SUMMER HEAT EPISODES IN THE CZECH REPUBLIC AND THE REPUBLIC OF MOLDOVA: A COMPARATIVE ANALYSIS

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Introduction

Many research activities during the 20th century have focused on extreme climate phenomena, including heat waves, because of their influences on ecosystems and human society (agriculture, water resources, energy demand and human mortality). One reason for the enhanced interest in the warm temperature extremes stems from a concern that the frequency and severity of such events, especially across Europe, have increased recently, and that this trend is likely to continue due to global warming [11,12,18]. The impact of extreme events is more serious when the extreme weather conditions prevail over extended periods. Moreover, unusually warm summers, observed increasingly frequently in various regions of the world in the recent years, indicate that such a «hot future» is not so far [2]. A classic example is an extremely hot summer of 2003 in Western Europe that caused thousands of excess deaths and enormous economic damage in many countries, including the developed ones. The 2006 European heat wave was also a period of exceptionally hot weather that arrived at the end of June, 2006 in certain European countries and was clearly located more northward of Europe than in the summer of 2003. The regions such as Northern France, Germany, Belgium, and the Czech Republic, which were strongly exposed to the 2003 heat wave, were affected by an even more extreme heat wave in the July of 2006, in terms of absolute mean monthly values. Much less studied is the summer heat of 2007 in South-Eastern Europe that affected a lot of countries, including Italy, Greece, Hungary, Romania, Bulgaria, Moldova and others.

In this paper, we present the results of two research goals: *(1)* a comparative assessment of the extremely hot summer of 2006 in the Czech Republic (CR) and of 2007 in the Republic of Moldova (RM) as climatic phenomenon and *(2)* identification of heat episodes (tropical days and heat waves) in these countries during 1961-2009 as evidence of changing climate.

Material and methods

This paper analyses a 49-yr (1961-2009) time series of daily temperatures (maximum, minimum, and mean daily temperature) in the Republic of Moldova and the Czech Republic. The data series of daily air temperature in summer season (June-July-August) were available for the Czech Republic from the Czech Hydrometeorological Institute and for Republic of Moldova from the Hydrometeorology data service system CliWare of the All-Russian Research Institute of Hydrometeorological Information [22]. There are no missing values in the datasets over the period of June to August. Available datasets consist of measurements at two selected weather stations in both

countries. The observations for Moldova were taken from the Chisinau weather station (φ=46°58'03''N, λ=28°51'23''E, h=173 m). Because of the small size of RM (33,846 km^2), the relatively homogeneous terrain, and the location of Chisinau near its geographic centre, the research results could be considered as representative of the whole country. The methodology for the Czech Republic were applied on the Czech study area located in the middle part of Polabí (*Elbeland*) lowland, where one of the largest farming regions is situated, specialized in growing marketing vegetable crops. The observations were taken at the Hradec Králové (φ=50°10'N, λ=15°50'E, h=278 m) weather station. In addition, the data records of 90 weather stations over the Czech Republic and 15 weather stations over the Republic of Moldova were used to examine spatial distribution of temperature anomalies.

Assessment of the extremely hot summers both in the Czech Republic and the Republic of Moldova is based on long-term series analysis, considering the criterion of an extreme, adopted by IPCC [12]. Due to the fact that the identification of heat waves for a given region requires a specific approach and therefore there is no single definition, as well as for the convenience of comparative assessment, we have decided to use the Serbian approach. Unkašević and Tošić [21] have chosen to define a heat wave by applying heat wave duration index (HWDI) as a maximum period greater than five consecutive days with maximum air temperature (*Tmax*) >5 °C above 1961–1990 and normal daily *Tmax* [12]. The cumulative *Tmax* excess above 30.0 °C ($\Sigma\Delta Tmax>30$) and the temperature peak during heat waves are used to characterize the heat wave severity [13]. Tropical days refer to the days with *Tmax* reaching or exceeding 30.0 °C.

All statistical analyses were carried out with the aid of the Statgraphics Centurion Data Analysis and Statistical Software [17]. The Golden Software Surfer 7.04 and ArcGis Software 9.1 were used for mapping.

Results and discussion

With respect to the studies of the heat waves pattern in the Czech Republic, many climatologists have studied the frequency and severity of this event, e.g. [10,14] over the past decade. Since 1961, the warmest summer seasons occurred in the Czech Republic in 1983, 1992, 1994, 2003, and 2006. In the July of 2006, the most severe heat wave was linked to persistent anticyclonic situations favouring the advection of dry air masses over the Czech Republic. A more recent study [13] shows that the July 2006 heat wave that lasted 33 days, has been the longest and most severe one in Prague since 1775.

In the July of 2006, as in the June and August of 2003, the deviation of the mean temperature from the norm was more than +4.7 °C over the Czech Republic, so this month was the warmest in the summer of 2006 in the Czech Republic (Fig. 1). In the majority stations, beginning with the 5th of July, a maximum temperature was recorded from 27.0 to 33.0 °C, reaching occasionally up to 37.0 °C. ***The highest*** above normal ***temperature deviation*** has occurred at the Milesovka mountain station (833 m.a.s.l), where it was +6.0 °C. Also, the chart from Figure 1a shows that the averaged temperatures exceeded four standard deviations ($\delta T/\sigma = 4.2$) in the case of the normal distribution with respect to the reference period. This distribution shows

that July was an exceptionally hot summer month with a probability in current climate only of 0.3 %. The highest positive deviation from the normal average temperature (+4.7°C) was recorded in July, followed by the autumn months when it reached +2.6 °C in September, +2.1 °C in October, +3.0 °C in November, and +2.7 °C in December. These abnormal temperature distributions continued until the July of 2007. Moreover, an unusual warm weather in the 2006/2007 winter, when this period with a mean air temperature deviation was more than +3.9 °C in comparison with the normal one, accentuated the severe drought event in the spring season [16].

In its turn, the year 2007 was extremely hot across South Eastern Europe, and the warmest in the history of instrumental observations in the Republic of Moldova. Practically all air temperature records were broken in winter, spring and especially in summer, with numerous heat waves and an extreme shortage of precipitation [3]. In the first decade of June, the mean air temperature was +19.9+23.5 ºC (or +2.7+4.3 ºC > normal), *Tmax* in some places exceeded by 0.2-0.4 ºC the absolute records for the 2nd decade. The absolute records for the whole period of observations of mean daily temperatures (+21.5+27.2 ºC) were registered on the 15th to 17th of June. The absolute monthly *Tmax* in Moldova (+39.5ºC at the Făleşti weather station) was recorded on the 26th of June. July was the warmest month for the whole observation period with a mean air temperature deviation of more than +3.7 °C as compared to the normal one. The absolute maximum of daily temperature was observed in Moldova (+41+41.5 ºC) on the 19th to 21st July. The highest daily *Tmin* in Moldova was recorded on the 23rd of July (+26.7 ºC); on the 24th of July, the sum of the accumulated degree-days for a continuous period without precipitation was the highest for all the observations making 15,000 ºC. The absolute temperature maximum for August in Moldova (+40.5 ºC at the Tiraspol weather station) was registered on the 25th of August. The season mean temperature (+21.0+24.7 ºC) exceeded the norm by +2.4+3.8 ºC. The duration of hot days (*Tmax*≥30 °C) during the summer season was 45-60 (by 3-4 times higher than the norm); days with *Tmax* ≥35 °C – 15-22 against one (as a norm); *Tmax* ≥40 °C – 5 days (for the first time).

Moreover, a recent research has also shown that while the summer of 2007 was unusual for the current climate, its temperature regime is very similar to what is projected for the second half of this century [5-7].

In Figure 1b (map), the mean temperature anomalies in July are based upon 1961-1990 means (shaded) and normalized showing the 30-year standard deviation (curves). The chart below shows the curve signifying the normal mean temperature distribution at the Chisinau weather station, while the bold line represents the mean 2007 temperature value. Table1 shows such normalized deviations of three air temperature parameters *(Tmean, Tmax and Tmin)* for every month and summer, on the whole.

As can be observed, all temperature anomalies exceeded their baseline in July by 3-4σ and in summer by up to 5σ (Table 1b). It should be mentioned that in the case of normal distribution, which is characteristic of the averaged temperatures, an anomaly of ≥2σ can occur with a probability of 5%, and ≥3σ of 0.3% (i.e. with respect to our analysis, respectively, five times in 100 years and three times in 1000 years), it is easy to imagine, even speculatively, that the summer of 2007 was rare in the Republic of Moldova. In the Czech Republic, such exceptional period was July – anomalies of

all temperature variables are more than 4σ (Table 1a). Interestingly, both in CR and RM, the greatest exceedance is observed for summer minimum temperatures; in other words, the greatest contribution into the exceptionality of these summers was made by the increase in minimum (or night) temperatures.

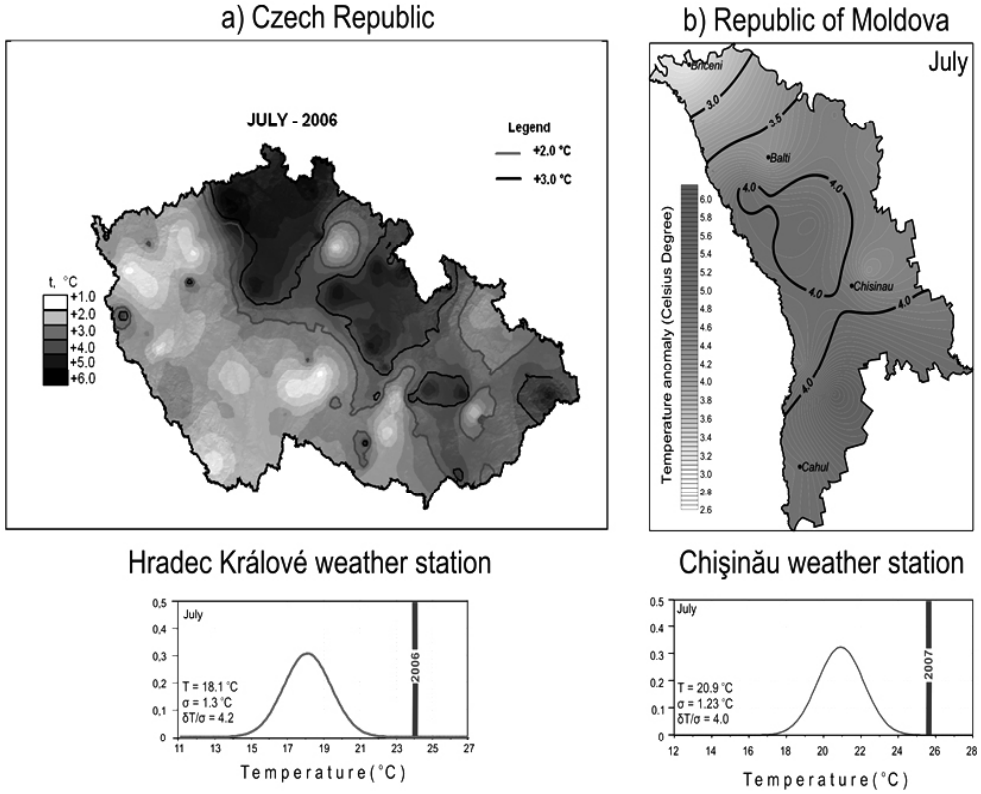

Figure 1. Anomalies of averaged July temperatures in the Czech Republic and Moldova (maps) and averaged summer temperatures at the Hradec Králové and Chişinău weather stations (charts) in 2006 and 2007 on the background of the baseline (1961-1990) temperatures approximated by a normal distribution curve.

Map of Moldova includes isolines of normalized deviations T – the average July temperature; σ –the standard deviation of the reference period; δT/σ – the normalized deviation.

Such anomalies of monthly temperatures resulted from the extremely hot days over the summer (Figure 2b). With few exceptions, the mean, maximum, and minimum temperatures in almost all days and, especially in July and August, were significantly higher (up to 10 ºC and higher) than their baseline norms at the Chişinău weather station. As can be seen from Figure 2a, the 2006 June and July mean, maximum, and minimum temperatures in the Czech Republic were constantly above the normal temperatures with the exception of August.

However, not only the 2007 summer temperatures in Moldova were higher than their mean baseline values, but they are also considered as extremes. In particular, the IPCC Glossary [12, p. 875] defines an extreme weather event as "an event that is rare within its statistical distribution at a particular place". The criteria of «rarity» vary

from place to place and are normally calculated as rare as (or rarer than) 90th percentile values. How extreme were 2006 in the Czech Republic and 2007 in Moldova can be judged by comparing the observed in these years mean, maximum, and minimum temperatures with 90th and 95th percentiles of two different periods – baseline (1961-1990) and current (2000-2009, without 2006 for CR and 2007 for RM as extreme years) climates (Table 2). Despite the fact that the summer climate in Moldova is hotter than in the Czech Republic because of its geographical position, there is a general pattern for the two countries in identifying an extremely hot summer.

Table 1. The 2006 (Hradec Králové, CR, *a*) and 2007 (Chisinau, MD, *b*) summer anomalies in comparison with the baseline [monthly values of mean (Tmean), maximal (TMax), and minimal (Tmin) temperatures].

a – **Hradec Králové, CR**												
Period	**TMean**				**TMax**				**TMin**			
	Mean	**σ**	**2006**	**δT/σ**	**Mean**	**σ**	**2006**	**δT/σ**	**Mean**	**σ**	**2006**	**δT/σ**
June	16.7	1.0	18.5	**1.8**	22.3	1.1	24.4	**1.9**	10.9	0.8	12.4	**1.9**
July	18.1	1.3	23.5	**4.2**	23.8	1.7	30.7	**4.1**	12.3	0.9	16.0	**4.1**
August	17.6	1.0	16.5	**-1.1**	23.6	1.2	21.2	**-2.0**	12.1	0.6	12.5	**0.7**
Summer	*17.5*	*0.6*	19.5	***3.3***	*23.2*	*0.9*	25.4	***2.4***	*11.8*	*0.4*	13.6	***4.5***
b – **Chişinău, RM**												
Period	**TMean**				**TMax**				**TMin**			
	Mean	**σ**	**2007**	**δT/σ**	**Mean**	**σ**	**2007**	**δT/σ**	**Mean**	**σ**	**2007**	**δT/σ**
June	19.4	1.3	23.2	**2.9**	24.5	2.0	28.9	**2.2**	14.4	1.2	17.7	**2.8**
July	20.9	1.2	25.8	**4.1**	26.2	1.7	32.3	**3.6**	16.0	1.2	19.7	**3.1**
August	20.5	1.3	23.9	**2.6**	26.1	1.9	29.3	**1.7**	15.5	1.1	19.1	**3.3**
Summer	*20.3*	*0.8*	*24.3*	***5.0***	*25.6*	*1.2*	*30.2*	***3.8***	*15.3*	*0.7*	*18.8*	***5.0***

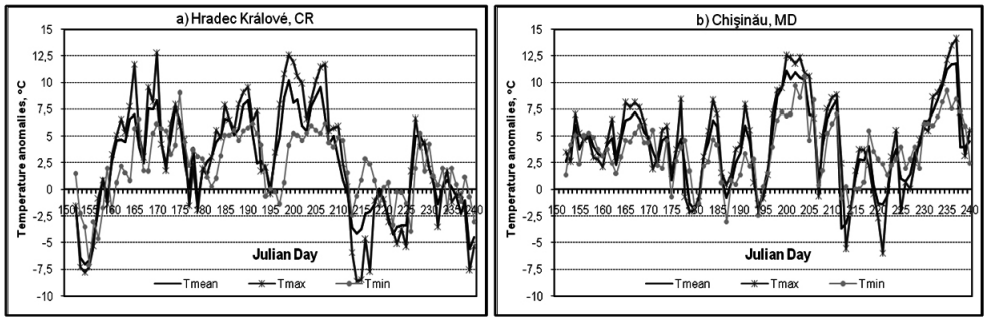

Figure 2. Deviations of summer daily air temperatures in Hradec Králové, CR, 2006 (a) and in Chişinău, RM, 2007 (b) from their baseline values *(horizontal null line).*

As can be seen from Table 2, monthly temperatures (mean, minimum, and maximum) of the 2006 summer at the Hradec Králové station far exceeded the mean of the reference period (with the exception of August). Moreover, the exceptionally high July temperature of 2006 exceeded its 95th quantile of three standard deviations. The mean summer (June–August) temperatures in that year were higher than the 1961–90 mean by about 1.0 °C.

As to Moldova, all three parameters of the 2007 summer temperatures in Chişinău were significantly higher than extremely possible in the baseline climate; at the same time, they are approaching the climate extremes of the last decades. Thus, extremely

hot years indicate that both the Czech Republic and the Republic of Moldova are living in the new climatic conditions.

Table 2. 2006 (for Hradec Králové, CR, *a*) and 2007 (for Chişinău, RM, *b*) summer temperatures (ºC) in comparison with 90% and 95% quantiles of their distribution in baseline and current climates.

***a* – Hradec Králové, CR**															
Period	Mean temperature					Maximal temperature					Minimal temperature				
	2006	1961-1990		2000-2009		2006	1961-1990		2000-2009		**2006**	**1961-1990**		**2000-2009**	
		90%	**95%**	**90%**	**95%**		**90%**	**95%**	**90%**	**95%**		**90%**	**95%**	**90%**	**95%**
June	18.5	17.9	19.1	20.8	20.8	24.4	23.5	24.7	27.0	27.0	12.4	13.3	13.4	13.9	13.9
July	23.5	19.9	20.2	20.1	20.1	30.7	26.1	26.5	26.4	26.4	16.0	14.3	14.5	14.4	14.4
August	16.5	19.1	19.7	21.1	21.1	21.2	25.8	26.7	28.4	28.4	12.5	13.9	14.4	15.4	15.4
Summer	19.5	18.4	18.6	20.5	20.5	25.4	24.4	24.5	27.2	27.2	13.6	13.6	14.0	14.1	14.1
***b* – Chişinău, RM**															
Period	Mean temperature					Maximal temperature					Minimal temperature				
	2007	1961-1990		2000-2009		2007	1961-1990		2000-2009		2007	1961-1990		2000-2009	
		90%	95%	90%	95%		90%	95%	90%	95%		90%	95%	90%	**95%**
June	23.2	20.7	21.0	21.5	22.5	28.9	26.3	26.7	27.4	29.1	17.7	15.6	15.9	17.0	17.6
July	25.8	21.8	22.0	23.5	23.9	32.3	27.4	27.7	29.3	29.4	19.7	16.7	16.9	18.7	18.9
August	23.9	22.0	22.4	24.0	24.1	29.3	27.8	28.2	29.9	30.2	19.1	16.8	17.2	18.9	19.2
Summer	24.3	21.7	22.2	23.7	24.0	30.2	27.4	27.9	29.4	29.8	18.8	16.7	17.1	18.6	18.9

One of the key characteristics of extremely hot summers is the number of tropical days (*Tmax* ≥30.0 °C). These days are considered very hot, and they are particularly of great importance not only for bioclimatology and applied sciences, but also for the individuals who are sensitive to heat stress. It is interesting to analyze the number of tropical days (TD) and its change during a long-term period. If to compare the total number of TD in summer season for two research periods (baseline and current climate), it is evident that the average number of tropical days in the summer season has increased by more than 1.5 times in Moldova and a two-fold increase has been observed in the Czech Republic over the past 20 years (Table 3). Moreover, the highest excess ratio (i.e. "speed" of TD growing) is observed in CR in August, and in July in Moldova. Additionally, it is necessary to mark the difference between the two countries in the average number of TD – in Moldova they are by 1.5 times higher than in the Czech Republic.

Table 3. Mean number of tropical days (by IPCC 2001) in CR (Hradec Králové) and RM (Chişinău) for two research periods.

Period	Czech Republic			Republic of Moldova		
	1961-1990	1991-2009	Excess ratio	1961-1990	1991-2009	Excess ratio
June	1.7	3.0	1.76	3.1	4.7	1.52
July	3.4	6.2	1.82	5.3	8.6	1.62
August	3.0	5.9	1.96	5.6	8.9	1.59
Summer	8.2	15.2	1.85	14.5	23.4	1.61

The summers of 1994, 2003, and 2006 in the Czech Republic were characterized by the highest number of tropical days (33 days, 31 days, and 28 days respectively) (Figure 3, upper). The average number of tropical days per year is 14. The findings are well confirmed by previous research [15].

In its turn, Moldova's summer is hotter – the highest number of TD was recorded in 2007 (44 days), 2009 (38 days), and in 1999-2001 (34-32 days) with an average number of tropical days of 18 per year. If to compare the total number of tropical days in the summer season for the two research periods (1961-1990 and 1991-2009), it is evident that the average number of tropical days has increased over the past 20 years.

We ***used second-order*** polynomial regression to analyze the variability of tropical days. The form of polynomial curve for Moldova is characterized by a concave, in contrast to the Czech Republic, where the curve has a clear bottom-up character (Figure 3). The coefficient of determination (R^2) of TD polynomial regression is higher in Moldova than in the Czech Republic (0.35 vs. 0.21). The growing number of tropical days is accompanied by increase in absolute maximum temperatures during the whole period (R^2 is 0.37 in Moldova and 0.17 in Czechia at a 95% confidence level).

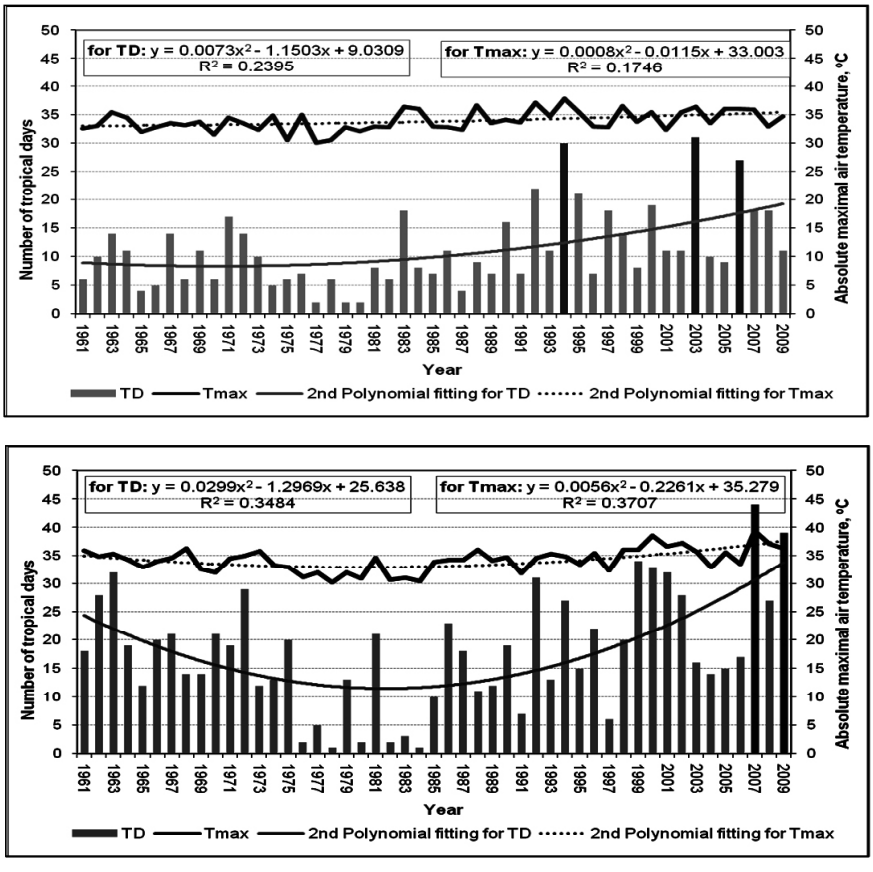

Figure 3. Tendency of tropical day number in the summer during 1961-2009 in the Czech Republic (upper) and the Republic of Moldova (lower).

Based on the surface temperature data from 100 European stations, the European Climate Support Network (ECSN) [8] reports a temperature increase from the beginning of the 20th century until 1940, a period of stabilization or even cooling until around 1970, followed by a new increase extending up to the present time. Our results both for the Hradec Králové (CR) and Chişinău (MD) weather stations coincide with ECSN [8]

and Founda et al. [9]. Barnett et al. [1] have concluded that the most probable cause of the observed warming of the atmosphere since 1970 is a combination of internally and externally forced natural variability and anthropogenic sources.

The cumulative *Tmax* excess above certain threshold during heat waves and the peak temperature are used to characterize heat waves in both compared countries and their duration. According to Kyselý [14], the cumulative *Tmax* excess ($\Sigma\Delta Tmax > 30$) is probably the most appropriate variable to characterize the severity of heat waves. The period of June–July–August was chosen since heat waves both in CR and RM occur during these three months.

Regarding the analysis of heat waves in the middle part of Polabí (CR), we can mentioned, that the absolute maximum temperatures were recorded in Hradec Králové on July 30, 1994 (*Tmax* = 37.8 °C), i.e. in that summer when the longest and most severe heat wave has been recorded since 1961 (Table 4a). However, on the whole territory of the Czech Republic, the absolute maximum air temperature was observed on the 27th of July, 1983 (40.2°C) at the Prague-Uhrineves weather station [14].

The 2006 summer heat waves with the highest number of tropical days and peak of maximum heat wave temperature reached 36.1 °C (the highest summer temperature in the Czech Republic). The longest heat wave in the summer of 2006 started on the 12th of June and lasted to the 17th of June, and after a break, it resumed on the 6th of July and lasted until the 13th of July.

In Moldova, the longest cumulative heat wave duration (that lasted totally 24 days with very short breaks of 1-2 days), as well as the highest number of heat waves (three) were recorded in 2007 (Table 4b). This was followed by heat waves recorded in 1992 (13 days) and in 2002 and 1999 with a total heat wave duration of 12 days. The most severe heat wave in Chişinău (as measured in terms of the cumulative *Tmax* excess above 30 °C) was recorded in 2007 (127.2 °C) and heat waves that were by more than 2.5 times less severe occurred in 2008 and 2002 (~47 °C). In Moldova, the frequency of heat waves has increased by four times, their duration and severity (by 5 and 10 times respectively) simultaneously increasing.

An overwhelming percentage (76.2%) of the heat waves in RM during the whole period has been observed the last two decades. Such comparative analysis of two periods (1961-1990 and 1991-2009) leads to disappointing conclusions about the drastic change in the nature of heat episode manifestations over the past 20 years. Taking into account the hot summer climate of the country, the continuation of this tendency could result in very negative consequences for all biological systems, primarily affecting the most vulnerable components – agriculture and human health. A catastrophic drought that occurred in 2007, led to disastrous consequences – 90% of country's territory and 80% of rural population depending of agriculture were affected by the diminished harvest. The output of cereal crops declined by 63% compared to 2006 and the wheat harvest reduced by 10 times. The total losses during this drought amounted $1 billion USD [20]. The oppressive weather of that summer resulted in both direct and indirect effects on human health, increased ambulance call-outs and the increase in total mortality, especially from cardiovascular disease among the elderly population. As it is shown in recent study, the direct heat effect during the 2007 hot summer in Chisinau was responsible for about 200 excess deaths [4].

Table 4. The most severe* heat waves in Hradec Králové (middle part of Polabí, Czech Republic) and Chişinău (Republic of Moldova) from 1961 to 2009.

Year	Tropical Days	Heat wave number	Heat wave duration, total days	Severity of heat waves (ΣΔTmax>30), ºC	Highest Tmax during heat waves, ºC	Highest Tmax for summer season, ºC
***a* – Hradec Králové, CR**						
1994	30	1	17	72.8	37.8	37.8
1992	22	3	17	41.5	31.3	37.1
1995	20	1	11	18.7	34.5	35.5
1963	12	1	9	15.0	35.4	35.4
2008	15	2	11	14.5	32.7	33.0
2006	27	2	14	14.1	36.1	36.1
1996	6	2	14	13.5	33.0	33.0
1997	16	2	15	10.2	32.2	32.8
2003	29	1	11	8.3	33.6	36.4
1983	17	2	20	8.2	30.4	36.4
1986	11	2	12	6.8	32.2	32.8
2002	17	1	13	1.4	30.4	35.5
***b* – Chişinău, RM**						
2007	44	3	24	127.2	39.4	39.4
2008	27	2	11	47.5	37.1	37.1
2002	28	1	12	46.6	37.2	37.2
2000	33	1	6	29.9	38.5	38.5
1999	34	2	12	27.8	35.3	36.1
1992	31	2	13	26.9	34.6	34.6
1963	32	2	10	25	35.3	35.3
2005	15	1	5	22	35.6	35.6
1998	20	1	6	17.1	33.5	36.0
1961	18	1	5	36.7	35.9	35.9
2001	32	1	5	11.8	34.0	36.6
1968	14	1	5	7.5	32.4	36.3
1972	29	1	6	6.1	32.4	35.0
2003	16	1	5	4.9	32.2	35.7
2009	39	1	5	4.2	32.8	36.3

** The heat waves are listed in descending order of their severity*

The picture is no less depressing in the Czech Republic with its quite mild summer. Thus, the drought spell of the 2006 hot summer affected 70% of agricultural areas in the Czech Republic. However, the yield losses of agriculture crops due to the hot and dry summer of 2006 were not as high as in the summer of 2003 [19].

Conclusion

A comparative analysis of heat episodes, including heat waves and tropical days, etween the Republic of Moldova and the Czech Republic as representative countries of Central and Eastern Europe has been performed in this study for the first time. The application of an unified methodology for both countries has permitted us to conclude the following:

1. The summer of 2006 in the Czech Republic was recorded as very hot; however, the temperatures in June and July did not break the record. However,

the absolute temperature records for different parameters were registered for the whole observation period (since 1887) in the Republic of Moldova during the summer of 2007.

2. The exceptionality of the summer season in 2006 in Hradec Králové, Czech Republic, and in 2007 in Chisinau, Republic of Moldova, was confirmed by (1) normalized standard deviation – the temperature anomalies in some months exceeded more than 4σ in both countries; (2) by the 90th and 95th quantiles –all three parameters of the 2007 summer temperatures were significantly higher than extremely possible in the baseline climate in Chişinău, while such exceedance was observed in 2006 only in June and July at the Czech weather station.

3. The average number of tropical days in the summer season has increased by more than 1.5 times over the past 20 years both in Moldova and in the middle part of Polabí (CR) with the highest excess ratio in August in CR, and in July in Moldova. The growing number of tropical days is accompanied by increase of maximum temperatures during the whole period (coefficient of determination in Moldova is 0.39, in Czech Republic ~ 0.30 at a 95% probability level).

4. The last two decades (1990s and 2000s) in the Czech Republic were characterized by prolonged periods of severe heat waves, whereas the number of heat waves diminished or they were completely absent in the 1970s and 1980s. The hottest summer by the heat wave duration and severity occurred in the CR in 1994 (the longest heat wave that lasted 17 days and a cumulative *Tmax* excess of 72.8 ºC at the Hradec Králové weather station) and in 2007 in Moldova (24 days and 127.2 ºC respectively at the Chişinău weather station).

5. It is evident that the total number of heat episodes in the two countries has increased significantly during the last two decades resulting in climate variability; extremely hot years indicate that both the Czech Republic and the Republic of Moldova are living in the new climatic conditions.

In conclusion, we should mention that an unified methodology for identification of heat episodes and heat waves, in particular, is a necessary condition for comparative analysis of individual countries or territories, thereby facilitating assessment of their impacts and, hence, the development of the measures to mitigate them. Such methodology has been actively developed during the past years due to the challenges of more frequent heat episodes around the world and especially in Europe. The establishment of a heat-wave temperature threshold must be based on knowledge of the cause-effect relationship between the temperature and mortality as an appropriate indicator of population health. The future effects of climate change render it essential for this relationship to be studied on a local scale to provide truly efficient prevention plans.

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References

1. Barnett T.P., Hasselmann K., Chelliah M., Delworth T., Hegerl G., Jones P., Rasmusson E., Roeckner E., Ropelewski C., Santer B., Tett S. Detection and attribution of recent climate change: a status report. //Bull Am Meteor Soc, 1999, № 80, p. 2631-2659.

2. Beniston M., Stephenson D.B., Christensen O.B., et al. Future extreme events in European climate: an exploration of regional climate model projections. //Clim Chan, 2007, № 81, p. 71-95

3. Cazac V., Boian I., Mironov T. Caracterizarea condiţiilor meteorologice şi agrometeorologice din vara anului 2007. // Mediul Ambiant, 2007, № 5(35), p. 44-45

4. Corobov R. and Opopol N. Some temperature-mortality relationships in the warm season in Chisinau. //Curier Medical, 2010, № 2, p. 35-43

5. Corobov R. and Overcenco A. To normality of air temperature distribution with an emphasis on extremes. //Collection of Scientific Articles in commemoration of 100 birth anniversary the Academician E. Fiodorov, 2010, Bender, Moldova, p. 35-41

6. Corobov R., Sheridan S., Overcenco A., Terinte N. Air temperature trends and extremes in Chisinau (Moldova) as evidence of climate change. //Clim Res, 2010, № 42, p. 247-256; doi: 10.3354/cr00922

7. Corobov R. and Overcenco A. Recent tendencies in Moldova's temperature extremes. // Proceedings of the 1st International Conference "Innovations transfer in agricultural activities in the context of climate change and sustainable development", 2009, 11-12 November, Chişinău, Moldova, p. 374-382

8. ECSN, European Climate Support Network, 1st European Climate Assessment. KNMI, De Bilt, ISDN 90-369-2069-8.

9. Founda D., Papadopoulos K.H., Petrakis M., Giannakopoulos C., Good P. Analysis of mean, maximum, and minimum temperature in Athens from 1897 to 2001 with emphasis on the last decade: trends, warm events, and cold events. //Glob Planet Change, 2004, № 44, p. 27-38.

10. Huth R., Kyselý J., Pokorná L. A GCM simulation of heat waves, dry spells, and their relationships to circulation. //Clim Chang, 2000, № 46, p. 29-60.

11. IPCC Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, *Solomon S., Qin D., Manning M., Chen Z., Marquis M., Averyt K.B., Tignor M. and Miller H.L.* (eds), 2007, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

12. IPCC Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, *Parry M.L., Canziani O.F., Palutikof J.P., van der Linden P.J. and Hanson C.E.* (eds), 2007, Cambridge University Press, Cambridge, UK, 976 p.

13. Kyselý J. Recent severe heat waves in central Europe: how to view them in a long-term prospect? //Int J Climatol, 2010, № 30, p. 89-109.

14. Kyselý J., Kalvova J., Kveton V. Heat waves in the south Moravian region during the period 1961-1995. //Studia geoph et geod, 2000, № 44, p. 57-72.

15. Potop V. and Türkott L. Poisson modelling of the heat waves and tropical days in the Czech Republic. //In: Sustainable Development and Bioclimate, Stará Lesná, Slovakia, 2009, p. 50-51.

16. Potop V., Türkott L., Kožnarová V., Možný M. Drought episodes in the Czech Republic and their potential effects in agriculture. //Theor Appl Climatol, 2010, № 99, p. 373-388.

17. Statgraphics Centurion XVI User Manual, 2009, StatPoint Technologies, Inc., 297 p.

18. Tebaldi C., Haynoe K., Arblaster J.M., and Meehl G.A. Going to the extremes: An

intercomparison of model-simulated historical and future changes in extreme events. //Clim Chan, 2006, № 79, p. 185-211

19. Trnka M., Hlavinka P., Semeradova D., Dubrovsky M., Zalud Z., Mozny M. Agricultural drought and spring barley yields in the Czech Republic. //Plant Soil Environ, 2007, № 53, p. 306-316

20. UNDP National Human Development Report 2009/2010. Climate Change in Moldova. Socio-economic Impact and Policy Options for Adaptation. UNDP-Moldova, 2009, 224 p.

21. Unkaśević M. and Tośić I. An analysis of heat waves in Serbia. //Global Planet Change, 2009, № 65, p. 17-26

22. World Data Center, All-Russian Research Institute of Hydrometeorological Information. Hydrometeorology data service system CliWare (Accessed: May 15, 2010); available at: http://cliware.meteo.ru/inter/data.html

23. IPCC Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, *Solomon S., Qin D., Manning M., Chen Z., Marquis M., Averyt K.B., Tignor M. and Miller H.L.* (eds), 2007, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

24. IPCC Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, *Parry M.L., Canziani O.F., Palutikof J.P., van der Linden P.J. and Hanson C.E.* (eds), 2007, Cambridge University Press, Cambridge, UK, 976 p.

25. Kyselý J. Recent severe heat waves in central Europe: how to view them in a long-term prospect? //Int J Climatol, 2010, № 30, p. 89-109

26. Kyselý J., Kalvova J., Kveton V. Heat waves in the south Moravian region during the period 1961-1995. //Studia geoph et geod, 2000, № 44, p. 57-72.

27. Potop V. and Türkott L. Poisson modelling of the heat waves and tropical days in the Czech Republic. //In: Sustainable Development and Bioclimate, Stará Lesná, Slovakia, 2009, p. 50-51.

28. Potop V., Türkott L., Kožnarová V., Možný M. Drought episodes in the Czech Republic and their potential effects in agriculture. //Theor Appl Climatol, 2010, № 99, p. 373-388.

29. Statgraphics Centurion XVI User Manual, 2009, StatPoint Technologies, Inc., 297 p.

30. Tebaldi C., Haynoe K., Arblaster J.M., and Meehl G.A. Going to the extremes: An intercomparison of model-simulated historical and future changes in extreme events. //Clim Chan, 2006, № 79, p. 185-211

31. Trnka M., Hlavinka P., Semeradova D., Dubrovsky M., Zalud Z., Mozny M. Agricultural drought and spring barley yields in the Czech Republic. //Plant Soil Environ, 2007, № 53, p. 306-316

32. UNDP National Human Development Report 2009/2010. Climate Change in Moldova. Socio-economic Impact and Policy Options for Adaptation. UNDP-Moldova, 2009, 224 p.

33. Unkaśević M. and Tośić I. An analysis of heat waves in Serbia. //Global Planet Change, 2009, № 65, p. 17-26

34. World Data Center, All-Russian Research Institute of Hydrometeorological Information. Hydrometeorology data service system CliWare (Accessed: May 15, 2010); available at: http://cliware.meteo.ru/inter/data.html