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# Quarterly Temperature Patterns Across China: A 2016–2023

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**Abstract:** This study investigates the spatial and temporal dynamics of temperature variations across China from 2016 to 2023 utilizing ERA5-LAND temperature data. The analysis reveals pronounced regional differences in temperature distribution, with colder conditions prevailing in northern and western China during winter, contrasted by warmer temperatures in the south. The long-term trend shows a gradual decline in monthly mean temperatures despite clear seasonal fluctuations. Additionally, the quarterly analysis identifies a faster rate of warming during the first half of the year, particularly in the cooler months, while the fourth quarter shows minimal change. These findings underscore the complexity and heterogeneity of climate responses across different regions and seasons in China, suggesting that localized climatic changes are driven by both global climate forces and regional factors.

**Keywords:** Temperature variability; Spatial distribution; Temporal trends; China climate

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## 1. Introduction

Temperature plays a pivotal role in shaping local climates and ecosystems, and understanding its spatial and temporal patterns is essential for assessing climate change impacts and formulating effective adaptation strategies [1]. The vastness and geographical diversity of China, with its temperate, arid, and tropical zones, result in significant regional variations in temperature [2]. With increasing concerns about climate change, it is crucial to analyze these variations over a comprehensive timespan to identify long-term trends and patterns. This study focuses on the spatial and temporal temperature variations across China from 2016 to 2023, leveraging the high-resolution ERA5-LAND dataset. By analyzing both seasonal and quarterly temperature trends, this research aims to provide a more nuanced understanding of the dynamics driving temperature shifts across different regions. The findings will contribute to the broader field of climate change research, offering valuable insights for policymakers and climate scientists working on climate adaptation and mitigation strategies.

## 2. Data

The temperature data used in this study were sourced from ERA5-LAND, a high-resolution global climate reanalysis dataset. The data span from January 2016 to December 2023, providing both spatial and temporal dimensions essential for understanding the regional climate variations in China. The analysis examines mean temperature values for each month and quarter across various geographical zones in China, segmented by season.

## 3. Results

### 3.1. Spatial distribution of temperatures across four seasonal quarters

The spatial distribution of temperatures in China from 2016 to 2023, based on the ERA5-LAND temperature data, is depicted in **Figure 1**, showing seasonal variations across the four quarters of each year. The first map represents the mean temperature for the months of January to March, while the second map displays the average temperature for April to June, and the third and fourth maps show temperatures for the July to September and October to December periods, respectively. As observed, temperature distributions exhibit notable regional differences. During the winter months (January to March), colder temperatures dominate northern and western China, with warmer conditions observed in the southern regions. Conversely, the spring to summer transition (April to June) sees a general increase in temperatures across the country, especially in the northern and central parts. The highest temperatures are recorded during the summer months (July to September), particularly in the northwestern and central areas, reflecting the intensity of the seasonal warming. In contrast, the autumn period (October to December) shows a slight cooling, with the southern regions experiencing milder temperatures. These spatial patterns highlight the strong seasonal variability in temperature across China over the analyzed period.

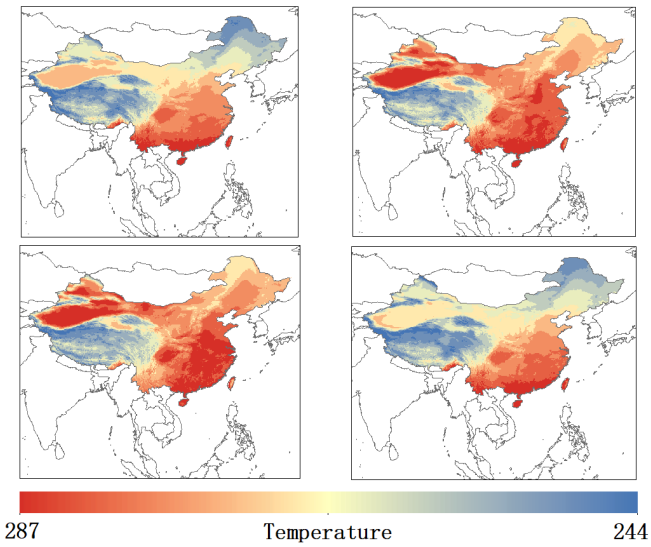


**Figure 1.** Spatial distribution of mean temperatures in China from 2016 to 2023 across four seasonal quarters based on ERA5-LAND temperature data. The maps represent the average temperature for each quarter: (a) January to March, (b) April to June, (c) July to September, and (d) October to December

### 3.2. Monthly mean temperature trend

**Figure 2** illustrates the monthly mean temperature trend in China from 2016 to 2023, with each blue dot representing the average temperature for each respective month from January 2016 to December 2023. The red

dashed line indicates the trendline, revealing a discernible downward trend in the monthly temperatures over the study period. Despite seasonal fluctuations, which show clear seasonal cycles of higher temperatures in summer and lower temperatures in winter, the overall trend suggests a gradual decrease in the temperature across the years. This declining trend may reflect broader climatic changes and variations over the study period. The monthly data points provide insight into the seasonal temperature variations, while the trendline highlights the long-term temperature decline.

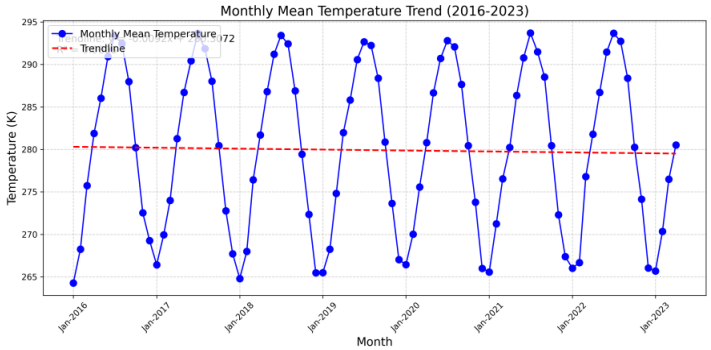


**Figure 2.** Monthly mean temperature trend in China from 2016 to 2023. Blue dots represent the monthly average temperature, and the red dashed line indicates the overall temperature trend

## 3.3. Trend of temperature in four quarters

Analysis of quarterly temperature trends (2016–2023) highlights pronounced seasonal warming disparities (**Figure 3**). Q1 exhibits the steepest increase (K = 0.1649), marked by interannual fluctuations superimposed on a robust upward trajectory. Q2, initially stable, shows a recent surge (2022–2023), yielding a comparable trend slope (K = 0.1647). Q3 transitions to sustained warming post-2021 (K = 0.1152), while Q4 displays minimal overall change (K = 0.0293), despite an anomalously low 2018 value. These divergent warming patterns emphasize accelerated temperature rise in cooler seasons (Q1–Q2) and evolving thermal regimes in warmer periods (Q3), underscoring seasonally heterogeneous climate responses.

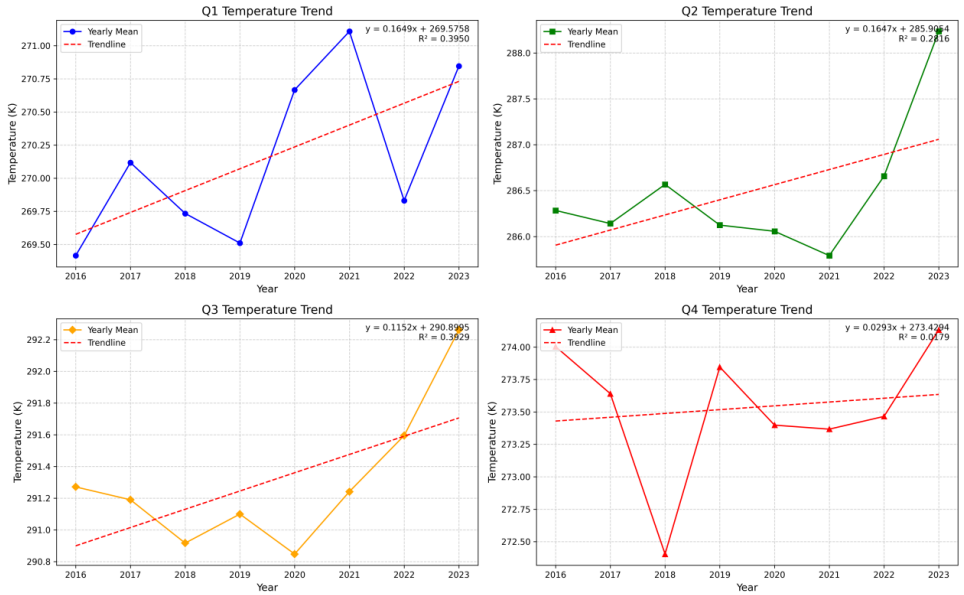


**Figure 3.** ERA5-LAND-derived quarterly means (colored lines) and linear trends (dashed lines) showing accelerated warming in Q1–Q2 (slope K = 0.1649–0.1647) and muted Q4 changes (K = 0.0293)

## 4. Discussion

The spatial and temporal temperature variations observed in this study highlight the complex climate dynamics of China. The findings indicate that temperature changes are not uniform across the country, and regional factors such as topography, latitude, and altitude play a significant role in shaping temperature patterns [3]. The general trend of declining temperatures over the study period, despite seasonal fluctuations, suggests that broader climate forces are at play, potentially related to global warming or other large-scale atmospheric phenomena [4]. The accelerated warming observed in the cooler months (Q1 and Q2) could be linked to changes in atmospheric circulation patterns, such as shifts in the jet stream or changes in solar radiation [5]. In contrast, the muted warming in the fourth quarter suggests that warmer months are less susceptible to these changes, possibly due to the buffering effects of monsoons or oceanic influences [6].

These findings underscore the need for targeted climate adaptation strategies that consider the seasonal and regional differences in temperature patterns. Localized climate models and more granular temperature data are essential for understanding the specific impacts of climate change in different regions of China. Further research is needed to identify the drivers behind these temperature trends and to assess their potential effects on agriculture, water resources, and ecosystems.

## 5. Conclusion

In conclusion, this study has provided a detailed analysis of temperature trends across China from 2016 to 2023, revealing significant regional and seasonal variations. The findings suggest that while temperatures are gradually declining, seasonal warming is more pronounced during the cooler months. This research offers valuable insights into the evolving climate conditions in China, emphasizing the complexity and heterogeneity of climate change impacts. Continued monitoring and further investigation are essential for developing effective climate adaptation strategies and mitigating the impacts of future climate changes.

## Disclosure statement

The author declares no conflict of interest.

## References


[1] Hannah L, Midgley GF, Millar D, 2002, Climate Change-integrated Conservation Strategies. Global Ecology and Biogeography, 11(6): 485–495. https://doi.org/10.1046/j.1466-822X.2002.00306.x

[2] Ni J, 2011, Impacts of Climate Change on Chinese Ecosystems: Key Vulnerable Regions and Potential Thresholds. Regional Environmental Change, 11(1): 49–64. https://doi.org/10.1007/s10113-010-0170-0

[3] Moeslund JE, Arge L, Bocher PK, et al., 2013, Topography as a Driver of Local Terrestrial Vascular Plant Diversity Patterns. Nordic Journal of Botany, 31(2): 129–144. https://doi.org/10.1111/j.1756-1051.2013.00082.x

[4] Zwiers FW, Alexander L, Hegerl GC, et al., 2013, Climate Extremes: Challenges in Estimating and Understanding Recent Changes in the Frequency and Intensity of Extreme Climate and Weather Events, in Climate Science for Serving Society: Research, Modeling and Prediction Priorities. Springer Netherlands, Dordrecht, 339–389. https://doi.org/10.1007/978-94-007-6692-1_13

[5] Trenberth KE, Stepaniak DP, 2004, The Flow of Energy through the Earth's Climate System. Quarterly Journal of the

Royal Meteorological Society, 130(603): 2677–2701. https://doi.org/10.1256/qj.04.83

[6] Ashish S, 2011, A Global Context for Megadroughts in Monsoon Asia during The Past Millennium. Quaternary Science Reviews, 30(1–2): 47–62. https://doi.org/10.1016/j.quascirev.2010.10.005

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