

PAPER • OPEN ACCESS

Correlation analysis of AQI characteristics and meteorological conditions in heating season

To cite this article: YuHui Di and RuoRong Li 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **242** 022067

View the [article online](#) for updates and enhancements.

You may also like

- [Preliminary study of \$^{10}\text{Be}/^7\text{Be}\$ in rainwater from Xi'an by Accelerator Mass Spectrometry](#)
Li Zhang, , Yun-Chong Fu et al.
- [Effects of photochemical oxidation on the mixing state and light absorption of black carbon in the urban atmosphere of China](#)
Qiyuan Wang, Rujin Huang, Zhuzi Zhao et al.
- [Study on water resource carrying capacity of Xi'an based on AHP-fuzzy synthetic evaluation model](#)
Wenwen Feng, Panpan Xu and Hui Qian

ECS
The
Electrochemical
Society
Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

Correlation analysis of AQI characteristics and meteorological conditions in heating season

YuHui DI¹, RuoRong LI²

¹School of Urban Planning and Municipal Engineering, Xi'an Polytechnic University, Xi'an, Shaanxi, 710048, China

²School of Urban Planning and Municipal Engineering, Xi'an Polytechnic University, Xi'an, Shaanxi, 710048, China

Abstract. According to the China air quality monitoring platform, the monthly average of the Air Quality Index for monitoring the heating season in Xi'an and the monthly concentration of major atmospheric pollutants in the past three years, the relationship between five major atmospheric pollutants and meteorological conditions was analyzed, the main results are as follows: (1) in the past three years, the air quality in Xi'an heating season was mild pollution, and the most serious degree of pollution was in January each year. (2) The main pollutants in Xi'an were PM_{2.5} and PM₁₀, but in recent years, the content of pollutants NO₂ and O₃ has risen sharply, so we should strengthen the protection and the treatment of NO₂ and O₃. (3) The precipitation has a certain impact on air quality index. (4) The air quality in Xi'an is closely related to meteorological elements.

1. Introduction

In recent years, the air quality index remains high, which has a great impact on people's living standards. with the constant acceleration of the economy, China has entered a period of high environmental risks. at the same time, the various kinds of environmental pollution incidents emerge in endlessly[1]. especially in the last decade, the scale of development, damage consequences and pollution types of environmental pollution incidents are increasingly expanding, which has aroused widespread concern in society. JZ Zhang and other scholars found that there have been many serious pollution processes in Beijing area, and the AQI shows a decreasing trend from southeast to northwest, the results showed that the winter is the season when the indicators such as AQI and PM_{2.5} in Xi'an show obvious monthly changes, and the index is higher than summer[2]. JN Xiao and other scholars found that the air quality of Xiamen in autumn and winter is poor, it is significant that AQI was negatively correlated with temperature, positively correlated with air pressure, but not significantly correlated with meteorological factors of wind speed and relative humidity. there are obvious spatial distribution differences between PM_{2.5}, PM₁₀, SO₂, NO₂ and O₃ pollution factors[3].

Xi'an city ranks among the most polluted cities in China at the beginning and end of the year, and according to the 《Environmental Air Quality Standards》 (GB3095-2012), the annual average value of pollutants such as PM_{2.5} in Xi'an is seriously exceeded[4]. the seasonal variation of pollutants in Xi'an city showed that high in cold moon and low in warm moon[5], and the air pollution in Xi'an heating period is more serious than that in non-heating period[6]. heavy pollution events occur especially frequently during the heating season[7], therefore, it is very necessary to study the relationship between AQI characteristics and meteorological conditions during heating period.



The data used in this paper comes from China's air quality monitoring platform and the weather website, the average monthly mass concentration of major atmospheric pollutants was obtained from the arithmetic mean of 13 monitoring stations.

2. Correlation Analysis

2.1 The analysis of air quality characteristics

2.1.1 Time variation characteristics of air quality . From figure 1 it we can see the general change of air quality. in the past three years, the average value of AQI in Xi'an heating season is 149, the overall situation of air quality is mild pollution, and the average trend of AQI index is from rising to decreasing, the monthly average AQI index is rising from November to January each year, the pollution degree is increasing, and the air pollution is getting worse, from January to March, the AQI monthly average index shows a downward trend, and the degree of air pollution has slowed down, the peak of AQI appears in January every year. it shows that at that time, the degree of air pollution was the most serious and we should strengthen the monitoring and management of the environment. it is evident from the figure that the AQI index in the winter of 2017 is significantly higher than the other two years, indicating the air quality in Xi'an in the winter of 2017 is poor, this is because the wind pressure in the winter is relatively stable and it is easy to accumulate pollutants. since February, the degree of air pollution has gradually decreased, and air quality has gradually improved.

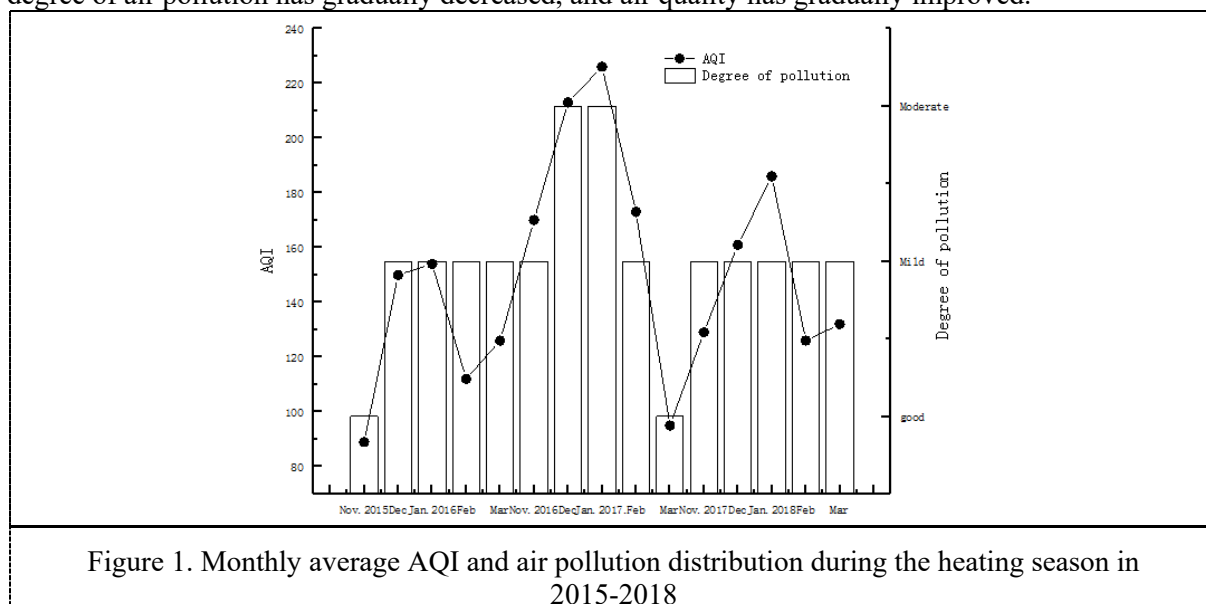


Figure 1. Monthly average AQI and air pollution distribution during the heating season in 2015-2018

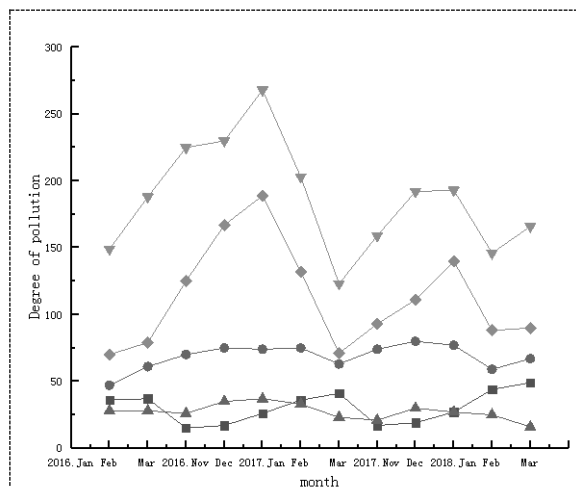


Figure 2. Monthly distribution of major pollutants in Xi'an

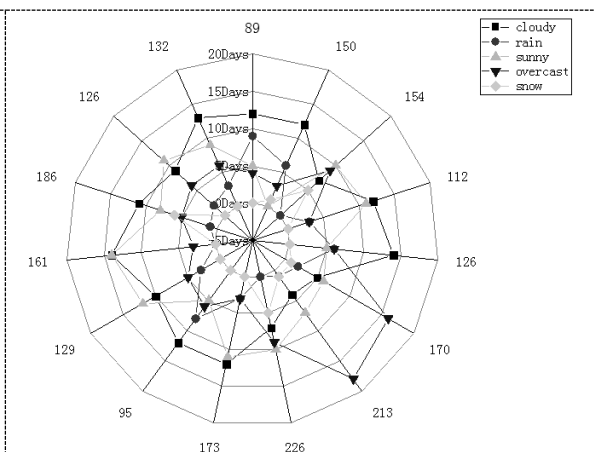


Figure 3. The relationship between AQI and climate

2.1.2 the Major pollutants. The main pollutant is the most important pollutant in the air when AQI is greater than 50. Sulfur dioxide (SO_2), nitrogen oxides (NO_2), inhalable particles (PM_{10}), fine particles ($\text{PM}_{2.5}$) and ozone (O_3) have become the main pollutants in the air of China[8]. from figure 2 we can see that the content of PM_{10} is much higher than that of the others, this is due to the widespread development of coal-fired heating in winter and the increase in the emission of PM_{10} pollutants[9], the smaller the size of particulate matter, the more serious the impact will be, which will cause great harm to human body[10], not only that, this particulate also have great harm to weather and climate, may reduce atmospheric visibility, change temperature and precipitation pattern and so on[11], the content of O_3 and SO_2 is relatively low, however, the average concentration of SO_2 during the heating period is 4.19 times that of the non-heating period[12]. In February and March of each year, the amount of O_3 in the air increases rapidly[13], and we can see that the monthly distribution of the two pollutants O_3 and SO_2 shows a phenomenon of trade-off. at present, the treatment of these pollutants is urgent, reducing the amount of particulate matter can be achieved by planning the layout of the city reasonably, and effectively preventing and controlling the diffusion and pollution of the particles[14], reducing SO_2 requires us to burn less coal and use pre- and post-desulfurization methods[15]. if you want to control the formation of O_3 , it is an important way to reduce the use of refrigerants [16].

2.2 The Relationship between AQI and meteorological parameters

2.2.1 The relationship between air pollutants and temperature. In order to study the relationship between pollutants and temperature during the heating period in Xi'an more effectively, the correlation between the monthly average temperature of the heating season and the monthly average mass concentration of the atmospheric pollutants was analyzed, the pearson correlation coefficient method is used to calculate the correlation coefficient between the monthly mean temperature and the monthly mean mass concentration of the main pollutants in the atmosphere in the past three years. the basic evaluation criteria are a correlation coefficient of 0.8-1.0, a strong correlation of 0.6-0.8, a moderate correlation of 0.4-0.6, a moderate correlation of 0.2-0.4, and a weak correlation or irrelevance of 0-0.2. as the pollution is more serious in 2016-2017. taking it as an example, from table 1, it can be seen that there is a negative linear correlation between the monthly mean mass concentration of four major pollutants ($\text{PM}_{2.5}$, SO_2 , PM_{10} , NO_2) and temperature, that is, as the temperature increases, the content of these pollutants will decrease. among them, the linear correlation between monthly mean mass concentration and temperature of SO_2 , $\text{PM}_{2.5}$ and PM_{10} is significant, and the temperature change has a

great influence on its content. it is significant that the linear correlation between monthly mean mass concentration and temperature of SO₂, PM_{2.5} and PM₁₀ is strong, it shows that the change of temperature has a great influence on its content, but the effect of temperature on NO₂ is minimal. there is a significant positive linear correlation between the monthly mean mass concentration of O₃ and the temperature, that is, as the temperature increases, the content of O₃ will increase significantly, but the correlation is weak.

Table 1 . The relationship between temperature and main air pollutants concentration in 2016-2017

pollutants($\mu\text{g}/\text{m}^3$)	Linear equation	intercept	Slope	pearson' R square	(COD)
PM2.5	$y=a+b*x$	224.384	-16	-0.97	0.944
PM10	$y=a+b*x$	304.411	-17	-0.87	0.772
SO2	$y=a+b*x$	42.562	-2	-0.98	0.957
NO2	$y=a+b*x$	56.761	-0.2	-0.13	0.018
O3	$y=a+b*x$	18.678	1.5	0.36	0.133

Table 2 shows the pearson correlation coefficient between temperature and major atmospheric pollutants in the past three years. it can be seen from the table that the relationship between particulate matter, SO₂ and temperature is increasing year by year, and it has a strong relationship with temperature, the concentration can be reduced by reducing the greenhouse effect, the relationship between NO₂ and O₃ and temperature is not significant. in the next few years, how to control the reduction of these two gases becomes the key problem.

Table2. The relationship between the temperature and the main pollutants of the atmosphere, Pearson phase, in the last three years.

year	PM2.5($\mu\text{g}/\text{m}^3$)	PM10($\mu\text{g}/\text{m}^3$)	SO2($\mu\text{g}/\text{m}^3$)	NO2($\mu\text{g}/\text{m}^3$)	O3($\mu\text{g}/\text{m}^3$)
2015-2016	0.451	0.626	0.596	0.084	0.244
2016-2017	0.945	0.772	0.957	0.019	0.133
2016-2017	0.877	0.88	0.885	0.071	0.204

2.2.2 The relationship between atmospheric major pollutants and climate. In order to study the relationship between AQI and climate, we compared the monthly average AQI index of the heating season with the monthly weather conditions in the past three years. from figure 3, it is easy to see that in the month when the AQI is relatively high, cloudy and overcast weather become the dominant of the month, the proportion of rain and snow days is relatively low, with almost no precipitation, and the wind speed is slow, which is not conducive to the diffusion of particulates, therefore, the average concentration of particulate is higher and the air pollution is more serious. when the average air quality index is low, the proportion of rain and snow weather increases accordingly, this is because precipitation increases, which has purification effect on particulate and dust[17]. it is concluded that the amount of precipitation has a certain influence on the concentration of pollutants. when there is a lot of precipitation, the pollutant diffuses more quickly, the content of it is relatively reduced, and the air quality is better. without precipitation, the main pollutants in the atmosphere are easy to accumulate, and the concentration is usually at a high level. and with the occurrence of precipitation, the concentration of pollutants will be reduced to a certain extent, and the air quality is ideal[18]. it can be seen that the air quality can be improved by increasing the amount of precipitation.

3.Conclusion

(1) In the past three years, the average index of AQI in the heating season of xi 'an was 149, the overall situation of air quality is mild pollution, the annual trend goes up first and then down, the peak of AQI appears in January each year, indicating that the degree of air pollution was the most serious at

that time, the degree of air pollution gradually slowed down in February and March, and the air quality was gradually improved.

(2) The primary pollutants in the heating season of Xi'an are $PM_{2.5}$ and PM_{10} , moreover, the linear correlation between monthly mean mass concentration and temperature of SO_2 , $PM_{2.5}$ and PM_{10} is significant, which has a strong correlation, we should study and treat air quality according to this characteristic, while the correlation between NO_2 and O_3 is not strong, with the increase of NO_2 and O_3 in recent years, how to control the reduction of these two gases becomes the key problem in the next few years.

(3) The precipitation has a certain impact on air quality, when there is a large amount of precipitation, the concentration of pollutants in the air is small, this is because precipitation accelerates the diffusion of pollutants in the air, when there is no precipitation, the pollutants are easy to accumulate and the air quality is poor, therefore, in the weather with more serious air pollution, the air quality can be improved by increasing the amount of precipitation.

(4) The Xi'an air quality index is closely related to meteorological elements, and different pollutants have different dependence on different meteorological factors, according to different climatic characteristics, different air treatment schemes can be formulated.

References

- [1] Y Li, H Song, YZ Li, WL Ding. (2014) Xi'an City Air $PM_{2.5}$ problem research. Journal of Natural Science of Heilongjiang University, 2: 233-237.
- [2] JZ Zhang, J Sun, GL Wang, LC An, WH Wang, (2014) Temporal and Spatial Distribution Characteristics of Air Quality Index in Beijing and Their Relationship with Meteorological Conditions [J], Meteorological and Environmental Sciences, 2: 33-39.
- [3] JN Xiao, GM Du, YQ Shi, YY Wen, J Yao, YT Gao, JY Lin, (2016) Temporal and spatial characteristics of environmental air pollution in Xiamen and its correlation with meteorological factors [J], Journal of Environmental Science, 9: 3363-3371.
- [4] XH Li, WW Li, DQ Xu, (2017) Typical Correlation Analysis of Air Quality and Meteorological Factors in Xi'an City, Journal of Environmental Hygiene, (3): 203-208.
- [5] HJ Wang, TB Zhao, YX Ma, P Ma, SM Yang, S Wang. (2015) relationship between air pollution characteristics and meteorological factors in xi'an. Environmental chemistry, 2: 386-387.
- [6] TJ Shao, JB Zhao, L MA, (2008) analysis of spatial and temporal variation characteristics of air pollutants in xi'an, resource and environment in arid regions, 7: 77-83.
- [7] HF Hao, T Yang, ZF Wang, HT Zheng (2018) Study on the relationship between the cause of heavy pollution and the weather situation in Beijing during the period of frequent pollution in 2013-2015, Journal of Environmental Science, 6: 2201-2213.
- [8] FY Zhang, Z Huang, B Zha, HF Shen. (2016) Distribution Characteristics of Hangzhou AQI and Its Correlation with Meteorological Conditions, Zhejiang Meteorology, 3: 27-32.
- [9] LN Jin, C Hong. (2017) Analysis of the Influence of Meteorological Conditions on the Pollution of Xi'an City and Its Surroundings, Journal of Gansu Sciences, 5: 132-139.
- [10] QF Liu, X Gao, Y Yao. (2013) Hazard and Control Countermeasures of PM_{10} and $PM_{2.5}$, Value Engineering, 13: 288-289.
- [11] YR Xu, DX Wang, JW Zhang, YQ Zhang, RB Han, JY Shen, XC Yu. (2013) The overview of PM_{10} and $PM_{2.5}$ hazards, governance and standard systems, Occupation and Health, 1: 117-119.
- [12] TJ Shao, JB Zhao. (2008) analysis of spatial and temporal variation of air quality in xi'an, study on arid regions, 5: 119-124.
- [13] YP Luo, MJ Liu, J Gan, XT Zhou, M Jiang, RB Yang. (2015) study on the correlation between $PM_{2.5}$ and O_3 mass concentrations in ambient air in changzhutan city, journal of safety and environment, 4: 313-317.

- [14] S Li , l Zhu, TM Shi, W Wang.(2014)planning strategy for particulate pollution control in urban blocks, sustainable development,1:42-45.
- [15] DM Cao.(2013)China's SO₂ pollution, hazard and control technology, environmental science guide ,2:73-74.
- [16] LF Han , JMguo.(2014)roof greening is an important method to control haze, China building waterproof. 24-27.
- [17] SN Gao.(2018) correlation analysis of air quality and meteorological elements in xi 'an , journal of xi 'an university of arts and sciences. 104-110.
- [18] M Cao,B wang,N Qiu,YM Zhang.(2012) the relationship between atmospheric pollutant change characteristics and meteorological conditions in xi 'an from 2006 to 2015, jiangxi journal of agriculture, 9 : 109-115.