Introduction

- Our data spans 22 days, capturing a snapshot of **weather and air quality conditions** throughout this period.
- We have at our disposal a dataset consisting of a staggering **4,287 rows**.
- These records encompass information from a total of **197 unique locations (Cities)**, scattered across **185 countries**.

```
# Importing libraries

import numpy as np
import pandas as pd
import datetime
import missingno

import seaborn as sns
import matplotlib.pyplot as plt
import plotly.io as pio
import plotly.express as px
import plotly.figure_factory as ff
from plotly.subplots import make_subplots
import plotly.graph_objects as go
from ipywidgets import widgets
import scipy.stats as stats

import os
from google.colab import files
from google.colab import output
output.enable_custom_widget_manager()
```

```
# Upload dataset to Colab workspace
uploaded = files.upload()
```

Choose files No file chosen Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to e

```
Saving GlobalWeather.csv to GlobalWeather.csv
```

```
os.getcwd()
```

```
'/content'
```

```
os.listdir()
```

```
['.config', 'GlobalWeather.csv', 'sample_data']
```

```
#!rm 'GlobalWeather.csv'
```

Importing and exploring the dataset

```
# Import the dataset into a DataFrame

global_weather = pd.read_csv('GlobalWeather.csv')
global_weather.head()
```

	country	location_name	latitude	longitude	timezone	last_updated_epoch	last_updated	temperature_celsius	temperature_
0	Afghanistan	Kabul	34.52	69.18	Asia/Kabul	1693301400	8/29/2023 14:00	28.8	
1	Albania	Tirana	41.33	19.82	Europe/Tirane	1693301400	8/29/2023 11:30	27.0	
2	Algeria	Algiers	36.76	3.05	Africa/Algiers	1693301400	8/29/2023 10:30	28.0	
3	Andorra	Andorra La Vella	42.50	1.52	Europe/Andorra	1693301400	8/29/2023 11:30	10.2	
4	Angola	Luanda	-8.84	13.23	Africa/Luanda	1693301400	8/29/2023 10:30	25.0	

5 rows × 41 columns

```
global_weather.shape
```

```
(4287, 41)
```

```
columns = global_weather.columns.values
columns
```

```
array(['country', 'location_name', 'latitude', 'longitude', 'timezone',
       'last_updated_epoch', 'last_updated', 'temperature_celsius',
       'temperature_fahrenheit', 'condition_text', 'wind_mph', 'wind_kph',
       'wind_degree', 'wind_direction', 'pressure_mb', 'pressure_in',
       'precip_mm', 'precip_in', 'humidity', 'cloud',
       'feels_like_celsius', 'feels_like_fahrenheit', 'visibility_km',
       'visibility_miles', 'uv_index', 'gust_mph', 'gust_kph',
       'air_quality_Carbon_Monoxide', 'air_quality_Ozone',
       'air_quality_Nitrogen_dioxide', 'air_quality_Sulphur_dioxide',
       'air_quality_PM2.5', 'air_quality_PM10',
       'air_quality_us-epa-index', 'air_quality_gb-defra-index',
       'sunrise', 'sunset', 'moonrise', 'moonset', 'moon_phase',
       'moon_illumination'], dtype=object)
```

Data cleaning

Renaming columns

[ ] ↳ *1 cell hidden*

Checking for duplicates

[ ] ↳ *1 cell hidden*

Checking for incorrectly listed entries

[ ] ↳ *10 cells hidden*

Checking for missing data

```
global_weather.isna().sum()

# Observation - There are no NaN values
# 'No Moonrise' has been converted to NaT...... NaT represents missing or invalid values in datetime data
```

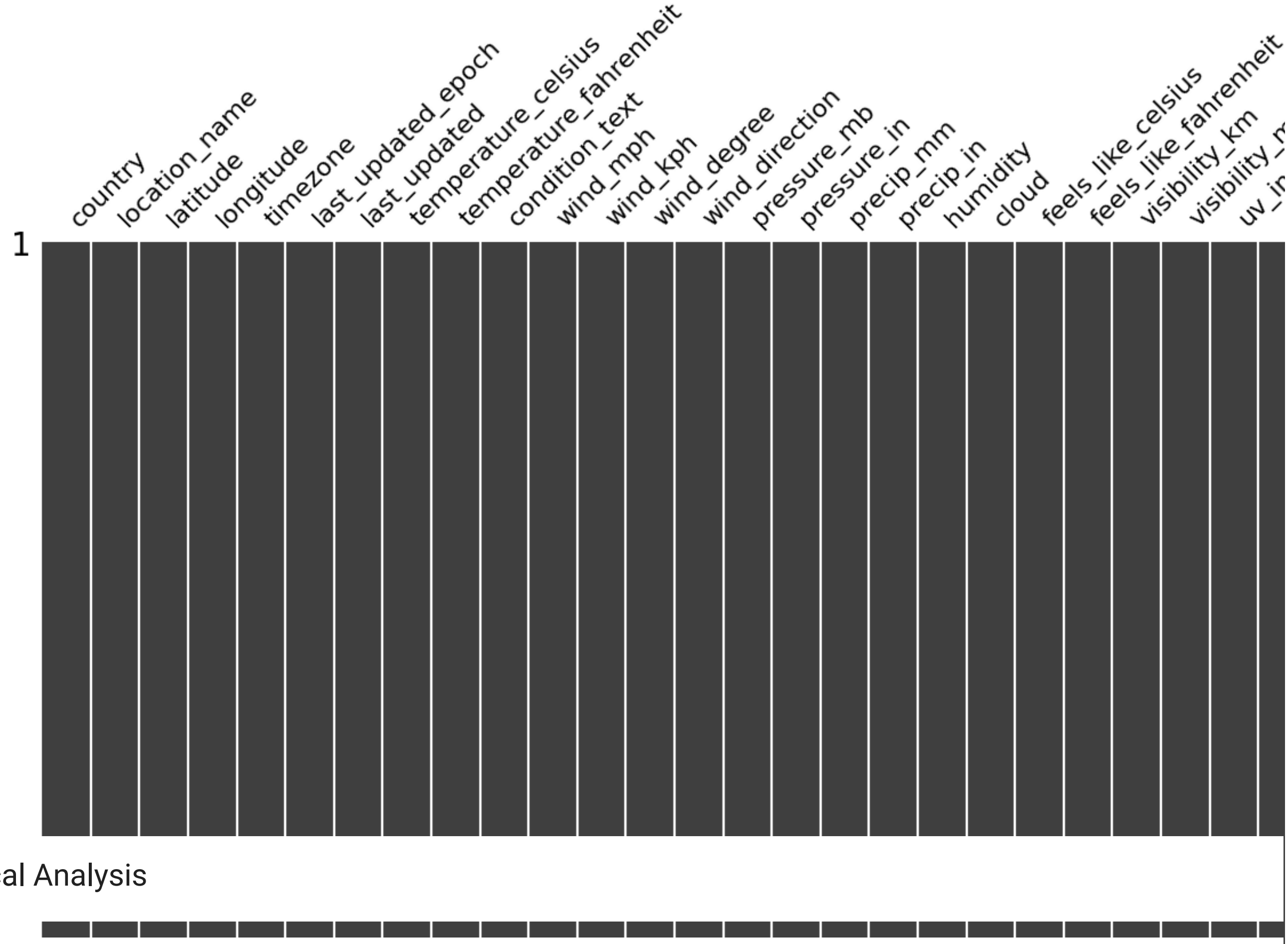
```
country                   0
location_name             0
latitude                  0
longitude                 0
timezone                  0
last_updated_epoch        0
last_updated              0
temperature_celsius       0
temperature_fahrenheit    0
condition_text            0
wind_mph                  0
wind_kph                  0
wind_degree               0
wind_direction            0
pressure_mb               0
pressure_in               0
precip_mm                 0
precip_in                 0
humidity                  0
cloud                     0
feels_like_celsius        0
feels_like_fahrenheit     0
visibility_km             0
visibility_miles          0
uv_index                  0
gust_mph                  0
gust_kph                  0
Carbon_Monoxide           0
Ozone                     0
Nitrogen_dioxide          0
Sulphur_dioxide           0
PM2.5                     0
PM10                      0
us-epa-index              0
gb-defra-index            0
sunrise                   0
sunset                    0
```

```
moonrise                  195
moonset                     0
moon_phase                  0
moon_illumination           0
dtype: int64
```

```
# Visual representation of the missing data in the dataset
```

```
missingno.matrix(global_weather)
```

```
<Axes: >
```



Statistical Analysis

```
glb_weather = global_weather.loc[:, ~global_weather.columns.isin(['temperature_fahrenheit', 'wind_mph', 'pressure_in', 'precip_in', 'feel
glb_weather.columns
```

```
Index(['country', 'location_name', 'latitude', 'longitude', 'timezone',
       'last_updated_epoch', 'last_updated', 'temperature_celsius',
       'condition_text', 'wind_kph', 'wind_degree', 'wind_direction',
       'pressure_mb', 'precip_mm', 'humidity', 'cloud', 'feels_like_celsius',
       'visibility_km', 'uv_index', 'gust_kph', 'Carbon_Monoxide', 'Ozone',
       'Nitrogen_dioxide', 'Sulphur_dioxide', 'PM2.5', 'PM10', 'us-epa-index',
       'gb-defra-index', 'sunrise', 'sunset', 'moonrise', 'moonset',
       'moon_phase', 'moon_illumination'],
      dtype='object')
```

```
global_weather.describe()
```

```
global_weather.describe(include=['category', 'object'])
```

	country	location_name	timezone	condition_text	wind_direction	sunrise	sunset	moonrise	moonset	moon_phase
count	4287	4287	4287	4287	4287	4287	4287	4092	4287	4287
unique	185	197	183	22	16	167	202	1015	1063	7
top	Bulgaria	'S-Gravenwezel	Europe/Rome	Partly cloudy	N	05:54:00	18:04:00	05:51:00	19:42:00	Waning Crescent
freq	66	22	66	1753	509	90	75	17	16	1170

```
all_corr = glb_weather.corr()
all_corr
```

```
<ipython-input-26-2ee7b737104d>:1: FutureWarning: The default value of numeric_only in DataFrame.corr is deprecated. In a future ver
  all_corr = glb_weather.corr()
```

	latitude	longitude	temperature_celsius	wind_kph	wind_degree	pressure_mb	precip_mm	humidity	cloud	fee
latitude	1.000000	-0.012946	-0.212455	-0.133391	0.069346	-0.032076	-0.026931	0.118230	-0.129685	
longitude	-0.012946	1.000000	-0.082883	-0.097008	0.021482	-0.099416	-0.003362	0.087272	0.047590	
temperature_celsius	-0.212455	-0.082883	1.000000	0.141516	0.009488	-0.557531	0.027785	-0.232697	0.075645	
wind_kph	-0.133391	-0.097008	0.141516	1.000000	0.099575	-0.096546	0.033535	-0.092590	0.157593	
wind_degree	0.069346	0.021482	0.009488	0.099575	1.000000	-0.063781	0.023963	0.004575	0.027570	
pressure_mb	-0.032076	-0.099416	-0.557531	-0.096546	-0.063781	1.000000	-0.048373	0.061262	-0.114283	
precip_mm	-0.026931	-0.003362	0.027785	0.033535	0.023963	-0.048373	1.000000	0.125208	0.184434	
humidity	0.118230	0.087272	-0.232697	-0.092590	0.004575	0.061262	0.125208	1.000000	0.372744	
cloud	-0.129685	0.047590	0.075645	0.157593	0.027570	-0.114283	0.184434	0.372744	1.000000	
feels_like_celsius	-0.220043	-0.095380	0.969729	0.145306	0.003114	-0.540124	0.051975	-0.131675	0.113424	
visibility_km	-0.032225	0.023573	0.098103	0.050882	0.002072	0.043817	-0.037158	-0.146049	0.047218	
uv_index	-0.141539	-0.026577	0.379051	0.166053	-0.008244	-0.132992	-0.004615	-0.134302	0.173171	
gust_kph	-0.136533	-0.047505	0.214200	0.568537	0.047171	-0.168512	0.069068	-0.036240	0.107963	
Carbon_Monoxide	-0.136347	0.084440	0.013554	-0.112120	-0.003900	-0.028797	-0.006738	0.062077	-0.001093	
Ozone	0.074767	-0.123249	0.178883	0.202671	0.080588	-0.101406	-0.039353	-0.364122	-0.123182	
Nitrogen_dioxide	0.104529	0.066551	-0.010497	-0.174109	-0.020118	-0.046637	-0.028304	-0.055013	-0.104005	
Sulphur_dioxide	0.028229	0.079316	0.073612	-0.098212	-0.027969	-0.092219	-0.003767	-0.100957	-0.056661	
PM2.5	-0.067472	0.125652	0.026547	-0.125978	0.003173	-0.064641	-0.031734	0.019224	-0.064395	
PM10	-0.070703	0.136612	0.089370	-0.106515	0.016698	-0.116523	-0.042395	-0.061776	-0.095000	
us-epa-index	-0.030460	0.168636	0.088815	-0.183426	0.006068	-0.143456	-0.045734	-0.070994	-0.137401	
gb-defra-index	-0.027831	0.170316	0.090222	-0.174872	-0.003097	-0.156093	-0.040212	-0.059254	-0.113438	
moon_illumination	0.000021	-0.001577	-0.023750	0.012928	0.031285	-0.015742	0.089413	0.053971	0.058986	

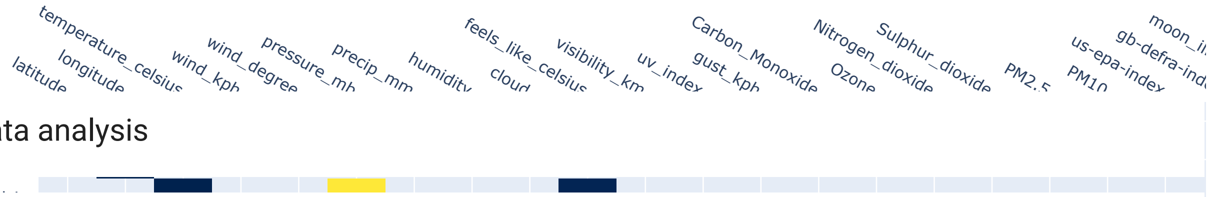
22 rows × 22 columns

```
fig = px.imshow(all_corr, text_auto=True, aspect="auto", color_continuous_scale = 'Viridis', width=2000, height=1400)
fig.update_xaxes(side="top")

fig.show()
```

```
# Plotting only the significant correlation

fig = px.imshow(all_corr[(all_corr >= 0.5) |(all_corr <= -0.35)], text_auto=True, aspect="auto", color_continuous_scale = 'Cividis_r', wi
fig.update_xaxes(side="top")
fig.show()
```



Exploratory data analysis

Feature Analysis - Univariate Analysis

```
def plot_box_hist(col1, col2, nbins, title):
  fig = make_subplots(rows=2, cols=2)

  trace0 = go.Box(y  = global_weather[col1], name = col1)
  trace1 = go.Box(y = global_weather[col2], name = col2)
  trace2 = go.Histogram(x  = global_weather[col1], name = col1, nbinsx = nbins)
  trace3 = go.Histogram(x = global_weather[col2], name = col2, nbinsx = nbins)

  fig.add_trace(trace0, row=1, col=1)
  fig.add_trace(trace1, row=1, col=2)
  fig.add_trace(trace2, row=2, col=1)
  fig.add_trace(trace3, row=2, col=2)

  fig.update_layout(height=800, width=1200, title_text=title, showlegend=True)
  fig.show()
```

```
print('Number of Weather condition types: ', len(global_weather['condition_text'].unique()), '\n')
global_weather['condition_text'].value_counts()
```

```
Number of Weather condition types:  22

Partly cloudy                          1753
Clear                                  1513
Sunny                                   248
Overcast                                136
Light rain                              116
Mist                                    116
Patchy rain possible                    108
Light rain shower                        73
Moderate or heavy rain with thunder      50
Patchy light rain with thunder           45
Fog                                      35
Cloudy                                   25
Moderate rain                            23
Moderate or heavy rain shower            14
Thundery outbreaks possible              10
Light drizzle                             5
Heavy rain                                4
Moderate rain at times                    3
Patchy light rain                         3
Torrential rain shower                    3
Patchy light drizzle                      2
Heavy rain at times                       2
Name: condition_text, dtype: int64
```

```
print('Number of distinct wind directions: ', len(global_weather['wind_direction'].unique()), '\n')
global_weather['wind_direction'].value_counts()
```

```
Number of distinct wind directions:  16

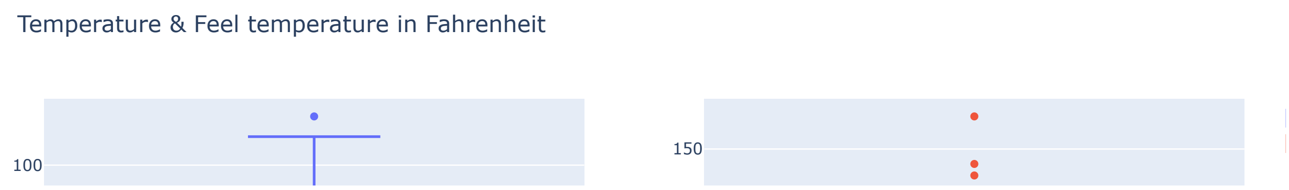
N      509
E      395
S      318
ESE    310
ENE    276
SE     265
SW     260
SSW    257
NE     257
W      244
WSW    227
SSE    220
NNE    210
NW     188
NNW    186
WNW    165
Name: wind_direction, dtype: int64
```

```
print('Number of distinct moon illumination values: ', global_weather['moon_illumination'].unique())
```

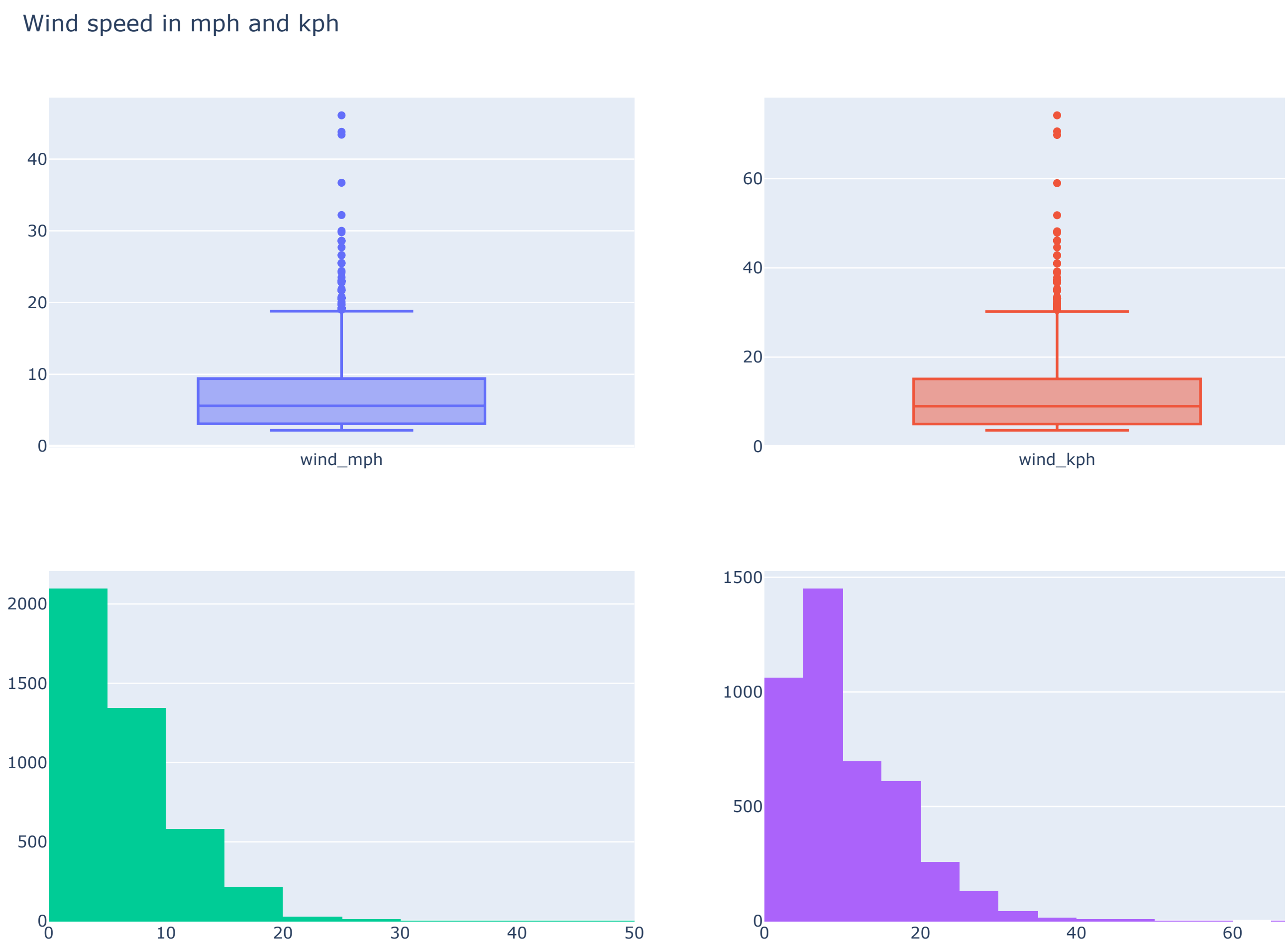
```
Number of distinct moon illumination values:  [ 93  98 100  99  94  88  79  70  60  49  39  30  22  14   8   1   0   3]
```

```
plot_box_hist('temperature_celsius', 'feels_like_celsius', 50, 'Temperature & Feel temperature in Celsius')
```

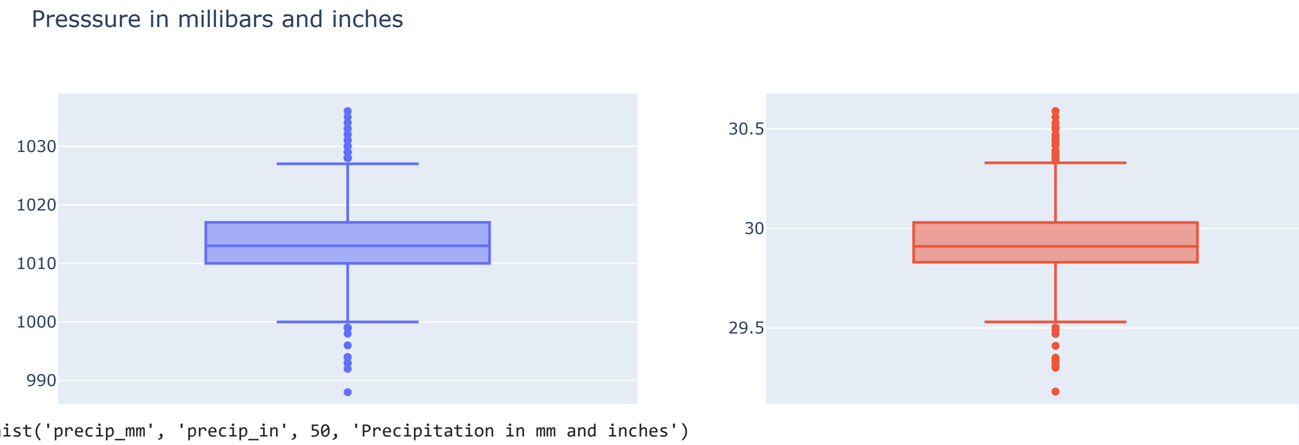
```
plot_box_hist('temperature_fahrenheit', 'feels_like_fahrenheit', 50, 'Temperature & Feel temperature in Fahrenheit')
```



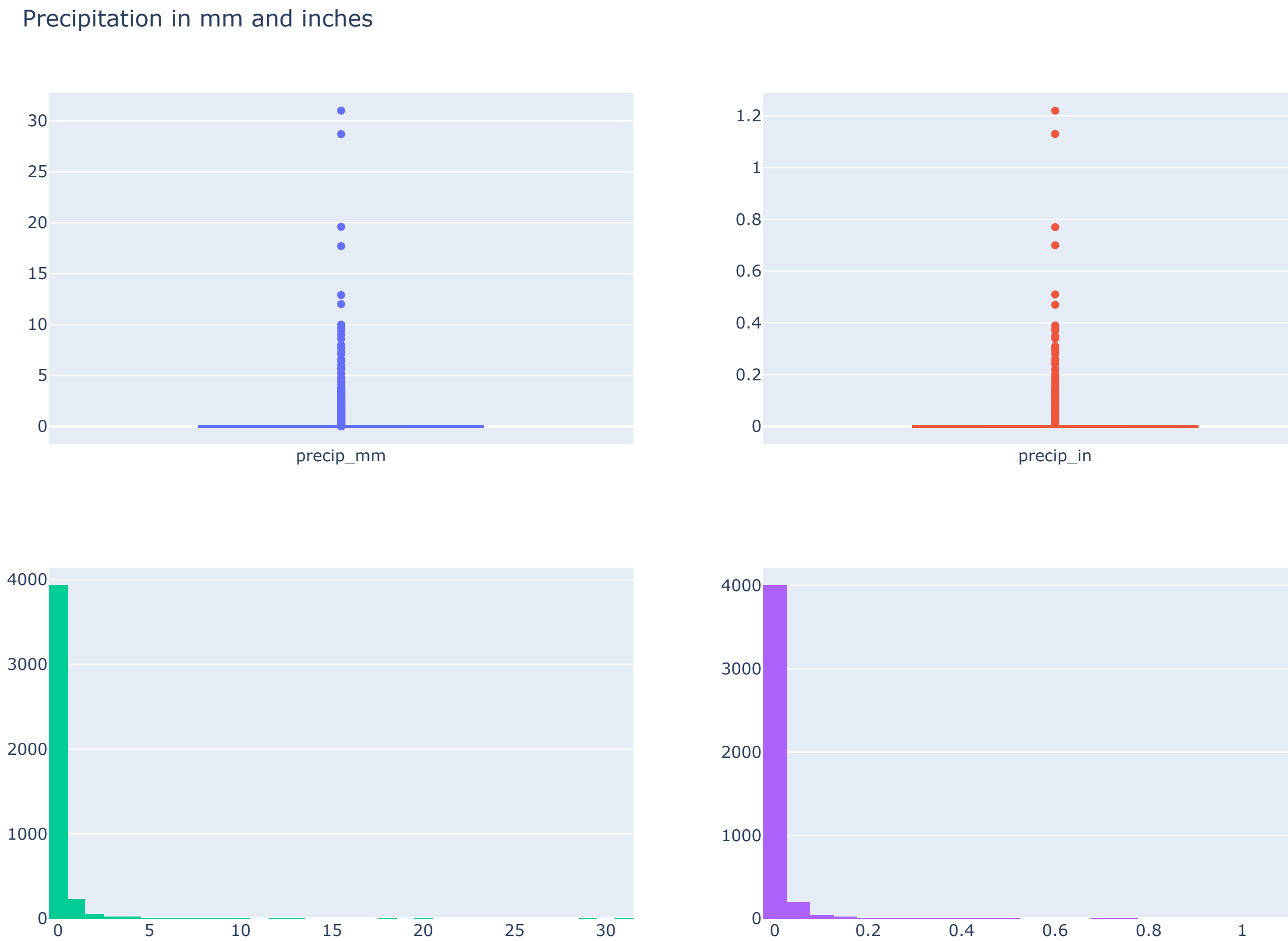

```
plot_box_hist('wind_mph', 'wind_kph', 20, 'Wind speed in mph and kph')
```




```
plot_box_hist('pressure_mb', 'pressure_in', 20, 'Presssure in millibars and inches')
```




```
plot_box_hist('precip_mm', 'precip_in', 50, 'Precipitation in mm and inches')
```




```
plot_box_hist('visibility_km', 'visibility_miles', 12, 'Visibility in km and miles')
```


```
px.box(global_weather, y = 'humidity')
```

```
px.histogram(global_weather, 'humidity', nbins = 20)
```

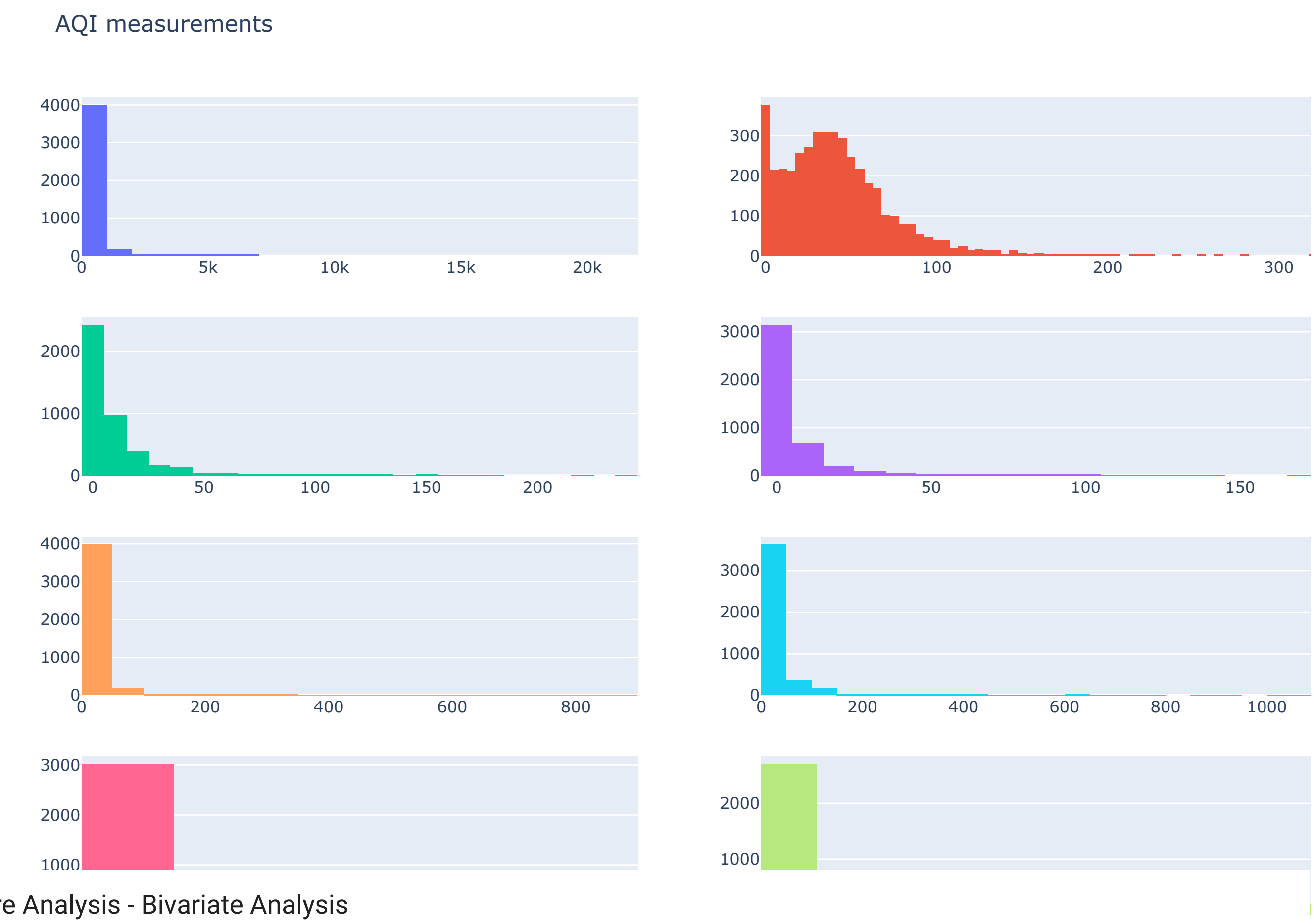
```
plot_box_hist('gust_mph', 'gust_kph', 12, 'Wind gust in mph and kph')
```

```
fig = make_subplots(rows=4, cols=2)

trace0 = go.Histogram(x  = global_weather['Carbon_Monoxide'], name = 'Carbon_Monoxide', nbinsx = 30)
trace1 = go.Histogram(x  = global_weather['Ozone'], name = 'Ozone')
trace2 = go.Histogram(x  = global_weather['Nitrogen_dioxide'], name = 'Nitrogen_dioxide', nbinsx = 30)
trace3 = go.Histogram(x = global_weather['Sulphur_dioxide'], name = 'Sulphur_dioxide', nbinsx = 30)
trace4 = go.Histogram(x = global_weather['PM2.5'], name = 'PM2.5', nbinsx = 30)
trace5 = go.Histogram(x  = global_weather['PM10'], name = 'PM10', nbinsx = 30)
trace6 = go.Histogram(x = global_weather['us-epa-index'], name = 'us-epa-index')
trace7 = go.Histogram(x  = global_weather['gb-defra-index'], name = 'gb-defra-index')

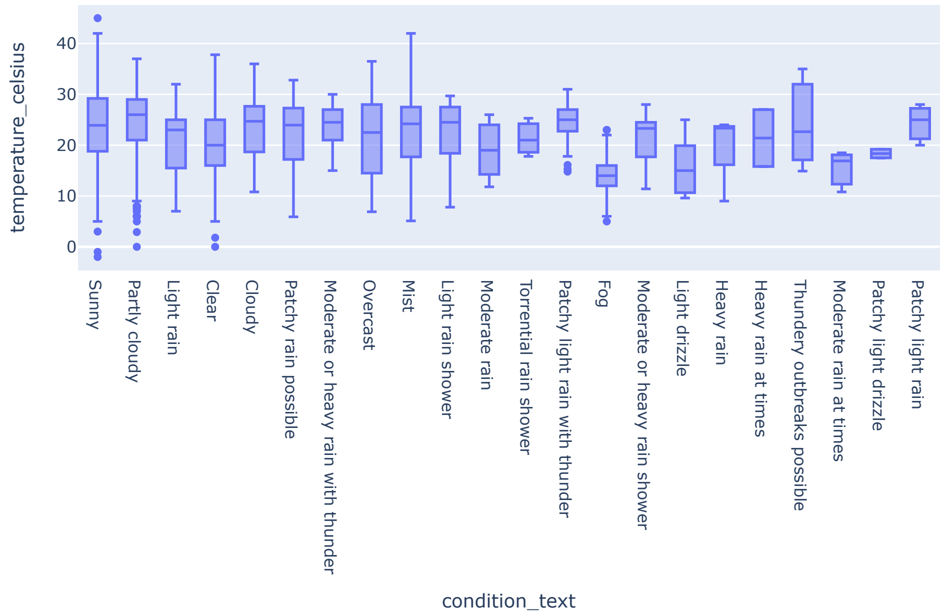
fig.add_trace(trace0, row=1, col=1)
fig.add_trace(trace1, row=1, col=2)
fig.add_trace(trace2, row=2, col=1)
fig.add_trace(trace3, row=2, col=2)
fig.add_trace(trace4, row=3, col=1)
fig.add_trace(trace5, row=3, col=2)
fig.add_trace(trace6, row=4, col=1)
fig.add_trace(trace7, row=4, col=2)

fig.update_layout(height=800, width=1200, title_text='AQI measurements', showlegend=True)
fig.show()
```

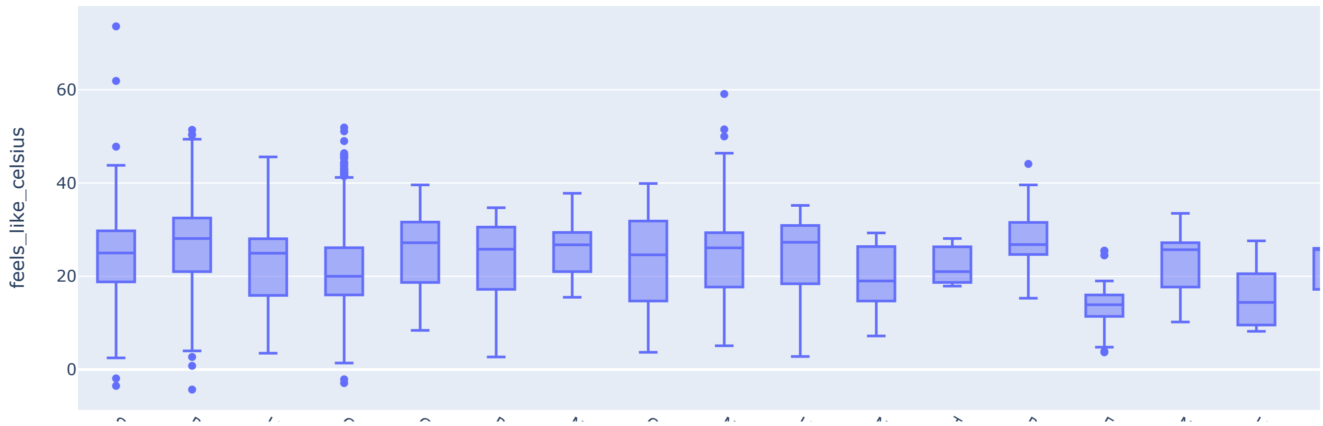


Feature Analysis - Bivariate Analysis

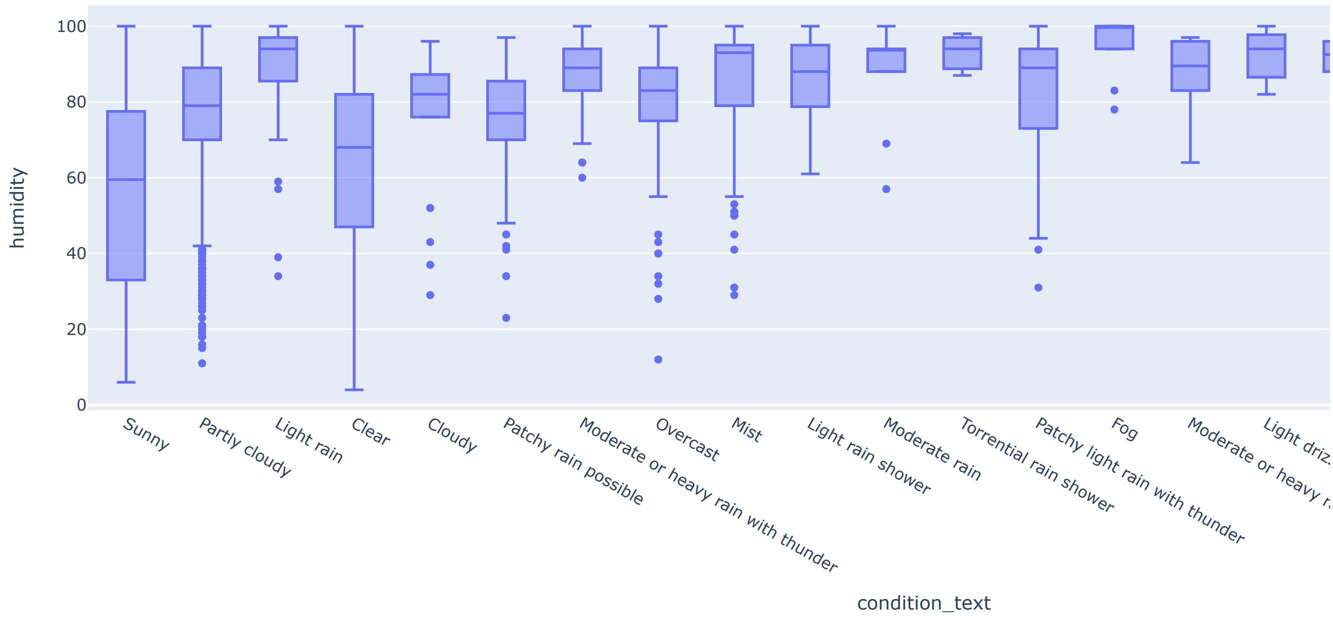
```
px.box(global_weather, x = 'condition_text', y = 'temperature_celsius')
```




```
px.box(global_weather, x = 'condition_text', y = 'feels_like_celsius')
```



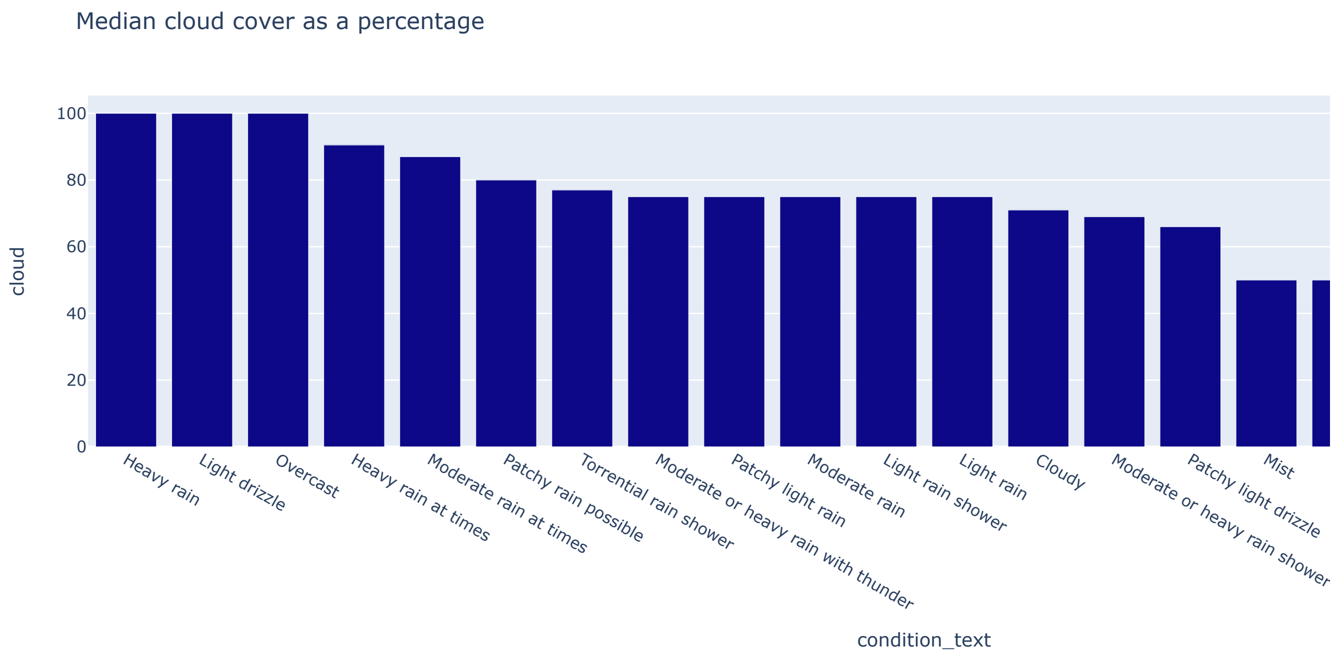

```
px.box(global_weather, x = 'condition_text', y = 'humidity')
```




```
px.scatter(global_weather, x = 'temperature_celsius', y = 'humidity',
           marginal_x='histogram',
           marginal_y='rug')
```

```
condition_grps = glb_weather.groupby('condition_text')

#data = condition_grps['cloud'].mean()
data = condition_grps['cloud'].median()
data_sorted = data.sort_values(ascending=False)
px.bar(data_sorted, y = 'cloud', title = 'Median cloud cover as a percentage', color_discrete_sequence = px.colors.sequential.Plasma)
```




```
condition_grps = glb_weather.groupby('condition_text')
cloud_grp = condition_grps.get_group('Cloudy')
cloud_grp
```

	country	location_name	latitude	longitude	timezone	last_updated_epoch	last_updated	temperature_celsius	co
13	Bangladesh	Dhaka	23.72	90.41	Asia/Dhaka	2023-08-29 09:30:00+00:00	2023-08-29 15:30:00	34.0	
604	Bhutan	Thimphu	27.48	89.60	Asia/Thimphu	2023-08-31 23:45:00+00:00	2023-09-01 05:45:00	12.3	
661	Iceland	Hella	63.83	-20.40	Atlantic/Reykjavik	2023-08-31 23:45:00+00:00	2023-08-31 23:45:00	10.8	
722	Peru	Lima	12.05	77.05	America/Lima	2023-08-31	2023-08-31	18.7	

```
# Group the moon phases and calculate the mean of moon illumination
glb_weather_moon = glb_weather.groupby('moon_phase')['moon_illumination'].agg(['mean']).reset_index()

glb_weather_moon = glb_weather_moon.rename(columns={'mean': 'moon_illumination'})
glb_weather_moon
```

	moon_phase	moon_illumination
0	Full Moon	98.000000
1	Last Quarter	60.000000
2	New Moon	1.000000
3	Waning Crescent	27.000000
4	Waning Gibbous	88.324209
5	Waxing Crescent	2.996144
6	Waxing Gibbous	93.000000

2638	Maldives	Farukolhufunadhoo	6.15	73.27	Indian/Maldives	[illegible]	[illegible]	27.6

```
fig = px.pie(
    glb_weather_moon,
    names='moon_phase',
    values='moon_illumination',
    title='Moon Phase and Moon Illumination',
    height=600,
    hole=0.4,
    labels=(
        {
            'moon_phase': 'Moon Phase',
            'moon_illumination': 'Moon Illumination (%)'
        }
    ),
)

fig.update_traces(textposition='inside', textinfo='label+percent')

fig.show()
```

Moon Phase and Moon Illumination

Feature Analysis - Multivariate Analysis

```
user_location = 'New Delhi'  # Change this into your desired location

# Filter dataframe for the desired location
location_df = glb_weather[glb_weather['location_name'] == user_location]

# Extracting wind df
wind_speeds = location_df['wind_kph']
wind_degrees = location_df['wind_degree']

# Converting wind degrees to radians
wind_radians = np.deg2rad(wind_degrees)

#rose wind plot

plt.figure(figsize=(8, 8))
ax = plt.subplot(111, polar=True)
n_bins = 16
hist, bins = np.histogram(wind_radians, bins=n_bins)

# width of each bin
width = 2 * np.pi / n_bins

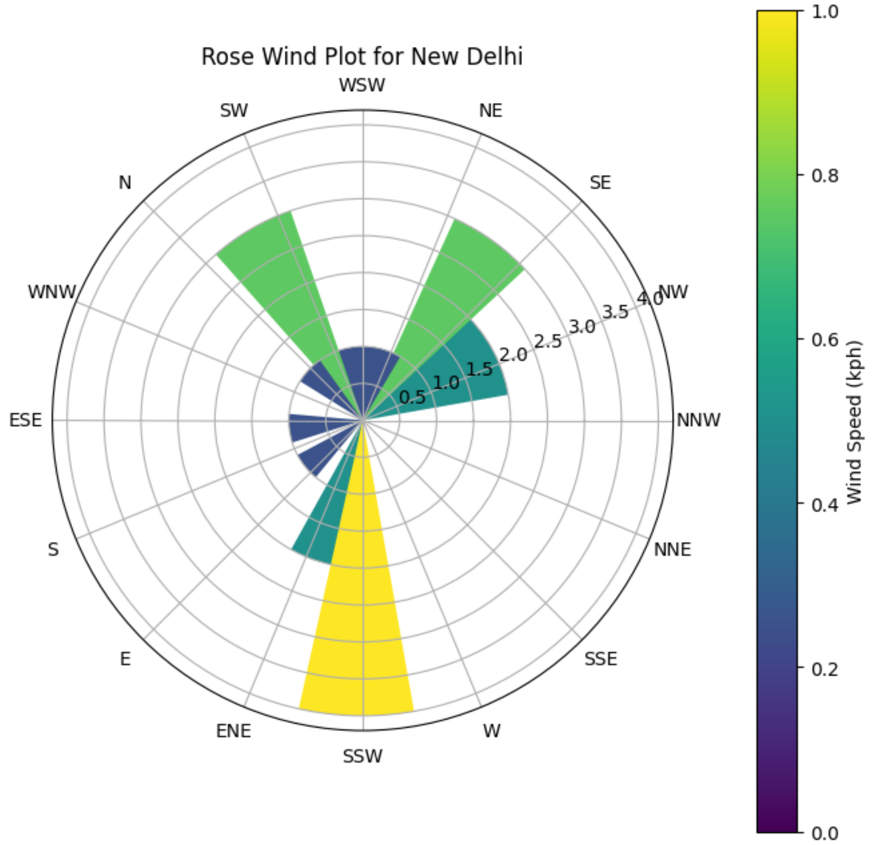
# list of colors for each bin
colors = plt.cm.viridis(hist / hist.max())

# histogram as a bar plot with colors
bars = ax.bar(bins[:-1], hist, width=width, align="edge", color=colors)

# direction labels
ax.set_xticks(np.arange(0, 2 * np.pi, width))
ax.set_xticklabels(['NNW','NW','SE','NE','WSW','SW','N','WNW','ESE','S','E','ENE','SSW','W','SSE','NNE'])

#color bar legend
color_legend = plt.colorbar(plt.cm.ScalarMappable(cmap=plt.cm.viridis), ax=ax, pad=0.1)
color_legend.set_label('Wind Speed (kph)')

plt.title(f'Rose Wind Plot for {user_location}')
plt.show()
```



Forecasting and Inferences

Feature Engineering

```
# Splitting the data based on climate zones

glb_weather.loc[(glb_weather['latitude'] < 23.5) & (glb_weather['latitude'] > -23.5), 'region'] = 'Tropical'
glb_weather.loc[((glb_weather['latitude'] >= 23.5) & (glb_weather['latitude'] <= 66.5)) | ((glb_weather['latitude'] <= -23.5) & (glb_wea
glb_weather.loc[(glb_weather['latitude'] > 66.5) | (glb_weather['latitude'] < -66.5), 'region'] = 'Polar'


# counting unique 'location_name' values for each region

tropical_df = glb_weather[glb_weather['region'] == 'Tropical']
temperate_df = glb_weather[glb_weather['region'] == 'Temperate']
polar_df = glb_weather[glb_weather['region'] == 'Polar']

tropical_location_count = tropical_df['location_name'].nunique()
temperate_location_count = temperate_df['location_name'].nunique()
polar_location_count = polar_df['location_name'].nunique()


print("Total Locations in Tropical region:", tropical_location_count)
print("Total Locations in Temperate region:", temperate_location_count)
print("Total Locations in Polar region:", polar_location_count)
```

```
Total Locations in Tropical region: 97
Total Locations in Temperate region: 100
Total Locations in Polar region: 0
```

Observation - No data available from Polar region

Temperature Trends

```
city_country = {}

cities = global_weather['location_name'].unique()
for city in cities:
  city_first_index = global_weather[global_weather['location_name'] == city].index[0]
  city_country[city] = global_weather.loc[city_first_index, 'country']

city_country
```

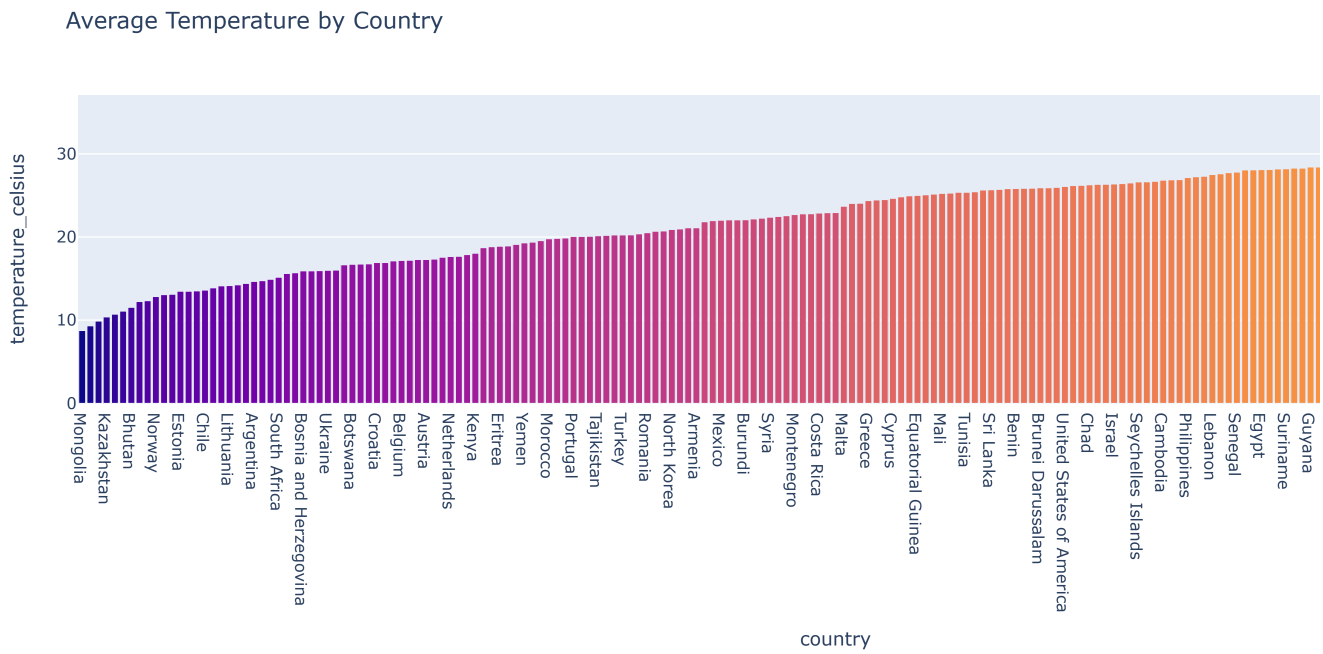
```
{'Kabul': 'Afghanistan',
 'Tirana': 'Albania',
 'Algiers': 'Algeria',
 'Andorra La Vella': 'Andorra',
 'Luanda': 'Angola',
 "Saint John's": 'Antigua and Barbuda',
 'Buenos Aires': 'Argentina',
 'Yerevan': 'Armenia',
 'Canberra': 'Australia',
 'Vienna': 'Austria',
 'Baku': 'Azerbaijan',
 'Nassau': 'Bahamas',
 'Manama': 'Bahrain',
 'Dhaka': 'Bangladesh',
 'Bridgetown': 'Barbados',
 'Minsk': 'Belarus',
 'Brussels': 'Belgium',
 'Belmopan': 'Belize',
 'Porto-Novo': 'Benin',
 'Thimphu': 'Bhutan',
 'Sucre': 'Bolivia',
 'Sarajevo': 'Bosnia and Herzegovina',
 'Gaborone': 'Botswana',
 'Bras': 'Brazil',
 'Bandar Seri Begawan': 'Brunei Darussalam',
 'Sofia': 'Bulgaria',
 'Ouagadougou': 'Burkina Faso',
 'Bujumbura': 'Burundi',
 'Ivory': 'Madagascar',
 'Praia': 'Cape Verde',
 'Phnom Penh': 'Cambodia',
 'Bafoussam': 'Cameroon',
 'Ottawa': 'Canada',
 'Bangui': 'Central African Republic',
 "N'djamena": 'Chad',
 'Santiago': 'Chile',
```

```
'Beijing': 'China',
'Bogot': 'Bulgaria',
'Moroni': 'Comoros',
'Brazzaville': 'Congo',
'San Juan': 'Costa Rica',
'Zagreb': 'Croatia',
'Havana': 'Cuba',
'Nicosia': 'Cyprus',
'Prague': 'Czech Republic',
'Kinshasa': 'Democratic Republic of Congo',
'Copenhagen': 'Denmark',
'Djibouti': 'Djibouti',
'Roseau': 'Dominica',
'Santo Domingo': 'Dominican Republic',
'Quito': 'Ecuador',
'Cairo': 'Egypt',
'San Salvador': 'El Salvador',
'Malabo': 'Equatorial Guinea',
'Asmara': 'Eritrea',
'Tallinn': 'Estonia',
'Mbabane': 'Swaziland',
'Addis Ababa': 'Ethiopia',
```

```
global_country_grp_mean = glb_weather.groupby('country').mean().reset_index()
global_temp_mean = global_country_grp_mean.sort_values(by = 'temperature_celsius')
px.bar(global_temp_mean, x='country', y='temperature_celsius', color = 'temperature_celsius',
       color_discrete_sequence = px.colors.sequential.thermal,
       title='Average Temperature by Country')
```

```
<ipython-input-59-21cc452224cc>:1: FutureWarning:

The default value of numeric_only in DataFrameGroupBy.mean is deprecated. In a future version, numeric_only will default to False. E
```




```
global_city_grp_mean = glb_weather.groupby('location_name').mean().reset_index()
global_temp_mean = global_city_grp_mean.sort_values(by = 'temperature_celsius')
```

```
<ipython-input-60-2a3d1832f075>:1: FutureWarning:

The default value of numeric_only in DataFrameGroupBy.mean is deprecated. In a future version, numeric_only will default to False.
```

```
def create_bar_chart(data, title, color):
    fig = px.bar(data, x='location_name', y='temperature_celsius', title=title)
    fig.update_traces(marker_color=color, marker_line_color='black', marker_line_width=1)
    fig.update_xaxes(categoryorder='total ascending')
    return fig

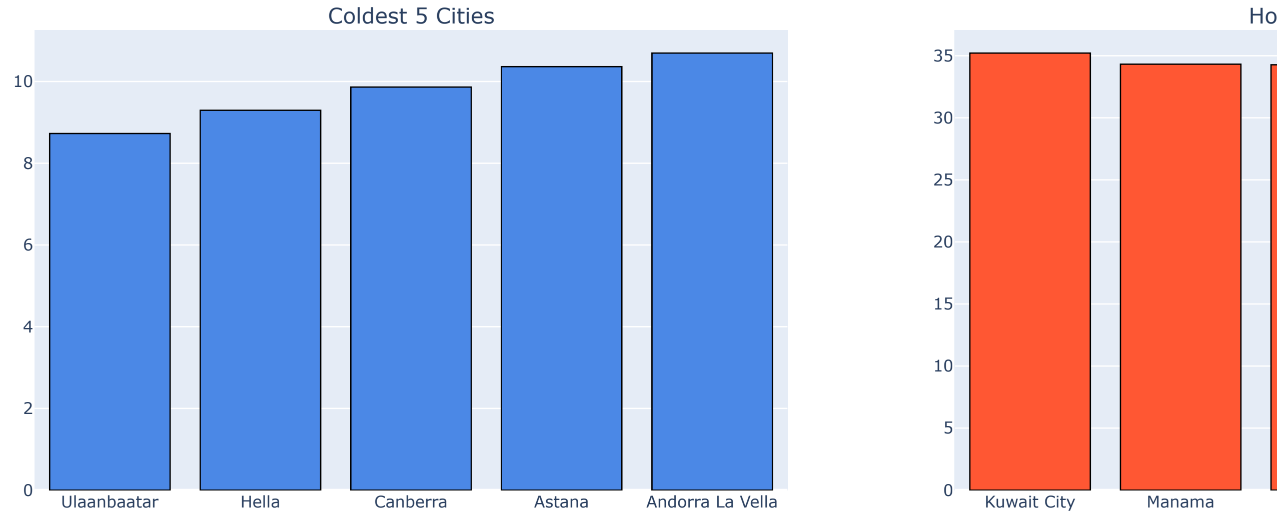

coldest_chart_color = 'rgb(75, 136, 230)'  # Blue
hottest_chart_color = 'rgb(255, 87, 51)'  # Red

coldest_5_cities = global_temp_mean.iloc[:5, :]
hottest_5_cities = global_temp_mean.iloc[-5:, :]
```

```
hottest_bar_chart = create_bar_chart(hottest_5_cities.sort_values(by = 'temperature_celsius', ascending = False),
                                     'Top 5 Cities by Maximum Average Temperature', hottest_chart_color)
coldest_bar_chart = create_bar_chart(coldest_5_cities, 'Bottom 10 Cities by Minimum Average Temperature', coldest_chart_color)

fig = make_subplots(rows=1, cols=2, subplot_titles=('Coldest 5 Cities', 'Hottest 5 Cities'))
fig.add_trace(coldest_bar_chart.data[0], row=1, col=1)
fig.add_trace(hottest_bar_chart.data[0], row=1, col=2)

fig.show()
```



Mean Temperature(°C), Pressure(mb) and Humidity Data - Location Wise

```
grouped_data = glb_weather.groupby(['latitude', 'longitude'])[['temperature_celsius', 'pressure_mb', 'humidity']].mean().reset_index()

# Merging 'location_name' back to the grouped data
grouped_data = pd.merge(grouped_data, glb_weather[['latitude', 'longitude', 'location_name']], on=['latitude', 'longitude'], how='left')

# scatter plot with hover information
fig = px.scatter_geo(grouped_data,
                     lat='latitude',
                     lon='longitude',
                     hover_name='location_name',
                     hover_data=['temperature_celsius', 'pressure_mb', 'humidity'],
                     color='temperature_celsius',
                     labels={'temperature_celsius': 'Mean Temp (°C)',
                             'pressure_mb': 'Mean Pressure (mb)',
                             'humidity': 'Humidity'},
                     title='Mean Weather Data',
                     projection="natural earth")

fig.show()
```

Mean Weather Data

```
aggs = ["count","sum","avg","median","mode","rms","stddev","min","max","first","last"]

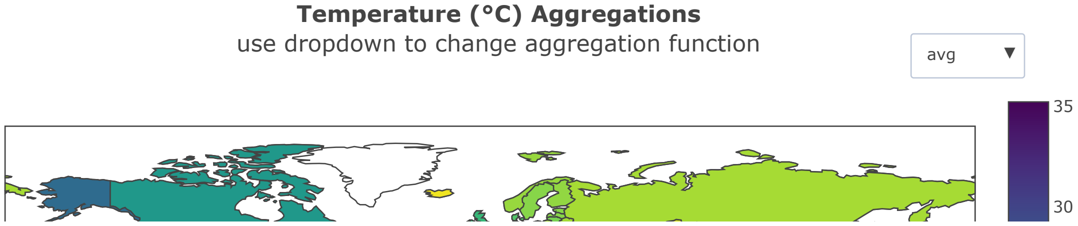
agg = []
agg_func = []
for i in range(0, len(aggs)):
    agg = dict(
        args=['transforms[0].aggregations[0].func', aggs[i]],
        label=aggs[i],
        method='restyle'
    )
    agg_func.append(agg)

data = [dict(
  type = 'choropleth',
  locationmode = 'country names',
  locations = glb_weather['country'],
  z = glb_weather['temperature_celsius'],
  autocolorscale = False,
  colorscale = 'Viridis',
  reversescale = True,
  transforms = [dict(
    type = 'aggregate',
    groups = glb_weather['country'],
    aggregations = [dict(
        target = 'z', func = 'avg', enabled = True)
    ]
  )]
)]

layout = dict(
  title = '<b>Temperature (°C) Aggregations</b><br>use dropdown to change aggregation function',
  #xaxis = dict(title = 'Subject'),
  #yaxis = dict(title = 'Score', range = [0,22]),
  height = 600,
  width = 900,
  updatemenus = [dict(
        x = 1.05,
        y = 1.10,
        xref = 'paper',
        yref = 'paper',
        yanchor = 'top',
        active = 2,
        showactive = False,
        buttons = agg_func
  )]
)

fig_dict = dict(data=data, layout=layout)

pio.show(fig_dict, validate=False)
```




```
countries = glb_weather['country'].unique()
rand_country_list = np.random.choice(countries, 4)

temp_trend = glb_weather[glb_weather['country'].isin(rand_country_list)]
temp_trend_grp = temp_trend.groupby('country')

temp_trend.head(4)
```

	country	location_name	latitude	longitude	timezone	last_updated_epoch	last_updated	temperature_celsius	condit
28	Madagascar	Ivory	-24.37	46.45	Indian/Antananarivo	2023-08-29 09:30:00+00:00	2023-08-29 12:30:00	22.9	
97	Thailand	Nan	18.78	100.78	Asia/Bangkok	2023-08-29 09:45:00+00:00	2023-08-29 16:45:00	33.0	Pa
101	Madagascar	Antananarivo	-18.92	47.52	Indian/Antananarivo	2023-08-29 09:45:00+00:00	2023-08-29 12:45:00	21.0	Pa
132	Palau	Adkip	7.36	134.51	Pacific/Palau	2023-08-29 09:45:00+00:00	2023-08-29 18:45:00	29.0	Pa

4 rows × 36 columns

```
fig = go.Figure()
colors = ['firebrick', 'rebeccapurple', 'royalblue', 'mediumseagreen']

for idx in range(4):
  country = rand_country_list[idx]
  rand_country_grp = temp_trend_grp.get_group(country)
  fig.add_trace(go.Scatter(x = rand_country_grp['last_updated'], y = rand_country_grp['temperature_celsius'],
                          mode='lines+markers',
                          name = country,
                          line=dict(color=colors[idx])))

fig.update_layout(title='Temperature Trends for randomly selected 4 cities',
                  xaxis_title='Last Updated',
                  yaxis_title='Temperature (°C)')
fig.show()
```

```
option_list = ['uv_index', 'wind_kph', 'Carbon_Monoxide', 'Ozone', 'Nitrogen_dioxide', 'Sulphur_dioxide', 'PM2.5', 'PM10']
option_val_tuple = list((k,v) for v, k in list(enumerate(option_list, 1)))
option_val_tuple
```

```
[('uv_index', 1),
 ('wind_kph', 2),
 ('Carbon_Monoxide', 3),
 ('Ozone', 4),
 ('Nitrogen_dioxide', 5),
 ('Sulphur_dioxide', 6),
 ('PM2.5', 7),
 ('PM10', 8)]
```

```
text_dict = {1: ['uv_index', 'UV index'],
             2: ['wind_kph', 'Wind Seepd in kph'],
             3: ['Carbon_Monoxide', 'Carbon monoxide'],
             4: ['Ozone', 'Ozone'],
             5: ['Nitrogen_dioxide', 'Nitrogen dioxide'],
             6: ['Sulphur_dioxide', 'Sulphur dioxide'],
             7: ['PM2.5', 'PM 2.5'],
             8: ['PM10', 'PM 10']}


pollutants = widgets.RadioButtons(
    options = option_val_tuple,
    value = 1,            # Default value
    disabled = False
)

# Assign an empty figure widget with two traces
min_value = min(global_country_grp_mean['uv_index'])      # Minimum mean value by country
max_value = max(global_country_grp_mean['uv_index'])
delta_value = global_country_grp_mean['uv_index'].mean()  # Mean value of parameter
text = 'UV index'

fw = go.FigureWidget({
    'data': [{'delta': {'reference': delta_value},
              'domain': {'x': [0, 1], 'y': [0, 1]},
              'gauge': {'axis': {'range': [None, 40]},
                        'bar': {'color': 'darkblue'},
                        'steps': [{'color': 'whitesmoke', 'range': [0, 10]},
                                  {'color': 'palegreen', 'range': [10, 20]},
                                  {'color': 'lightsalmon', 'range': [20, 30]},
                                  {'color': 'indianred', 'range': [30, 40]}]},
              'mode': 'gauge+number+delta',
              'title': {'text': 'UV index'},
              'type': 'indicator',
              'value': min_value}]})


def update_pollutant_widget(change):
  selected_option=pollutants.value
  selected_col = text_dict[selected_option][0]
  min_value = min(global_country_grp_mean[selected_col])    # Minimum mean value by country
  max_value = max(global_country_grp_mean[selected_col])    # Maximum mean value by country
  avg_value = global_country_grp_mean[selected_col].mean()  # Mean value of parameter
  text = text_dict[selected_option][1]
  with fw.batch_update():
    trace1 = fw.data[0]
    trace1.delta.reference = avg_value
    trace1.value = min_value
    trace1.title.text = text
    trace2 = fw.data[1]
    trace1.delta.reference = avg_value
    trace1.value = max_value
    trace1.title.text = text

pollutants.observe(update_pollutant_widget , names='value')

widgets.HBox([pollutants])
```

```
widgets.VBox([fw])
```

```
from google.colab import output
output.enable_custom_widget_manager()
```

Support for third party widgets will remain active for the duration of the session. To disable support:

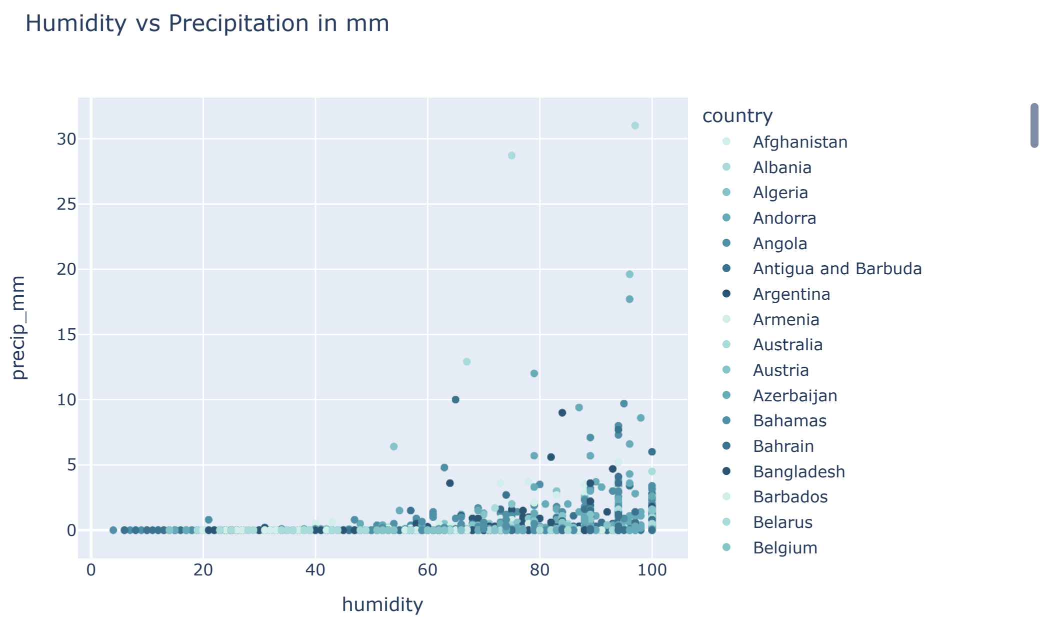
```
from google.colab import output
output.disable_custom_widget_manager()
```

```
px.scatter(global_weather, x='temperature_celsius', y='humidity', color='country', title='Temperature vs Humidity', color_discrete_sequer
```

```
px.scatter(global_weather, x = 'temperature_celsius', y = 'humidity',
           size='visibility_km',
           color='condition_text',
           facet_col = 'wind_direction',
           facet_col_wrap = 4)
```

Precipitation Trends

```
px.scatter(global_weather, x='humidity', y='precip_mm', color='country', title='Humidity vs Precipitation in mm', color_discrete_sequence
```



Day Wise Percipitation (mm) - Taking Location as User Input

```
location_name = input('Please Enter the location name for check day wise Precipitation: ').strip().lower()

# Filtering the DataFrame for the specific location
location_data = glb_weather[glb_weather['location_name'].str.lower() == location_name]

if location_data.empty:
    print(f"No data found for the location '{location_name}'. Please check the spelling and try again.")

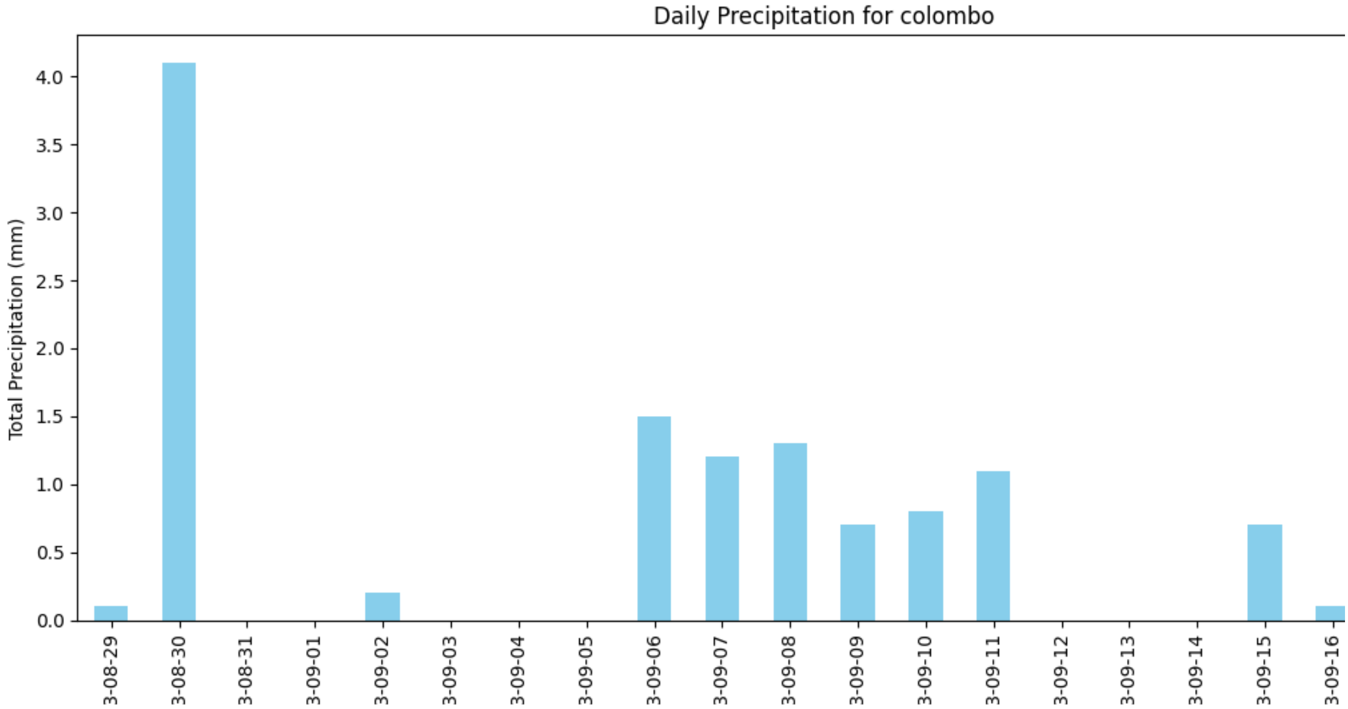
else:

    # Extracting the date part from the 'last_updated' column
    location_data['date'] = location_data['last_updated'].dt.date

    # total precipitation for each day
    daily_precipitation = location_data.groupby('date')['precip_mm'].sum()

    # bar plot for daily precipitation
    plt.figure(figsize=(12, 6))
    daily_precipitation.plot(kind='bar', color='skyblue')
    plt.title(f'Daily Precipitation for {location_name}')
    plt.xlabel('Date')
    plt.ylabel('Total Precipitation (mm)')
    plt.xticks(rotation=90)
    plt.tight_layout()
    plt.show()
```

Please Enter the location name for check day wise Precipitation: Colombo



Geographical Trends

Distribution Comparison (Tropical vs Temperate)

```
tropical_data = glb_weather[glb_weather['region'] == 'Tropical']
temperate_data = glb_weather[glb_weather['region'] == 'Temperate']

sns.set_style("whitegrid")

# 2 x 2 subplots
fig, axes = plt.subplots(2, 2, figsize=(12, 8))
fig.suptitle("Distribution Comparison ('Tropical' vs 'Temperate')")

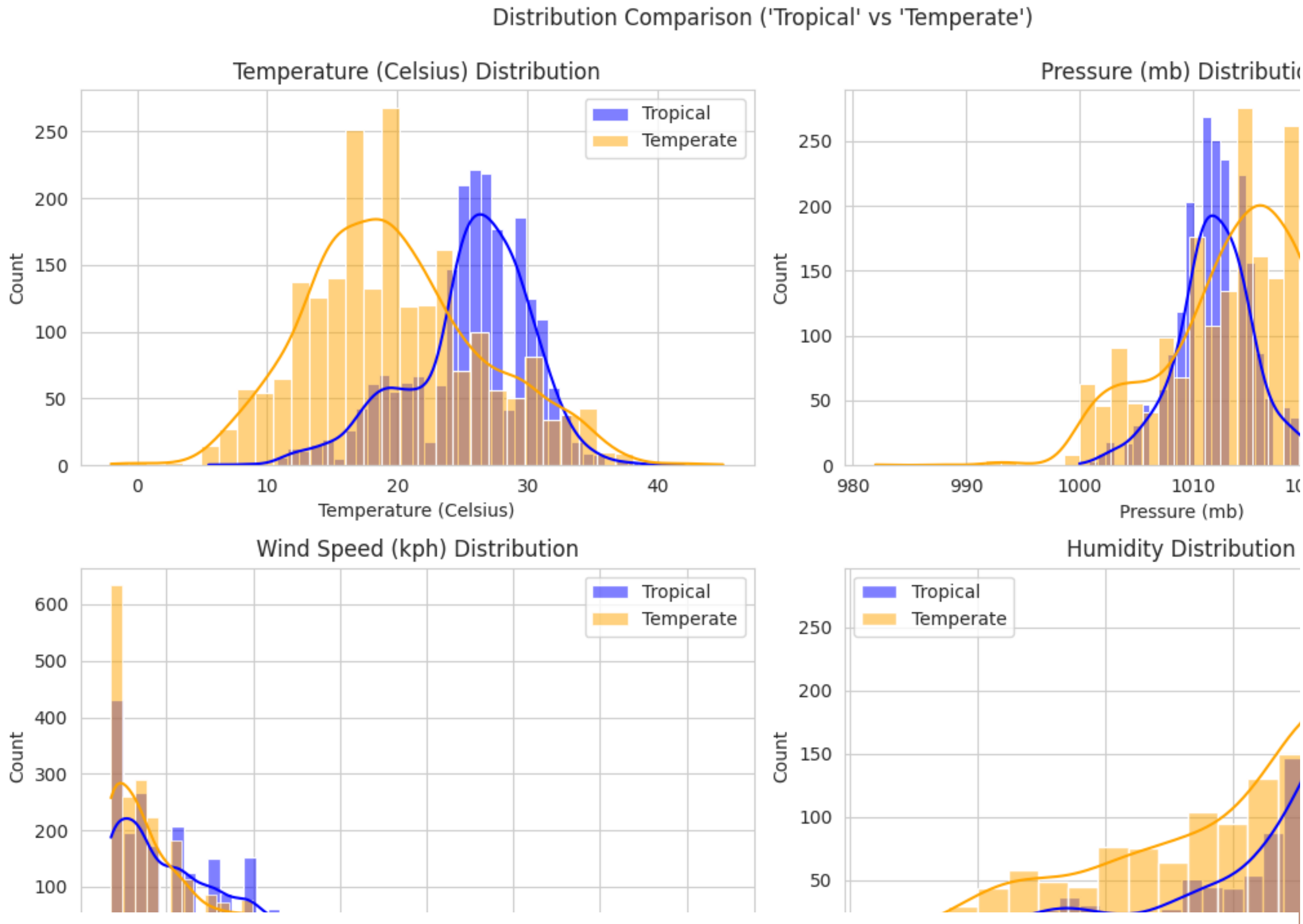
# temperature_celsius distribution
sns.histplot(tropical_data['temperature_celsius'], ax=axes[0, 0], label='Tropical', kde=True, color='blue')
sns.histplot(temperate_data['temperature_celsius'], ax=axes[0, 0], label='Temperate', kde=True, color='orange')
axes[0, 0].set_title('Temperature (Celsius) Distribution')
axes[0, 0].set_xlabel('Temperature (Celsius)')
axes[0, 0].legend()

# pressure_mb distribution
sns.histplot(tropical_data['pressure_mb'], ax=axes[0, 1], label='Tropical', kde=True, color='blue')
sns.histplot(temperate_data['pressure_mb'], ax=axes[0, 1], label='Temperate', kde=True, color='orange')
axes[0, 1].set_title('Pressure (mb) Distribution')
axes[0, 1].set_xlabel('Pressure (mb)')
axes[0, 1].legend()

# wind_mph distribution
sns.histplot(tropical_data['wind_kph'], ax=axes[1, 0], label='Tropical', kde=True, color='blue')
sns.histplot(temperate_data['wind_kph'], ax=axes[1, 0], label='Temperate', kde=True, color='orange')
axes[1, 0].set_title('Wind Speed (kph) Distribution')
axes[1, 0].set_xlabel('Wind Speed (kph)')
axes[1, 0].legend()

# humidity distribution
sns.histplot(tropical_data['humidity'], ax=axes[1, 1], label='Tropical', kde=True, color='blue')
sns.histplot(temperate_data['humidity'], ax=axes[1, 1], label='Temperate', kde=True, color='orange')
axes[1, 1].set_title('Humidity Distribution')
axes[1, 1].set_xlabel('Humidity')
axes[1, 1].legend()

plt.tight_layout()
plt.subplots_adjust(top=0.9)
plt.show()
```

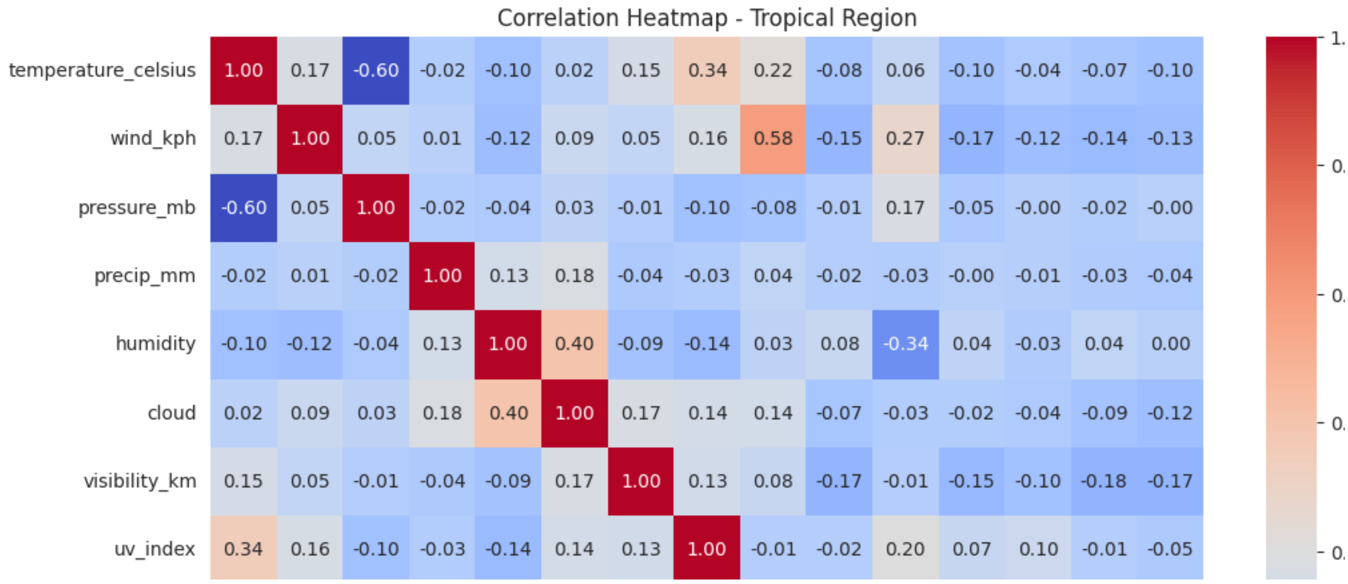


Co-Relation Heatmap for Tropical and Temperate Data

```
  req_columns = ['temperature_celsius', 'wind_kph', 'pressure_mb', 'precip_mm', 'humidity', 'cloud', 'visibility_km', 'uv_index', 'gust_

def create_correlation_heatmap(data, title):
    correlation_matrix = data[req_columns].corr()
    plt.figure(figsize=(12, 10))
    sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f")
    plt.title(title)
    plt.show()

create_correlation_heatmap(tropical_data, "Correlation Heatmap - Tropical Region")
create_correlation_heatmap(temperate_data, "Correlation Heatmap - Temperate Region")
```



AQI Trends

For PM 2.5 index

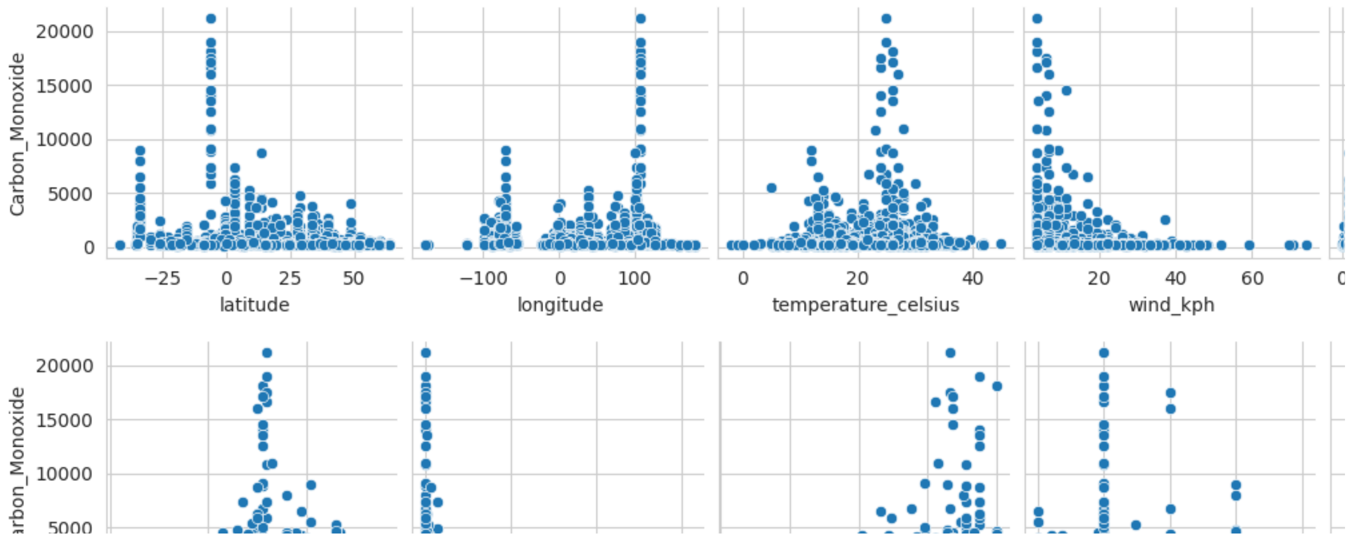
```
# Using isin() method to drop multiple columns
pollutant_df = glb_weather.loc[:, ~glb_weather.columns.isin(['PM2.5', 'PM10', 'us-epa-index', 'gb-defra-index'])]
pollutant_df.columns
```

```
     Index(['country', 'location_name', 'latitude', 'longitude', 'timezone',
            'last_updated_epoch', 'last_updated', 'temperature_celsius',
            'condition_text', 'wind_kph', 'wind_degree', 'wind_direction',
            'pressure_mb', 'precip_mm', 'humidity', 'cloud', 'feels_like_celsius',
            'visibility_km', 'uv_index', 'gust_kph', 'Carbon_Monoxide', 'Ozone',
            'Nitrogen_dioxide', 'Sulphur_dioxide', 'sunrise', 'sunset', 'moonrise',
            'moonset', 'moon_phase', 'moon_illumination', 'heat_zone', 'region'],
           dtype='object')
```

```
# Correlation using pairplot

pollutant_df_num = pollutant_df.select_dtypes(include = ['float64', 'int64'])

for i in range(0, len(pollutant_df_num.columns),5):
    sns.pairplot(pollutant_df_num, y_vars ='Carbon_Monoxide', x_vars = pollutant_df_num.columns[i:i+5])
```



Climate Zone vs Major Pollutant Level (Median)

```
glb_weather.rename(columns={
    'Carbon_Monoxide': 'Carbon Monoxide (CO)',
    'Ozone': 'Ozone (O3)',
    'Nitrogen_dioxide': 'Nitrogen Dioxide (NO2)',
    'Sulphur_dioxide': 'Sulphur Dioxide (SO2)',
    'PM2.5': 'PM2.5',
    'PM10': 'PM10'
}, inplace=True)

# Group and calculate medians
grouped_data = glb_weather.groupby('region').agg({
    'Carbon Monoxide (CO)': 'median',
    'Ozone (O3)': 'median',
    'Nitrogen Dioxide (NO2)': 'median',
    'Sulphur Dioxide (SO2)': 'median',
    'PM2.5': 'median',
    'PM10': 'median'
}).reset_index()

sns.set(style="whitegrid")

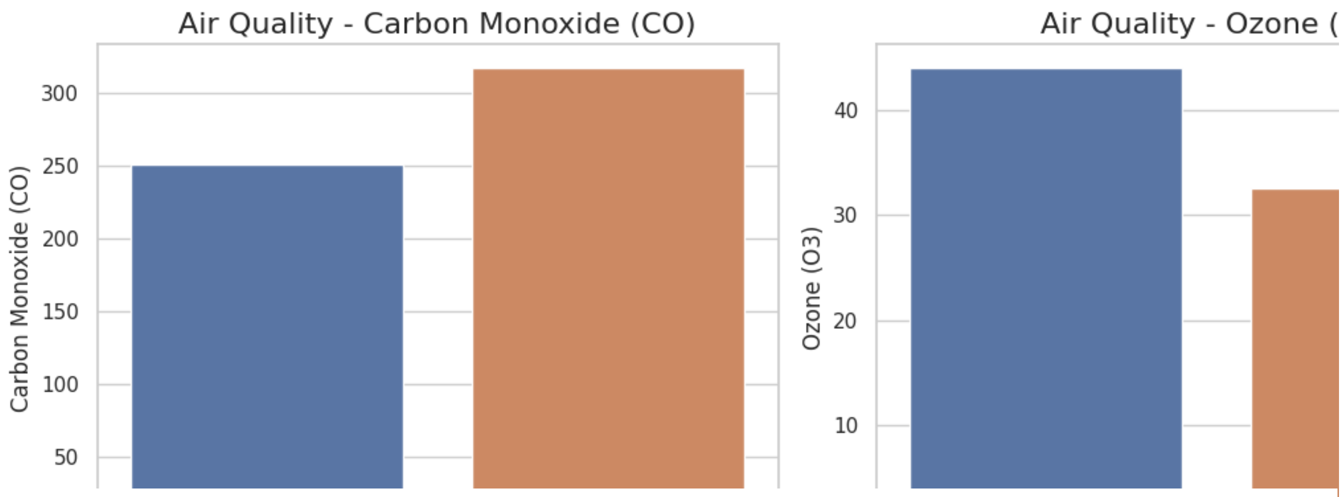
# subplots : 2 x 3
fig, axes = plt.subplots(2, 3, figsize=(18, 10))

# Bar charts for each air quality metric
metrics = ['Carbon Monoxide (CO)', 'Ozone (O3)', 'Nitrogen Dioxide (NO2)', 'Sulphur Dioxide (SO2)', 'PM2.5', 'PM10']

for i, metric in enumerate(metrics):
    row, col = divmod(i, 3)
    ax = axes[row, col]

    sns.barplot(data=grouped_data, x='region', y=metric, ax=ax)
    ax.set_title(f'Air Quality - {metric}',fontsize=16)
    ax.set_xlabel('')
    ax.set_ylabel(metric)
    ax.set_xticklabels(ax.get_xticklabels(), rotation=45, ha='right')  # Rotate x-axis labels for better readability

plt.tight_layout()
plt.show()
```



- Higher Air Pollution level in Temerate Zone : Typically, warm rising air near the ground lifts pollution away, but during the winter the layer of warm air acts like a lid, keeping cold air at the surface.

Hypothesis Testing

Hypothesis Test: Air quality between coastal and landlocked countries

```
coastal_countries = ['Australia', 'Brazil', 'Canada', 'China', 'France', 'Germany', 'India', 'Indonesia', 'Italy', 'Japan', 'Mexico', 'Ru
landlocked_countries = ['Afghanistan', 'Armenia', 'Austria', 'Belarus', 'Bolivia', 'Botswana', 'Burkina Faso', 'Hungary', 'Kazakhstan',

coastal_data = glb_weather[glb_weather['country'].isin(coastal_countries)]['PM2.5']
landlocked_data = glb_weather[glb_weather['country'].isin(landlocked_countries)]['PM2.5']

t_stat_air_quality, p_value_air_quality = stats.ttest_ind(coastal_data, landlocked_data)
t_stat_air_quality, p_value_air_quality
```

```
(5.8207752657048735, 8.557563716938736e-09)
```

Result: Since the p-value is significantly smaller than 0.05, we reject the null hypothesis. This suggests that there is a statistically significant difference in air quality (PM2.5 levels) between coastal and landlocked countries

Hypothesis test using the t-test and determine whether there is a significant difference in AQI values between the two groups

```
temperate_cntry_grp = temperate_data.groupby('country', as_index=False)
temperate_rand_country_list = np.random.choice(temperate_data['country'].unique(), 16)
sample1 = temperate_rand_country_list[:8]
sample2 = temperate_rand_country_list[8:]

group1 = pd.DataFrame()
group2 = pd.DataFrame()

for country in sample1:
  group_data = temperate_cntry_grp.get_group(country).reset_index()
  group1 = group1.append(group_data, ignore_index=True)

for country in sample2:
  group_data = temperate_cntry_grp.get_group(country).reset_index()
  group2 = group2.append(group_data, ignore_index=True)


# Separate the AQI data for the two groups
group1_aqi = group1['gb-defra-index']
group2_aqi = group2['gb-defra-index']

# Perform the t-test
t_stat, p_value = stats.ttest_ind(group1_aqi, group2_aqi)

# Print the results
print('T-statistic:', t_stat)
print('P-value:', p_value, '\n\n')
```

```
T-statistic: 2.7773133045315572
P-value: 0.005776197814597932
```

```
<ipython-input-100-58140651f009>:11: FutureWarning:

The frame.append method is deprecated and will be removed from pandas in a future version. Use pandas.concat instead.

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