ASSESSMENT OF THE LONG-TERM DYNAMICS OF AIR TEMPERATURE CHANGE IN THE KASHKADARYA REGION AND ITS IMPACT ON WATER RESOURCES

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https://doi.org/10.5281/zenodo.17936358

ARTICLE INFO

Received: 12th December 2025
Accepted: 13th December 2025
Online: 14th December 2025

KEYWORDS

Dynamics of air temperature, long-term observations, maximum and minimum temperatures, seasonal temperature changes, high-mountain areas, Severtsov glacier, climate change, impact on water resources, statistical analysis.

ABSTRACT

This article analyzes the dynamics of air temperature changes based on long-term meteorological observations in the Kashkadarya region. During the study, statistical comparisons were made of the average, maximum, and minimum annual and seasonal temperatures recorded at five main weather stations of the region and the Severtsov Glacier Metrostation. The results of the analysis showed that the temperature increase in different altitudinal zones occurs at different rates, especially in glacial zones. The limited number of years of observation and the possible causes of the "jumps" observed at some stations were also discussed. The obtained scientific results are important for assessing climate change processes in the Kashkadarya basin, studying the stability of glaciers, and determining their impact on water resources.

Input. Climate change has become one of the most serious global problems for developing countries, seriously affecting their economic stability and social security. Forest fires observed in Europe and a number of other regions in recent decades indicate a sharp change in climate dynamics. For example, in 2000, about 1.2 million people in the Republic of South Africa suffered from climate-related emergencies. Due to limited water supply in El Paso, Texas, the use of water resources is strictly regulated.

The Kyoto Protocol, adopted in 1994, laid the foundation for international climate policy and set the task of reducing greenhouse gas emissions by 5% over 10 years. At the same time, the disruption of dams in the Netherlands can lead to the risk of flooding of most of the country's territory, which is also evidence of the climate risk.The increase in global average temperature by 0.4-0.6°C over the past thirty years has caused rapid melting of glaciers in the Arctic and Antarctic, increased drought in some areas, and rising ocean levels. The global community aims to significantly reduce greenhouse gas emissions by 2050, and the US has announced plans to reduce emissions by up to 60% by this time.

These negative trends in global climate dynamics are also intensifying their impact at the regional level. The increase in temperature, changes in the precipitation regime, and the depletion of water resources are especially noticeable in arid regions such as Central Asia. The regions of Uzbekistan are not exempt from these processes. The impact of climate change is particularly evident in the Kashkadarya region, located in the southern part of the country, where water resources are mainly dependent on the harvest of snow, glaciers, and rain. From this point of view, in this article, data from long-term observations at the main meteorological stations of the Kashkadarya region - Chimkurgan, Severtsov Glacier, and Mingchukur - are an important source for assessing the dynamics of climate change at the local level. Below is a detailed analysis of air temperature changes recorded at these stations during 1928-2023, their frequency, trends, and overall results.

Results of the analysis: In the northeast of the Kashkadarya region, the western peaks of the Zafarsakh mountain range - the Chaqilkalon, Karatepa, Zirabulok, and Ziyovuddin mountains - are located. Chaqilkalon Mountain stretches mainly latitudinally, ends at the Takhtakoracha Pass, and continues westward with the Karatepa Mountain, the highest peak of which is 2165 meters. The north of the Chachikalyan and Karatepa mountains is relatively flat, while the south forms steep snowdrifts. The composition of the mountains consists of Paleozoic limestone, granite, crystalline shale, and marble, and the foothills and hills are covered with soft rocks. Paleozoic limestone is especially widespread on the Kyrktog peak in the western part of the Chakylkalan mountain. The foothills are located in the lower parts of the mountains of the region, stretching from the southern foothills of the Karatepa Mountains to Guzar in the north and bordering the plain part of the region from the east.

By studying the available data on weather stations in the Kashkadarya region, we can see the impact of climate change on the environment. The reason for the cessation of observations at the Chimkurgan weather station in 2006 is that the main increase at previous stations was observed after 2008.

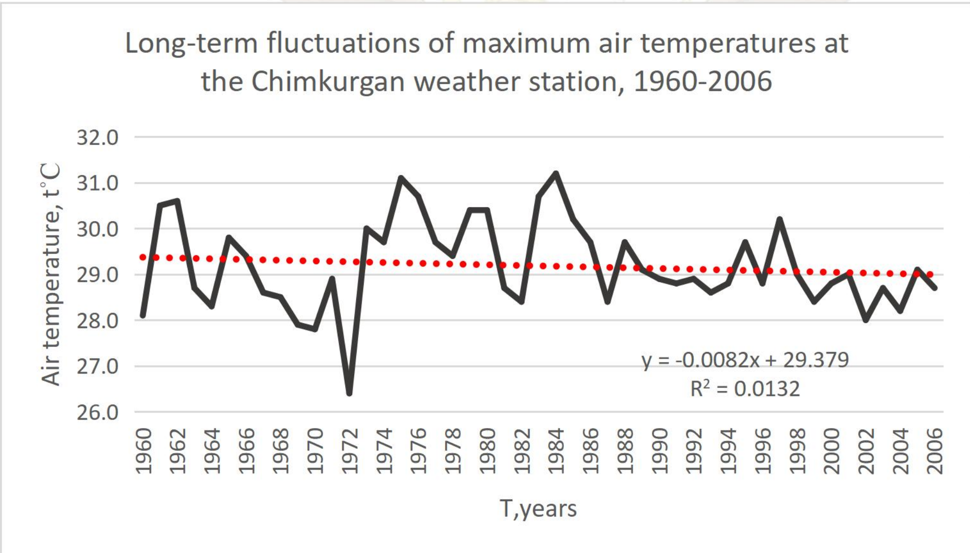

Figure 1. Dynamics of maximum air temperatures at the Chimkurgan meteorological station, 1960-2023.

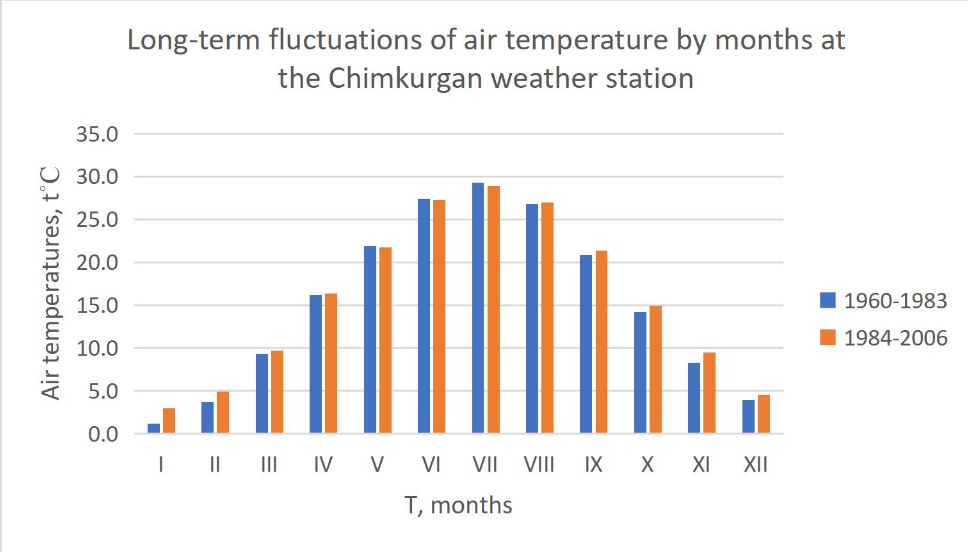

Figure 2. Histogram of average air temperatures at the Chimkurgan meteorological station by months, 1960-2023.

As can be seen from the histogram, in January-February and October-December, the air temperature increased according to the 1984-2006 group. Among them, the increase in temperature in January and November was even more intensive. This means that the temperature during the winter months has increased compared to previous years.

Analysis of long-term average air temperature data from 3 meteorological stations in the Kashkadarya region showed similar trends (Chimkurgan, Severtsov Glacier, and Mingchukur). However, the Severtsov Glacier weather station yielded results different from others. If the dynamics of average air temperatures at the remaining weather stations showed 2.0-2.5 C, then at the Severtsov glacier the change in temperature was 4.5-5.0 C (Fig. 3).

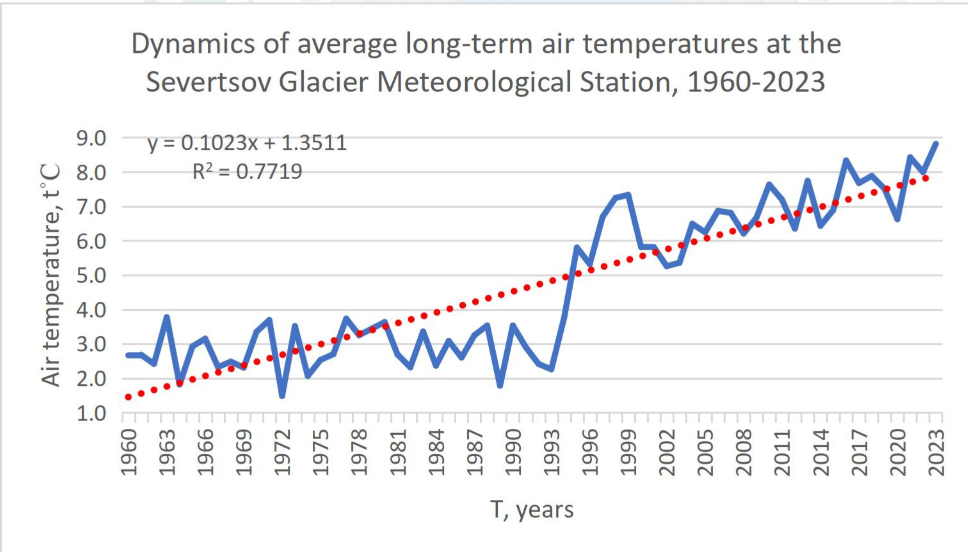

Figure 3. Dynamics of average long-term air temperatures at the Severtsov Glacier Weather Station, 1960-2023.

The correlation coefficient was also the highest value, equal to 0.77. At other stations, this indicator did not exceed 0.54 (at the Shakhrisabz station). The main "jump" in air temperature occurred in 1994. The sharp changes relate to the average long-term and maximum air temperatures (Fig. 4). However, the change in the minimum air temperature did not show such a result (Fig. 5).

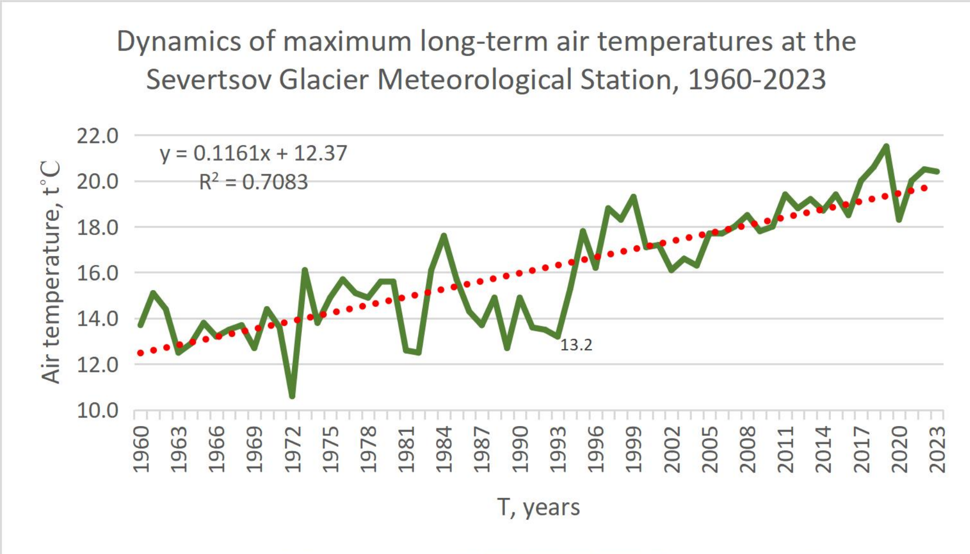

Figure 4. Dynamics of maximum air temperatures at the Severtsov Glacier Weather Station, 1960-2023.

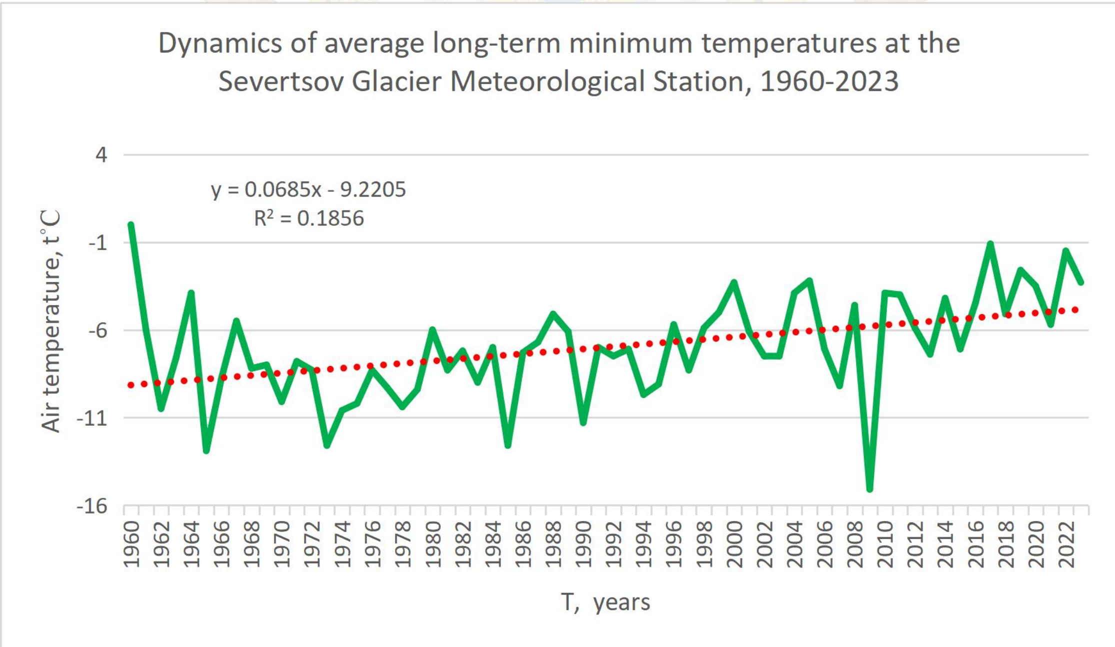

Figure 5. Dynamics of minimum air temperatures at the Severtsov Glacier Meteorological Station, 1960-2023.

It can be said that the temporal trend in the long-term fluctuations of minimum air temperatures at the Severtsov Glacier Station was also insignificant. Consequently, strong changes in air temperature relate only to average long-term and maximum values. The lowest values of minimum temperatures for the observation period were observed in 2008. At other stations, the periodicity of long-term fluctuations in minimum air temperatures was not observed in the Severtsov glacier. This can be explained by the relatively short years of observation of the situation (1960-2023).

Below are histograms of air temperatures drawn based on data from the Mingchukur and Seretsov glacier stations, which are high-altitude stations for comparison.

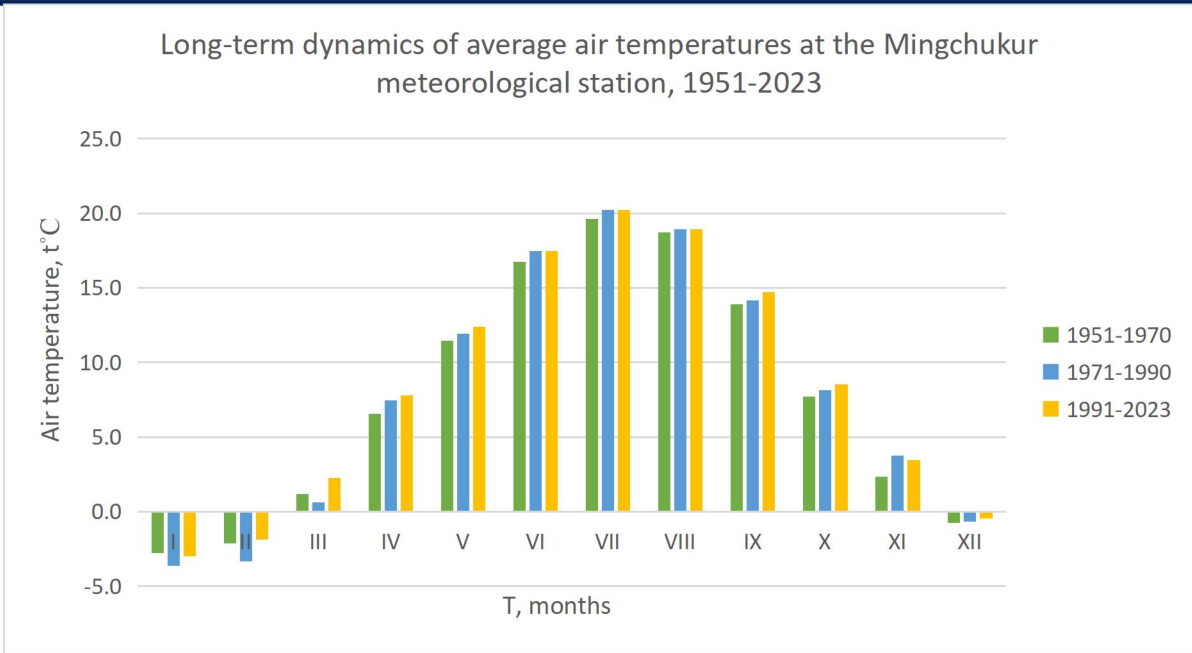

Figure 6. Histogram of the monthly distribution of air temperature at the Mingchukur meteorological station, 1951-2023.

As can be seen from Figure 6, despite the division of the observation period into three groups, the monthly changes in air temperature at the Mingchukur meteorological station are insignificant. Only in the group of 1991-2023 did the decline and rise occur in March.

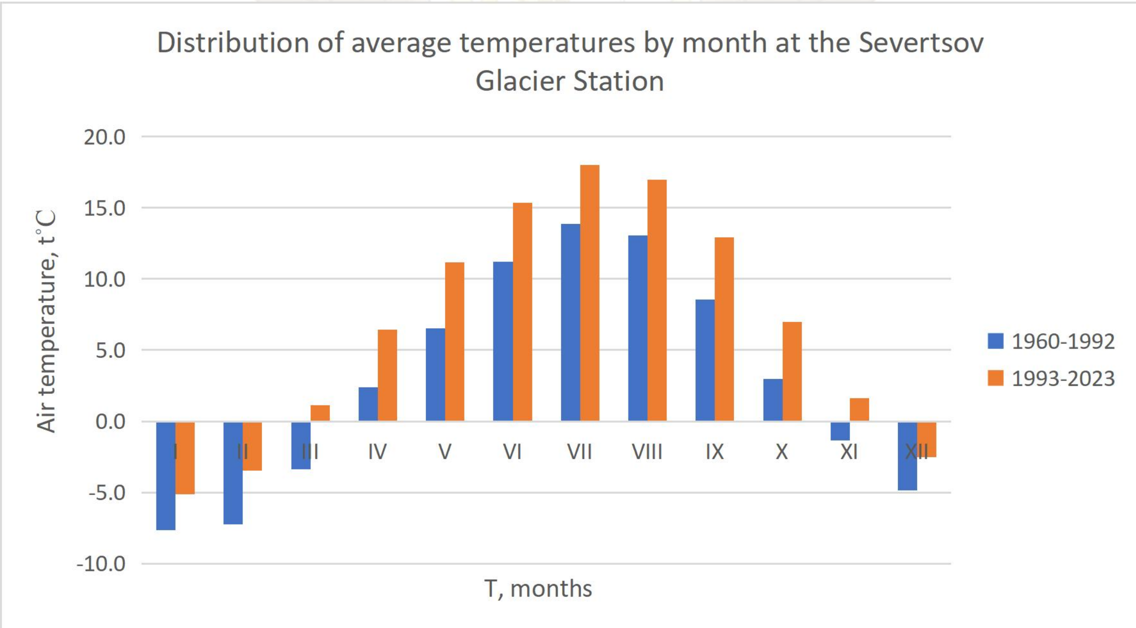

Figure 7. Histogram of the monthly distribution of air temperatures at the Severtsov Glacier Meteorological Station, 1960-2023.

In Figure 7, the situation is completely different. In all months of the year, the air temperature rises by 4-5°C. However, the area where the Severtsov Glacier is located is almost 150 m below the Mingchukur station. This difference is not proportional to the difference in air temperatures. This means that air temperatures are rising in the Kashkadarya region, especially in areas with glaciers.

General conclusion: Analysis of long-term meteorological observations in the Kashkadarya region, in particular, data from the Chimkurgan, Mingchukur, and Severtsov glacier stations, accurately describes the dynamics of regional air temperature. According to the results of observations, an increase in average annual and maximum temperatures was recorded at all stations, especially in high-mountain areas, in particular around the Mingchukur and Severtsov glaciers, changes accelerated significantly. Minimum temperatures are relatively stable in most cases, with seasonal changes observed only at some stations. Observations at Chimqo'rg'on station confirm the general trend, although it stopped in 2006, and show that the temperature increase is especially noticeable during the winter months. At the Mingchukur station, monthly changes in air temperature are relatively stable, with significant fluctuations observed in March in recent years. The significant temperature increase observed in the Severtsov Glacier creates a scientific basis for regional monitoring and water resource management. The results make it possible to assess the direct impact of climate change in the region on water resources, in particular, changes in river flows fed by snow and glaciers, seasonal water supply, and planning of irrigation systems. At the same time, the rapid manifestation of climate change in high-altitude areas increases the importance of scientific analysis.

In conclusion, it can be said that the analysis based on data from the Chimkurgan, Mingchukur, and Severtsov glaciers creates an important scientific basis for sustainable water resource management in the region, assessing the state of glaciers, and forecasting the territorial consequences of climate change.

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