delhi-airqualitydata

July 14, 2024

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

[4]:
```
df=pd.read_csv("/Users/apple/Documents/delhiaqi.csv")
```

[5]:
```
df.head()
```

[5]:

	date	co	no	no2	o3	so2	pm2_5	pm10	nh3
0	2023-01-01 00:00:00	1655.58	1.66	39.41	5.90	17.88	169.29	194.64	5.83
1	2023-01-01 01:00:00	1869.20	6.82	42.16	1.99	22.17	182.84	211.08	7.66
2	2023-01-01 02:00:00	2510.07	27.72	43.87	0.02	30.04	220.25	260.68	11.40
3	2023-01-01 03:00:00	3150.94	55.43	44.55	0.85	35.76	252.90	304.12	13.55
4	2023-01-01 04:00:00	3471.37	68.84	45.24	5.45	39.10	266.36	322.80	14.19

[6]:
```
df.head()
```

[6]:

	date	co	no	no2	o3	so2	pm2_5	pm10	nh3
0	2023-01-01 00:00:00	1655.58	1.66	39.41	5.90	17.88	169.29	194.64	5.83
1	2023-01-01 01:00:00	1869.20	6.82	42.16	1.99	22.17	182.84	211.08	7.66
2	2023-01-01 02:00:00	2510.07	27.72	43.87	0.02	30.04	220.25	260.68	11.40
3	2023-01-01 03:00:00	3150.94	55.43	44.55	0.85	35.76	252.90	304.12	13.55
4	2023-01-01 04:00:00	3471.37	68.84	45.24	5.45	39.10	266.36	322.80	14.19

```
4  14.19
```

[7]:
```
df.dtypes
```

[7]:
```
date      object
co       float64
no       float64
no2      float64
o3       float64
so2      float64
pm2_5    float64
pm10     float64
nh3      float64
dtype: object
```

[8]:
```
df.isnull().sum()
```

[8]:
```
date     0
co       0
no       0
no2      0
o3       0
so2      0
pm2_5    0
pm10     0
nh3      0
dtype: int64
```

[9]:
```
df.shape
```

[9]:
```
(561, 9)
```

[10]:
```
df.columns
```

[10]:
```
Index(['date', 'co', 'no', 'no2', 'o3', 'so2', 'pm2_5', 'pm10', 'nh3'],
dtype='object')
```

[11]:
```
df.select_dtypes(include="number")
```

[11]:

	co	no	no2	o3	so2	pm2_5	pm10	nh3
0	1655.58	1.66	39.41	5.90	17.88	169.29	194.64	5.83
1	1869.20	6.82	42.16	1.99	22.17	182.84	211.08	7.66
2	2510.07	27.72	43.87	0.02	30.04	220.25	260.68	11.40
3	3150.94	55.43	44.55	0.85	35.76	252.90	304.12	13.55
4	3471.37	68.84	45.24	5.45	39.10	266.36	322.80	14.19
..	…	…	…	…	…	…	…	…
556	1762.39	4.64	37.01	33.26	30.52	231.15	289.84	6.27

```
557  1735.69   6.82  34.96  46.49   34.33  225.08  280.52   9.12
558  1922.61   8.16  40.10  56.51   43.39  242.49  296.07  12.54
559  1361.85   9.05  52.78  71.53  100.14  165.67  191.82   7.47
560  1134.87   8.61  56.89  80.11  110.63  123.76  140.26   5.51

[561 rows x 8 columns]
```

[12]:
```
df.select_dtypes(include="object")
```

[12]:
```
                    date
0    2023-01-01 00:00:00
1    2023-01-01 01:00:00
2    2023-01-01 02:00:00
3    2023-01-01 03:00:00
4    2023-01-01 04:00:00
..                   …
556  2023-01-24 04:00:00
557  2023-01-24 05:00:00
558  2023-01-24 06:00:00
559  2023-01-24 07:00:00
560  2023-01-24 08:00:00

[561 rows x 1 columns]
```

[13]:
```
df.describe()
```

[13]:
```
                co          no         no2          o3         so2  \
count    561.000000  561.000000  561.000000  561.000000  561.000000
mean    3814.942210   51.181979   75.292496   30.141943   64.655936
std     3227.744681   83.904476   42.473791   39.979405   61.073080
min      654.220000    0.000000   13.370000    0.000000    5.250000
25%     1708.980000    3.380000   44.550000    0.070000   28.130000
50%     2590.180000   13.300000   63.750000   11.800000   47.210000
75%     4432.680000   59.010000   97.330000   47.210000   77.250000
max    16876.220000  425.580000  263.210000  164.510000  511.170000

             pm2_5        pm10         nh3
count   561.000000  561.000000  561.000000
mean    358.256364  420.988414   26.425062
std     227.359117  271.287026   36.563094
min      60.100000   69.080000    0.630000
25%     204.450000  240.900000    8.230000
50%     301.170000  340.900000   14.820000
75%     416.650000  482.570000   26.350000
max    1310.200000 1499.270000  267.510000
```

[14]:
```
df['date'] = pd.to_datetime(df['date'])
df.head()
```

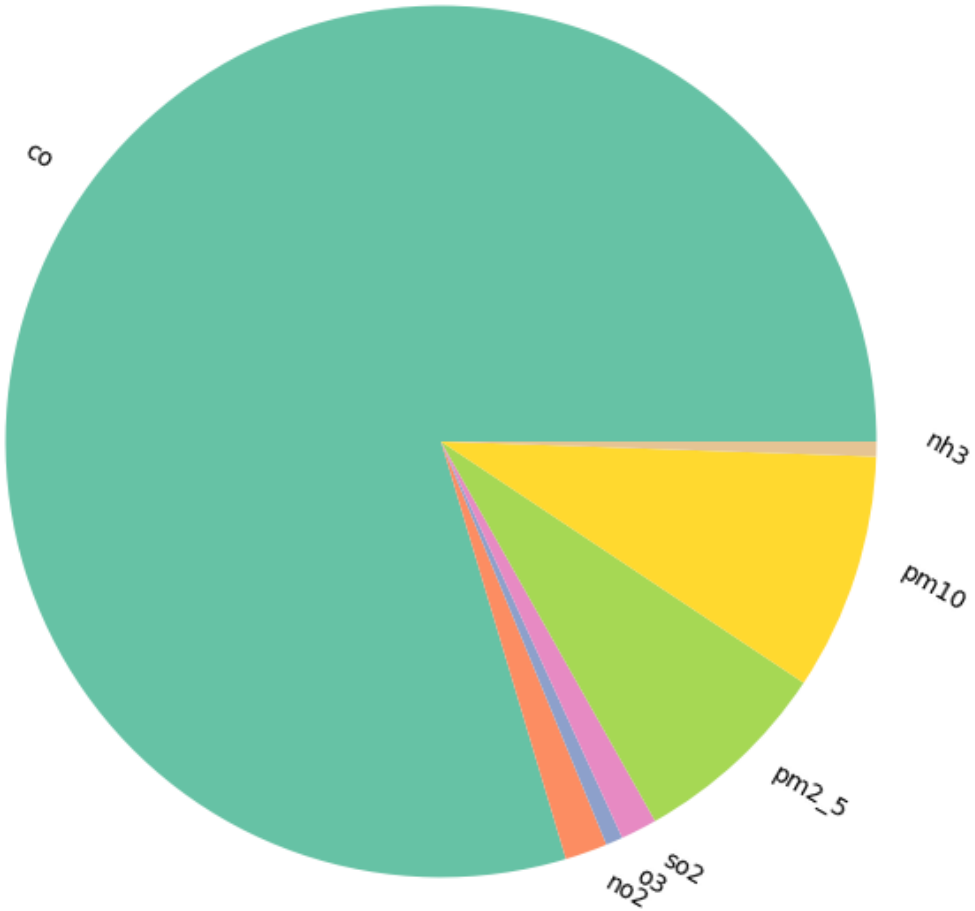
[14]:

	date	co	no	no2	o3	so2	pm2_5	pm10	nh3
0	2023-01-01 00:00:00	1655.58	1.66	39.41	5.90	17.88	169.29	194.64	5.83
1	2023-01-01 01:00:00	1869.20	6.82	42.16	1.99	22.17	182.84	211.08	7.66
2	2023-01-01 02:00:00	2510.07	27.72	43.87	0.02	30.04	220.25	260.68	11.40
3	2023-01-01 03:00:00	3150.94	55.43	44.55	0.85	35.76	252.90	304.12	13.55
4	2023-01-01 04:00:00	3471.37	68.84	45.24	5.45	39.10	266.36	322.80	14.19

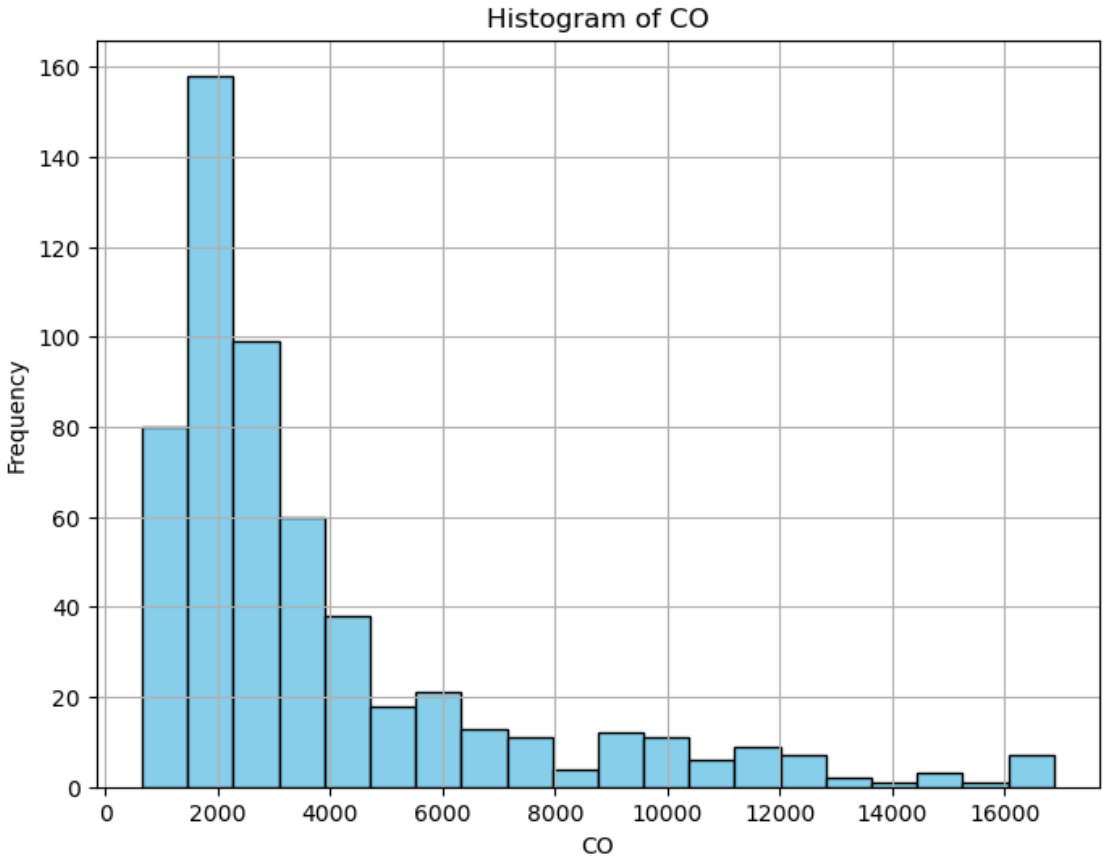
[15]:
```
pollutants = df[['co', 'no2', 'o3', 'so2', 'pm2_5', 'pm10', 'nh3']].sum()
```

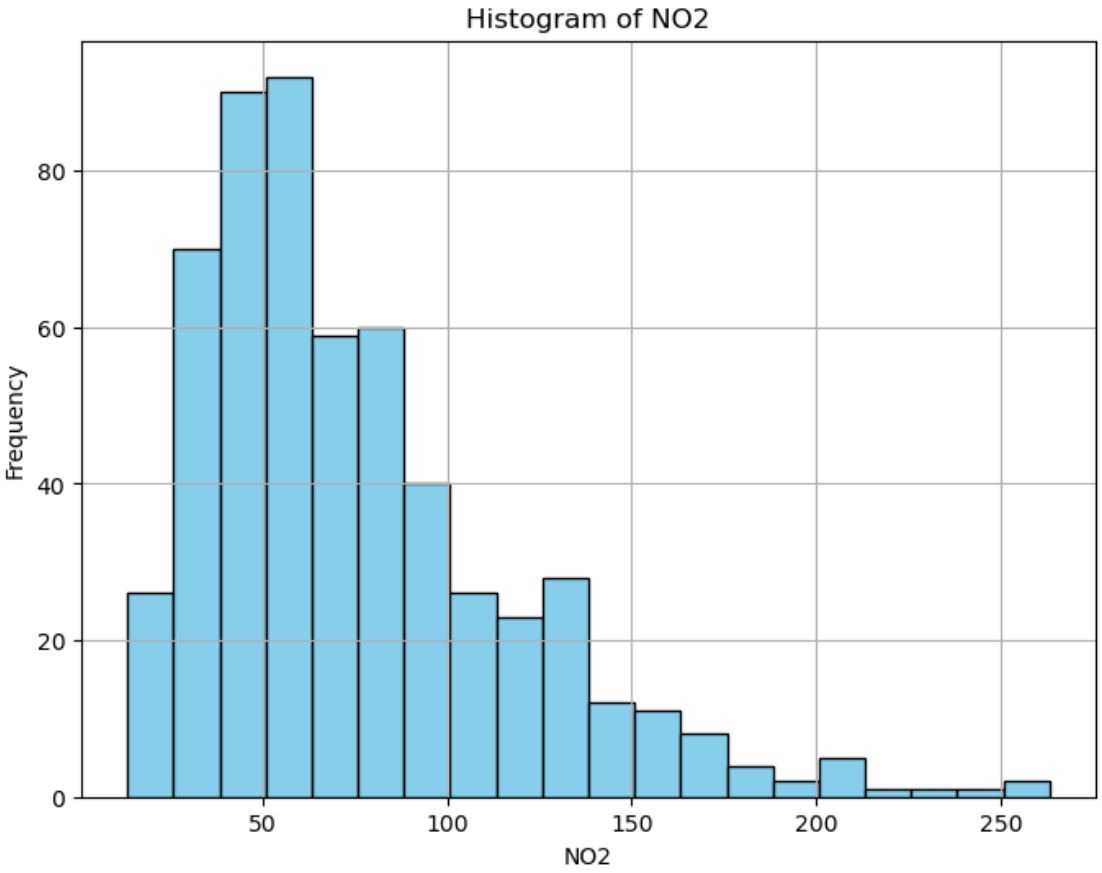
[16]:
```
plt.figure(figsize=(8, 8))
sns.set_palette("Set2")
plt.pie(pollutants, labels=pollutants.index, textprops={'rotation': 330})
```

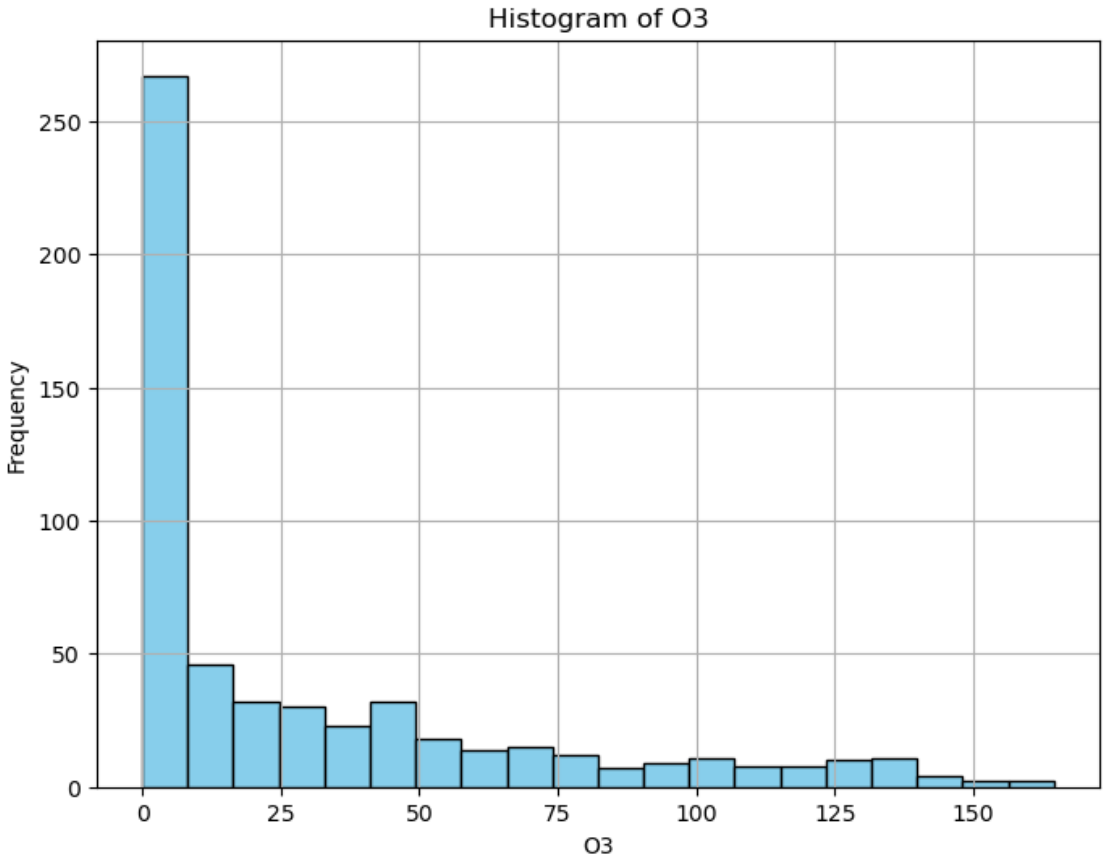
[16]:
```
([<matplotlib.patches.Wedge at 0x13d6efcd0>,
  <matplotlib.patches.Wedge at 0x13d6ecad0>,
  <matplotlib.patches.Wedge at 0x13d776150>,
  <matplotlib.patches.Wedge at 0x13d7770d0>,
  <matplotlib.patches.Wedge at 0x13d7802d0>,
  <matplotlib.patches.Wedge at 0x13d7816d0>,
  <matplotlib.patches.Wedge at 0x13d782490>],
 [Text(-0.8823887735726856, 0.6568029021501746, 'co'),
  Text(0.36727634684128235, -1.0368741895962703, 'no2'),
  Text(0.43803183445999155, -1.009023345616748, 'o3'),
  Text(0.4998717402337833, -0.9798613388207789, 'so2'),
  Text(0.749048612490199, -0.8055595422602277, 'pm2_5'),
  Text(1.0473222062840684, -0.3363275133322747, 'pm10'),
  Text(1.09983484786791, -0.01906062473717321, 'nh3')])
```

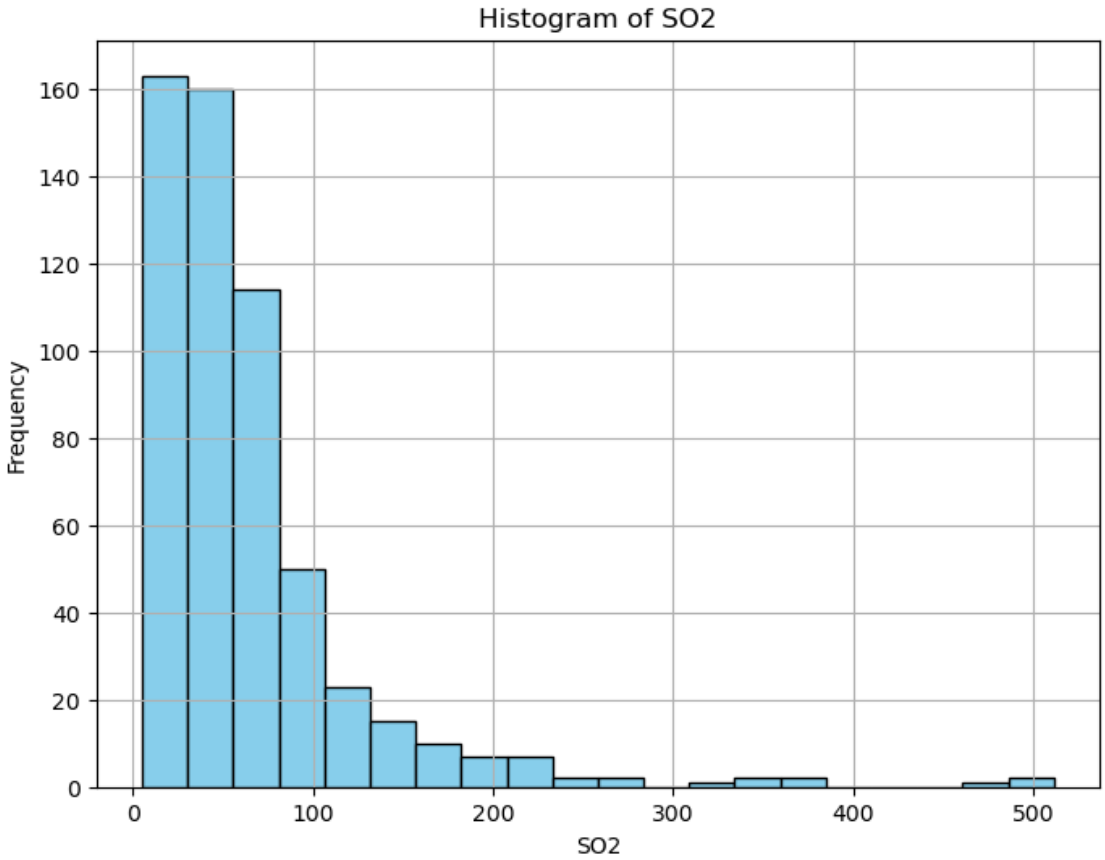


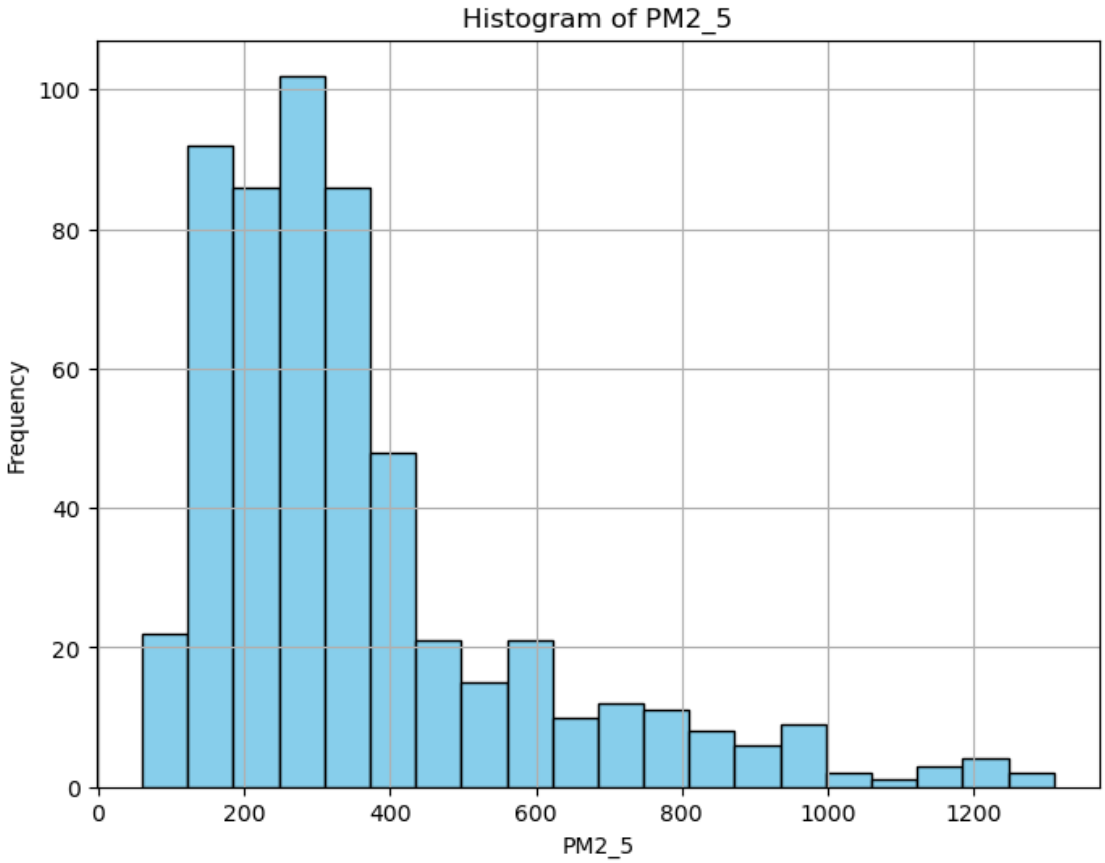
[17]:
```
pollutants = ['co', 'no2', 'o3', 'so2', 'pm2_5', 'pm10', 'nh3']

for pollutant in pollutants:
    plt.figure(figsize=(8, 6))
    plt.hist(df[pollutant], bins=20, color='skyblue', edgecolor='black')
    plt.xlabel(pollutant.upper())
    plt.ylabel('Frequency')
    plt.title(f'Histogram of {pollutant.upper()}')
    plt.grid(True)
    plt.show()
```

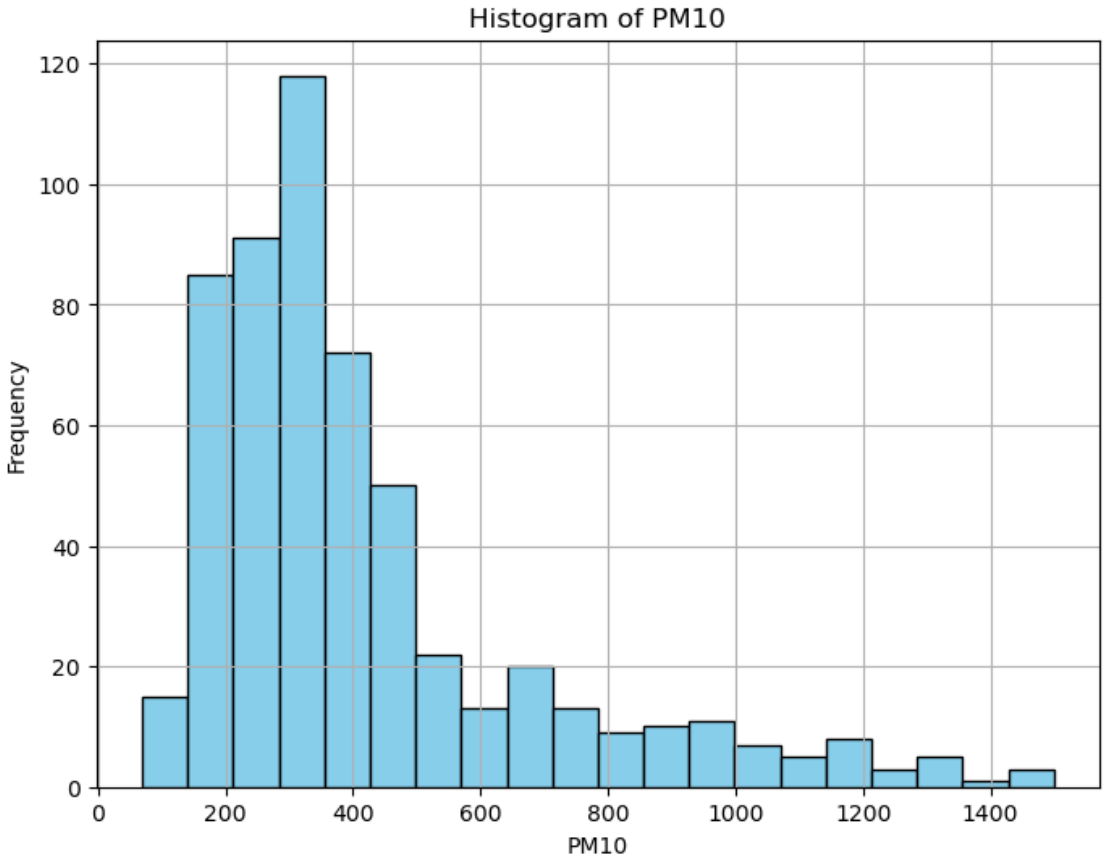

Histogram of CO
Frequency
CO
0
20
40
60
80
100
120
140
160
0
2000
4000
6000
8000
10000
12000
14000
16000

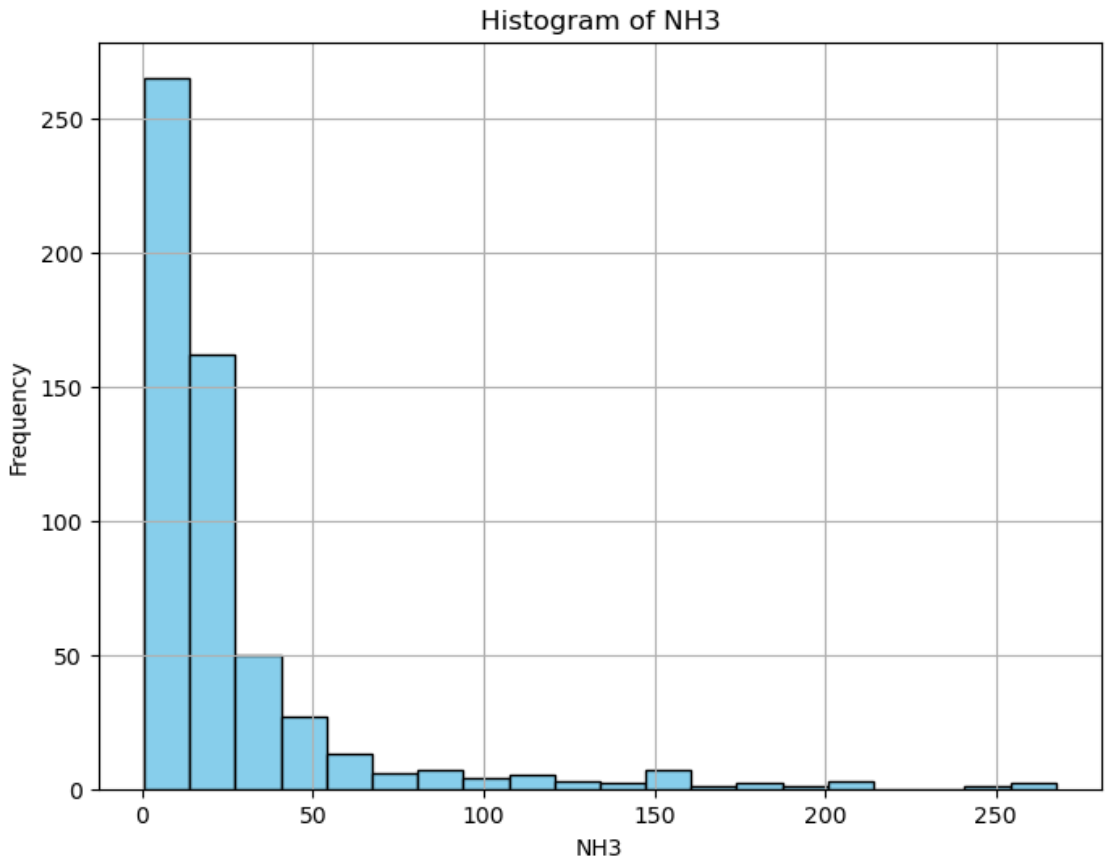

Histogram of NO2
Frequency
0
20
40
60
80
50
100
150
200
250
NO2


Histogram of O3
Frequency
250
200
150
100
50
0
0
25
50
75
100
125
150
O3

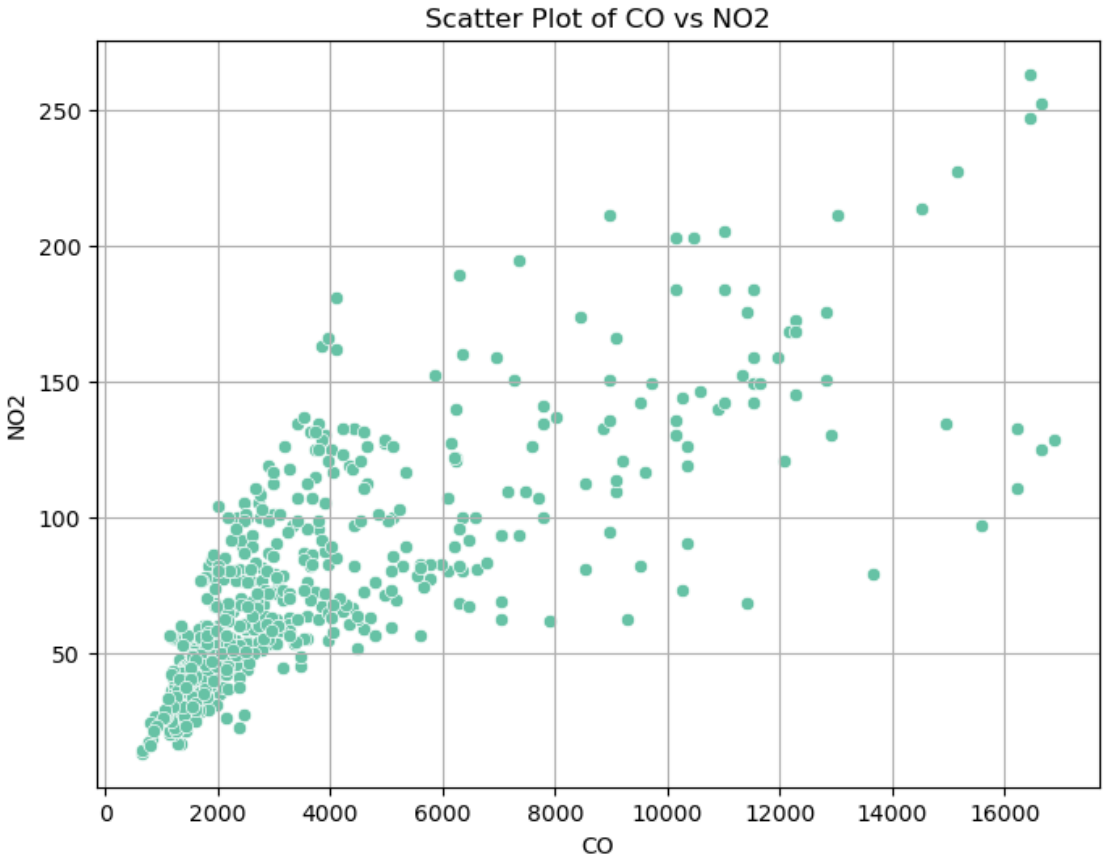

Histogram of SO2
Frequency
SO2
0
20
40
60
80
100
120
140
160
0
100
200
300
400
500

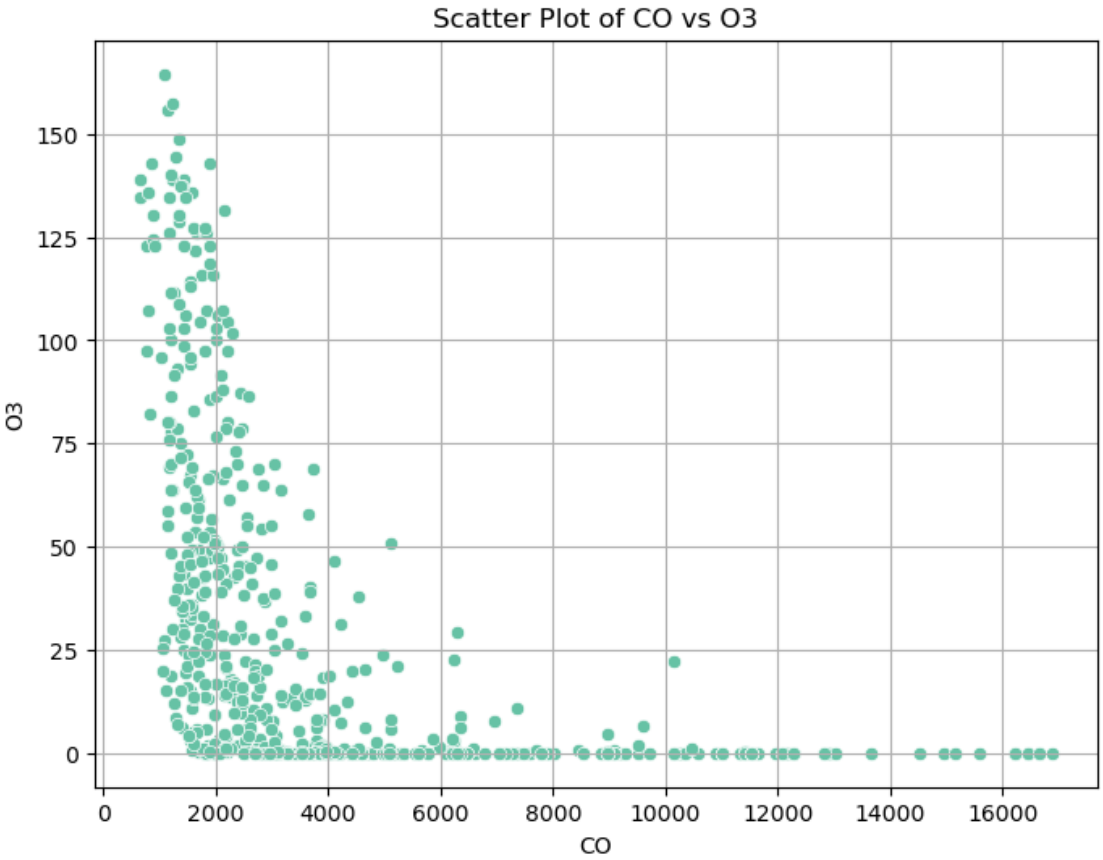

Histogram of PM2_5
Frequency
PM2_5
0
20
40
60
80
100
0
200
400
600
800
1000
1200

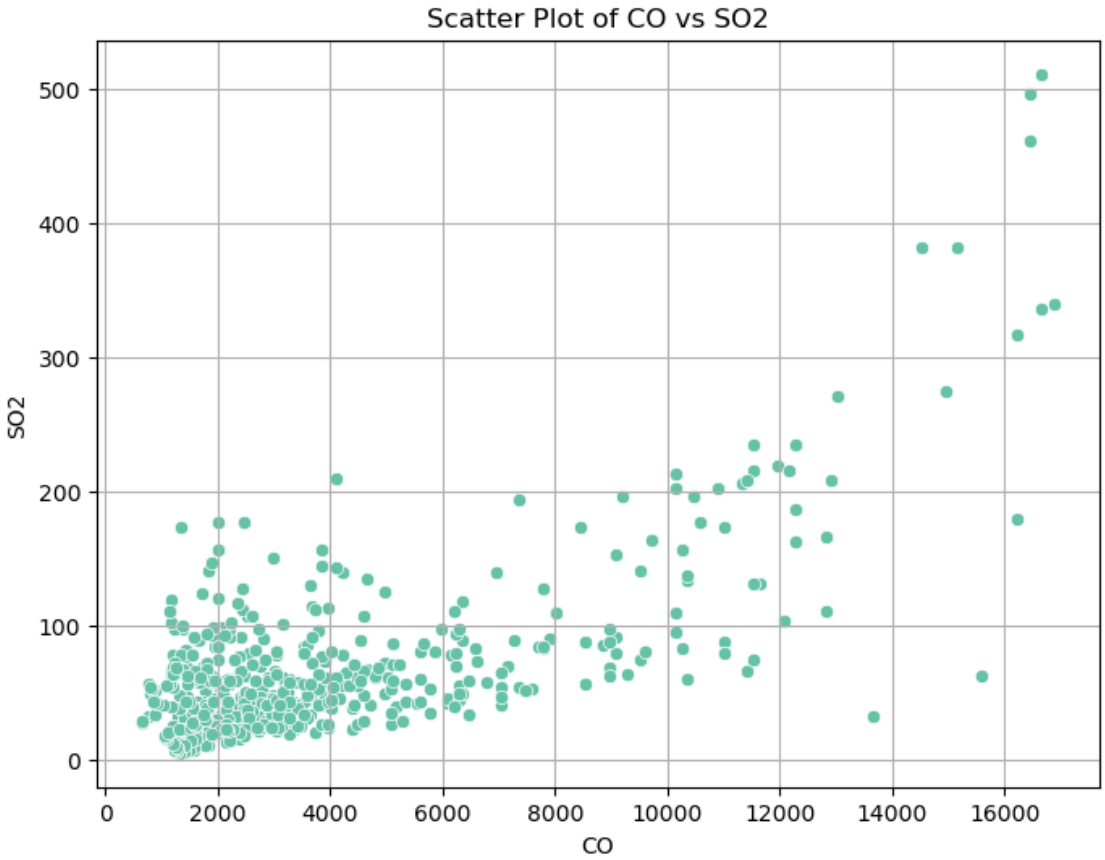

Histogram of PM10
Frequency
PM10
0
20
40
60
80
100
120
0
200
400
600
800
1000
1200
1400

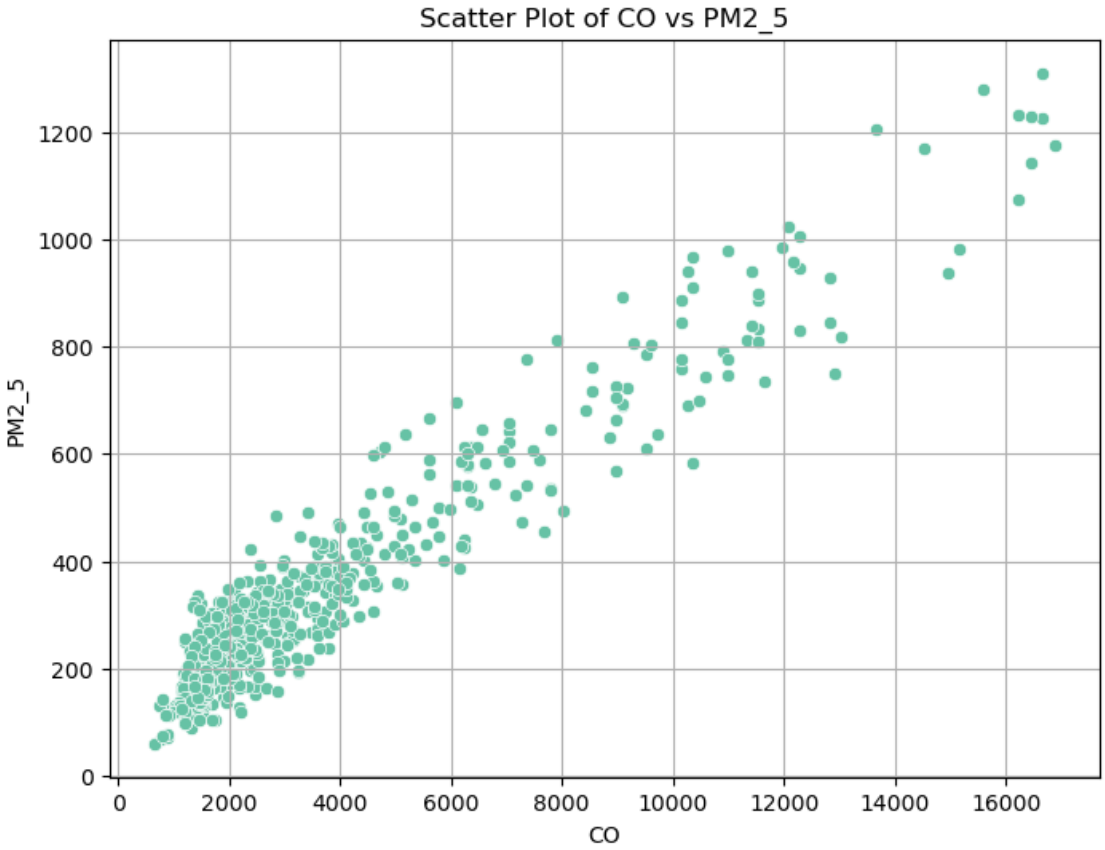


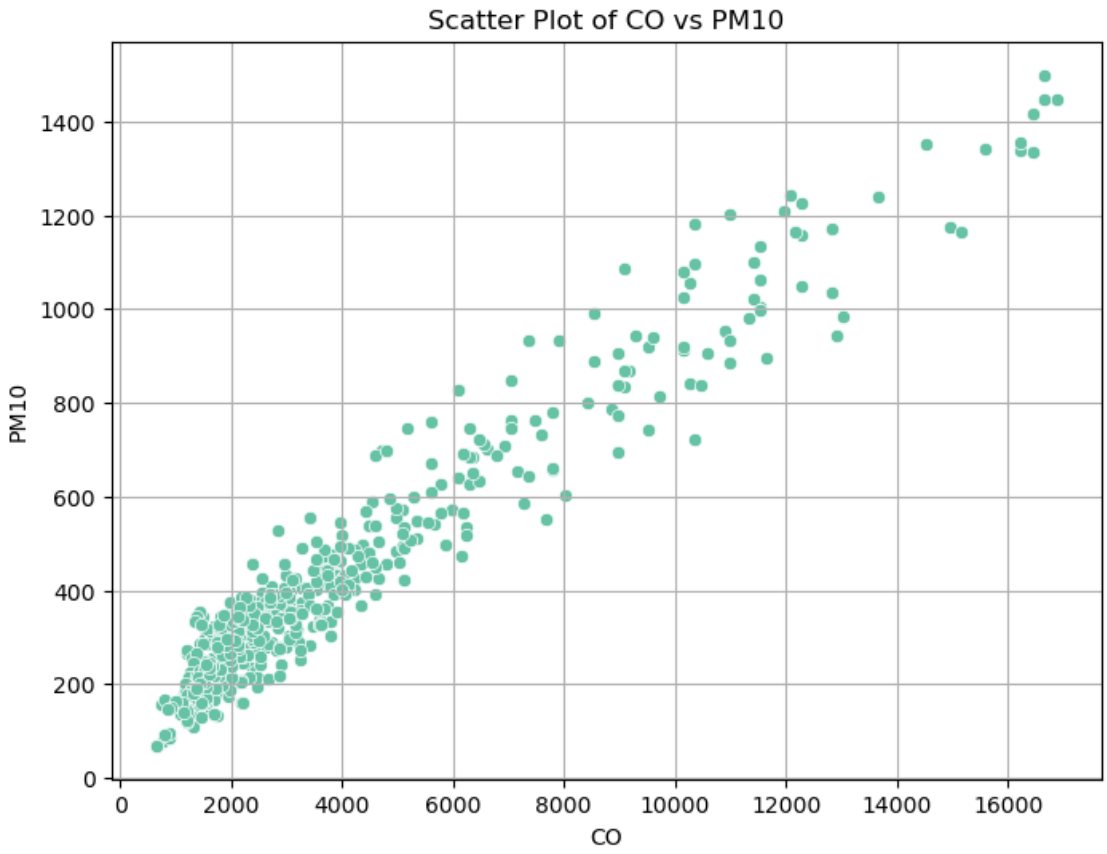
[18]:
```
for i in range(len(pollutants)):
    for j in range(i+1, len(pollutants)):
        plt.figure(figsize=(8, 6))
        sns.scatterplot(data=df, x=pollutants[i], y=pollutants[j])
        plt.xlabel(pollutants[i].upper())
        plt.ylabel(pollutants[j].upper())
        plt.title(f'Scatter Plot of {pollutants[i].upper()} vs {pollutants[j].
↪upper()}')
        plt.grid(True)
        plt.show()
```

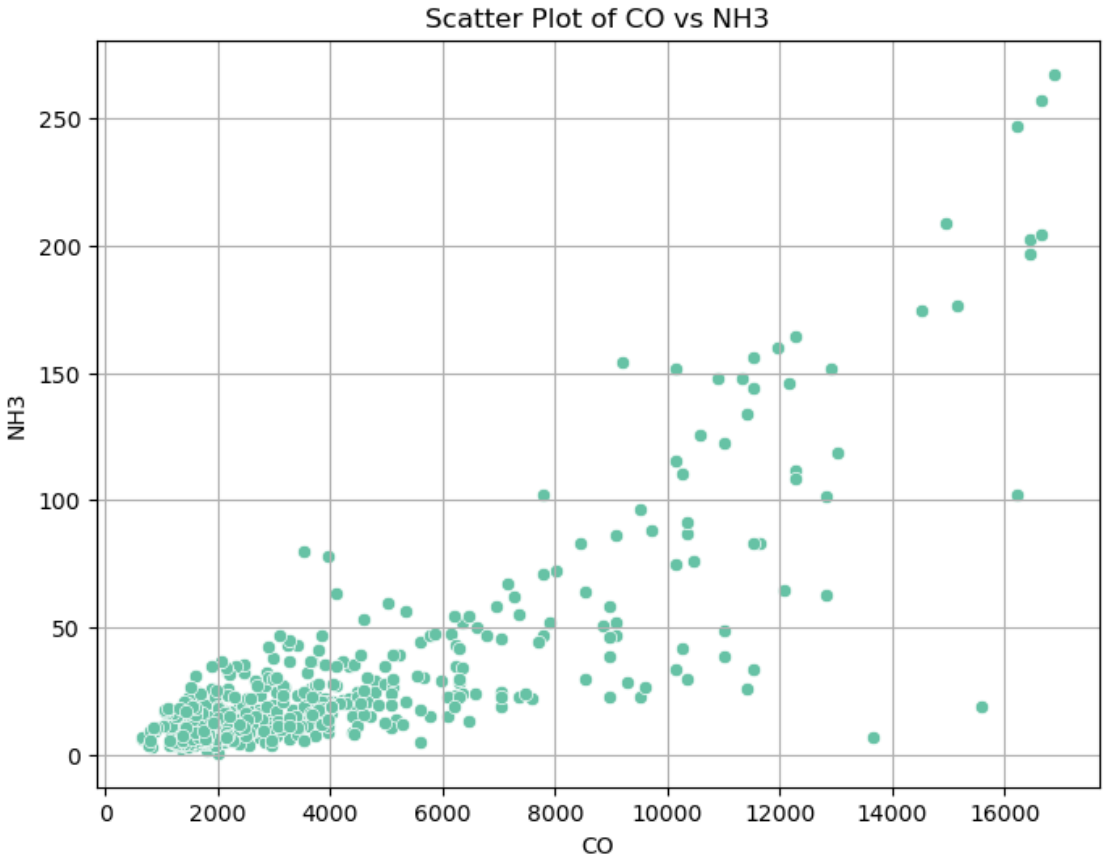

Scatter Plot of CO vs NO2
NO2
CO
250
200
150
100
50
0
2000
4000
6000
8000
10000
12000
14000
16000

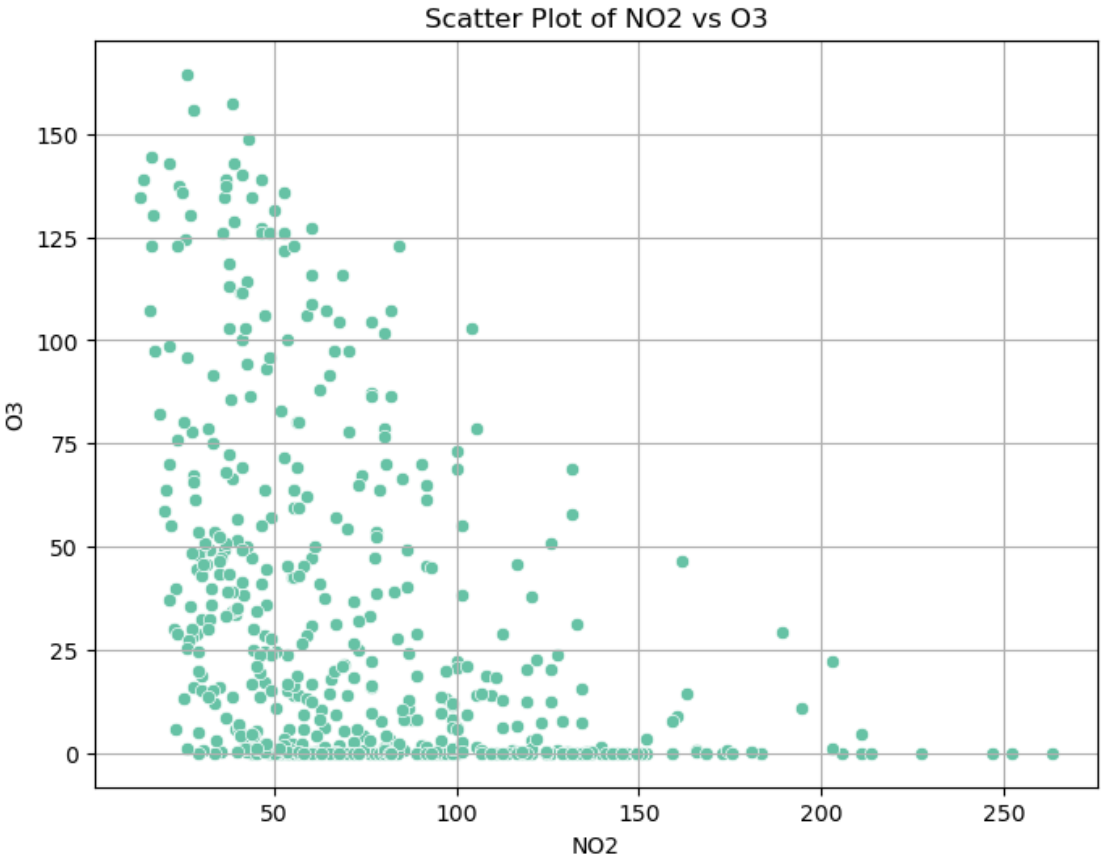

Scatter Plot of CO vs O3
O3
CO
0
25
50
75
100
125
150
0
2000
4000
6000
8000
10000
12000
14000
16000

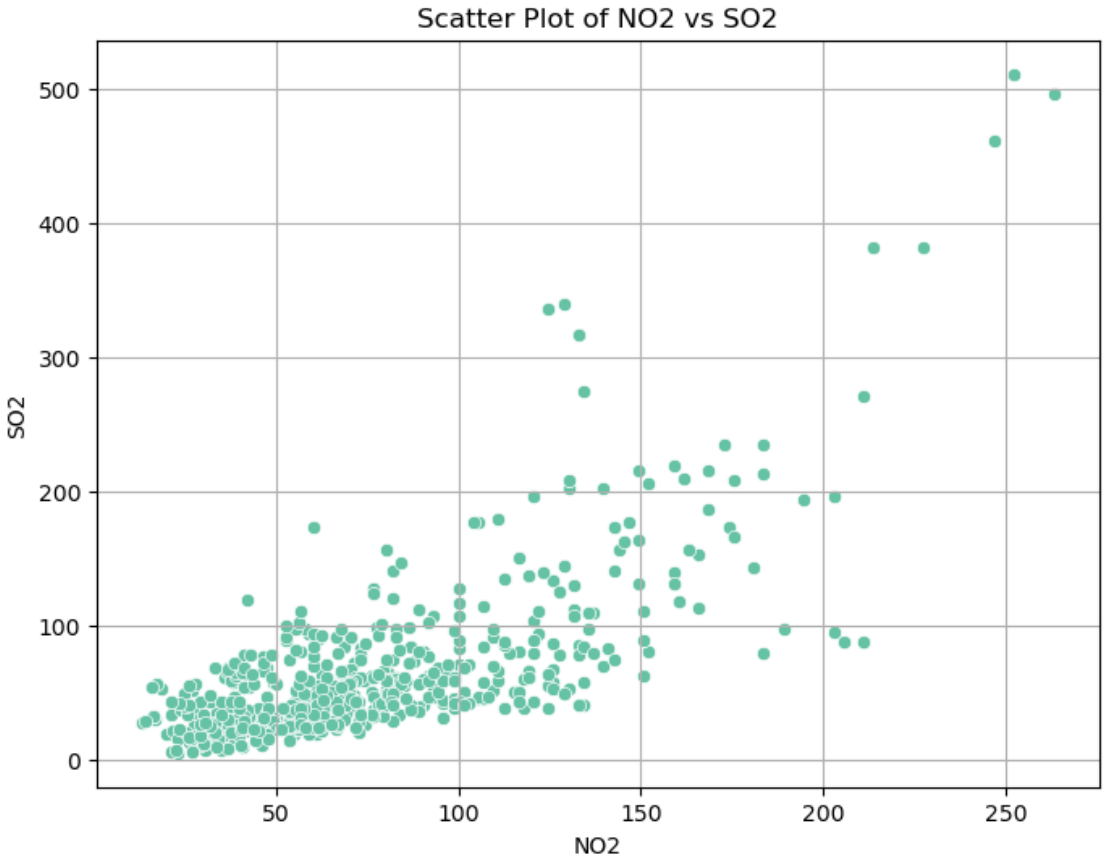

Scatter Plot of CO vs SO2
SO2
CO
0
100
200
300
400
500
0
2000
4000
6000
8000
10000
12000
14000
16000

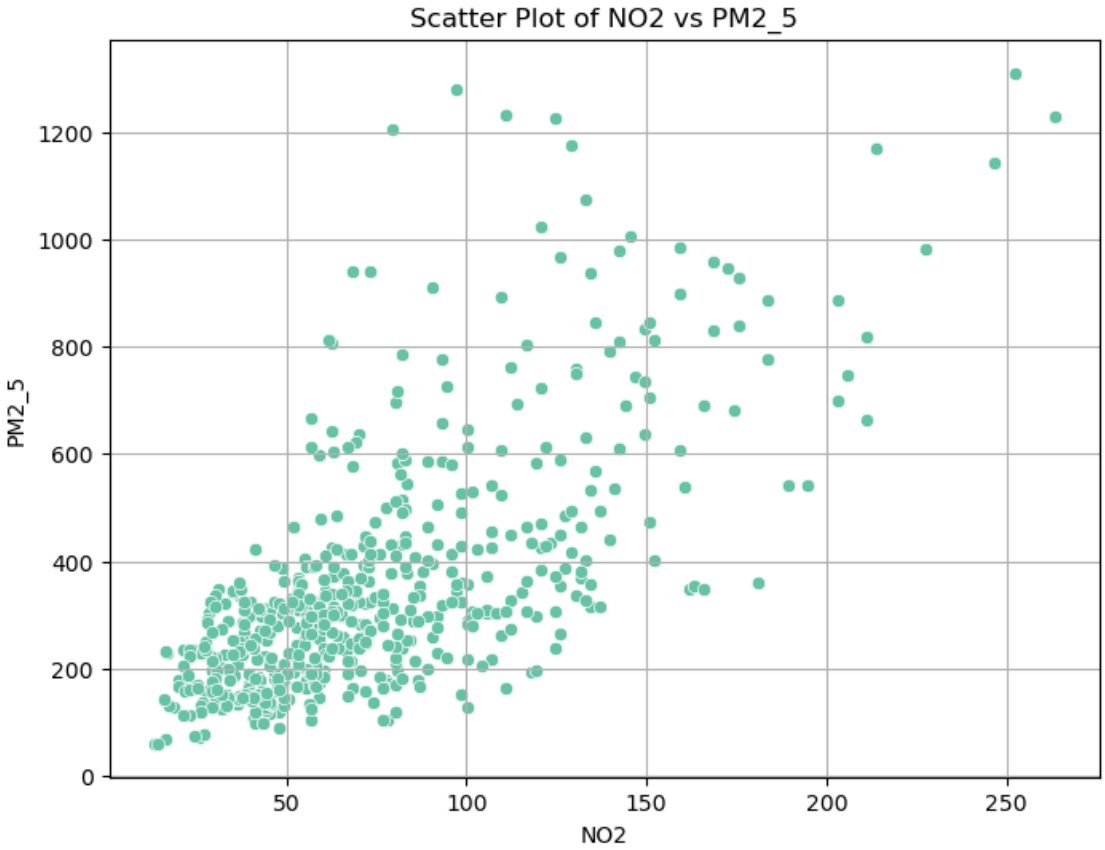

Scatter Plot of CO vs PM2_5
PM2_5
CO
0
200
400
600
800
1000
1200
0
2000
4000
6000
8000
10000
12000
14000
16000

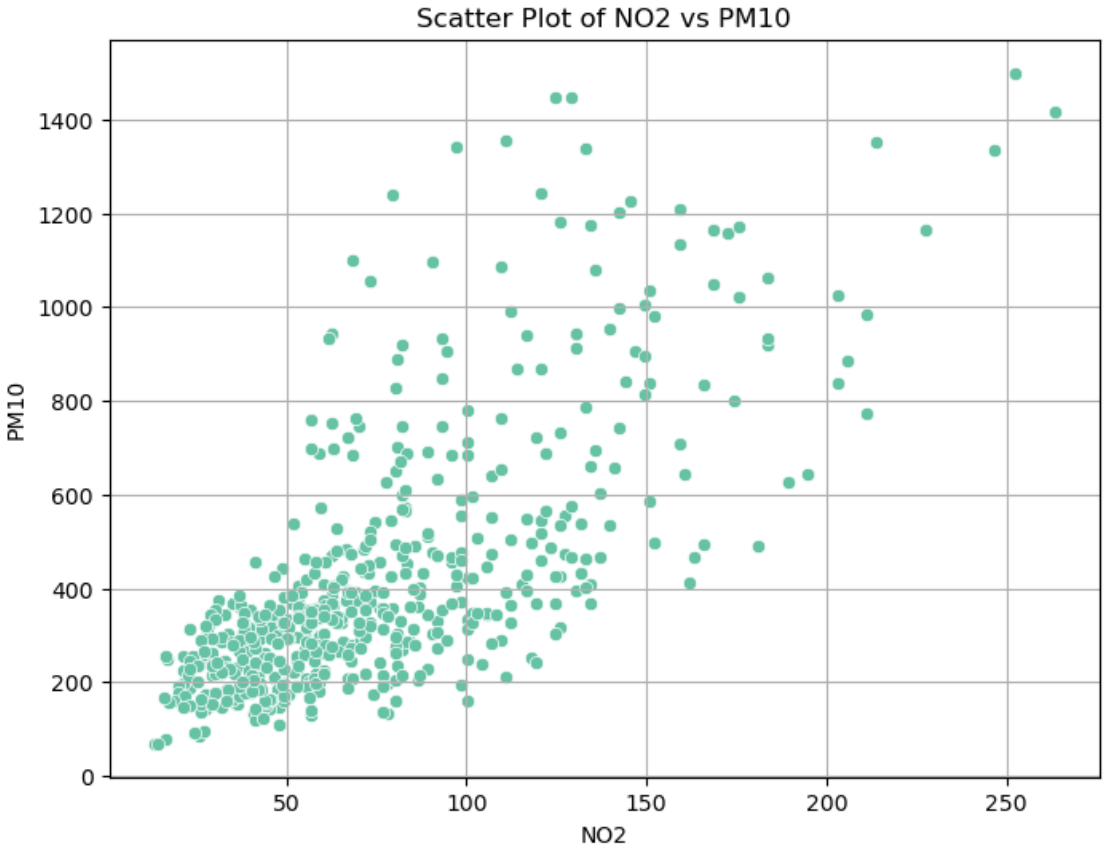

Scatter Plot of CO vs PM10
PM10
CO
0
200
400
600
800
1000
1200
1400
0
2000
4000
6000
8000
10000
12000
14000
16000

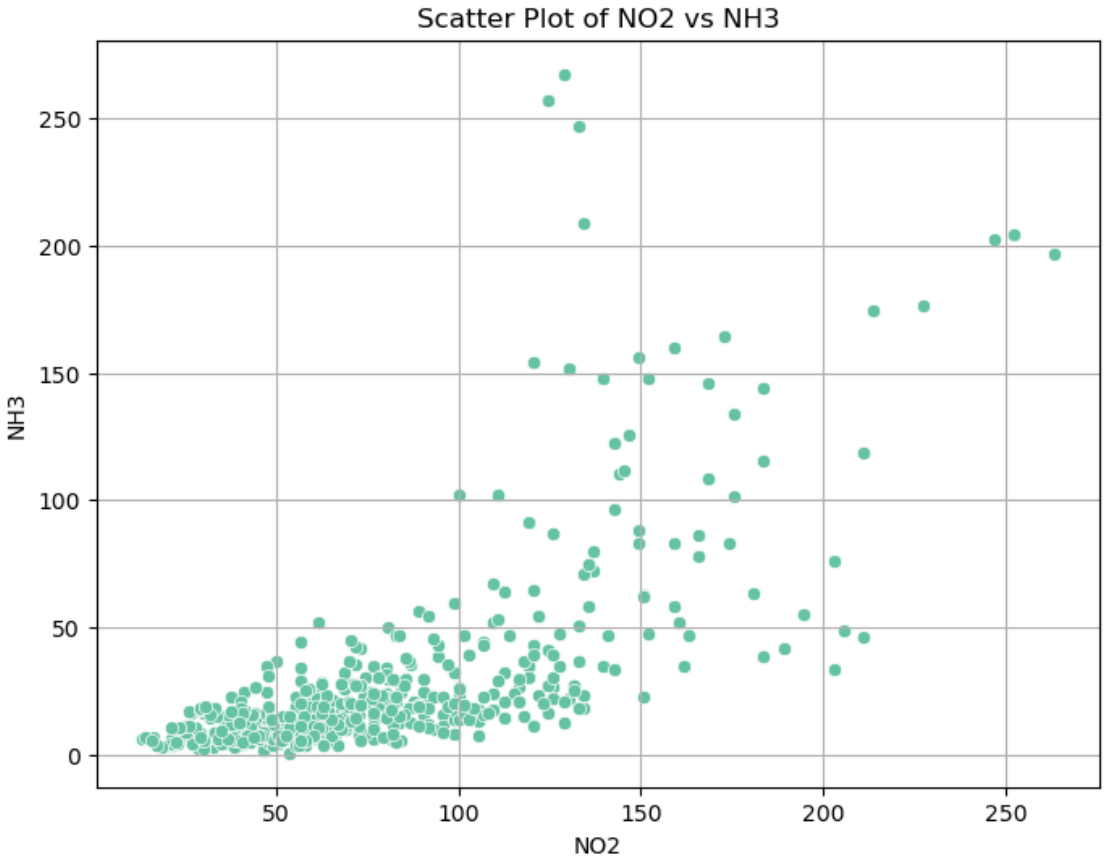

Scatter Plot of CO vs NH3
NH3
CO
0
50
100
150
200
250
0
2000
4000
6000
8000
10000
12000
14000
16000

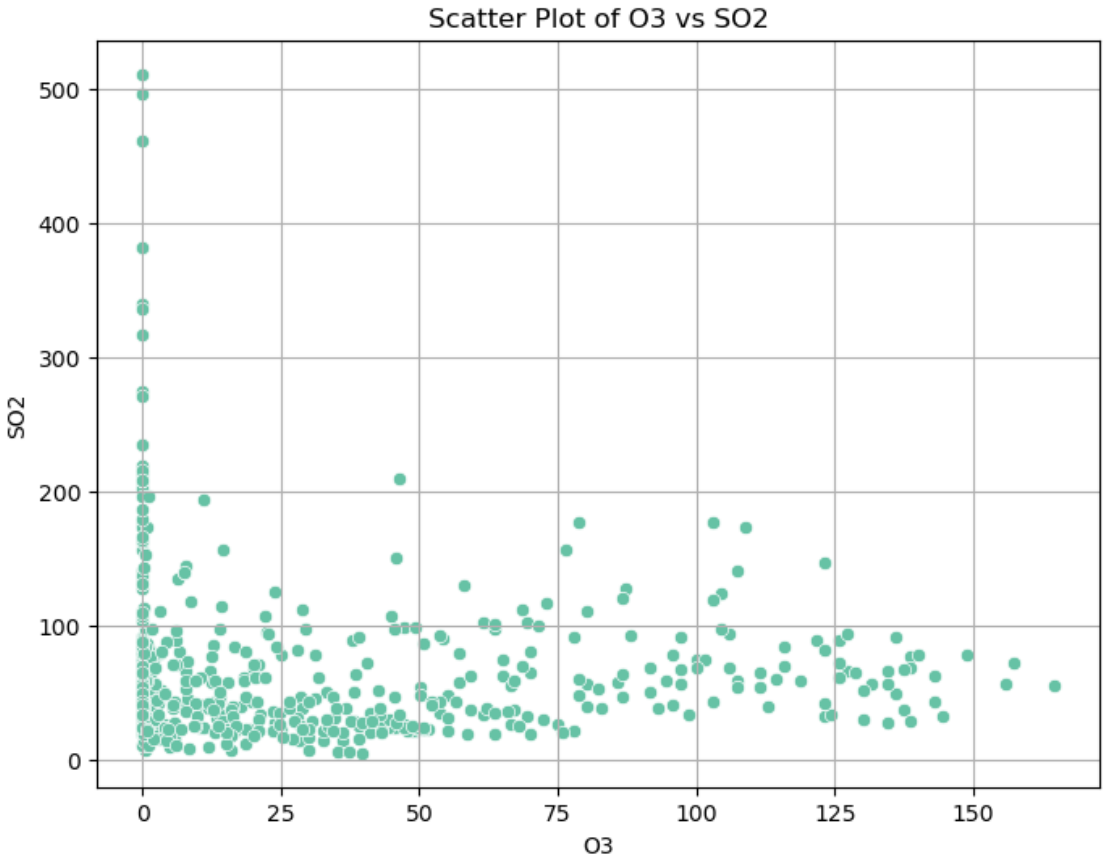

Scatter Plot of NO2 vs O3
O3
NO2
150
125
100
75
50
25
0
50
100
150
200
250

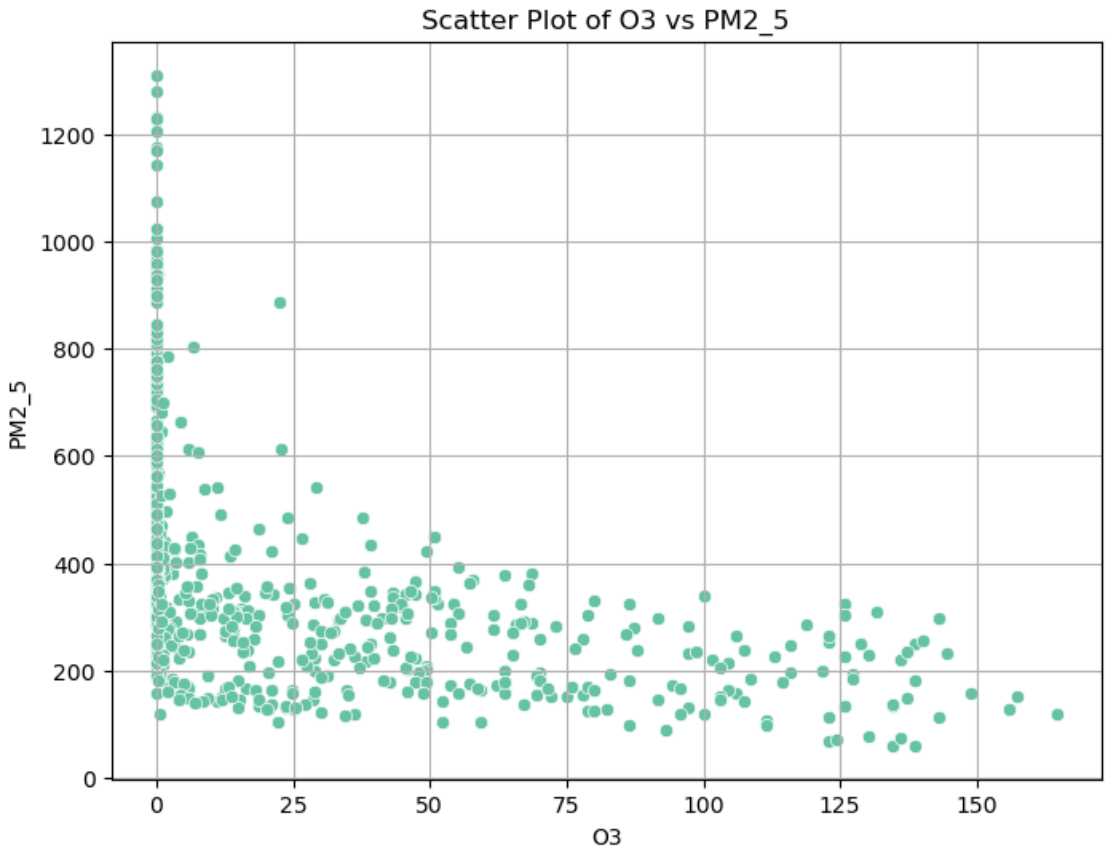

Scatter Plot of NO2 vs SO2
SO2
NO2
0
100
200
300
400
500
50
100
150
200
250

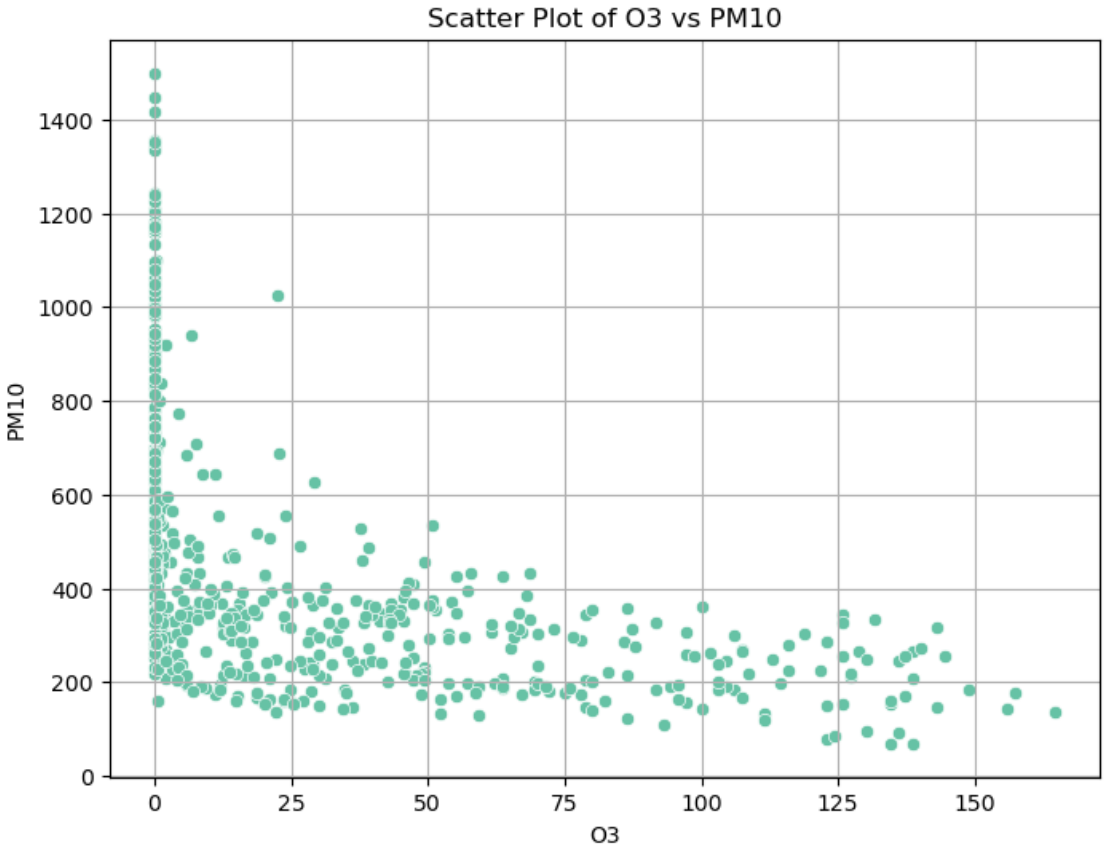

Scatter Plot of NO2 vs PM2_5
PM2_5
NO2
0
200
400
600
800
1000
1200
50
100
150
200
250

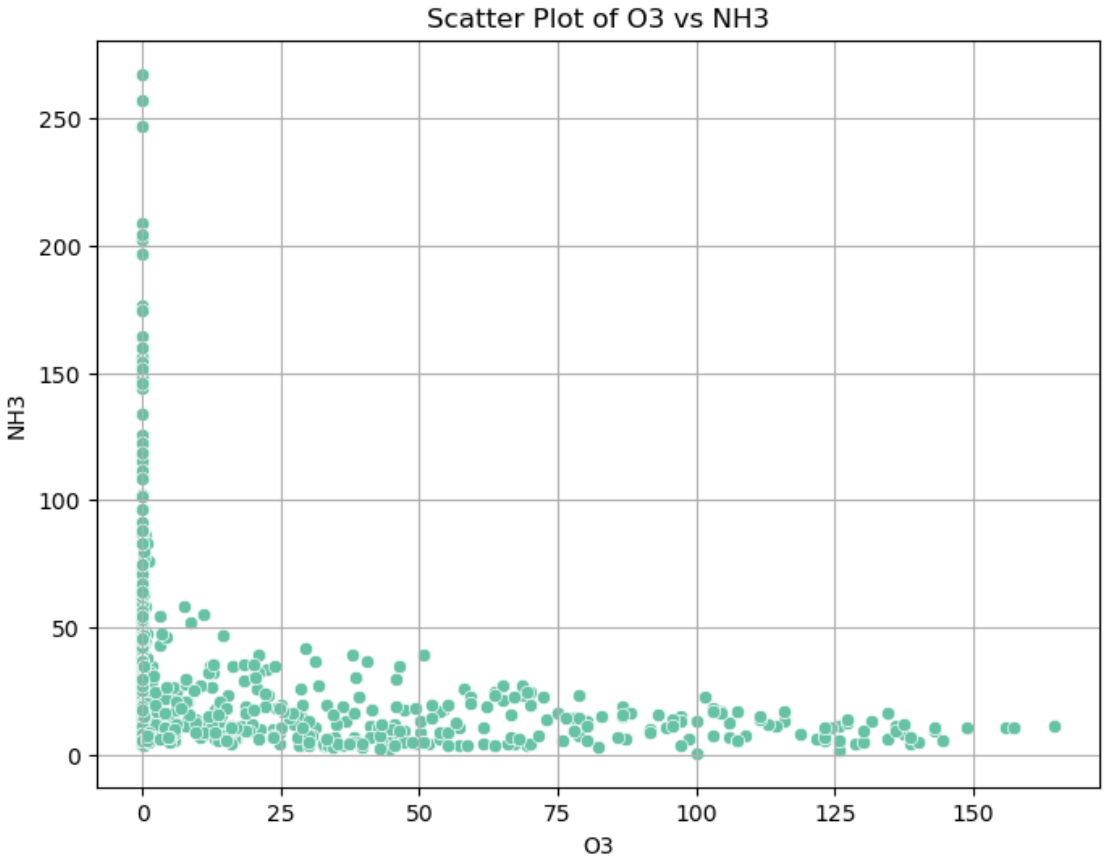

Scatter Plot of NO2 vs PM10
PM10
NO2
0
200
400
600
800
1000
1200
1400
50
100
150
200
250

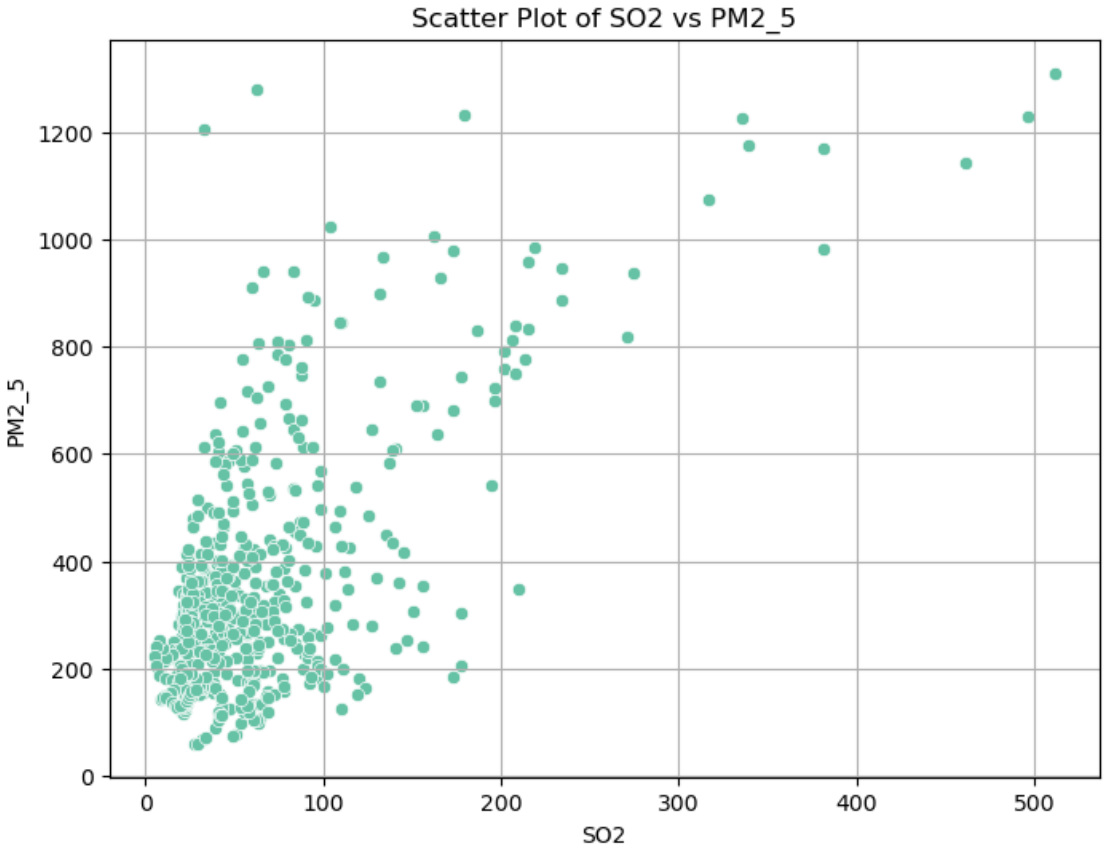

Scatter Plot of NO2 vs NH3
NH3
NO2
0
50
100
150
200
250
50
100
150
200
250

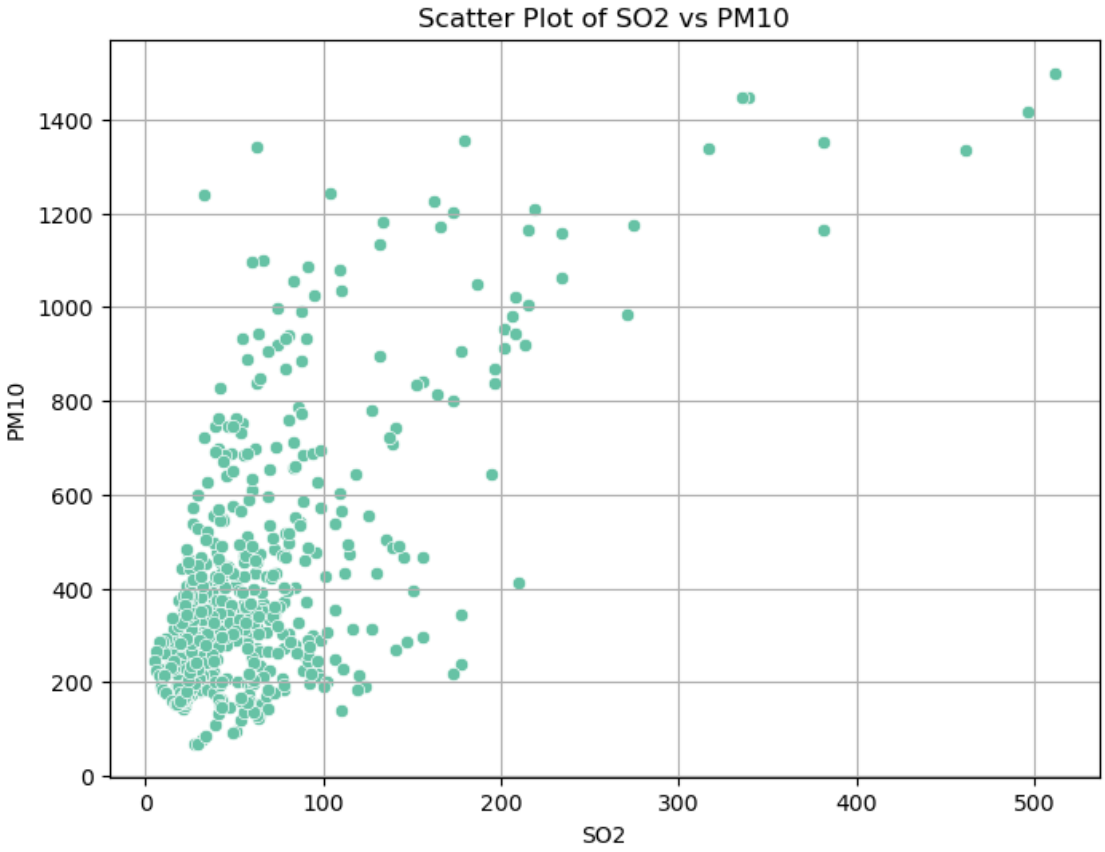

Scatter Plot of O3 vs SO2
SO2
O3
0
100
200
300
400
500
0
25
50
75
100
125
150

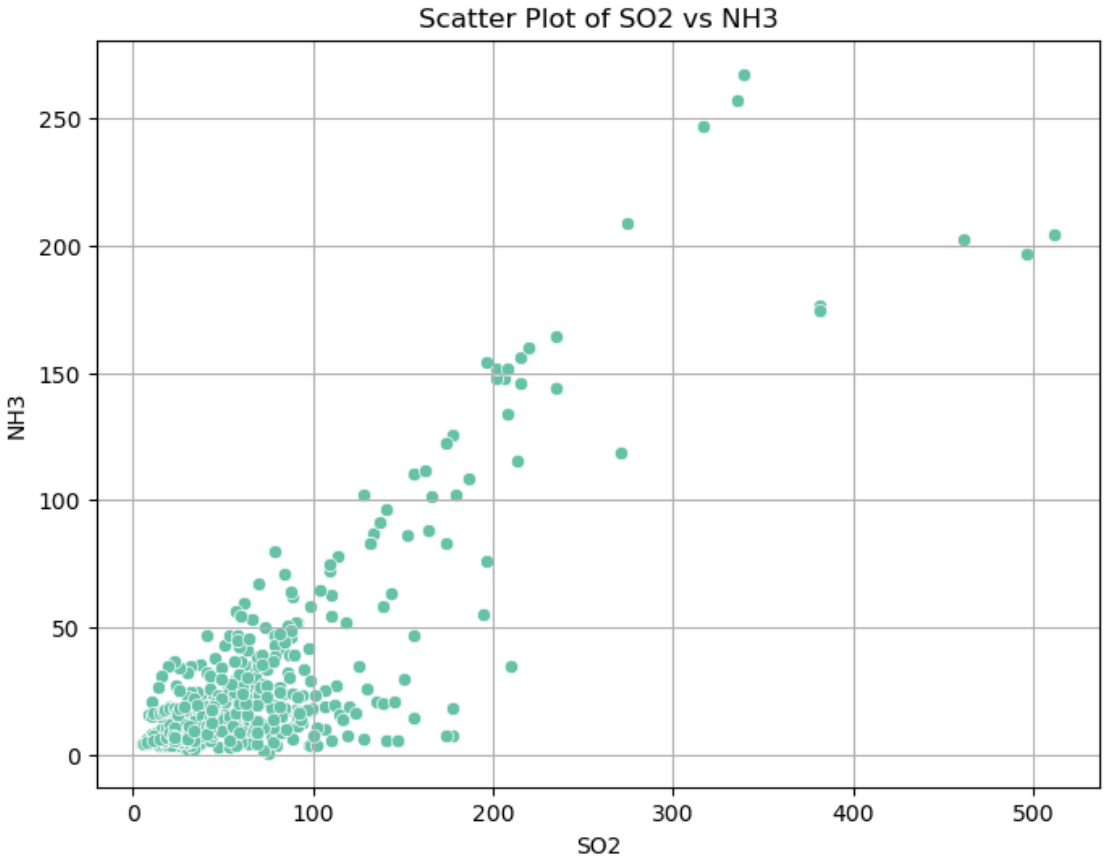

Scatter Plot of O3 vs PM2_5
PM2_5
O3
0
200
400
600
800
1000
1200
0
25
50
75
100
125
150

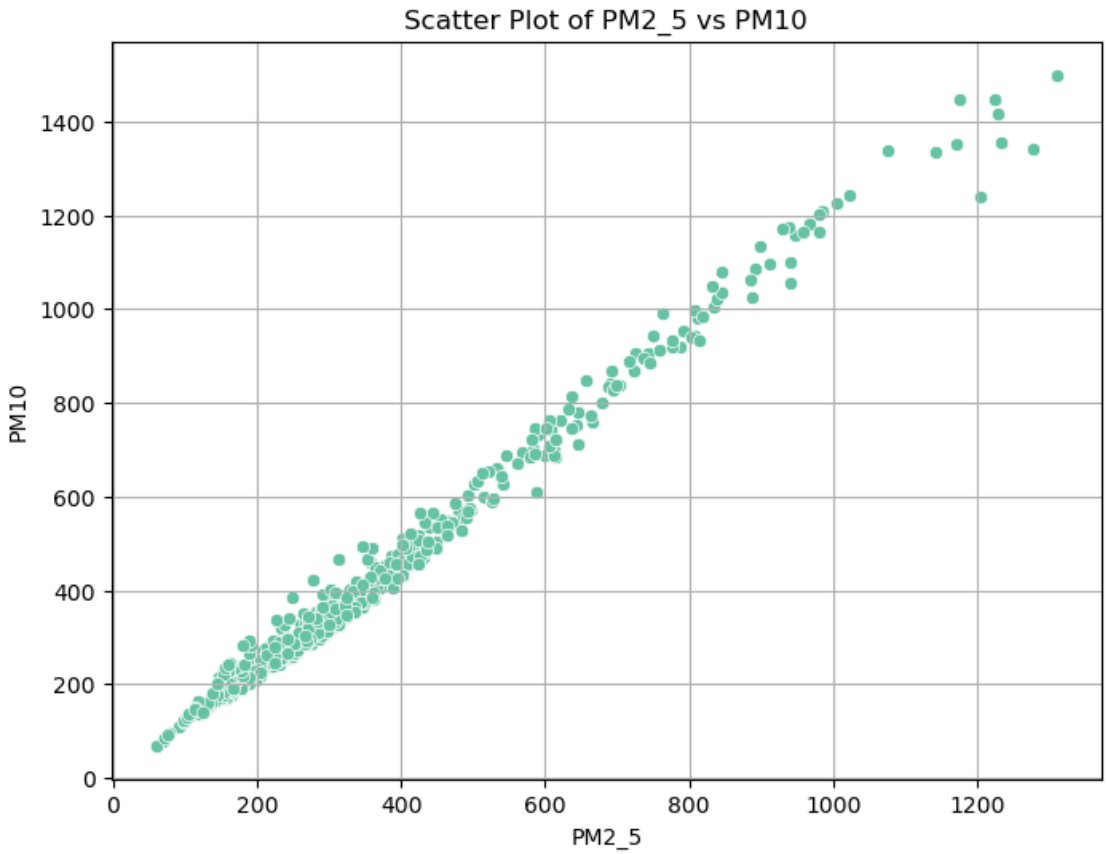

Scatter Plot of O3 vs PM10
PM10
O3
0
200
400
600
800
1000
1200
1400
0
25
50
75
100
125
150

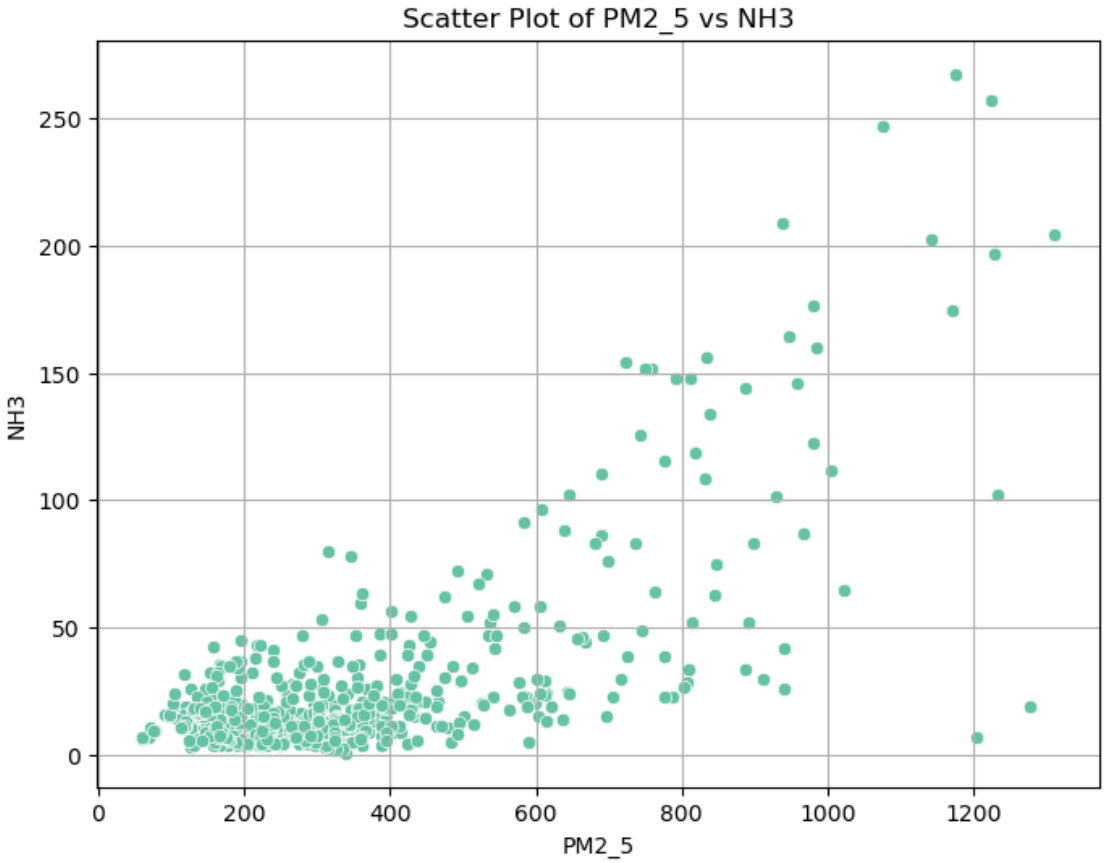

Scatter Plot of O3 vs NH3
NH3
O3
0
50
100
150
200
250
0
25
50
75
100
125
150

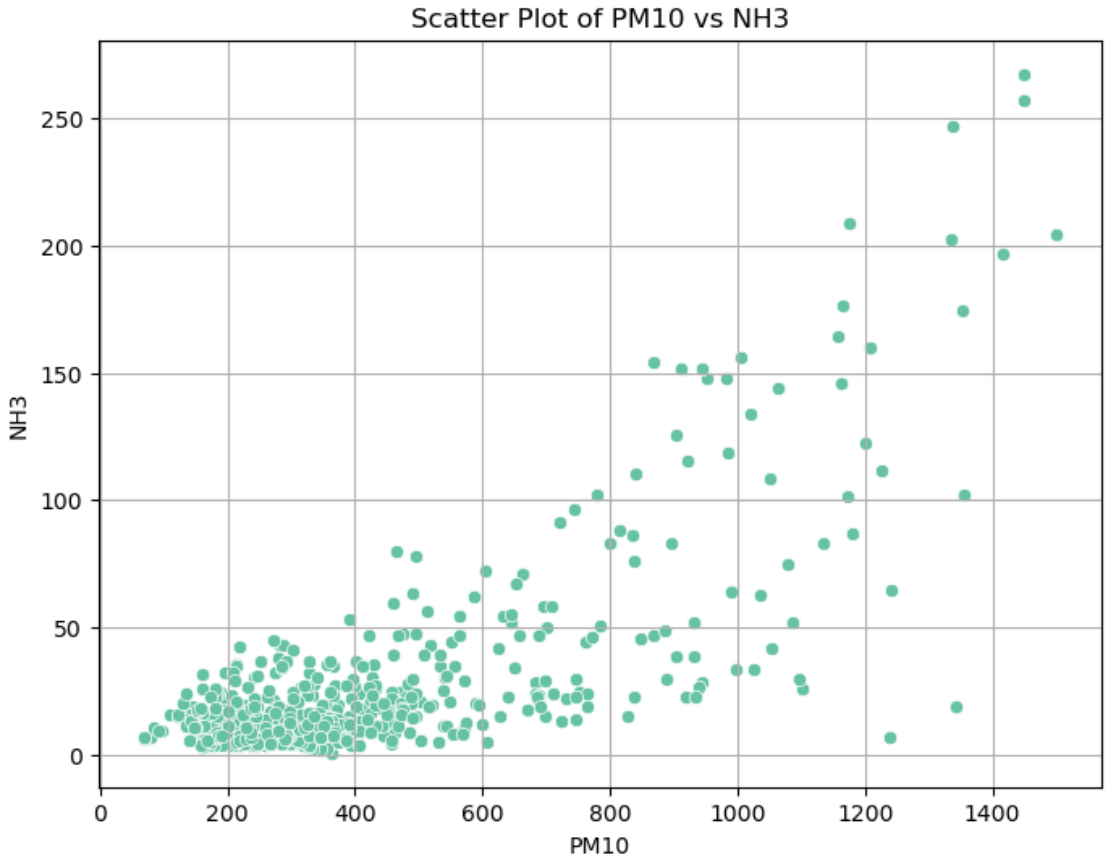

Scatter Plot of SO2 vs PM2_5
PM2_5
SO2
0
200
400
600
800
1000
1200
0
100
200
300
400
500


Scatter Plot of SO2 vs PM10
PM10
SO2
0
200
400
600
800
1000
1200
1400
0
100
200
300
400
500

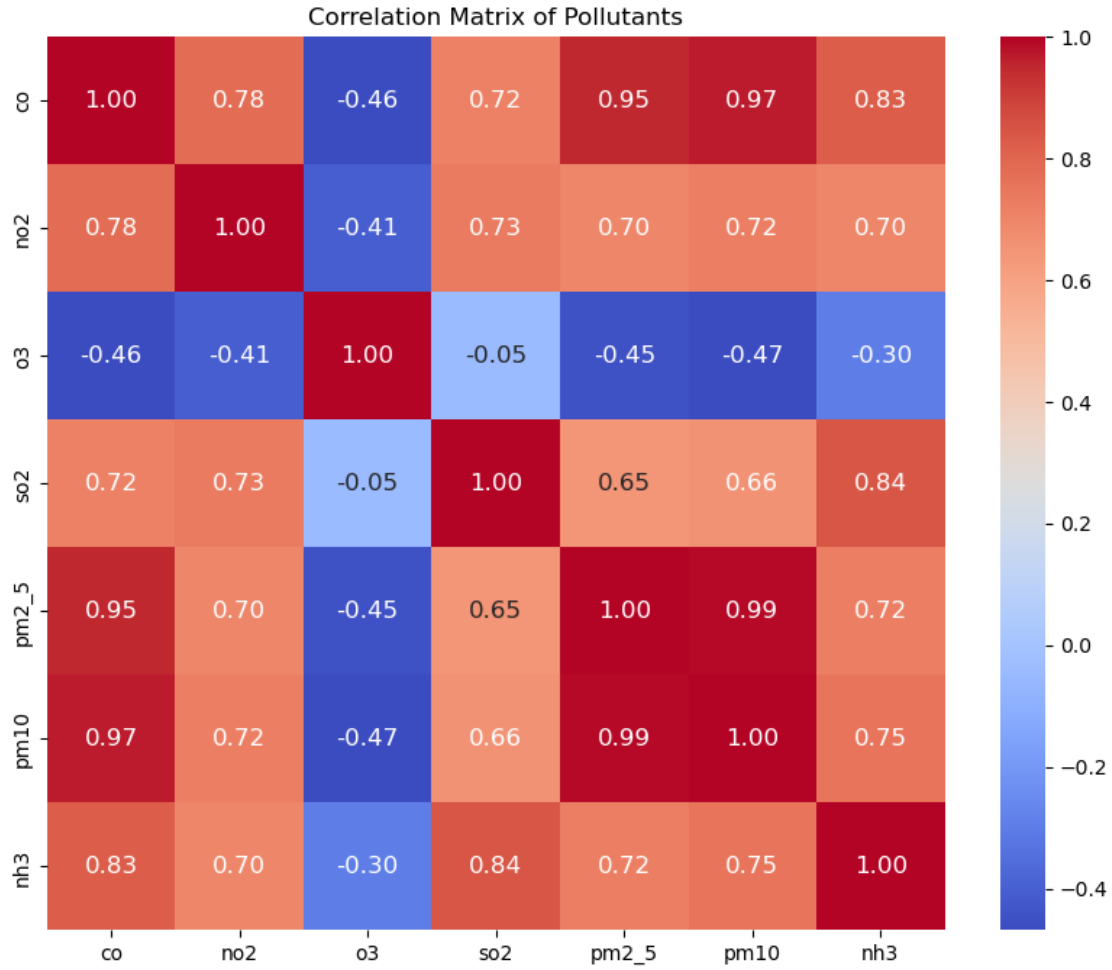

Scatter Plot of SO2 vs NH3
NH3
SO2
0
50
100
150
200
250
0
100
200
300
400
500


Scatter Plot of PM2_5 vs PM10
PM10
PM2_5
0
200
400
600
800
1000
1200
1400


Scatter Plot of PM2_5 vs NH3
NH3
PM2_5
0
50
100
150
200
250
0
200
400
600
800
1000
1200



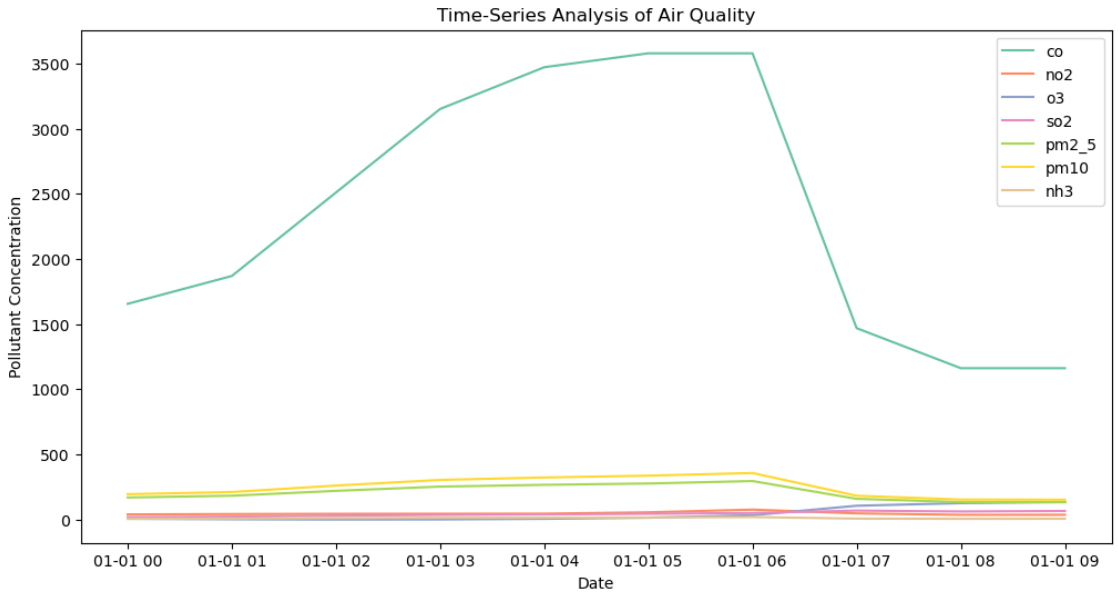
[19]:
```
correlation_matrix = df[pollutants].corr()

plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f",␣
↪annot_kws={"size": 12})
plt.title('Correlation Matrix of Pollutants')
plt.show()
```



[20]:
```
df['date'] = pd.to_datetime(df['date'])


df['year'] = df['date'].dt.year.astype('category')
df['month'] = df['date'].dt.month.astype('category')
df['day'] = df['date'].dt.day.astype('category')
```

[21]:
```
df.set_index('date', inplace=True)


pollutants = ['co', 'no2', 'o3', 'so2', 'pm2_5', 'pm10', 'nh3']
df = df.iloc[:10]
plt.figure(figsize=(12, 6))
for pollutant in pollutants:
    plt.plot(df.index, df[pollutant], label=pollutant)

plt.xlabel('Date')
```

```
plt.ylabel('Pollutant Concentration')
plt.title('Time-Series Analysis of Air Quality')
plt.legend()
plt.show()
```



[22]:
```
aqi_breakpoints = {
    'co': [0, 4.4, 9.4, 12.4, 15.4, 30.4, 40.4],
    'no2': [0, 53, 100, 360, 649, 1249, 1649],
    'o3': [0, 54, 70, 85, 105, 200, 404],
    'so2': [0, 35, 75, 185, 304, 604, 1004],
    'pm2_5': [0, 12, 35.4, 55.4, 150.4, 250.4, 350.4],
    'pm10': [0, 54, 154, 254, 354, 424, 604],
    'nh3': [0, 53, 104, 154, 204, 304, 404]
}

def calculate_aqi(row):
    max_aqi = 0
    for pollutant in aqi_breakpoints:
        concentration = row[pollutant]
        breakpoints = aqi_breakpoints[pollutant]
        index = next((i for i, x in enumerate(breakpoints) if x >=␣
 ↪concentration), len(breakpoints) - 1)
        aqi = ((breakpoints[index] - breakpoints[index - 1]) / (concentration -␣
 ↪breakpoints[index - 1])) * (index - 1) + breakpoints[index - 1]
        if aqi > max_aqi:
            max_aqi = aqi
    return max_aqi
```

```
df['AQI'] = df.apply(calculate_aqi, axis=1)

df.tail(20)
```

[22]:

date	co	no	no2	o3	so2	pm2_5	pm10	nh3	year	month	day	AQI
2023-01-01 00:00:00	1655.58	1.66	39.41	5.90	17.88	169.29	194.64	5.83	2023	1	1	171.575225
2023-01-01 01:00:00	1869.20	6.82	42.16	1.99	22.17	182.84	211.08	7.66	2023	1	1	162.730456
2023-01-01 02:00:00	2510.07	27.72	43.87	0.02	30.04	220.25	260.68	11.40	2023	1	1	298.910180
2023-01-01 03:00:00	3150.94	55.43	44.55	0.85	35.76	252.90	304.12	13.55	2023	1	1	450.400000
2023-01-01 04:00:00	3471.37	68.84	45.24	5.45	39.10	266.36	322.80	14.19	2023	1	1	281.728321
2023-01-01 05:00:00	3578.19	64.37	55.52	14.13	44.35	276.54	336.79	16.21	2023	1	1	269.527774
2023-01-01 06:00:00	3578.19	46.94	76.09	33.26	50.54	295.40	357.07	19.25	2023	1	1	445.205212
2023-01-01 07:00:00	1468.66	9.83	47.30	105.86	68.66	158.83	182.61	7.09	2023	1	1	546.860465
2023-01-01 08:00:00	1161.58	5.81	35.99	125.89	61.99	134.39	153.47	5.51	2023	1	1	123.190522
2023-01-01 09:00:00	1161.58	4.58	36.33	134.47	65.80	133.22	152.09	6.02	2023	1	1	117.894469

[23]:
```
def categorize_aqi(aqi):
    if 0 <= aqi <= 50:
        return 'Good'
    elif 51 <= aqi <= 100:
        return 'Satisfactory'
    elif 101 <= aqi <= 200:
        return 'Moderately Polluted'
    elif 201 <= aqi <= 300:
        return 'Poor'
    elif 301 <= aqi <= 400:
        return 'Very Poor'
    elif 401 <= aqi <= 500:
        return 'Severe'
    else:
        return 'Invalid AQI Value'
```

```
df['Air Quality Category'] = df['AQI'].apply(categorize_aqi)

df.head()
```

[23]:

date	co	no	no2	o3	so2	pm2_5	pm10	nh3	year	month	day	AQI	Air Quality Category
2023-01-01 00:00:00	1655.58	1.66	39.41	5.90	17.88	169.29	194.64	5.83	2023	1	1	171.575225	Moderately Polluted
2023-01-01 01:00:00	1869.20	6.82	42.16	1.99	22.17	182.84	211.08	7.66	2023	1	1	162.730456	Moderately Polluted
2023-01-01 02:00:00	2510.07	27.72	43.87	0.02	30.04	220.25	260.68	11.40	2023	1	1	298.910180	Poor
2023-01-01 03:00:00	3150.94	55.43	44.55	0.85	35.76	252.90	304.12	13.55	2023	1	1	450.400000	Severe
2023-01-01 04:00:00	3471.37	68.84	45.24	5.45	39.10	266.36	322.80	14.19	2023	1	1	281.728321	Poor

[ ]:

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[ ]: