IMPACT OF AIR TEMPERATURE DEVELOPMENT IN WINTER ON RECREATION

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Abstract

Winter recreation is essentially fully dependent on the course of the air temperature. The occurrence of snow and ice in the landscape is conditioned by air temperatures below zero. However, climate change, typical of global warming, also manifests itself in the winter season. From the analysis of the air temperature databases at the climatological stations of the Czech Hydrometeorological Institute, it follows that for the period 1961 to 2020, despite partial differences, it statistically significantly increases in winter. The increase in air temperature during this period ranges from 1 to 1.6 °C. In the southern parts of our territory, in several places, the average monthly temperature does not drop below zero in winter. This means that if it snows, the snow melts quickly, the natural areas of ice are for a short time, therefore unusable for recreation.

Keywords: global warming, seasons, snow, frosts

Introduction

Air temperature trends over the past year and in the early months of 2024 are evidence of the manifestations of global warming, which is occurring at all times of the year. As reported by Pfister (1992), from the results of a network of stations evenly distributed around the globe, the average air temperature has been increasing since 1850. The initial very slow rise has accelerated in recent decades and the rise is accelerating. While the global average temperature increased by 0.2ºC between 1850 and 1950, it increased by 0.7ºC over the next 60 years (Brohan et al., 2006).

Generally, the amplification of the greenhouse effect due to the increasing concentration of greenhouse gases in the Earth's atmosphere is the cause of the increase in air temperature (Sun and Wang, 1996). CO_2 is most often mentioned, but other gases from humanity's economic activities are also involved. Given the nature of this process, it is expected that global warming will continue to increase in the future, and it cannot be ruled out that it will increase even faster (Hansen and Sato, 2004).

Various studies show that the rise in air temperature is not the same everywhere, and there are differences even in smaller areas, as the values from our area show. The air temperature rise in different seasons is also different (Střeštík et al., 2014), but it is statistically significant in all these seasons in our territory. Here it is necessary to emphasize that the demonstrable increase in air temperature has impacts on winter recreation, mostly negative. Higher temperatures mean fewer days with natural ice, faster melting of snow cover and reduced skiing opportunities.

It should be noted, here that the climate characteristics presented in the documents used so far no longer correspond to the conditions of the last two decades (Kolektiv 1961, Tolasz et al 2007).

Materials and methods

The results are based on the so-called technical series of monthly average air temperatures at 267 climatological stations in the Czech Republic for the period 1961-2020, i.e. for the third (1961-1990) and fourth (1991-2020) normal periods. A more detailed description of the methods used and their outputs, is given by Štěpánek and Zahradníček (2008).

The assessment of the snow cover is based on daily measured values of its total height (in centimetres) according to the methodology for climatological stations of the Czech Hydrometeorological Institute. From these data, statistical characteristics were calculated, and

maps were drawn. Long-term changes in air temperature and average total snow cover height were expressed using regression lines.

Results

A statistical analysis of air temperatures from the above climatological stations in our area shows that, like the average annual air temperatures, the average air temperatures are also increasing in each season, albeit differently at each station. Our results show that winter air temperatures increase more in Bohemia than in Moravia.

There are also differences in air temperature rise between months in the same season. January is the most noticeable in winter. In this month temperatures rise fastest, almost as fast as in summer. In contrast, the rise is much slower in months of December and February. The faster rise in air temperature in January than in February has one interesting consequence. Usually, January is the coldest month of the year, but sometimes February is colder. December has rarely been colder than January, with no difference between the first and second half of the studied period.

From the conducted analysis of the daily total snow cover with respect to the length of the article, we present the assessment for the station Frenštát pod Radhoštěm (Fig. 1). The beginning of snowfall in this area is in November, which is the month with the lowest snow depth of the months evaluated. The snow cover is very variable in this month, with years with no snow at all or only about 1 centimetre (cm). Such a continuous period was the longest between 2014 and 2020. The maximum height was 15.5 cm in 1985. The continuous period with snow depths above 5 cm was from 1997 to 1999. In November, the trend is for a 1 cm decrease in snow cover height. Conditions for skiing have been consistently unfavourable since 2006.

The first month of winter, December, also does not always have snow for the whole period. If we take a snow depth of 5 cm as suitable for skiing, then two continuous periods were from 1980 to 1983 and 1989 to 1992 to 2020. The maximum height reached 30.6 cm in 1993. However, the downward trend in snow depth for the years 1961 to 2023 is 4 cm, the highest of any month. Unlike November, conditions for skiing have been acceptable in the last two years.

January, the coldest month in the long term but also the richest in snow, does not show snow cover above 5 cm in all years. The maximum height was in 2006 with a value of 63 cm. The longest continuous period with snow depths above 5 cm was from 1965 to 1972. Since 2014, the snow depth has not reached 10 cm, only in three years has it exceeded 5 cm.

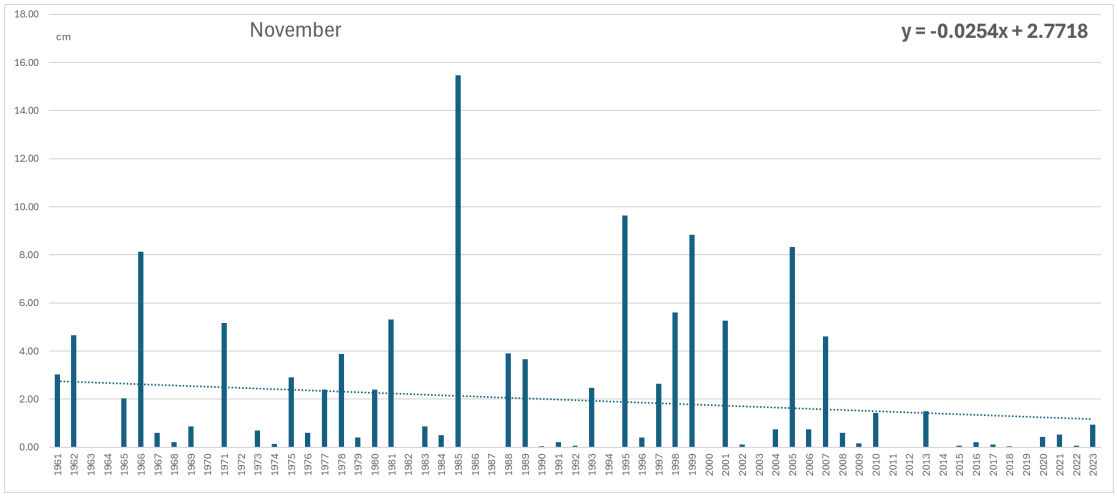
The final winter month of February also has years without snow cover above 5 cm and with higher variability than January. The longest continuous period was from 1983 to 1988. The maximum height was also 63 cm in January and in 1986. In terms of trend, February is identical to January. Since 2016, conditions were favourable for skiing only in 2021.

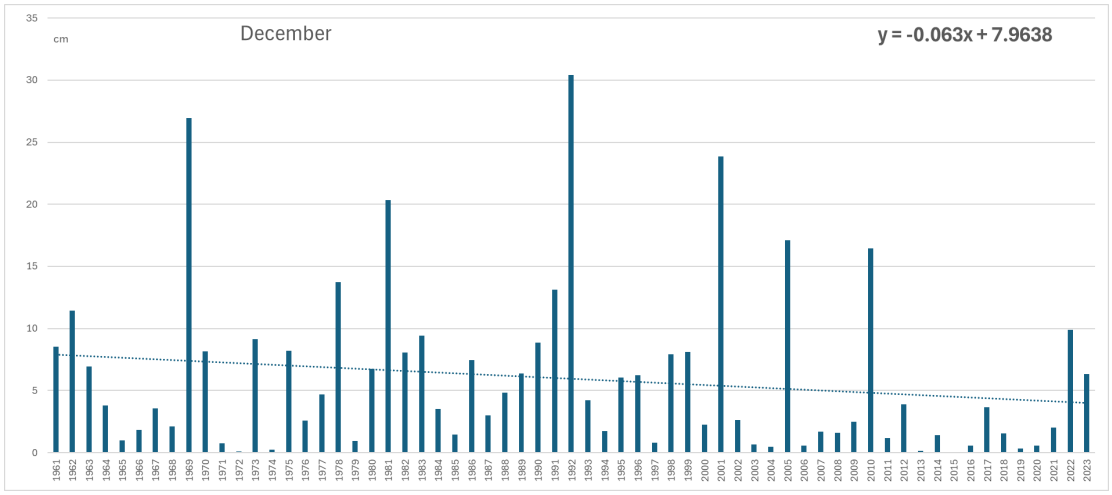
It is logical that the first spring month, March, will have less favourable conditions for skiing than the winter months. Only 15 years of the assessed period have a snow cover higher than 5 cm. Such a continuous period was from 2004 to 2006. This also had a relatively high maximum height of 36 cm compared to other years. However, since this year, conditions for skiing have not occurred. The downward trend is 2 cm, which, given the snow depth in March, represents unfavourable conditions for skiing.

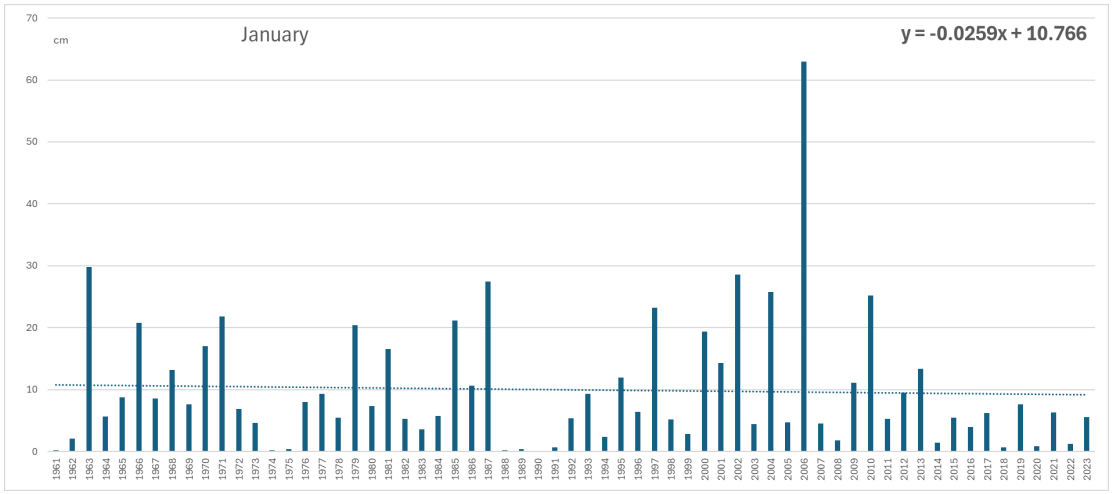
Discussion

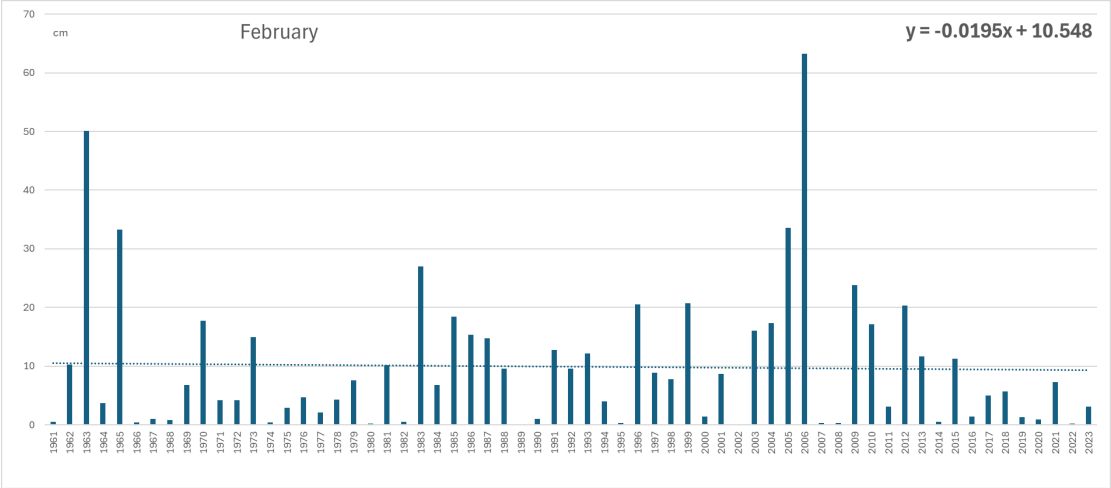
These results show that air temperature increases in winter, in Bohemia more than in Moravia. At the same time, it must be stressed that this is not an even increase, but there is a relatively high dynamics of air temperature, i.e. changes over a short period. Thus, extremely high temperatures are replaced by significant drops within two or three days. These results are consistent with published studies by other authors.

From the point of view of winter recreation, these air temperature dynamics have a negative impact. Higher air temperatures mean that the ice season is shorter, so skating on natural surfaces is shorter. However, higher temperatures also affect the snow cover. Compared to the published climatological evidence from the last century, there is a lower snow cover in winter, especially in the last decade. Although the length of its occurrence has not been assessed, it can be deduced that the favourable conditions for various forms of skiing have been shortening in recent years.


November
cm
y = -0.0254x + 2.7718
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00


December
cm
y = -0.063x + 7.9638
35
30
25
20
15
10
5
0


January
cm
y = -0.0259x + 10.766
70
60
50
40
30
20
10
0



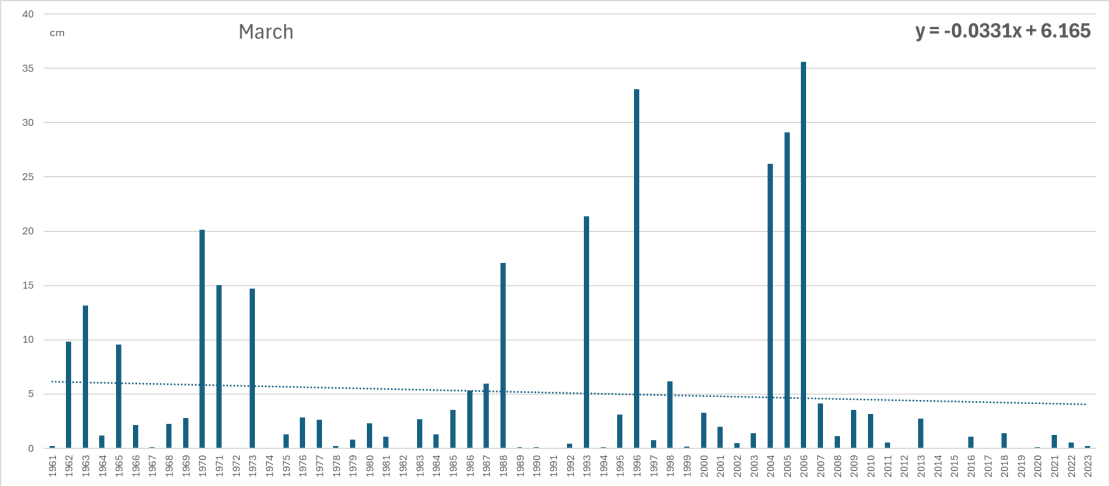


Fig. 1: Snow cover height (cm) and its trend in the months November to March for the period 1961 to 2023 at the climatological station of the Czech Hydrometeorological Institute Frenštát pod Radhoštěm

Conclusion

The air temperature in winter is demonstrably rising. This also affects the conditions for winter recreation. Overall, when we evaluate the snow cover at all stations assessed, we can conclude that it is highly variable between November and March for the years 1961 to 2023. In terms of trend, all months for these years show a decrease in snow cover. With a set threshold of 5 cm of snow as a condition for skiing, the beginning comes later, and the end comes earlier. Thus, the current climate trend also means a shortening of the ski season in our mountains.

From the point of view of the outlook for winter sports, it must be stressed that it will be necessary to replace natural conditions with artificial ones to ensure them.

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Souhrn
Změna klimatu je nejvíce vyjadřována globálním oteplováním. Z naší analýzy teploty vzduchu za období 1961 až 2020 naměřené na klimatologických stanicích Českého hydrometeorologického ústavu vyplývá, že zimní teploty statisticky prokazatelně rostou. Tato skutečnost má dopad i na podmínky rekreace v chladném období, které jsme vyjádřili měsíci listopad až březen. Z hodnocení denní celkové výšky sněhové pokrývky na vybraných klimatologických stanicích v pohoří Beskyd, Jizerských hor a Šumavy vyplývá, za výskyt sněhové pokrývky byl za hodnocené období vždy proměnlivý s tím, že trend vyjadřuje její postupný pokles. Na mnoha místech v posledních letech nebyla dostatečně vysoká sněhová pokrývka potřebná pro lyžování. Díky postupnému oteplování se jeví, že přírodní podmínky pro lyžování bude nutné nahrazovat umělým zasněžováním.

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