

## SUMMER AIR TEMPERATURES IN LJUBLJANA (SLOVENIA) AND OLOMOUC (CZECH REPUBLIC) IN THE PERIOD 1961–2000

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### Abstract

The paper analyses daily maximum temperatures in Ljubljana, Slovenia, and Olomouc, Czech Republic, in the summer months 1961–2000 in order to validate the assumption on global warming affecting climate in Central Europe. Data on maximum temperatures were processed to reveal trends in temperature variability as well as in the frequency of summer days (days with maximum temperature 25.0°C or higher) and tropical days ( $t_{\max}$  30.0°C or higher).

**Key words:** Olomouc, Ljubljana, summer temperature, summer days, tropical days, period 1961–2000.

## POLETNE TEMPERATURE ZRAKA V LJUBLJANI (SLOVENIJA) IN OLOMOUCU (ČEŠKA) V OBDOBJU 1961–2000

### Izveček

Članek analizira maksimalne dnevne temperature zraka v Ljubljani in v Olomucu (CZ) za obdobje 1961-1990. Potrditi skuša domnevo o vplivu globalnega ogrevanja ozračja na temperature v Srednji Evropi. Obdelani podatki prikazujejo trende temperaturne spremenljivosti, kot tudi pogostnost toplih ( $T_{\max} \geq 25,0$  °C) in vročih dni ( $T_{\max} \geq 30$  °C).

**Ključne besede:** Olomouc, Ljubljana, poletne temperature, topli dnevi, vroči dnevi, obdobje 1961-1990.

## I. INTRODUCTION, DATA, AND METHODS

Validating the hypothesis on global warming of the Earth and its accelerating in the last decades of the twentieth century has become a frequent objective in recent climatological research (Climate Change 2001, IPCC). Vast majority of studies relative to this issue document rise in levels of summer air temperatures. These changes may also already affect climate in Central Europe.

In order to either verify or cast doubt on the assumption, we carried out an analysis of the summer temperature time series recorded in two Central European cities: Ljubljana (SI, Ljubljanska kotlina – Ljubljana Basin) and Olomouc (CZ, Hornomoravský úval – Upper Moravia Valley). Considering geographical location of the cities, a generally warmer climate is expected in Ljubljana compared to Olomouc. Outputs of the temperature analysis prove these expectations relevant. Nevertheless, in case of a global rise in temperatures, long-term variability curves as well as the trend curves shall follow a similar pattern both for Ljubljana and Olomouc.

The paper describes temporal variability in course and levels of maximum daily air temperatures and their monthly averages in the two Central European cities. Considering appropriate meteorological data availability, a reference period 1961–2000 was chosen to set the timeframe of the analysis.

Maximum daily air temperatures were taken from records of two weather stations: the first being SHI Ljubljana-Bežigrad, Vojkova cesta, located 46°3'57"N, 14° 38'28"E, 299 m a. s. l. and operational since 1851 on, the second being CHMI Olomouc-Slavonín (astronomical observatory), located 49°34'10"N, 17°13'01"E, 259 m a. s. l. and operational in 1961–2000. The time series are representative and homogenous, thus suitable as data inputs for the study.

Daily maximum air temperatures were analysed for the summer months of June, July, and August, and for the four distinct decades between 1961–2000 as well. The main goal was to describe temporal changes in course of temperature not only for either of the two stations, but also to detect the level of correlation in records of the stations. This objective had determined the choice of statistical methods.

The study analyses the course and levels of daily maximum temperatures and their monthly averages. Such data are commonly used to define particular characteristic days. In this paper, frequencies of *summer days* and *tropical days* are analysed.

Outputs were derived for the forty-year period as a whole, as well as for each of the four decades, providing an inter-decade comparison and comparing each of the decades to the entire forty-year period.

Following basic statistical characteristics were derived: mean, extremes, range, variance, standard deviation, and frequency. In accordance with Nosek (1972), a quartile deviation of the normal distribution, called the *probable error* ( $c$ ), is used to categorise temperature records within their normal distribution (mean designated  $\mu$ , standard deviation  $\sigma$ ):

$$c = 0.6745 \sigma$$

temperature range	category
less or equal to $\mu - 3c$	extremely subnormal
$\mu - 3c$ to $\mu - 2c$	very subnormal
$\mu - 2c$ to $\mu - c$	subnormal
$\mu - c$ to $\mu + c$	normal
$\mu + c$ to $\mu + 2c$	supernormal
$\mu + 2c$ to $\mu + 3c$	very supernormal
$\mu + 3c$ and more	extremely supernormal

Plots of the data outputs include course of 5-year running mean, departures from mean, cumulative departures from mean, and the 3<sup>rd</sup> order polynomial trend.

The course of summer temperatures, as well as the frequency of summer and tropical days, were analysed for each summer month, summer season, the period 1961–2000 as a whole and each of the four decades, following a uniform pattern:

- monthly averages of daily maximum temperatures (June, July, August, and summer season)
- number of summer days and tropical days
- course of cumulative departures from mean
- course of 5-year running mean
- course of 3<sup>rd</sup> order polynomial trend

The description of results, presented lower, points out only the significant changes and trends.

## 2. MONTHLY AND SEASONAL AVERAGES OF DAILY MEAN AND MAXIMUM AIR TEMPERATURES, VARIABILITY AND TRENDS 1961–2000

Monthly and seasonal averages of daily mean temperatures and daily maximum temperatures are presented for the period 1961–2000 and each of the four decades in Tables 2.1 and 2.2. Departures from mean are plotted in Figures 2.1 and 2.2, respectively.

The summer average of *mean daily temperature* in Ljubljana shows generally higher levels compared to Olomouc (the difference being around 0.7–1.7°C). Nevertheless, the 5-year running mean follows a similar trend in both stations. The decade 1991–2000 appears as the warmest, the decade 1971–1980 as the coldest. In 1992, Olomouc experienced an exceptionally hot summer, with departure from mean reaching almost 4°C – apparently different from the Ljubljana value. A similar non-paired peak appeared in 1983. It may be best explained by the higher degree of continentality in Olomouc, which can result in more extremal heat waves, as opposed to the moderating effect of the Adriatic Sea on the climate in Ljubljana. Although the 5-year running mean reveals general rise in the course of average summer temperature, a trend common in both cities, the cooling in the decade 1971–1990 was more pronounced in Ljubljana. In the 1990s, Olomouc experienced some cooling

in the latter half of the decade, while the departures from mean in Ljubljana remained even then strongly positive.

Table 2.1. Monthly and seasonal averages of daily mean air temperatures (°C), Ljubljana and Olomouc 1961–2000.

Period	Ljubljana				Olomouc			
	June	July	August	JJA	June	July	August	JJA
1961–1970	18.3	19.7	18.8	18.9	17.4	18.3	17.2	17.6
1971–1980	17.7	19.4	18.8	18.6	17.0	18.2	18.0	17.7
1981–1990	17.7	20.7	19.6	19.3	16.9	19.3	18.7	18.3
1991–2000	19.2	21.0	21.0	20.4	17.5	19.5	19.5	18.8
<b>1961–2000</b>	<b>18.2</b>	<b>20.2</b>	<b>19.6</b>	<b>19.3</b>	<b>17.2</b>	<b>18.8</b>	<b>18.3</b>	<b>18.1</b>
Tmax	20.9	22.8	23.7	21.3	19.5	22.5	24.4	21.9
Year	1992	1994	1992	1992	1992	1994	1992	1992
Tmin	16.0	17.8	16.2	17.4	14.8	16.2	15.9	16.1
Year	1985	1978	1961	1978	1985	1978	1961	1978
Range	4.8	5.0	7.5	3.9	4.7	6.3	8.5	5.8

Table 2.2. Monthly and seasonal averages of daily maximum air temperatures (°C), Ljubljana and Olomouc 1961–2000.

Period	Ljubljana				Olomouc			
	June	July	August	JJA	June	July	August	JJA
1961–1970	24.0	25.9	25.1	25.0	21.8	24.0	23.3	23.0
1971–1980	23.5	25.6	25.0	24.7	22.4	23.8	24.0	23.4
1981–1990	23.3	26.8	26.0	25.4	22.2	24.9	24.6	23.9
1991–2000	24.8	27.0	27.4	26.4	23.0	25.0	25.0	24.3
<b>1961–2000</b>	<b>23.9</b>	<b>26.3</b>	<b>25.9</b>	<b>25.4</b>	<b>22.4</b>	<b>24.6</b>	<b>24.5</b>	<b>23.8</b>
Tmax	27.1	30.2	31.5	27.6	25.3	29.5	30.6	27.5
Year	1992	1983	1992	1994	2000	1994	1992	1992
Tmin	21.8	23.9	21.9	23.6	13.6	21.4	21.6	20.2
Year	1985	1978	1961	1978	1970	1980	1987	1970
Range	5.4	6.3	9.6	4.0	11.7	8.1	9.0	7.2

The *mean maximum temperature* in Ljubljana reached higher levels compared to Olomouc (the difference ranging between 1.0–2.2°C, see Table 2.2). As in the case of mean daily temperatures, the 5-year running mean followed a similar, generally rising trend at both stations, with the decade 1991–2000 being the warmest. While in the period 1965–1980 correlation between the trends in Ljubljana and Olomouc varied, the following rise in mean maximum temperatures appears as strongly correlated. A larger-scale climatic event may be

Figure 2.1 Departures from Mean of Average Summer (JJA) Temperatures, Ljubljana and Olomouc 1961–2000.

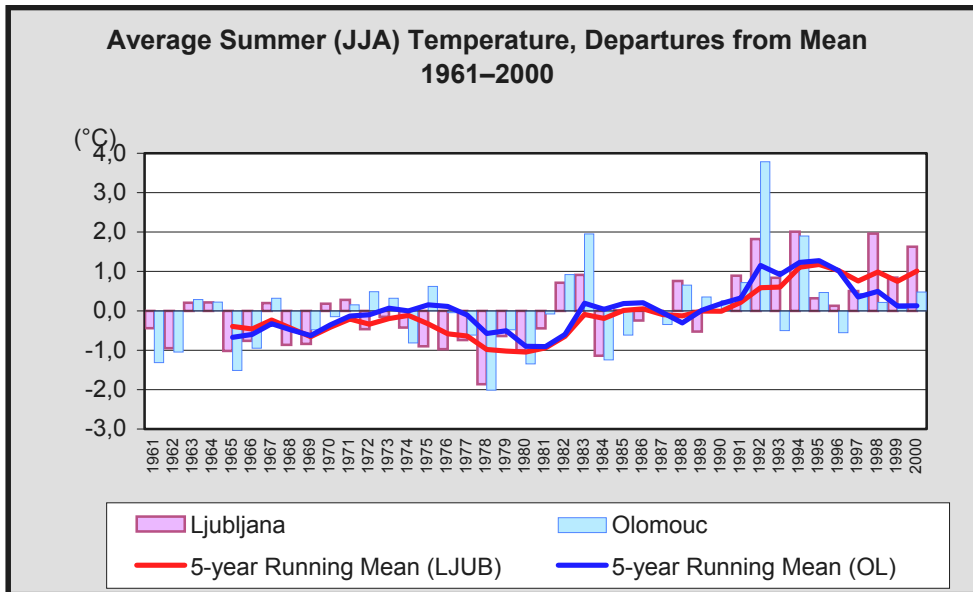
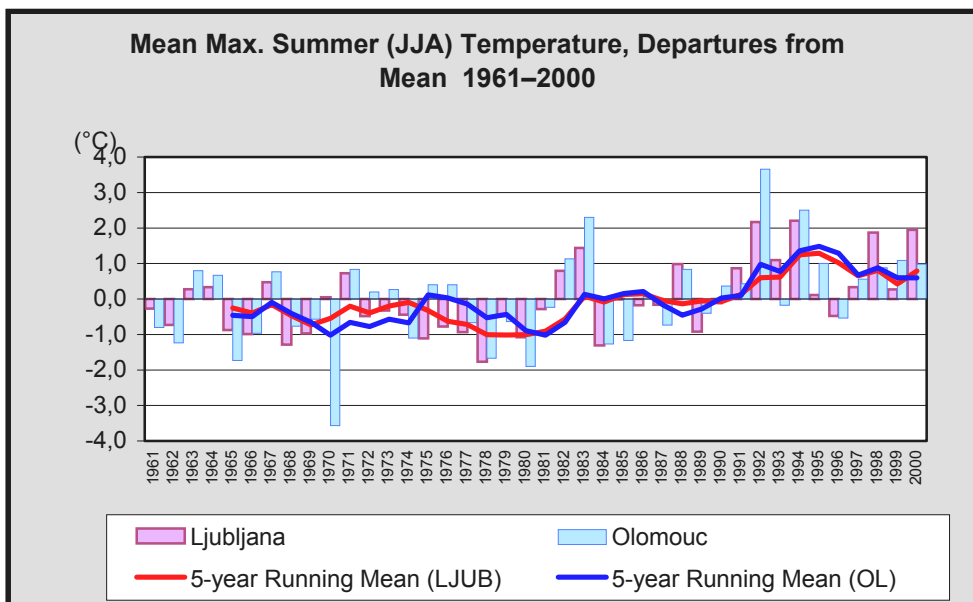


Figure 2.2. Departures from Mean of Mean Maximum Summer (JJA) Temperatures, Ljubljana and Olomouc 1961–2000.



overruling the local variations in maximum temperature trends, however a longer time series analysis is necessary to confirm the assumption.

Comparing averages of both mean and maximum daily temperatures, June was the coldest of the three summer months, and July the warmest. Considering the hottest months in the analysed period, all of them appeared after year 1991, except for the hottest mean maximum July 1983, while the lowest values occurred before 1991 in all cases. The highest mean monthly temperature as well as the highest monthly mean maximum temperature occurred in August 1992 both in Ljubljana (23.7°C mean, 31.5°C mean max.) and Olomouc (24.4°C mean, 30.6°C mean max.).

Using criteria of normality for the mean maximum temperatures of the summer seasons, subnormal and supernormal summer seasons were sorted out – see Table 2.3 (seasons common for both cities in bold type).

*Table 2.3. Subnormal and supernormal summer seasons according to the mean maximum temperature, Ljubljana and Olomouc 1961–2000.*

category of normality	Ljubljana	Olomouc
extremely subnormal	–	1970
very subnormal	1978	1980
subnormal	<b>1962, 1965, 1966</b> , 1968, 1969, 1975, 1976, 1977, 1980, <b>1984</b> , 1989	<b>1962, 1965, 1966</b> , 1974, 1978, <b>1984</b> , 1985
supernormal	1971, <b>1982</b> , 1988, 1991, 1993	<b>1982</b> , 1995, 1999, 2000
very supernormal	<b>1983</b> , 1998, 2000	<b>1983</b> , 1994
extremely supernormal	<b>1992</b> , 1994	<b>1992</b>

### 3. SUMMER DAYS ( $T_{D,MAX} \geq 25.0^{\circ}C$ ), VARIABILITY AND TRENDS IN 1961–2000

Summer days, defined as days with the maximum temperature of 25.0°C and higher, occur not only in the summer months of June, July and August, but commonly during the spring and autumn season as well, as shown in Table 3.1. However, this study takes into account only the three months of climatological summer season. Temporal variability in the occurrence of summer days is illustrated in Fig. 3.1.

A generally warmer climate of Ljubljana projects into higher totals of summer days compared to Olomouc. At both stations the highest rate of summer days occurred in July, followed by August, yet the contribution of June was also significant. Although there was a slight decrease in the total number of June summer days in the period 1961–1990, sharp increase in the following decade led to exceeding the sums of 1961–1970. For July and August, the totals were rising continuously at both stations. Considering the maximum potential sums for a single decade (July 310, August 310), the rise was strong. For the decades 1961–1970 and 1990–2000 respectively, the July sums increased from 60% to 73% of the maximum in Ljubljana, and from 34% to 56% in Olomouc. August sums increased from 50% to 71% in Ljubljana, and from 27% to 59% in Olomouc. In June (the maximum poten-

tial sum for a decade is 300), the levels rose moderately from 44 % to 50% in Ljubljana, and from 29% to 36% in Olomouc.

Figure 3.1. Number of Summer Days in Summer (JJA), Departures from Mean, Ljubljana and Olomouc 1961–2000.

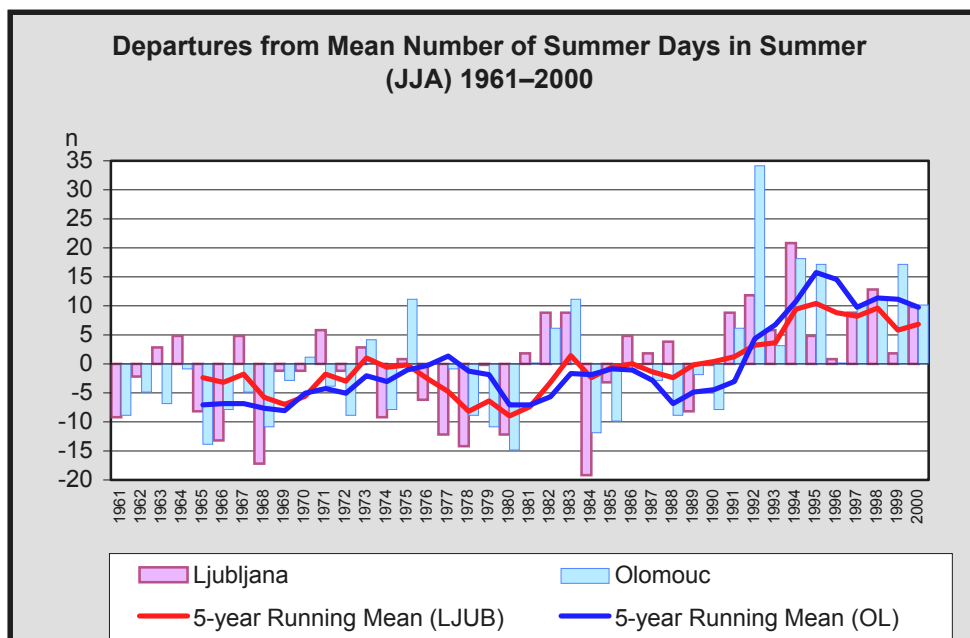


Table 3.1. Summer days ( $s_d$ ), Ljubljana and Olomouc 1961–2000.

Period		April		May		June		July		August	
		L	O	L	O	L	O	L	O	L	O
Total	1961–1970	17	14	33	30	132	87	186	106	154	85
	1971–1980	1	1	49	41	126	87	185	103	155	108
	1981–1990	0	5	60	51	108	75	213	120	190	117
	1991–2000	6	11	78	63	150	108	228	175	220	183
	<b>1961–2000</b>	<b>24</b>	<b>31</b>	<b>220</b>	<b>185</b>	<b>516</b>	<b>357</b>	<b>812</b>	<b>504</b>	<b>719</b>	<b>493</b>
Average	1961–1970	1.7	1.4	3.3	3.0	13.2	8.7	18.6	10.6	15.4	8.5
	1971–1980	0.1	0.1	4.9	4.1	12.6	8.7	18.5	10.3	15.5	10.8
	1981–1990	0.0	0.5	6.0	5.1	10.8	7.5	21.3	12.0	19.0	11.7
	1991–2000	0.6	1.1	7.8	6.3	15.0	10.8	22.8	17.5	22.0	18.3
	<b>1961–2000</b>	<b>0.6</b>	<b>0.8</b>	<b>5.5</b>	<b>4.6</b>	<b>12.9</b>	<b>8.9</b>	<b>20.3</b>	<b>12.6</b>	<b>18.0</b>	<b>12.3</b>
$s_{d,max}$		6	7	16	12	22	16	30	26	28	30
Year		1962, 1968	1962	1986	1971	1979	2000	1983	1994, 1995	1992	1992

Period		September		October		Total		Total JJA	
		L	O	L	O	L	O	L	O
Total	1961–1970	65	37	4	2	591	361	472	278
	1971–1980	53	38	2	0	571	378	466	298
	1981–1990	72	47	3	0	646	415	511	312
	1991–2000	66	35	0	0	748	575	598	466
	<b>1961–2000</b>	<b>256</b>	<b>157</b>	<b>9</b>	<b>2</b>	<b>2556</b>	<b>1729</b>	<b>2047</b>	<b>1354</b>
Average	1961–1970	6.5	0.3	0.4	0.2	59.1	36.1	47.2	27.8
	1971–1980	5.3	3.8	0.2	0.0	57.1	37.8	46.6	29.8
	1981–1990	7.2	4.7	0.3	0.0	64.6	41.5	51.1	31.2
	1991–2000	6.6	3.5	0.0	0.0	74.8	57.5	59.8	46.6
	<b>1961–2000</b>	<b>6.4</b>	<b>3.9</b>	<b>0.2</b>	<b>0.1</b>	<b>63.9</b>	<b>43.2</b>	<b>51.2</b>	<b>33.9</b>
S <sub>d,max</sub>		17	16	2	2	91	71	72	68
Year		1987	1982	1970, 1985	1966	1994	1992	1994	1992

Table 4.1. Tropical days ( $tr_d$ ), Ljubljana and Olomouc 1961–2000.

Period		May		June		July		August	
		L	O	L	O	L	O	L	O
Total	1961–1970	3	1	25	19	45	34	38	19
	1971–1980	1	0	8	10	33	28	38	29
	1981–1990	0	0	10	11	61	41	51	40
	1991–2000	1	3	35	18	67	51	91	60
	<b>1961–2000</b>	<b>5</b>	<b>4</b>	<b>78</b>	<b>58</b>	<b>206</b>	<b>154</b>	<b>218</b>	<b>148</b>
Average	1961–1970	0.3	0.1	2.5	1.9	4.5	3.4	3.8	1.9
	1971–1980	0.1	0.0	0.8	1.0	3.3	2.8	3.8	2.9
	1981–1990	0.0	0.0	1.0	1.1	6.1	4.1	5.1	4.0
	1991–2000	0.0	0.3	3.5	1.8	6.7	5.1	9.1	6.0
	<b>1961–2000</b>	<b>0.1</b>	<b>0.1</b>	<b>2.0</b>	<b>1.5</b>	<b>5.2</b>	<b>3.9</b>	<b>5.5</b>	<b>3.7</b>
tr <sub>d,max</sub>		3	2	10	7	15	18	21	18
Year		1986	1993	1998	2000	1983	1994	1992	1992

Period		September		Total		Total JJA	
		L	O	L	O	L	O
Total	1961–1970	2	0	113	73	108	72
	1971–1980	6	3	86	70	79	67
	1981–1990	1	0	123	92	122	92
	1991–2000	1	0	195	132	193	129
	<b>1961–2000</b>	<b>10</b>	<b>3</b>	<b>517</b>	<b>367</b>	<b>502</b>	<b>360</b>

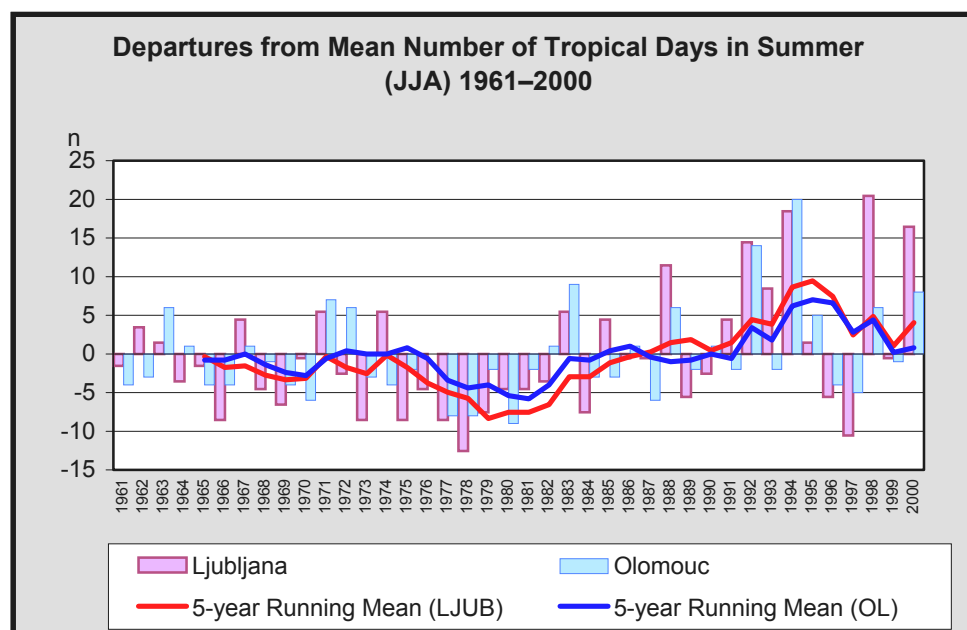


Period		September		Total		Total JJA	
		L	O	L	O	L	O
Average	1961–1970	0.2	0.0	11.3	7.3	10.8	7.2
	1971–1980	0.6	0.3	8.6	7.0	7.9	2.2
	1981–1990	0.1	0.0	12.3	9.2	12.0	3.1
	1991–2000	0.0	0.0	19.5	13.2	19.3	17.5
	<b>1961–2000</b>	<b>0.3</b>	<b>0.1</b>	<b>12.9</b>	<b>9.2</b>	<b>12.6</b>	<b>9.0</b>
tr <sub>d,max</sub>		5	3	33	29	33	29
Year		1987	1973	1994	1994	1994	1994

#### 4. TROPICAL DAYS ( $T_{D,MAX} \geq 30.0^{\circ}C$ ), VARIABILITY AND TRENDS IN 1961–2000

Tropical days, defined as days with the maximum temperature of  $30.0^{\circ}C$  and higher, are quite rare to occur in Central Europe in months other than June, July or August. Table 4.1 gives their frequency also for May and September, yet the levels are close to zero. Temporal variability in the occurrence of tropical days during the climatological summer season is illustrated in Fig. 4.1.

Figure 4.1. Number of Tropical Days in Summer (JJA), Departures from Mean, Ljubljana and Olomouc 1961–2000.



Comparing the sums of tropical days in Ljubljana and Olomouc, the ratio (Olomouc counts for 71% of the Ljubljana total) appears similar to that of the summer days (Olomouc reaches 68% of the Ljubljana total). Also the trends follow patterns similar to those marking rise in the frequency of summer days. However, increase in the number of tropical in August is by far the sharpest: totals for the decade 1991–2000 represent 239% and 315% of those for the decade 1961–1970 in Ljubljana and Olomouc respectively. August sums also overrun those of July in the last decade of the 20<sup>th</sup> century.

## 5. TEN HOTTEST SUMMER SEASONS IN LJUBLJANA AND OLOMOUC IN 1961–2000

Meteorological records world-wide indicated the last decade of the 20th century to be the hottest so far since the beginning of regular temperature observations (Jones&Moberg, 2003). Ten hottest summer seasons of the 1961–2000 period in Ljubljana and Olomouc are listed in Table 5.1.

Table 5.1. Ten hottest summer seasons, Olomouc and Ljubljana 1961–2000.

Ljubljana				Olomouc							
Year	JJA		monthly mean (°C)			Year	JJA		monthly mean (°C)		
	(°C)	c.n.	June	July	Aug		(°C)	c.n.	June	July	Aug
<b>1994</b>	21.3	exsn	19.3	22.5	22.1	<b>1992</b>	21.9	exsn	19.5	21.8	24.4
<b>1998</b>	21.3	exsn	20.7	21.5	21.6	<b>1983</b>	20.1	vsn	17.9	22.2	20.1
<b>1992</b>	21.1	vsn	18.5	21.2	23.7	<b>1994</b>	20.0	vsn	17.4	22.5	20.2
<b>2000</b>	20.9	vsn	20.9	19.9	22.1	<b>1982</b>	19.0	sn	18.1	19.9	19.1
<b>1983</b>	20.2	sn	18.4	22.6	19.7	<b>1991</b>	18.8	n	16.5	20.9	19.1
<b>1991</b>	20.2	sn	18.2	21.8	20.6	<b>1988</b>	18.8	n	17.4	19.9	19.0
<b>1999</b>	20.2	sn	19.1	20.9	20.5	<b>1975</b>	18.7	n	17.1	19.7	19.4
<b>1993</b>	20.2	sn	19.2	20.4	20.9	<b>1972</b>	18.6	n	17.8	20.3	17.7
<b>1988</b>	20.1	sn	17.4	22.0	20.8	<b>2000</b>	18.6	n	18.8	16.9	20.0
<b>1982</b>	20.0	sn	19.0	21.2	19.9	<b>1995</b>	18.6	n	16.2	21.3	18.3

Abbreviations: *c.n.* – category of normality; *n* – normal; *sn* – supernormal; *vsn* – very supernormal; *exsn* – extremely supernormal

Distribution of the seasons appears to be strongly inclined towards the latter decades of the studied period. In 1991–2000 seven of the ten hottest seasons occurred in Ljubljana, and five in Olomouc. In 1981–1990 three of the season occurred in Ljubljana, and three in Olomouc as well, the remaining two for Olomouc during the 1970s.

Seven of the seasons are listed both for Ljubljana and Olomouc. In Ljubljana, July was the peak month in six cases, while August in 1992, 1993, 1998, and 2000. In Olomouc,

August 1992 and 2000 were the peak months, July at the other eight cases. Extremity of the hottest seasons revealed to be more pronounced in Ljubljana, all the ten summers being categorized supernormal to extremely supernormal. In Olomouc, six of the seasons were listed from the normal range of mean summer temperature.

## 6. DISCUSSION

The performed analysis of the forty-year time series of meteorological records in Ljubljana (SI) and Olomouc (CZ) revealed that:

- the course of mean and mean maximum temperatures for the summer season (JJA) followed a similar pattern,
- the differences require to be studied in detail in order to describe their nature; most likely they reflect the specific local conditions in the climate of the two sites.

Outputs of the analysed temperature variability features verified the following:

- overall increase in mean monthly temperatures, as well as in the monthly means of daily maximum temperatures,
- a rather stagnating trend in temperature levels in 1961–1970, and 1971–1980, followed by an increasing trend during the 1981–1990 period and a sound rise in the decade 1991–2000,
- the rise in maximum temperature levels leading to a consequent increase in number of both summer and tropical days, especially in the decade 1991–2000,
- comparing the three summer months, June contributed less to the overall rise than July and August; in Olomouc, August increase appeared to be even more pronounced than the July trend, considering temperature levels as well as occurrence of both summer and tropical days.

In order to broaden evidence on the rising trend in temperature, a subsequent study should carry out an analysis of the correlation between temperature and other meteorological elements, such as sunshine, intensity of solar radiation, albedo, and cloudiness. It is essential to reveal possible causes of excessive warming during the summer season depending on long-term fluctuations in atmospheric circulation over Central Europe

## 7. CONCLUSION

The analysis of mean and maximum summer temperatures in Ljubljana and Olomouc in the period 1961–2000 verified that the rise in surface air temperature, recorded and described by scientists on a global scale, reflects also in the local temperature patterns of the two cities. After years of interim stagnation, decades 1981–1990 and 1991–2000 brought a new rise in temperature levels.

Analogical studies may be performed using input data from other Central European stations in order to extend knowledge about temperature oscillations and possible warming of the climatic system, this way supplementing the global monitoring projects currently

performed. The outputs of the analysis may also serve as the ground for further research of temperature variability, e. g. analysing occurrence of heat waves (Kyselý 2003).

A common view of the problem points out anthropogenic factor as the main contributor to the recent climatic change. In order to reveal the nature and source of the global environmental processes, regional and local studies should detect the various impacts of human activity and its possible relation to altered meteorological patterns.

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## POLETNE TEMPERATURE ZRAKA V LJUBLJANI (SLOVENIJA) IN OLOMOUCU (ČEŠKA) V OBDOBJU 1961–2000

### Povzetek

Preučevanje trendov klimatskih parametrov je ob koncu 20. stoletja dobilo novo nalogo in sicer potrditi ali ovreči trditve o globalnem segrevanju ozračja. V predstavljeni raziskavi je bila uporabljena metoda statističnega raziskovanja temperature zraka in karakterističnih dni (poletni, topli in tropski, vroči dnevi) na primeru dveh srednjeevropskih mest, Ljubljane (SI) in Olomouca (CZ). Analizirano je bilo obdobje 1961-2000 in sicer poletni meseci junij, julij in avgust.

Srednje poletne temperature so v Ljubljani nekoliko višje od temperatur v Olomouci (za 0.7 do 1.7 °C), na obeh postajah pa je opazen zelo podoben trend naraščanja. Proti koncu obravnavanega obdobja je opazno tudi naraščanje števila poletnih dni, čeprav niso bili analizirani vsi poletni dnevi, saj se ti pojavljajo tudi izven obravnavanih mesecev.

Pojav tropski (vročih) dni je skoraj izključno vezan na poletne mesece, saj se izven poletja pojavi le kak vroči dan vsakih nekaj let. Analiza števila tropskih dni je pokazala

podobne rezultate kot pri poletnih dnevih. Tudi tu je opazen naraščajoč trend, z razliko, da je odstopanje števila tropskih dni v avgustu od dolgoletnega povprečja v zadnji obravnavani dekadi daleč največje. Tako je število tropskih dni v avgustu v obdobju 1991-2000, glede na obdobje 1961-1970, v Ljubljani narastlo za 239 %, v Olomoucu pa za 315 %.

Koncentracija najtoplejših poletij v obdobju 1961-2000 je močno pomaknjena k zadnji dekadi. V Ljubljani je bilo v tej dekadi 7 od 10 najtoplejših poletij, v Olomoucu pa 5. V Ljubljani so bila vsa najtoplejša poletja obdobja skoncentrirana v zadnjih dveh dekadah, v Olomoucu pa sta bili dve najtoplejši poletji v dekadi 1971-1980, vsa ostala pa kasneje. Raziskava je pri vseh parametrih pokazala naraščanje poletnih temperatur, ki se je začelo v osemdesetih letih in močno okrepilo v devetdesetih letih prejšnjega stoletja. Med tremi poletnimi meseci je v obeh mestih opazen najšibkejši trend naraščanja junijskih temperatur, v Olomoucu je izrazitejše naraščanje avgustovskih temperatur, manj julijskih, podobno je pri Ljubljani.

Analiza je potrdila globalni dvig temperature na lokalnem nivoju dveh mest. Prevladuje mnenje, da so klimatske spremembe posledica človekovega vpliva. Da bi odkrili naravo globalnih okoljskih procesov, moramo izvajati lokalne raziskave, ki bodo preučile številne učinke človekovega delovanja in njihovo povezavo s podnebnimi spremembami.