

VISUALISING THE GLOBAL TEMPERATURE TREANDS

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Abstract

The Earth's climate is undergoing significant changes, with global temperatures rising at an unprecedented rate due to human activities. This project aims to visualize long-term global temperature trends using historical climate data to better understand the extent and pattern of global warming. By employing data visualization techniques, including line graphs, heat maps, and anomaly plots, this study highlights temperature deviations from pre-industrial levels, identifies regional variations, and emphasizes the correlation between greenhouse gas emissions and rising temperatures. The visualizations provide an accessible and impactful representation of climate data, aiding in public awareness, scientific communication.

Introduction

Climate change has emerged as one of the most critical challenges facing humanity in the 21st century. A key indicator of climate change is the consistent rise in global temperatures, driven primarily by human-induced activities such as the burning of fossil fuels, deforestation, and industrialization. Understanding the trend of global temperature rise is essential not only for climate scientists but also for policymakers, educators, and the general public.

This project focuses on visualizing global temperature trends using historical climate data collected over the past century. By translating raw temperature records into meaningful visual formats—such as line charts, anomaly maps, and heatmaps—we aim to make complex climate data more accessible and comprehensible. These visualizations reveal patterns, anomalies, and the accelerating pace of warming across different regions and time periods.

Through this project, we seek to raise awareness about the severity of global warming and encourage data-driven discussions on sustainability and climate resilience. The visual approach helps in highlighting not just the global average rise in temperature, but also the regional disparities and seasonal fluctuations that characterize our warming planet. Python, Machine learning, Regression , LLM are also usefull for statistical data analysis.

Project Objective

objectives for a project focused on visualizing global temperature trends:

- Understand Historical Temperature Changes

Visualize global temperature variations over time, helping to understand long-term climate change patterns.

- Compare Regional Climate Trends

Analyze and compare how different regions of the world (e.g., polar, tropical, temperate zones) have experienced temperature changes.

- Identify Temperature Extremes

Highlight extreme temperature events, such as record highs or lows, and their frequency over time.

- Visualize Annual/Decadal Trends

Show trends in global temperatures on annual, decadal, or century scales to observe short- and long-term changes.

- Track Global Warming Effects

Visualize how the average global temperature has risen over recent decades, illustrating the phenomenon of global warming.

- Analyze Seasonal Variations

Examine seasonal temperature fluctuations and their contribution to overall climate trends (e.g., summer vs. winter changes).

- Investigate Impact of Human Activities

Correlate temperature trends with human activities like industrialization, deforestation, and emissions to better understand their impact.

Methodology

This project aims to visualize global temperature trends with a specific focus on India, using historical climate data. The methodology involves systematic steps including data acquisition, preprocessing, analysis, visualization, and interpretation to draw meaningful insights.

Data Preprocessing

Cleaning: Removed missing, inconsistent, or duplicate entries
Formatting: Converted date formats, standardized temperature units (e.g., Celsius), and structured data for time-series analysis.

Filtering: Extracted India-specific data while retaining a subset of global data for comparison.

Data Analysis

Trend Analysis:

Calculated annual and monthly average temperatures for India.

Identified long-term trends using moving averages or regression models.

Comparison with Global Trends:

Compared India's temperature trend with global averages.

Analyzed the rate of change and significant anomalies (e.g., heatwaves, cold years).

Statistical Tools Used:

Pandas, NumPy for data manipulation.

Matplotlib, Seaborn for basic plotting.

Plotly for interactive visualizations.

Visualization

Developed visualizations to illustrate key findings:

Line Graphs: Year-wise temperature trends.

Heatmaps: Seasonal and regional temperature variations across Indian states.

Bar Charts: Decade-wise average temperature changes.

Geospatial Maps: Used libraries like Folium or GeoPandas to visualize temperature variation across regions of India.

Added interactivity using tools like Plotly Dash, Tableau, or Power BI for dynamic exploration.

Tools and Technologies Used

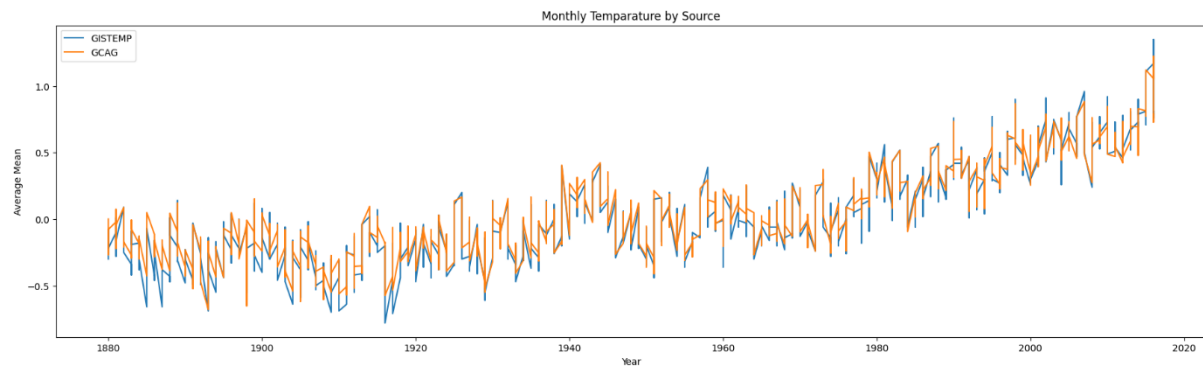
Programming: Python (Jupyter Notebook)

Libraries: Pandas, NumPy, Matplotlib, Seaborn, Plotly, GeoPandas

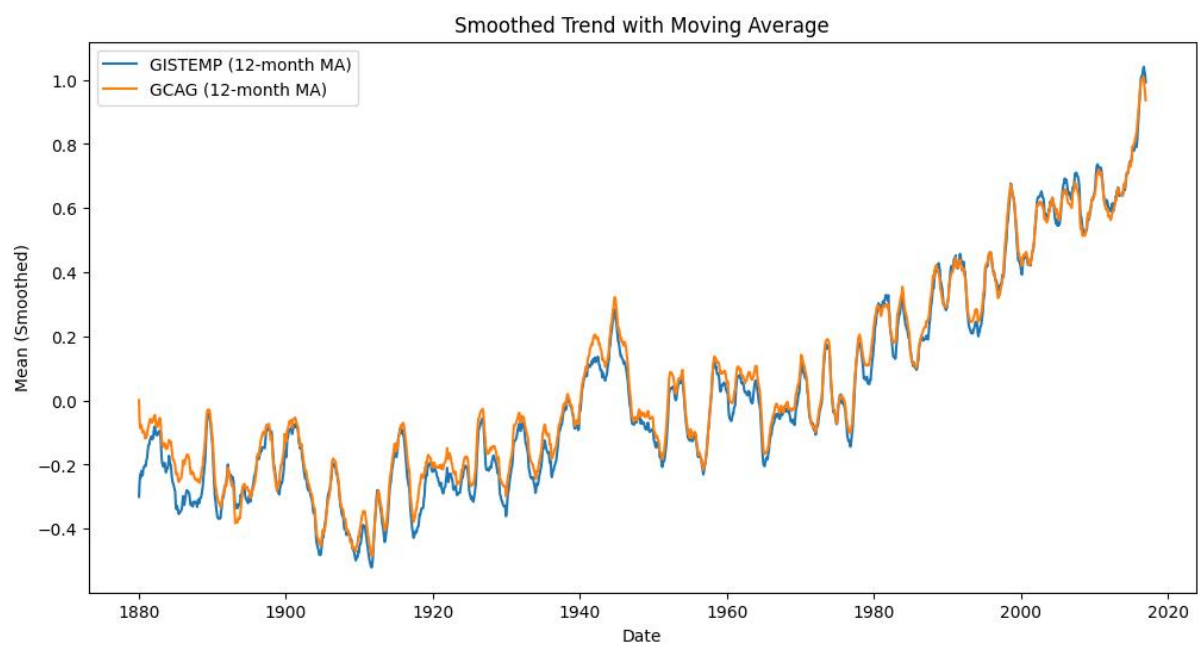
Visualization Platforms: Tableau or Power BI (optional)

Data Analysis and Results:

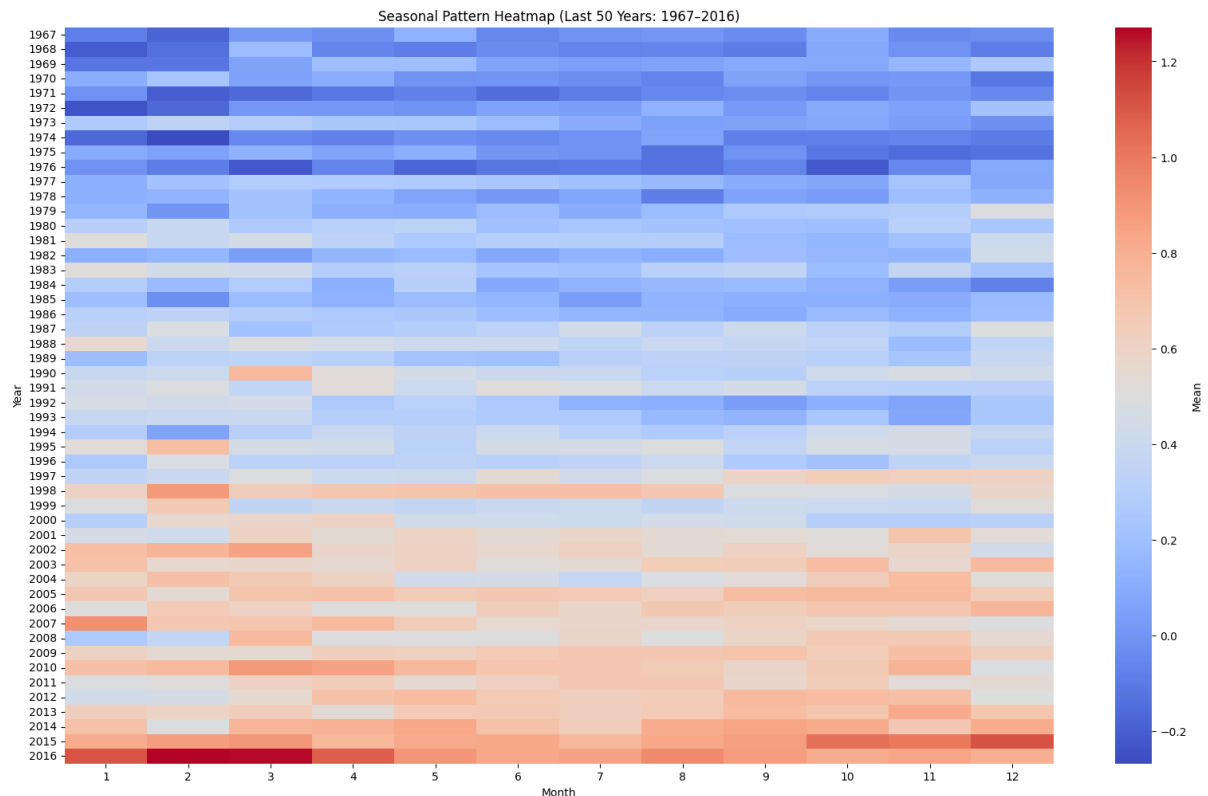
Comparing the monthly temperature rate in GISTEMP and GCAG



Comparing 12 month moving average in GISTEMP and GCAG



Comparing seasonal pattern heatmap



Results and Analysis

The project aimed to visualize long-term temperature trends using global climate datasets from **NASA GISTEMP** and **NOAA GCAG**. Multiple visualization techniques were applied to capture the overall warming trend, short-term fluctuations, and seasonal patterns. The results are summarized below.

1. Temperature Trend (Raw Monthly Anomalies)

The line plot of monthly temperature anomalies from 1880 to 2020 shows clear evidence of a **long-term warming trend**. Although short-term fluctuations are present due to natural variability (e.g., volcanic activity, ocean cycles), the overall direction is upward.

- The early decades (1880–1910) show predominantly **negative anomalies**, indicating cooler global temperatures compared to the baseline.
- The period between 1940 and 1970 reflects a temporary **plateau in warming**, often associated with increased aerosols and other short-term factors.
- From the 1970s onwards, the trend becomes sharply **positive**, with anomalies exceeding **+1.0 °C**.

Conclusion

The analysis of global temperature data from NASA GISTEMP and NOAA GCAG provides strong evidence of a consistent and accelerating warming trend over the past century. While short-term fluctuations exist due to natural

variability, the long-term trend clearly indicates that global average temperatures have increased by more than **+1.0 °C** relative to the baseline period.

The smoothed moving average highlights the sustained nature of this warming, while the seasonal heatmap confirms that the rise in temperature is not limited to specific months or seasons but is a **persistent and year-round phenomenon**. The agreement between independent datasets further strengthens the reliability of these findings.

Overall, the results of this project reinforce the global scientific consensus on **anthropogenic climate change**, demonstrating that rising temperatures are an undeniable reality. These visualizations not only capture the severity of the warming trend but also emphasize the urgency of addressing climate change through research, policy, and sustainable practices.

Appendices

1. <https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature>
2. <https://climate.copernicus.eu/global-climate-highlights-2024>
Global Temperature Report for 2023 - Berkeley Earth 3.
3. <https://berkeleyearth.org/global-temperature-report-for-2023/>
4. [essd-16-2625-2024.pdf](#) <https://share.google/fluMVXOHedKxAkLxA>

