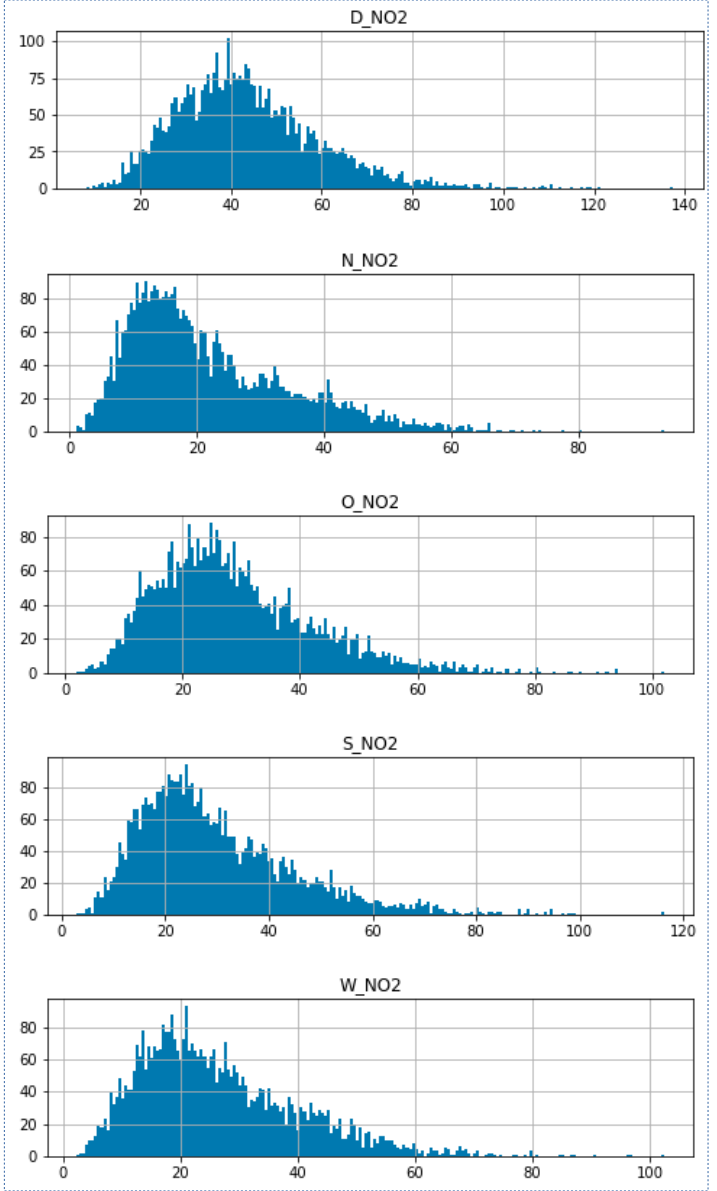
# Graz Data

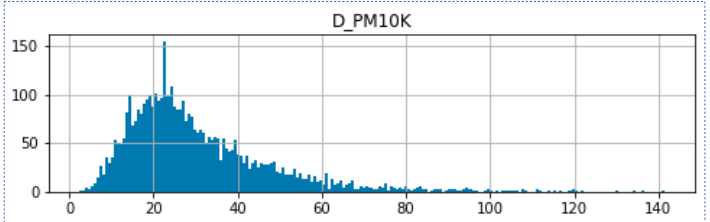
# Overview

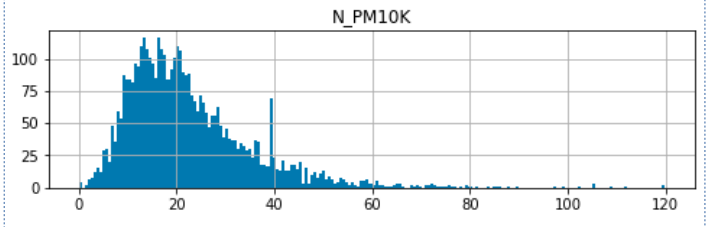
| | count | mean | std | min | 25% | 50% | 75% | max |
|---|---|---|---|---|---|---|---|---|
| D_NO2 | 4177.0 | 43.574199 | 15.698322 | 8.024886 | 32.481518 | 41.671497 | 52.239890 | 137.524250 |
| N_NO2 | 4177.0 | 21.808625 | 12.631127 | 1.144127 | 12.350074 | 18.415941 | 29.199263 | 93.462555 |
| O_NO2 | 4177.0 | 28.756654 | 13.302504 | 1.981802 | 19.231106 | 26.405266 | 36.207573 | 102.040640 |
| S_NO2 | 4177.0 | 29.787456 | 14.946322 | 2.919650 | 19.170780 | 26.351784 | 37.671535 | 116.251520 |
| W_NO2 | 4177.0 | 26.562450 | 13.606479 | 2.341851 | 16.582745 | 23.776577 | 34.365726 | 102.439360 |
| D_PM10K | 4177.0 | 30.412091 | 17.181764 | 2.248819 | 18.873556 | 26.145586 | 37.964490 | 141.548540 |
| N_PM10K | 4177.0 | 22.573188 | 13.088543 | 0.000000 | 13.585777 | 19.806145 | 28.339638 | 119.885475 |
| O_PM10K | 4177.0 | 29.302954 | 16.359887 | 4.071145 | 17.942915 | 24.923760 | 36.712193 | 130.208820 |
| S_PM10K | 4177.0 | 29.176028 | 18.246191 | 3.718005 | 16.598820 | 23.810854 | 36.867650 | 138.784260 |
| W_PM10K | 4177.0 | 24.601936 | 14.785938 | 1.535183 | 14.404179 | 21.113316 | 31.224894 | 125.431984 |
| N_O3 | 4177.0 | 42.692068 | 26.360824 | 0.000000 | 18.670616 | 44.490800 | 64.091110 | 114.304600 |
| S_O3 | 4177.0 | 38.137154 | 24.687726 | 0.069498 | 14.864059 | 38.797195 | 57.992140 | 107.530620 |
| N_Ox | 4177.0 | 64.500693 | 19.320632 | 17.863999 | 49.933612 | 64.306597 | 78.474891 | 127.550975 |
| S_Ox | 4177.0 | 67.924610 | 18.725901 | 18.003436 | 54.274630 | 68.279770 | 81.365561 | 127.010152 |

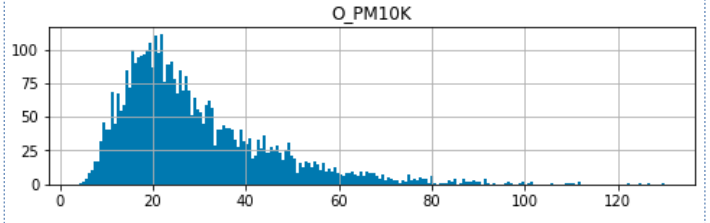
- Only N & W has O3 and Ox

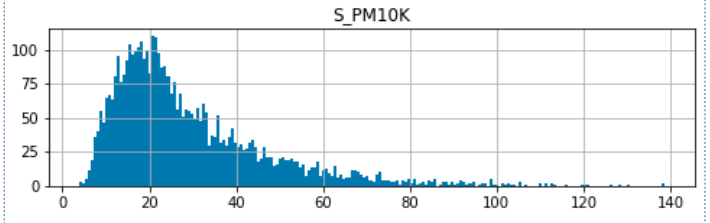


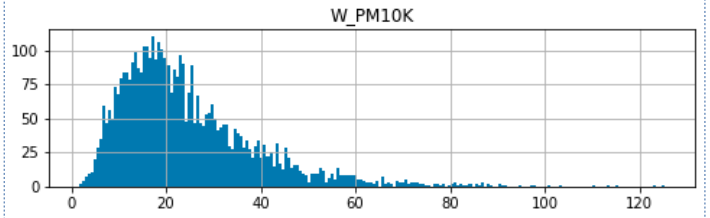

- D has the highest NO2 and PM10, in both max and avg
- N has the least

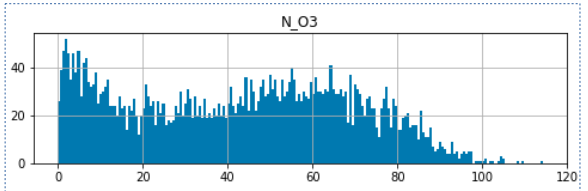

D_PM10K
0
50
100
150
0
20
40
60
80
100
120
140

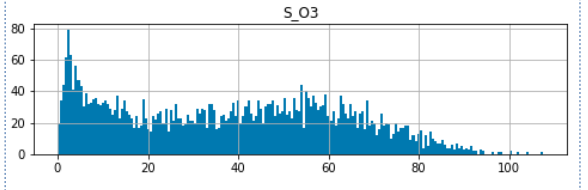

N_PM10K
0
25
50
75
100
0
20
40
60
80
100
120

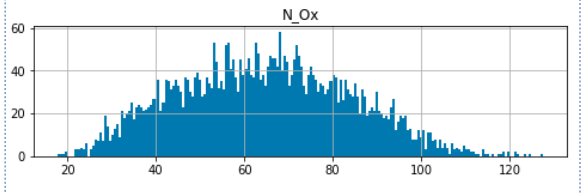

O_PM10K
0
25
50
75
100
0
20
40
60
80
100
120

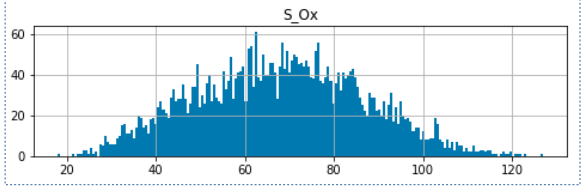

S_PM10K
0
25
50
75
100
0
20
40
60
80
100
120
140

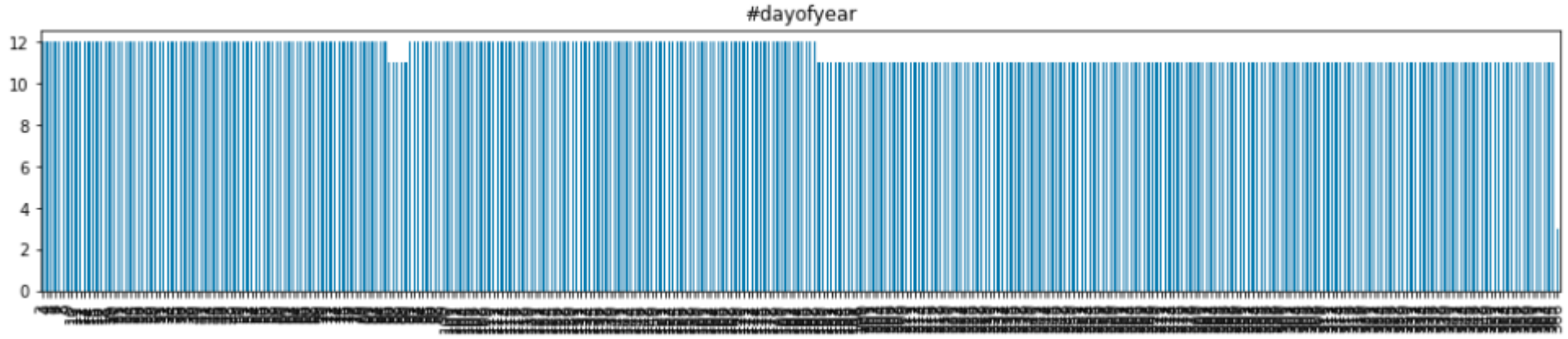

W_PM10K
0
25
50
75
100
0
20
40
60
80
100
120


N_O3
0
20
40
0
20
40
60
80
100
120


S_O3
0
20
40
60
80
0
20
40
60
80
100


N_Ox
0
20
40
60
20
40
60
80
100
120

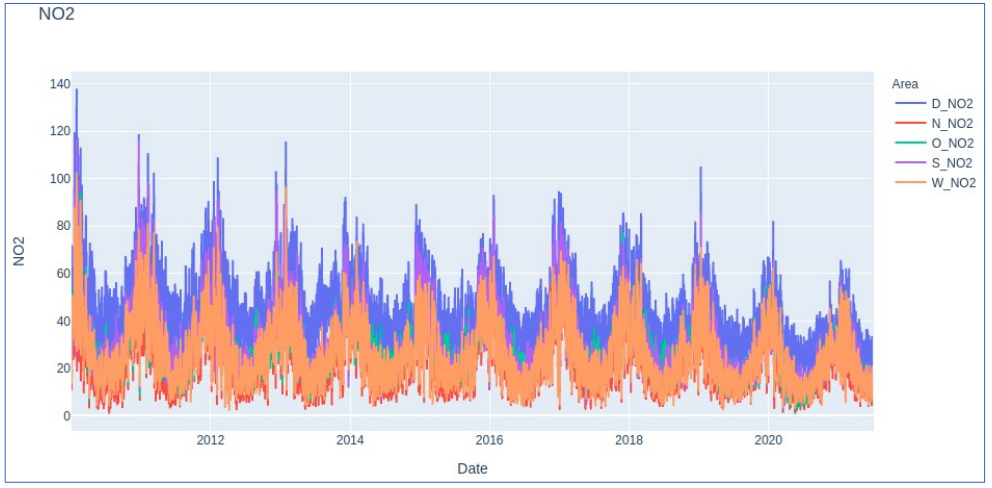

S_Ox
0
20
40
60
20
40
60
80
100
120

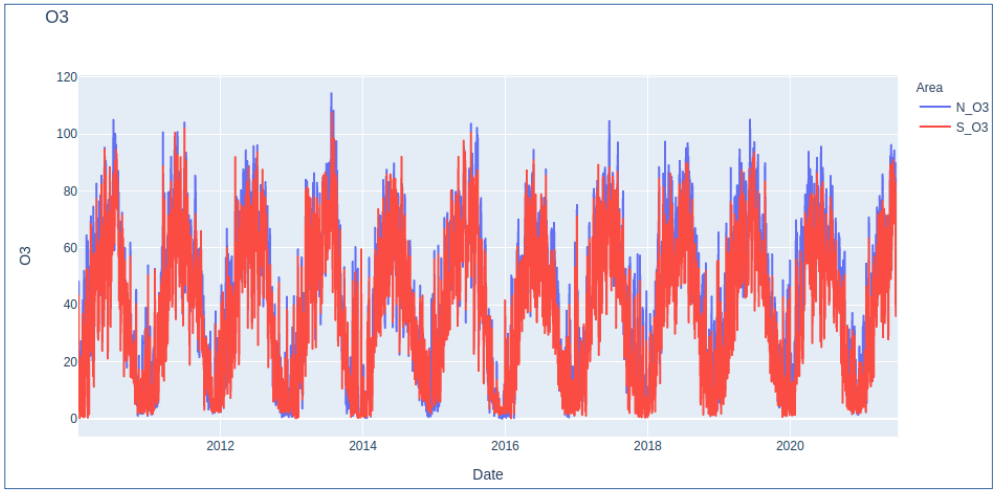


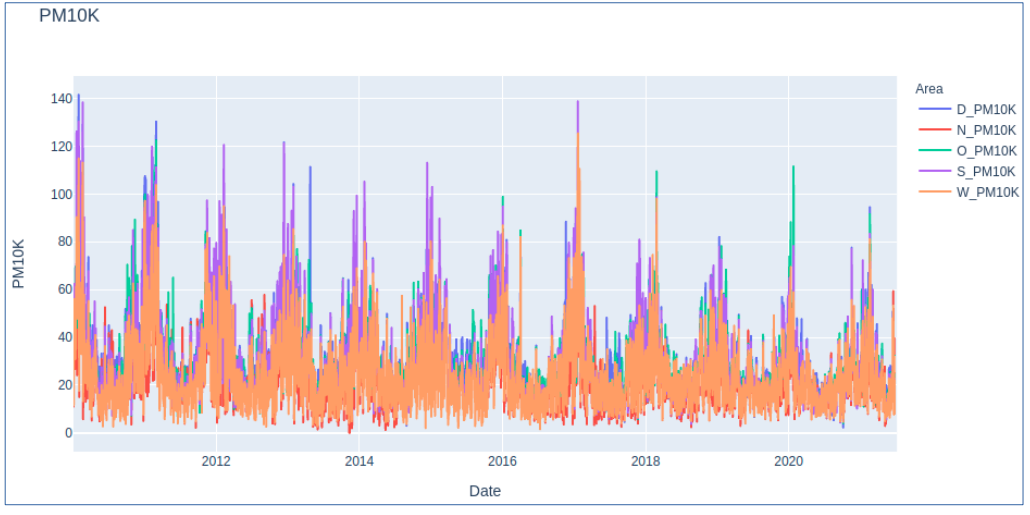

- 86 → 90 and 189 → 365: 11 days
- 366: 3 days
  → should or not put 29.02 as an extra instead of 366?

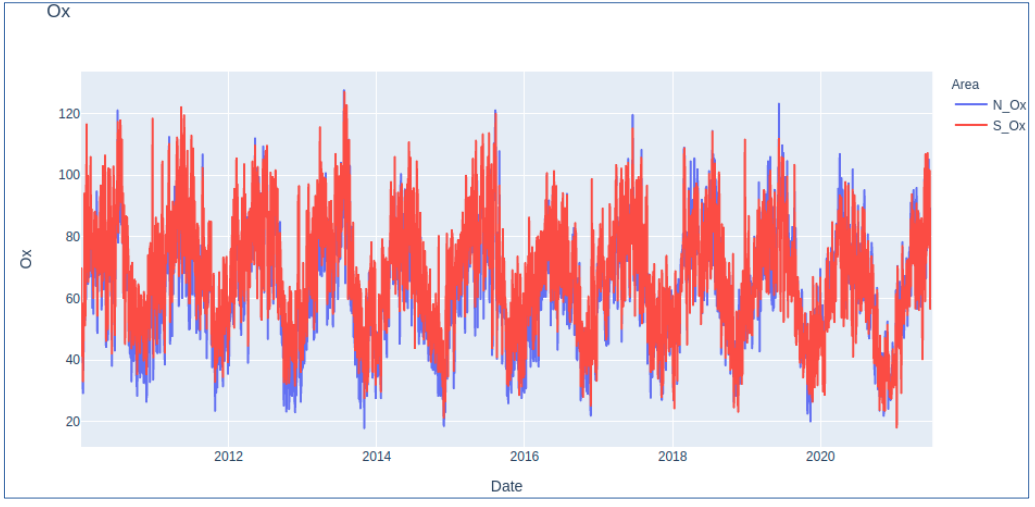
- Patterns throughout the years
- NO2 Peaks reduced since 2014

# All

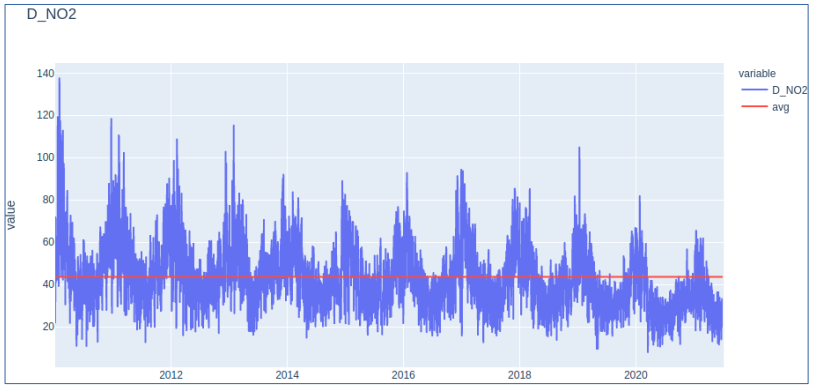


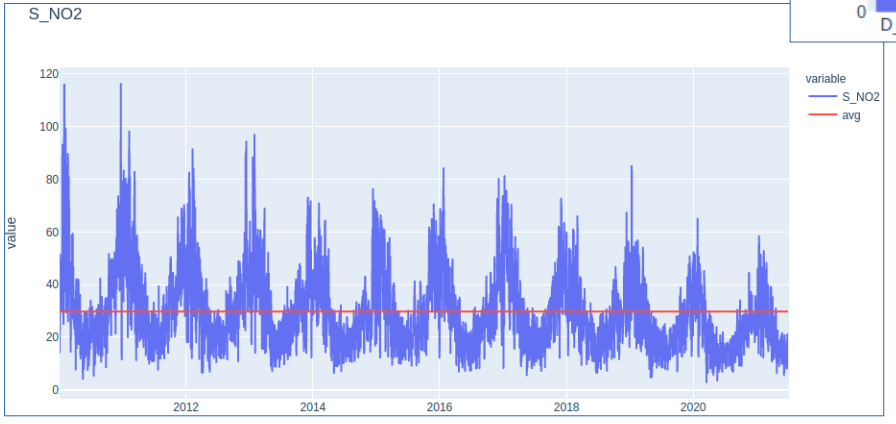



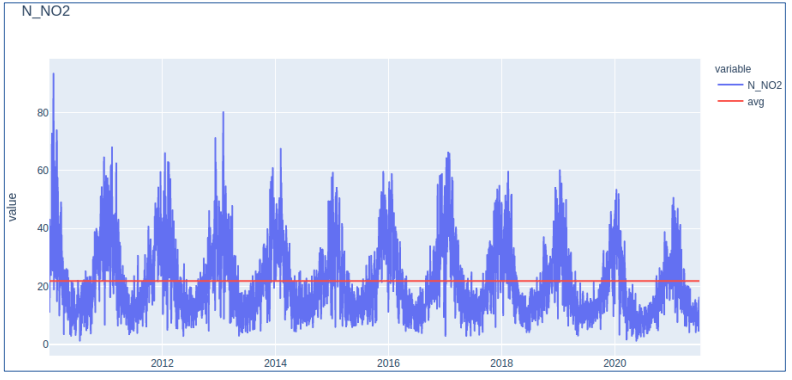



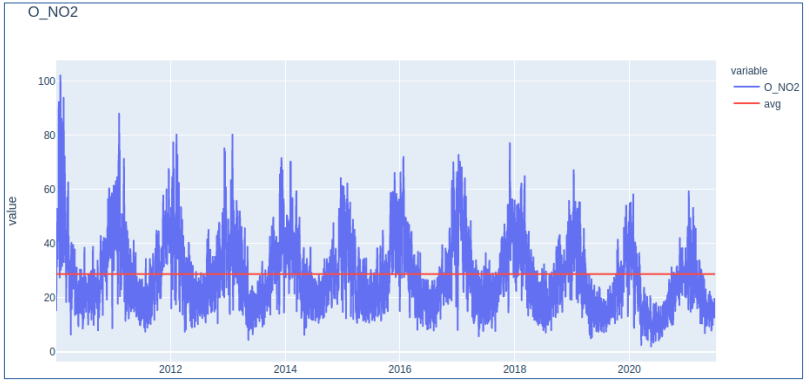
# All – NO2

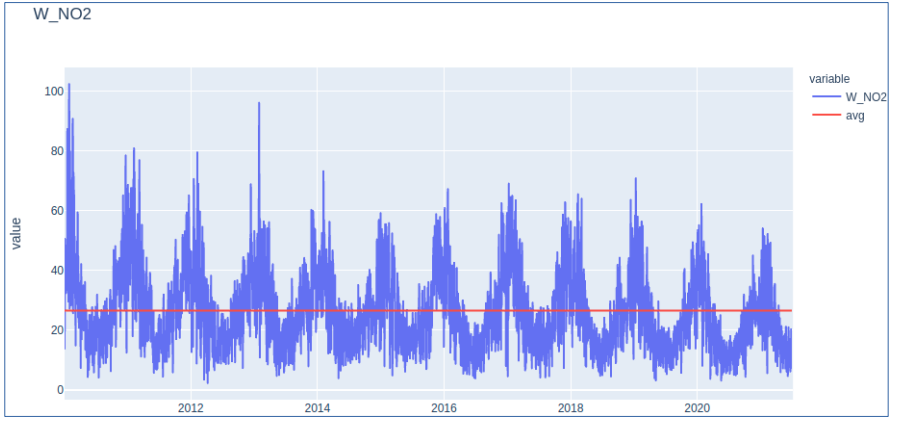

D_NO2
value
variable
D_NO2
avg
140
120
100
80
60
40
20
2012
2014
2016
2018
2020


NO2_Avg
43.6
21.8
28.8
29.8
26.6
40
30
20
10
0
D_NO2
N_NO2
O_NO2
S_NO2
W_NO2

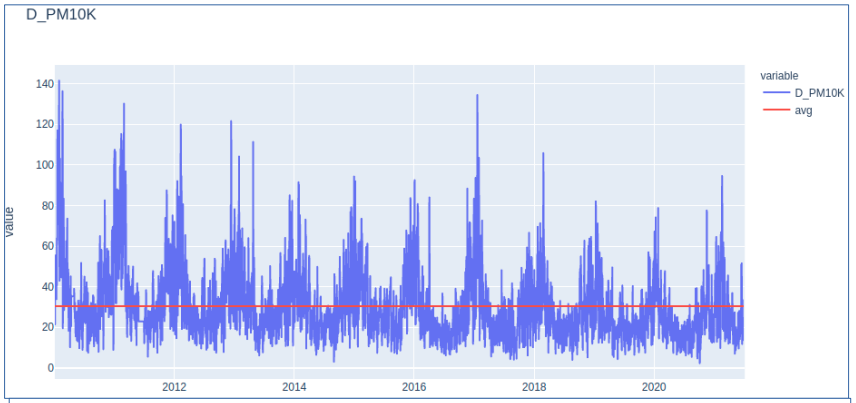

S_NO2
value
variable
S_NO2
avg
120
100
80
60
40
20
0
2012
2014
2016
2018
2020


N_NO2
value
variable
N_NO2
avg
80
60
40
20
0
2012
2014
2016
2018
2020

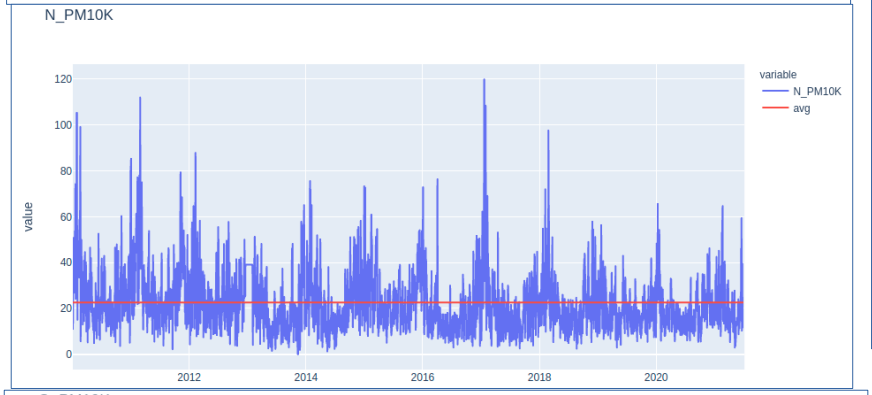

O_NO2
value
variable
O_NO2
avg
100
80
60
40
20
0
2012
2014
2016
2018
2020

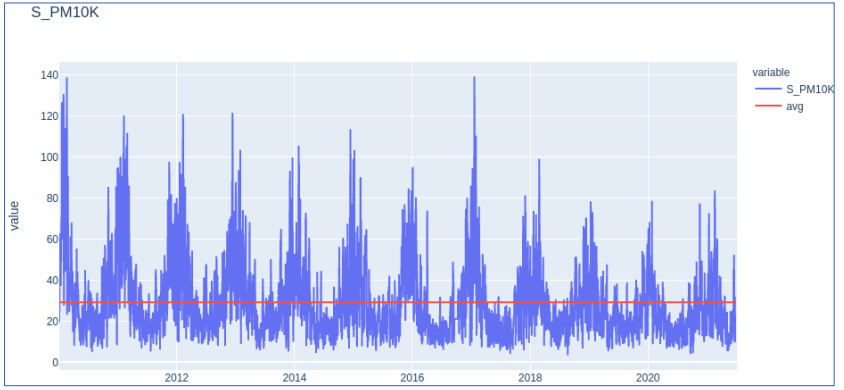

W_NO2
value
variable
W_NO2
avg
100
80
60
40
20
0
2012
2014
2016
2018
2020

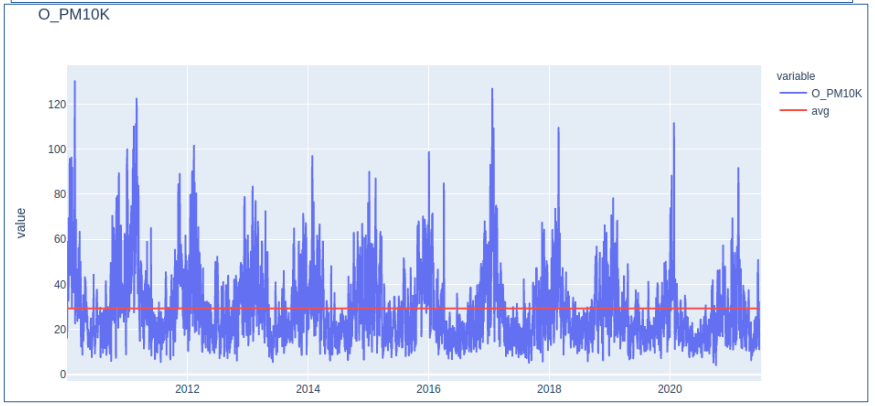
# PM10K

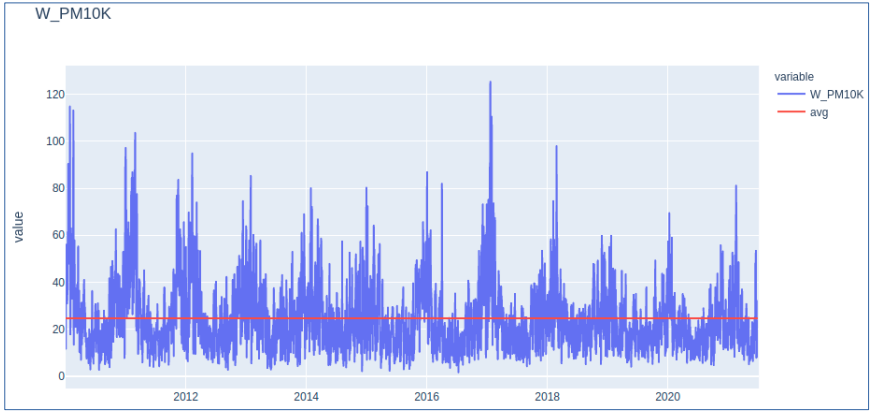

D_PM10K
value
variable
D_PM10K
avg
2012
2014
2016
2018
2020


PM10K_Avg
30.4
22.6
29.3
29.2
24.6
D_PM10K
N_PM10K
O_PM10K
S_PM10K
W_PM10K

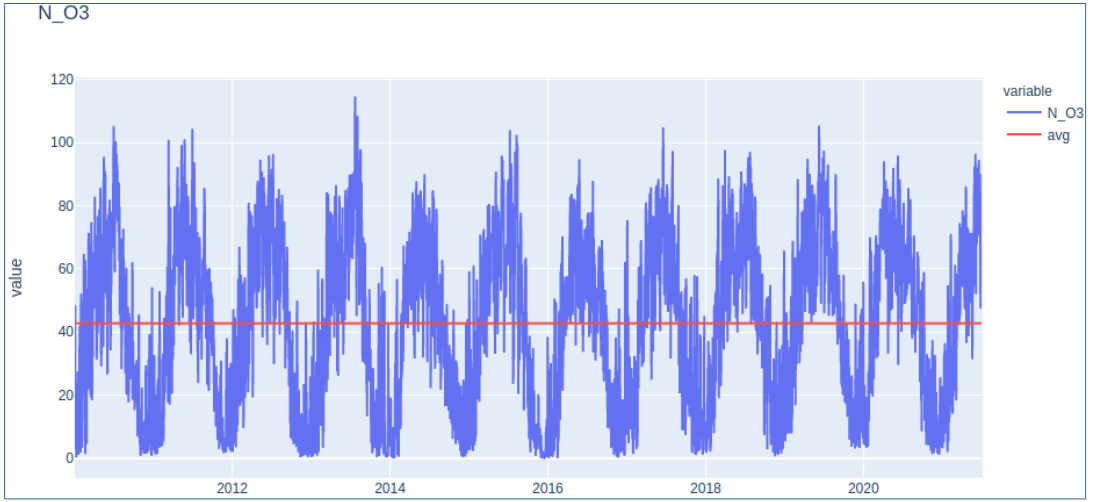

N_PM10K
value
variable
N_PM10K
avg
2012
2014
2016
2018
2020

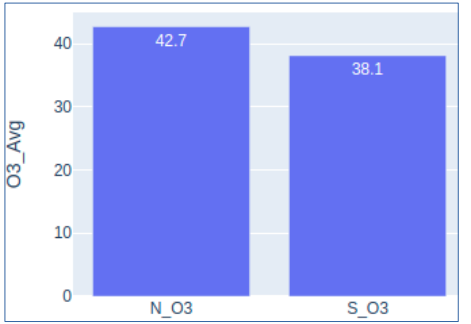

S_PM10K
value
variable
S_PM10K
avg
2012
2014
2016
2018
2020

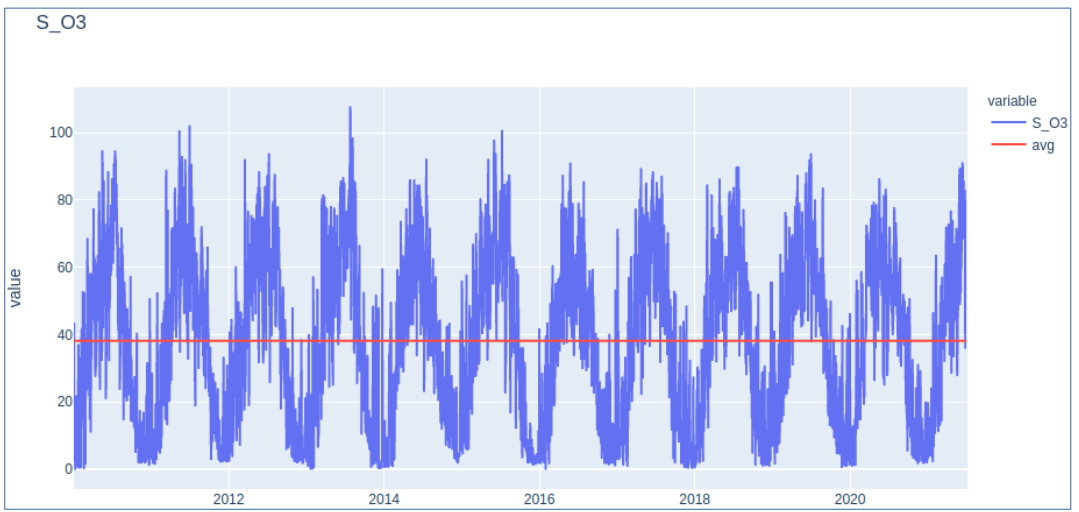

O_PM10K
value
variable
O_PM10K
avg
2012
2014
2016
2018
2020


W_PM10K
value
variable
W_PM10K
avg
2012
2014
2016
2018
2020

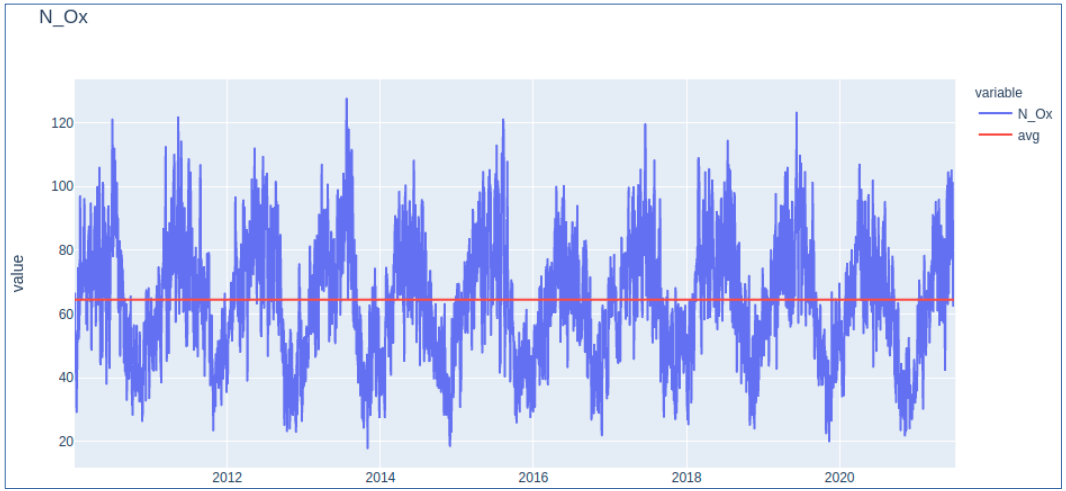
# O3

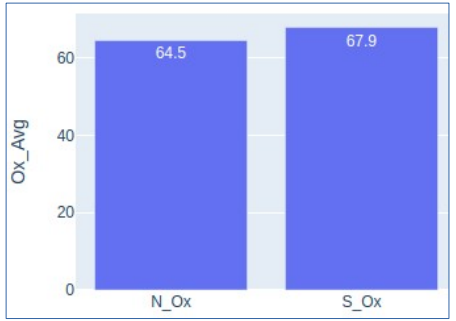

N_O3
value
variable
N_O3
avg
120
100
80
60
40
20
0
2012
2014
2016
2018
2020

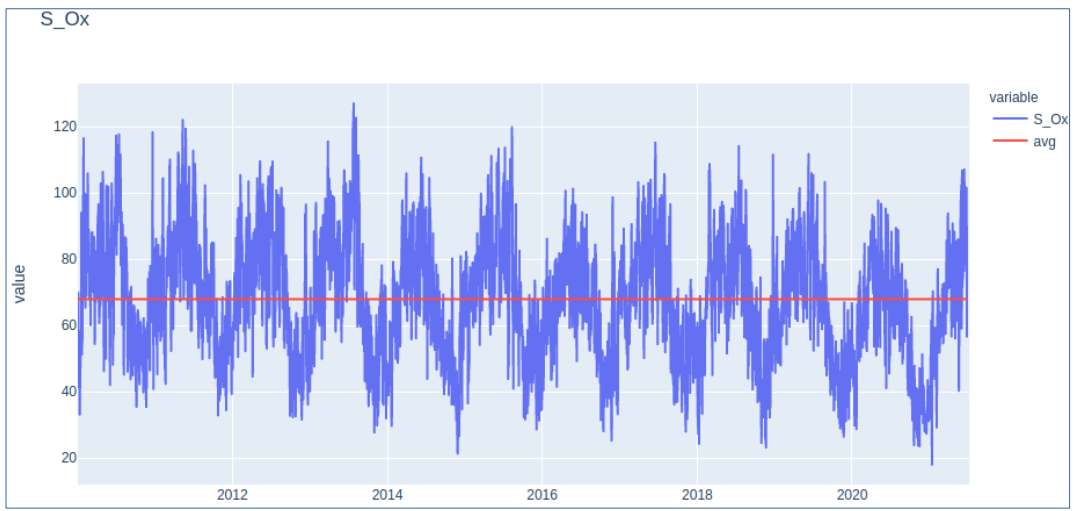

O3_Avg
42.7
38.1
40
30
20
10
0
N_O3
S_O3

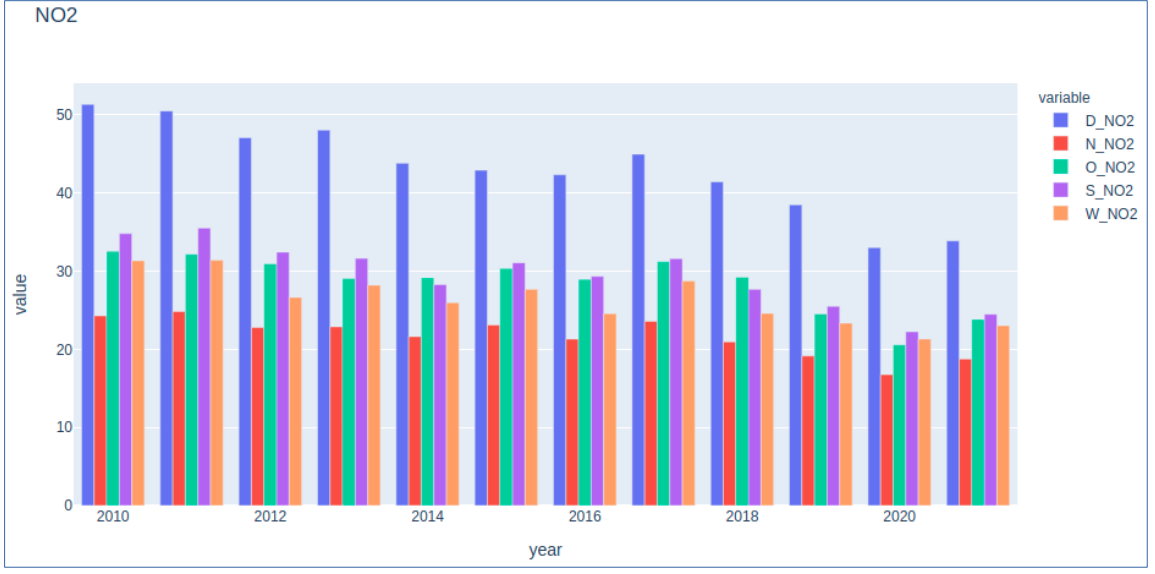

S_O3
value
variable
S_O3
avg
100
80
60
40
20
0
2012
2014
2016
2018
2020

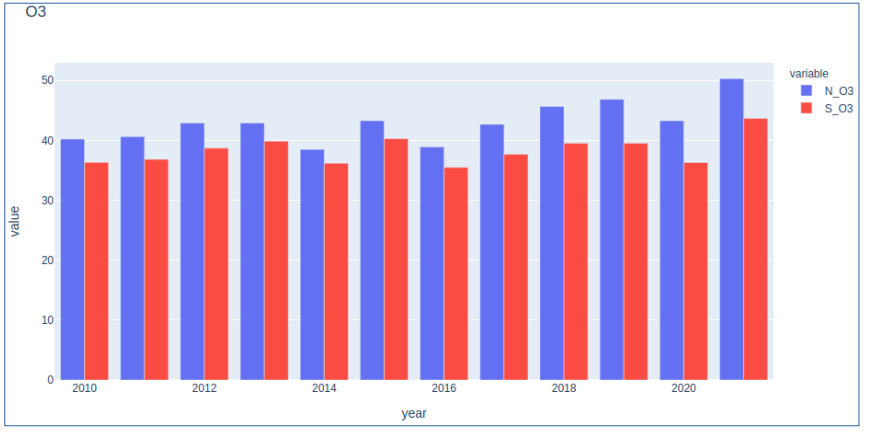
# Ox

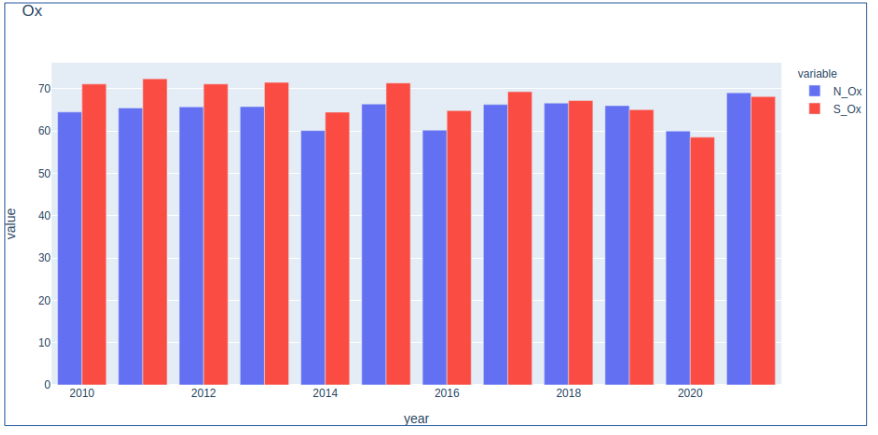

N_Ox
value
variable
N_Ox
avg
120
100
80
60
40
20
2012
2014
2016
2018
2020

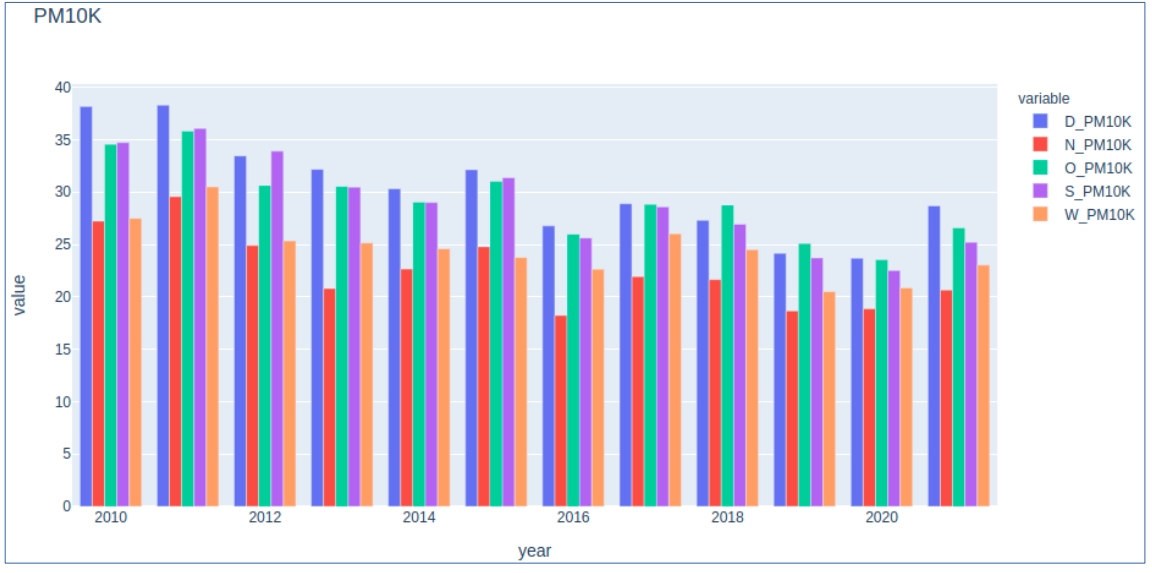

Ox_Avg
64.5
67.9
60
40
20
0
N_Ox
S_Ox


S_Ox
value
variable
S_Ox
avg
120
100
80
60
40
20
2012
2014
2016
2018
2020

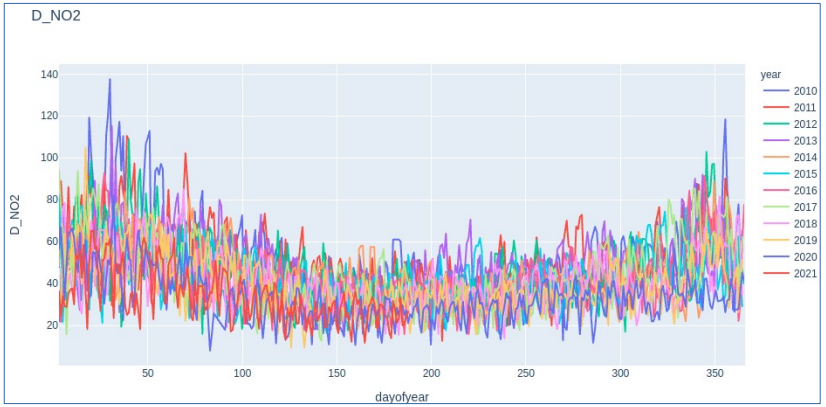

NO2
value
year
variable
D_NO2
N_NO2
O_NO2
S_NO2
W_NO2

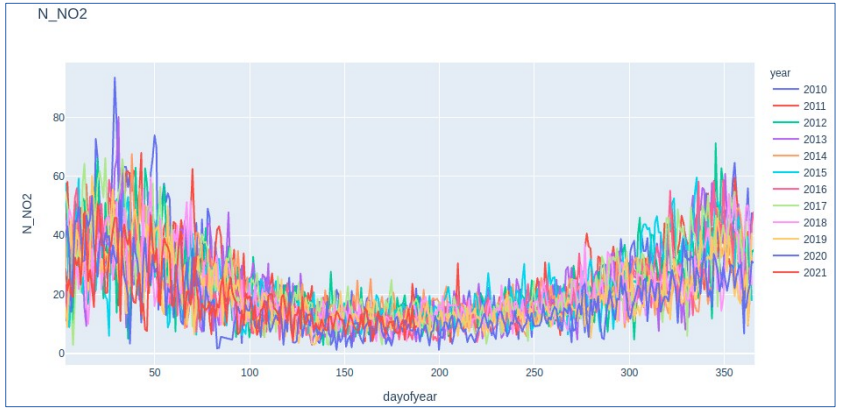

O3
value
year
variable
N_O3
S_O3

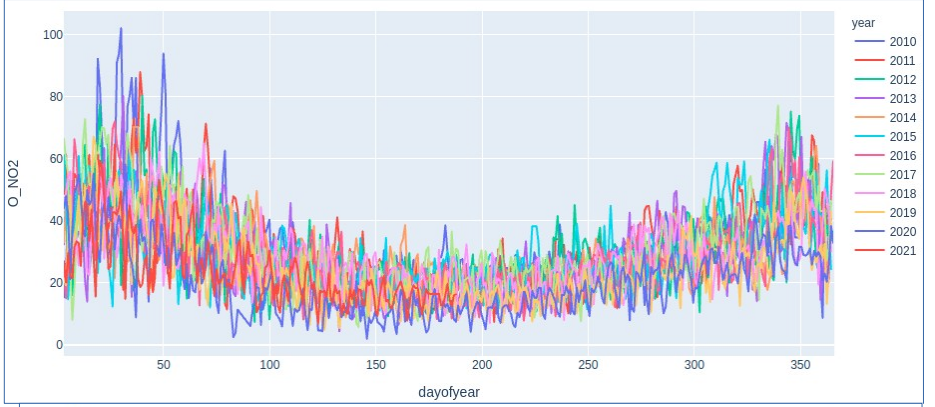

Ox
value
year
variable
N_Ox
S_Ox

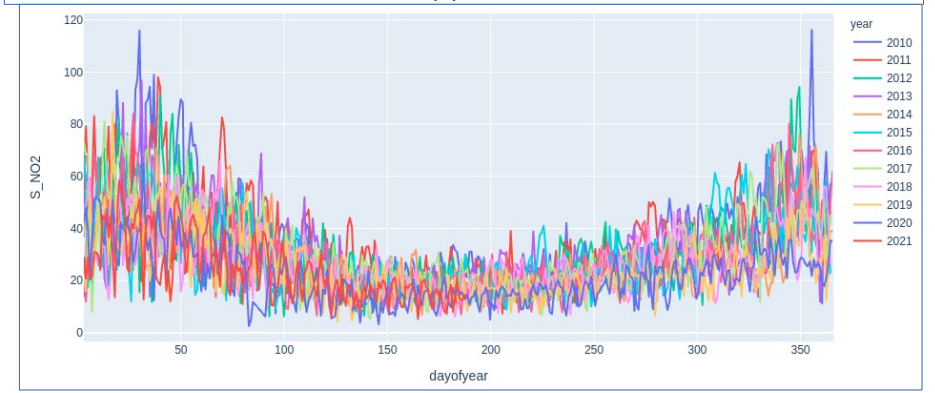

PM10K
value
year
variable
D_PM10K
N_PM10K
O_PM10K
S_PM10K
W_PM10K

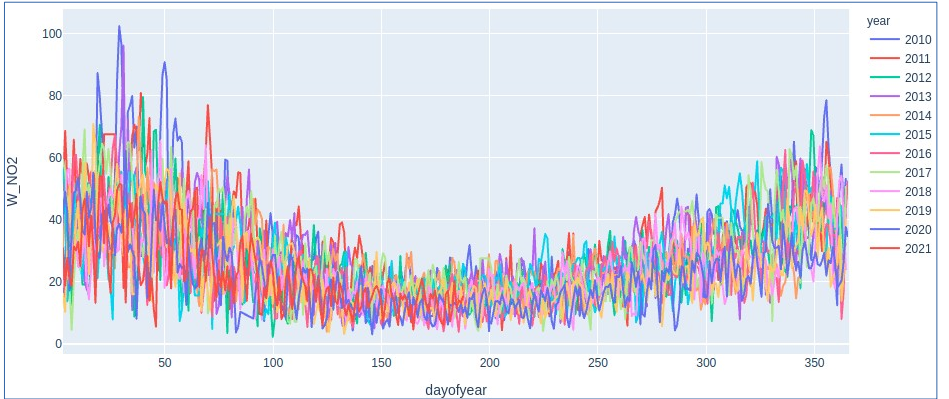
# Yearly – NO2


D_NO2
D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

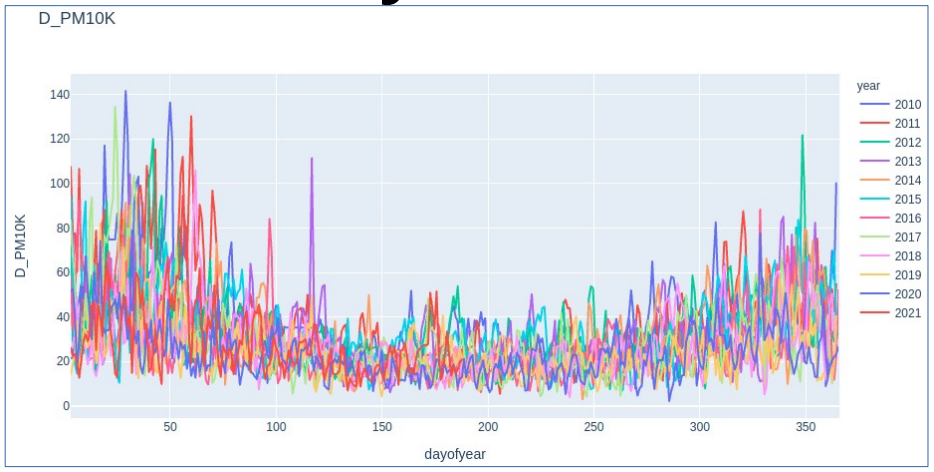

N_NO2
N_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

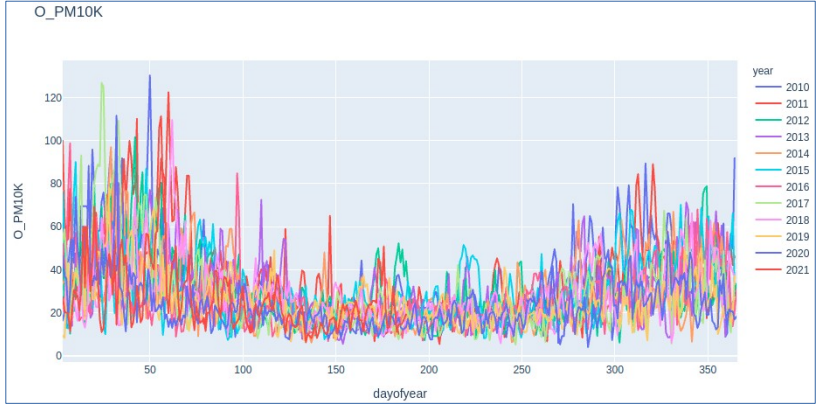

O_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

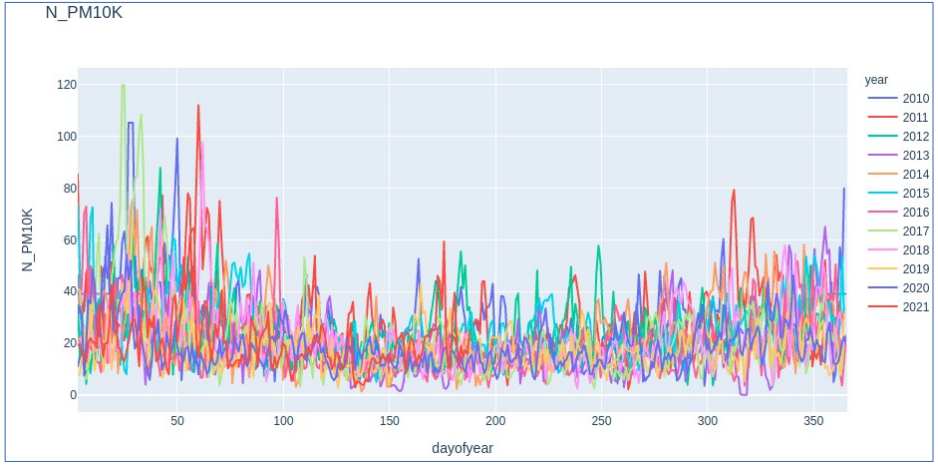

S_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

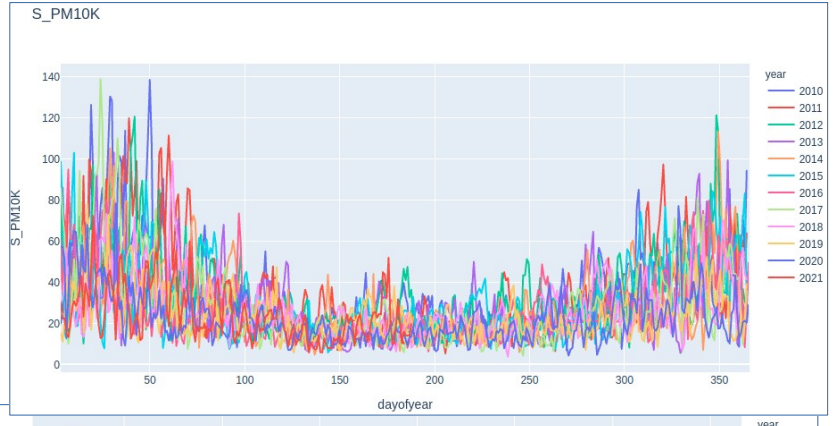

W_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

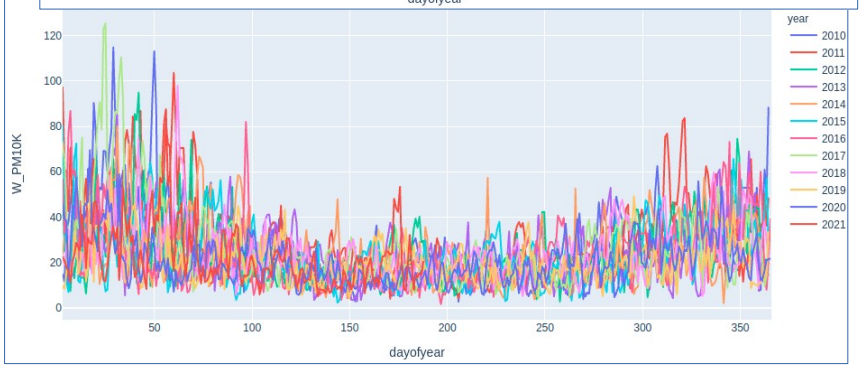
# Yearly – PM10K



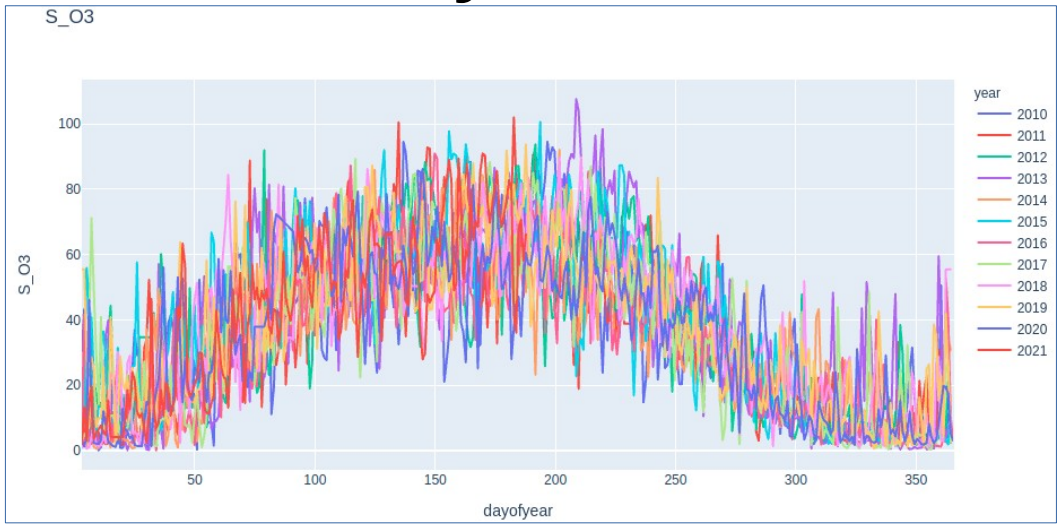



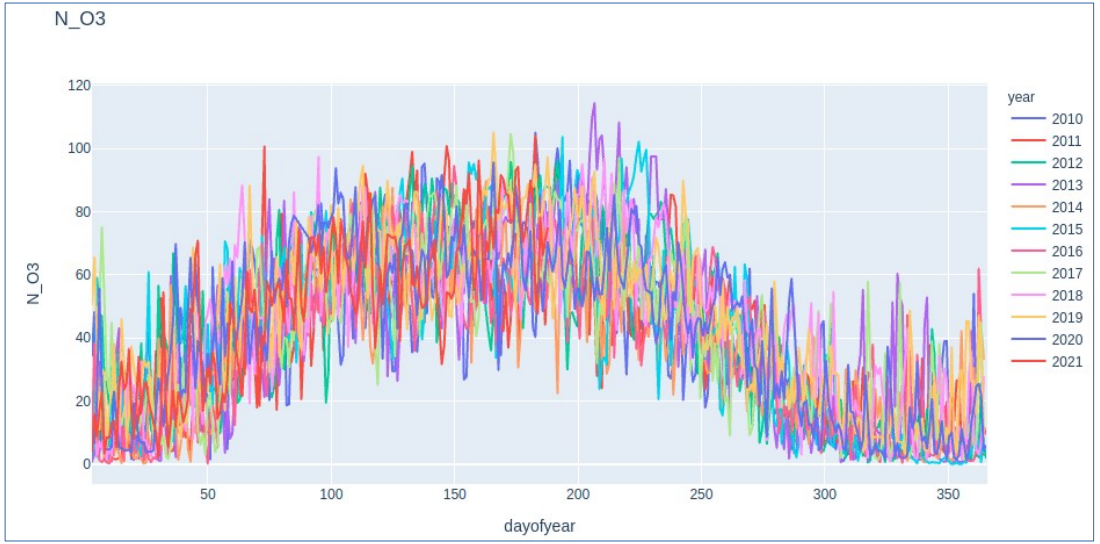



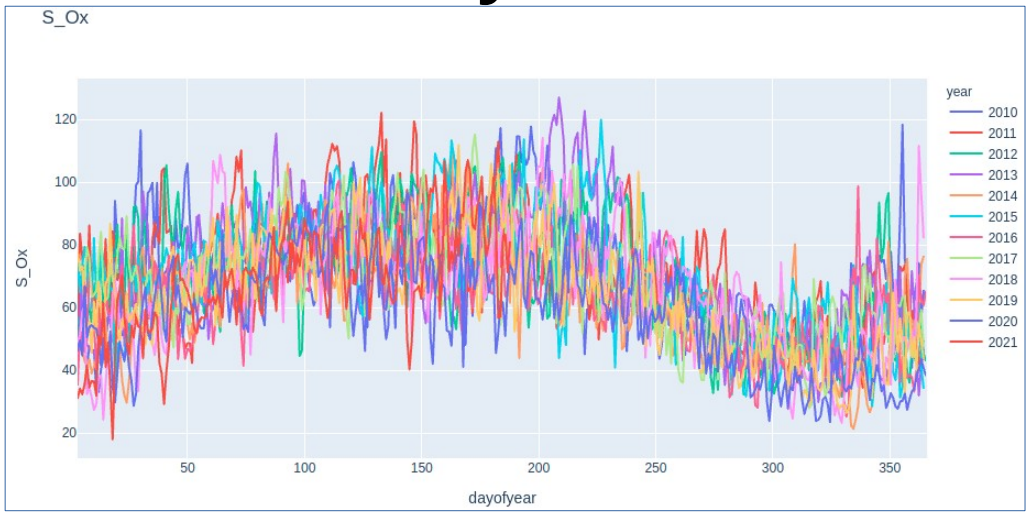



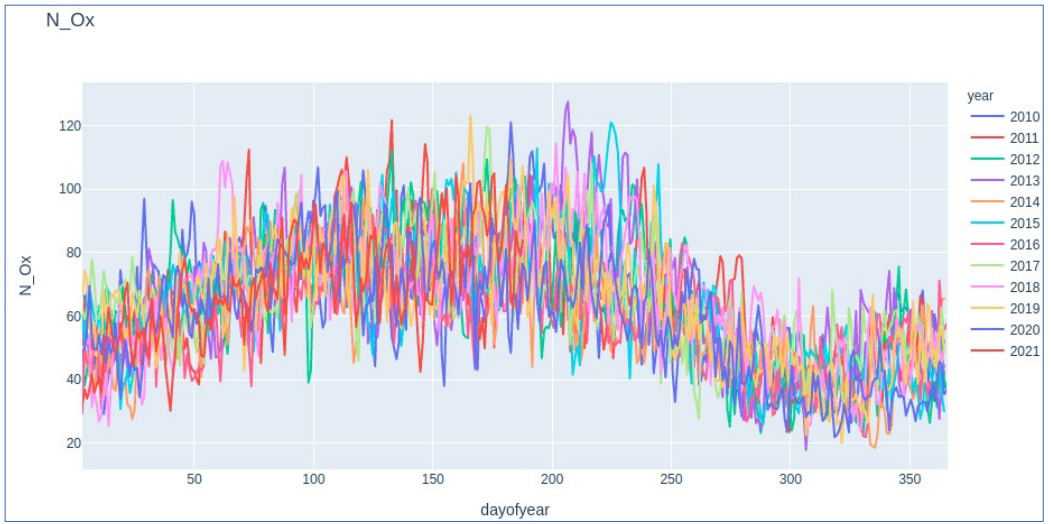
# Yearly – O3


S_O3
S_O3
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

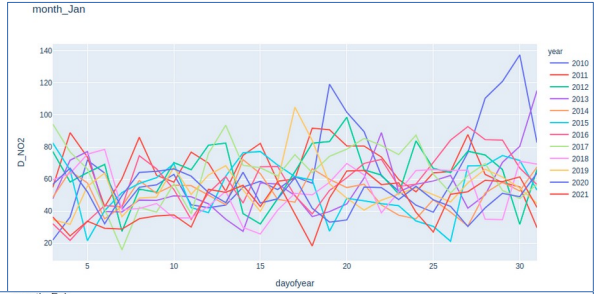

N_O3
N_O3
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

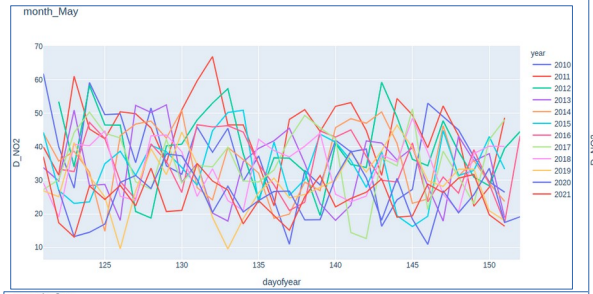
# Yearly – Ox


S_Ox
S_Ox
120
100
80
60
40
20
50
100
150
200
250
300
350
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

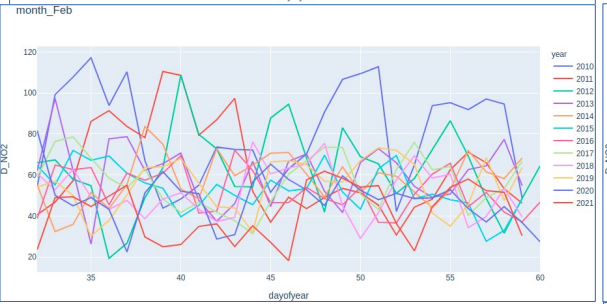

N_Ox
N_Ox
120
100
80
60
40
20
50
100
150
200
250
300
350
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

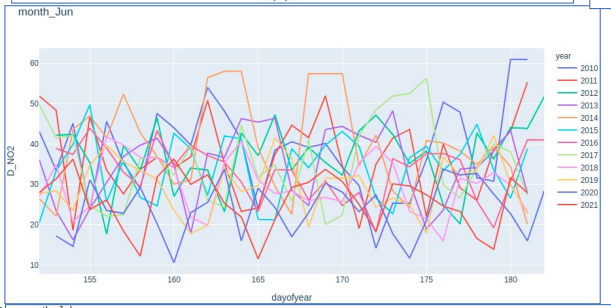
# Monthly – NO2

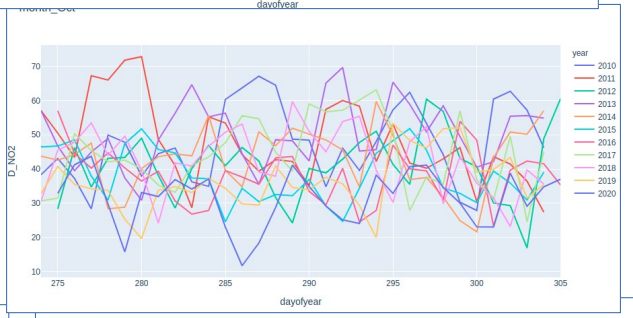

month_Jan
D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

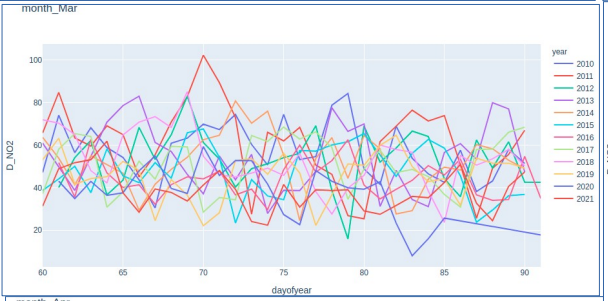

month_May
D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021


month_Sep
D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

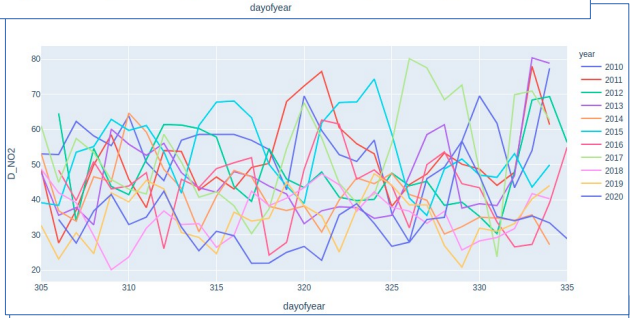

month_Feb
D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021


month_Jun
D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021

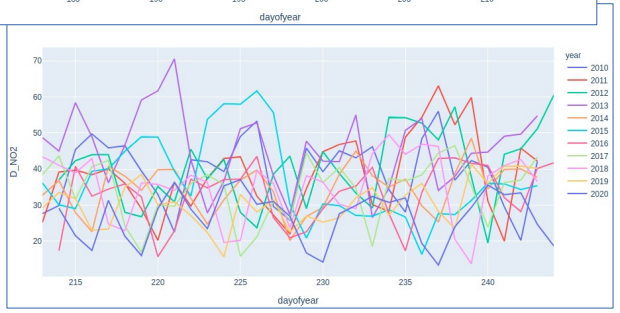

D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


month_Mar
D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021


month_Jul
D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021


D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


month_Apr
D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021


D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

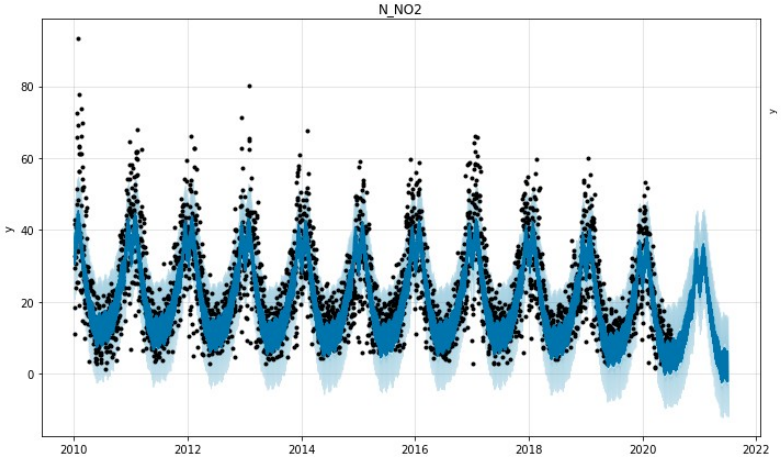

D_NO2
dayofyear
year
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

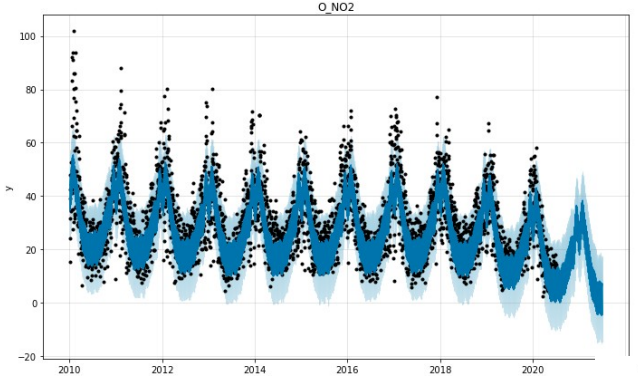
# Summary

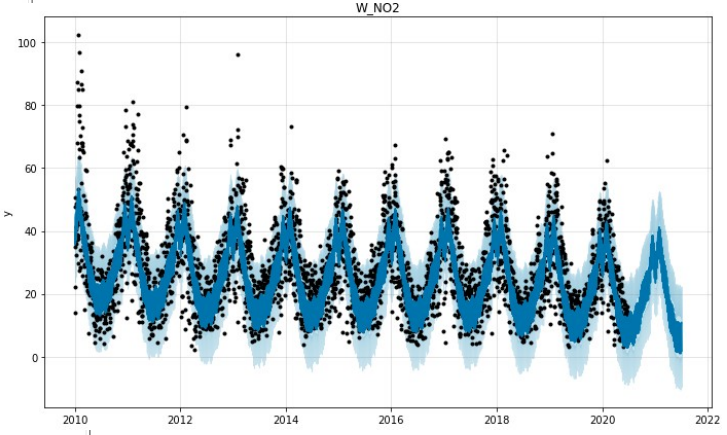
# Prophet – NO2

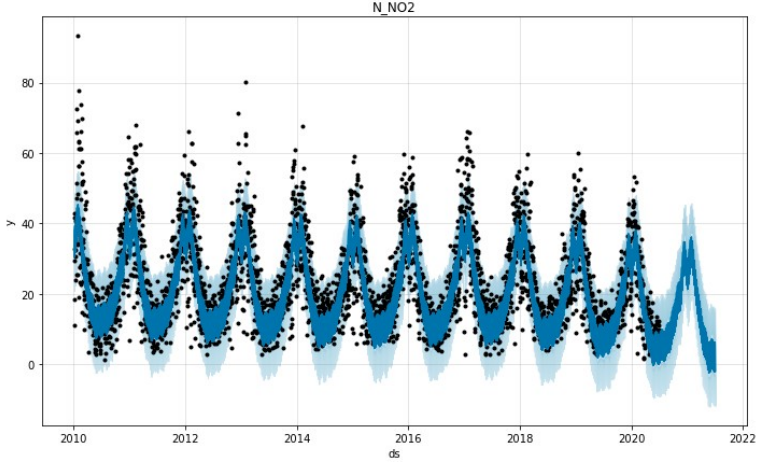
1 year prediction

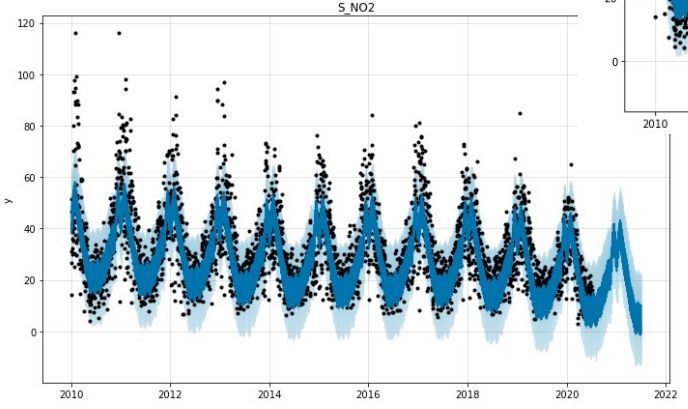
| | D_NO2 | N_NO2 | O_NO2 | S_NO2 | W_NO2 |
|---|---|---|---|---|---|
| RMSE | 7.584696 | 6.229241 | 8.33146 | 7.404700 | 6.978748 |
| MAE | 5.996124 | 4.824166 | 6.78993 | 5.872394 | 5.388518 |



# Prophet – Baseline

## 1 year

| | D_NO2 | N_NO2 | O_NO2 | S_NO2 | W_NO2 |
|---|---|---|---|---|---|
| RMSE | 7.58 | 6.23 | 8.33 | 7.40 | 6.98 |
| MAE | 6.00 | 4.82 | 6.79 | 5.87 | 5.39 |

| | D_PM10K | N_PM10K | O_PM10K | S_PM10K | W_PM10K |
|---|---|---|---|---|---|
| RMSE | 12.16 | 9.65 | 11.75 | 12.61 | 11.22 |
| MAE | 8.96 | 7.09 | 8.84 | 9.44 | 8.21 |

| | N_O3 | S_O3 |
|---|---|---|
| RMSE | 13.39 | 11.40 |
| MAE | 11.06 | 9.14 |

| | N_Ox | S_Ox |
|---|---|---|
| RMSE | 11.54 | 11.55 |
| MAE | 9.56 | 9.17 |

## LD#1

| | D_NO2 | N_NO2 | O_NO2 | S_NO2 | W_NO2 |
|---|---|---|---|---|---|
| RMSE | 9.64 | 5.82 | 6.93 | 7.37 | 7.39 |
| MAE | 7.04 | 4.23 | 5.19 | 5.15 | 5.66 |

| | D_PM10K | N_PM10K | O_PM10K | S_PM10K | W_PM10K |
|---|---|---|---|---|---|
| RMSE | 7.59 | 6.39 | 6.16 | 7.85 | 7.76 |
| MAE | 6.47 | 5.19 | 4.93 | 6.62 | 6.55 |

| | N_O3 | S_O3 |
|---|---|---|
| RMSE | 12.84 | 12.93 |
| MAE | 10.71 | 10.71 |

| | N_Ox | S_Ox |
|---|---|---|
| RMSE | 11.65 | 10.83 |
| MAE | 9.62 | 8.96 |

## LD#2

| | D_NO2 | N_NO2 | O_NO2 | S_NO2 | W_NO2 |
|---|---|---|---|---|---|
| RMSE | 8.03 | 5.87 | 6.56 | 6.23 | 7.05 |
| MAE | 6.56 | 4.45 | 5.28 | 4.61 | 5.41 |

| | D_PM10K | N_PM10K | O_PM10K | S_PM10K | W_PM10K |
|---|---|---|---|---|---|
| RMSE | 11.56 | 8.71 | 9.59 | 13.12 | 10.18 |
| MAE | 7.79 | 6.32 | 7.60 | 9.41 | 7.54 |

| | N_O3 | S_O3 |
|---|---|---|
| RMSE | 10.50 | 8.2 |
| MAE | 8.97 | 6.4 |

| | N_Ox | S_Ox |
|---|---|---|
| RMSE | 7.12 | 6.53 |
| MAE | 5.91 | 5.61 |

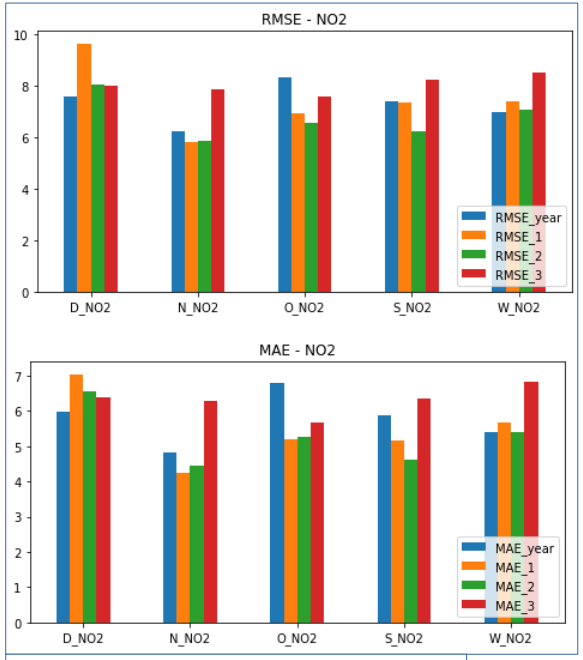
## LD#3

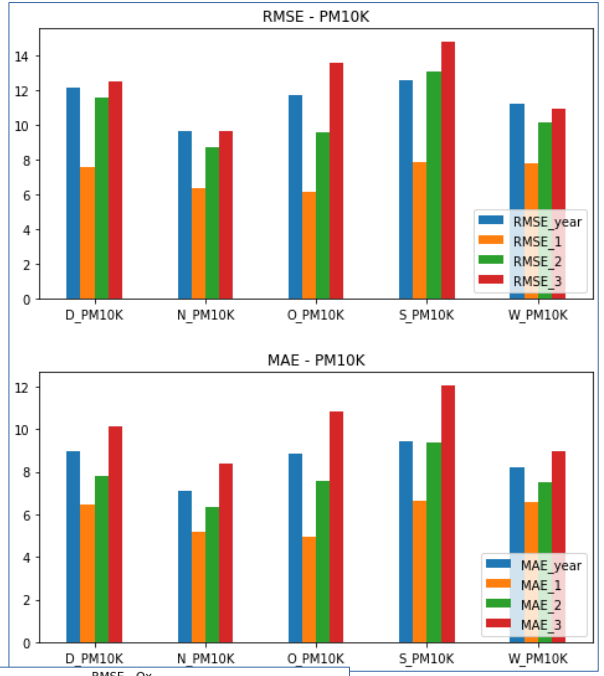
| | D_NO2 | N_NO2 | O_NO2 | S_NO2 | W_NO2 |
|---|---|---|---|---|---|
| RMSE | 8.00 | 7.86 | 7.57 | 8.22 | 8.52 |
| MAE | 6.39 | 6.28 | 5.67 | 6.34 | 6.82 |

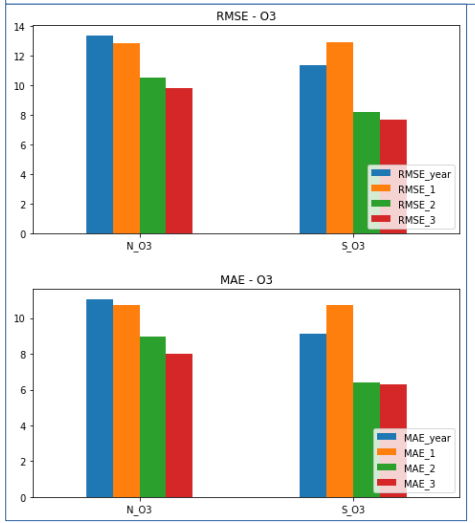
| | D_PM10K | N_PM10K | O_PM10K | S_PM10K | W_PM10K |
|---|---|---|---|---|---|
| RMSE | 12.49 | 9.68 | 13.59 | 14.81 | 10.95 |
| MAE | 10.12 | 8.37 | 10.82 | 12.07 | 8.96 |

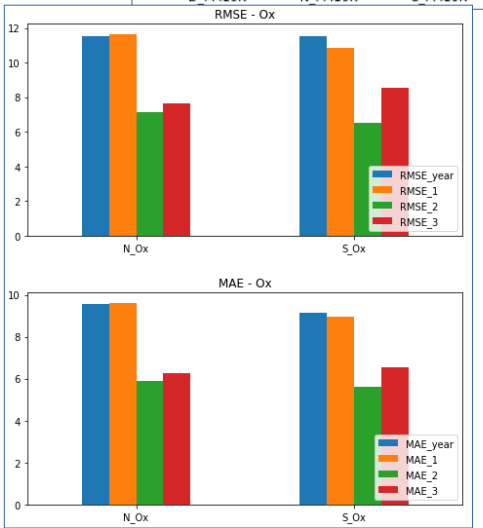
| | N_O3 | S_O3 |
|---|---|---|
| RMSE | 9.80 | 7.70 |
| MAE | 7.99 | 6.31 |

| | N_Ox | S_Ox |
|---|---|---|
| RMSE | 7.63 | 8.56 |
| MAE | 6.25 | 6.55 |



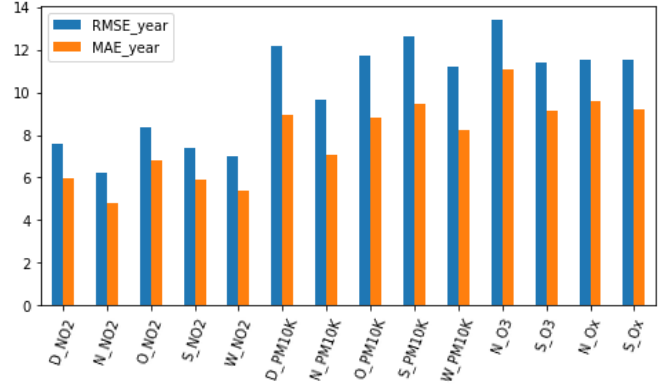



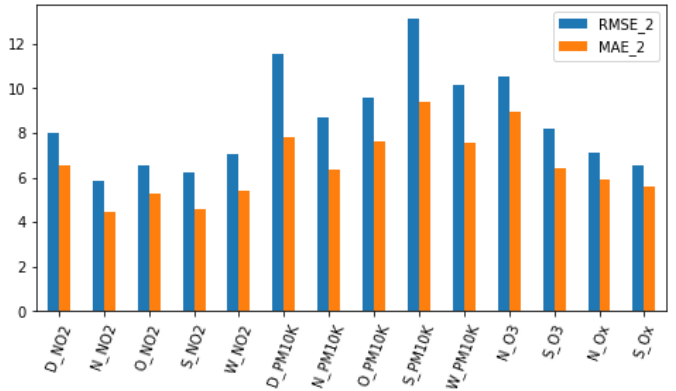



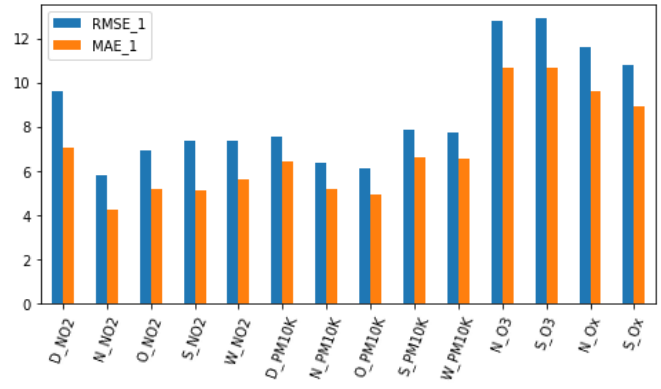



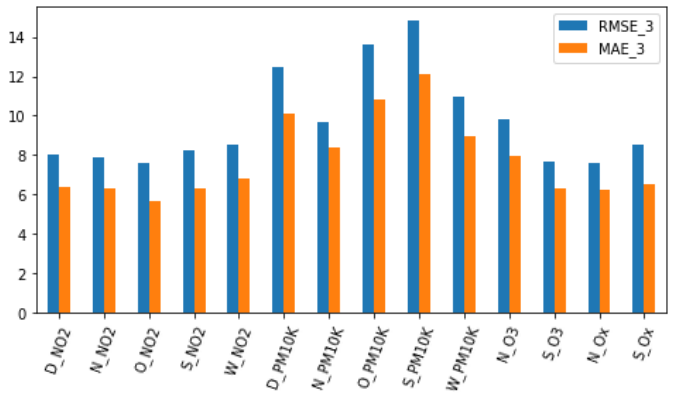

| | #days |
|---|---|
| LD1 | 54 |
| LD2 | 34 |
| LD3 | 44 |

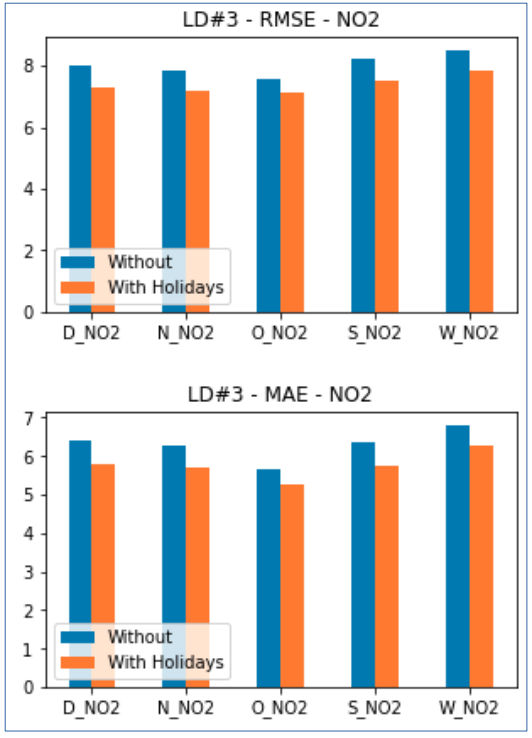
1. PM10: Lowest error in the 1st LD, highest in the last
2. Wheras O3 and Ox got high error in the 1st LD
3. Errors in O3 and Ox are reduced in 2 last lockdowns


RMSE_year
MAE_year
D_NO2
N_NO2
O_NO2
S_NO2
W_NO2
D_PM10K
N_PM10K
O_PM10K
S_PM10K
W_PM10K
N_O3
S_O3
N_Ox
S_Ox


RMSE_2
MAE_2
D_NO2
N_NO2
O_NO2
S_NO2
W_NO2
D_PM10K
N_PM10K
O_PM10K
S_PM10K
W_PM10K
N_O3
S_O3
N_Ox
S_Ox

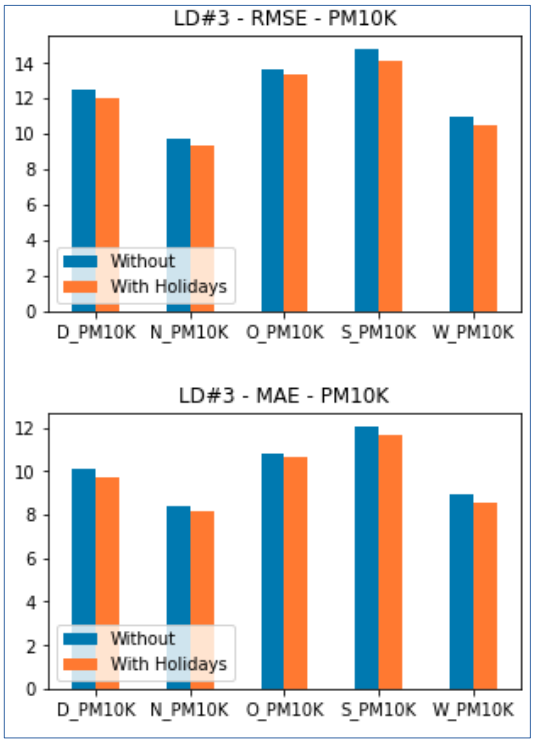

RMSE_1
MAE_1
D_NO2
N_NO2
O_NO2
S_NO2
W_NO2
D_PM10K
N_PM10K
O_PM10K
S_PM10K
W_PM10K
N_O3
S_O3
N_Ox
S_Ox


RMSE_3
MAE_3
D_NO2
N_NO2
O_NO2
S_NO2
W_NO2
D_PM10K
N_PM10K
O_PM10K
S_PM10K
W_PM10K
N_O3
S_O3
N_Ox
S_Ox



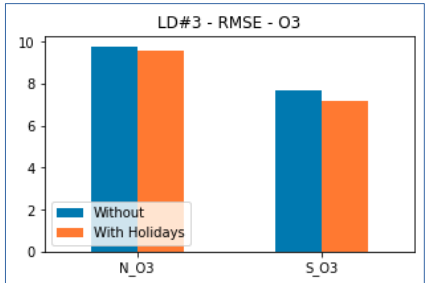


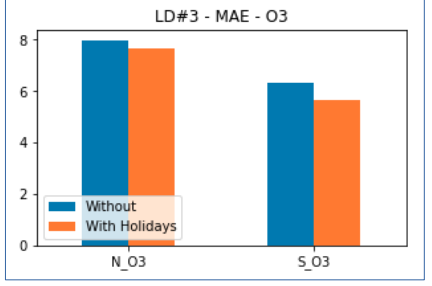


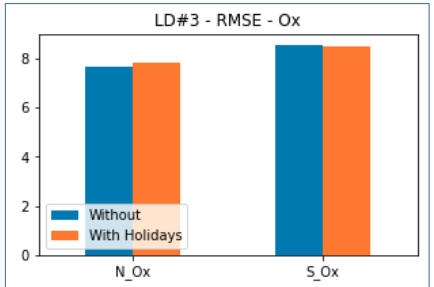


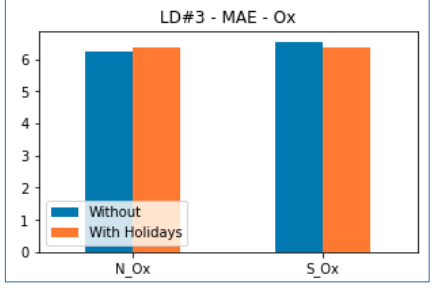






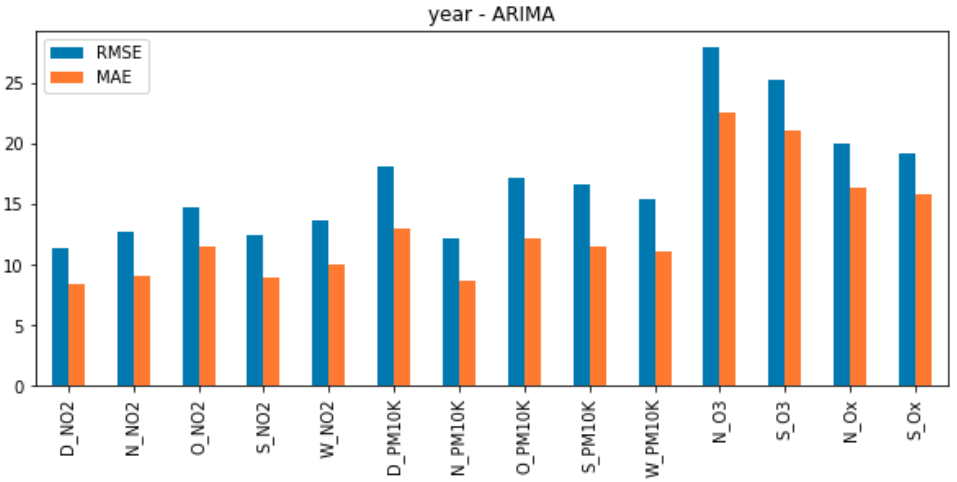



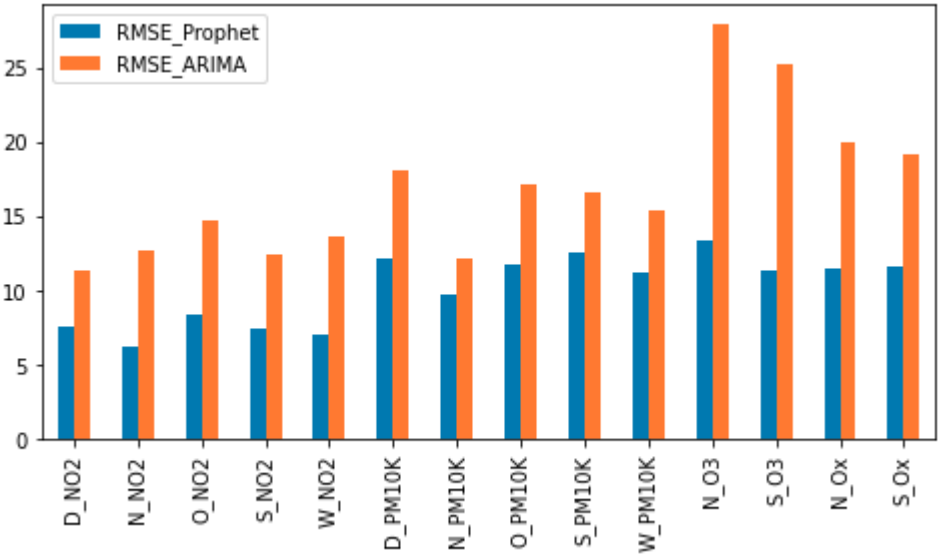



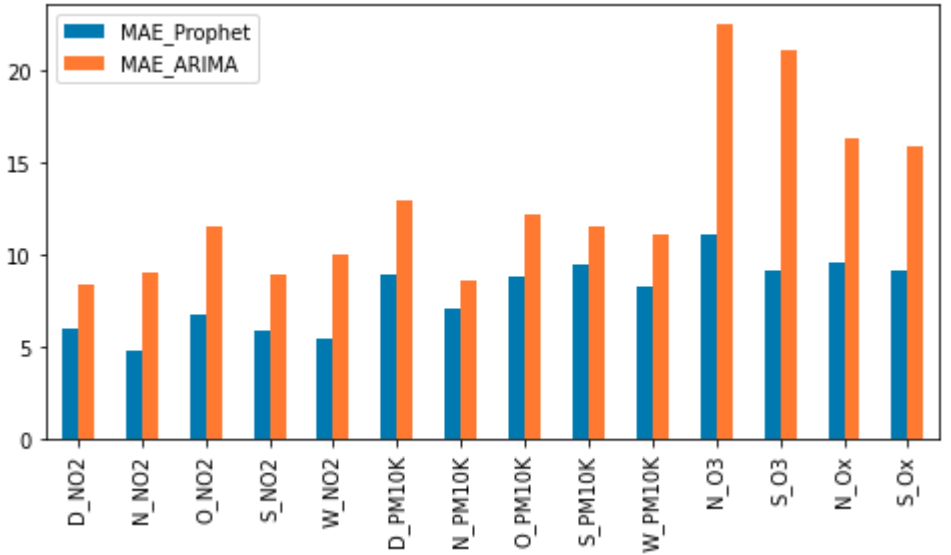

With holidays, LD3 is improved

# ARIMA


year - ARIMA
RMSE
MAE
25
20
15
10
5
0
D_NO2
N_NO2
O_NO2
S_NO2
W_NO2
D_PM10K
N_PM10K
O_PM10K
S_PM10K
W_PM10K
N_O3
S_O3
N_Ox
S_Ox

# 1 year: Prophet vs. ARIMA



Thank you!