

Pollution Analysis

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Introduction

This presentation is a follow up for the analysis of the Pollution dataset provided by West Bengal Pollution Control Board (WBPCB) and Central Pollution Control Board (CPCB), which contains the measurement of PM10 (Particular Matter), SO_2 (Sulphar dioxide) and NO_2 (Nitrogen dioxide), measured at the rooftop of Asansol Municipal Corporation. The dataset consists of irregularly spaced measurement of the above from January, 2005 to December, 2011 and from October, 2012 to January, 2017. Therefore, there are some **missing data** between January, 2012 to September, 2012, about 9 months.

PART - 1: PM10

About PM10

Particulate matter or PM, is a mixture of solids and liquid droplets floating in the air. Some particles are released directly from a specific source, while others form in complicated chemical reactions in the atmosphere. Particles come in a wide range of sizes. PM10 is particulate matter of 10 micrometers or less in diameter.

The Air quality standards for concentration of PM10 in the air suggests a regulation level of **100** microgram per cubic meter, as specified in https:

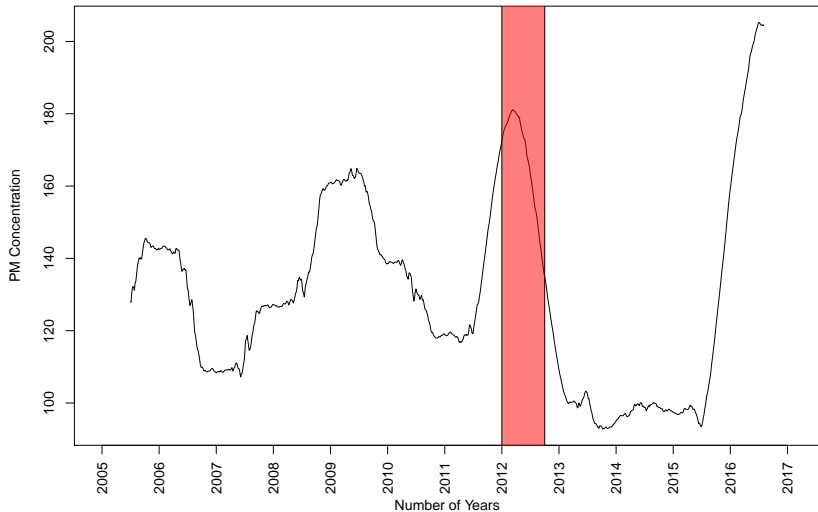
[//www.transportpolicy.net/standard/india-air-quality-standards/](https://www.transportpolicy.net/standard/india-air-quality-standards/) .

About the Data

The processed dataset contains the measurements of PM10 concentration in the air during 3 shifts in a day. In each week of each month, the concentration was measured for 3 different shifts on 2 randomly chosen days. Rather than containing the date, it contains the number of days passed from first measurement, which is a bit easier to work with.

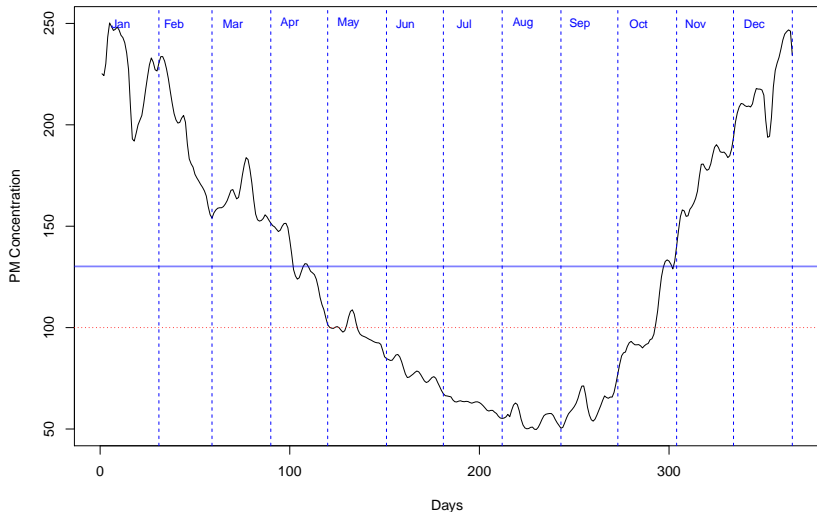
	DateTime	PM.Values	ShiftTime
1	0.0000000	151	1
2	0.3333333	266	2
3	0.6666667	221	3
4	3.0000000	179	1
5	3.3333333	196	2
6	3.6666667	209	3
7	6.0000000	156	1

Time vs Year to Year PM10 Concentration



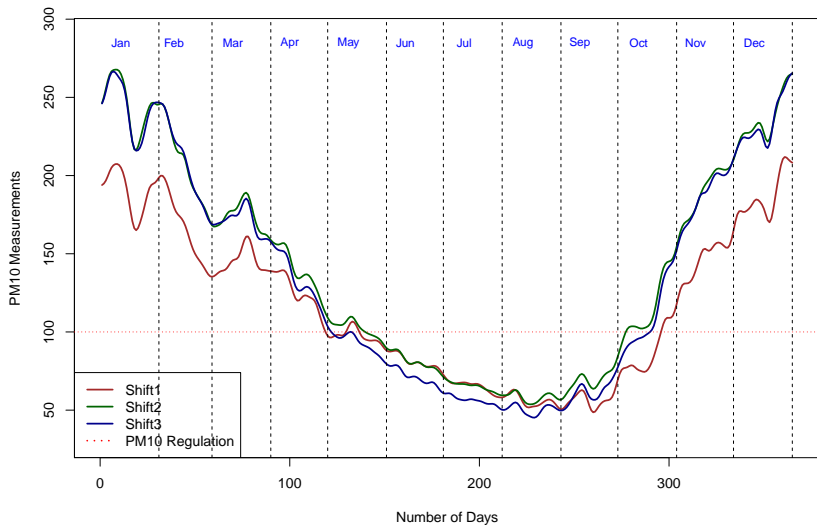
The general trend of PM10 concentration shows an increment and decrement over the course of different years. The peaks on this cyclical variations seems to be increasing.

Average PM10 Concentration on different Days of the Year



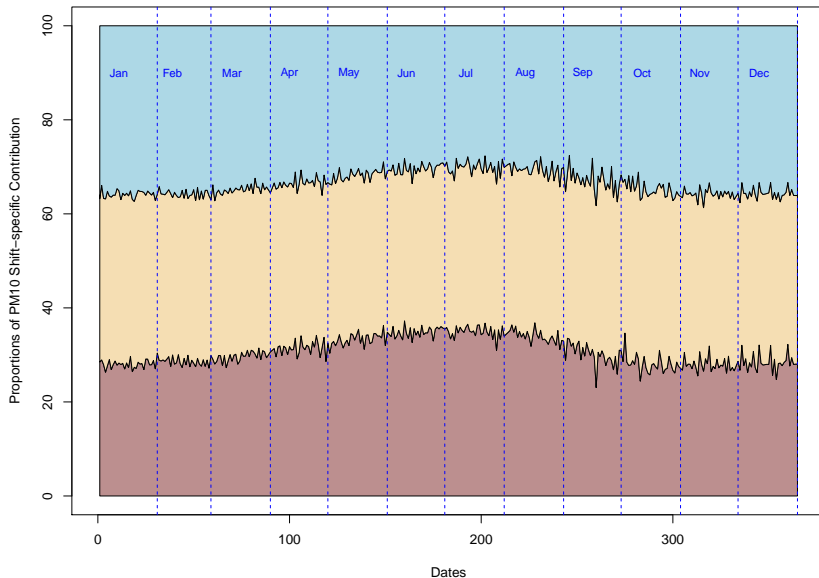
Daily Averages of PM10 concentration is more in Winters and is less during Summers. PM10 concentration stays under the regulation level from middle of May to middle of October.

Shift-specific PM10 Concentration on different Days of the Year



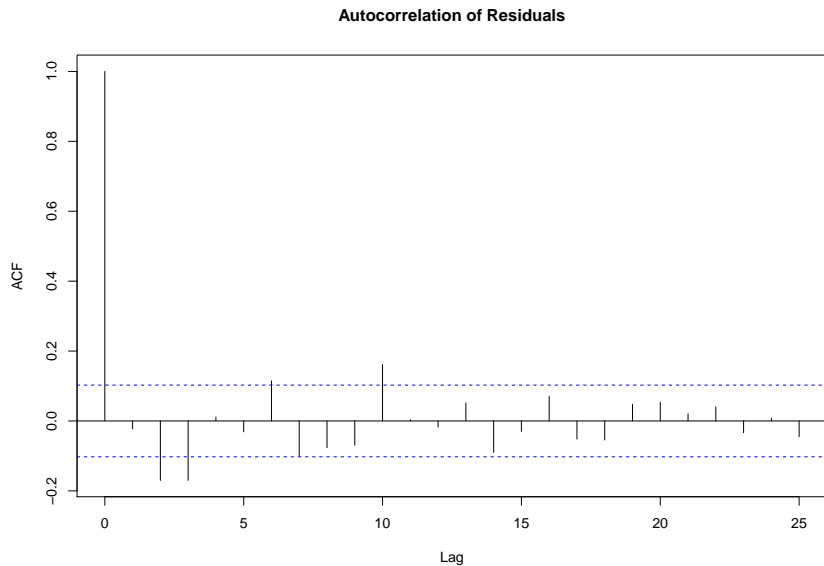
Shift1 measurements of PM10 concentration mostly stays lower than Shift2 and Shift3. From May to August, Shift1 concentration increases more than Shift3 but stays below Shift2 measurements for all of the year.

Proportions of PM10 Shift-specific Contribution

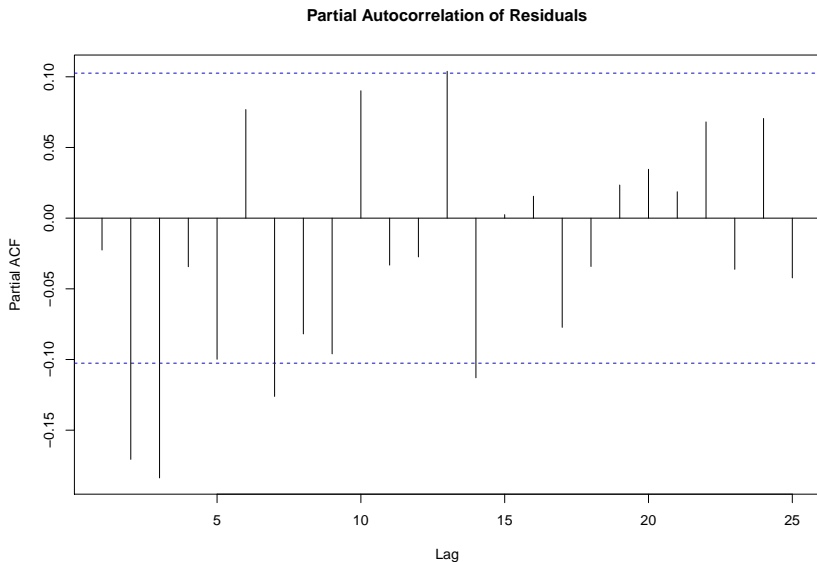


Contribution of Shift2 PM10 Concentration stays about one-third of the total PM10 Concentration of that day. The contribution of shift1 increases in rainy season, while shift3 decreases. The reverse happens in winters.

Autocorrelation of Residuals



Partial Autocorrelation of Residuals



An anomaly of PM10 concentration may remain effective for the following 2 or 3 days.

Conclusions (PM10)

- ▶ The general trend of PM10 concentration shows an increment and decrement over the course of different years. The peaks on this cyclical variations seems to be increasing.
- ▶ Daily Averages of PM10 concentration is more in Winters and is less during Summers.
- ▶ Shift1 measurements of PM10 concentration mostly stays lower than daily averages, while Shift2 and Shift3 measurements stays higher than daily averages.
- ▶ Shift1 measurements becomes close to daily averages (may be a little higher) during Rainy Season (May to August). At this time, Shift3 measurements falls below the daily average level.
- ▶ PM10 concentration stays under the regulation level from middle of May to middle of October.
- ▶ An anomaly of PM10 concentration may remain effective for the following 2 or 3 days.

PART - 2: NO₂

About NO₂

Nitrogen dioxide is part of a group of gaseous air pollutants produced as a result of road traffic and other fossil fuel combustion processes. Its presence in air contributes to the formation and modification of other air pollutants, such as ozone and particulate matter, and to acid rain.

The Air quality standards for concentration of NO₂ in the air suggests a regulation level of **80** microgram per cubic meter, as specified in [https:](https://www.transportpolicy.net/standard/india-air-quality-standards/)

[//www.transportpolicy.net/standard/india-air-quality-standards/](https://www.transportpolicy.net/standard/india-air-quality-standards/) .

About the Data

The processed dataset contains the measurements of NO_2 concentration in the air during 6 shifts in a day. In each week of each month, the concentration was measured for 6 different shifts on 2 randomly chosen days. Rather than the date, the processed dataset contains the number of days passed from first measurement, which is a bit easier to work with.

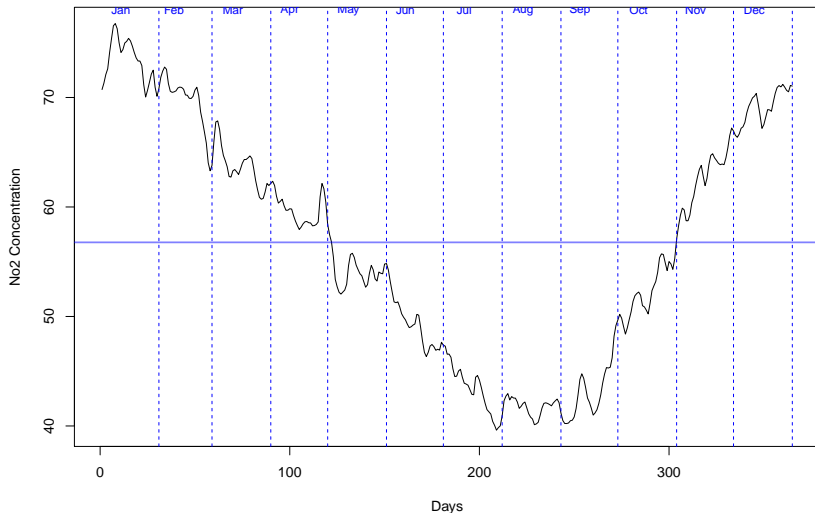
	DateTime	No2.Values	ShiftTime
1	0.0000000	55.2	1
2	0.1666667	80.2	2
3	0.3333333	76.0	3
4	0.5000000	88.5	4
5	0.6666667	47.9	5
6	0.8333333	45.8	6
7	3.0000000	70.8	1
8	3.1666667	103.1	2

Time vs Year to Year No2 Concentration



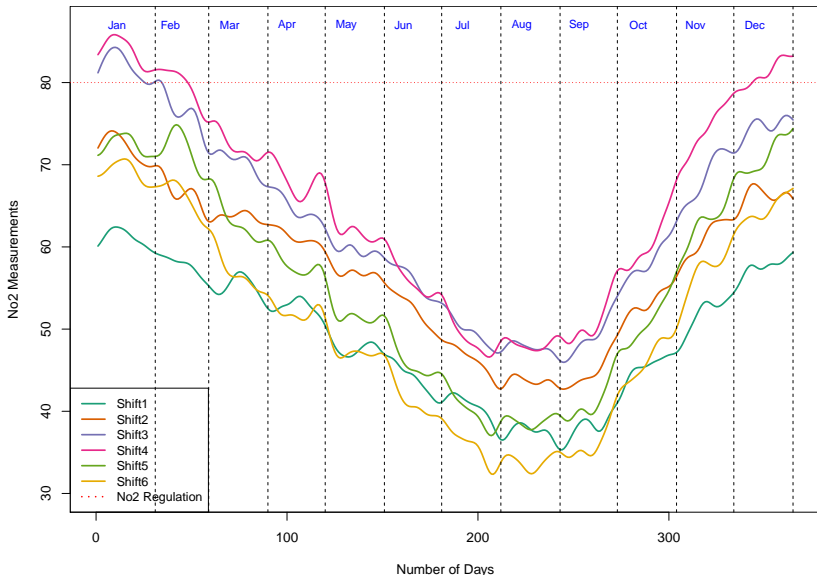
The general trend of No2 concentration was increasing till 2008 and after that it has followed a more or less decreasing trend. There are also cyclical fluctuations over the course of different years, but the peaks seems to be decreasing.

Average NO_2 Concentration on different Days of the Year



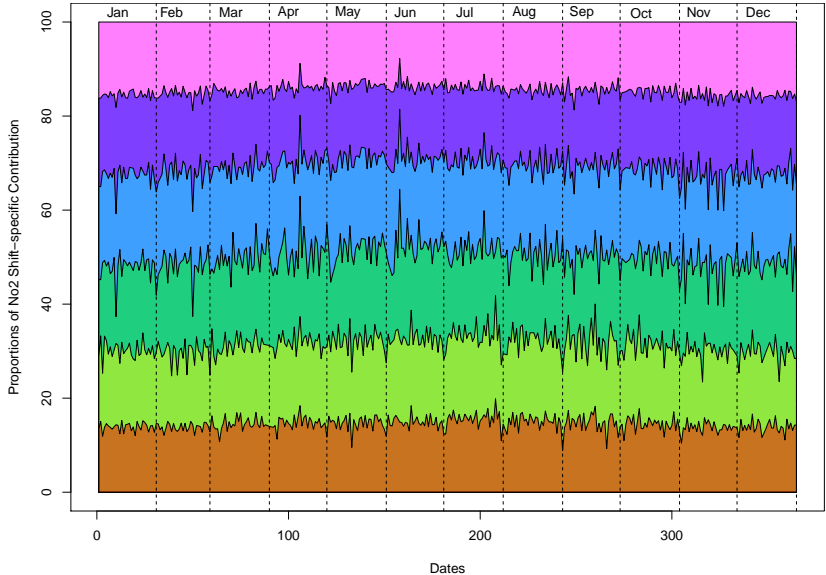
Daily Averages of NO_2 concentration is more in Winters and is less during Summer and Rainy Season (May to October).

Shift-specific No2 Concentration of distinct days of a Year



Shift3 and Shift4 measurements stay higher than other shifts. Shift2 and shift5 measurements are next, and shift1 and shift6 measurements are the lowest. Shift6 measurements increase drastically in Winters.

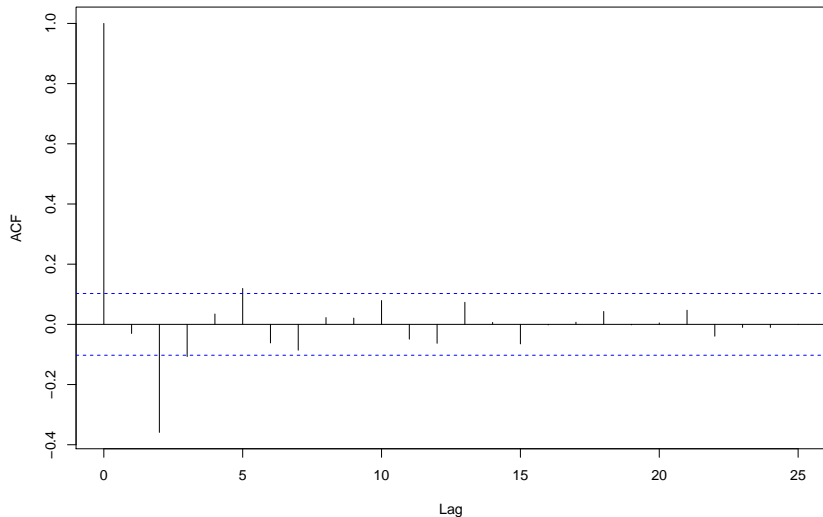
Shift Specific Proportional Contribution of No_2



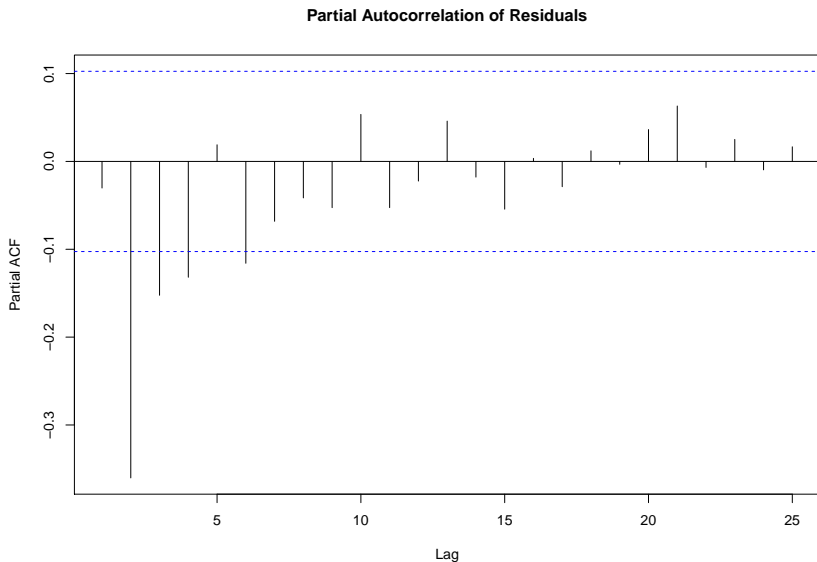
Contribution of Shift3 and shift4 are largest. Contribution of Shift1 is the smallest in general. The rest of the shifts contribute almost same.

Autocorrelation of Residuals of NO_2 Concentration

Autocorrelation of Residuals



Partial Autocorrelation of Residuals of NO_2 Concentration



An anomaly of NO_2 concentration may remain effective for the following 5 or 6 days.

Conclusions (NO₂)

- ▶ The general trend of No₂ concentration was increasing till 2008 and after that it has followed a more or less decreasing trend. There are also cyclical fluctuations over the course of different years, but the peaks seems to be decreasing.
- ▶ Daily Averages of No₂ concentration is more in Winters and is less during Rainy Season (June to October).
- ▶ Shift3 and Shift4 measurements of No₂ concentration stays higher than daily averages in general.
- ▶ Shift2 and Shift5 measurements of No₂ concentration stays more or less similar to Daily Averages, while Shift2 becomes a little higher than daily averages and shift5 becomes a little lower during middle of the year (May - August).

Conclusions (NO₂) (Contd.)

- ▶ Shift1 and Shift6 measurements stays below the daily average level for most of the time, however, Shift6 is closer to daily average level during winters, and a lot less in other times, while Shift1 is lot less in winters and is closer to the daily average level in summers.
- ▶ No2 concentration stays under the regulation level during the whole of the years except January.
- ▶ An anomaly of No2 concnetration may remain effective for the following week.

PART - 3: SO₂

About SO₂

Sulfur dioxide is a gas primarily emitted from fossil fuel combustion at power plants and other industrial facilities, as well as fuel combustion in mobile sources such as locomotives, ships, and other equipment.

The Air quality standards for concentration of SO₂ in the air suggests a regulation level of **80** microgram per cubic meter, as specified in https:

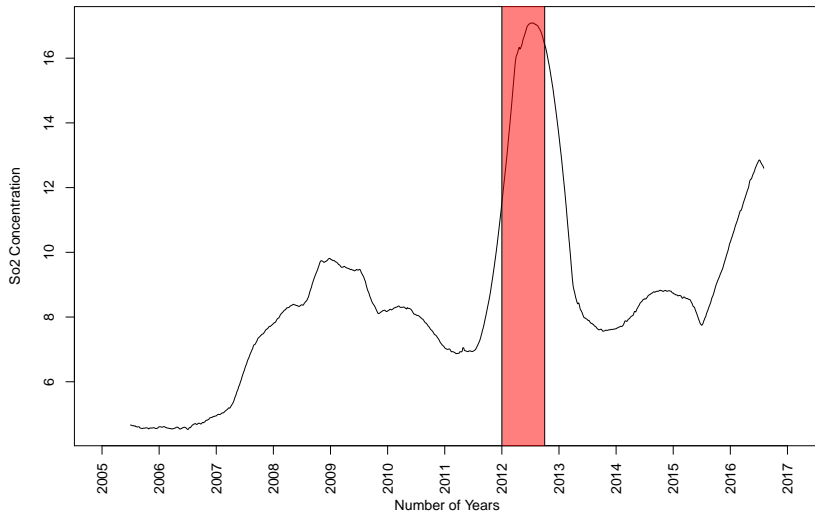
[//www.transportpolicy.net/standard/india-air-quality-standards/](https://www.transportpolicy.net/standard/india-air-quality-standards/) .

About the Data

The processed dataset contains the measurements of SO_2 concentration in the air during 6 shifts in a day. In each week of each month, the concentration was measured for 6 different shifts on 2 randomly chosen days. Rather than the date, the processed dataset contains the number of days passed from first measurement, which is a bit easier to work with.

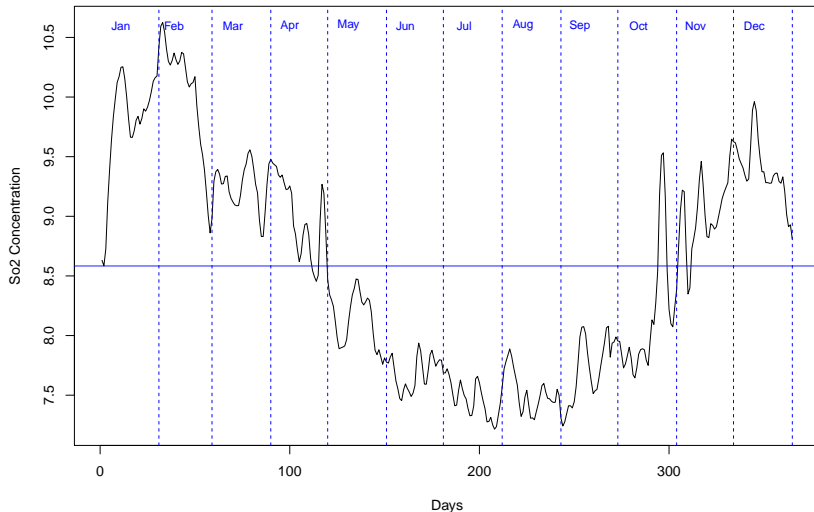
	DateTime	so2.Values	ShiftTime
1	0.0000000	4.0	1
2	0.1666667	5.9	2
3	0.3333333	4.9	3
4	0.5000000	4.0	4
5	0.6666667	2.0	5
6	0.8333333	2.0	6
7	3.0000000	4.9	1
8	3.1666667	4.0	2

Time vs Year to Year SO_2 Concentration



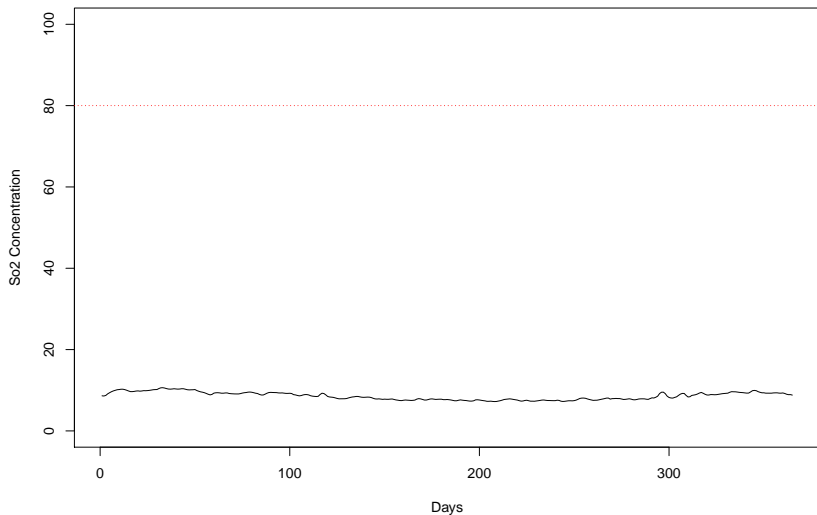
The general trend of SO_2 concentration was increasing over the course of different years.

Average SO_2 Concentration on distinct days of the Year



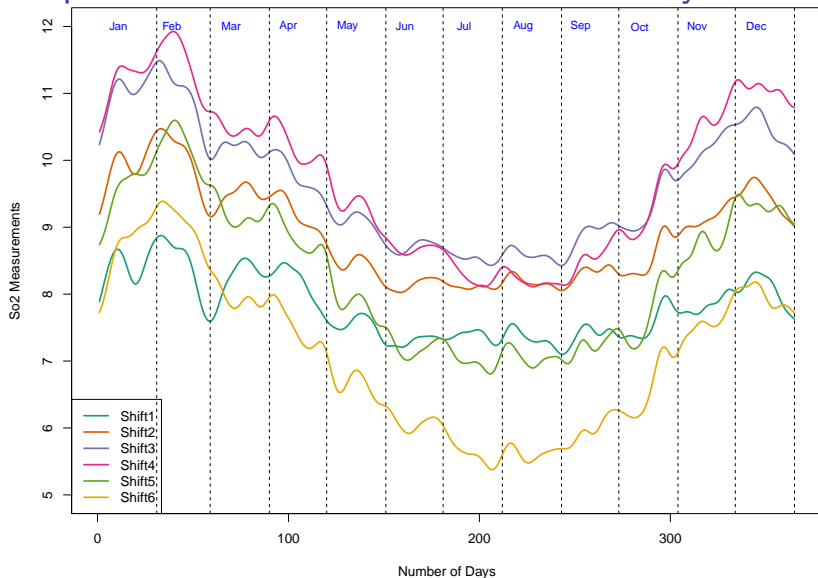
Daily Averages of SO_2 concentration is more in Winters and is less during late summer and Rainy Season (May to October). However the magnitude of such variations are very small.

Average SO_2 Concentration with Regulation Level



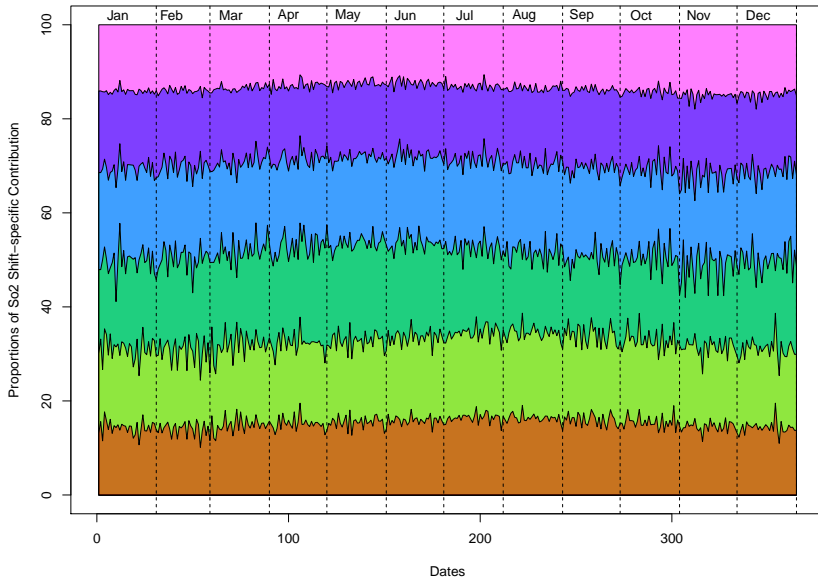
SO_2 Concentration does not usually exceed the Regulation Level and stays far below it.

Shift-Specific So2 Concentration of distinct days of a Year



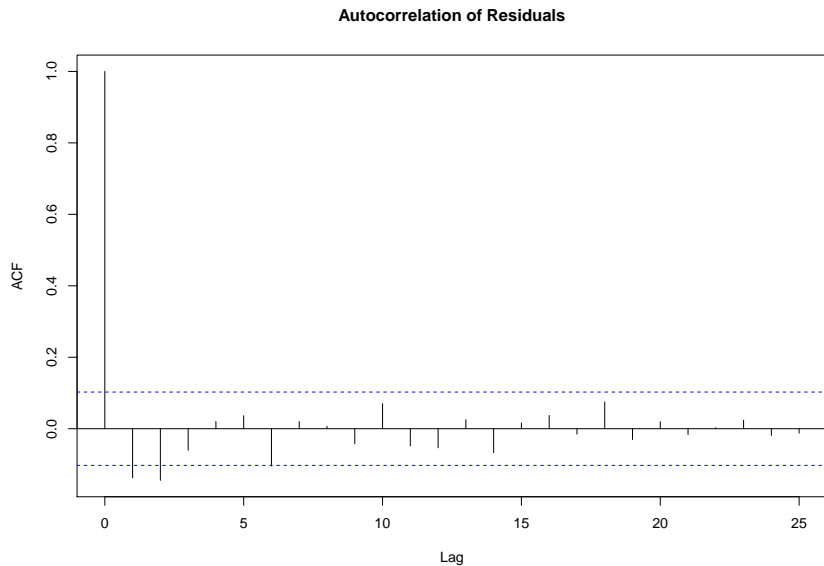
Shift2, Shift3 and shift4 measurements stay higher than others. Shift3 exceeds shift4 concentration during Rainy Season. Shift6 measurements are the lowest. Shift5 is closer to shift2 during Winters, and is closer to shift1 during Summers.

Shift-specific Proportional Contribution of SO_2

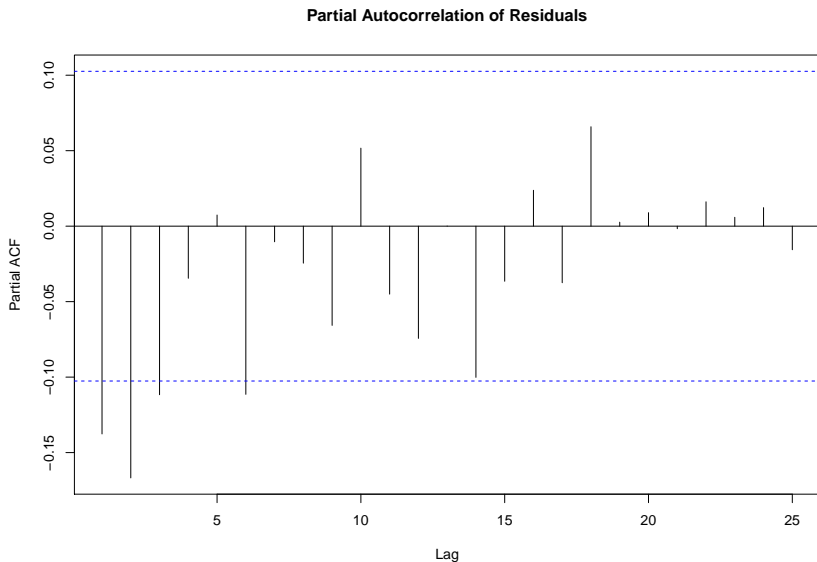


Contribution of Shift3 is the largest during Summers, while Shift6 contributes the lowest. The other shifts contribute more or less equally.

Autocorrelation of Residuals



Partial Autocorrelation of Residuals



An anomaly of SO_2 concentration may remain effective for the following 5 or 6 days at most.

Conclusions (SO₂)

- ▶ The general trend of So₂ concentration was increasing over the course of different years.
- ▶ Daily Averages of So₂ concentration is more in Winters and is less during late summer and Rainy Season (May to October). However the magnitude of such variations are very small.
- ▶ Shift3 and Shift4 measurements of So₂ concentration stays higher than daily averages in general.
- ▶ Shift2 and Shift5 measurements of So₂ concentration stays more or less similar to Daily Averages, while Shift2 becomes a little higher than daily averages and shift5 becomes a little lower during middle of the year (June - September).

Conclusions (SO₂) (Contd.)

- ▶ Shift1 and Shift6 measurements stays below the daily average level for most of the time, however, Shift1 is closer to daily average level during the Rainy season, and a lot less in other time.
- ▶ So₂ has never crossed the regulation level yet.
- ▶ An anomaly of So₂ concentration may remain effective for the following 6 days atmost.

THANK YOU