Weather and Air Quality

Project 01 – **Data Analysis of Singapore Rainfall**
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13th July 2023

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Problem Statement

We are part of the **National Environment Agency (NEA) taskforce** to

develop a set of air quality early warning systems to predict potential periods of air quality deterioration, allowing the government to take necessary precautionary actions.

As such, we would **provide insights to the impact that the various weather factors have on air quality**.

Background

- Ongoing Climate Change

- Return of El Nino and La Nina

- Recurrent transboundary SouthEast Asian (SEA) Haze

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Data Cleaning and Import

- Import datasets in 2 batches
  1) Weather Related
  2) Air Quality Related

- Data Source: Data.gov.sg

- Data collected from similar period, with similar date-time formatting

Data Dictionary

Feature	Type	Dataset	Description
date	*datetime*	all datasets	1982, January to 2023, May
year	*datetime*	all datasets	1982 to 2023
month	*datetime*	all datasets	Jan - Dec, represented by 01 - 12 respectively

Weather

Feature	Type	Dataset	Description
rainy_days	*int*	rainfall-monthly-number-of-rain-days	The number of rain days (day with rainfall amount of 0.2mm or more) in a month recorded
total_rainfall	*float*	rainfall-monthly-total	The total monthly rainfall in mm
max_daily_rainfall	*float*	rainfall-monthly-highest-daily-total	The highest daily total rainfall for the month
mean_rh	*float*	relative-humidity-monthly-mean	The monthly mean relative humidity recorded
min_daily_temp	*float*	SurfaceAirTemperatureMonthlyMeanDailyMaximum	The monthly mean daily minimum temperature recorded
max_daily_temp	*float*	surface-air-temperature-monthly-mean-daily-minimum	The monthly mean daily maximum temperature recorded
extr_max_temp	*float*	SurfaceAirTemperatureMonthlyAbsoluteExtremeMaximum	The monthly extreme maximum air temperature recorded
extr_min_temp	*float*	SurfaceAirTemperatureMonthlyAbsoluteExtremeMinimum	The absolute extreme minimum air temperature recorded
mean_sunshine_hrs	*float*	sunshine-duration-monthly-mean-daily-duration	The monthly mean sunshine hours in a day recorded

Air Quality

| Feature	Type	Dataset	Description
ozone_max_mean	*float*	air-pollutant-ozone	Annual daily maximum 8-hr means for ozone (μg/m3)
pm2.5_mean	*float*	air-pollutant-particulate-matter-pm2-5	Annual means for PM2.5 (μg/m3)
pm10_mean	*float*	AirPollutantParticulateMatterPM10	Annual 24-hr means (99th percentile) for PM10 (μg/m3)
co_max_mean	*float*	AirPollutantCarbonMonoxide2ndMaximum8HourMean	Annual maximum 8-hr means for carbon monoxide (mg/m3)
no2_mean	*float*	AirPollutantNitrogenDioxide	Annual means for nitrogen dioxide (μg/m3)
so2_mean	*float*	AirPollutantSulphurDioxide	Annual means for sulphur dioxide (μg/m3)
psi	*float*	historical-24-hr-psi	Historical regional 24-hr PSI

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Charting yearly mean of various weather conditions

- Weather conditions are correlated to each other

- Total rainfall and max daily rainfall have a stronger correlation

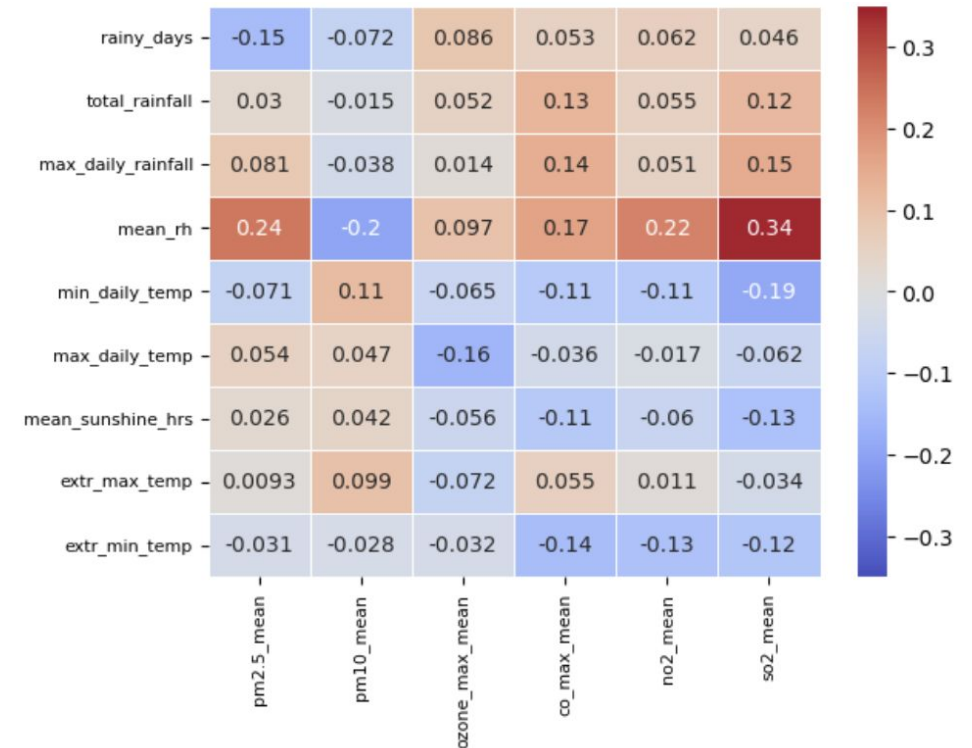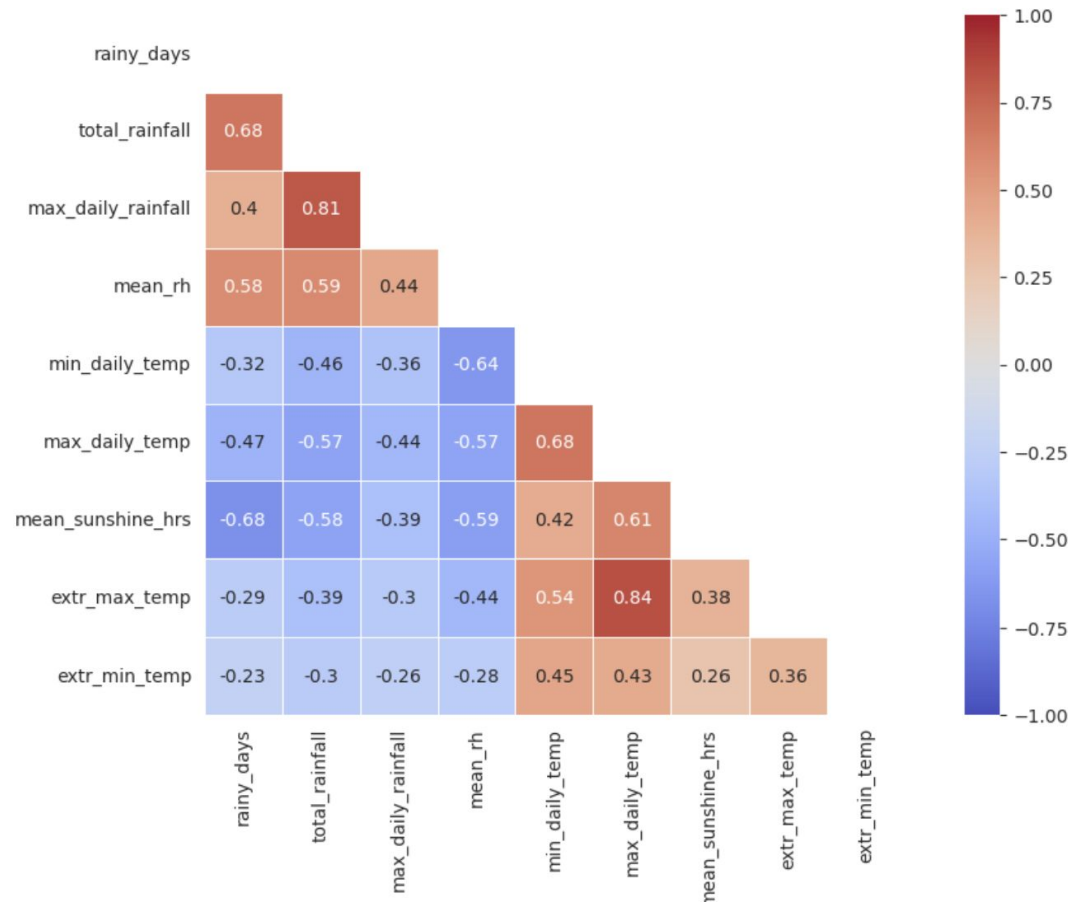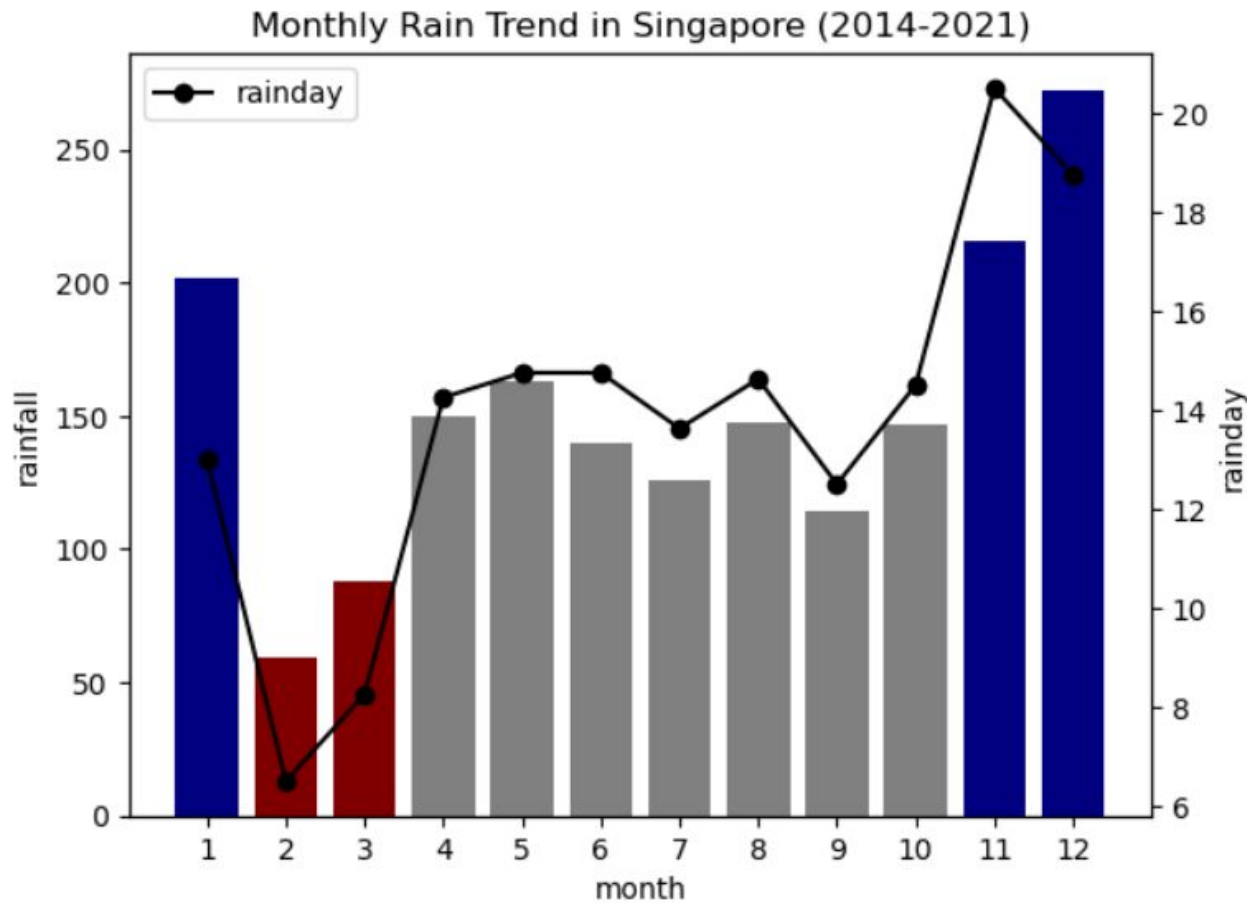- Mean sunshine hours is inversely correlated to the relative humidity and rainfall
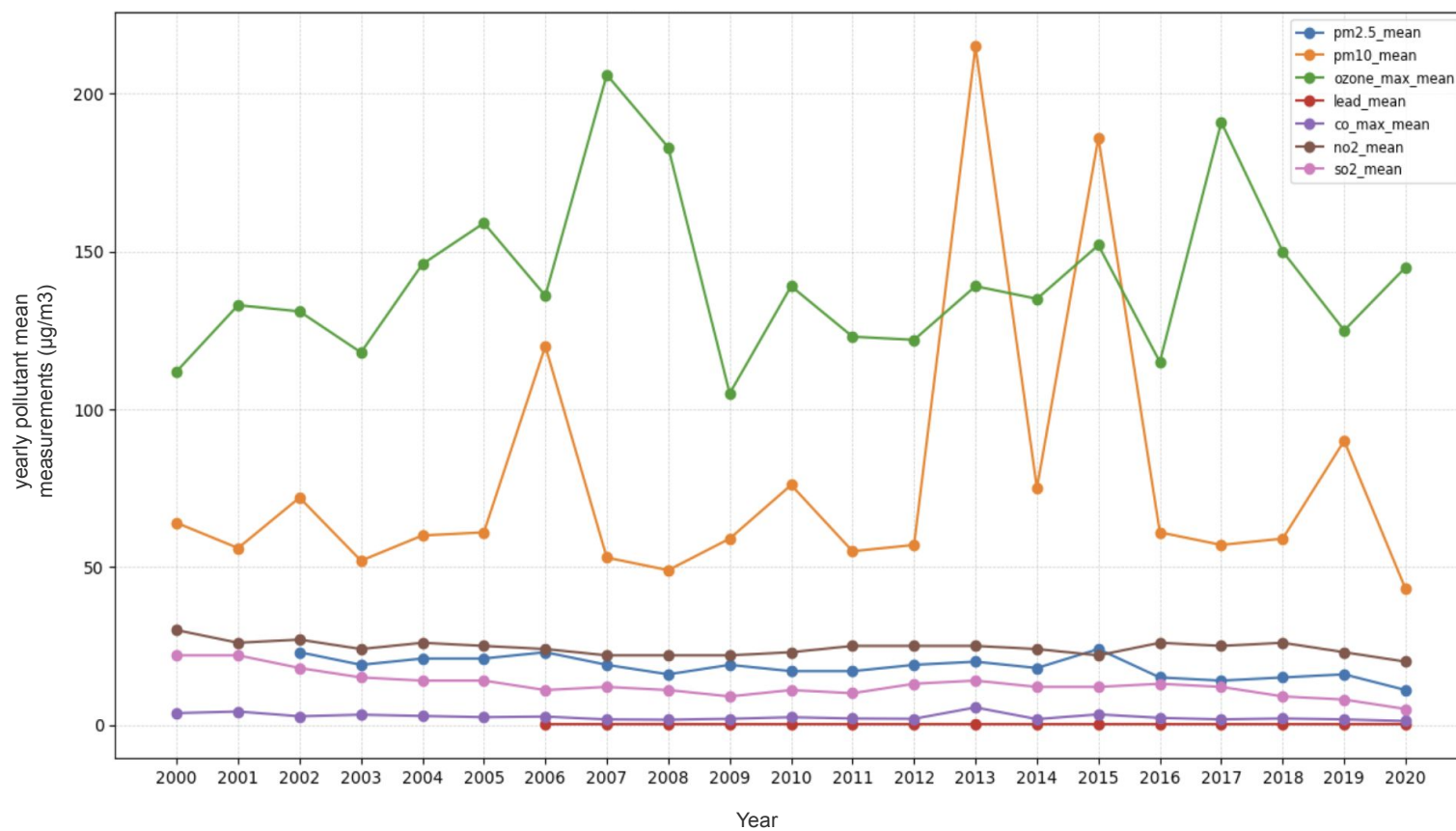
- Correlation between ozone, pm2.5 and pm10

Correlation between
weather conditions

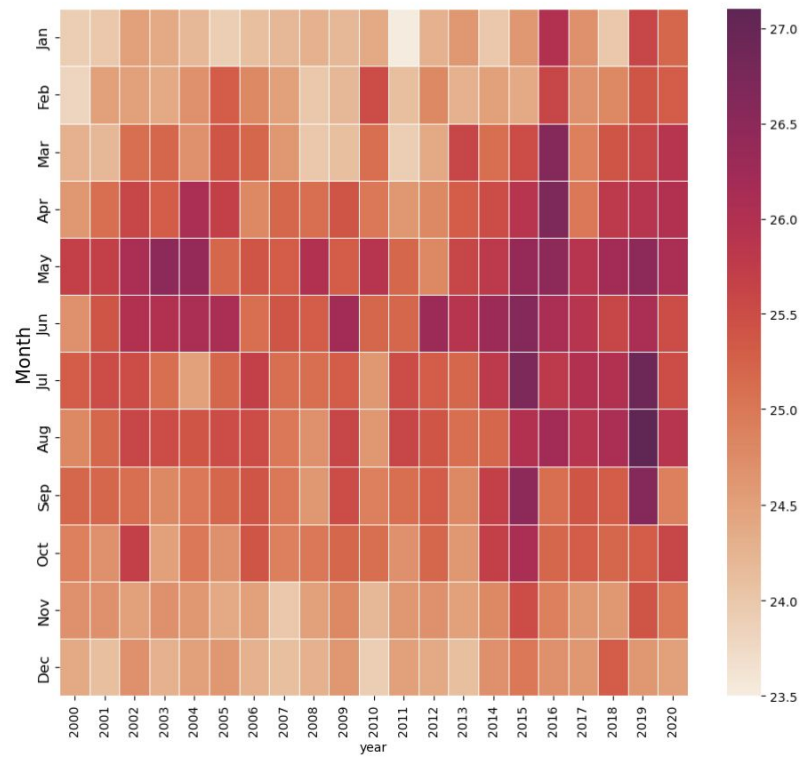# Correlation between
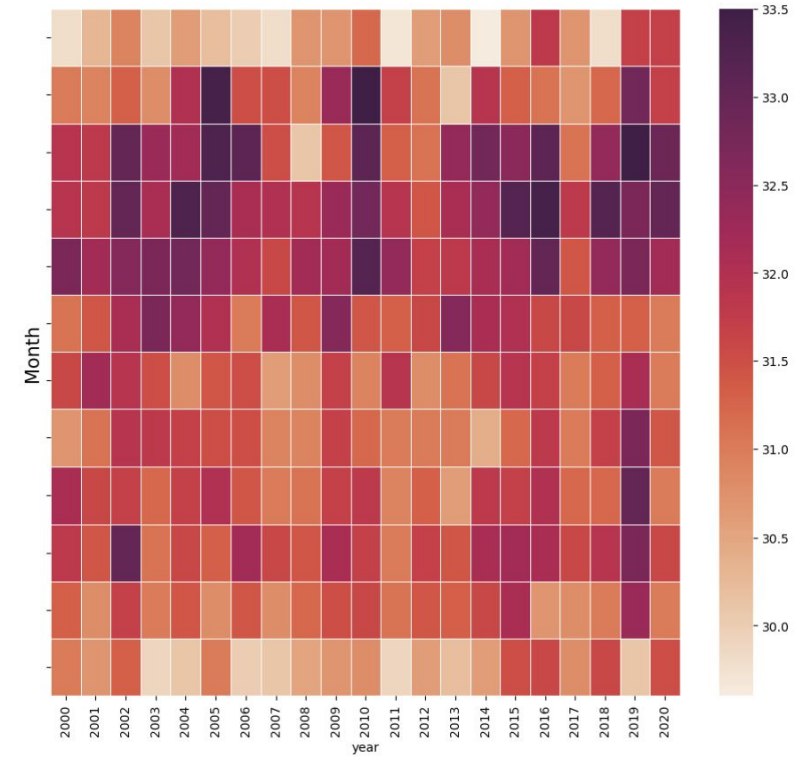## weather conditions vs air pollutants

Monthly Trend of
Total Rainfall

Monthly Rain Trend in Singapore (2014-2021)

- Singapore observed highest rainfall towards the end of year through first month of the year.

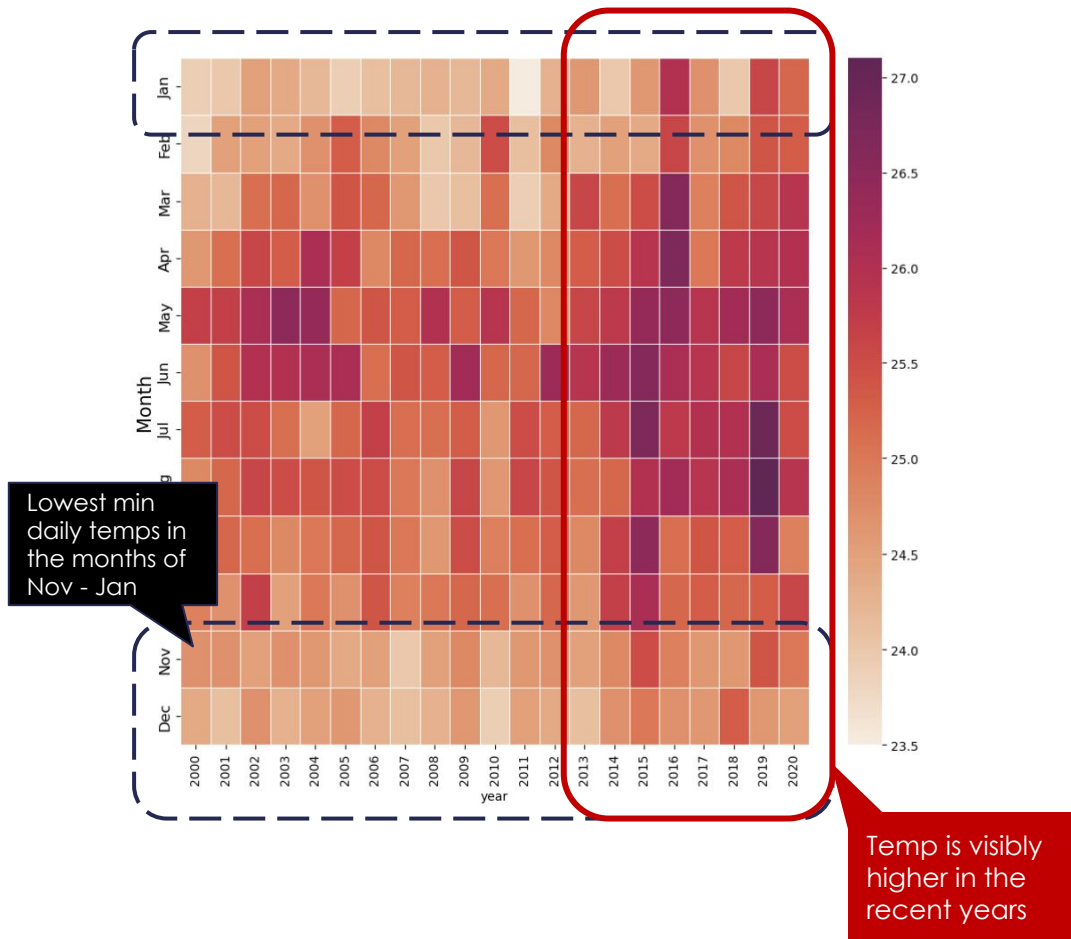- Meanwhile, drier months is between February and March.
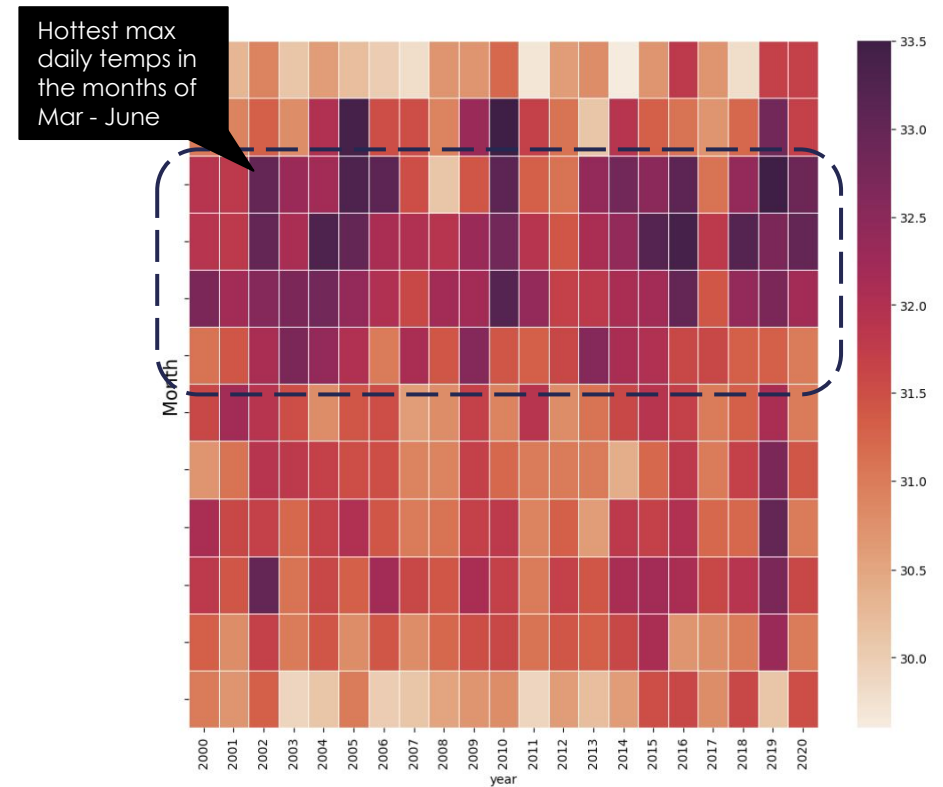
Mean Minimum Daily Temperatures

Mean Maximum Daily Temperatures
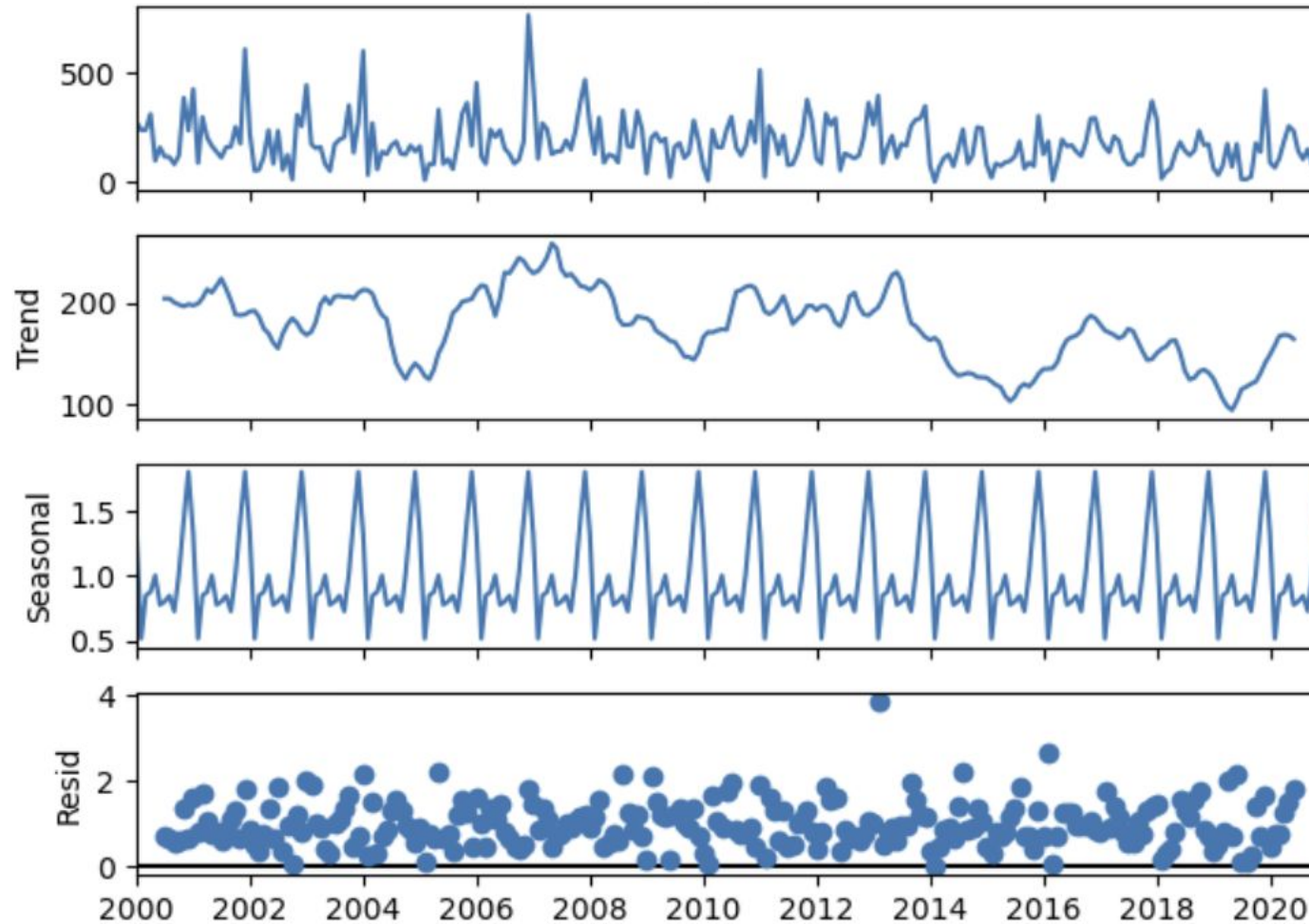

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Mean Minimum Daily Temperatures

Mean Maximum Daily Temperatures

Lowest min daily temps in the months of Nov - Jan

Temp is visibly higher in the recent years
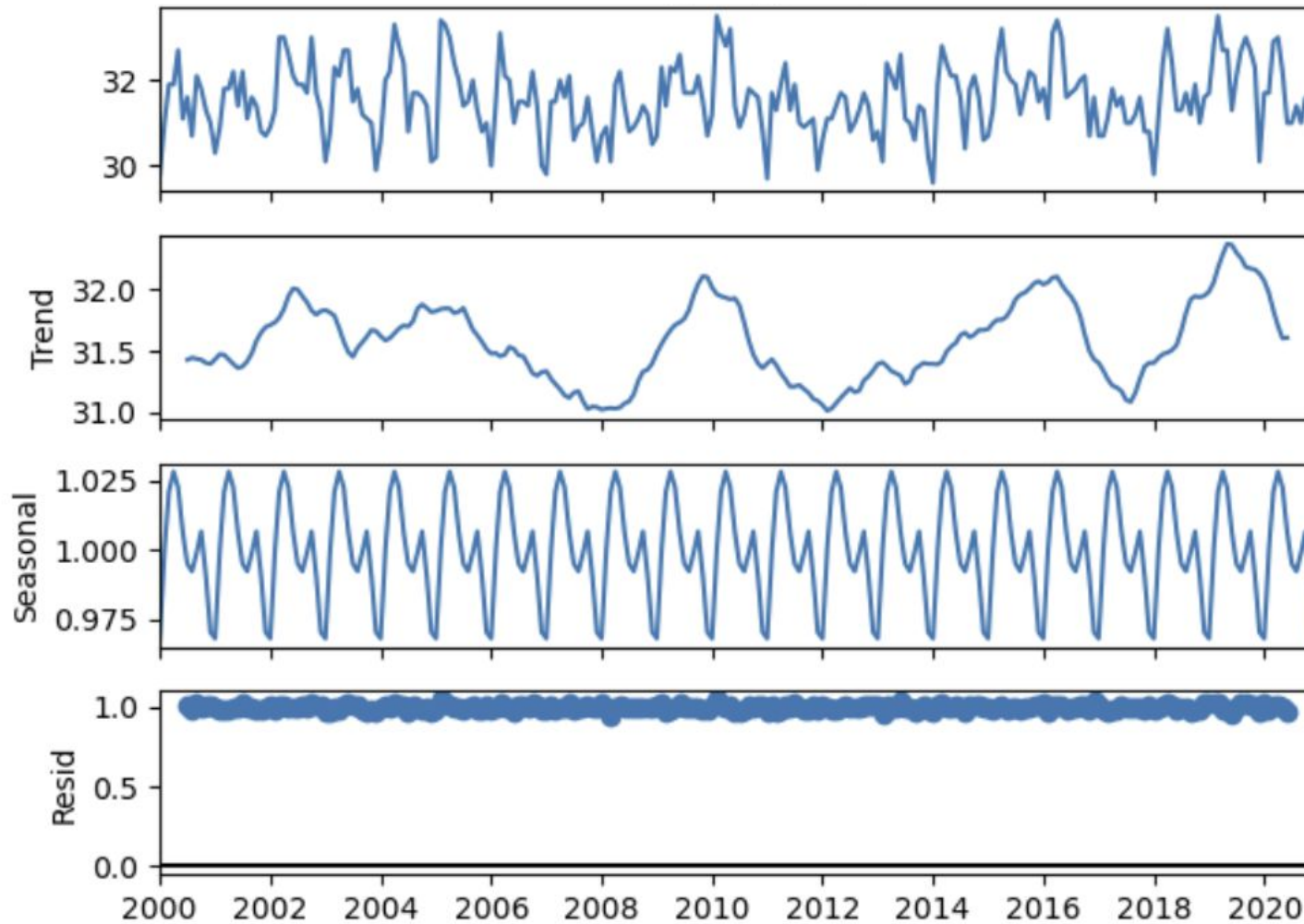
Hottest max daily temps in the months of Mar - June

- Seasonal pattern (occuring yearly) is observed, with total rainfall peaking at the end of the year.

- Trend: Total rainfall gradually decreases over time

- Seasonal pattern (occuring yearly) is observed, with maximum daily temperature peaking at the front part of the year and falling.

- Trend: Maximum daily temperature gradually increases over time

Pollutant	Singapore Targets by 2020	Long Term Targets
Sulphur Dioxide (SO$_2$)	24-hour mean: 50µg/m^3 (WHO Interim Target)	24-hour mean: 20µg/m^3 (WHO Final)
Particulate Matter (PM$_{2.5}$)	Annual mean: 12µg/m^3 (Sustainable Singapore Blueprint target) 24-hour mean: 37.5µg/m^3 (WHO Interim Target)	Annual mean: 10µg/m^3 24-hour mean: 25µg/m^3 (WHO Final)
Particulate Matter (PM$_{10}$)	Annual mean: 20 µg/m^3 24-hour mean: 50 µg/m^3 (WHO Final)	
Ozone	8-hour mean: 100µg/m^3 (WHO Final)	
Nitrogen Dioxide (NO$_2$)	Annual mean: 40µg/m^3 1-hour mean: 200µg/m^3 (WHO Final)	
Carbon Monoxide (CO)	8-hour mean: 10mg/m^3 1-hour mean: 30mg/m^3 (WHO Final)	

Pollutant Values
Air Quality targets

Sulphur Dioxide (SO2)

Particulate Matter (PM2.5)

Carbon Monoxide (CO)

Particulate Matter (PM10)

Ozone

Nitrogen Dioxide (NO2)

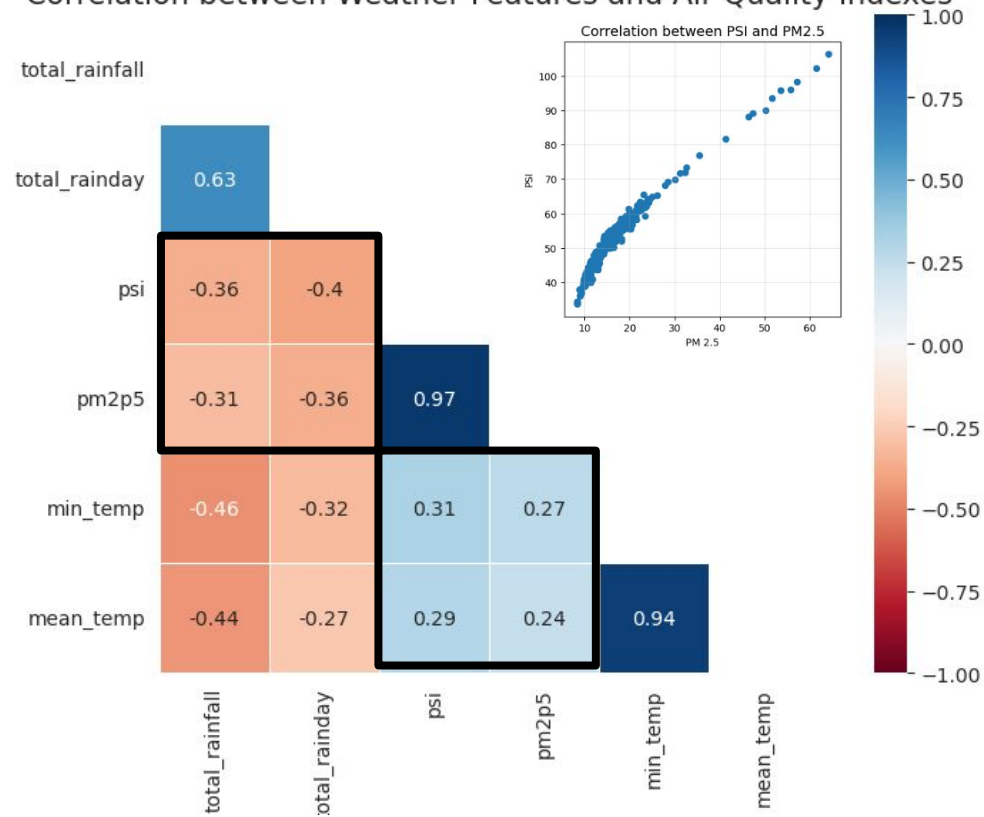19
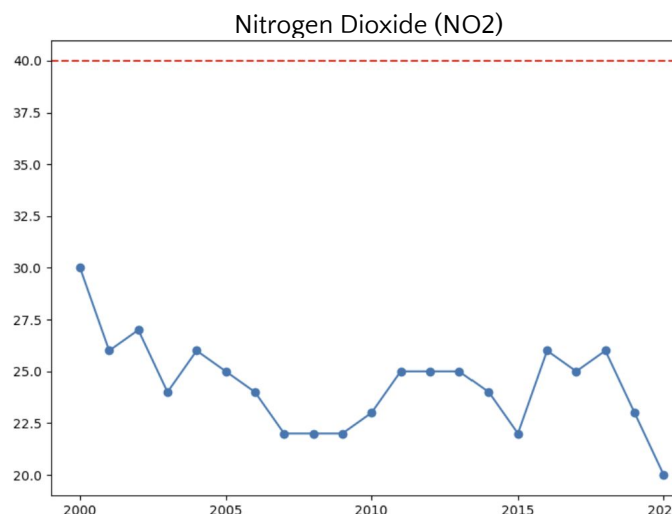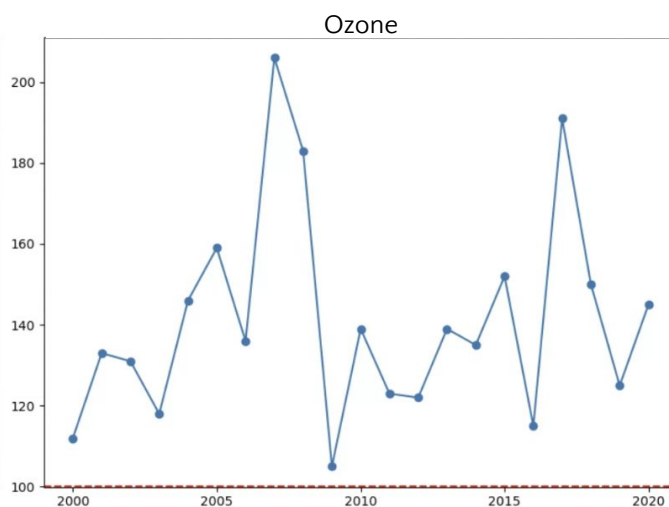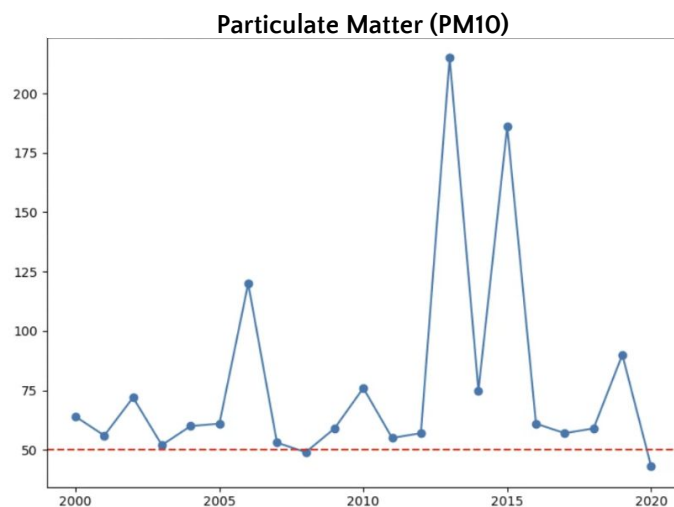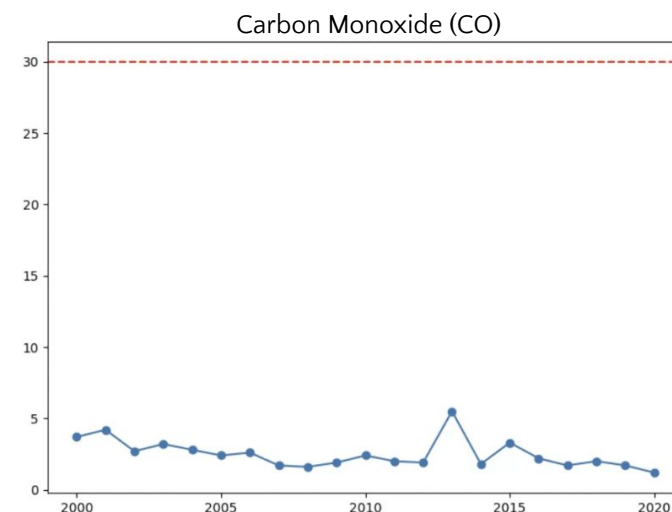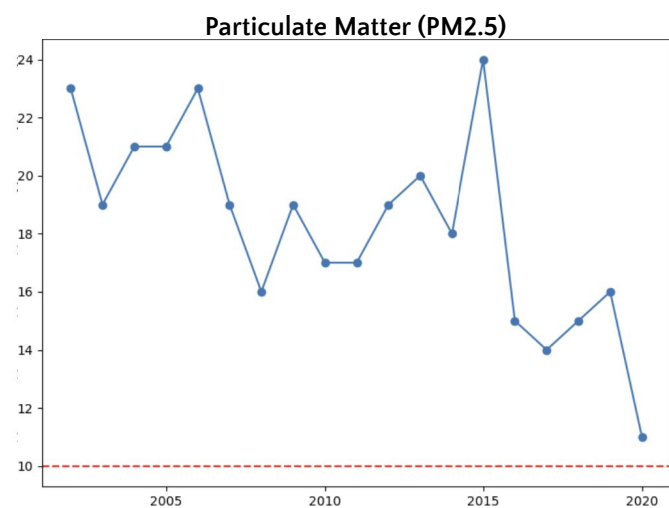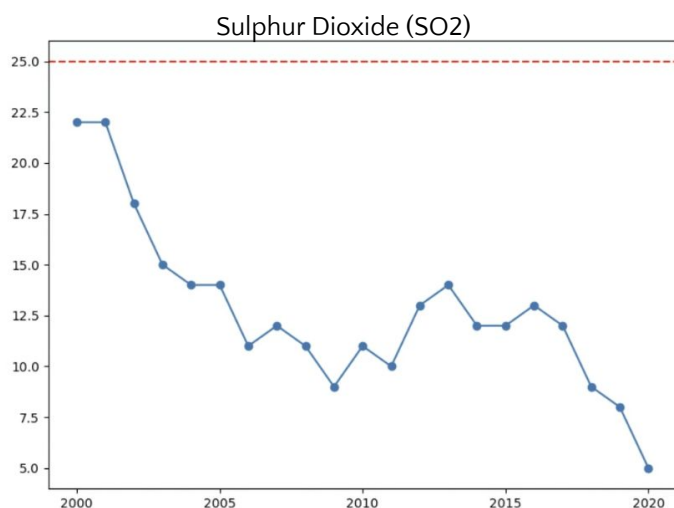
Distributions of
Air Quality Index

Distribution of PSI

Distribution of PM 2.5
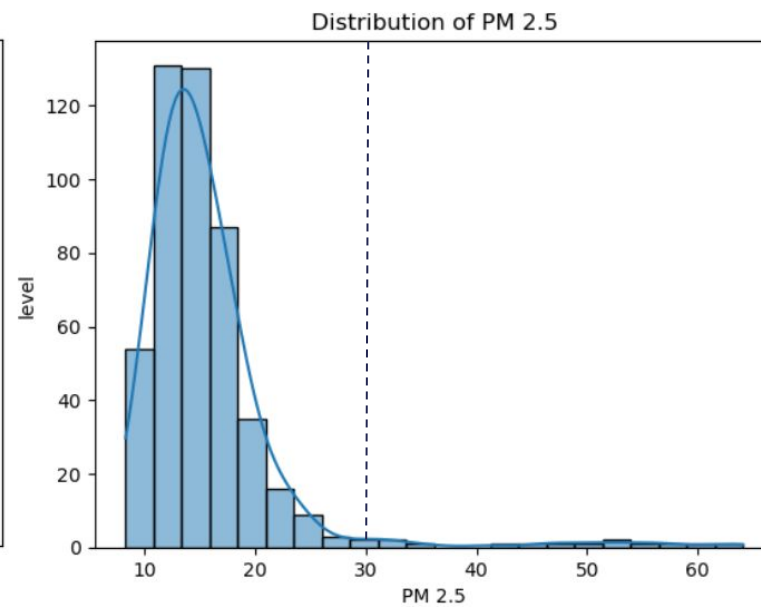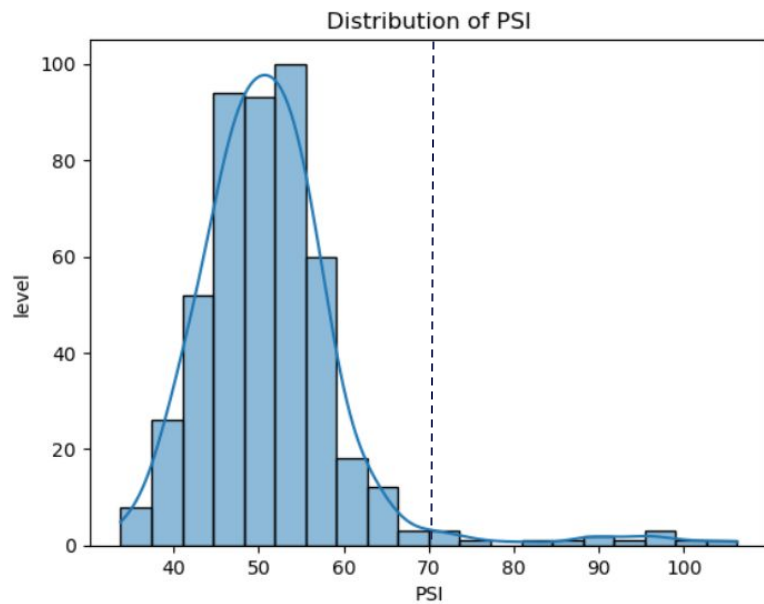
- Both PSI and PM2.5 distribution have a positively skewed distribution

- Average at 50 and 14, respectively.

Correlation between Weather Features and Air Quality Indexes

Total Rainy Day vs PSI
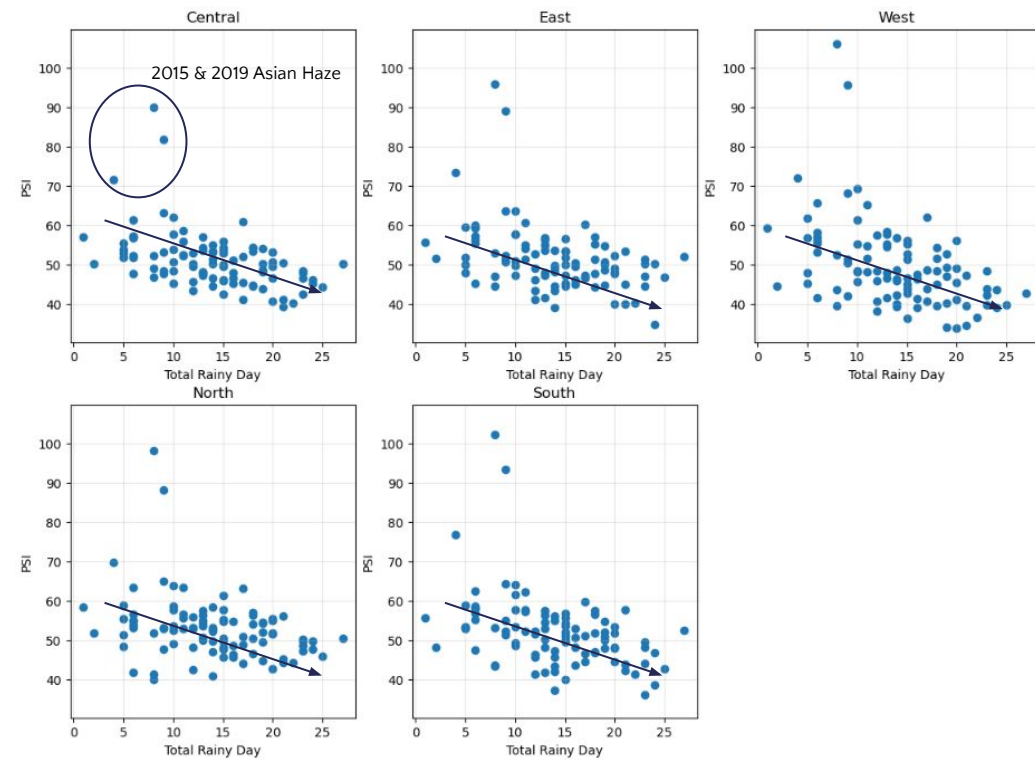
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Conclusion

We can see the effects of global warming in the graphs, with temperatures generally rising, and total rainfall amounts falling over time. From the research done, theory tells us it is likely possible that decreased rainfall, and hotter temperatures should lead to deterioration of air quality. However, the correlation is not strong, and conducting a more in-depth analysis would be necessary to gain further insights. As majority of the pollutant datasets only provide a yearly mean, data was of lower granularity.

Key Takeaways/ Recommendations

- Temperature and rainfall are seasonal variables, and the seasonality remains quite stable over time for the Singapore context.

- Relative humidity seems to have a slightly stronger correlation to the various pollutants, so this relationship could be further explored for the modelling and prediction stage.

- It is also important to note that while our focus is currently on weather and its impact on air quality, we would need to consider several other factors in order to develop a comprehensive air quality early warning system.

Weather and Air Quality

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THANK YOU

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