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Postprint: Characteristic Analysis of Temperature Variation in Northwest China Over the Past Half Century Based on K-means Clustering Regionalization

Authors: Feng Kepeng, Tian Juncang, Shen Hui

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Abstract

Using methods such as K-means clustering for regionalization, Sen' s slope estimator, and Kendall-Tau non-parametric test, this study analyzed and discussed the characteristics of temperature variations over the past half-century (1960–2015) in different regions of Northwest China. It was found that Northwest China maintained a continuous and significant warming trend over the past half-century, with the rate of increase in annual mean minimum temperature higher than that of annual mean temperature and annual mean maximum temperature. From a spatial perspective, the regions with the most rapid warming include the northeastern part of northern Xinjiang, northern, western, and central-eastern Inner Mongolia, central and western Gansu, northern and central Qinghai, central and northern Ningxia, and northern Shaanxi. Although the overall temperature trend in Northwest China is upward, it is not temporally uniform. Starting from 1998, the warming rate in Northwest China slowed down, with some regions exhibiting a decreasing trend. The trends of seasonal temperature and interannual temperature variation in Northwest China over the past half-century are not consistent, and the warming slowdown elicits different responses across seasons in this region. During 1998–2015, winter was the season with the smallest warming magnitude, with most sub-regions experiencing a slowdown in the warming trend or even a shift to a decreasing trend.

Full Text

Temperature Variation Characteristics of Northwest China Based on K-means Clustering Partition in the Past Half Century

Feng Kepeng[1,2,3], Tian Juncang[1,2,3], Shen Hui[1,2,3]

[1] School of Civil and Hydraulic Engineering, Ningxia University, Yinchuan 750021, Ningxia, China;
[2] Ningxia Research Center of Technology on Water-saving Irrigation and Water Resources Regulation, Yinchuan 750021, Ningxia, China;
[3] Engineering Research Center for Efficient Utilization of Water Resources in Modern Agriculture in Arid Regions, Yinchuan 750021, Ningxia, China

Abstract

The northwest region of China is vast, encompassing administrative divisions that include parts of Shaanxi, Gansu, Ningxia, Qinghai, Xinjiang, and Inner Mongolia. Arid, semi-arid, and semi-humid climates coexist across the region, where mountainous areas, Gobi deserts, oases, and other topographical features are interwoven. This region is ecologically fragile and highly sensitive to climate change. It is well established that climate warming accelerates the hydrological cycle and intensifies the frequency and severity of extreme weather events such as high temperatures, droughts, and heavy rainfall. Concurrently, it leads to temporal and spatial unevenness in water resource distribution, complicating flood and drought management. Conversely, if temperature rise ceases, the hydrological circulation process would slow down, inevitably altering regional water cycle components including precipitation, evaporation, and runoff, thereby impacting industrial and agricultural production as well as people' s livelihoods.

In the context of the recent global warming hiatus, this study analyzes and discusses temperature changes in Northwest China. Specifically, it investigates whether a warming slowdown has occurred and how temperature trends vary across different seasons. Based on temperature observations from 184 meteorological stations in the region and employing K-means clustering partition, Sen' s slope estimation, and Kendall-Tau nonparametric test methods, we analyzed temperature variation characteristics in Northwest China over the past half-century (1960–2015).

The results demonstrate that temperatures in the northwestern region have increased significantly over the past 50 years, with the annual average minimum temperature rising faster than both the annual mean temperature and annual average maximum temperature. Spatially, the fastest warming areas include the northeastern part of northern Xinjiang; the northern, western, central, and eastern parts of Inner Mongolia; the central and western parts of Gansu Province; the northern and central parts of Qinghai Province; the central and northern parts of Ningxia Province; and the northwestern part of Shaanxi Province.

Although the overall trend shows regional warming, significant spatial heterogeneity exists. Since 1998, the rate of temperature increase has slowed across the region, with some areas even experiencing cooling trends. Over the past half-century, seasonal and interannual temperature patterns have been inconsistent, with varying degrees of warming slowdown across seasons. During 1998–2015, winter exhibited the smallest temperature increase, with the warming

trend decelerating or even reversing to a cooling trend in most sub-regions.

This study analyzes spatial temperature change trends in Northwest China over the past half-century and documents a consistent warming mitigation phenomenon across different sub-regions and seasons. The timing of the warming hiatus identified herein aligns with findings from related studies. These conclusions enhance understanding of spatiotemporal climate changes in the region and provide a foundation for further investigation of regional temperature variation patterns.

Keywords: cluster analysis; silhouette coefficient; warming mitigation; northwest China

Note: Figure translations are in progress. See original paper for figures.

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