In [1]:
```
!pip install scikit-learn xgboost joblib plotly prophet matplotlib seaborn sta
```

```
Requirement already satisfied: scikit-learn in c:\users\mohammed hayath rk\anac
onda3\lib\site-packages (1.6.1)
Collecting xgboost
  Downloading xgboost-3.1.2-py3-none-win_amd64.whl.metadata (2.1 kB)
Requirement already satisfied: joblib in c:\users\mohammed hayath rk\anaconda3\
lib\site-packages (1.4.2)
Requirement already satisfied: plotly in c:\users\mohammed hayath rk\anaconda3\
lib\site-packages (5.24.1)
Requirement already satisfied: prophet in c:\users\mohammed hayath rk\anaconda
3\lib\site-packages (1.2.1)
Requirement already satisfied: matplotlib in c:\users\mohammed hayath rk\anacon
da3\lib\site-packages (3.10.0)
Requirement already satisfied: seaborn in c:\users\mohammed hayath rk\anaconda
3\lib\site-packages (0.13.2)
Requirement already satisfied: statsmodels in c:\users\mohammed hayath rk\anaco
nda3\lib\site-packages (0.14.4)
Requirement already satisfied: numpy>=1.19.5 in c:\users\mohammed hayath rk\ana
conda3\lib\site-packages (from scikit-learn) (2.1.3)
Requirement already satisfied: scipy>=1.6.0 in c:\users\mohammed hayath rk\anac
onda3\lib\site-packages (from scikit-learn) (1.15.3)
Requirement already satisfied: threadpoolctl>=3.1.0 in c:\users\mohammed hayath
rk\anaconda3\lib\site-packages (from scikit-learn) (3.5.0)
Requirement already satisfied: tenacity>=6.2.0 in c:\users\mohammed hayath rk\a
naconda3\lib\site-packages (from plotly) (9.0.0)
Requirement already satisfied: packaging in c:\users\mohammed hayath rk\anacond
a3\lib\site-packages (from plotly) (24.2)
Requirement already satisfied: cmdstanpy>=1.0.4 in c:\users\mohammed hayath rk\
anaconda3\lib\site-packages (from prophet) (1.3.0)
Requirement already satisfied: pandas>=1.0.4 in c:\users\mohammed hayath rk\ana
conda3\lib\site-packages (from prophet) (2.2.3)
Requirement already satisfied: holidays<1,>=0.25 in c:\users\mohammed hayath r
k\anaconda3\lib\site-packages (from prophet) (0.86)
Requirement already satisfied: tqdm>=4.36.1 in c:\users\mohammed hayath rk\anac
onda3\lib\site-packages (from prophet) (4.67.1)
Requirement already satisfied: importlib_resources in c:\users\mohammed hayath
rk\anaconda3\lib\site-packages (from prophet) (6.5.2)
Requirement already satisfied: python-dateutil in c:\users\mohammed hayath rk\a
naconda3\lib\site-packages (from holidays<1,>=0.25->prophet) (2.9.0.post0)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\mohammed hayath rk\
anaconda3\lib\site-packages (from matplotlib) (1.3.1)
Requirement already satisfied: cycler>=0.10 in c:\users\mohammed hayath rk\anac
onda3\lib\site-packages (from matplotlib) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\mohammed hayath r
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Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\mohammed hayath r
k\anaconda3\lib\site-packages (from matplotlib) (1.4.8)
Requirement already satisfied: pillow>=8 in c:\users\mohammed hayath rk\anacond
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Requirement already satisfied: pyparsing>=2.3.1 in c:\users\mohammed hayath rk\
anaconda3\lib\site-packages (from matplotlib) (3.2.0)
Requirement already satisfied: patsy>=0.5.6 in c:\users\mohammed hayath rk\anac
onda3\lib\site-packages (from statsmodels) (1.0.1)
Requirement already satisfied: stanio<2.0.0,>=0.4.0 in c:\users\mohammed hayath
rk\anaconda3\lib\site-packages (from cmdstanpy>=1.0.4->prophet) (0.5.1)
```

```
Requirement already satisfied: pytz>=2020.1 in c:\users\mohammed hayath rk\anac
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Requirement already satisfied: tzdata>=2022.7 in c:\users\mohammed hayath rk\an
aconda3\lib\site-packages (from pandas>=1.0.4->prophet) (2025.2)
Requirement already satisfied: six>=1.5 in c:\users\mohammed hayath rk\anaconda
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Requirement already satisfied: colorama in c:\users\mohammed hayath rk\anaconda
3\lib\site-packages (from tqdm>=4.36.1->prophet) (0.4.6)
Downloading xgboost-3.1.2-py3-none-win_amd64.whl (72.0 MB)
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   ---------------------------------------  71.8/72.0 MB 2.4 MB/s eta 0:00:01
   ---------------------------------------- 72.0/72.0 MB 2.3 MB/s eta 0:00:00
Installing collected packages: xgboost
Successfully installed xgboost-3.1.2
```

In [2]:
```
!pip install requests pandas
```

```
Requirement already satisfied: requests in c:\users\mohammed hayath rk\anaconda
3\lib\site-packages (2.32.3)
Requirement already satisfied: pandas in c:\users\mohammed hayath rk\anaconda3\
lib\site-packages (2.2.3)
Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\mohammed ha
yath rk\anaconda3\lib\site-packages (from requests) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in c:\users\mohammed hayath rk\anac
onda3\lib\site-packages (from requests) (3.7)
Requirement already satisfied: urllib3<3,>=1.21.1 in c:\users\mohammed hayath r
k\anaconda3\lib\site-packages (from requests) (2.3.0)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\mohammed hayath r
k\anaconda3\lib\site-packages (from requests) (2025.4.26)
Requirement already satisfied: numpy>=1.26.0 in c:\users\mohammed hayath rk\ana
conda3\lib\site-packages (from pandas) (2.1.3)
Requirement already satisfied: python-dateutil>=2.8.2 in c:\users\mohammed haya
th rk\anaconda3\lib\site-packages (from pandas) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in c:\users\mohammed hayath rk\anac
onda3\lib\site-packages (from pandas) (2025.2)
Requirement already satisfied: tzdata>=2022.7 in c:\users\mohammed hayath rk\an
aconda3\lib\site-packages (from pandas) (2025.2)
Requirement already satisfied: six>=1.5 in c:\users\mohammed hayath rk\anaconda
3\lib\site-packages (from python-dateutil>=2.8.2->pandas) (1.17.0)
```

In [3]:

```
import requests
import pandas as pd
from datetime import datetime, timedelta
import time

API_KEY = "YOUR_OWN_API_KEY"   # <-- put your WeatherAPI key here
BASE_URL = "http://api.weatherapi.com/v1"

# Function to fetch historical weather for 1 day
def get_history(city, date):
    url = f"{BASE_URL}/history.json"
    params = {
        "key": API_KEY,
        "q": city,
        "dt": date
    }
    response = requests.get(url, params=params)
    return response.json()

# Convert history JSON → DataFrame (hourly data)
def history_to_df(history_json, city):
    rows = []
    for day in history_json["forecast"]["forecastday"]:
        for hour in day["hour"]:
            hour["city"] = city  # Add city column
            rows.append(hour)
    return pd.DataFrame(rows)


# -------------------------
#  MULTIPLE CITY INPUT BOX
```

```python
# -------------------------

city_input = input("Enter city names (comma separated): ")
city_list = [c.strip() for c in city_input.split(",")]

days = int(input("How many past days do you want? (e.g., 30): "))


# -------------------------
# FETCH DATA FOR ALL CITIES
# -------------------------

all_data = []

for city in city_list:
    print(f"\nFetching data for: {city}")
    for i in range(days):
        date = (datetime.today() - timedelta(days=i+1)).strftime("%Y-%m-%d")
        print(f"  - {date}")

        try:
            json_data = get_history(city, date)
            df = history_to_df(json_data, city)
            all_data.append(df)
        except Exception as e:
            print("Error:", e)

        time.sleep(1)  # avoid hitting API limits


# -------------------------
# MERGE INTO ONE BIG DATASET
# -------------------------

big_df = pd.concat(all_data, ignore_index=True)
print("\nFinal Big Dataset Shape:", big_df.shape)
big_df.head()
```

```
Fetching data for: Bangalore
  - 2025-12-04
  - 2025-12-03
  - 2025-12-02
  - 2025-12-01
  - 2025-11-30
  - 2025-11-29
  - 2025-11-28

Fetching data for: Hyderabad
  - 2025-12-04
  - 2025-12-03
  - 2025-12-02
  - 2025-12-01
  - 2025-11-30
  - 2025-11-29
  - 2025-11-28

Fetching data for: Kolkata
  - 2025-12-04
  - 2025-12-03
  - 2025-12-02
  - 2025-12-01
  - 2025-11-30
  - 2025-11-29
  - 2025-11-28

Fetching data for: Lucknow
  - 2025-12-04
  - 2025-12-03
  - 2025-12-02
  - 2025-12-01
  - 2025-11-30
  - 2025-11-29
  - 2025-11-28

Fetching data for: Patna
  - 2025-12-04
  - 2025-12-03
  - 2025-12-02
  - 2025-12-01
  - 2025-11-30
  - 2025-11-29
  - 2025-11-28

Fetching data for: Chennai
  - 2025-12-04
  - 2025-12-03
  - 2025-12-02
  - 2025-12-01
  - 2025-11-30
  - 2025-11-29
  - 2025-11-28
```

```
Fetching data for: Mumbai
  - 2025-12-04
  - 2025-12-03
  - 2025-12-02
  - 2025-12-01
  - 2025-11-30
  - 2025-11-29
  - 2025-11-28

Final Big Dataset Shape: (1176, 35)
```

Out[3]:

	time_epoch	time	temp_c	temp_f	is_day	condition	wind_mph	wind_k
0	1764786600	2025-12-04 00:00	20.0	68.0	0	{'text': 'Light rain shower', 'icon': '//cdn.w...	9.6	1
1	1764790200	2025-12-04 01:00	19.9	67.8	0	{'text': 'Patchy rain possible', 'icon': '//cd...	9.6	1
2	1764793800	2025-12-04 02:00	19.4	66.9	0	{'text': 'Light rain shower', 'icon': '//cdn.w...	10.1	1
3	1764797400	2025-12-04 03:00	19.6	67.3	0	{'text': 'Patchy rain possible', 'icon': '//cd...	10.3	1
4	1764801000	2025-12-04 04:00	19.6	67.3	0	{'text': 'Patchy rain possible', 'icon': '//cd...	10.1	1

5 rows × 35 columns

In [4]:

```
big_df.shape
```

Out[4]: (1176, 35)

Basic EDA - Exploatory Data Analysism

In [5]:

```
import pandas as pd
```

```python
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt

sns.set(style="whitegrid")

from warnings import filterwarnings
filterwarnings('ignore')
```

In [6]:

```python
# Shape of the Data and information from the columns
print("Shape of dataset:", big_df.shape)
big_df.info()
```

```
Shape of dataset: (1176, 35)
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1176 entries, 0 to 1175
Data columns (total 35 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   time_epoch      1176 non-null   int64  
 1   time            1176 non-null   object 
 2   temp_c          1176 non-null   float64
 3   temp_f          1176 non-null   float64
 4   is_day          1176 non-null   int64  
 5   condition       1176 non-null   object 
 6   wind_mph        1176 non-null   float64
 7   wind_kph        1176 non-null   float64
 8   wind_degree     1176 non-null   int64  
 9   wind_dir        1176 non-null   object 
 10  pressure_mb     1176 non-null   float64
 11  pressure_in     1176 non-null   float64
 12  precip_mm       1176 non-null   float64
 13  precip_in       1176 non-null   float64
 14  snow_cm         1176 non-null   float64
 15  humidity        1176 non-null   int64  
 16  cloud           1176 non-null   int64  
 17  feelslike_c     1176 non-null   float64
 18  feelslike_f     1176 non-null   float64
 19  windchill_c     1176 non-null   float64
 20  windchill_f     1176 non-null   float64
 21  heatindex_c     1176 non-null   float64
 22  heatindex_f     1176 non-null   float64
 23  dewpoint_c      1176 non-null   float64
 24  dewpoint_f      1176 non-null   float64
 25  will_it_rain    1176 non-null   int64  
 26  chance_of_rain  1176 non-null   int64  
 27  will_it_snow    1176 non-null   int64  
 28  chance_of_snow  1176 non-null   int64  
 29  vis_km          1176 non-null   float64
 30  vis_miles       1176 non-null   float64
 31  gust_mph        1176 non-null   float64
 32  gust_kph        1176 non-null   float64
 33  uv              1176 non-null   float64
 34  city            1176 non-null   object 
dtypes: float64(22), int64(9), object(4)
memory usage: 321.7+ KB
```

In [7]:

```
# Checking the duplicates
big_df.isnull().sum()
```

Out[7]:
```
time_epoch        0
time              0
temp_c            0
temp_f            0
is_day            0
condition         0
wind_mph          0
wind_kph          0
wind_degree       0
wind_dir          0
pressure_mb       0
pressure_in       0
precip_mm         0
precip_in         0
snow_cm           0
humidity          0
cloud             0
feelslike_c       0
feelslike_f       0
windchill_c       0
windchill_f       0
heatindex_c       0
heatindex_f       0
dewpoint_c        0
dewpoint_f        0
will_it_rain      0
chance_of_rain    0
will_it_snow      0
chance_of_snow    0
vis_km            0
vis_miles         0
gust_mph          0
gust_kph          0
uv                0
city              0
dtype: int64
```

In [8]:
```
#Convert columns → correct datatypes

big_df['time'] = pd.to_datetime(big_df['time'])
big_df['temp_c'] = pd.to_numeric(big_df['temp_c'])
big_df['humidity'] = pd.to_numeric(big_df['humidity'])
big_df['wind_kph'] = pd.to_numeric(big_df['wind_kph'])
big_df['pressure_mb'] = pd.to_numeric(big_df['pressure_mb'])
big_df['precip_mm'] = pd.to_numeric(big_df['precip_mm'])
```

In [9]:
```
# Add useful time features
big_df["year"] = big_df["time"].dt.year
big_df["month"] = big_df["time"].dt.month
big_df["day"] = big_df["time"].dt.day
big_df["hour"] = big_df["time"].dt.hour
big_df["day_of_week"] = big_df["time"].dt.dayofweek
```

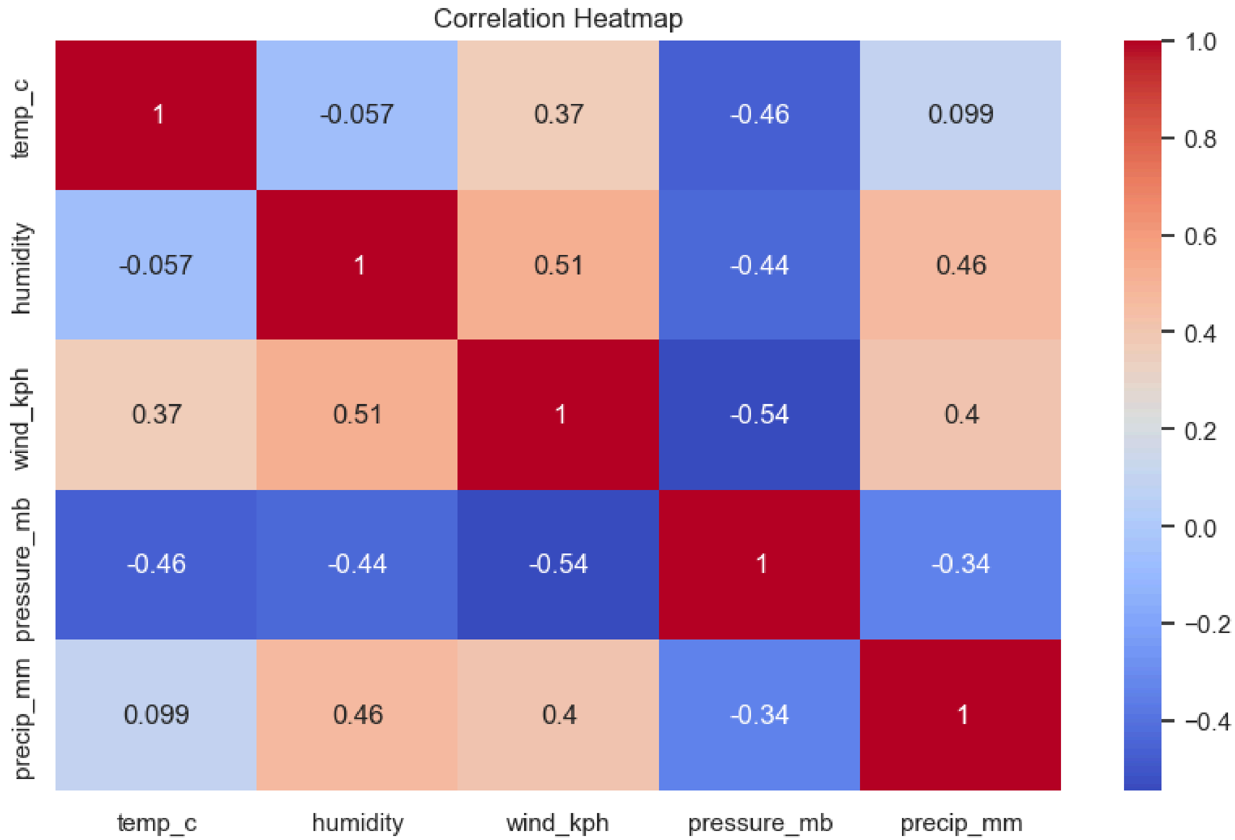
In [10]:
```python
# City-wise basic statistics
big_df.groupby("city")[["temp_c","humidity","wind_kph","precip_mm"]].describe(
```

Out[10]:

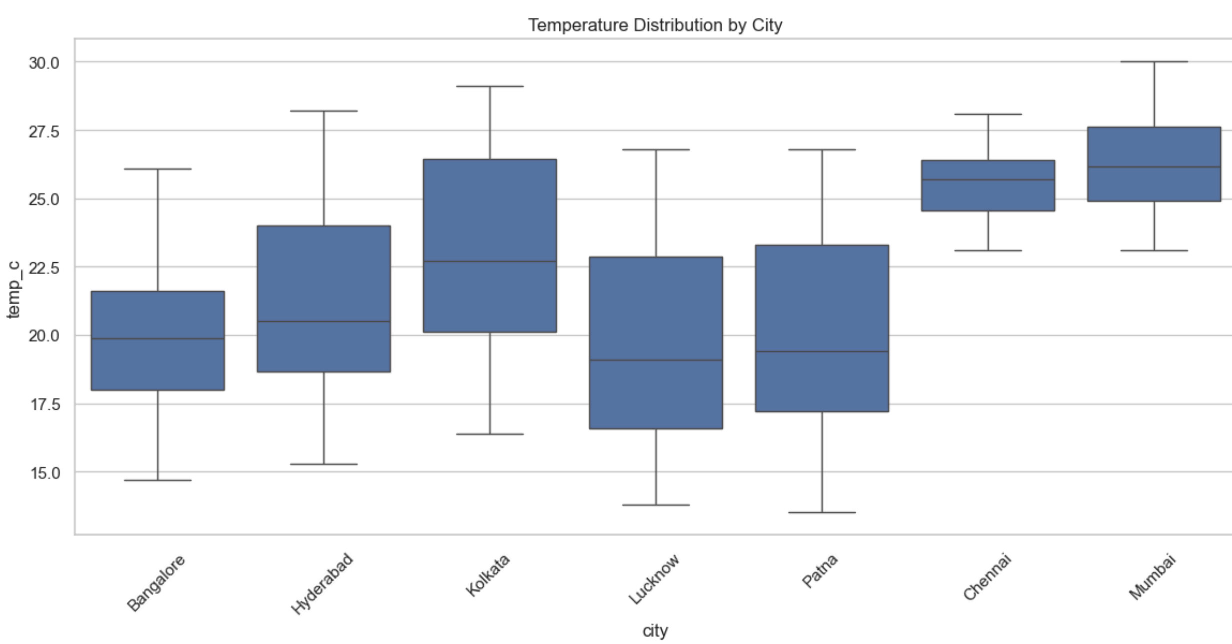
	temp_c								
	count	mean	std	min	25%	50%	75%	max	count
city									
Bangalore	168.0	19.967857	2.481460	14.7	18.000	19.90	21.600	26.1	168.0
Chennai	168.0	25.548810	1.275658	23.1	24.575	25.70	26.400	28.1	168.0
Hyderabad	168.0	21.208333	3.341275	15.3	18.675	20.50	24.025	28.2	168.0
Kolkata	168.0	23.080952	3.518232	16.4	20.100	22.70	26.425	29.1	168.0
Lucknow	168.0	19.728571	3.717706	13.8	16.575	19.10	22.850	26.8	168.0
Mumbai	168.0	26.266667	1.753343	23.1	24.900	26.15	27.625	30.0	168.0
Patna	168.0	20.152976	3.703954	13.5	17.200	19.40	23.300	26.8	168.0

7 rows × 32 columns

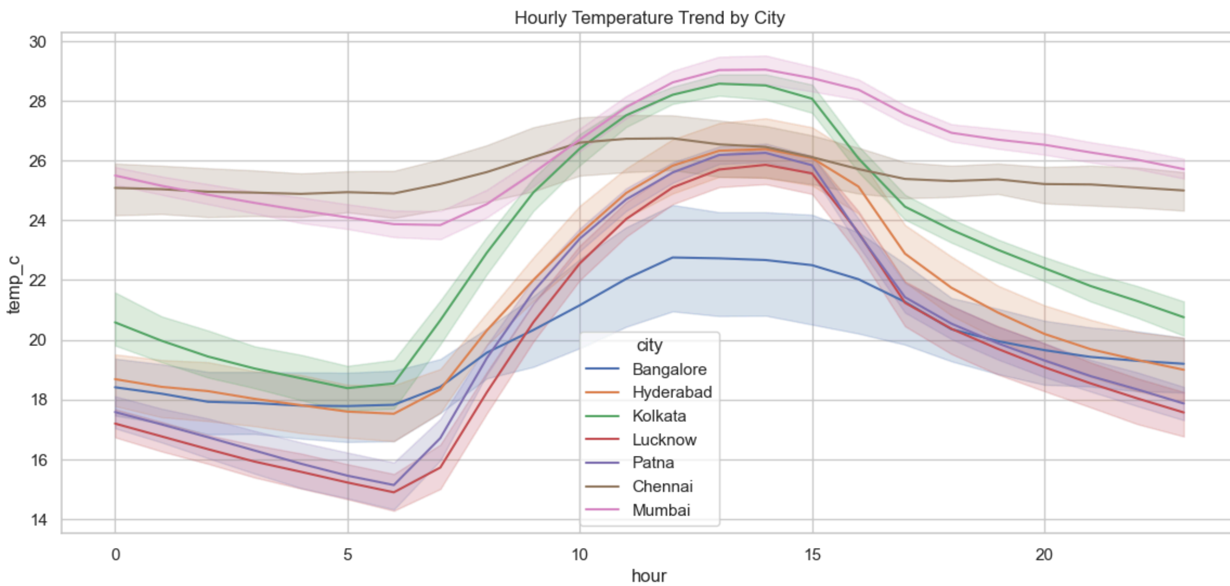
In [11]:
```python
# Correlation Heatmap (Numerical Features)
plt.figure(figsize=(10,6))
sns.heatmap(big_df[["temp_c","humidity","wind_kph","pressure_mb","precip_mm"]]
            annot=True, cmap="coolwarm")
plt.title("Correlation Heatmap")
plt.show()
```



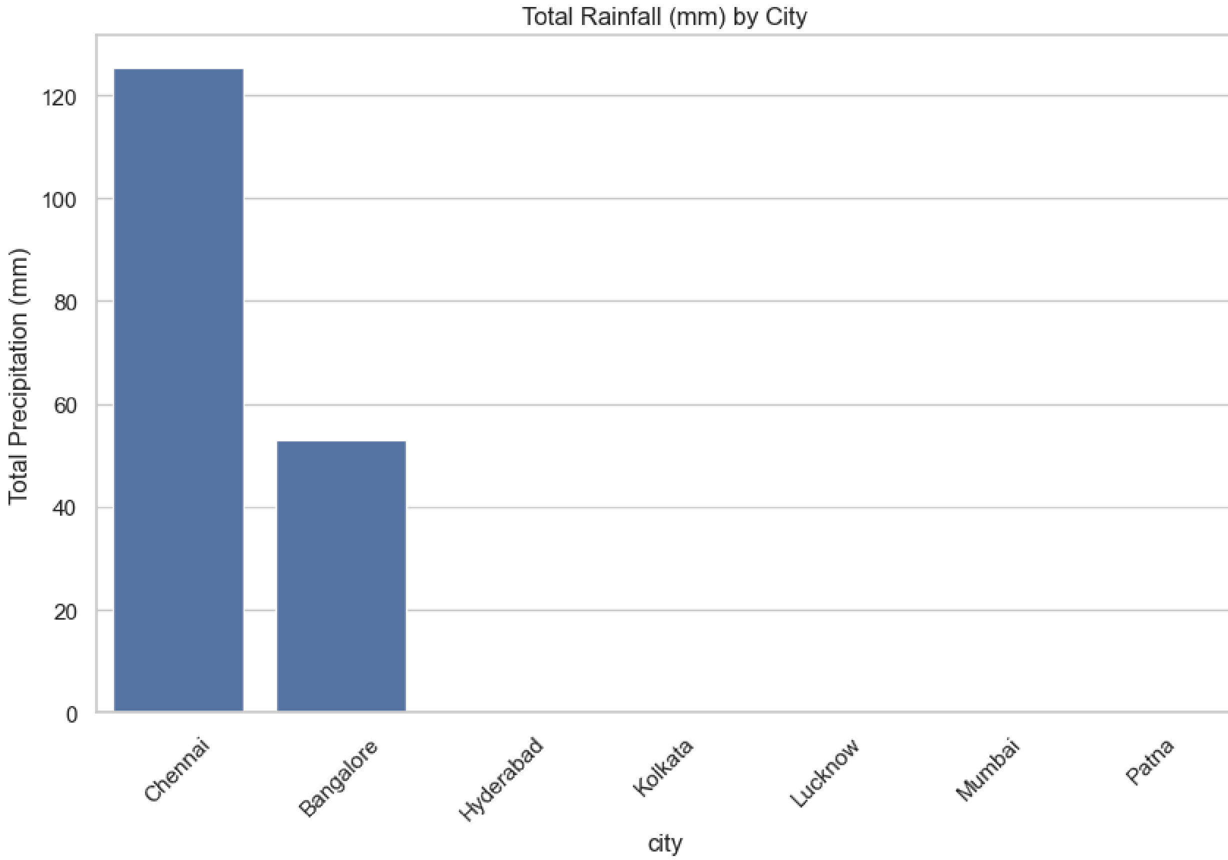
In [12]:
```
# City-wise Temperature Distribution

plt.figure(figsize=(14,6))
sns.boxplot(x="city", y="temp_c", data=big_df)
plt.xticks(rotation=45)
plt.title("Temperature Distribution by City")
plt.show()
```



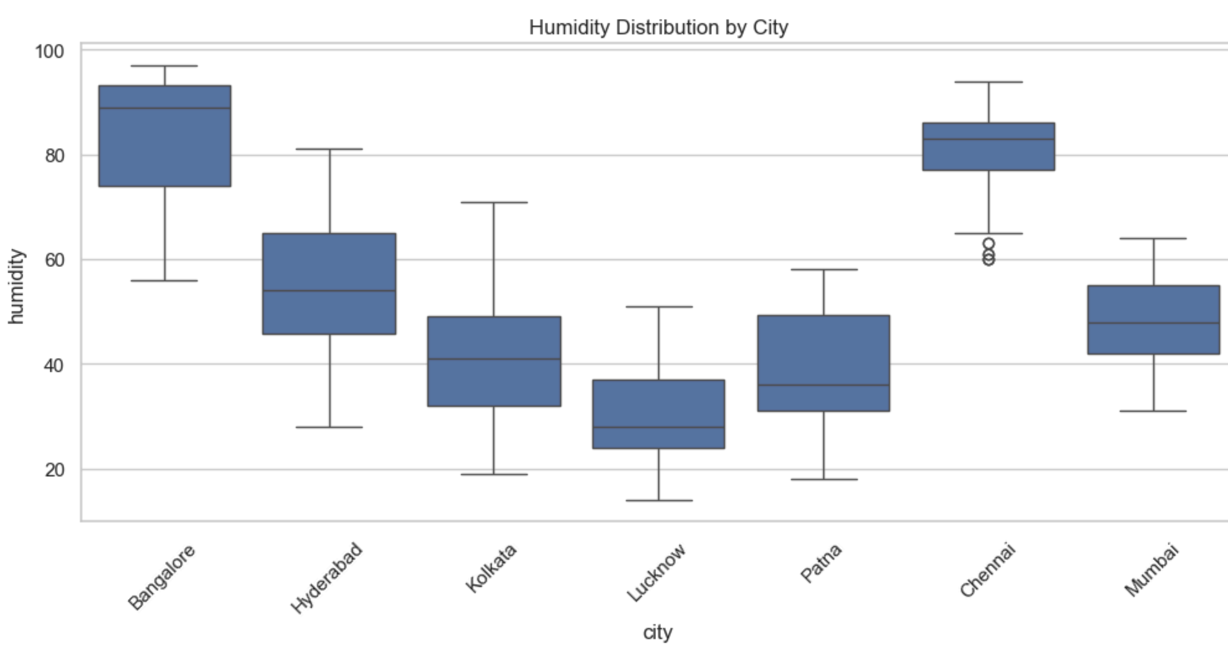
In [13]:
```
# Hourly Temperature Trend for Each City

plt.figure(figsize=(14,6))
sns.lineplot(data=big_df, x="hour", y="temp_c", hue="city")
plt.title("Hourly Temperature Trend by City")
plt.show()
```



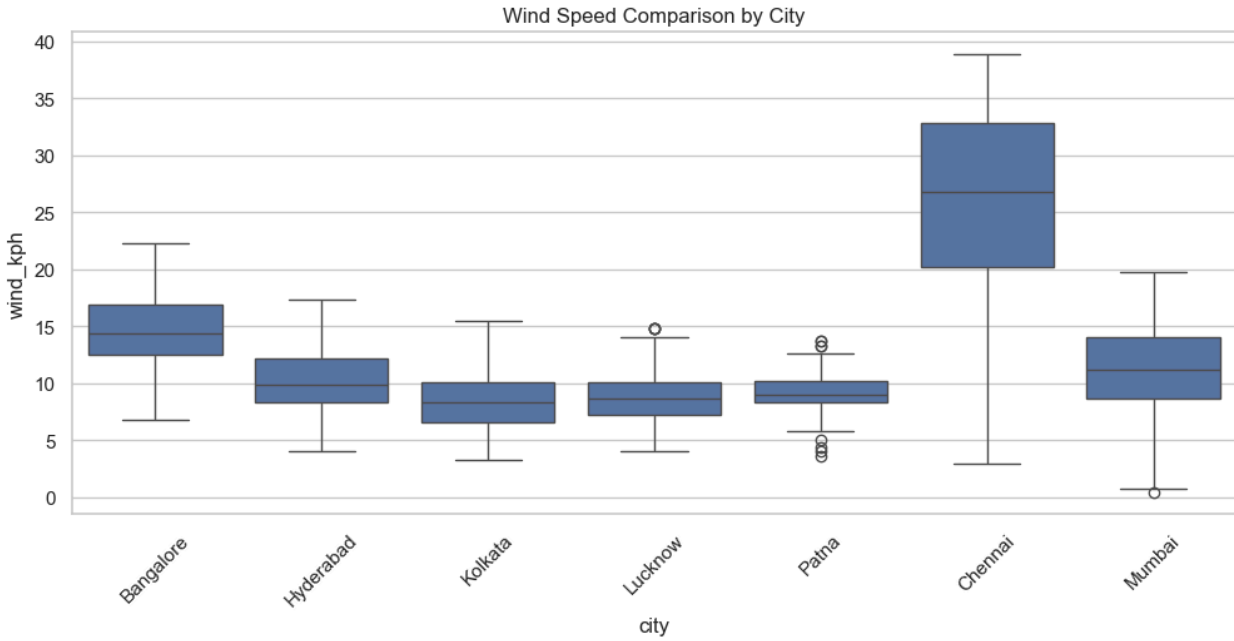
In [14]:
```
# Rainfall Analysis (Which city rains more?)

rain_df = big_df.groupby("city")["precip_mm"].sum().sort_values(ascending=Fals

plt.figure(figsize=(10,6))
sns.barplot(x=rain_df.index, y=rain_df.values)
plt.title("Total Rainfall (mm) by City")
plt.xticks(rotation=45)
plt.ylabel("Total Precipitation (mm)")
plt.show()
```



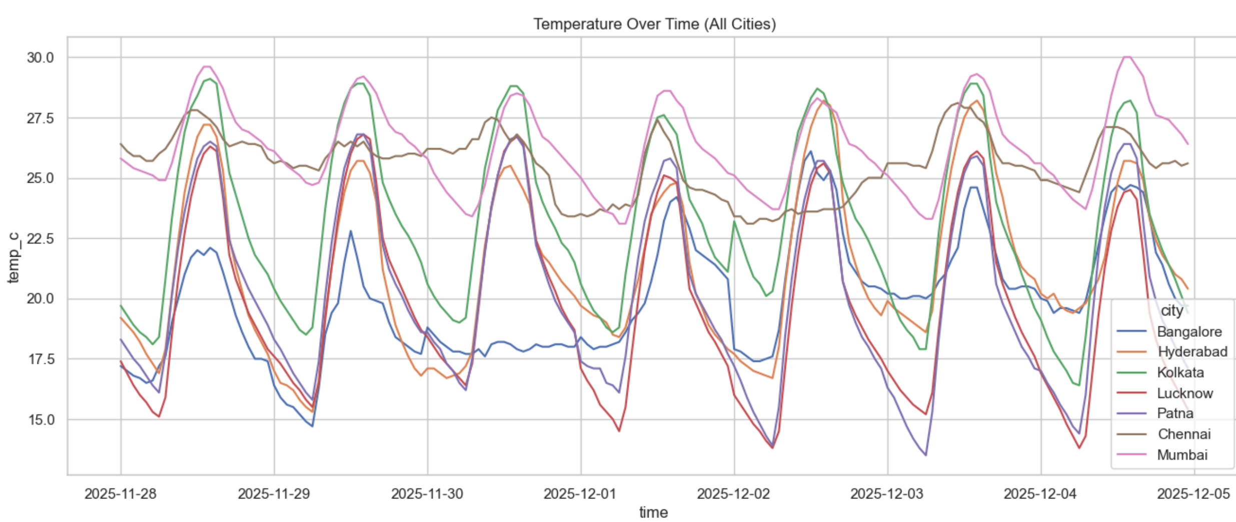
In [15]:
```
# Humidity Comparison (City-wise)

plt.figure(figsize=(12,5))
sns.boxplot(data=big_df, x="city", y="humidity")
plt.xticks(rotation=45)
plt.title("Humidity Distribution by City")
plt.show()
```



In [16]:
```
# Wind Speed Comparison

plt.figure(figsize=(12,5))
sns.boxplot(data=big_df, x="city", y="wind_kph")
plt.xticks(rotation=45)
plt.title("Wind Speed Comparison by City")
plt.show()
```

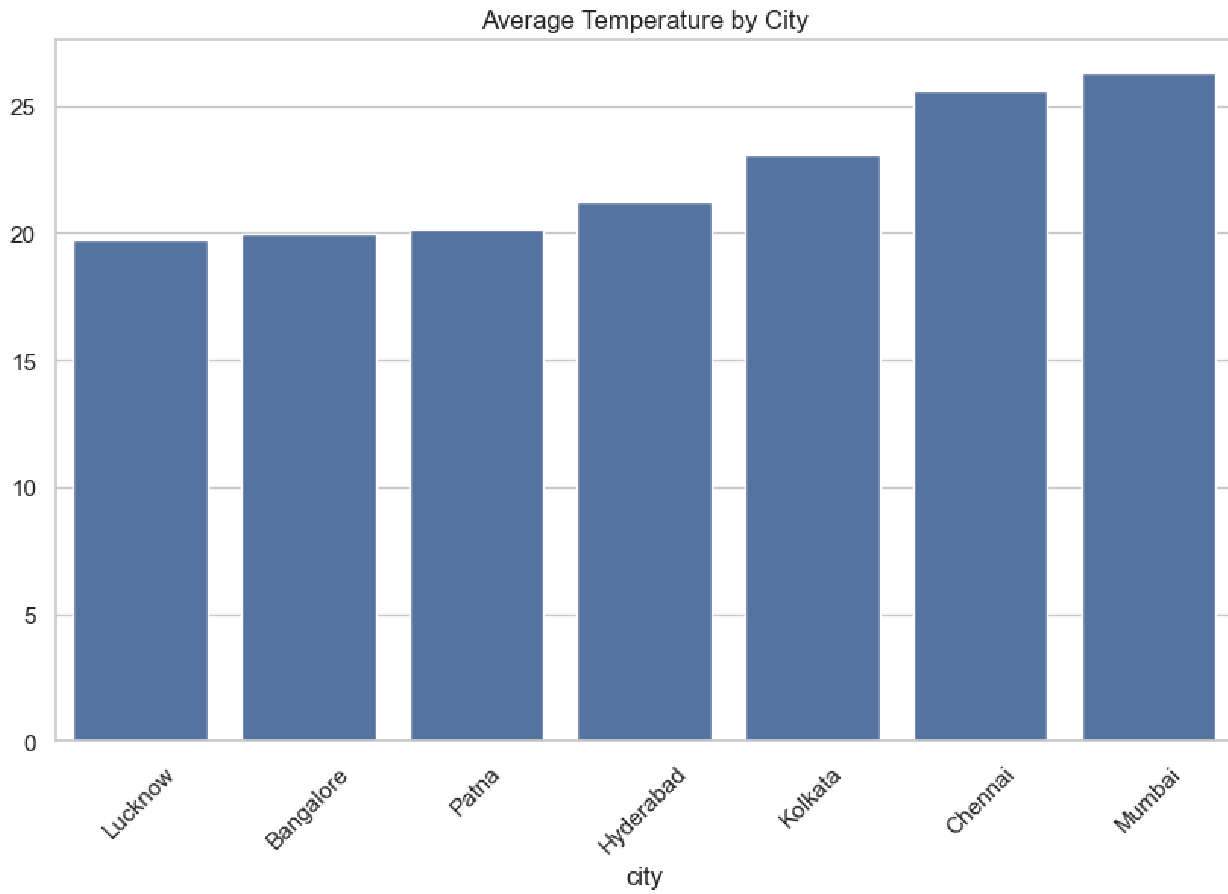


In [17]:
```
# Temperature Over Time for Each City

plt.figure(figsize=(16,6))
sns.lineplot(x="time", y="temp_c", hue="city", data=big_df)
plt.title("Temperature Over Time (All Cities)")
plt.show()
```



In [18]:
```
# City-wise Average Temperature Ranking
```

```python
avg_temp = big_df.groupby("city")["temp_c"].mean().sort_values()

plt.figure(figsize=(10,6))
sns.barplot(x=avg_temp.index, y=avg_temp.values)
plt.xticks(rotation=45)
plt.title("Average Temperature by City")
plt.show()
```



1. Feature Engineering

1.1.create features for ML

In [19]:
```python
df = big_df.copy()  # keep original intact
# Ensure types
df['time'] = pd.to_datetime(df['time'])
for col in ['temp_c','humidity','wind_kph','precip_mm','pressure_mb']:
    if col in df.columns:
        df[col] = pd.to_numeric(df[col], errors='coerce')

# Basic time features
df['year'] = df['time'].dt.year
df['month'] = df['time'].dt.month
df['day'] = df['time'].dt.day
```

```
df['hour'] = df['time'].dt.hour
df['dayofweek'] = df['time'].dt.dayofweek
df['is_weekend'] = df['dayofweek'].isin([5,6]).astype(int)

# Rolling and lag features (per city)
df = df.sort_values(['city','time']).reset_index(drop=True)
window_hours = [1,3,6,24]  # adjust as needed

for w in window_hours:
    df[f'temp_roll_mean_{w}'] = df.groupby('city')['temp_c'].transform(lambda
    df[f'temp_lag_{w}'] = df.groupby('city')['temp_c'].shift(w)

# Precipitation lag and binary rain target for classification
df['precip_mm'] = df['precip_mm'].fillna(0)
df['precip_lag_1'] = df.groupby('city')['precip_mm'].shift(1).fillna(0)
# Binary target: will it rain next hour? (1 if next hour precip > 0)
df['rain_next_hour'] = (df.groupby('city')['precip_mm'].shift(-1) > 0).astype(

# Temperature target for regression: next hour temp
df['temp_next_hour'] = df.groupby('city')['temp_c'].shift(-1)

# Drop rows with NA in target columns
df = df.dropna(subset=['temp_next_hour']).reset_index(drop=True)

print("Feature engineering done. Shape:", df.shape)
df.head()
```

```
Feature engineering done. Shape: (1169, 53)
```

Out[19]:

	time_epoch	time	temp_c	temp_f	is_day	condition	wind_mph	wir
0	1764268200	2025-11-28 00:00:00	17.2	63.0	0	{'text': 'Partly cloudy', 'icon': '//cdn.weath...	8.3	
1	1764271800	2025-11-28 01:00:00	17.0	62.6	0	{'text': 'Partly cloudy', 'icon': '//cdn.weath...	8.1	
2	1764275400	2025-11-28 02:00:00	16.8	62.2	0	{'text': 'Partly cloudy', 'icon': '//cdn.weath...	7.6	
3	1764279000	2025-11-28 03:00:00	16.7	62.1	0	{'text': 'Partly cloudy', 'icon': '//cdn.weath...	8.7	
4	1764282600	2025-11-28 04:00:00	16.5	61.7	0	{'text': 'Partly cloudy', 'icon': '//cdn.weath...	9.2	

5 rows × 53 columns

2. Train/Test Splitting (time-aware)

In [20]:

```
from sklearn.model_selection import TimeSeriesSplit

# Choose features for both tasks
features = [
    'hour','dayofweek','is_weekend','temp_c','humidity','wind_kph',
    'temp_roll_mean_1','temp_roll_mean_3','temp_roll_mean_6','temp_roll_mean_2
    'temp_lag_1','temp_lag_3','temp_lag_6','temp_lag_24',
    'precip_lag_1'
]
# ensure features exist
features = [f for f in features if f in df.columns]
print("Using features:", features)

# Sort by time
df = df.sort_values('time').reset_index(drop=True)

# Simple holdout split: last 20% time as test
split_index = int(len(df) * 0.8)
train_df = df.iloc[:split_index].copy()
test_df  = df.iloc[split_index:].copy()

print("Train shape:", train_df.shape, "Test shape:", test_df.shape)
```

```
Using features: ['hour', 'dayofweek', 'is_weekend', 'temp_c', 'humidity', 'win
d_kph', 'temp_roll_mean_1', 'temp_roll_mean_3', 'temp_roll_mean_6', 'temp_rol
l_mean_24', 'temp_lag_1', 'temp_lag_3', 'temp_lag_6', 'temp_lag_24', 'precip_la
g_1']
Train shape: (935, 53) Test shape: (234, 53)
```

3. Rain Prediction (Classification) — RandomForest + XGBoost

In [21]:

```
!pip install joblib
```

```
Requirement already satisfied: joblib in c:\users\mohammed hayath rk\anaconda3\
lib\site-packages (1.4.2)
```

In [22]:

```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report, roc_auc_score
import joblib
import os

# Prepare X/y
X_train = train_df[features].fillna(-999)
y_train = train_df['rain_next_hour']

X_test  = test_df[features].fillna(-999)
y_test  = test_df['rain_next_hour']
```

In [23]:
```python
# Train RandomForest
rfc = RandomForestClassifier(n_estimators=200, random_state=42, n_jobs=-1, cla
rfc.fit(X_train, y_train)
```

Out[23]:

RandomForestClassifier

```
RandomForestClassifier(class_weight='balanced', n_estimators=200, n_j
obs=-1,
                       random_state=42)
```

In [24]:
```python
# Predict & evaluate
y_pred = rfc.predict(X_test)
y_proba = rfc.predict_proba(X_test)[:,1]
```

In [26]:
```python
print("Classification Report (RandomForest):")
print(classification_report(y_test, y_pred))
print("ROC AUC:", roc_auc_score(y_test, y_proba))

# Create directory if it doesn't exist
os.makedirs("models", exist_ok=True)

# Save the model
joblib.dump(rfc, "models/rain_rf_model.joblib")

print("Model saved successfully!")
```

```
Classification Report (RandomForest):
              precision    recall  f1-score   support

           0       0.97      0.97      0.97       191
           1       0.86      0.86      0.86        43

    accuracy                           0.95       234
   macro avg       0.91      0.91      0.91       234
weighted avg       0.95      0.95      0.95       234

ROC AUC: 0.978692317058322
Model saved successfully!
```

In [27]:
```python
city_models = {}
for city in df['city'].unique():
    sub = df[df['city']==city].sort_values('time').reset_index(drop=True)
    if len(sub) < 500:  # skip tiny datasets
        continue
    si = int(len(sub)*0.8)
    Xtr, Xte = sub.iloc[:si][features].fillna(-999), sub.iloc[si:][features].f
    ytr, yte = sub.iloc[:si]['rain_next_hour'], sub.iloc[si:]['rain_next_hour'
    m = RandomForestClassifier(n_estimators=150, random_state=42, n_jobs=-1)
    m.fit(Xtr, ytr)
    city_models[city] = m
    print(city, "trained; test size:", len(yte))
```

4. Temperature Forecasting (Regression) — RandomForest / XGBoost

In [28]:
```
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_absolute_error, mean_squared_error
import numpy as np

# Regression target
X_train_r = train_df[features].fillna(-999)
y_train_r = train_df['temp_next_hour']
X_test_r  = test_df[features].fillna(-999)
y_test_r  = test_df['temp_next_hour']
```

In [29]:
```
rf_reg = RandomForestRegressor(n_estimators=200, random_state=42, n_jobs=-1)
rf_reg.fit(X_train_r, y_train_r)
pred_r = rf_reg.predict(X_test_r)

print("MAE:", mean_absolute_error(y_test_r, pred_r))
print("RMSE:", np.sqrt(mean_squared_error(y_test_r, pred_r)))

joblib.dump(rf_reg, "models/temp_rf_model.joblib")
```

```
MAE: 0.317108974358974
RMSE: 0.4544784262836517
```

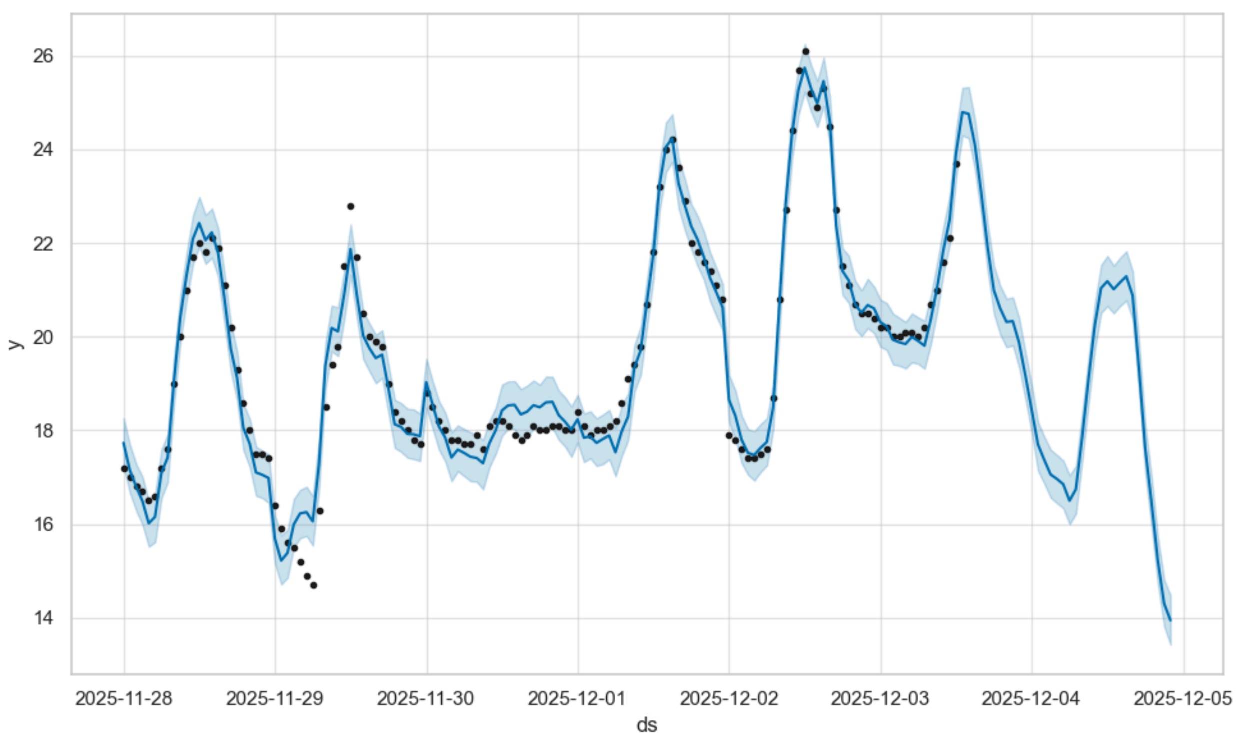
Out[29]:
```
['models/temp_rf_model.joblib']
```

5. Time-Series Model (Prophet) — per city daily or hourly

In [31]:
```
from prophet import Prophet
from sklearn.metrics import mean_absolute_error

city = 'Bangalore'
city_df = df[df['city'] == city].sort_values('time').reset_index(drop=True)

# Include humidity in prophet dataframe
prophet_df = city_df[['time', 'temp_c', 'humidity']].rename(
    columns={'time': 'ds', 'temp_c': 'y'}
)

# Initialize model
m = Prophet(
    daily_seasonality=True,
    yearly_seasonality=True,
    weekly_seasonality=True
)
```

```python
# Add regressor
m.add_regressor('humidity')

# Split 80%
split = int(len(prophet_df) * 0.8)

# Fit model WITH regressor
m.fit(prophet_df.iloc[:split])

# Build future dataframe
future = m.make_future_dataframe(periods=len(prophet_df) - split, freq='H')

# Add humidity values to future (Prophet requires it)
future['humidity'] = prophet_df['humidity']

# Predict
forecast = m.predict(future)

# Evaluate
pred = forecast.iloc[split:]['yhat'].values
true = prophet_df.iloc[split:]['y'].values

print(city, "Prophet MAE:", mean_absolute_error(true, pred))

# Plot forecast
fig = m.plot(forecast)
```

```
00:27:23 - cmdstanpy - INFO - Chain [1] start processing
00:27:24 - cmdstanpy - INFO - Chain [1] done processing
Bangalore Prophet MAE: 2.4587280347100595
```



6. Model Diagnostics & Feature Importance

In [32]:
```
# Feature importances for the RF regression model

fi = pd.DataFrame({'feature': features, 'importance': rf_reg.feature_importanc
fi.head(20)
```

Out[32]:

	feature	importance
6	temp_roll_mean_1	0.491230
3	temp_c	0.458038
0	hour	0.014422
8	temp_roll_mean_6	0.008104
11	temp_lag_3	0.005730
9	temp_roll_mean_24	0.004544
7	temp_roll_mean_3	0.004531
10	temp_lag_1	0.003522
12	temp_lag_6	0.002797
4	humidity	0.002651
5	wind_kph	0.002345
13	temp_lag_24	0.001243
1	dayofweek	0.000648
2	is_weekend	0.000102
14	precip_lag_1	0.000094

6. Simple Plotly Dashboard (interactive)

In [34]:
```
import plotly.express as px
import plotly.graph_objects as go

# 1) Interactive time series for chosen city
city_choice = input("Enter city to visualize (e.g., Delhi): ").strip()
vis_df = df[df['city']==city_choice].sort_values('time')

fig = px.line(vis_df, x='time', y='temp_c', title=f"{city_choice} - Temperatur
fig.show()

# 2) Interactive scatter: temperature vs humidity colored by city
```

```
fig2 = px.scatter(df.sample(min(2000,len(df))), x='temp_c', y='humidity', colo
fig2.update_layout(title="Temp vs Humidity (sample)")
fig2.show()

# 3) Map-style: if you have lat/lon columns
if 'lat' in df.columns and 'lon' in df.columns:
    latest = df.sort_values('time').groupby('city').tail(1)
    fig3 = px.scatter_mapbox(latest, lat='lat', lon='lon', hover_name='city',
    fig3.update_layout(mapbox_style="open-street-map")
    fig3.show()
```

8. Save Models and Pipelines

In [35]:
```
import joblib
joblib.dump(rf_reg, "models/temp_rf_model.joblib")
joblib.dump(rfc, "models/rain_rf_model.joblib")
# Example: save label encoders / scalers if used
```

Out[35]:
```
['models/rain_rf_model.joblib']
```