Global Temperature Trends: A Long-Term Perspective on Climate Change

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Introduction

Climate change is one of the most significant challenges facing our planet today. Understanding historical temperature patterns and their changes over time is crucial for contextualising current climate trends and informing future policy decisions.

This report presents a comprehensive analysis of global temperature data, examining temperature trends across six representative countries spanning different continents and climate zones: the United States, China, India, Germany, Brazil, and Australia.

The analysis leverages historical temperature records, dating back as early as 1750 for some regions, to provide a long-term perspective on climate change. The data is sourced from the "global_temperature_data.csv" dataset.
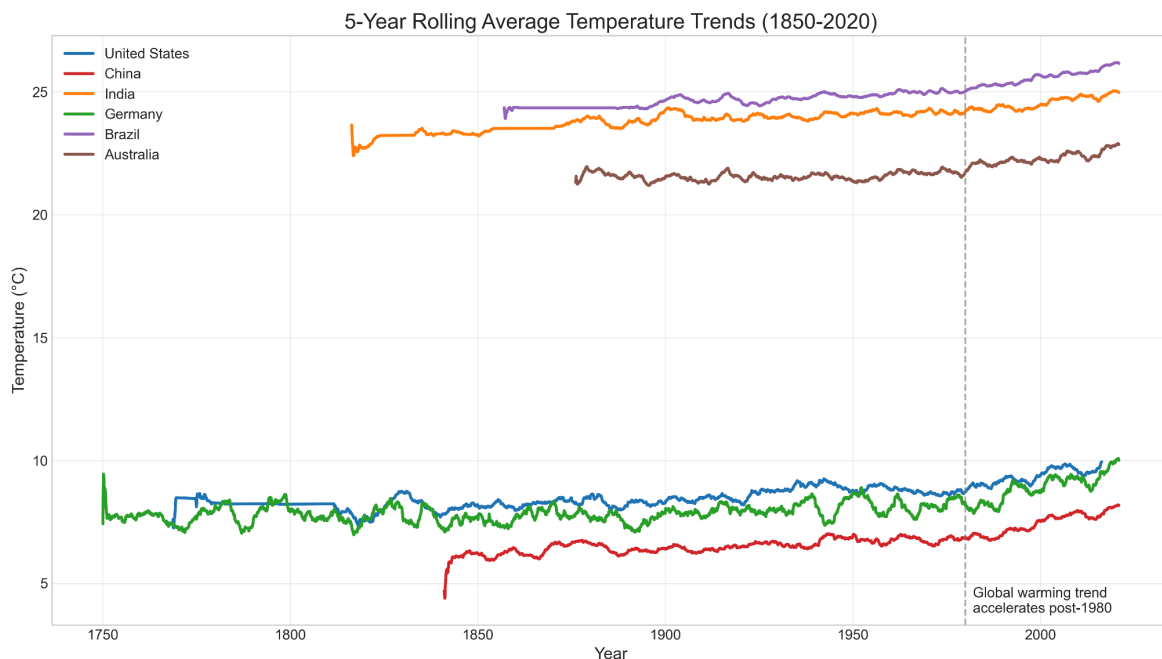
Long-Term Temperature Trends

Figure 1

Figure 1: The 5-year rolling average temperature trends from 1850 to 2020 for six countries across different continents. The visualisation reveals a clear global warming trend in all countries, with a noticeable acceleration after 1980. Brazil and India exhibit the highest average temperatures, around 25°C, due to their tropical and subtropical climates. Despite being on different continents, Germany and the United States display similar warming patterns. Overall, the figure highlights that global warming is a worldwide phenomenon, affecting countries across various geographic and climate zones.

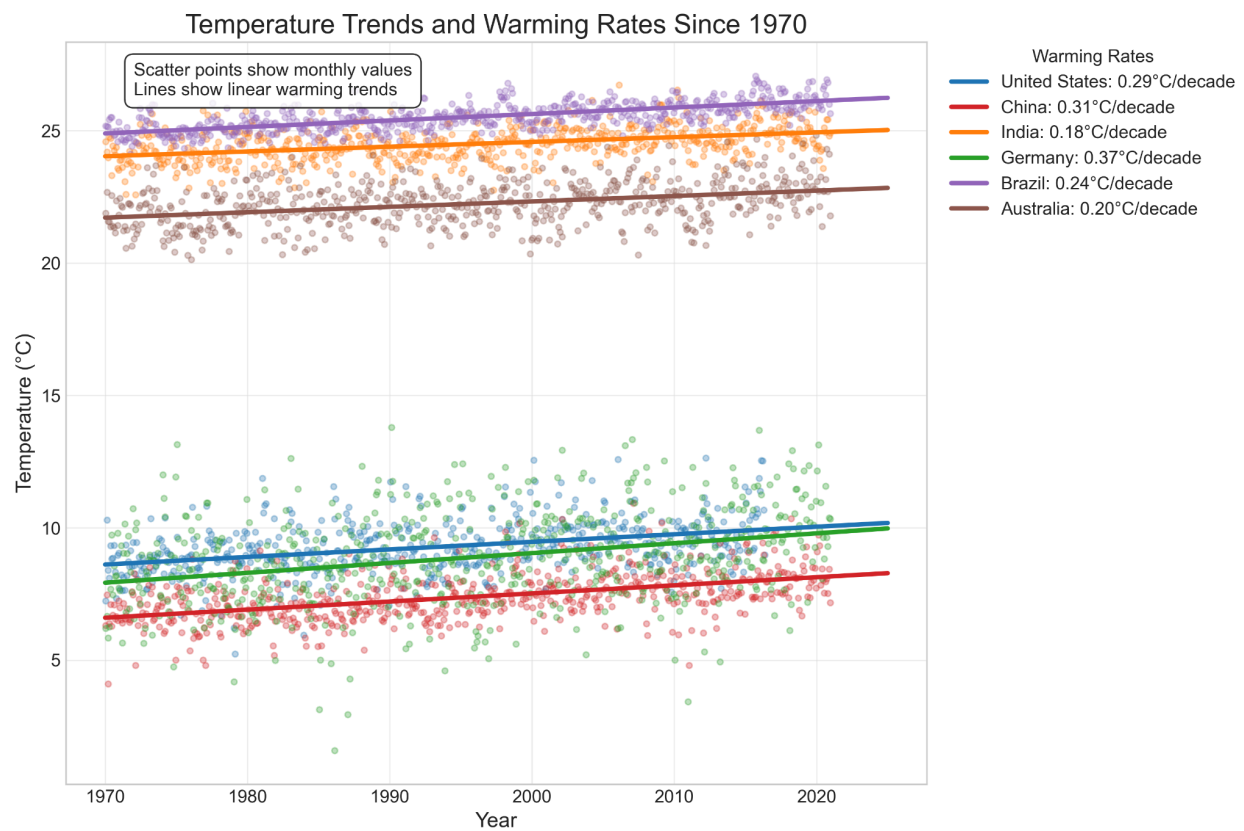## Recent Warming Rates (Post-1970 Analysis)

Figure 2

Figure 2: Linear regression analysis of post-1970 data reveals varying warming rates by country. Germany shows the fastest warming (0.37°C/decade), followed by China (0.31°C/decade), while Australia and India show more moderate rates (0.20°C/decade and 0.18°C/decade respectively). If these trends continue, they would result in temperature increases of 1.8°C to 3.7°C a century, which aligns with projections from

climate models and exceeds the 1.5°C target established in the Paris Climate Agreement.

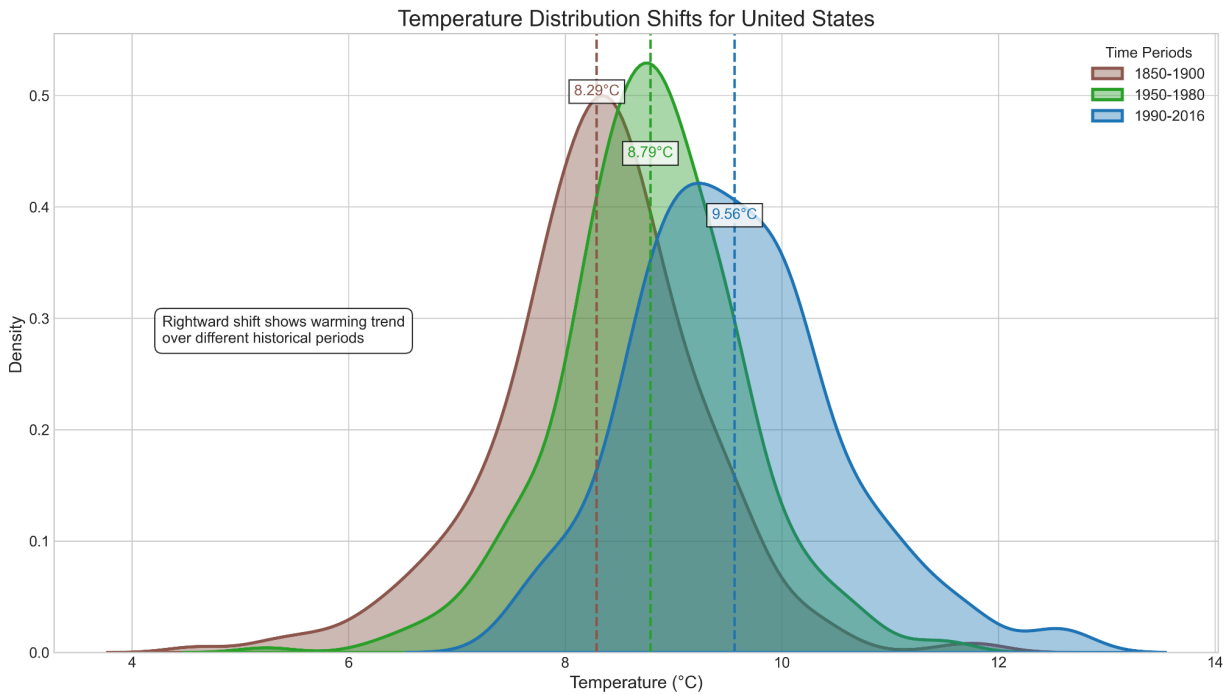## Temperature Distribution Shifts: United States Case Study

Figure 3

Figure 3: The United States temperature distribution shows a clear rightward shift over time. The mean temperature increased from 8.29°C (1850-1900) to 8.79°C (1950-1980) and further to 9.56°C (1990-2016), demonstrating a total increase of 1.27°C since the preindustrial period. Such a shift indicates a higher frequency of extreme heat events and could have critical implications for health and agriculture sectors.
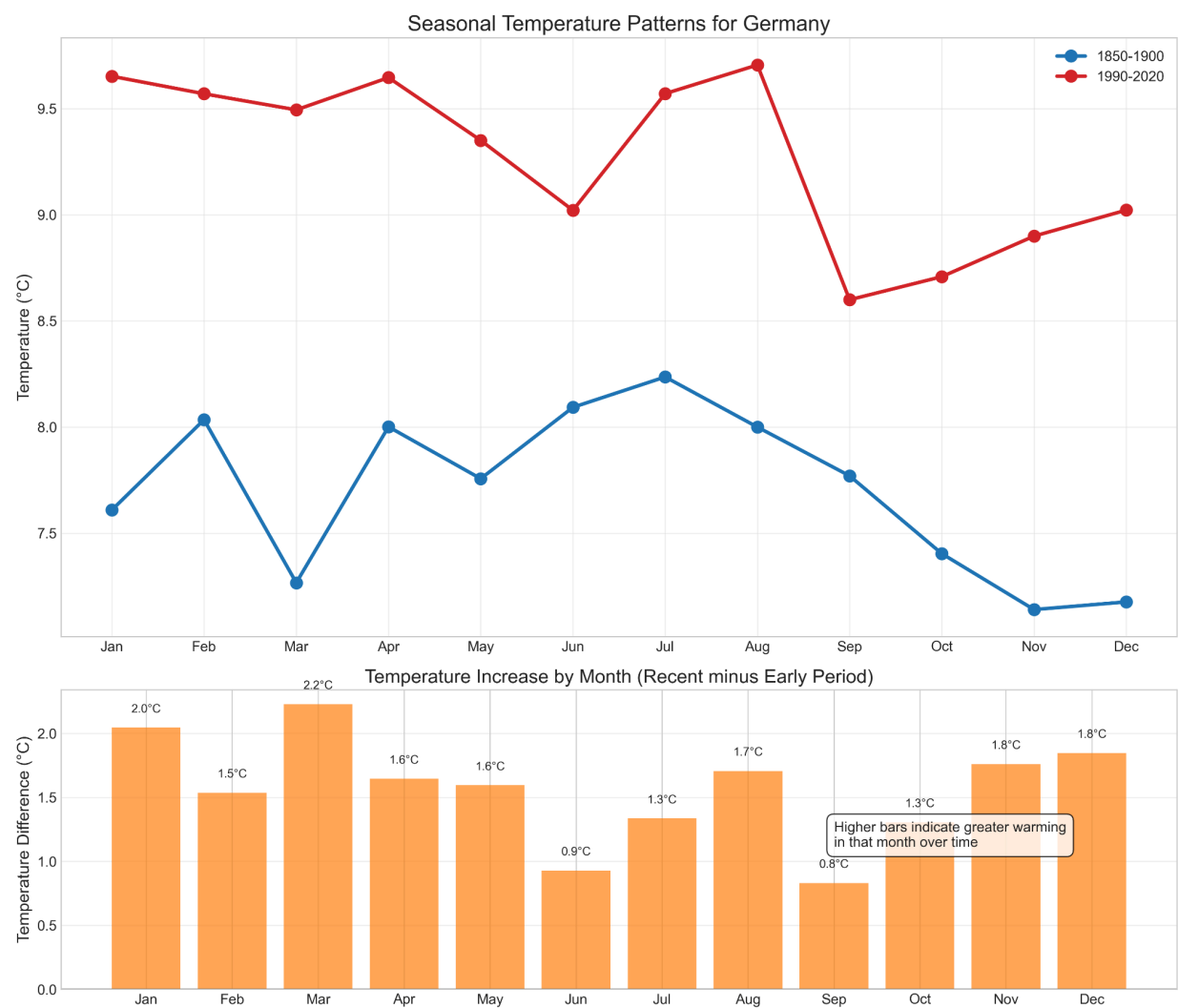
Seasonal Temperature Changes: Germany

Figure 4

Figure 4: Seasonal temperature patterns for Germany, showing monthly temperature averages for two time periods (top) and the temperature increase by month (bottom). This analysis reveals that warming is not uniform throughout the year. Winter months (December-March) show the most significant temperature increases (1.8-2.2°C), while September shows the smallest increase (0.8°C). This seasonal variation has important implications for agriculture (e.g., shifting planting seasons), energy demand (e.g., reduced heating needs in winter), and ecosystems.

Summary Statistics

Country	Avg Temp (1850–1900)	Avg Temp (1950–1980)	Avg Temp (1990–2020)	Total Change (°C)	Recent Warming Rate (°C/decade)
United States	8.29	8.79	9.56	1.27	0.29
China	6.38	6.78	7.71	1.32	0.31
India	23.82	24.17	24.65	0.84	0.18
Germany	7.71	8.12	9.27	1.56	0.37
Brazil	24.48	24.97	25.77	1.28	0.24
Australia	21.57	21.71	22.43	0.86	0.2

Table 1

Table 1: Summary statistics for six countries, showing average temperatures across different time periods, total temperature change since the 1850-1900 period, and recent warming rates (1970-2020). These statistics highlight that mid-latitude countries, such as Germany, generally experience faster warming compared to tropical regions like India and Brazil.

Conclusion

This analysis demonstrates that global warming is occurring across diverse geographic regions, with variations in magnitude and seasonal patterns. The acceleration of warming post-1980 aligns with increased greenhouse gas emissions, highlighting the anthropogenic influence on climate change.

Seasonal effects are especially pronounced in mid-latitude countries, which could face significant disruptions in agriculture, ecosystems, and energy demands. These findings underscore the importance of region-specific adaptation strategies and global cooperation to meet climate targets like those in the Paris Agreement.

While this report assumes relative homogeneity within national averages, future studies could enhance precision by considering more granular regional temperature patterns.