

EXTREME AIR TEMPERATURES IN BRATISLAVA, MLYNSKÁ DOLINA FOR THE PERIOD 1983-2005

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The work brings results of thermograms processing for meteorological observatory of the Department of Astronomy, Physics of the Earth and Meteorology of the Faculty of Mathematics, Physics and Informatics of Comenius University in Bratislava, Mlynská dolina for the period 1983-2005. Absolute and mean maxima as well as minima of air temperature are evaluated in individual months together with its linear trend. These data are completed with the maximum, minimum and mean number of ice, frost, warm and tropical days as well as with number of days with tropical night in annual course. The statistically important increase of mean aperiodic daily amplitude was computed for the months since February till June. These months distinguished by higher mean monthly air temperatures in 10-year period 1993-2002 than in that 1983-1992. The increasing tendency is caused by decrease of mean monthly cloudiness for the period 1983-2005. This result is in good agreement with that obtained by means of GCMs CCCM 2000 for increase of global solar radiation. Annual number of warm days has also increasing linear trend within this period.

Key words: extreme, air temperature, daily and annual course, long-term course

Introduction

In the last two 10-year periods data of mean monthly and annual temperatures were often discussed in our scientific literature in connection with increasing influence of greenhouse effect (Hrvol', J., 2004, Ostrožlík, M., Smolen, F., 2000). Air temperature measurements are performed 3 times a day at 7, 14 and 21 o'clock of the mean local time. The daily air temperature mean is calculated as a weighted arithmetic mean from these measurements. The air temperatures measured at 7 and 14 o'clock are considered with the weight 1 and air temperature measured at 21 o'clock with the weight 2. In this work we concentrate on evaluation of thermograph records from meteorological observatory of the Department of Astronomy, Physics of the Earth and Meteorology of the Faculty of Mathematics, Physics and Informatics of Comenius University in Bratislava, Mlynská dolina ($\varphi = 48^{\circ}09'$, $\lambda = 17^{\circ}04'$, $H = 182$ m a. s. l.) for the period 1983-2005.

Method and results

There is an uninterrupted time series of meteorological measurements which makes possible to determine the air temperature daily course for the given period and to estimate the maximum and minimum daily air temperatures. Maximum and minimum air temperatures are estimated from thermograph records for a calendar day as the highest and the lowest air temperatures for the time interval since 0.00 to 24.00 o'clock. This accuracy of air temperature estimation is lesser by several tenths of degree than that reached with maximum and minimum thermometers (Nieplová, E., Šťastný, P., Lapin, M., 2000). Extreme thermometers are set at 21 and 7 o'clock in order to estimate the maximum and minimum air temperatures during the night (21.00-7.00 o'clock) and day (7.00-21.00 o'clock). It must be emphasized that extreme air temperatures estimated by these two ways do not have to correspond (they do not concern the same time interval).

Table 1 introduces daily course of air temperature in individual months of a year for the period 1983-2005, that is for 23 years. The monthly means of air temperature determined from hourly

values are given in Table 2. We can find out, by comparison of these true monthly means with those determined as a weighted arithmetic mean, that the differences do not exceed 0.2°C . Irregularities did not occur in daily course of air temperature for the period 1983-2005. The maximum of mean air temperature falls on 14 till 15 o'clock, the minimum is observed at sunrise.

There is no month with negative mean monthly air temperature in its annual course for the processed period 1983-2005. The mean monthly air temperature reached minimum, 0.0°C , in January. The maximum mean monthly air temperature, 20.8°C , was measured in July. The mean monthly air temperatures in July and in August estimated on the basis of thermograph records are the same (20.7°C). Absolute monthly maxima and minima air temperatures were determined as the maximum and minimum values in Tables 3 and 4, respectively. There are the maximum and minimum air temperatures introduced for every calendar day of a year there. The maximum and minimum monthly air temperatures are emphasized with type of writing.

It follows from Table 3 that in winter months the air temperature can reach more than 17°C . Maximum air temperature 39.3°C was recorded on 13th August 2003. Maximum temperature measured in February (18.9°C) was lower than that measured in January (19.8°C) although the coldest month on the long-term average is January. The value gained by maximum thermometer was 20.2°C in January, that is, the difference in accuracy is less than 0.5°C . We can also see from Table 3 that the 1st warm day (day with maximum air temperature 25.0°C or higher) can be expected at first in April, in individual years also later in May or in June (1987, 1991). Tropical day (day with maximum air temperature 30.0°C or higher) occurs at first in May, but in some years this temperature can be reached only in July (1985) - Table 5. The air temperature 30.0°C in July was overtopped every year in this period. This air temperature can be measured in September at the latest.

The minimum air temperature, -22.2°C , was reached on 7th January 1985. The negative air temperature is not measured in meteorological screen in the period since May till September (Tables 4 and 6). It can be still recorded in spring at the end of April (29th of April), but it was not observed in years 1989 and 1991 even by thermometers measurements. We can see from Table 5 and Figure 1 that the absolute maxima of air temperature were measured mostly in the second half of the processed period and absolute minimum of air temperature was recorded in 1985, that is, nearly at the beginning of the studied period - Figure 2. The data of Table 5 – maximum and minimum monthly air temperatures in individual years for May and June for the period 1983-2005 with linear trend are introduced in Figures 3 and 4, respectively. Statistically significant is the increasing tendency of maximum air temperature in May (Figure 3) and in June (Figure 4). Statistically significant decrease of extreme air temperatures was not found out (Rumshinskiy, L. Z. , 1970).

The mean maxima and minima of air temperature in individual months and years are introduced in Tables 7 and 8, respectively. These values reflect temperature conditions of the month better than the absolute extremes because the mean maximum (minimum) air temperature is a mean of maxima (minima) of air temperature for every day in a given month. The highest value of mean maximum air temperature, 32.7°C , was calculated for August of 1992, the lowest mean minimum air temperature, -8.8°C , was estimated for January of 1987.

Table 9 brings the comparison of mean maximum and minimum air temperatures as well as the mean monthly air temperatures in decades 1983-1992 and 1993-2002. The second decade, which had the mean of annual air temperature by 0.3°C higher than that of 1983-1992, had also higher mean maximum air temperature in February (difference 2.6°C), in May and in June (differences 2.0°C).

The long-term course of mean maximum and minimum air temperatures with the linear trend in May and June for the given period is shown in Figures 5 and 6, respectively. Statistically significant values of increasing tendency of mean maximum air temperature can be found out in these months.

Statistically significant decrease of mean maximum and minimum temperatures was not observed. Numbers of days with characteristic air temperatures - the ice, frost, warm and tropical days as well as the days with tropical night are drawn in Figures 7-11. As ice days the days with maximum daily temperature below or equal to -0.1°C and as frost days the days with minimum temperature below or equal to -0.1°C are considered. Decreasing tendency of ice days number and increasing tendency of frost days number are not statistically significant. Statistically significant trend at level 0.05 is observed for increasing number of warm days, i.e. days when the air temperature equals or is higher than 25.0°C . Increasing trend of tropical days number (days with maximum air temperature 30.0°C or

Table 1. Daily course of air temperature in °C in Bratislava, Mlynská dolina for the period 1983-2005

Month	1	2	3	4	5	6	7	8	9	10	11	12
1	-0.8	-1.0	-1.1	-1.1	-1.2	-1.2	-1.2	-1.1	-0.7	-0.2	0.4	0.9
2	0.1	-0.2	-0.3	-0.5	-0.6	-0.7	-0.7	-0.4	0.4	1.3	2.1	2.8
3	3.6	3.4	3.1	2.9	2.7	2.7	2.9	3.8	4.7	5.8	6.8	7.6
4	8.1	7.7	7.3	7.1	6.9	7.1	8.1	9.3	10.5	11.8	12.8	13.6
5	12.6	12.2	11.8	11.5	11.4	12.4	13.7	15.0	16.2	17.4	18.4	19.1
6	14.9	14.5	14.1	13.9	13.9	15.0	16.4	17.8	19.1	20.3	21.2	21.9
7	17.1	16.6	16.2	15.9	15.9	16.9	18.4	19.8	21.2	22.5	23.6	24.3
8	17.4	17.0	16.6	16.2	16.0	16.6	17.9	19.4	20.9	22.4	23.6	24.5
9	13.4	13.1	12.8	12.6	12.3	12.3	13.1	14.4	15.7	16.9	18.1	18.9
10	9.1	8.8	8.5	8.3	8.2	8.1	8.2	9.1	10.2	11.3	12.4	13.2
11	3.8	3.7	3.5	3.4	3.3	3.3	3.3	3.6	4.2	4.9	5.4	6.0
12	0.0	-0.1	-0.2	-0.3	-0.4	-0.3	-0.3	-0.3	0.1	0.6	1.1	1.5
Month	13	14	15	16	17	18	19	20	21	22	23	24
1	1.3	1.5	1.4	1.0	0.6	0.3	0.1	0.0	-0.2	-0.3	-0.5	-0.7
2	3.4	3.8	3.8	3.5	2.9	2.3	1.9	1.5	1.2	0.9	0.6	0.4
3	8.2	8.6	8.7	8.5	7.9	7.1	6.4	5.8	5.3	4.8	4.5	4.1
4	14.2	14.6	14.6	14.5	14.0	13.1	12.0	11.0	10.3	9.6	9.1	8.7
5	19.7	20.2	20.2	19.9	19.4	18.7	17.5	16.0	15.0	14.3	13.7	13.1
6	22.4	22.7	22.7	22.4	21.9	21.3	20.2	18.7	17.6	16.7	16.1	15.6
7	24.9	25.2	25.3	25.2	24.7	23.9	22.7	20.9	19.7	18.8	18.2	17.6
8	25.2	25.6	25.6	25.4	24.8	23.7	22.0	20.5	19.6	18.8	18.3	17.8
9	19.6	19.9	20.0	19.6	18.8	17.5	16.2	15.4	14.9	14.4	14.0	13.6
10	13.9	14.3	14.2	13.6	12.7	11.7	11.0	10.6	10.3	9.9	9.6	9.2
11	6.4	6.6	6.4	6.0	5.5	5.1	4.9	4.6	4.4	4.2	4.0	3.8
12	1.7	1.8	1.7	1.3	1.0	0.8	0.6	0.5	0.4	0.3	0.2	0.0

Table 2. Annual course of air temperature in °C at station Bratislava, Mlynská dolina for the period 1983-2005

Characteristic	1	2	3	4	5	6	7	8	9	10	11	12	Year
Absolute max.	19.8	18.9	24.4	28.0	34.7	38.0	36.8	39.3	32.4	26.1	21.1	17.4	39.3
Mean max.	2.5	4.8	9.7	15.7	21.4	24.0	26.8	26.8	21.0	15.1	7.5	2.9	14.9
Mean	0.0	1.4	5.5	10.8	16.0	18.6	20.8	20.7	15.7	10.8	4.7	0.6	10.5
Mean ¹	-0.2	1.2	5.4	10.7	15.8	18.4	20.7	20.7	15.7	10.7	4.6	0.5	10.4
Mean min.	-2.6	-1.9	1.6	5.9	10.5	12.9	14.9	15.2	11.3	7.0	2.0	-1.7	6.3
Absolute min.	-22.2	-18.7	-14.0	-3.7	2.0	5.2	7.5	7.7	2.0	-6.3	-9.9	-16.7	-22.2

Mean¹ - arithmetical mean from 24 hourly values

Table 3. Absolute daily and monthly maxima of air temperature in °C at station Bratislava, Mlynská dolina for the period 1983-2005

Day	1	2	3	4	5	6	7	8	9	10	11	12
1	12.8	14.2	14.1	21.8	26.5	27.2	34.5	36.8	28.2	25.9	18.5	9.2
2	11.8	12.9	14.8	21.9	28.2	30.5	32.4	34.9	28.5	24.6	17.8	12.0
3	12.4	12.4	17.2	22.4	27.3	29.9	33.1	35.8	30.5	25.6	18.0	10.5
4	12.4	14.8	17.5	22.5	28.6	31.0	34.5	34.5	29.9	25.3	16.8	11.5
5	10.5	17.0	15.2	20.3	27.2	32.7	32.0	34.3	28.7	23.7	15.8	11.5
6	10.2	18.9	18.1	21.5	30.2	33.4	34.6	34.1	30.9	23.6	19.6	9.5
7	13.6	16.4	18.0	23.4	29.8	35.4	34.0	36.3	27.8	23.0	20.4	7.6
8	14.2	17.7	16.6	24.2	31.8	31.5	32.9	36.3	29.3	24.0	19.1	12.5
9	14.4	14.8	19.0	24.6	28.9	31.9	33.3	35.4	28.2	23.7	15.1	9.3
10	12.1	13.2	17.5	20.9	28.9	32.6	35.0	36.8	29.1	22.8	14.5	10.8
11	10.7	14.6	19.2	23.2	30.4	35.9	33.1	32.5	27.3	24.0	16.4	12.0
12	10.4	15.4	19.4	23.1	29.6	34.5	34.8	36.4	29.1	25.3	17.8	14.5
13	9.4	13.7	16.3	21.2	28.9	33.9	33.5	39.3	31.5	26.1	17.6	14.5
14	10.1	14.6	18.8	21.5	30.1	33.8	33.2	36.4	32.4	25.7	20.6	14.4
15	10.1	17.0	18.2	23.1	29.7	32.9	36.8	33.7	27.5	22.3	21.1	12.8
16	14.3	18.1	19.5	22.3	30.6	28.6	32.9	33.2	28.9	22.5	18.7	16.5
17	10.7	13.1	21.7	24.3	30.6	30.0	33.3	35.1	26.4	21.4	19.1	17.4
18	15.0	10.2	21.2	21.0	29.2	33.0	34.7	35.7	29.3	18.6	15.3	14.2
19	7.2	14.6	22.3	25.2	28.2	34.8	35.5	38.1	28.5	20.7	17.1	17.2
20	12.4	15.3	21.4	23.6	29.4	33.3	35.2	36.3	30.4	19.3	16.2	11.1
21	12.0	17.4	22.2	26.9	28.4	35.0	34.8	35.4	31.0	18.7	14.4	10.6
22	16.6	14.6	23.9	28.0	25.9	37.4	34.3	34.0	31.3	19.6	12.4	9.9
23	14.4	13.8	18.5	27.0	29.2	38.0	34.9	33.2	29.8	22.5	14.7	10.6
24	16.9	16.6	22.9	26.8	27.7	30.1	36.1	30.7	27.5	23.2	16.8	12.2
25	10.5	16.2	20.4	26.5	29.5	31.6	33.3	33.2	27.2	23.7	14.5	11.5
26	12.3	17.1	20.5	26.6	31.0	32.4	34.5	35.9	26.9	21.6	11.9	13.0
27	14.2	18.4	21.8	25.4	31.2	33.6	36.2	34.4	24.5	21.4	16.5	10.7
28	15.1	16.1	20.7	25.7	32.4	34.4	35.2	37.1	25.4	22.1	12.1	13.0
29	19.8	14.4	24.3	27.6	33.4	33.0	35.4	36.9	24.3	21.2	11.0	13.6
30	16.8		20.9	27.3	34.7	33.8	36.4	34.0	28.0	21.5	12.3	15.2
31	12.7		24.4		31.8		35.4	31.7		21.8		13.1
Month	19.8	18.9	24.4	28.0	34.7	38.0	36.8	39.3	32.4	26.1	21.1	17.4

higher) is not statistically significant for the given period as well as the decreasing tendency of the day with tropical night (minimum daily air temperature is not less than 20.0°C). Table 10 brings the annual course of these days. Number of days between the first and the last frost days does not manifest statistically significant trend in the long-term course for the period 1983/84 - 2005/06 – Figure 12, similarly as the data of the last frost day – Figure 13. At first the last frost day was recorded on 22nd February 1989 and at the latest, as it was mentioned above, on 29th April 1984.

If we subtract the mean minimum air temperature from its mean maximum, we gain the mean aperiodic daily amplitude of air temperature. We can find the statistically significant tendency of mean aperiodic daily amplitude in the long-term course for the months since February till June (Figures 14-18). The tendency is increasing. In these months, when the higher mean monthly air temperatures were measured for the 10-year period 1993-2002 than for that 1983-1992, the decreasing trends of mean cloudiness were observed. This caused increase of maximum daily temperature and decrease of its night minimum.

Table 4. Absolute daily and monthly minima of air temperature in °C at station Bratislava, Mlynská dolina for the period 1983-2005

Day	1	2	3	4	5	6	7	8	9	10	11	12
1	-10.5	-14.8	-13.4	-3.7	5.5	5.2	8.5	11.6	7.3	3.7	-1.9	-8.9
2	-13.4	-12.2	-9.1	0.3	4.5	6.8	10.8	10.7	8.6	2.8	-1.4	-10.0
3	-14.6	-10.0	-11.9	-0.2	2.0	7.5	10.3	11.2	6.6	5.2	-1.4	-11.5
4	-14.6	-11.3	-13.4	0.3	3.0	8.7	9.5	10.1	6.7	3.6	-4.4	-9.1
5	-12.7	-13.4	-14.0	-0.7	6.7	6.3	10.0	10.6	7.9	3.6	-4.2	-5.4
6	-15.6	-15.7	-11.7	-2.1	4.2	6.1	10.2	8.1	7.2	1.8	-3.6	-6.6
7	-22.2	-14.2	-10.6	-2.5	3.5	5.8	9.6	9.5	5.5	1.1	-2.1	-5.3
8	-20.8	-16.1	-11.9	-2.3	4.2	8.4	8.2	11.6	8.4	2.6	-2.7	10.7
9	-18.6	-12.0	-10.5	-3.5	2.8	7.1	9.7	9.6	8.0	0.6	-5.2	-12.9
10	-14.9	-14.9	-8.8	-0.2	3.0	8.2	9.6	8.8	5.4	2.4	-2.5	-13.3
11	-14.8	-16.1	-8.8	-0.5	4.0	10.0	9.5	11.1	7.0	1.3	-4.4	-11.0
12	-18.7	-18.7	-9.2	-1.8	2.9	7.2	8.2	9.7	9.3	1.1	-3.6	-8.8
13	-18.2	-17.0	-10.4	-3.0	5.3	5.9	8.3	9.8	6.2	-0.9	-5.4	-13.9
14	-13.5	-12.9	-6.2	-2.6	5.8	8.9	9.6	9.3	6.1	0.6	-6.5	-14.4
15	-9.8	-11.4	-6.6	-2.7	3.1	7.7	9.2	10.2	7.2	0.9	-9.2	-14.7
16	-8.1	-12.2	-4.2	-0.5	4.2	8.2	10.6	10.5	6.8	0.5	-3.5	-9.1
17	-8.7	-10.6	-1.9	-1.1	4.8	7.3	10.1	12.1	4.9	-2.2	-4.1	-11.0
18	-8.2	-11.6	-3.8	-1.0	5.8	7.8	8.8	11.7	6.0	-1.5	-7.6	-6.3
19	-8.8	-7.9	-5.6	-1.1	5.6	8.4	9.7	10.9	6.1	-0.5	-8.2	-7.5
20	-9.9	-9.7	-5.4	0.1	4.4	10.6	7.5	9.1	5.6	1.1	-8.2	-8.5
21	-10.8	-9.8	-4.0	-1.1	4.6	9.5	8.0	9.7	4.0	0.0	-8.5	-10.5
22	-11.3	-8.7	-3.9	-1.7	4.3	8.1	8.2	11.2	6.9	-3.1	-9.0	-8.9
23	-9.6	-10.0	-5.0	0.7	4.0	7.4	10.9	8.6	6.1	-0.7	-9.9	-10.5
24	-10.6	-10.6	-4.1	-0.5	4.2	8.2	10.2	9.7	5.8	-3.1	-7.6	-12.4
25	-12.1	-12.8	-2.4	1.3	2.8	7.0	10.4	9.7	6.2	-5.6	-5.3	-11.2
26	-10.9	-13.2	-3.6	3.8	4.4	9.1	10.6	8.2	5.9	-0.9	-7.6	-14.1
27	-8.2	-14.9	-1.4	0.1	5.4	7.4	8.3	9.2	3.5	-2.8	-6.5	-16.7
28	-11.1	-13.3	-2.0	0.0	5.2	6.3	12.3	9.4	4.5	-4.1	-8.1	-16.4
29	-11.1	-4.2	-1.8	-0.6	5.1	9.1	11.9	9.2	4.5	-6.3	-5.8	-15.7
30	-14.9		-1.7	3.3	5.8	7.5	11.6	7.7	2.0	-5.0	-6.8	-13.2
31	-15.3		-1.9		4.6		11.4	8.3		-2.7		-12.6
Month	-22.2	-18.7	-14.0	-3.7	2.0	5.2	7.5	7.7	2.0	-6.3	-9.9	-16.7

Conclusion

Processing of thermograph records of extreme data confirmed increasing linear trend of mean daily aperiodic air temperature amplitude in April, May and June. This increasing tendency is caused by decrease of mean monthly cloudiness for the period 1983-2005. This result is in good agreement with that obtained by means of GCMs CCCM 2000 for increase of global solar radiation (Lapin, M. et al., 2000). Annual number of warm days has also increasing linear trend within this period.

Table 5. Maximum monthly and annual air temperatures in °C at station Bratislava, Mlynská dolina for the period 1983-2005

Month	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Maximum monthly air temperature												
1	15.0	12.8	6.7	8.9	10.8	12.9	10.6	11.5	9.3	12.2	16.9	13.6
2	11.7	9.1	9.1	4.7	9.3	12.0	15.3	17.4	12.3	14.4	6.8	12.8
3	18.1	19.8	16.5	16.4	17.0	14.9	24.4	23.9	19.5	15.8	21.5	22.9
4	25.2	22.3	21.3	26.5	21.7	22.9	23.2	21.9	20.3	26.6	25.1	25.4
5	30.6	27.2	28.1	27.7	24.6	26.0	26.5	27.2	22.7	26.5	31.0	27.4
6	29.6	29.9	28.1	30.4	29.9	30.6	28.2	32.7	30.0	30.0	31.5	34.4
7	36.2	34.1	32.9	32.5	31.5	36.1	32.9	34.0	34.8	35.4	32.8	36.4
8	33.8	31.8	31.9	32.7	28.4	33.7	31.8	33.5	31.6	37.5	34.0	36.8
9	29.1	30.5	27.8	28.9	32.4	26.6	28.1	26.0	28.7	27.1	27.5	29.3
10	25.3	21.8	23.7	24.4	24.0	21.5	23.4	25.9	22.8	23.0	25.7	23.2
11	13.8	16.8	14.0	11.7	13.6	11.7	17.8	15.3	16.8	16.8	12.1	17.8
12	13.0	7.8	10.3	11.5	13.6	12.2	17.4	6.3	6.7	11.5	10.8	14.5
Year	36.2	34.1	32.9	32.7	32.4	36.1	32.9	34.0	34.8	37.5	34.0	36.8
Month	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	83-05
Maximum monthly air temperature												
1	12.3	5.6	4.6	14.4	8.5	12.7	9.3	19.8	12.4	9.6	12.7	19.8
2	16.4	7.3	16.2	18.4	12.8	14.0	17.7	15.4	9.0	18.9	7.8	18.9
3	18.8	10.5	17.3	18.6	20.2	18.5	19.4	20.1	21.8	22.3	21.7	24.4
4	26.4	24.8	19.8	23.4	22.1	28.0	24.9	22.0	27.6	23.8	22.5	28.0
5	28.4	27.1	30.6	29.1	31.8	31.2	29.5	29.6	31.8	25.6	34.7	34.7
6	28.9	34.0	32.1	35.4	29.2	37.4	31.8	38.0	35.9	29.4	31.6	38.0
7	33.4	30.2	30.9	35.2	34.6	33.3	36.8	35.0	34.5	32.5	34.9	36.8
8	31.8	32.1	32.6	36.4	32.6	38.1	34.0	30.4	39.3	33.2	31.3	39.3
9	26.1	23.9	30.9	24.8	28.8	28.8	25.2	28.6	31.3	27.8	28.1	32.4
10	22.9	22.4	23.7	20.4	25.6	26.1	24.6	20.4	24.6	24.0	22.4	26.1
11	11.8	18.0	20.4	15.0	17.4	20.6	13.8	21.1	18.5	15.7	14.8	21.1
12	11.1	7.0	9.4	8.6	12.5	14.5	6.5	15.2	9.1	11.9	9.1	17.4
Year	33.4	34.0	32.6	36.4	34.6	38.1	36.8	38.0	39.3	33.2	34.9	39.3

Table 6. Minimum monthly and annual air temperatures in °C at station Bratislava, Mlynská dolina for the period 1983-2005

Month	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Minimum monthly air temperature												
1	-2.9	-6.2	-22.2	-8.9	-18.7	-3.2	-5.1	-10.1	-11.7	-10.4	-14.9	-6.0
2	-12.2	-9.3	-18.7	-16.1	-13.7	-5.0	-3.0	-0.6	-15.7	-4.8	-14.8	-9.7
3	-3.6	-5.6	-3.7	-10.1	-14.0	-3.0	1.0	0.4	0.3	-2.7	-6.9	-1.5
4	0.5	-0.7	1.6	-2.2	0.7	-0.4	1.0	-1.2	-1.7	-1.0	-0.2	-1.1
5	3.5	4.8	3.0	7.1	4.3	4.9	4.9	5.1	2.8	7.0	7.0	2.4
6	9.7	5.9	8.1	5.8	8.4	8.2	8.2	9.0	7.9	10.4	8.0	6.1
7	8.6	8.2	10.9	8.3	8.3	11.1	8.8	9.2	8.5	11.8	8.2	13.3
8	10.2	9.6	11.4	8.1	8.1	9.4	10.4	11.1	9.1	11.5	8.9	10.5
9	4.3	7.2	6.2	3.5	4.0	8.8	6.9	4.9	8.4	7.3	2.0	6.0
10	0.0	0.4	-1.4	2.0	-0.4	-1.3	3.5	-0.7	-3.2	-0.9	-1.1	-1.5
11	-9.2	-1.9	-7.6	-0.6	-1.4	-9.9	-7.6	-0.8	-1.9	-2.6	-8.2	-0.9
12	-11.5	-7.2	-5.9	-12.3	-10.4	-11.0	-8.9	-10.1	-13.3	-10.6	-5.4	-5.3
Year	-12.2	-9.3	-22.2	-16.1	-8.7	-11.0	-8.9	-10.1	-15.7	-10.6	-14.9	-9.7
Month	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	83-05
Minimum monthly air temperature												
1	-9.8	-11.7	-11.2	-10.2	-11.2	-10.9	-8.4	-14.6	-14.5	-13.2	-11.1	-22.2
2	-3.5	-14.9	-6.9	-13.4	-12.5	-3.8	-7.5	-4.5	-10.3	-7.8	-11.8	-18.7
3	-1.8	-9.5	-3.0	-6.4	-3.8	-2.0	-1.7	-1.5	-5.0	-7.9	-13.4	-14.0
4	-0.6	-3.7	-3.0	1.3	0.7	-1.5	-2.7	-2.5	-3.5	0.8	-1.3	-3.7
5	2.0	5.9	4.6	4.2	4.8	6.0	6.0	8.9	4.2	4.0	2.8	2.0
6	7.4	8.1	5.2	7.6	7.0	6.3	7.2	6.9	10.2	8.3	6.8	5.2
7	11.4	7.5	11.4	9.7	11.6	8.8	10.5	10.4	9.6	9.2	10.2	7.5
8	8.3	10.5	10.7	7.7	8.6	10.5	8.1	14.2	12.3	10.1	8.8	7.7
9	6.1	5.3	4.0	6.3	10.7	8.2	5.4	3.9	6.2	5.8	6.1	2.0
10	0.2	0.1	-6.3	2.2	-1.2	3.7	2.4	1.8	-5.6	1.3	-0.5	-6.3
11	-5.5	-2.2	-5.2	-8.5	-6.2	0.0	-3.5	-1.3	-1.0	-5.2	-5.6	-9.9
12	-9.9	-16.7	-6.3	-11.0	-9.8	-7.4	-14.7	-9.5	-11.2	-6.0	-7.8	-16.7
Year	-9.9	-16.7	-11.2	-13.4	-12.5	-10.9	-14.7	-14.6	-14.5	-13.2	-13.4	-22.2

Table 7. Long-term course of mean maximum daily air temperatures in °C at station Bratislava, Mlynská dolina for the period 1983-2005

Month	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Mean maximum												
1	7.3	2.8	-3.6	2.5	-2.6	4.7	2.6	3.0	2.8	4.6	4.8	6.8
2	1.6	2.4	-0.4	-2.4	3.0	6.0	7.5	10.6	1.7	7.2	2.1	4.7
3	11.0	8.3	6.8	6.5	3.5	7.2	13.2	14.3	10.2	10.5	8.4	12.5
4	16.5	14.0	15.1	16.8	14.9	14.9	15.9	14.1	14.0	15.7	15.9	15.8
5	21.3	18.6	20.4	22.8	17.2	21.5	20.4	22.4	16.4	21.7	24.6	20.6
6	23.3	22.1	19.6	23.4	22.3	23.2	22.1	23.8	22.9	24.8	24.4	24.7
7	30.0	23.6	26.1	25.5	26.1	27.7	26.4	26.0	27.5	28.2	25.3	31.0
8	27.3	24.8	24.0	26.4	22.5	26.1	24.4	28.6	26.1	32.7	26.6	28.6
9	22.2	19.1	21.2	21.0	23.6	20.2	21.0	19.1	22.3	22.5	20.6	23.6
10	15.7	15.7	14.4	15.7	15.1	14.3	16.7	15.8	13.3	12.5	15.1	13.2
11	5.9	7.9	4.8	7.8	7.7	4.2	6.4	8.8	7.9	8.0	3.2	9.2
12	3.5	1.8	5.3	1.7	4.2	5.3	4.8	1.6	1.6	2.2	4.4	4.1
Mean maximum												
Month	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2005
Mean maximum												
1	1.8	-1.0	-1.0	5.0	2.0	1.2	2.7	3.3	1.8	0.8	4.4	4.4
2	9.4	-0.1	7.5	10.7	3.8	8.1	7.4	9.0	2.6	6.0	1.6	1.6
3	8.6	5.6	10.6	9.6	12.0	10.4	11.4	12.5	12.0	8.5	9.4	9.4
4	15.6	15.4	12.9	17.3	17.1	20.0	15.1	14.8	16.2	16.6	17.0	17.0
5	20.1	21.0	22.1	21.9	21.4	24.4	23.9	23.4	24.4	19.5	22.0	22.0
6	22.6	25.3	24.5	25.9	23.6	27.3	23.0	26.9	29.0	23.4	24.9	24.9
7	29.5	24.3	23.9	26.3	27.0	24.8	27.1	29.1	27.8	25.8	26.5	26.5
8	25.8	25.0	27.3	27.5	25.3	28.7	28.9	26.4	31.3	27.9	24.2	24.2
9	19.0	16.0	22.5	19.1	24.2	20.7	18.4	20.3	23.1	21.7	21.9	21.9
10	16.6	15.6	13.6	14.9	15.4	17.6	17.7	13.5	12.5	15.8	16.3	16.3
11	4.3	10.6	8.4	5.6	5.5	11.7	6.7	10.8	10.5	8.8	7.0	7.0
12	1.4	-0.2	4.2	0.8	3.8	4.1	-0.6	1.4	3.9	3.6	3.1	3.1

Table 8. Long-term course of mean minimum daily air temperatures in °C at station Bratislava, Mlynská dolina for the period 1983-2005

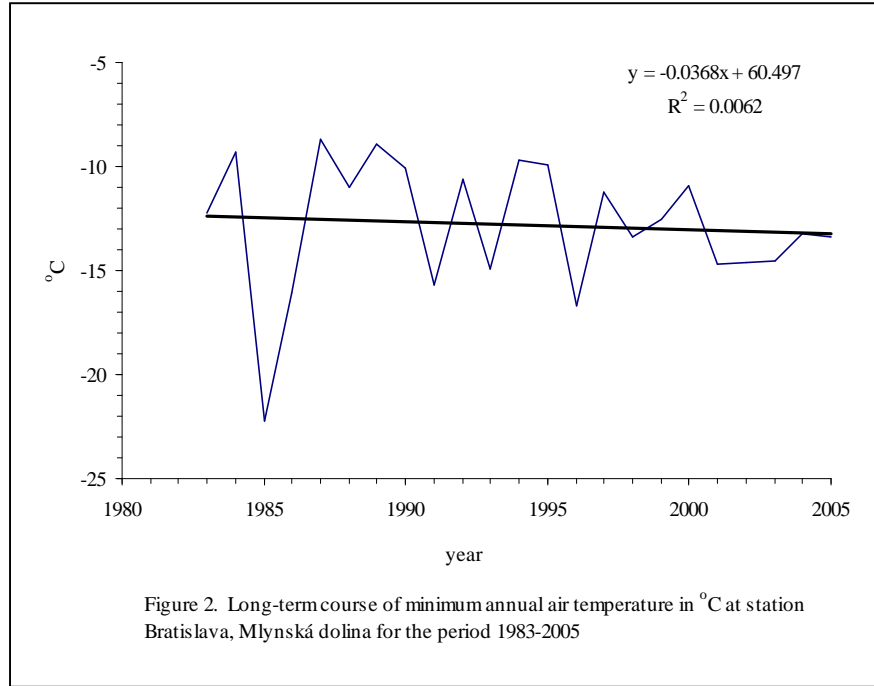
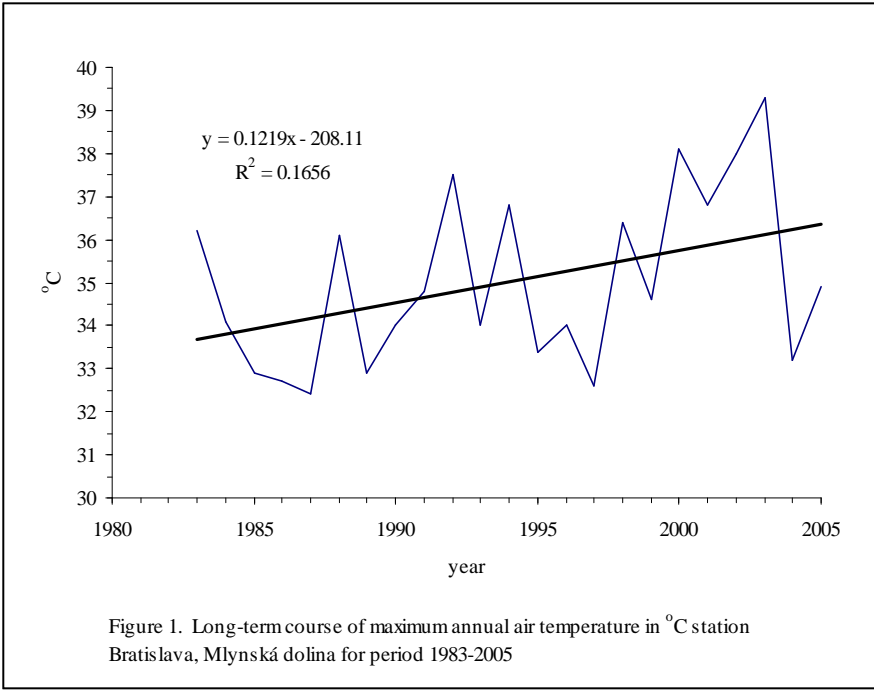
Month	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Mean minimum												
1	2.0	-1.6	-8.4	-2.2	-8.8	0.6	-1.5	-2.2	-1.8	-0.8	-2.8	1.2
2	-4.5	-1.7	-6.6	-7.9	-2.3	0.0	1.8	2.2	-5.3	0.4	-3.9	-1.8
3	2.4	0.5	1.3	-0.1	-3.6	1.0	4.1	4.9	4.4	2.2	0.7	4.3
4	7.3	4.9	6.3	7.0	5.7	5.7	6.6	5.5	4.7	5.6	6.7	6.0
5	11.3	9.5	12.2	12.4	8.2	11.1	10.0	10.5	6.8	10.0	12.5	9.9
6	13.4	11.6	12.0	12.6	13.0	12.6	11.6	12.8	11.9	14.1	13.2	13.0
7	16.9	13.5	15.0	13.4	15.3	15.1	15.6	13.3	15.7	15.6	13.9	17.0
8	15.7	14.3	15.0	15.1	13.2	14.9	15.7	15.1	15.1	18.6	14.8	16.5
9	11.1	11.7	11.7	9.9	13.5	11.6	12.4	9.3	12.2	11.6	11.0	13.1
10	6.5	7.4	6.4	6.3	8.1	7.2	7.5	7.2	6.1	5.6	7.6	5.0
11	-0.5	3.3	0.3	2.7	2.7	-2.3	1.1	3.7	2.3	2.2	-1.0	3.8
12	-2.2	-1.7	1.3	-2.1	0.0	0.0	-1.2	-1.9	-3.2	-1.8	0.1	-0.6
Mean minimum												
Month	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2005
Mean minimum												
1	-3.1	-4.7	-4.6	-0.8	-2.1	-4.4	-1.5	-2.2	-4.2	-5.2	-1.8	4.4
2	2.1	-6.0	-0.5	1.1	-2.4	0.7	-0.5	1.6	-5.6	-0.7	-4.2	1.6
3	1.0	-1.2	1.2	0.4	2.8	2.4	3.1	3.0	1.8	0.7	-0.5	9.4
4	6.6	5.4	2.4	6.9	6.6	8.3	4.8	5.2	4.8	7.0	6.3	17.0
5	9.2	10.9	10.6	10.0	10.4	10.9	10.9	12.7	12.3	8.6	9.9	22.0
6	12.4	13.4	13.4	13.7	12.7	13.1	11.3	14.1	15.6	12.7	12.8	24.9
7	16.9	12.7	14.3	15.0	15.4	13.4	14.8	15.5	15.1	14.6	15.6	26.5
8	14.6	14.1	15.2	14.4	13.7	15.5	15.7	16.7	16.5	15.3	13.8	24.2
9	10.5	9.1	10.5	11.1	13.7	11.2	10.5	10.2	10.8	10.9	12.9	21.9
10	7.9	7.8	3.8	7.6	6.8	9.6	10.1	6.0	3.7	8.3	8.0	16.3
11	0.1	4.6	2.3	-0.6	1.3	5.5	0.7	4.9	4.1	2.8	1.7	7.0
12	-1.9	-4.3	0.3	-3.7	-2.1	0.0	-6.7	-3.4	-1.6	-1.1	-2.0	3.1

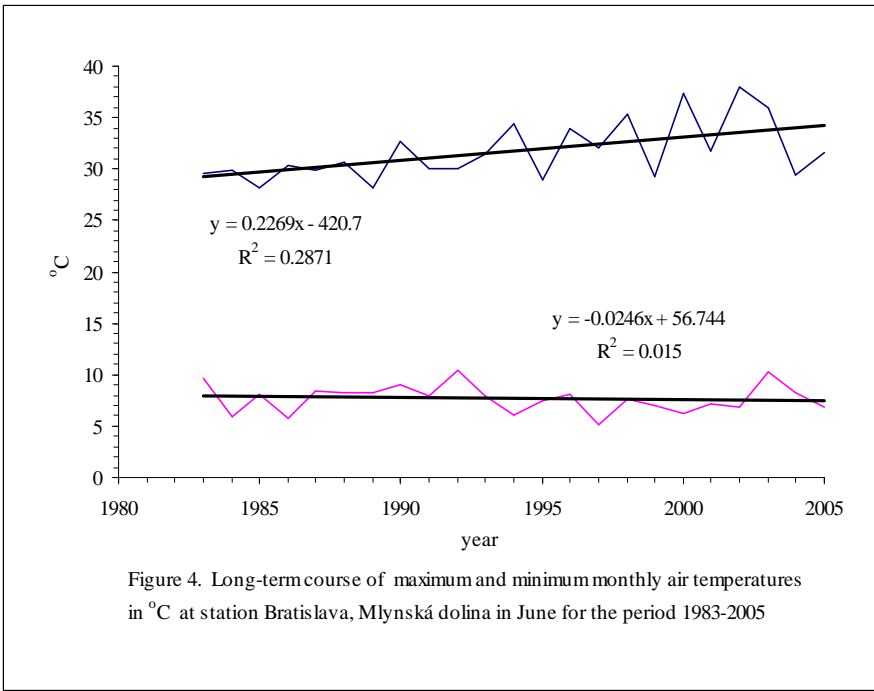
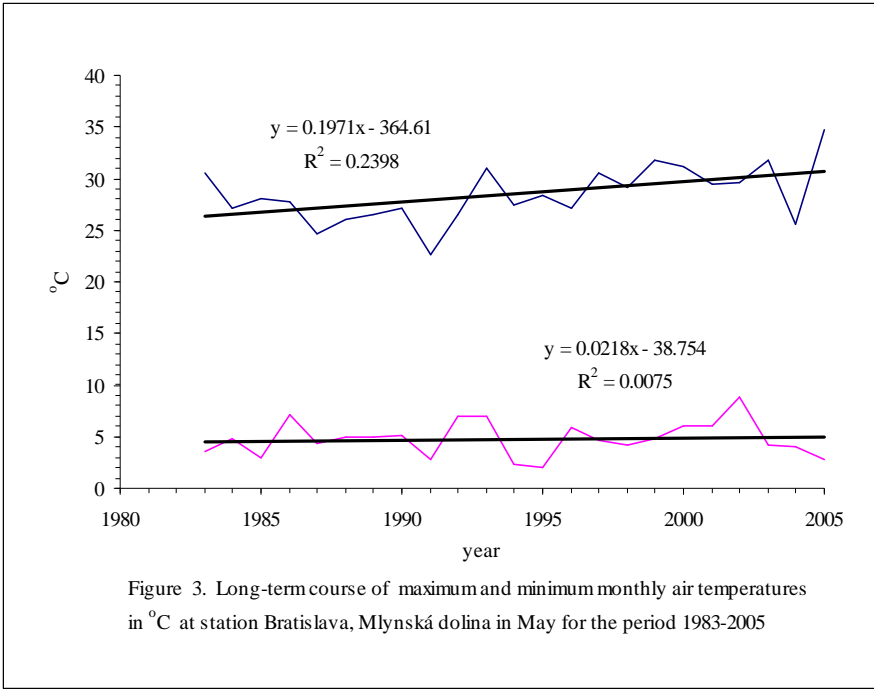
Table 9. Annual course of mean daily extremes and mean monthly air temperatures in °C at station Bratislava, Mlynská dolina for the periods 1983-1992, 1993-2002 and 1983-2005

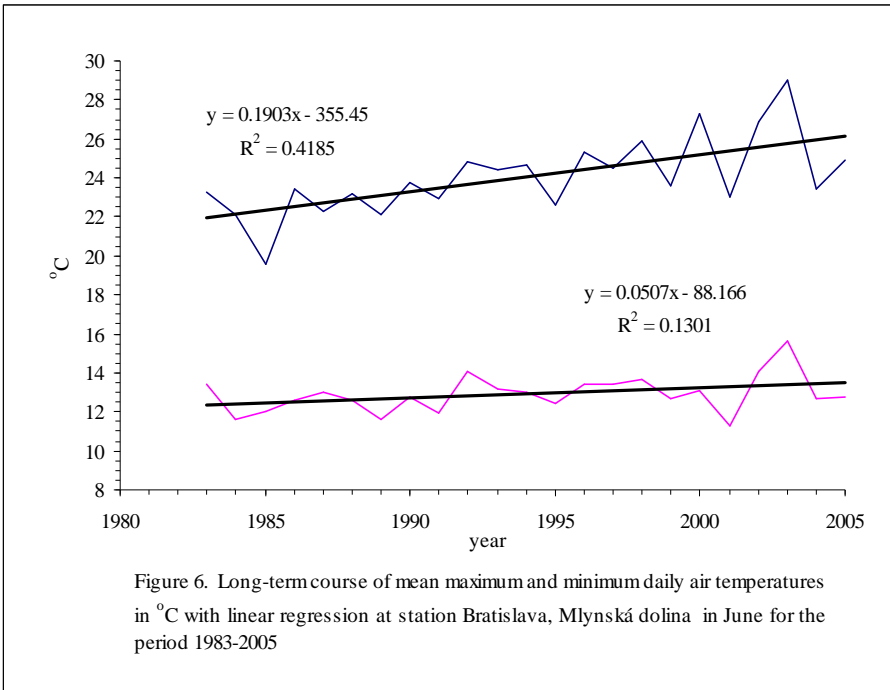
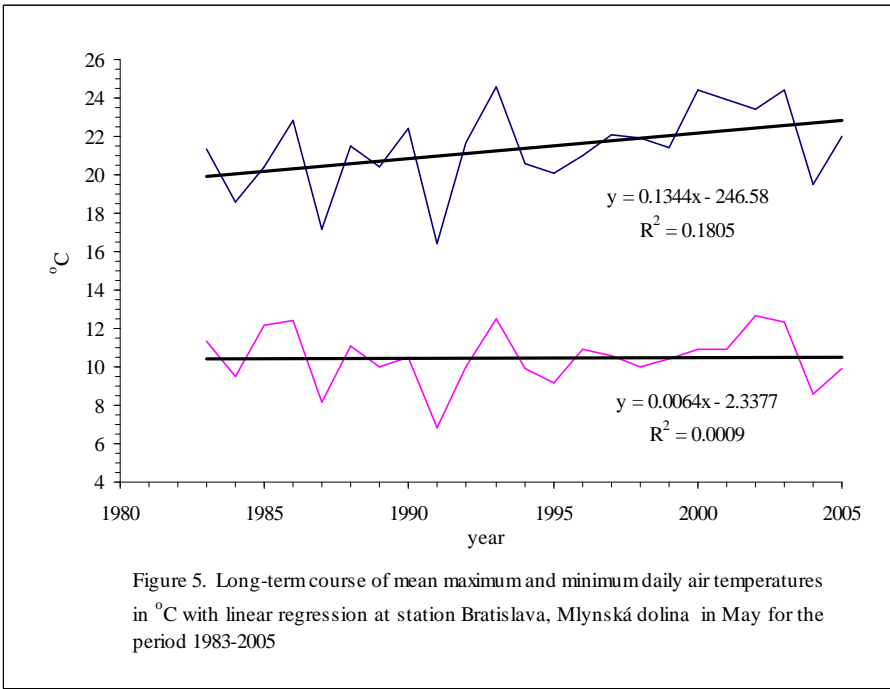
Period	1	2	3	4	5	6	7	8	9	10	11	12	Year
Mean daily maximum													
1983-1992	2.4	3.7	9.2	15.2	20.3	22.8	26.7	26.3	21.2	14.9	6.9	3.2	14.4
1993-2002	2.6	6.3	10.2	16.0	22.3	24.8	26.8	27.0	20.4	15.3	7.6	2.3	15.1
1983-2005	2.5	4.8	9.7	15.7	21.4	24.0	26.8	26.8	21.0	15.1	7.5	2.9	14.8
Mean daily minimum													
1983-1992	-2.5	-2.4	1.7	5.9	10.2	12.6	14.9	15.3	11.5	6.8	1.6	-1.3	6.2
1993-2002	-2.5	-1.0	1.8	5.9	10.8	13.0	14.9	15.1	11.1	7.2	2.2	-2.2	6.4
1983-2005	-2.6	-1.9	1.6	5.9	10.5	12.9	14.9	15.2	11.3	7.0	2.0	-1.7	6.3
Mean monthly air temperature													
1983-1992	0.1	0.7	5.5	10.6	15.4	17.7	20.9	20.5	16.1	10.7	4.2	1.0	10.3
1993-2002	0.2	2.6	5.8	10.9	16.6	19.0	20.6	20.7	15.3	10.9	4.8	0.0	10.6
1983-2005	0.0	1.4	5.5	10.8	16.0	18.6	20.8	20.7	15.7	10.8	4.7	0.6	10.5

Table 10. Annual course of number of ice, frost, warm and tropical days as well as days with tropical night at station Bratislava, Mlynska dolina for the period 1983-2005

Characteristic	1	2	3	4	5	6	7	8	9	10	11	12	Year
Ice days													
Average	10.4	5.3	0.9								1.6	8.0	26.2
Maximum	22	20	10								11	18	51
Minimum	0	0	0								0	2	11
Frost days													
Average	20.8	17.1	9.6	1.9						1.7	9.8	19.9	80.8
Maximum	29	28	21	9						10	23	31	106
Minimum	7	4	0	0						0	0	8	49
Warm days													
Average				1.0	7.5	12.8	20.6	20.7	6.1	0.3			69.0
Maximum				7	19	28	29	30	14	2			112
Minimum				0	0	3	11	6	0	0			42
Tropical days													
Average					0.6	2.9	8.3	8.2	0.3				20.3
Maximum					3	11	20	24	3				48
Minimum					0	0	1	0	0				6
Days with tropical night													
Average					0.5	1.4	1.7						3.6
Maximum					2	5	11						11
Minimum					0	0	0						0







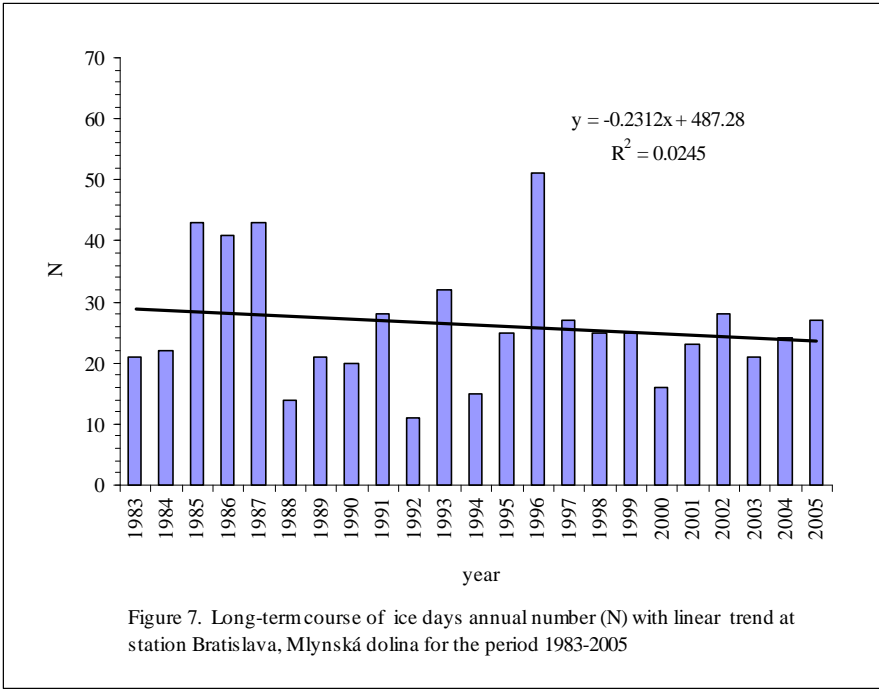


Figure 7. Long-term course of ice days annual number (N) with linear trend at station Bratislava, Mlynská dolina for the period 1983-2005

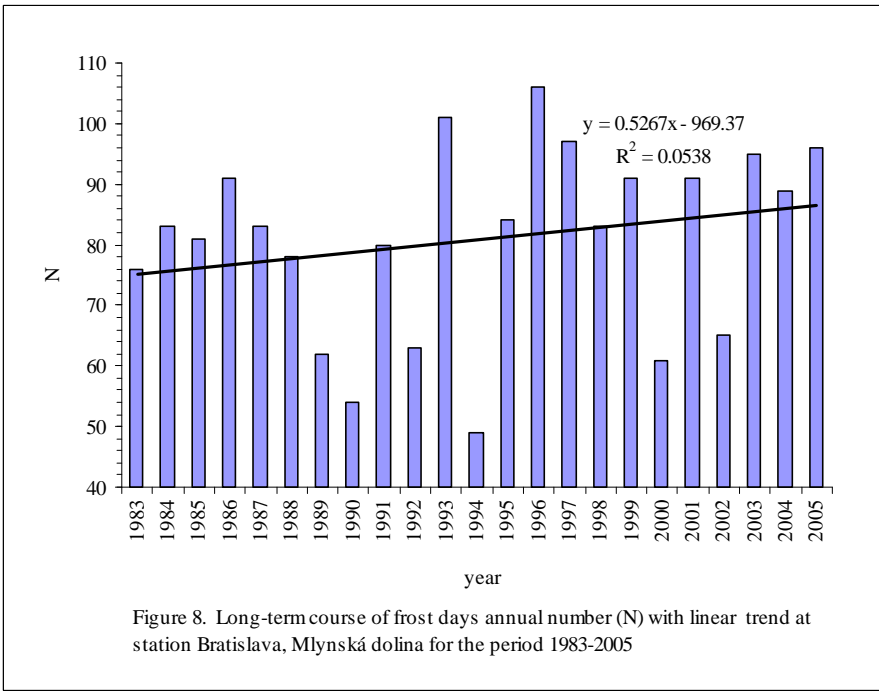


Figure 8. Long-term course of frost days annual number (N) with linear trend at station Bratislava, Mlynská dolina for the period 1983-2005

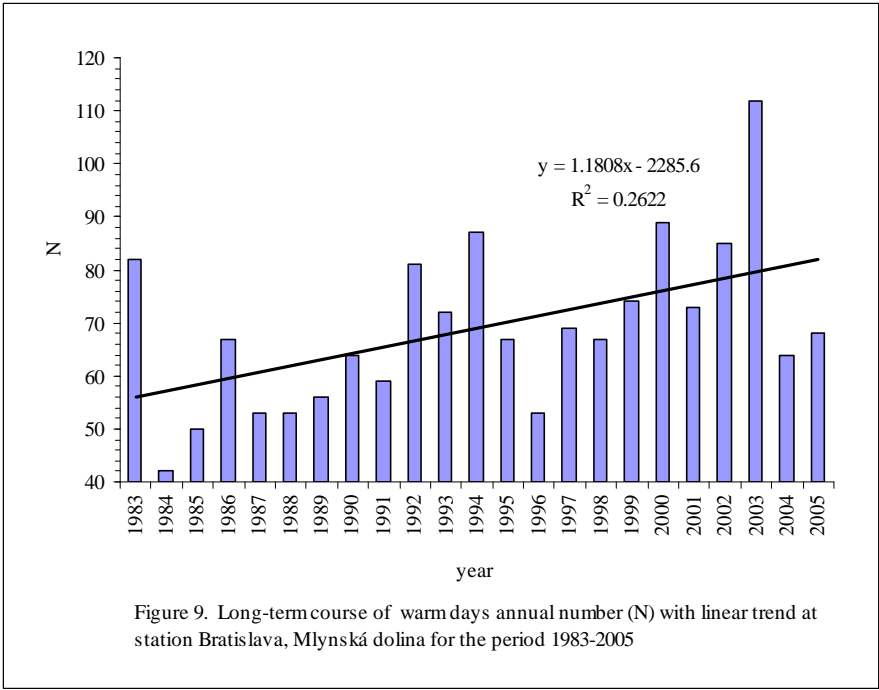


Figure 9. Long-term course of warm days annual number (N) with linear trend at station Bratislava, Mlynská dolina for the period 1983-2005

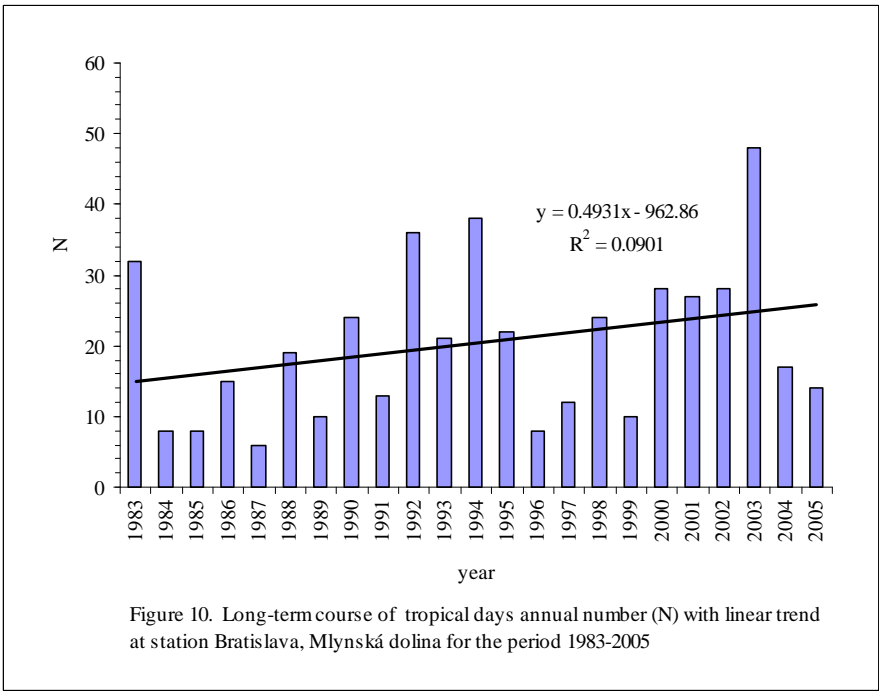


Figure 10. Long-term course of tropical days annual number (N) with linear trend at station Bratislava, Mlynská dolina for the period 1983-2005

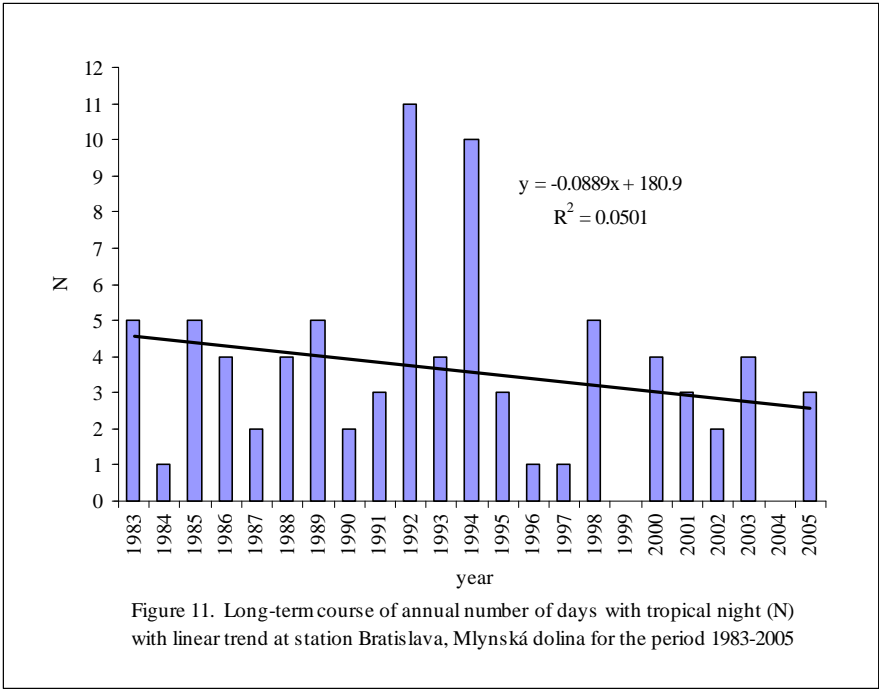


Figure 11. Long-term course of annual number of days with tropical night (N) with linear trend at station Bratislava, Mlynská dolina for the period 1983-2005

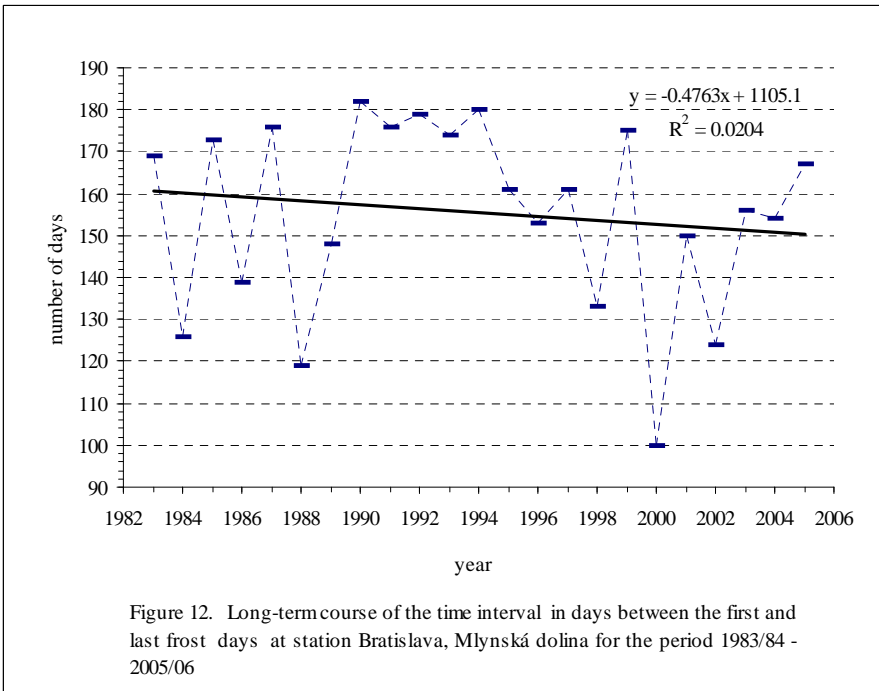
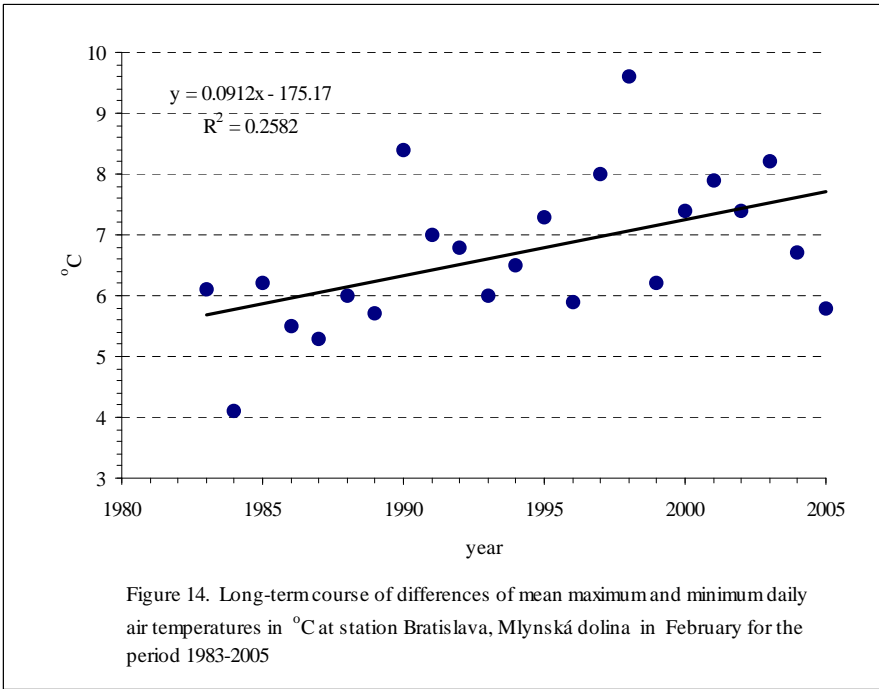
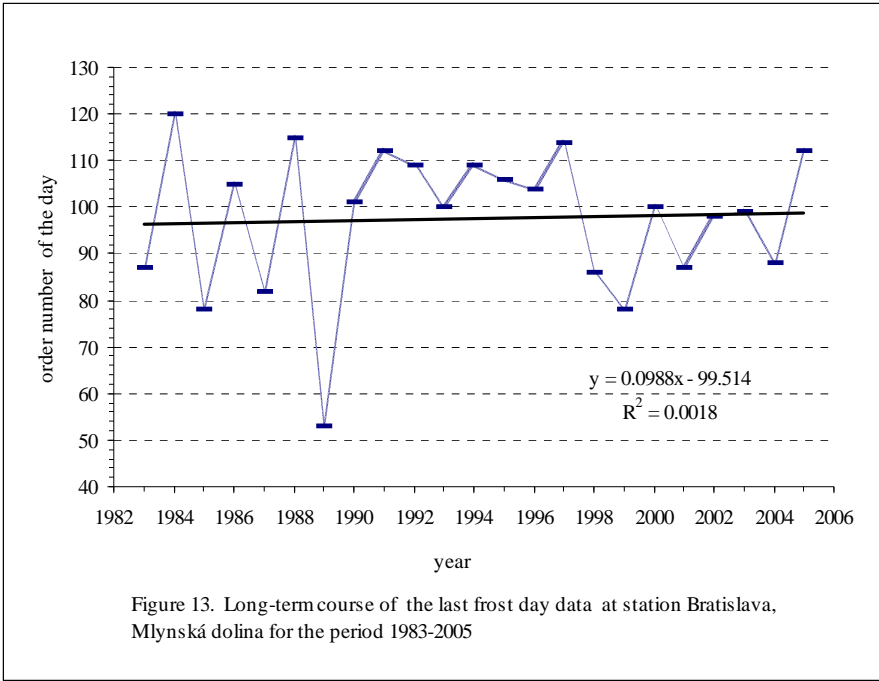
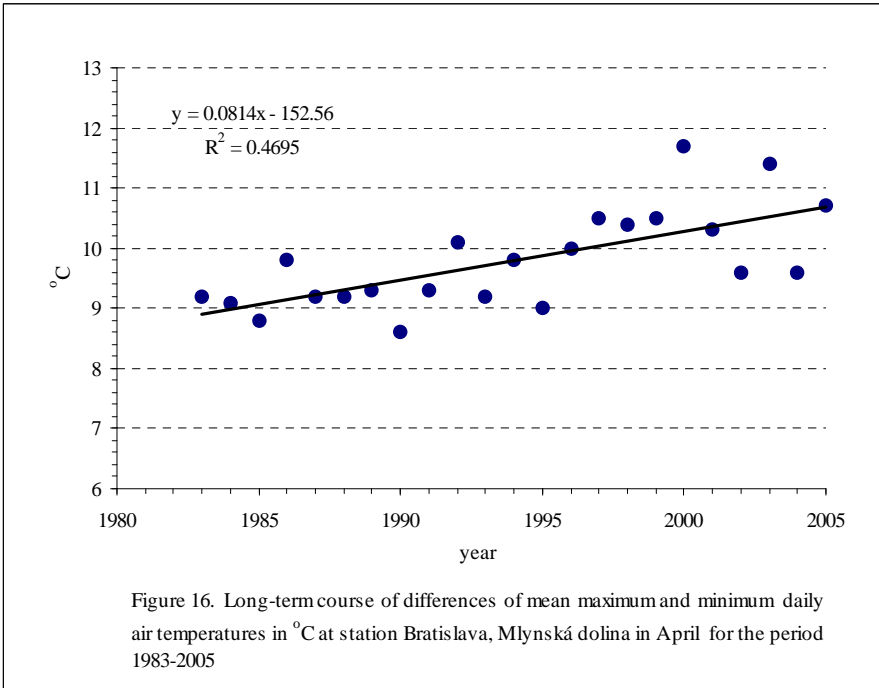
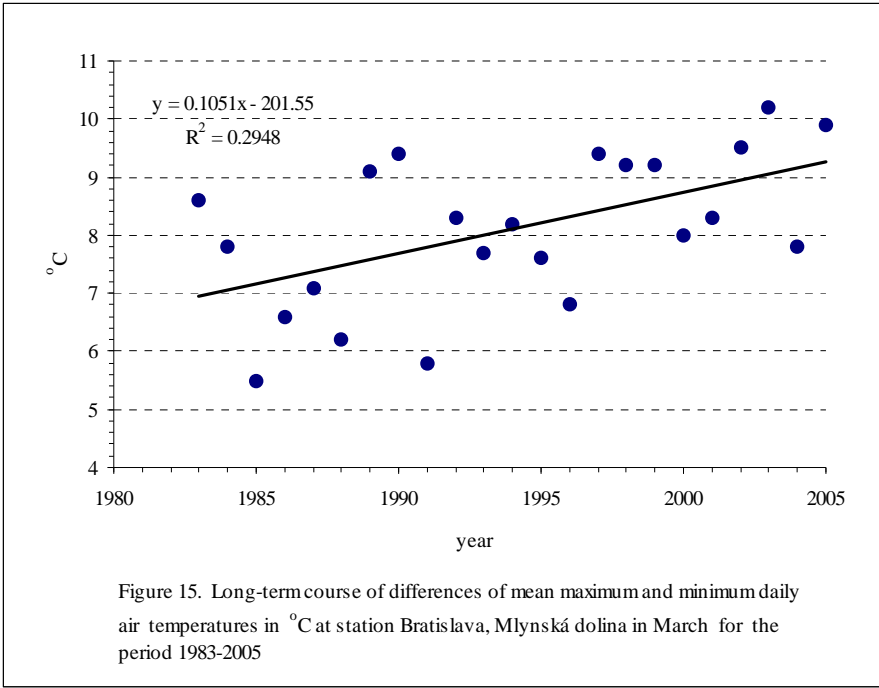
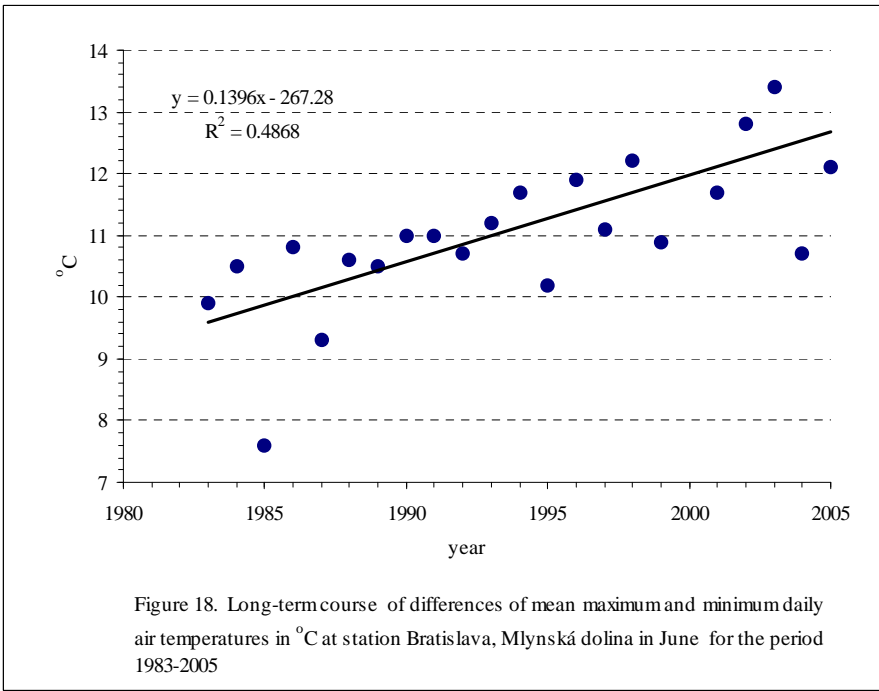
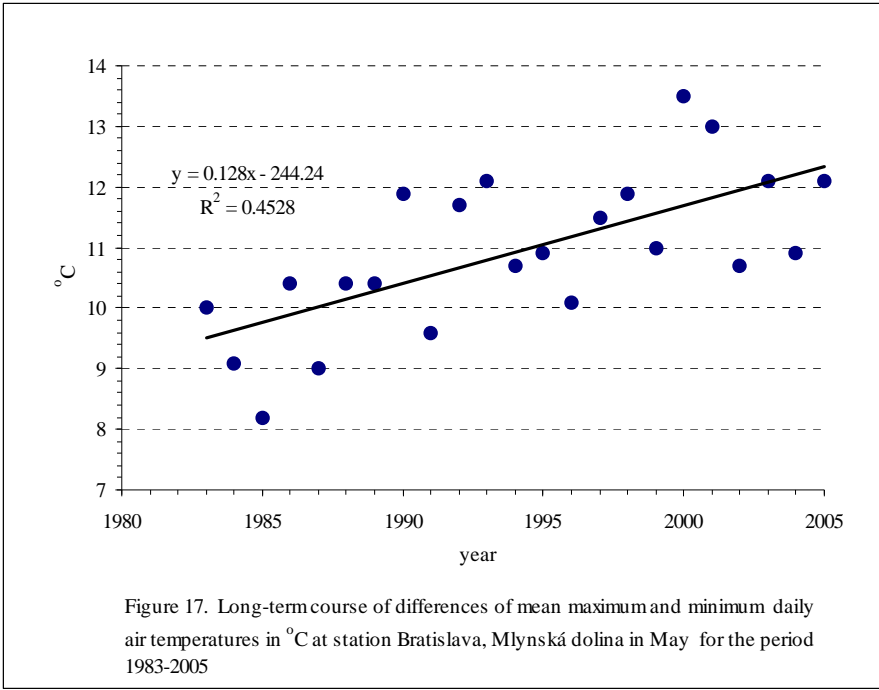


Figure 12. Long-term course of the time interval in days between the first and last frost days at station Bratislava, Mlynská dolina for the period 1983/84 - 2005/06







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