# Climatic Analysis of Manipal Weather Data

Task–5

## 1 Introduction

Climate analysis plays a crucial role in understanding long-term environmental changes and their impact on weather-dependent systems. This report presents a climatic analysis of historical weather data from **Manipal**, with a focus on identifying seasonality, long-term patterns, and quantifying climate change trends in both temperature and precipitation.

The analysis is entirely data-driven and based on exploratory data analysis (EDA) techniques applied to daily atmospheric observations.

## 2 Dataset Overview

The dataset consists of daily weather records for Manipal, including temperature and precipitation measurements along with other atmospheric variables. The timestamp was converted to datetime format and the data was sorted chronologically to preserve temporal consistency.

The primary variables used in this analysis are:

- Mean temperature at 2 meters height (°C)
- Daily precipitation sum (mm)

Additional time-based features such as year and month were extracted to study seasonal and long-term trends.

## 3 Seasonality and Climatic Patterns

### 3.1 Temperature Seasonality

Monthly averaging of daily mean temperature was performed to examine seasonal behavior.

The resulting pattern shows:

- Relatively higher temperatures during pre-monsoon and summer months
- Slight reduction in temperature during monsoon and post-monsoon periods
- Overall low seasonal amplitude, indicating a thermally stable coastal climate

This confirms that Manipal experiences limited temperature extremes throughout the year.

### 3.2 Precipitation Seasonality

Monthly aggregation of precipitation reveals strong seasonal dependence.

Key observations include:

- Very high rainfall during monsoon months
- Near-zero precipitation during dry seasons

- Rainfall concentrated in short temporal windows

Unlike temperature, precipitation exhibits sharp seasonal peaks driven by monsoon dynamics.

# 4 Long-Term Climatic Trends

## 4.1 Yearly Temperature Trend

To quantify long-term changes in temperature, yearly average temperature values were computed. A linear regression model was then fitted:

$$T_{avg}(y) = a \cdot y + b$$

where $y$ represents the year.
**Result:**

- The fitted regression line shows a positive slope
- This indicates a gradual increase in average temperature over the years

Although the yearly increase is small, the consistent upward trend provides quantitative evidence of long-term warming in the Manipal region, consistent with broader climate change observations.

## 4.2 Yearly Precipitation Trend

Annual precipitation was computed by summing daily rainfall for each year. The same linear regression approach was applied:

$$P_{sum}(y) = c \cdot y + d$$

**Result:**

- The regression slope is close to zero
- Large inter-annual variability dominates the precipitation pattern

This indicates that, unlike temperature, precipitation does not exhibit a strong monotonic trend over the years and is influenced more by short-term climatic variability.

# 5 Climate Change Impact Quantification

Using linear regression as the chosen model, the climate change impact was quantified as follows:

- **Temperature:** A slow but persistent upward trend in yearly mean temperature confirms gradual warming
- **Precipitation:** No clear long-term increasing or decreasing trend, but increased variability suggests instability rather than directional change

This contrast highlights that climate change effects in Manipal are more clearly observable in temperature than in precipitation totals.

## 6 Climatic Insights

Based on the analysis, the following data-driven insights were obtained:

- Manipal has a warm, coastal climate with minimal temperature extremes
- Rainfall is highly seasonal and dominated by monsoon activity
- Long-term warming trends are evident despite short-term fluctuations
- Precipitation patterns are highly variable and less predictable

These findings justify the need for sequence-based models when forecasting weather variables.

## 7 Conclusion

This climatic analysis successfully identifies seasonal patterns and long-term trends in Manipal's weather data. By quantifying climate change impact using a regression-based approach, the study shows that temperature exhibits a measurable warming trend, while precipitation remains dominated by variability rather than consistent change.