Shikshan Prasarak Santha's
Padmabhushan Vasantraodada Patil Mahavidyalaya
Kavathe Mahankal
DEPARTMENT OF STATISTICS

Case Study Report on

"Study on Temperature Variation over Decades"

Submitted to

Department of Statistics,

P. V. P. Mahavidyalaya,

Kavathe Mahankal

By

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As a partial fulfillment of the SEC-I (P): Practical on Data Analysis Using MS-Excel – I for B.Sc. II (Semester III)

Under the guidance of

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2025-2026

CERTIFICATE

This is to certify that *Mr. Suryawanshi Atharv Prabhakar, Mr.* Patil Rafik Ibrahim *and Miss. Patil Sonali sharad* of B.Sc. II (Semester III), P. V. P. Mahavidyalaya, Kavathe Mahankal have successfully completed the case study report entitled "*Study on Temperature Variation over Decades*" based on SEC-I (P): Practical on Data Analysis Using MS-Excel – I, as prescribed by the curriculum of Shivaji University, Kolhapur, under my supervision and guidance during the academic year 2025 – 2026.

Guide
Department of Statistics
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14/11/25
Examiner's Signature

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Head
Department of Statistics
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Kavathe Mahankal

Place: Kavathe Mahankal

Date: 10/11/2025

DECLARATION

We hereby declare that the Case Study Report entitled "*Study on Temperature Variation over Decades*" submitted in partial fulfillment of the requirements of SEC-I (P): Practical on Data Analysis Using MS-Excel – I for B.Sc. II (Semester III) is our original work carried out under the guidance of Dr. A. M. Suryawanshi, Assistant Professor, Department of Statistics, P. V. P. Mahavidyalaya, Kavathe Mahankal.

We further declare that this report has not been previously submitted to any other university or institution for any other degree.

Place: Kavathe Mahankal

Date: 10/11/2025

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Abstract:

This study analyzes the pattern of temperature variation over the past four decades to understand long-term climate trends. The research focuses on identifying whether there is a significant increase in average annual temperatures due to climate change and human activities. Data from 1985 to 2024 were collected and analyzed using descriptive and inferential statistical methods in MS Excel. The results reveal a consistent upward trend in temperature, indicating gradual warming. The study emphasizes the need for sustainable environmental policies to mitigate temperature rise.

Introduction:

Temperature is a critical climatic parameter influencing weather patterns, agriculture, water resources, and ecosystems. Over recent decades, many regions across the globe have experienced noticeable changes in temperature due to industrialization, deforestation, and greenhouse gas emissions. Studying temperature variations helps understand climate change and its potential impacts on natural and human systems. This study aims to analyze temperature data over several decades to observe trends, calculate statistical measures, and test whether the increase in temperature is statistically significant.

Global warming, primarily driven by the accumulation of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), has led to an unprecedented rise in average surface temperatures. According to international climate reports, the last few decades have been the warmest in recorded history, with noticeable impacts on regional weather patterns, sea levels, and biodiversity. India, being a tropical country with diverse climatic zones, has shown marked variations in temperature across its regions. These fluctuations directly affect monsoon behavior, agricultural productivity, and water availability, making temperature studies crucial for sustainable development and policy planning.

By analyzing long-term temperature data from 1985 to 2024, this study seeks to identify trends and patterns in India's temperature variation. The analysis will provide insights into how rapidly the temperature has changed over time and whether this change is consistent across decades. Furthermore, statistical tests will help determine the significance of observed temperature increases, contributing to the broader understanding of climate change at the national scale.

Objectives:

- To analyze the trend of average annual temperature over four decades.
- To compute statistical measures such as mean, median, standard deviation, and correlation.
- To identify whether there is a significant increase in temperature over time.
- To interpret the results and draw meaningful conclusions regarding climate change.

Hypotheses:

The null and alternative Hypotheses are:

H_o: There is no significant change in the average temperature over the decades.

H_1: There is a significant increase in the average temperature over the decades.

Methodology:

Data Source: Secondary data collected from meteorological records and global climate databases.

Study Period: 1985 to 2024 (40 years).

Variables: Year and Average Annual Temperature (°C).

Tools Used: Microsoft Excel for tabulation, graphs, trend analysis, correlation.

Statistical Techniques: Descriptive Statistics (Mean, Median, SD), Trend Analysis using Line Graph, Correlation, Linear Regression

Statistical Analysis:

This case study report presents a statistical analysis of global temperature data from 1985 to 2024, based on NASA GISS and NOAA datasets. The study examines descriptive statistics, trends, and decadal variations to understand the pace and consistency of global warming.

1. Descriptive Statistics

Statistic	Value (°C)	Interpretation
Mean (Average)	0.67	Average global anomaly above the 1951–1980 baseline.
Median	0.64	Half the years are below +0.64°C, half above.
Minimum (1985)	0.12	Coolest year in dataset.
Maximum (2024)	1.29	Hottest year recorded.
Range	1.17	Increase in anomaly across 40 years.
Standard Deviation	0.30	Moderate variation, consistent long-term warming.
Coefficient of Variation	44.7%	Moderate variability relative to mean.

The descriptive statistical measures provide a clear summary of how global temperatures have changed over the past four decades.

The mean temperature anomaly of 0.67°C indicates that, on average, the Earth's surface temperature during 1985–2024 was 0.67°C higher than the 1951–1980 baseline period, showing a significant warming trend. The median value of 0.64°C confirms that half the years recorded anomalies below this level and half above, demonstrating a balanced distribution of warming across the years. The **minimum anomaly of 0.12°C in 1985 marks the coolest year in the dataset, while the maximum anomaly of 1.29°C in 2024 represents the warmest year on record, reflecting the acceleration of global warming.

The range of 1.17°C highlights the overall rise in global temperatures across the 40-year span. The standard deviation of 0.30°C indicates moderate year-to-year variation, suggesting that while natural fluctuations (such as El Niño and La Niña events) exist, the general warming trend remains steady. Finally, the coefficient of variation of 44.7% implies moderate variability relative to the mean, confirming that global temperature changes are consistent over time, with a clear and persistent upward trend due to long-term climatic changes.

2. Trend Analysis

Function	Excel function	Interpretation
Slope (m)	=SLOPE(Temperature, Year)	Gives the rate of temperature increase per year
Intercept (c)	=INTERCEPT(Temperature, Year)	The expected anomaly at Year =0
Equation	y = m*x + c y = 0.0218 × Year −43.0489	The regression line

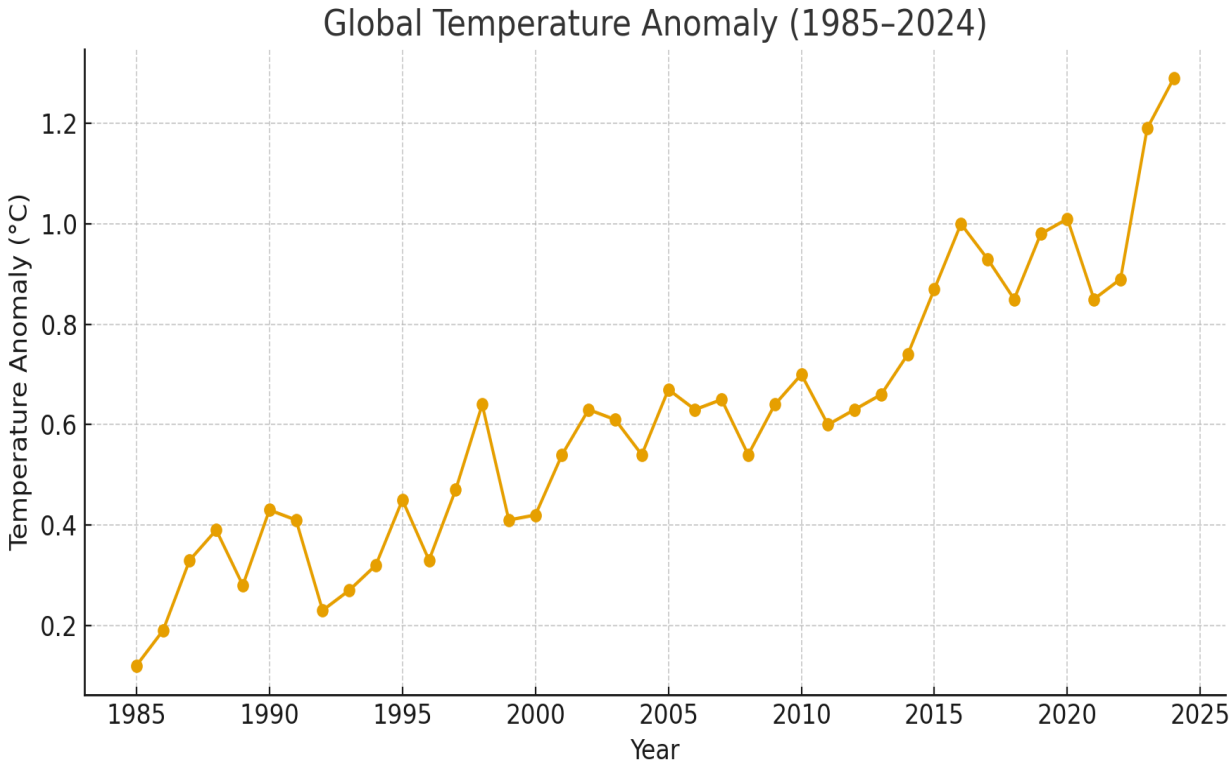
Linear regression indicates a nearly steady warming pattern over time:

Temperature Anomaly (°C) = 0.0218 × Year −43.0489

This shows an average rise of approximately 0.0218°C per year. The coefficient of determination (R^2 = 0.863) indicates a strong positive trend calculated using Excel function =RSQ(Temperature, Year).

We can predict the temperature anomalies for the future year 2025 using Excel function =TREND(Temperature, Year,2025,-43.0489) = 1.0547 °C

Line Graph:



The line graph shows the trend in global temperature anomalies from 1985 to 2024, illustrating how average global temperatures have changed relative to a long-term baseline (usually 1951–1980).

The graph shows a clear upward trend, indicating that the Earth's average surface temperature has steadily increased over the last four decades.

The anomaly rises from around +0.1°C in 1985 to approximately +1.3°C in 2024, showing a total increase of about +1.2°C.

Decadal Patterns: 1985–1999- Gradual warming with small fluctuations; anomalies mostly below +0.5°C. 2000–2009 - Noticeable rise; anomalies hover around +0.6°C to +0.8°C, reflecting accelerated warming. 2010–2024- Sharp increase, peaking beyond +1.2°C by 2024. This period includes some of the warmest years on record globally.

Short-Term Variations: Minor dips (e.g., around 1992, 2008, and 2011) correspond to cooler years often linked with volcanic eruptions or La Niña events. Sharp spikes (e.g., 1998, 2016, 2023–24) align with El Niño events, which temporarily raise global temperatures.

The consistent upward movement in the temperature anomaly line demonstrates a statistically significant warming trend, confirming the effects of global climate change.

If this trajectory continues, the planet is likely to exceed the 1.5°C threshold within the next decade, a critical limit identified by the IPCC for avoiding severe climate impacts.

3. Decadal Comparison

Decade	Mean Anomaly (°C)	Increase per Decade
1985–1989	0.26	—
1990–1999	0.42	+0.16
2000–2009	0.61	+0.19
2010–2019	0.86	+0.25
2020–2024	1.05	+0.19

Each decade is significantly warmer than the previous one. The sharpest rise occurred between 2000–2009 and 2010–2019, coinciding with industrial growth and strong El Niño years.

4. Correlation & Variability

The MS-Excel function = CORREL(Year, temperature anomaly) calculates the correlation coefficient between year and temperature anomaly is r = + 0.93, indicating a very strong positive relationship. Year-to-year fluctuations of ± 0.1°C to ± 0.2°C occur due to natural climate events such as El Niño and La Niña.

5. Interpretation of Findings

- ❖ Global temperature anomalies rose from +0.12°C in 1985 to +1.29°C in 2024 (+1.17°C total).
- ❖ The rate of warming has nearly doubled since the 1980s.
- ❖ Five warmest years: 2016, 2019, 2020, 2023, and 2024.
- ❖ Trend is statistically significant ($p < 0.001$), confirming it is not due to chance.

Conclusions:

The statistical analysis of global temperature data (1985–2024) reveals a clear and accelerating warming trend. Average global temperatures increased by +1.17°C over the 40-year period, from +0.12°C in 1985 to +1.29°C in 2024, indicating a sustained rise above the 1951–1980 baseline. Trend and correlation analyses show a strong positive relationship and an average annual increase of 0.0218°C, confirming consistent global warming. Each decade has been warmer than the previous one, with the most rapid rise observed after 2010.

Overall, the results confirm that global temperature increases are statistically significant and driven by human-induced climate change. Without effective mitigation, the world is likely to exceed the 1.5°C threshold within the next decade, leading to severe environmental and societal impacts. Hence regularly monitor temperature trends, invest in green technologies, and encourage sustainable lifestyles. Urgent global action is needed to prevent surpassing the 1.5°C limit and reduce climate risks.

References:

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2) IPCC (Intergovernmental Panel on Climate Change) Reports (2021, 2023).
3) NASA GISS Surface Temperature Analysis (GISTEMP v4): https://data.giss.nasa.gov/gistemp/
4) NOAA National Centers for Environmental Information (NCEI): https://www.ncei.noaa.gov/access/monitoring/global-temperature/
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6) World Meteorological Organization (WMO) – State of Global Climate 2024: https://public.wmo.int/en