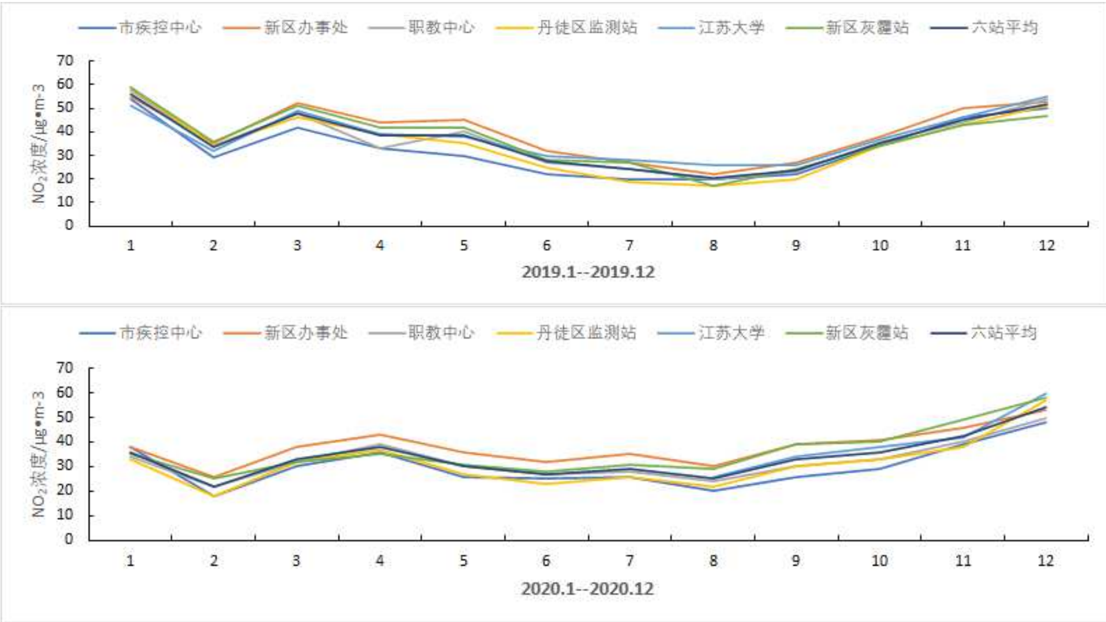


Figure 2-4 Monthly change of NO_2 pollutant concentration

2.5 Annual spatial change characteristics

In this part, based on the monitoring data of the environmental monitoring stations in the urban area of Zhenjiang City, the IDW in the spatial interpolation analysis is used to analyze the NO_2 concentration distribution map in the urban area. After coupling with the two-dimensional map of the urban area, the urban NO_2 concentration distribution can be observed more clearly. The essence of spatial interpolation is to determine the value of the surrounding points (predicted points) based on the value of the known point. Gas concentration interpolation has always been a difficult problem. There are many factors that affect gas concentration interpolation, such as longitude, latitude, elevation, and meteorological conditions. Therefore, it is difficult to establish a general concentration interpolation model in practical applications. Meng Bin, Zeng Qingyong and Zhang Xiaoyu[9-12] used GIS technology to intuitively compare the spatial distribution of pollutants in different periods, and theoretically demonstrated the feasibility of GIS technology in the diffusion and simulation of air pollutants.

IDW is to process the vectorized urban area map, first determine the point elements, effective fields and output pixel size and other elements, then limit the processing range and raster analysis in the environmental elements, and finally classify the layer attributes, Numerical field labels. The spatial distribution of NO_2 concentration in Zhenjiang urban area from 2016 to 2020 is shown in Figure 2-5.

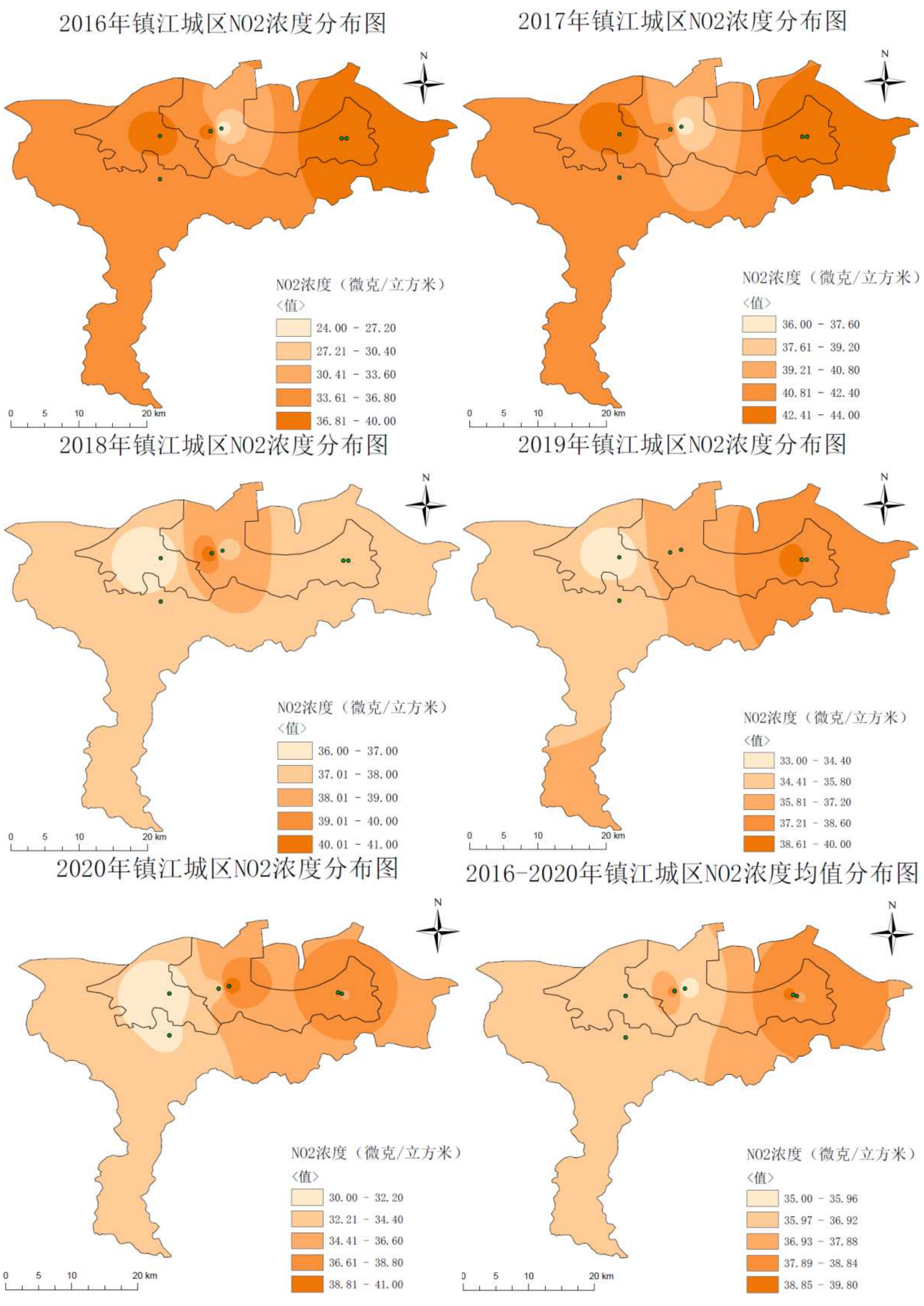


Figure 2-5 Spatial distribution map of NO_2 concentration in Zhenjiang urban area from 2016 to 2020

It can be seen from Figure 2-5 that the concentration of NO_2 in Zhenjiang urban area was significantly higher in 2016 and 2017, especially in the eastern part of the urban area, which is mainly related to the distribution of Zhenjiang's industry. The NO_2 concentration in the central part of Zhenjiang city has a slight increase trend, which may be related to the increase of private vehicles driven by economic development, which has led to an increase in vehicle exhaust emissions. However, the concentration of NO_2 in the environment of the western part of Zhenjiang has eased. On the whole, the NO_2 concentration in Zhenjiang urban area is low in the west and high in the east, which is inevitable related to the economic structure of the city.

CONCLUSION

The daily NO_2 concentration trend of the six stations is basically the same, indicating that there is no significant difference in the spatial distribution of the NO_2 concentration in Zhenjiang City, and the local environment around each monitoring point has little effect on its concentration. The overall trend of seasonal changes in NO_2 over the five years is: the highest in winter, followed by spring, autumn, and finally summer. The seasonal changes of NO_2 are more obvious, with the highest values of daily average concentration and over-standard rate both appearing in winter and the lowest in summer. The weekly change of NO_2 pollutant concentration is not obvious, and the average concentration of each day is basically the same (the relative standard deviation does not exceed 10%). In terms of hourly changes, the lowest value in a day is reached at 14 o'clock, and the peak is reached around 8 o'clock and 20 o'clock, which can basically be regarded as a positive "M"-shaped change trend. The monthly change of NO_2 pollutant concentration is basically the highest value of NO_2 pollutant concentration every year in winter, mostly in December, while the lowest value of NO_2 pollutant concentration occurs in summer, mostly in August.

The concentration of NO_2 in the eastern part of Zhenjiang urban area is obviously higher, which is mainly related to the distribution of Zhenjiang industry; in the middle part, with the economic development, automobile exhaust emissions have increased, leading to a slight increase in NO_2 concentration; while the concentration of NO_2 in the western environment has eased. On the whole, the NO_2 concentration in Zhenjiang urban area is low in the west and high in the east, which is inevitable related to the economic structure of the city.

REFERENCE

[1] Liu Jiaojiao, Song Dan, Liu Lanyu, Li Ling. Analysis of nitrogen dioxide pollution in the ambient air of the main city of Chongqing [J]. Sichuan Environment, **2014**, 33(05): 82-85.

[2] Chen Qian, Wang Xiaojun. Analysis of the characteristics and influencing factors of nitrogen dioxide pollution in Yantai City from 2012 to 2016[J]. Green Science and Technology, **2018**(02): 55-58.

[3] GaoJie, Wang Yu, Zhang Bei. my country's atmospheric nitrogen oxide pollution control countermeasures[J]. Environmental Protection Science, 2004(05):1-3.

[4] Wu Xiaoqing. The existing problems and countermeasures of the current situation of atmospheric nitrogen oxide pollution control in my country[J]. China Science and Technology Industry, **2009**(08): 13-16.

[5] Xianlong. Analysis of the temporal and spatial distribution and influencing factors of nitrogen dioxide in western China based on OMI satellite data[D]. Northwest Normal University, **2019**.

[6] LiShaomin. Analysis and treatment technology of nitrogen oxide pollutants in the air[J]. Henan Science and Technology, **2010**, 24(06).

[7] Hao Jiming, Ma Guangda. Air Pollution Control Engineering [M]. 2nd edition. Beijing: Higher Education Press, **2002**.

[8] Xu Qing, Zheng Zhangjing, Ling Changming, Li Jun. Current status and control measures of nitrogen oxide pollution [J]. Anhui Agricultural Sciences, **2011**, 38(29): 16388-16391.

[9] Meng Bin, Zhang Jingqiu, Wang Jinfeng, et al. The application of spatial analysis methods in the real estate market research——Taking Beijing as an example[J]. Geographical Research, **2005**(06): 956-964+1004.

[10] Zeng Qingyong, Chen Zhongnuan. Regional Differences of Economic Development in Guangdong Province Based on GIS Spatial Analysis [J]. Economic Geography, **2007**(04): 558-561+574.

[11] ANSELIN L. Local Indicators of Spatial Association—ISA[J]. Geographical Analysis, **1995**, 27(2): 93-115.

[12] Zhang Xiaoyu, Chen Zhenfei, Xu Wenzhe. Application of ArcGIS in the establishment of air pollution source emission inventory[J]. Environmental Science and Management, **2017**, (01): 135-139.