Spatiotemporal Variation Characteristics of Accumulated Temperature 10°C in Tacheng Region, 1961-2016 (Postprint)

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Abstract

Using daily temperature data from six meteorological stations in the Tacheng region from 1961 to 2016, this study analyzed the spatiotemporal variation characteristics of 10℃ accumulated temperature in the region by employing climatic tendency rate, cumulative anomaly method, Mann-Kendall abrupt change test, and ArcGIS spatial interpolation. The results revealed that: the start date, end date, duration days, and accumulated temperature of 10℃ in the study area exhibited trends of advancing, delaying, extending, and increasing at rates of -0.12d · (10a)-1, 0.15d · (10a)-1, 0.27d · (10a)-1, and 75.39℃ · (10a)-1, respectively, with abrupt changes occurring in the end date, duration days, and accumulated temperature of 10℃; the distribution of 10℃ accumulated temperature was primarily concentrated between 2450℃~3950℃, with higher values in the southern part of the study area compared to the northern part; compared with Phase I (1961-1994), Phase II (1995-2016) witnessed increases in 10℃ accumulated temperature across all locations, with the proportion of area featuring accumulated temperatures of 2450~3150℃ showing a significant decreasing trend relative to the total area, while the area proportions for the ranges 3150~3450℃, 3450~3950℃, 3950~4150℃, and 4150~4250℃ all increased, with the most pronounced increase observed in the 3150~3450℃ range.

Full Text

Spatiotemporal Variation Characteristics of 10℃ Accumulated Temperature in Tacheng District, 1961-2016

Abstract: Based on daily average temperature data from six meteorological stations in Tacheng district from 1961 to 2016, this study analyzed the spatiotemporal variation characteristics of accumulated temperature above 10℃

using linear climate tendency, cumulative anomalies, Mann-Kendall mutation test, and ArcGIS spatial interpolation. The results showed that the last day, duration days, and accumulated temperature above 10℃ in this region tended to increase at rates of 0.15 d · (10a) ^{1}, 0.27 d · (10a) ^{1}, and 75.39℃ · (10a) ^{1}, respectively, showing significant increases. However, the first day decreased at a rate of -0.12 d · (10a) ^{1}. Mutations occurred in the last day, duration days, and accumulated temperature above 10℃, except for the first day, which showed no mutation. The distribution of accumulated temperature above 10℃ in the study area was mainly between 2450℃ and 3950℃, with the southern region showing higher values than the northern region. Compared with Phase I (1961–1994) and Phase II (1995–2016), the accumulated temperature above 10℃ increased, and the proportion of total area occupied by the 2450–3150℃ range decreased obviously, while the 3150–3450℃, 3950–4150℃, and 4150–4250℃ ranges accounted for an increased proportion of the total area, with the 3150–3450℃ range showing the most obvious increase.

Keywords: Tacheng district; active accumulated temperature 10℃; M-K test; spatiotemporal change

2.1 Data Sources and Processing

The analysis utilized daily average temperature data from six meteorological stations in Tacheng district spanning 1961–2016. The methods employed included linear climate tendency analysis, cumulative anomaly calculation, Mann-Kendall mutation testing, and ArcGIS spatial interpolation to examine the spatial distribution of accumulated temperature 10℃.

2.2 Analytical Methods

The study examined four key metrics: the first date when temperature 10℃ occurred, the last date, the duration in days, and the accumulated temperature. Linear trend analysis revealed that over the 56-year period, the first date showed a decreasing trend of -0.12 d · (10a) ^{1}, while the last date increased at 0.15 d · (10a) ^{1}, duration increased at 0.27 d · (10a) ^{1}, and accumulated temperature increased significantly at 75.39℃ · (10a) ^{1} (= 0.01).

[Figure 2: see original paper] shows the interannual variability of these parameters. The first date exhibited a decreasing trend of -0.12 d · (10a) ^{1}, with notable anomalies in 1994. The last date showed an increasing trend of 0.15 d · (10a) ^{1}, with significant anomalies in 1994, 1997, 2000, 2011, 2012, and 2016. Duration days increased at 0.27 d · (10a) ^{1}, with the longest duration reaching 189 days in 1997. Accumulated temperature increased at 75.39℃ · (10a) ^{1}, with the highest value reaching 4099.8℃ in 1997.

[Figure 3: see original paper] presents the Mann-Kendall test results. The test statistics indicate that the first date showed a decreasing trend, with significant mutations occurring around 1994. The last date demonstrated an increasing trend with mutations in 1990–1991, 1996–1997, and 1999–2016. Duration days

exhibited an increasing trend with mutations in 1977, 1979, 1980, 1982, and 1984. Accumulated temperature showed an increasing trend with mutations in 1996, 1998, and 1999.

[Figure 4: see original paper] illustrates the spatial distribution of accumulated temperature 10℃. The distribution was primarily concentrated in the 2450–3950℃ range, with southern regions showing higher values than northern regions. Phase I (1961–1994) showed accumulated temperature ranges of 2077.8–4019.1℃, while Phase II (1995–2016) showed 2253.3–4224.4℃, indicating a clear increase.

provides the climate tendency rates for different periods. The table shows that for 1961–2016, the first date decreased at -0.125 d · a ^{1}, the last date increased at 0.122 d · a ^{1}, duration increased at 0.292 d · a ^{1}, and accumulated temperature increased at 11.906℃ · a ^{1}, all statistically significant at the 0.01 level.

[Figure 5: see original paper] displays the percentage of area covered by different accumulated temperature ranges. During 1961–2016, the 2450–3150℃ and 3450–3950℃ ranges covered 81.9% of the total area. In Phase I, these ranges covered 83.1%, while in Phase II they covered 89.3%, showing an increasing concentration in the optimal temperature range.

3 Conclusions

(1) From 1961–2016, the first date of 10℃ temperature in Tacheng district decreased at a rate of -0.12 d · (10a) ^{1}, the last date increased at 0.15 d · (10a) ^{1}, duration increased at 0.27 d · (10a) ^{1}, and accumulated temperature increased at 75.39℃ · (10a) ^{1}, with the latter three trends being statistically significant at = 0.01. Mutations occurred around 1994 for the last date, duration days, and accumulated temperature.

(2) The spatial distribution of accumulated temperature 10℃ was mainly between 2450℃ and 3950℃. The area proportion of the 3150–3450℃ range increased from 9.8% in Phase I to 28.7% in Phase II, while the 3450–3950℃ range increased from 1.2% to 5.9%. The area with accumulated temperature below 3150℃ decreased correspondingly.

(3) Over the 56-year period, the first date showed a decreasing trend, while the last date, duration days, and accumulated temperature showed increasing trends. These changes indicate a warming climate pattern in the Tacheng region.

(4) The accumulated temperature 10℃ was primarily distributed in the 2450–3950℃ range, representing the optimal thermal resource zone for agricultural production in this region.

(5) Phase I accumulated temperature ranged from 2077.8℃ to 4019.1℃, while Phase II ranged from 2253.3℃ to 4224.4℃, demonstrating a significant increase in thermal resources between the two periods.

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