PROJECT REPORT

CONTENTS

1)

SUMMARY STATISTICS

AOTIZHONGXIN

Metric	PM2.5	PM10	SO2	NO2	CO	O3
Count	35064	35064	35064	35064	35064	35064
Mean	81.96	109.42	17.13	58.86	1239.50	55.80
Std	81.19	94.35	22.57	36.66	1194.42	56.53
Min	3.00	2.00	0.29	2.00	100.00	0.21
25%	23.00	39.00	3.00	31.00	500.00	9.00
Median	56.00	84.00	8.00	52.00	800.00	45.00
75%	112.00	153.00	21.00	81.00	1500.00	80.00
Max	898.00	984.00	341.00	290.00	10000.00	423.00

CHANGPING

Metric	PM2.5	PM10	SO2	NO2	CO	O3
Count	35064	35064	35064	35064	35064	35064
Mean	70.68	94.40	14.83	44.18	1137.02	57.72
Std	71.58	82.77	20.81	29.24	1081.25	53.87
Min	2.00	2.00	0.29	1.85	100.00	0.21
25%	18.00	34.00	2.00	22.00	500.00	16.00
Median	48.00	74.00	7.00	37.00	800.00	45.00
75%	98.00	129.00	18.00	60.00	1400.00	79.00
Max	882.00	999.00	310.00	226.00	10000.00	429.00

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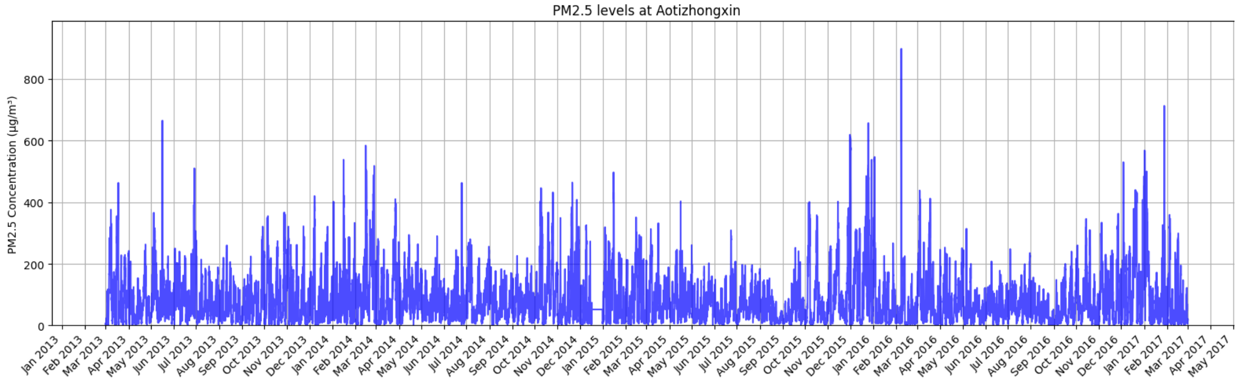
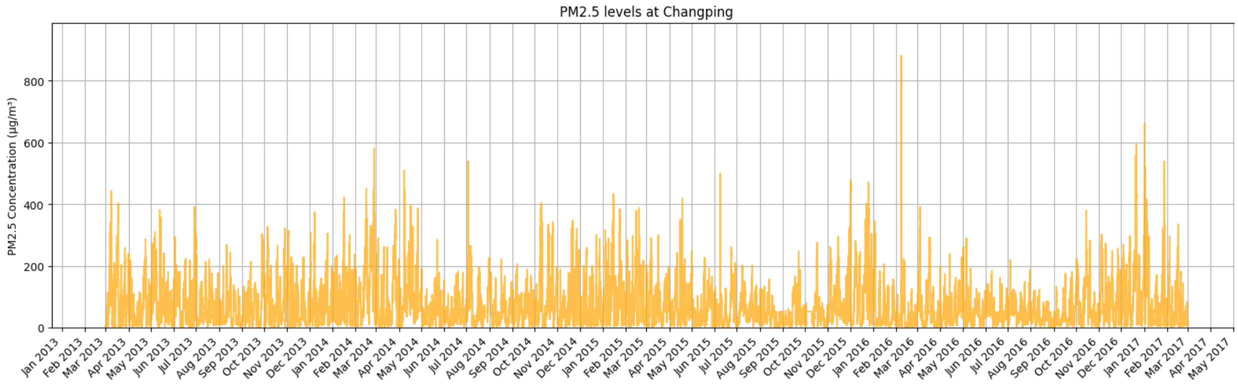
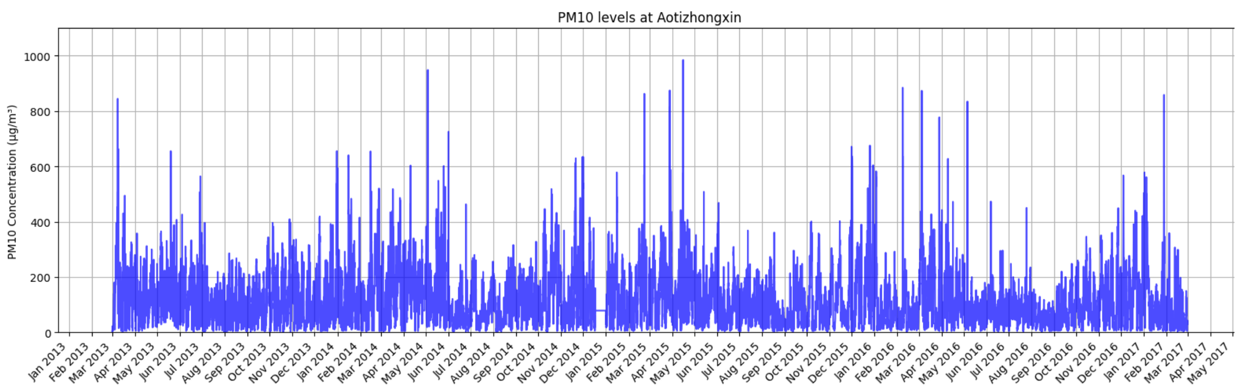
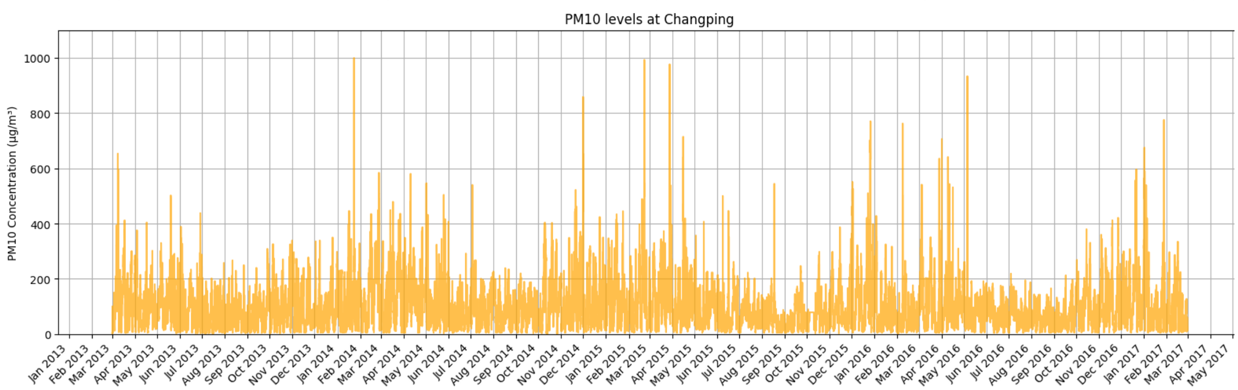
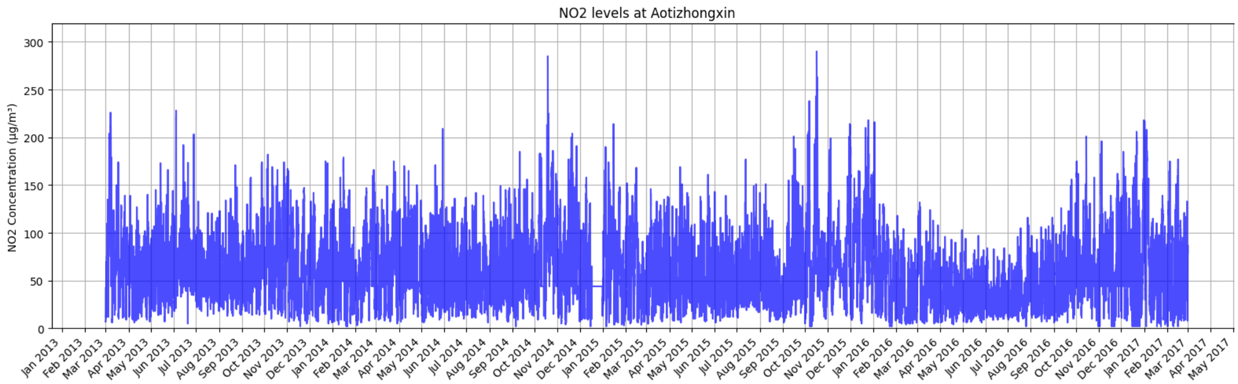
TIME SERIES PLOTS

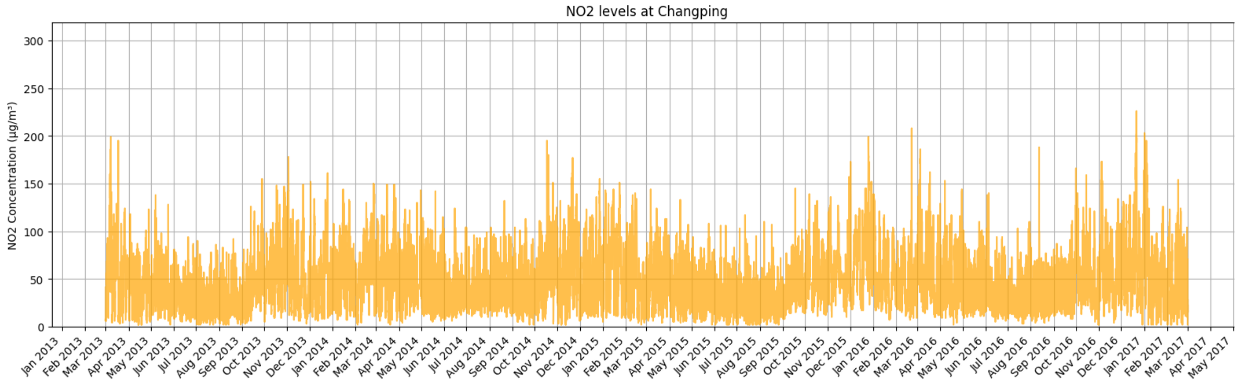

PM2.5 levels at Aotizhongxin
PM2.5 Concentration (µg/m³)

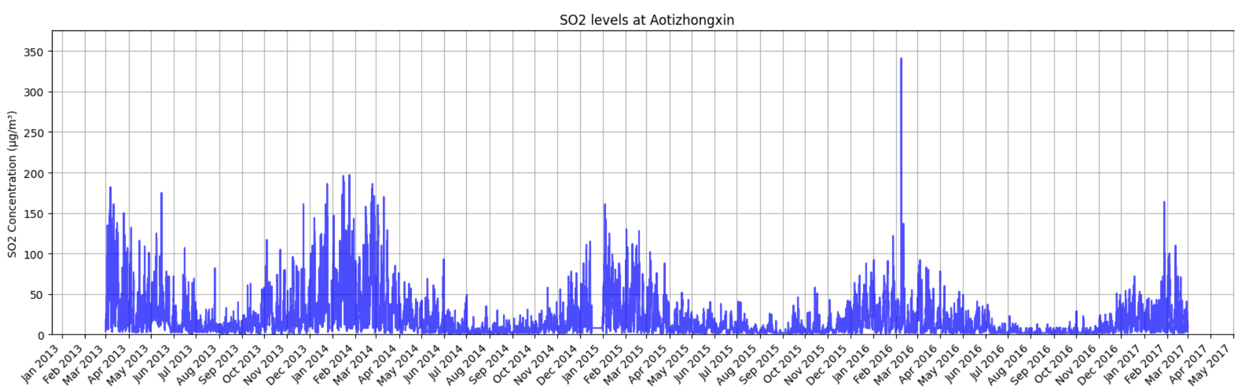

PM2.5 levels at Changping
PM2.5 Concentration (µg/m³)

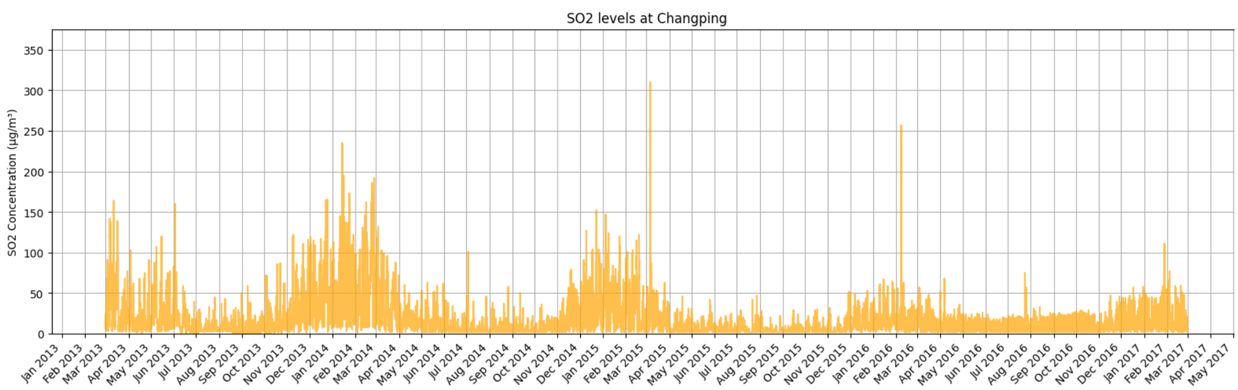

PM10 levels at Aotizhongxin
PM10 Concentration (µg/m³)

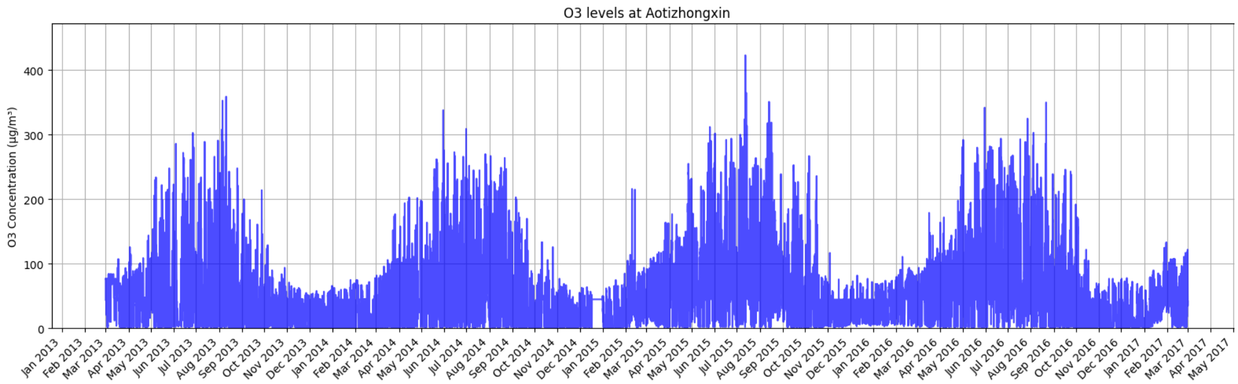

PM10 levels at Changping
PM10 Concentration (µg/m³)

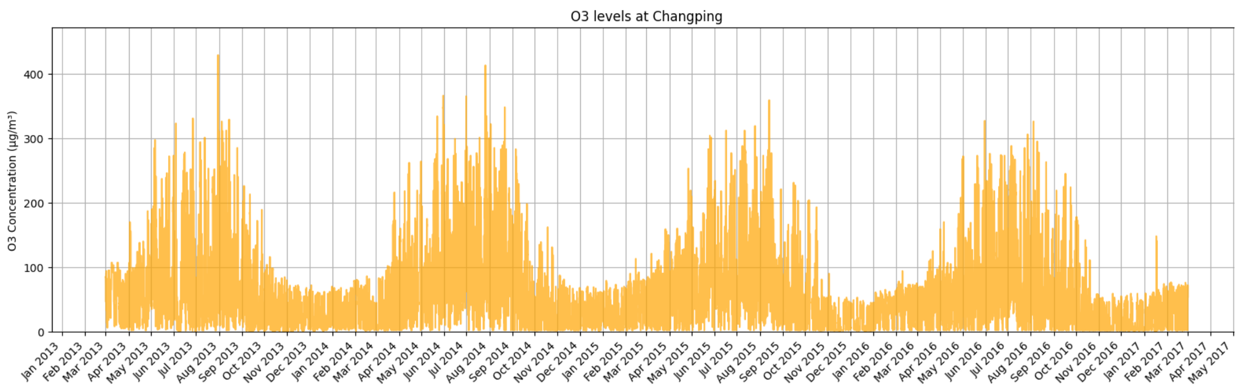

NO2 levels at Aotizhongxin
NO2 Concentration (µg/m³)
0
50
100
150
200
250
300
Jan 2013 Feb 2013 Mar 2013 Apr 2013 May 2013 Jun 2013 Jul 2013 Aug 2013 Sep 2013 Oct 2013 Nov 2013 Dec 2013 Jan 2014 Feb 2014 Mar 2014 Apr 2014 May 2014 Jun 2014 Jul 2014 Aug 2014 Sep 2014 Oct 2014 Nov 2014 Dec 2014 Jan 2015 Feb 2015 Mar 2015 Apr 2015 May 2015 Jun 2015 Jul 2015 Aug 2015 Sep 2015 Oct 2015 Nov 2015 Dec 2015 Jan 2016 Feb 2016 Mar 2016 Apr 2016 May 2016 Jun 2016 Jul 2016 Aug 2016 Sep 2016 Oct 2016 Nov 2016 Dec 2016 Jan 2017 Feb 2017 Mar 2017 Apr 2017 May 2017


NO2 levels at Changping
NO2 Concentration (µg/m³)
0
50
100
150
200
250
300
Jan 2013 Feb 2013 Mar 2013 Apr 2013 May 2013 Jun 2013 Jul 2013 Aug 2013 Sep 2013 Oct 2013 Nov 2013 Dec 2013 Jan 2014 Feb 2014 Mar 2014 Apr 2014 May 2014 Jun 2014 Jul 2014 Aug 2014 Sep 2014 Oct 2014 Nov 2014 Dec 2014 Jan 2015 Feb 2015 Mar 2015 Apr 2015 May 2015 Jun 2015 Jul 2015 Aug 2015 Sep 2015 Oct 2015 Nov 2015 Dec 2015 Jan 2016 Feb 2016 Mar 2016 Apr 2016 May 2016 Jun 2016 Jul 2016 Aug 2016 Sep 2016 Oct 2016 Nov 2016 Dec 2016 Jan 2017 Feb 2017 Mar 2017 Apr 2017 May 2017


SO2 levels at Aotizhongxin
SO2 Concentration (µg/m³)
0
50
100
150
200
250
300
350
Jan 2013 Feb 2013 Mar 2013 Apr 2013 May 2013 Jun 2013 Jul 2013 Aug 2013 Sep 2013 Oct 2013 Nov 2013 Dec 2013 Jan 2014 Feb 2014 Mar 2014 Apr 2014 May 2014 Jun 2014 Jul 2014 Aug 2014 Sep 2014 Oct 2014 Nov 2014 Dec 2014 Jan 2015 Feb 2015 Mar 2015 Apr 2015 May 2015 Jun 2015 Jul 2015 Aug 2015 Sep 2015 Oct 2015 Nov 2015 Dec 2015 Jan 2016 Feb 2016 Mar 2016 Apr 2016 May 2016 Jun 2016 Jul 2016 Aug 2016 Sep 2016 Oct 2016 Nov 2016 Dec 2016 Jan 2017 Feb 2017 Mar 2017 Apr 2017 May 2017


SO2 levels at Changping
SO2 Concentration (µg/m³)
0
50
100
150
200
250
300
350
Jan 2013 Feb 2013 Mar 2013 Apr 2013 May 2013 Jun 2013 Jul 2013 Aug 2013 Sep 2013 Oct 2013 Nov 2013 Dec 2013 Jan 2014 Feb 2014 Mar 2014 Apr 2014 May 2014 Jun 2014 Jul 2014 Aug 2014 Sep 2014 Oct 2014 Nov 2014 Dec 2014 Jan 2015 Feb 2015 Mar 2015 Apr 2015 May 2015 Jun 2015 Jul 2015 Aug 2015 Sep 2015 Oct 2015 Nov 2015 Dec 2015 Jan 2016 Feb 2016 Mar 2016 Apr 2016 May 2016 Jun 2016 Jul 2016 Aug 2016 Sep 2016 Oct 2016 Nov 2016 Dec 2016 Jan 2017 Feb 2017 Mar 2017 Apr 2017 May 2017


O3 levels at Aotizhongxin
O3 Concentration (µg/m³)
0 100 200 300 400
Jan 2013 Feb 2013 Mar 2013 Apr 2013 May 2013 Jun 2013 Jul 2013 Aug 2013 Sep 2013 Oct 2013 Nov 2013 Dec 2013 Jan 2014 Feb 2014 Mar 2014 Apr 2014 May 2014 Jun 2014 Jul 2014 Aug 2014 Sep 2014 Oct 2014 Nov 2014 Dec 2014 Jan 2015 Feb 2015 Mar 2015 Apr 2015 May 2015 Jun 2015 Jul 2015 Aug 2015 Sep 2015 Oct 2015 Nov 2015 Dec 2015 Jan 2016 Feb 2016 Mar 2016 Apr 2016 May 2016 Jun 2016 Jul 2016 Aug 2016 Sep 2016 Oct 2016 Nov 2016 Dec 2016 Jan 2017 Feb 2017 Mar 2017 Apr 2017 May 2017


O3 levels at Changping
O3 Concentration (µg/m³)
0 100 200 300 400
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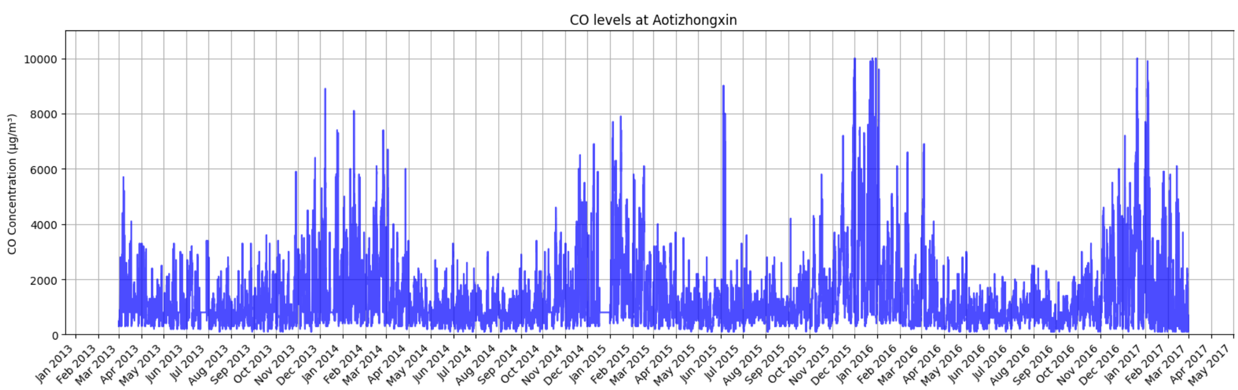
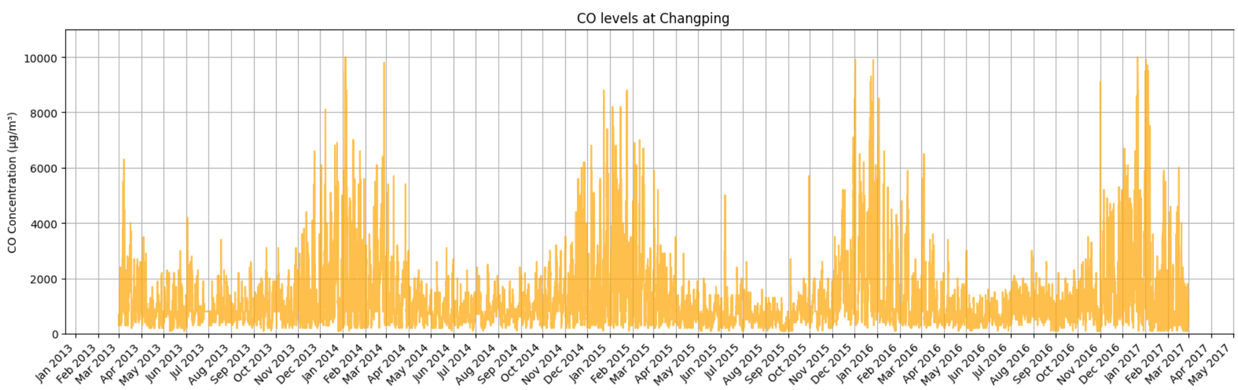
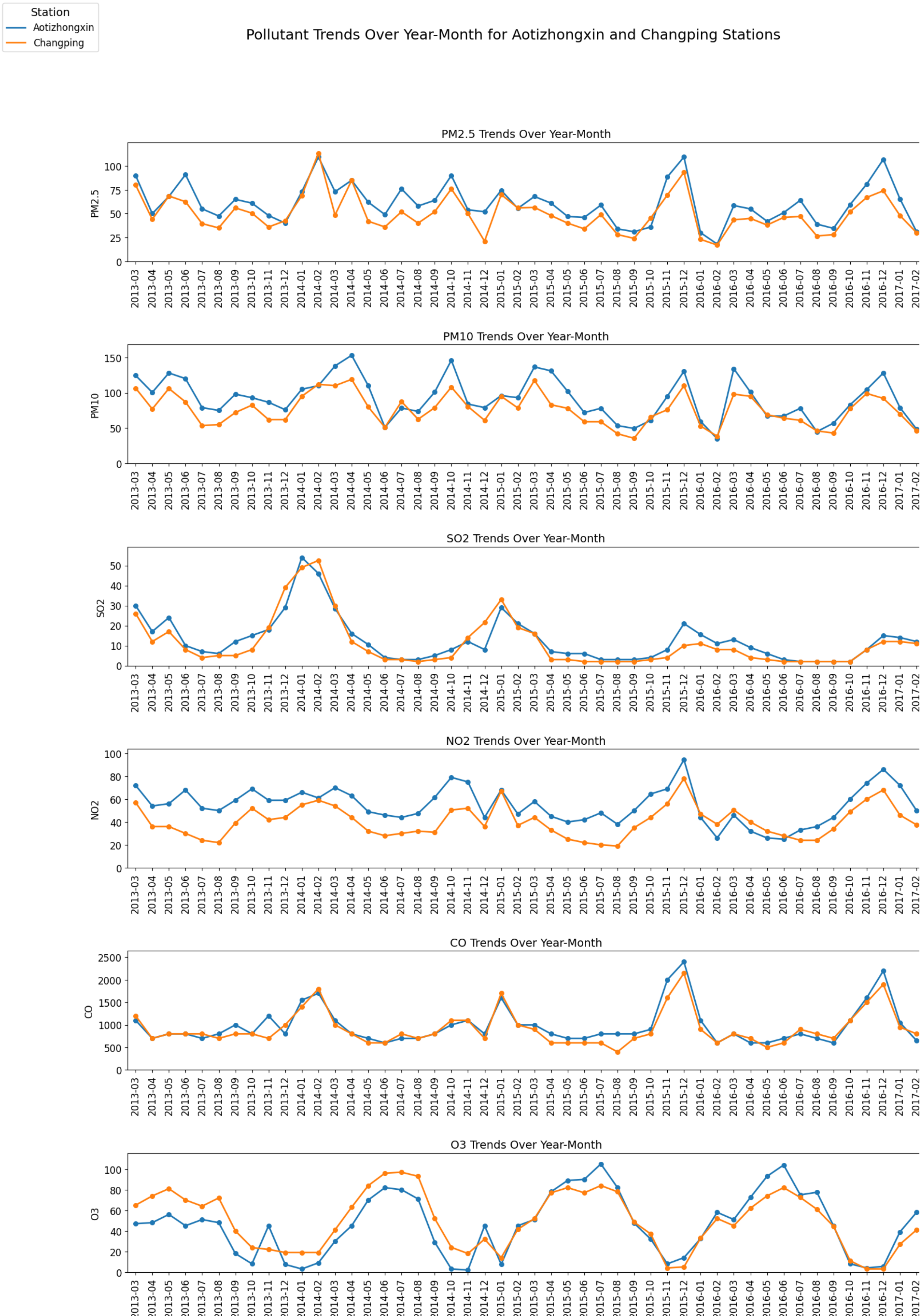

CO levels at Aotizhongxin
CO Concentration (µg/m³)
0 2000 4000 6000 8000 10000
Jan 2013 Feb 2013 Mar 2013 Apr 2013 May 2013 Jun 2013 Jul 2013 Aug 2013 Sep 2013 Oct 2013 Nov 2013 Dec 2013 Jan 2014 Feb 2014 Mar 2014 Apr 2014 May 2014 Jun 2014 Jul 2014 Aug 2014 Sep 2014 Oct 2014 Nov 2014 Dec 2014 Jan 2015 Feb 2015 Mar 2015 Apr 2015 May 2015 Jun 2015 Jul 2015 Aug 2015 Sep 2015 Oct 2015 Nov 2015 Dec 2015 Jan 2016 Feb 2016 Mar 2016 Apr 2016 May 2016 Jun 2016 Jul 2016 Aug 2016 Sep 2016 Oct 2016 Nov 2016 Dec 2016 Jan 2017 Feb 2017 Mar 2017 Apr 2017 May 2017


CO levels at Changping
CO Concentration (µg/m³)
0 2000 4000 6000 8000 10000
Jan 2013 Feb 2013 Mar 2013 Apr 2013 May 2013 Jun 2013 Jul 2013 Aug 2013 Sep 2013 Oct 2013 Nov 2013 Dec 2013 Jan 2014 Feb 2014 Mar 2014 Apr 2014 May 2014 Jun 2014 Jul 2014 Aug 2014 Sep 2014 Oct 2014 Nov 2014 Dec 2014 Jan 2015 Feb 2015 Mar 2015 Apr 2015 May 2015 Jun 2015 Jul 2015 Aug 2015 Sep 2015 Oct 2015 Nov 2015 Dec 2015 Jan 2016 Feb 2016 Mar 2016 Apr 2016 May 2016 Jun 2016 Jul 2016 Aug 2016 Sep 2016 Oct 2016 Nov 2016 Dec 2016 Jan 2017 Feb 2017 Mar 2017 Apr 2017 May 2017


Station
Aotizhongxin
Changping
Pollutant Trends Over Year-Month for Aotizhongxin and Changping Stations
PM2.5 Trends Over Year-Month
PM2.5
PM10 Trends Over Year-Month
PM10
SO2 Trends Over Year-Month
SO2
NO2 Trends Over Year-Month
NO2
CO Trends Over Year-Month
CO
O3 Trends Over Year-Month
O3

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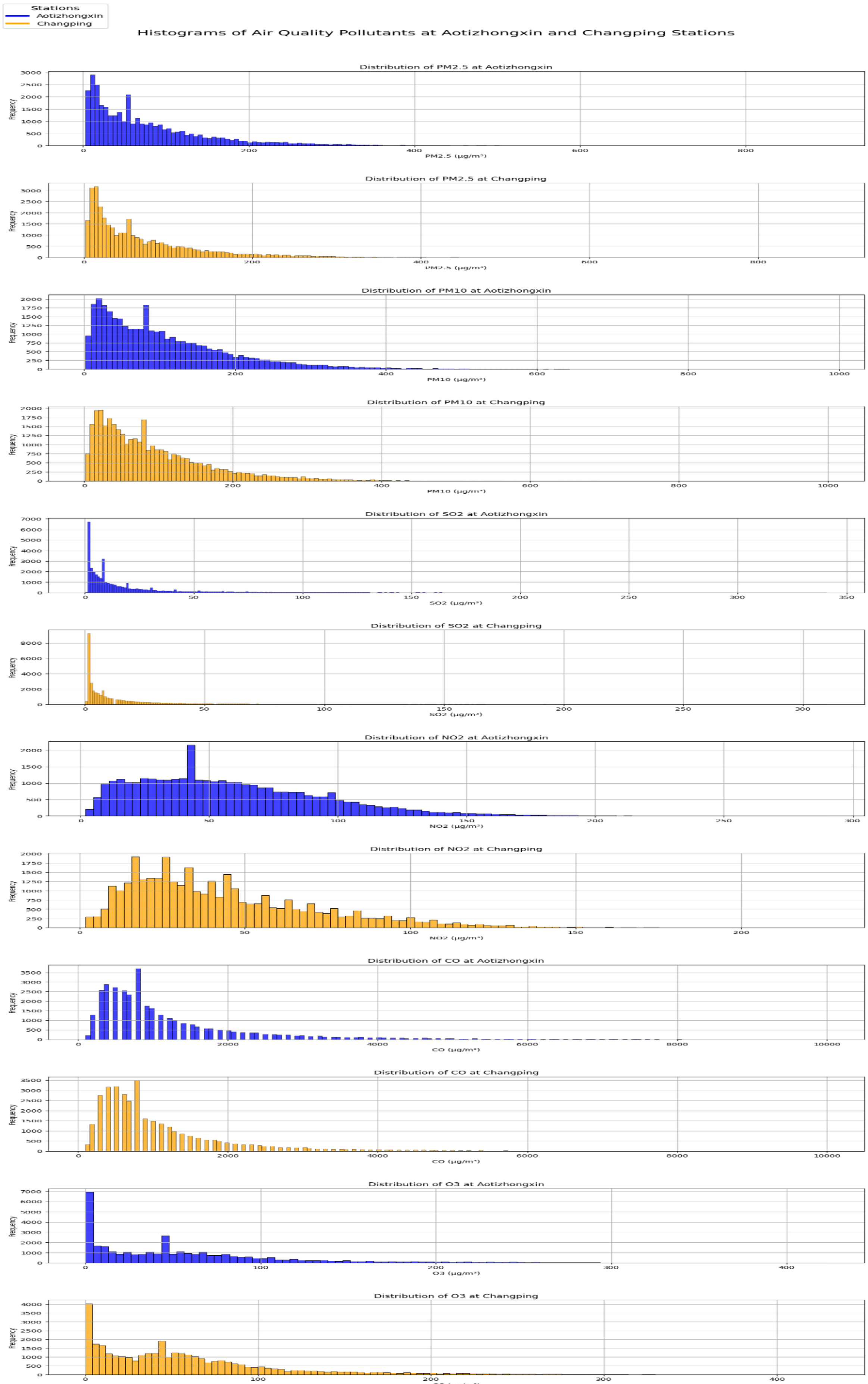
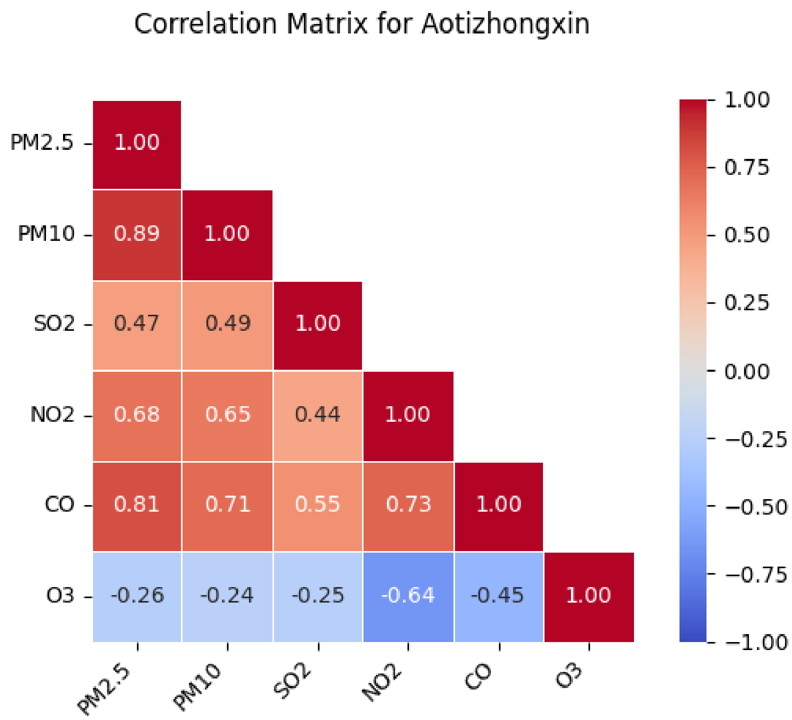
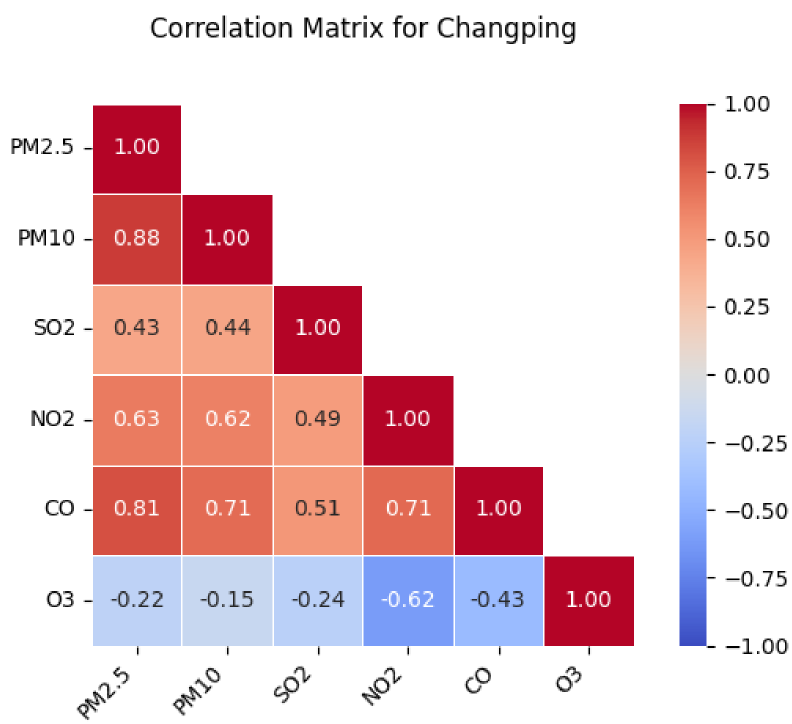
HISTOGRAMS


Stations
Aotizhongxin
Changping
Histograms of Air Quality Pollutants at Aotizhongxin and Changping Stations
Distribution of PM2.5 at Aotizhongxin
Frequency
PM2.5 (µg/m³)
Distribution of PM2.5 at Changping
Frequency
PM2.5 (µg/m³)
Distribution of PM10 at Aotizhongxin
Frequency
PM10 (µg/m³)
Distribution of PM10 at Changping
Frequency
PM10 (µg/m³)
Distribution of SO2 at Aotizhongxin
Frequency
SO2 (µg/m³)
Distribution of SO2 at Changping
Frequency
SO2 (µg/m³)
Distribution of NO2 at Aotizhongxin
Frequency
NO2 (µg/m³)
Distribution of NO2 at Changping
Frequency
NO2 (µg/m³)
Distribution of CO at Aotizhongxin
Frequency
CO (µg/m³)
Distribution of CO at Changping
Frequency
CO (µg/m³)
Distribution of O3 at Aotizhongxin
Frequency
O3 (µg/m³)
Distribution of O3 at Changping
Frequency
O3 (µg/m³)

3)

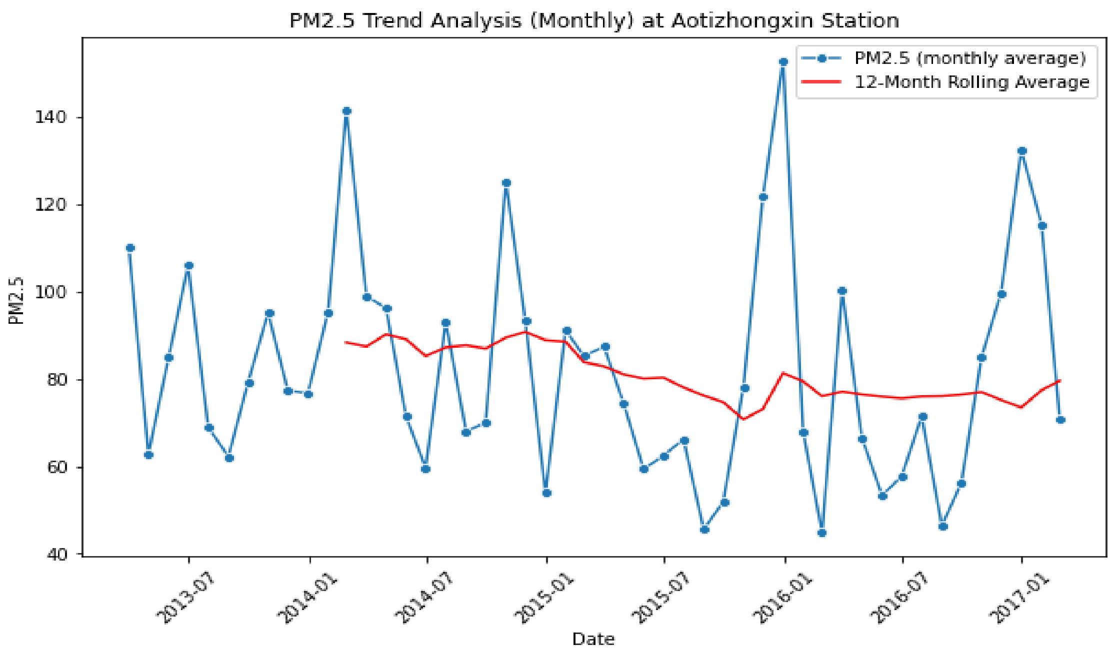
CORRELATION ANALYSIS


Correlation Matrix for Aotizhongxin
PM2.5
PM10
SO2
NO2
CO
O3
1.00
0.89
1.00
0.47
0.49
1.00
0.68
0.65
0.44
1.00
0.81
0.71
0.55
0.73
1.00
-0.26
-0.24
-0.25
-0.64
-0.45
1.00
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00


Correlation Matrix for Changping
PM2.5
PM10
SO2
NO2
CO
O3
1.00
0.88
1.00
0.43
0.44
1.00
0.63
0.62
0.49
1.00
0.81
0.71
0.51
0.71
1.00
-0.22
-0.15
-0.24
-0.62
-0.43
1.00
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00

4)

TREND ANALYSIS



Mann-Kendall Trend Test Results for PM2.5 at Aotizhongxin:
Mann_Kendall_Test(trend='no trend', h=False, p=0.1974795009683894, z=-1.2887658520962553, Tau=-0.12943262411347517, s=-146.0, var_s=12658.666666666666, slope=-0.35799914586346404, intercept=85.48506774141148)
OLS Regression Results for PM2.5 at Aotizhongxin:

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                  PM2.5   R-squared:                       0.008
Model:                            OLS   Adj. R-squared:                 -0.013
Method:                 Least Squares   F-statistic:                    0.3758
Date:                Thu, 10 Oct 2024   Prob (F-statistic):              0.543
Time:                        13:10:47   Log-Likelihood:                -222.83
No. Observations:                  48   AIC:                             449.7
Df Residuals:                      46   BIC:                             453.4
Df Model:                           1
Covariance Type:            nonrobust
=====================================================================================
=
                      coef    std err          t      P>|t|      [0.025      0.975]
-------------------------------------------------------------------------------------
const              85.8156      7.291     11.769      0.000      71.139     100.492
months_since_start   -0.1614      0.263     -0.613      0.543      -0.692       0.369
==============================================================================
Omnibus:                        7.598   Durbin-Watson:                   1.362
Prob(Omnibus):                  0.022   Jarque-Bera (JB):                6.894
Skew:                           0.910   Prob(JB):                       0.0318
Kurtosis:                       3.370   Cond. No.                         54.6
==============================================================================
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5)

INSIGHTS

1) The overall comparison between AOTIZHONGXIN and CHANGPING highlights that air quality in AOTIZHONGXIN tends to be worse on average for most pollutants. AOTIZHONGXIN consistently shows higher mean values for key pollutants like PM2.5, PM10, SO2, NO2, and CO, indicating more severe air pollution levels. However, both regions exhibit substantial variability, with high standard deviations and max values, reflecting occasional extreme pollution events. CHANGPING has slightly lower average pollution but still experiences high peaks, especially for CO and PM levels. In both locations, the minimum pollutant levels show that air quality can sometimes be very low, though extreme pollution events significantly impact overall air quality.

2) FINDINGS AS PER THE PLOTS

PM2.5

Both locations exhibit a general downward trend in PM2.5 levels over time, indicating the effectiveness of air quality management strategies. However, AOTIZHONGXIN consistently records higher PM2.5 levels than CHANGPING, likely due to its proximity to industrial sources, urbanization, and construction activities. Weather patterns, including wind direction and temperature, significantly influence PM2.5 dispersion and concentration. Despite overall reductions, certain periods of elevated pollution persist in AOTIZHONGXIN, emphasizing the need for ongoing monitoring and control measures.

PM10

PM10 levels display clear seasonal patterns, peaking in winter months (December-February) due to increased heating and less favorable atmospheric dispersion conditions. Both locations experience extreme PM10 peaks, often exceeding 800 µg/m³ and sometimes approaching 1000 µg/m³, which may correspond to severe pollution events driven by local emissions and dust from construction sites. Notably, baseline PM10 levels are generally lower in CHANGPING, suggesting better air quality overall. Inter-annual variations indicate fluctuating peak intensities, potentially linked to changing emission sources or pollution control effectiveness. Both sites frequently exceed PM10 compliance standards, underscoring persistent air quality challenges.

SO2

Seasonal variations in SO2 levels are evident, with concentrations rising in winter months (November-February) due to increased coal burning for heating. Extreme peaks occasionally exceed 300 µg/m³, likely resulting from specific industrial activities or unfavorable weather conditions. A general downward trend in SO2 levels, particularly in CHANGPING, suggests improvements due to effective pollution control measures and a shift away from sulfur-rich fuels. However, both locations frequently exceed SO2 compliance standards, particularly in earlier years, indicating ongoing challenges.

NO2

AOTIZHONGXIN consistently exhibits higher NO2 levels than CHANGPING, reflecting its urbanized setting and increased emissions from traffic and industrial sources. Seasonal patterns show elevated NO2 levels in winter months, likely due to heightened energy consumption for heating. Extreme peaks, sometimes exceeding 250 µg/m³ in AOTIZHONGXIN and 200 µg/m³ in CHANGPING, highlight severe pollution events. The long-term trend for NO2 remains ambiguous, with no clear indication of improvement or deterioration. Both locations frequently surpass compliance standards, particularly AOTIZHONGXIN, raising concerns about air quality management.

CO

Both stations show strong seasonal variations in CO levels, with peaks during winter months driven by increased fuel consumption for heating. Extreme CO levels occasionally exceed 8,000-10,000 μg/m³, indicative of severe pollution events often linked to traffic congestion and industrial activities. Baseline CO levels remain relatively low during non-winter months, highlighting that CO pollution is not a constant issue but rather a seasonal concern. Significant day-to-day and hour-to-hour variability in CO levels reflects the dynamic nature of this pollutant, emphasizing the impact of local emissions and weather conditions.

O3

Both locations exhibit consistent and severe spikes in O3 levels during winter, likely due to increased heating and poor air dispersion. Conversely, summer months generally see lower and more stable CO levels. Over the five-year period, no clear trend of improvement in peak O3 levels emerges, indicating ongoing challenges in managing this pollutant. AOTIZHONGXIN tends to have slightly higher baseline CO levels compared to CHANGPING, possibly due to more urban activities. Significant fluctuations in CO levels underscore the need for adaptive strategies to manage air quality effectively.

Both stations show right-skewed distributions for PM2.5 and PM10, with Aotizhongxin exhibiting higher frequencies of elevated concentrations, indicating worse particulate matter pollution. SO2 levels are also right-skewed, with Aotizhongxin showing a longer right tail, suggesting more frequent high concentration events than Changping. NO2 distributions are more symmetric; however, Aotizhongxin consistently has higher levels. For CO, both stations display similar right-skewed distributions, but Aotizhongxin has slightly higher frequencies of elevated concentrations. Interestingly, Changping shows a more spread-out O3 distribution with higher frequencies of higher concentrations compared to Aotizhongxin. Overall, Aotizhongxin generally faces higher pollution levels for most pollutants, while the differences highlight the role of local factors in air quality. These findings are crucial for understanding air quality dynamics and developing targeted management strategies for each area.

Conclusion

Overall, AOTIZHONGXIN presents more persistent air quality challenges compared to CHANGPING, influenced by higher industrial activity and urbanization. Seasonal variations are pronounced across all pollutants, particularly in winter, highlighting the need for targeted air quality management strategies to mitigate severe pollution events and comply with health standards. Both locations must continue to focus on improving air quality to protect public health and comply with regulatory requirements.