

Delhi Climate Analysis

Programme: B.Tech (Hons.) CSE

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Problem Statement:

To analyse and visualise the Delhi Daily Climate Dataset from Jan, 2022 to Jan, 2024 and use it to predict the future climatic conditions of this region as well use the results of this study for further urban development and research in this region.

Introduction:

This climate analysis project for Delhi aims to create an obvious trend of temperature specifically in Delhi, India, with a time period from January 2022 to January 2024, which is within a period of 2 years. The information in the paper will be very instrumental for applications in the field of urban planning and research in the field of climate change. This project aims to analyse daily temperature and precipitation data from January 2022 to December 2024 to identify trends and patterns, analyze seasonal variations, and understand the relationship between temperature and precipitation. The insights gained from this analysis will provide a reliable basis for further studies and practical applications in weather forecasting and urban planning. We will apply data visualization techniques to plot the pattern of temperature reading within Delhi and in an accessible graph.

Dataset:

The dataset comprises information about weather variables. It consists of 731 rows and 33 columns. Each row represents the following weather variable such as, 'Max Temp', 'Min Temp', 'Humidity', 'Precipitation', etc., for that corresponding date.

Weather Variables that dataset includes are:-

tempmax	tempmin	temp	feelslikemax	feelslikemin	feelslike	dew	humidity
solar energy	uvindex	severerisk	sunrise	sunset	moonphase	conditions	

Observations and Analysis:

Statistical Analysis:

	name	datetime	tempmax	tempmin	temp	feelslikemax	feelslikemin	feelslike	dew	humidity
0	Delhi,India	2022-01-01	19.5	6.3	11.9	19.5	6.0	11.8	8.3	80.7
1	Delhi,India	2022-01-02	19.7	7.5	12.7	19.7	6.9	12.6	9.0	80.9
2	Delhi,India	2022-01-03	20.6	7.5	13.8	20.6	7.5	13.8	9.0	76.1
3	Delhi,India	2022-01-04	22.5	9.8	15.8	22.5	9.8	15.8	9.2	71.1
4	Delhi,India	2022-01-05	15.0	12.2	13.7	15.0	12.2	13.7	12.3	91.8

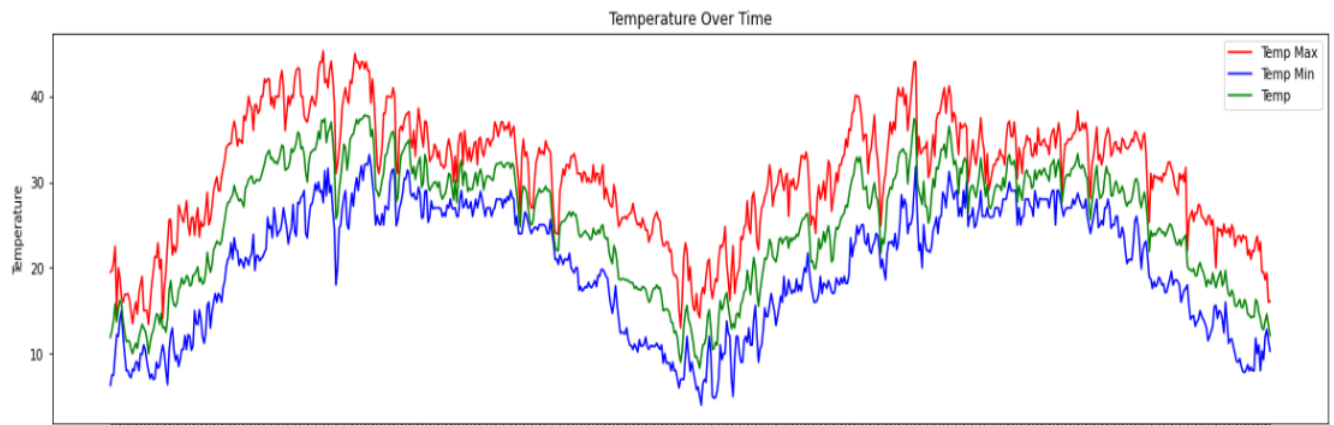
Statistical Analysis

Key Findings:

- The average humidity: 62.034%
- Average max temp:31.36°C, Average Min temp:19.9
- Extreme Temperatures: Highest 48°C, Lowest 3.9°C
- Precipitation: Max 146.0mm, Avg 2.81mm/day
- Humidity: Average 64.6%
- Average Temperature: 25.4°C
- Hottest day: 2023-05-22
- Coldest day: 2022-01-25

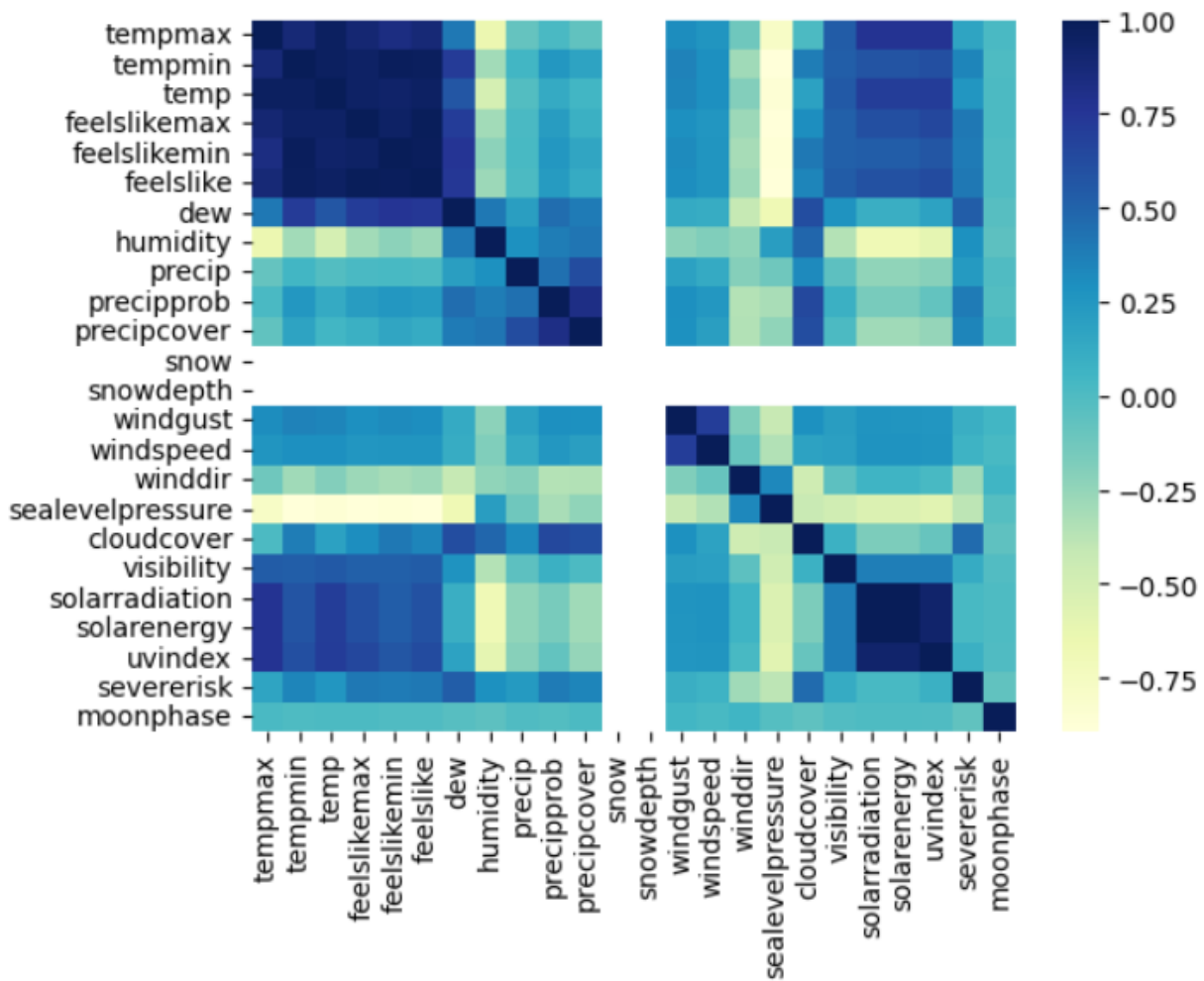
Data Visualization:

Delhi Climate analysis:



- According to temperature trends over time it shows highest (maximum) temperatures reaching around 45 degree Celsius .The peaks are sharp, indicating very warm conditions during the summer months.
- The average temperature generally lies between the maximum and minimum temperatures, averaging around 20-30 degrees Celsius.
- The minimum temperature drops to around 10 degrees Celsius during the winter months.
- The highest temperature is in 2023.
- The lowest temperature is in 2022.

Heatmap Analysis:



Strong Correlations:

- Feels Like and FeelsLikeMax (0.98): The "feels like" temperature is almost identical to the maximum "feels like" temperature, indicating that the perceived temperature doesn't vary much throughout the day.
- FeelsLikeMax and Feels Like (0.98): This is a repeat of the above, showing the same strong correlation.
- Tempmin and FeelsLikeMin (0.98): The minimum temperature is almost identical to the minimum "feels like" temperature, suggesting that the perceived minimum temperature closely follows the actual minimum temperature.
- FeelsLikeMin and TempMin (0.98): This is a repeat of the above, showing the same strong correlation.
- Feels Like and FeelsLikeMin (0.98): The "feels like" temperature is almost identical to the minimum "feels like" temperature, indicating that the perceived temperature doesn't vary much at the lower end.

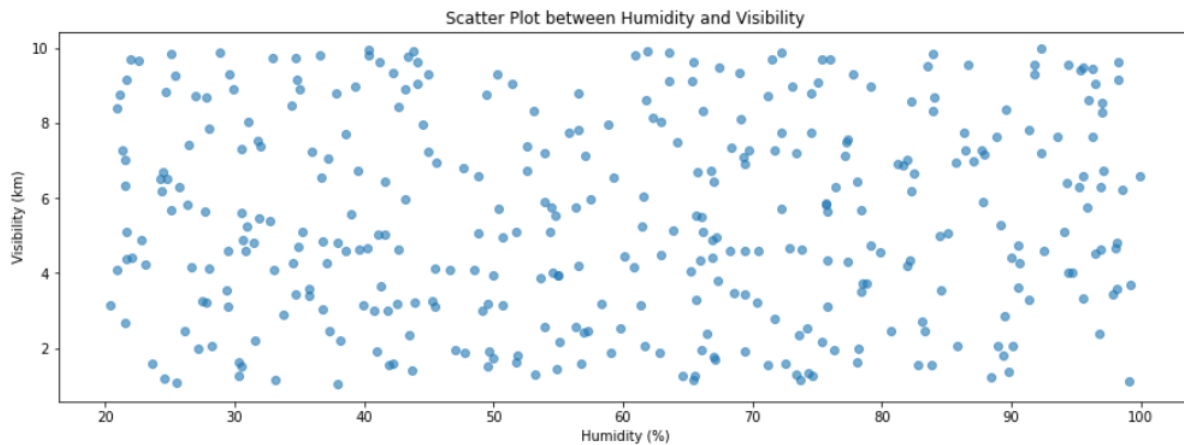
Moderate Correlations:

- Temp and Tempmax: There is a moderate correlation between the average temperature and the maximum temperature, indicating that higher average temperatures are associated with higher maximum temperatures.
- Temp and Temp Min: Similarly, there is a moderate correlation between the average temperature and the minimum temperature, indicating that higher average temperatures are associated with higher minimum temperatures.

Weak Correlations:

- Precipitation and Other Variables: Precipitation shows weak correlations with other variables, indicating that rainfall is not strongly related to temperature, humidity, or wind speed in this dataset.
- Wind Speed and Other Variables: Wind speed also shows weak correlations with other variables, suggesting that wind speed is relatively independent of temperature, humidity, and precipitation.

Scatter Plot Analysis:



Correlation coefficient between humidity and visibility: -0.441

This indicates a moderate negative correlation between humidity and visibility. As humidity increases, visibility tends to decrease, though the relationship is not extremely strong.

Average Visibility:

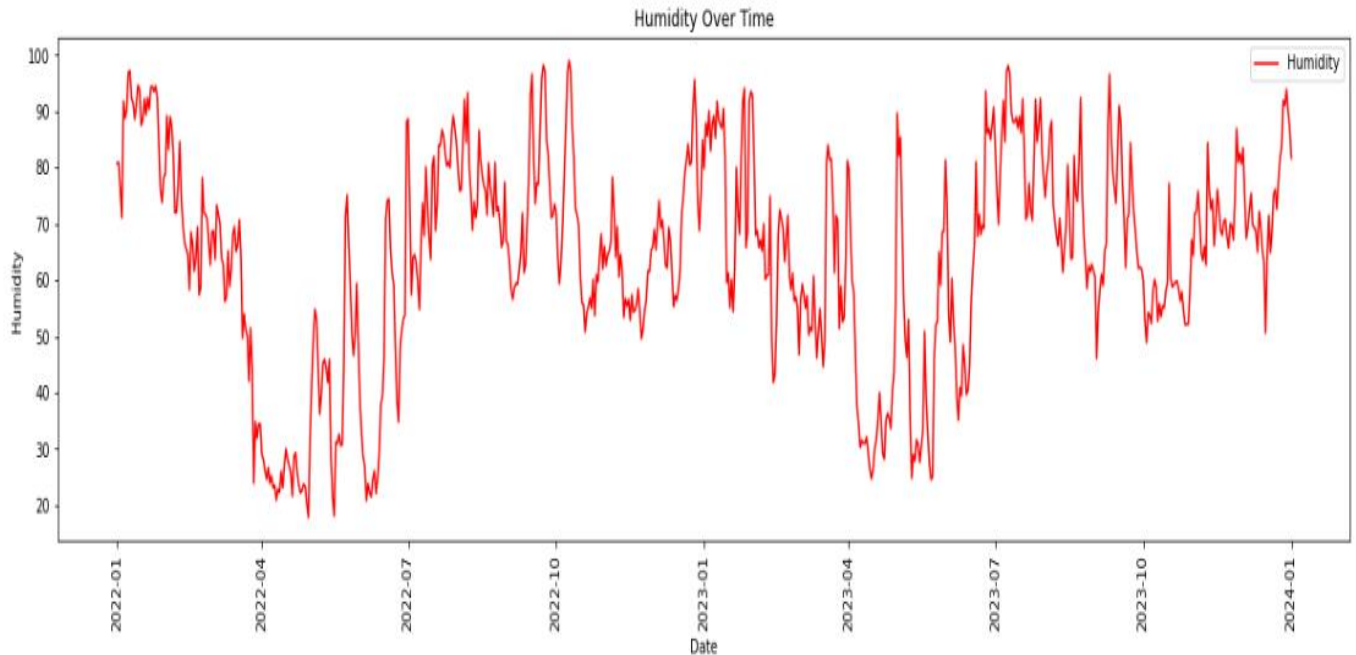
- Average visibility when humidity $\leq 50\%$: 3.39 km
- Average visibility when humidity $> 50\%$: 2.46 km

There's a noticeable difference in visibility between low and high humidity conditions. When humidity is lower ($\leq 50\%$), the average visibility is about 0.9 km better than when humidity is higher ($> 50\%$).

Extremes:

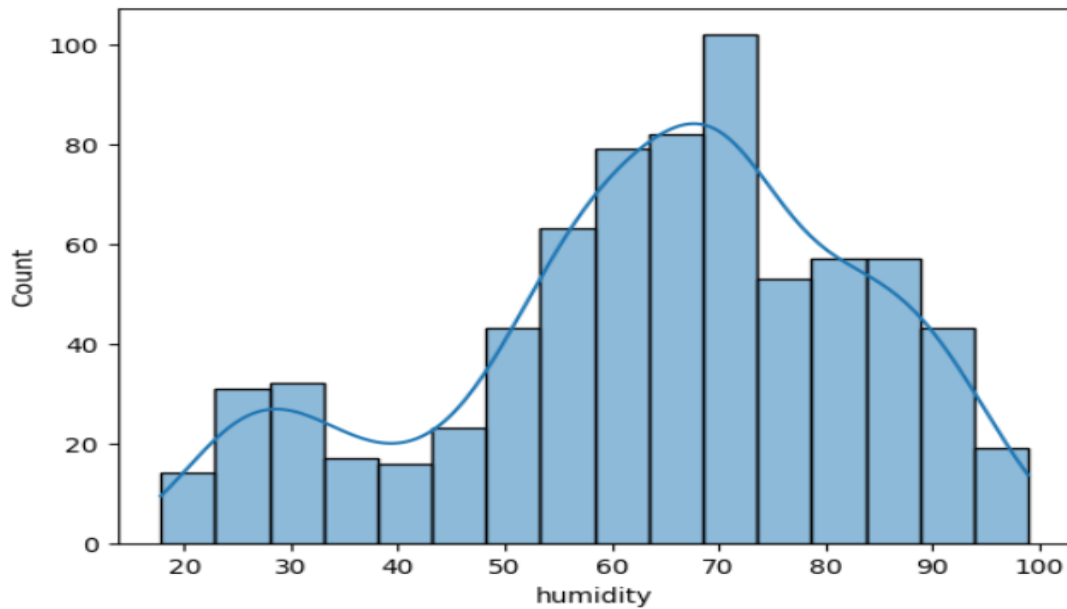
- Minimum visibility: 0.21 km
- Maximum visibility: 18.1 km
- Minimum humidity: 17.6%
- Maximum humidity: 99.4%
- **Inverse Relationship:** The scatter plot and correlation coefficient confirm an inverse relationship between humidity and visibility. As humidity increases, visibility generally decreases.
- **Variability:** There's considerable scatter in the plot, indicating that while there's a trend, other factors also influence visibility.

- **Humidity Impact:** The data shows that higher humidity levels are associated with reduced visibility. This could be due to increased water vapor in the air, which can scatter light and reduce how far we can see.
- **Range of Conditions:** Delhi experiences a wide range of both humidity (17.80% to 99.30%) and visibility (0.20 km to 17.90 km) conditions. This variability suggests that the city experiences diverse weather patterns.
- **Potential Factors:** While humidity plays a role in visibility, the moderate correlation suggests other factors are also important. These could include air pollution, temperature, or other meteorological conditions.
- **Implications:** The reduced visibility during high humidity conditions could have implications for transportation (especially air travel) and general urban life in Delhi.
- **Further Investigation:** It might be interesting to look at how these patterns change seasonally or to investigate what other factors contribute to the extremely low visibility days (0.20 km).

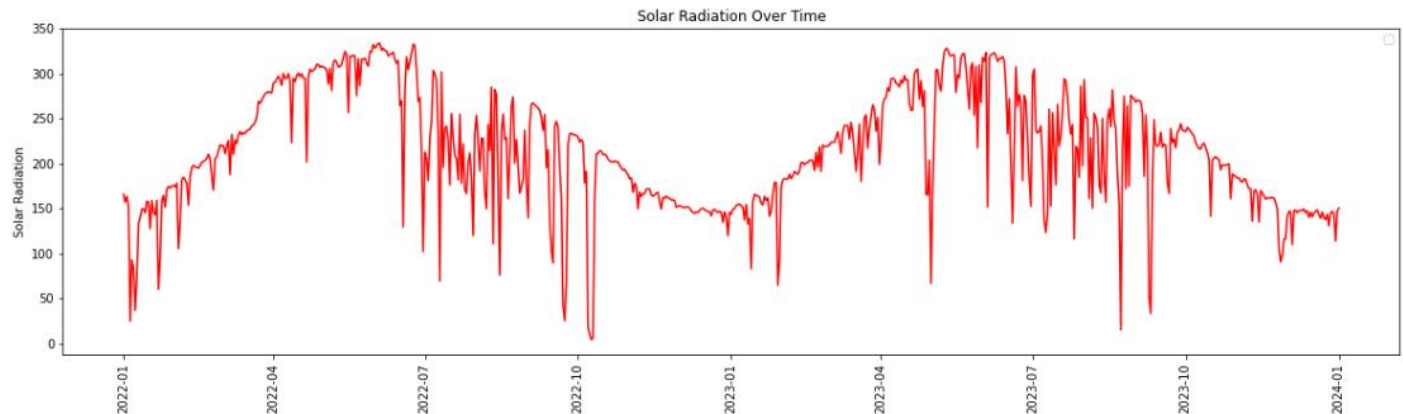


Humidity Trends:

- General range between 62% and 72% for full years of data.
- The overall average humidity for Delhi from 2022 to 2024 is 62.034%.
- Daily Fluctuations: The humidity levels in Delhi show significant day-to-day variations. For example, in the first few days of the data (June 26-30, 2022), we see humidity levels ranging from 52.1% to 82.8%.
- Seasonal Patterns: The graph shows clear seasonal patterns in humidity levels. There are regular peaks and troughs throughout the years, likely corresponding to the monsoon season (higher humidity) and drier seasons.
- Annual Cycle: The humidity trends appear to follow an annual cycle, with higher levels typically observed during the summer monsoon months (June to September) and lower levels during the winter and pre-monsoon periods.
- Long-term Trend: While there are clear seasonal fluctuations, it's difficult to discern a strong long-term trend in humidity levels from this visualization alone. The overall pattern seems relatively consistent across the years.
- Range of Humidity: The average daily humidity in Delhi varies widely, ranging from approximately 30% to 90% over the period analysed.
- Extreme Values: There are occasional spikes in humidity, reaching near 100%, which likely correspond to periods of heavy rainfall or extremely wet conditions.

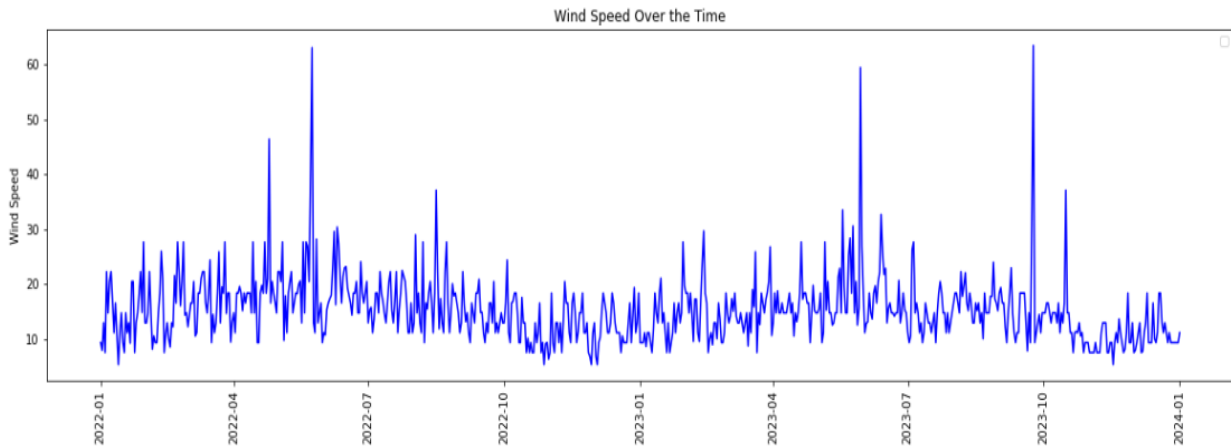


Solar Radiation Trends:



- The average solar radiation in Delhi during this period was approximately $214 W/m^2$.
- Wind solar radiation ranged from a minimum of $4.1 W/m^2$ to a maximum of $333.7 W/m^2$.
- The median wind speed (50th percentile) $213 W/m^2$.
- April to July tend to have the higher average solar radiation.
- October generally have lower average solar radiation.
- The standard deviation of solar deviation is about $65.6 W/m^2$, indicating a non-uniform spread in the data.
- 50% of the solar radiation readings fall between $163.95 W/m^2$ (25th percentile) and $267.1 W/m^2$ (75th percentile)

Wind speed Trends:



- The average wind speed in Delhi during this period was approximately 15.74 km/h.
- Wind speeds ranged from a minimum of 5.4 km/h to a maximum of 63.4 km/h.
- The median wind speed (50th percentile) was 14.8 km/h.
- Higher wind speeds typically occur in the summer months (May-July) and lower speeds in the winter months (October-December).
- The windiest day recorded was September 24, 2023, with a wind speed of 63.4 km/h.
- Four out of the five windiest days had wind speeds above 59 km/h.
- June and July tend to have the highest average wind speeds.
- October and November generally have lower wind speeds.
- The standard deviation of wind speeds is about 5.61 km/h, indicating a moderate spread in the data.
- 50% of the wind speed measurements fall between 11.2 km/h (25th percentile) and 18.4 km/h (75th percentile).
- While the average wind speed is moderate, there are occasional high wind events with speeds exceeding 60 km/h.

Conclusion:

The analysis of Delhi's weather data from 2022 to the forecasted 2024 shows consistent temperature patterns characteristic of a continental climate. Summer temperatures can reach up to 50°C, while winter temperatures can drop to 10°C. Over this six-year period, no signs of short-term climate change were detected, indicating stable weather patterns. This study provides valuable insights for urban planning, agriculture, and climate adaptation strategies in Delhi, laying the groundwork for ongoing monitoring to detect potential long-term climate changes.

References:

- Python for Data Analysis Book by Wes McKinney
- Crio.Do and Kaggle for dataset and other graphs.