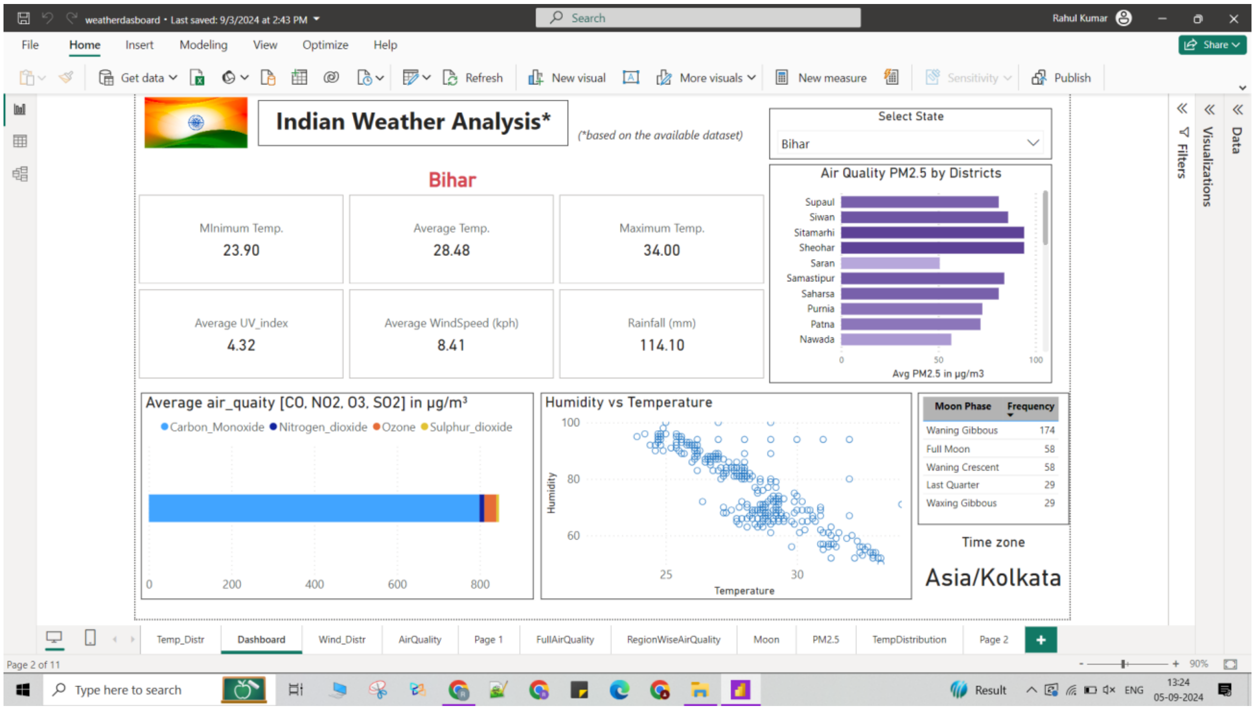
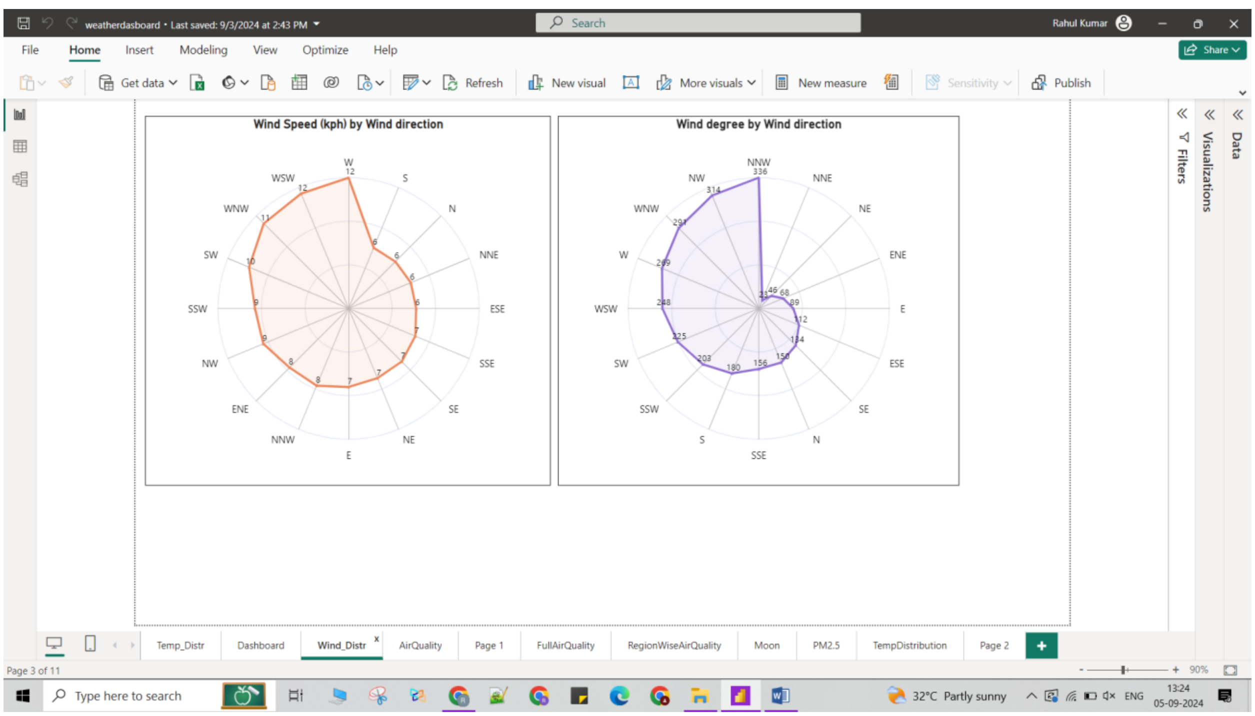
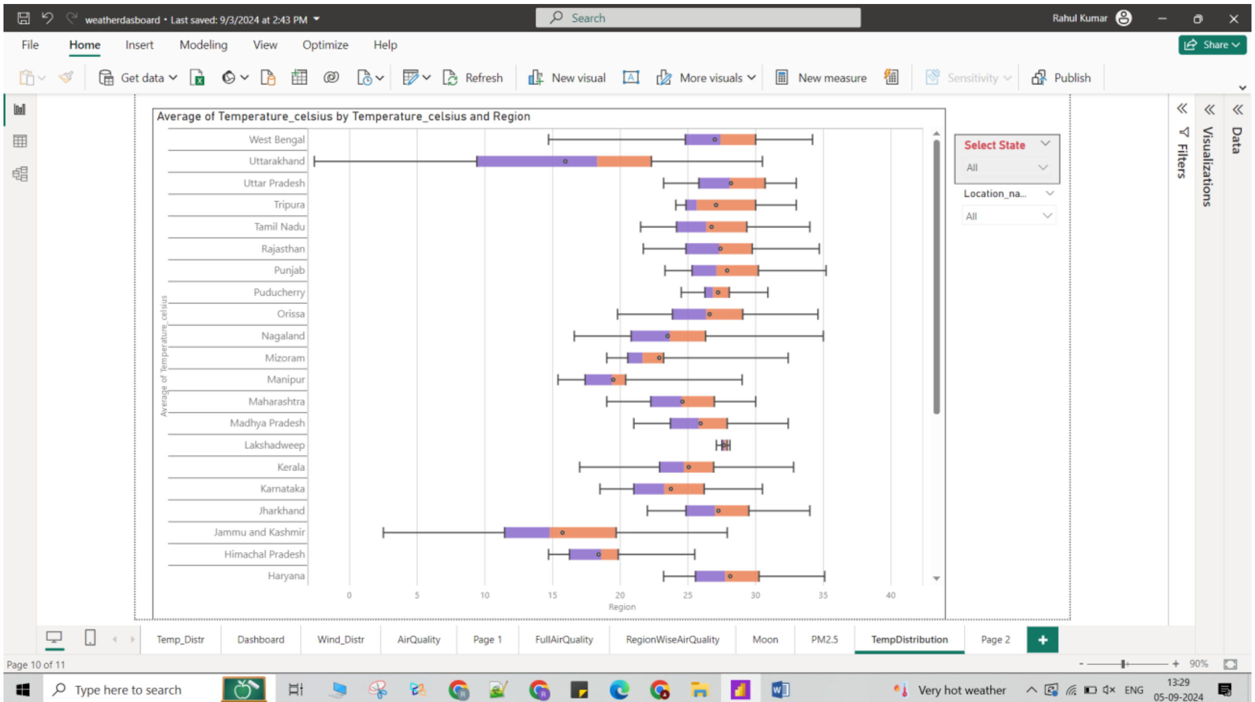
Weather Analysis and Forecast Project






weatherdasboard • Last saved: 9/3/2024 at 2:43 PM
Average of Temperature_celsius by Temperature_celsius and Region
West Bengal
Uttarakhand
Uttar Pradesh
Tripura
Tamil Nadu
Rajasthan
Punjab
Puducherry
Orissa
Nagaland
Mizoram
Manipur
Maharashtra
Madhya Pradesh
Lakshadweep
Kerala
Karnataka
Jharkhand
Jammu and Kashmir
Himachal Pradesh
Haryana
0 5 10 15 20 25 30 35 40
Region
Average of Temperature_celsius
Select State
All
Location_na...
All
Temp_Distr
Dashboard
Wind_Distr
AirQuality
Page 1
FullAirQuality
RegionWiseAirQuality
Moon
PM2.5
TempDistribution
Page 2
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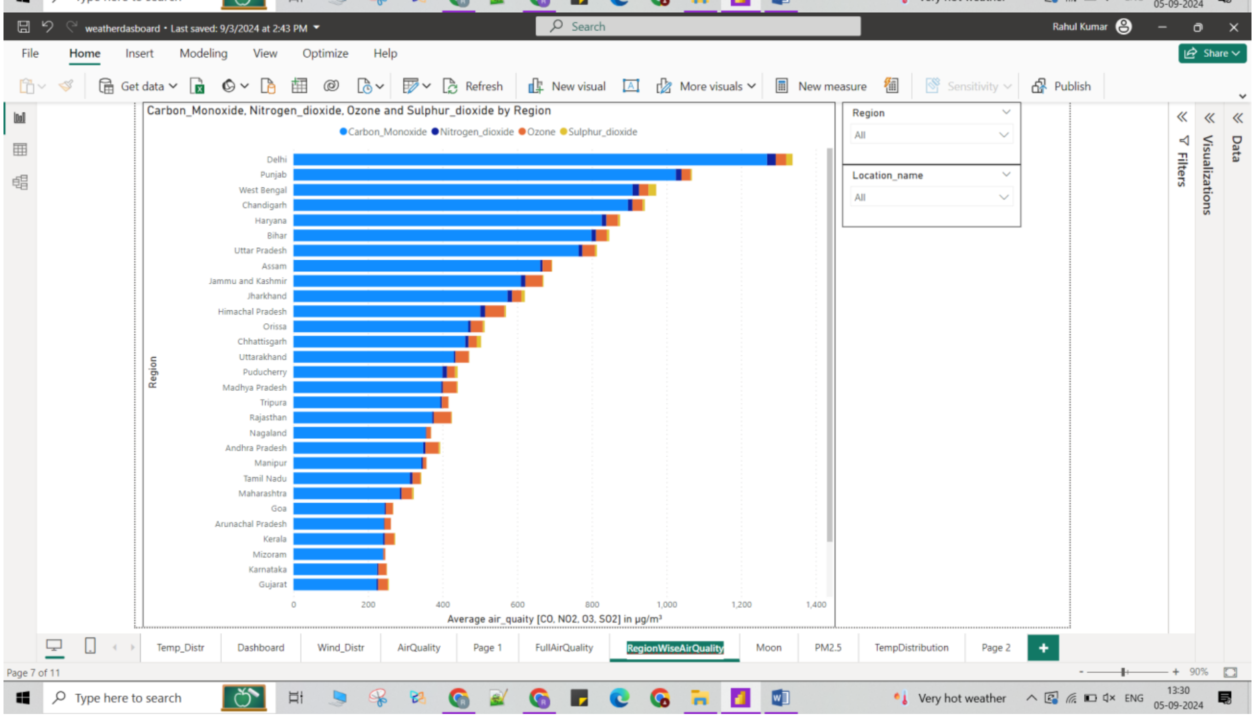
weatherdasboard • Last saved: 9/3/2024 at 2:43 PM
Carbon_Monoxide, Nitrogen_dioxide, Ozone and Sulphur_dioxide by Region
Carbon_Monoxide
Nitrogen_dioxide
Ozone
Sulphur_dioxide
Delhi
Punjab
West Bengal
Chandigarh
Haryana
Bihar
Uttar Pradesh
Assam
Jammu and Kashmir
Jharkhand
Himachal Pradesh
Orissa
Chhattisgarh
Uttarakhand
Puducherry
Madhya Pradesh
Tripura
Rajasthan
Nagaland
Andhra Pradesh
Manipur
Tamil Nadu
Maharashtra
Goa
Arunachal Pradesh
Kerala
Mizoram
Karnataka
Gujarat
Region
0 200 400 600 800 1,000 1,200 1,400
Average air_quaity [CO, NO2, O3, SO2] in µg/m³
Region
All
Location_name
All
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>> Gust Speed:
Wind gusts, which are short bursts of high-speed wind, can significantly impact the weather conditions of a place in several ways:

1. **Temperature Perception**: High wind gusts can make the air feel colder than the actual temperature, a phenomenon known as the wind chill effect. This can affect how comfortable people feel and can influence the risk of frostbite or hypothermia in cold conditions.

2. **Precipitation**: Wind gusts can affect the distribution of precipitation. For instance, strong winds can blow rain or snow sideways, making it difficult to predict where the precipitation will fall and how much will accumulate in different areas.

3. **Storm Intensity**: In severe weather events like thunderstorms or hurricanes, gusty winds can intensify the storm's impact. For example, hurricanes are characterized by their strong gusts, which can lead to extensive damage and increase the storm's overall destructiveness.

>> Dewpoint, Humidity and Wind Speed
Dewpoint

- **Definition**: The dewpoint is the temperature at which air becomes saturated with moisture and water vapor begins to condense into dew. It's a measure of the absolute moisture content in the air.

- **Implications**:

    - A higher dewpoint indicates more moisture in the air, which can lead to a muggy or humid feeling.

    - A lower dewpoint indicates drier air, which can feel more comfortable, especially in warmer temperatures.

Humidity

- **Definition**: Humidity refers to the amount of moisture in the air. It can be expressed in several ways:

Implications:

- High relative humidity makes the air feel warmer in summer because sweat evaporates more slowly, reducing the body's cooling efficiency.
- Low relative humidity can make the air feel cooler and can cause dryness in the skin and respiratory tract.

>>Wind can also affect humidity levels by moving air masses with different moisture contents. For example, a strong wind can carry moist air away from an area, leading to lower humidity levels.

Interactions Between Dewpoint, Humidity, and Windspeed

- **Comfort and Perception**:
  - When the dewpoint is high and humidity is high, the air feels sticky and uncomfortable, especially if windspeed is low, as there is less evaporative cooling.
  - If windspeed is high in a high humidity environment, it can help disperse moisture, reducing the muggy feeling to some extent.
  - Conversely, a low dewpoint and low humidity typically feel more comfortable, and the cooling effect of windspeed is more pronounced.
- **Weather Patterns**:
  - High humidity and high dewpoints are often associated with stormy weather, as the moisture in the air can lead to cloud formation and precipitation.
  - Wind can help modulate the local effects of humidity by redistributing air masses, which can influence temperature and dewpoint levels.

>> dewpoint is measured in units of temperature.

Understanding Barometric Pressure

- **Definition**: Barometric pressure is the force exerted by the weight of the air above a given point. It is measured using a barometer and is typically reported in units like inches of mercury (inHg) or millibars (mb) / hectopascals (hPa).

High Pressure Systems

- **Characteristics**: High pressure systems are often associated with descending air, which leads to generally clear skies and stable weather.
- **Weather Conditions**:
  - **Clear Skies**: High pressure generally brings fair weather and clear skies.
  - **Dry Conditions**: High pressure can lead to dry weather because descending air inhibits cloud formation.
  - **Stable Atmosphere**: High pressure systems often mean less turbulent conditions and fewer storms.

Low Pressure Systems

- **Characteristics**: Low pressure systems are associated with rising air, which can lead to cloud formation and stormy weather.
- **Weather Conditions**:
  - **Cloudy and Wet Weather**: Low pressure systems are often linked with cloudiness, precipitation, and stormy conditions.
  - **Windy Conditions**: Winds tend to be stronger around low pressure systems due to the pressure gradient force (the difference in pressure between high and low pressure areas).
  - **Instability**: Low pressure systems can lead to unstable atmospheric conditions, increasing the likelihood of thunderstorms and other severe weather events.

Pressure Trends and Weather Changes

- **Rising Pressure**:
  - **Associated Weather**: Generally indicates improving weather conditions. Rising pressure often signals that a high pressure system is moving in, which can lead to clearer skies and more stable weather.
- **Falling Pressure**:
  - **Associated Weather**: Often indicates worsening weather conditions. Falling pressure suggests that a low pressure system may be approaching, which can bring more clouds, precipitation, and potentially stormy weather.

Pressure Changes and Forecasting

- **Rapid Changes**: Rapid changes in barometric pressure can be an indicator of approaching weather systems. For example, a sudden drop in pressure might signal an incoming storm or low pressure system.
- **Pressure Gradients**: The rate of change in pressure over a distance (pressure gradient) affects wind speed. Steeper pressure gradients (large differences in pressure over a short distance) result in stronger winds.

Understanding Wind Direction

- **Definition**: Wind direction is the direction from which the wind is coming. For example, a wind from the north is a northerly wind.

Impact of Wind Direction on Weather

1. Winds from the North

- **Characteristics**: Typically associated with cooler, drier air.
- **Weather Conditions**:
  - **Cooler Temperatures**: Northern winds often bring cooler air masses, leading to lower temperatures.
  - **Dry Conditions**: In many regions, winds from the north can be dry, especially if they originate from a continental source.
  - **Clear Skies**: North winds can often be linked with high pressure systems, which bring clear skies and stable weather.

2. Winds from the South

- **Characteristics**: Often associated with warmer, more humid air.
- **Weather Conditions**:
  - **Warmer Temperatures**: Southern winds can bring warmer air masses, raising temperatures.
  - **Increased Humidity**: Winds from the south often come from oceanic or tropical regions, bringing higher humidity and potentially more precipitation.

- **Cloudiness and Rain**: In some cases, southerly winds can lead to cloud formation and precipitation, especially if they are picking up moisture from the ocean.

3. Winds from the East

- **Characteristics**: The effects of easterly winds can vary depending on the region but often bring specific weather patterns.
- **Weather Conditions**:
  - **Variable Effects**: In some regions, easterly winds can bring cooler, drier conditions, especially if they are originating from a continental source. In other areas, they might bring warmer, moist air.
  - **Local Effects**: For coastal regions, easterly winds might bring moisture from the sea, potentially leading to cloud cover or precipitation.

4. Winds from the West

- **Characteristics**: Commonly associated with weather patterns in mid-latitudes.
- **Weather Conditions**:
  - **Milder Temperatures**: Westerly winds often bring milder temperatures, especially in temperate regions.
  - **Moisture and Precipitation**: In many areas, westerly winds can bring moisture from the ocean, leading to increased cloudiness and precipitation.
  - **Storm Systems**: Westerly winds are often associated with low pressure systems and stormy weather, particularly in mid-latitude regions.

Influence of Global Wind Patterns

- **Trade Winds**: In the tropics, the trade winds blow from the northeast (northeasterly trades in the Northern Hemisphere) or southeast (southeasterly trades in the Southern Hemisphere). They influence weather patterns by driving ocean currents and affecting tropical storm formation.
- **Westerlies**: In mid-latitudes, the westerlies blow from the southwest in the Northern Hemisphere and from the northwest in the Southern Hemisphere. They play a major role in the movement of weather systems and storms across these regions.

Local Effects and Topography

- **Mountain Ranges**: Wind direction can be heavily influenced by local topography. For example, winds that are forced to rise over mountains can cool and condense, leading to orographic precipitation on the windward side and dry conditions on the leeward side (rain shadow effect).
- **Coastal Effects**: Coastal areas often experience sea breezes and land breezes, which are local winds that affect temperature and humidity based on the time of day.

>> The dataset was available on Indian Weather Repository Kaggle. It contained 42 columns and has comprehensive weather information starting from 29 Aug 2023 to 09 Sept 2023.

>> This dataset provides **real-time weather information for major cities in India**. Unlike forecast data, this dataset offers a comprehensive set of features that reflect the **current weather conditions**.

>> It provides over 40+ features, including temperature, wind, pressure, precipitation, humidity, visibility, and air quality measurements. This dataset is a valuable resource for analyzing **India's present weather trends** and exploring the relationships between various weather parameters.

- **country**: *Country of the weather data*
- **location_name**: *Name of the location (city)*
- **region**: *Administrative region of the location*
- **latitude**: *Latitude coordinate of the location*
- **longitude**: *Longitude coordinate of the location*
- **timezone**: *Timezone of the location*
- **last_updated_epoch**: *Unix timestamp of the last data update*
- **last_updated**: *Local time of the last data update*
- **temperature_celsius**: *Temperature in degrees Celsius*
- **temperature_fahrenheit**: *Temperature in degrees Fahrenheit*
- **condition_text**: *Weather condition description*
- **wind_mph**: *Wind speed in miles per hour*
- **wind_kph**: *Wind speed in kilometers per hour*
- **wind_degree**: *Wind direction in degrees*
- **wind_direction**: *Wind direction as 16-point compass*
- **pressure_mb**: *Pressure in millibars*
- **pressure_in**: *Pressure in inches*
- **precip_mm**: *Precipitation amount in millimeters*
- **precip_in**: *Precipitation amount in inches*
- **humidity**: *Humidity as a percentage*
- **cloud**: *Cloud cover as a percentage*
- **feels_like_celsius**: *Feels-like temperature in Celsius*
- **feels_like_fahrenheit**: *Feels-like temperature in Fahrenheit*
- **visibility_km**: *Visibility in kilometers*
- **visibility_miles**: *Visibility in miles*
- **uv_index**: *UV Index*
- **gust_mph**: *Wind gust in miles per hour*
- **gust_kph**: *Wind gust in kilometers per hour*
- **air_quality_Carbon_Monoxide**: *Air quality measurement: Carbon Monoxide*
- **air_quality_Ozone**: *Air quality measurement: Ozone*
- **air_quality_Nitrogen_dioxide**: *Air quality measurement: Nitrogen Dioxide*
- **air_quality_Sulphur_dioxide**: *Air quality measurement: Sulphur Dioxide*
- **air_quality_PM2.5**: *Air quality measurement: PM2.5*
- **air_quality_PM10**: *Air quality measurement: PM10*
- **air_quality_us-epa-index**: *Air quality measurement: US EPA Index*
- **air_quality_gb-defra-index**: *Air quality measurement: GB DEFRA Index*
- **sunrise**: *Local time of sunrise*
- **sunset**: *Local time of sunset*
- **moonrise**: *Local time of moonrise*
- **moonset**: *Local time of moonset*
- **moon_phase**: *Current moon phase*

- **moon_illumination**: *Moon illumination percentage*

Potential Use Cases:

- **Weather trend analysis:** Analyze historical weather data to identify long-term patterns and trends.
- **Geospatial analysis:** Explore geographical variations in weather conditions across different regions.
- **Weather condition correlations:** Investigate relationships between various weather parameters and their effects on each other.
- **Air quality impact:** Study the impact of weather conditions on air quality measurements.
- **Celestial events analysis:** Examine correlations between celestial events and weather phenomena.

---------------------------- Air Quality --------------------------------

I started by cleaning the dataset, checking for missing values, and detecting outliers in the air quality data. I then analyzed the distribution of pollutants using histograms and boxplots to understand their spread and identify any unusual patterns. A correlation matrix and heatmap revealed strong relationships between certain pollutants. I grouped the data by region to find pollution hotspots and used scatterplots to explore how weather conditions like temperature and humidity affect air quality. I compared the US EPA and GB DEFRA indices to assess consistency in air quality assessments. Finally, I applied an Isolation Forest model to detect anomalies, highlighting unusual pollution events for further investigation.

--------------------------- Wind Distribution ---------------------------

I analyzed wind distribution patterns using two types of visualizations, I chose radar charts to visualize wind speeds across different directions because they effectively display variations in a circular format, making it easy to compare multiple directions at once. This helps in understanding the relative strengths of winds from various directions in a clear and intuitive way.

1. **Polar Plot:** This plot revealed that the highest wind frequencies occur between 250 and 290 degrees, indicating prevailing wind directions from the WNW to NW.
2. **Radar Chart:** I used this chart to show average wind speeds across eight directions. The varying lengths of the sides illustrate differences in wind speeds for each direction.

These visualizations help in understanding both the common wind directions and the strength of the winds in those directions.

------------------------ MOON Phase --------------------------------

Moon phases refer to the different stages of illumination that the Moon goes through as observed from Earth. These phases result from the varying angles at which sunlight hits the Moon and how much of the Moon's surface is visible from Earth. The phases repeat in a cycle known as the lunar cycle, which lasts about 29.5 days.

Here’s a detailed overview of the main moon phases:

1. New Moon

- **Description:** The Moon is between Earth and the Sun, so the side of the Moon illuminated by the Sun is facing away from Earth. As a result, the Moon appears dark and is not visible from Earth.
- **Characteristics:** The Moon's illumination is 0%.

2. **Waxing Crescent**

   - **Description:** After the new moon, a small sliver of the Moon becomes visible. The illuminated part of the Moon is increasing, but less than half of the Moon is visible.
   - **Characteristics:** The Moon's illumination is between 0% and 50%.

3. **First Quarter**

   - **Description:** The Moon has completed about a quarter of its orbit around Earth. Half of the Moon's surface is illuminated and visible from Earth.
   - **Characteristics:** The Moon's illumination is 50%.

4. **Waxing Gibbous**

   - **Description:** More than half of the Moon is illuminated and increasing towards a full Moon. The illuminated portion continues to grow.
   - **Characteristics:** The Moon's illumination is between 50% and 100%.

5. **Full Moon**

   - **Description:** The Moon is on the opposite side of Earth from the Sun. The entire face of the Moon that faces Earth is fully illuminated.
   - **Characteristics:** The Moon's illumination is 100%.

6. **Waning Gibbous**

   - **Description:** After the full Moon, the amount of illumination decreases, but more than half of the Moon is still visible. The illuminated portion is decreasing.
   - **Characteristics:** The Moon's illumination is between 100% and 50%.

7. **Last Quarter**

   - **Description:** The Moon has completed about three-quarters of its orbit around Earth. Half of the Moon's surface is illuminated, but the opposite half from the First Quarter.
   - **Characteristics:** The Moon's illumination is 50%.

8. **Waning Crescent**

   - **Description:** Only a small crescent of the Moon is illuminated. The illuminated portion continues to decrease as it approaches the new Moon phase.
   - **Characteristics:** The Moon's illumination is between 50% and 0%.

Lunar Cycle

The full cycle from one new moon to the next is called the lunar cycle or lunation. It lasts approximately 29.5 days and includes all the above phases.

Additional Terms:

- **Supermoon:** A full moon that occurs when the Moon is at its closest point to Earth in its orbit, appearing larger and brighter than usual.
- **Blue Moon:** The second full moon in a single calendar month. This happens approximately every 2.5 years.
- **Blood Moon:** A term often used for a total lunar eclipse when the Moon takes on a reddish color due to the Earth’s shadow.

Visual Representation of Moon Phases:

Here’s a simplified illustration of the moon phases:

rust

Copy code

New Moon -> Waxing Crescent -> First Quarter -> Waxing Gibbous -> Full Moon -> Waning Gibbous -> Last Quarter -> Waning Crescent -> New Moon

Moon Phase Cycle:

1. **New Moon** (0% illumination)
2. **Waxing Crescent** (1% - 49% illumination)
3. **First Quarter** (50% illumination)
4. **Waxing Gibbous** (51% - 99% illumination)
5. **Full Moon** (100% illumination)
6. **Waning Gibbous** (99% - 51% illumination)
7. **Last Quarter** (50% illumination)
8. **Waning Crescent** (49% - 1% illumination)

---------------------- Temperature Distribution ---------------------

Here's a brief explanation of the analysis:

1. **Histogram:** We used this to see how temperatures are distributed over the 12 days. It helped us understand the range and how frequently different temperatures occurred.
2. **Box Plot:** This plot showed us the middle values and spread of temperatures, as well as any outliers. It gave us a clear picture of the temperature's overall consistency and any unusual spikes or drops.

3. **Line Plot:** By plotting temperatures over time, we could easily spot any trends or fluctuations during the 12 days. It helped us see how temperatures changed day by day.
4. **Rolling Average:** This smoothed out daily temperature changes, making it easier to spot long-term trends without getting distracted by daily variations.
5. **Scatter Plots and Correlation Matrices:** We looked at how temperature related to other factors like humidity. This helped us understand if changes in temperature were associated with changes in other weather conditions.

Certainly! Here's a concise summary of the analysis:

1. **Data Cleaning:** Verified and converted the `'temperature_celsius'` column to numeric, addressing any missing values.
2. **Descriptive Statistics:** Calculated basic statistics for temperature to understand central tendency and variability.
3. **Histogram:** Used to visualize the distribution of temperature values and identify common ranges and distribution shape.
4. **Box Plot:** Highlighted the median, quartiles, and outliers in temperature data, showing overall consistency and anomalies.
5. **Line Plot (Trends Over Time):** Displayed temperature changes over the 12 days, revealing trends and fluctuations.
6. **Rolling Average:** Applied a 7-day rolling average to smooth short-term variations and emphasize longer-term trends.
7. **Wind Analysis:** Examined wind speed and direction to understand wind patterns and their impact on weather.
8. **Air Quality:** Analyzed air quality indicators (e.g., CO, PM2.5) to assess environmental conditions.
9. **Moon Phases:** Studied moon phases and illumination to explore their effects on visibility and potential impacts on weather.
10. **Pressure and Humidity:** Briefly reviewed trends in pressure and humidity to understand their relationship and impact on overall weather conditions.

Points:

1. Weather has always been a subject of interest for many. This analysis aims to explore various factors related to weather in India, such as temperature and air quality metrics.
2. This notebook offers an in-depth exploration of a comprehensive real-time weather dataset that provides valuable insights into the current weather conditions of major cities in India. Unlike traditional forecast data, this dataset unveils the present state of weather phenomena, allowing for a detailed analysis of temperature variations, wind patterns, precipitation levels, air quality, and more. Whether you're a meteorology enthusiast, a data scientist, or someone curious about India's diverse climate, this curated dataset opens doors to a wealth of information. Throughout this notebook, we'll utilize the powerful Plotly library to visualize the dataset's features in an interactive and informative manner. From temperature distributions to wind patterns, air quality comparisons, and celestial events, we'll leverage Plotly's capabilities to bring the weather data to life. Let's dive into the world of real-time weather data analysis and uncover intriguing insights together.

--------------------->>> ########### **Summary** ############## <<<------------------------------

In my "Weather Analysis Dashboard" project for Indian States in December 2023, I leveraged my background in chemical engineering to conduct an in-depth analysis of weather data. I examined various fields such as temperature, air quality, humidity, and wind distribution using Power BI and Kaggle notebooks. Familiar with the attributes, I analysed each column meticulously, identifying cities with alarmingly high concentrations of air pollutants like PM2.5, PM10, ozone, and CO. These findings highlighted areas with potential health risks, prompting a deeper exploration of air quality patterns.

Further, I used radar and polar charts to analyse wind distribution, revealing that winds from the WNW and NW directions were predominant across many Indian cities, which could be linked to seasonal weather patterns or geographical influences. Additionally, I explored temperature distribution trends, providing insights into regional climate variations. This comprehensive analysis was visualized in a Power BI dashboard, offering a clear and interactive overview of state-wise weather patterns, which can inform policy-making and public awareness initiatives.