

Selected agroclimatological characteristics at Tušimice station in the period 1968–2012

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Abstract

In this paper were analyzed agroclimatological characteristics of Tušimice observatory. The observatory is located in the catchment of the Ohře River (50°22'36" N, 13°19'41" E, and 322 m ASL) and was established on 1st April 1967. Some agroclimatological characteristics recommended in the individual blocks according to the WMO methodology (Kožnarová and Klabzuba, 2010) were chosen into the processing: heat waves occurrence, number of tropical days and drought occurrence. Data were processed within the period 1968–2012. There were 35 heat waves in total (June: 6; July: 17; August: 10) within the 45 years period. The longest heat wave in July has lasted 11 days and it was recorded from July 18th to July 28th. Tropical days occur 7.1 days per year on average with extreme values 29 days in 2003. The longest drought occurrence was registered from 31st July to 31st December 2003.

Key words: heat wave, tropical day, drought, Tušimice station, Czech Republic

Introduction

Weather and climate are important components of the environment that constantly surround humans. Weather extremes cause a loss of human lives and significant damage every year. The question rises in connection with the observed global

warming, whether there is an increase in the frequency and intensity of extremes, the increase of climate variability.

Knowledge of available environmental resources and the interactions that occur in the area below the soil surface, the soil–air interface and the boundary layer of the atmosphere provides essential guidance for strategic agrometeorological decisions in long-range planning of agricultural systems. The aim of the study is the evaluation of selected agroclimatological characteristics (heat waves occurrence, number of tropical days and drought occurrence) of the Tušimice observatory in period 1968–2012 with a particular focus on the elaboration of particular elements of variability.



Figure 1. Tušimice meteorological observatory; source: chmi.cz/observator_tusimice

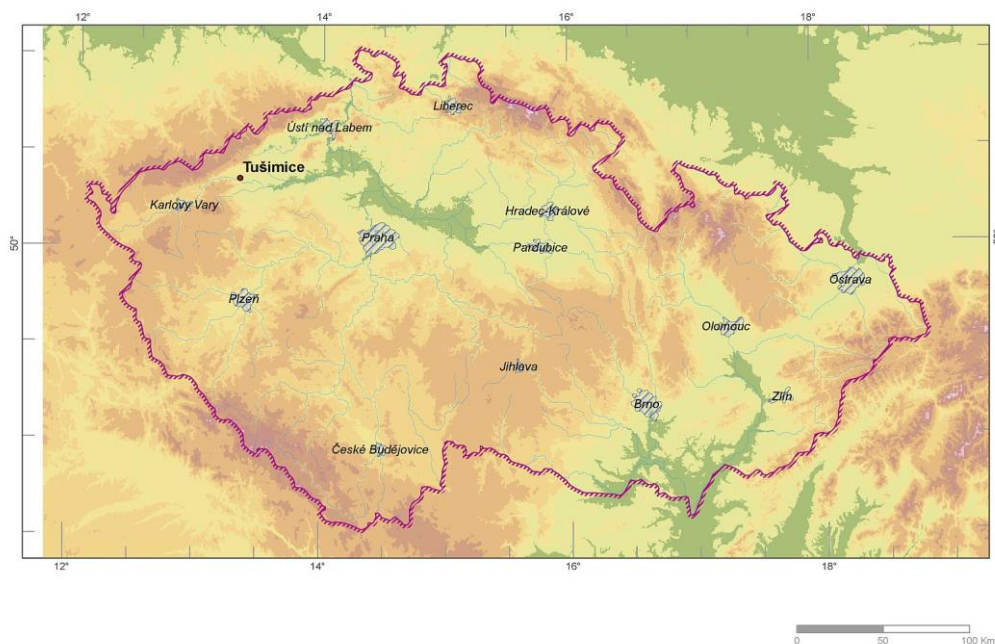


Figure 2. Map of the Czech Republic with Tušimice location

Material and methods

The Tušimice station (322 m ASL, 13°19'41"E, 50°22'36"N) was established on April 1st, 1967 and it was fully automated on November 30th, 2001 (Figure 1.). The station

is located in the Mostecká kotlina Basin in the catchment area of the Ohře River (Figure 2.). According to the Quitt classification the station belongs to MW7 unit (slightly warm area), which is characterized by 30–40 summer days, 110–130 frost days and 40–50 ice days (Květoň and Voženílek, 2011). The meteorological data (daily, monthly, and annual) were exported from the CHMI climatological database CLIDATA. The agroclimatological characteristics were described by the following basic statistical variables: mean, absolute maximum and minimum values and years of occurrence, median, upper and lower quartile, the first and ninth deciles, standard deviation, quartile deviation, coefficient of asymmetry and the coefficient of kurtosis. Evaluation of changes in the trend of particular elements and phenological characteristics was carried out using polynomial equation:

$$y = b + c_1x + c_2x^2 + c_3x^3 + c_4x^4 + c_5x^5 + c_6x^6.$$

The method of cumulative series (Sládek, 2001) was used in the evaluation of drought occurrence.

Results and discussion

Selected agroclimatological characteristics in comprehensive form are given in Table 1. Walter-Lieth climagram of Tušimice station describes agroclimatological conditions (Figure 3). Heat wave events are associated with marked short-term increases in mortality.

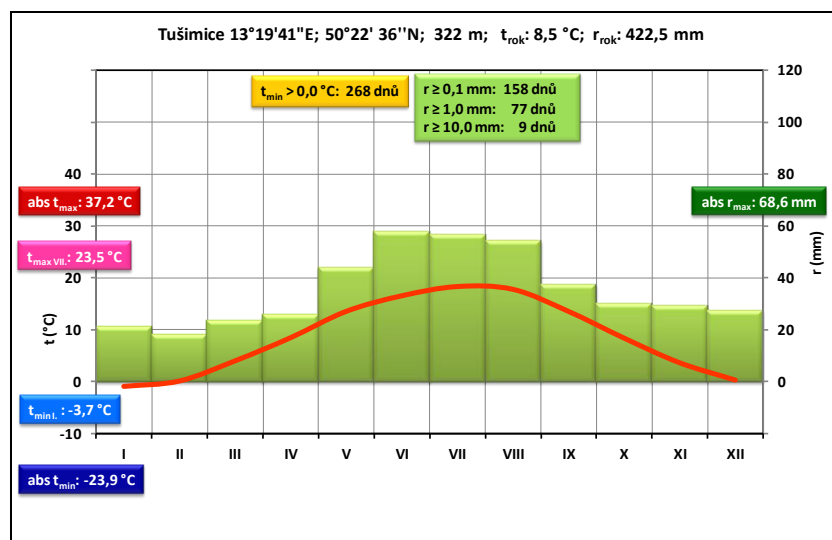


Figure 3. Walter-Lieth climagram (period 1968–2012)

Kyselý a Kalvová (1998) investigated the analysis of heat waves (at least 3 days with maximum air temperature ≥ 30 °C and with average air temperature in given period ≥ 25 °C) in the southern Moravia in the years 1961–1990. There were 35 heat waves in total (June: 6; July: 17 and August: 10) within the 45 years period. The longest heat wave in July has lasted 11 days and it was recorded from July 18th to July 28th. The longest heat wave in August was registered in the year 2003; it has lasted 8 days (August 7th – August 14th). The chart (Figure 4.) shows the variability of heat waves occurrence in particular years, the more frequent occurrence is in the last two decades. The average of maximum daily air temperature is 31.0 °C. Kyselý and Kalvová (1998) found out, that the heat wave lasts 4 to 7 days on average, Tušimice station shows similar results.

Table 1. Annual agrometeorological characteristics at Tušimice observatory (1968–2012)

Meteorological characteristic	abbreviation	value	unit
mean air temperature	t_{rok}	8.6	°C
sum of active air temperature > 5 °C	$\Sigma t > 5$ °C	3163.6	°C
sum of active air temperature > 10 °C	$\Sigma t > 10$ °C	2683.4	°C
mean maximum air temperature	t_{max}	13.0	°C
absolute maximum air temperature	abs tmax	37.9	°C
active sum of maximum air temperature > 5 °C	$\Sigma t_{max} > 5$ °C	4696.6	°C
active sum of maximum air temperature > 10 °C	$\Sigma t_{max} > 10$ °C	4249.0	°C
mean minimum air temperature	t_{min}	4,4	°C
absolute minimum air temperature	abs tmin	-23.9	°C
sunshine duration	ss_{rok}	1532.6	h
water vapour pressure	e_{rok}	9.1	hPa
precipitation total	r_{rok}	433.1	mm
number of days with precipitation total ≥ 0.1 mm	$r \geq 0,1$ mm	159.6	day
number of days with precipitation total ≥ 1 mm	$r \geq 1,0$ mm	79.2	day
number of days with precipitation total ≥ 10 mm	$r \geq 10, mm$	9.2	day
the highest daily precipitation total	abs r_{rok}	91.7	mm

Figure 5 illustrates the course of maximum air temperature in August 2003, the maximum air temperature during the heat wave was in the frame from 30.5 °C to 37.9 °C (this the absolute maximum air temperature measured at Tušimice station during the 45 years period). The results of heat wave occurrence correspond with Schär *et al.* (2004).

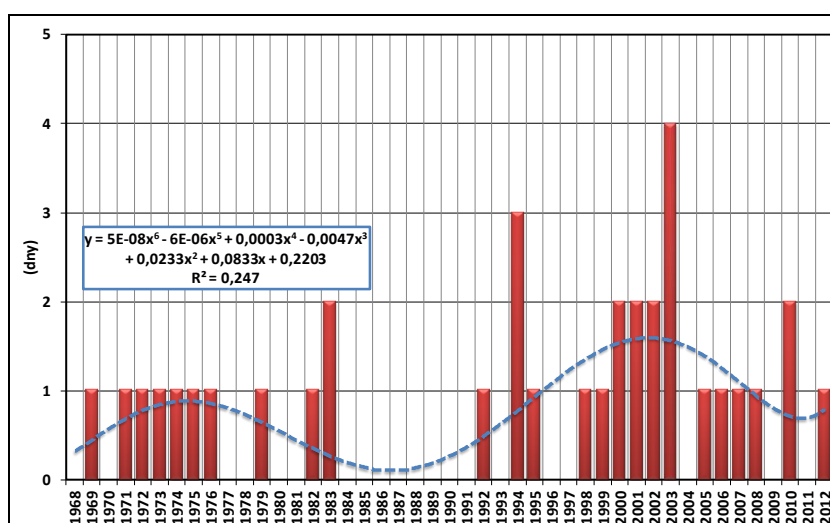


Figure 4. Number of heat waves in particular years

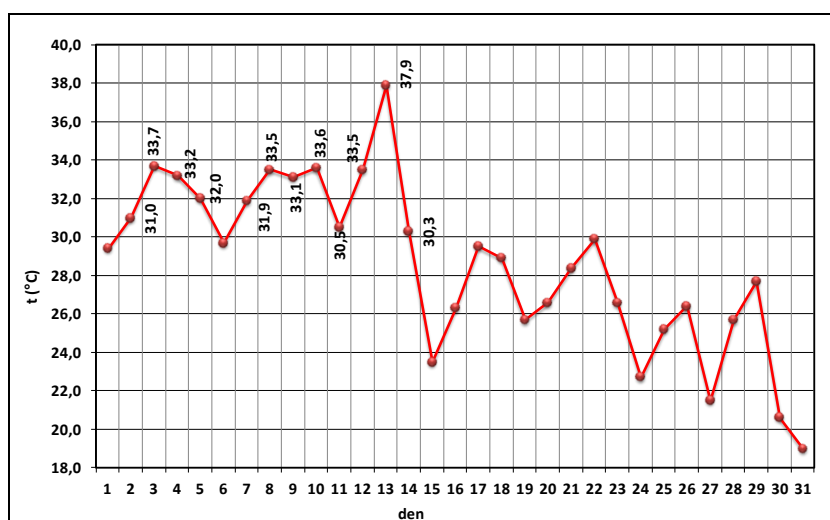


Figure 5. Course of maximum air temperature in August 2003 during the heat wave

Tropical days (it means day with the maximum air temperature 30.0 °C and more) occur 7.1 days per year on average with extreme values 29 days in 2003 and no tropical day occurrence in the years 1980, 1981 and 1987. Tropical days occurrence is typical for June, July and August, even though they can also occur in May (1969, 1999, 2005 and 2007) and September (1973 and 2003). Figure 6 shows the number of tropical days in particular years including polynomial equation:

$$y = -1E-07x^6 + 2E-05x^5 - 0.0012x^4 + 0.0346x^3 - 0.4828x^2 + 2.4971x + 3.0403;$$

$$R^2 = 0.2584.$$

There were observed 319 tropical days in the sum during the 45years period and from this amount 209 days (i.e. 65.5 %) were recorded in the period from 1991 to 2012. The similar results were found out by Kožnarová *et al.* (2012).

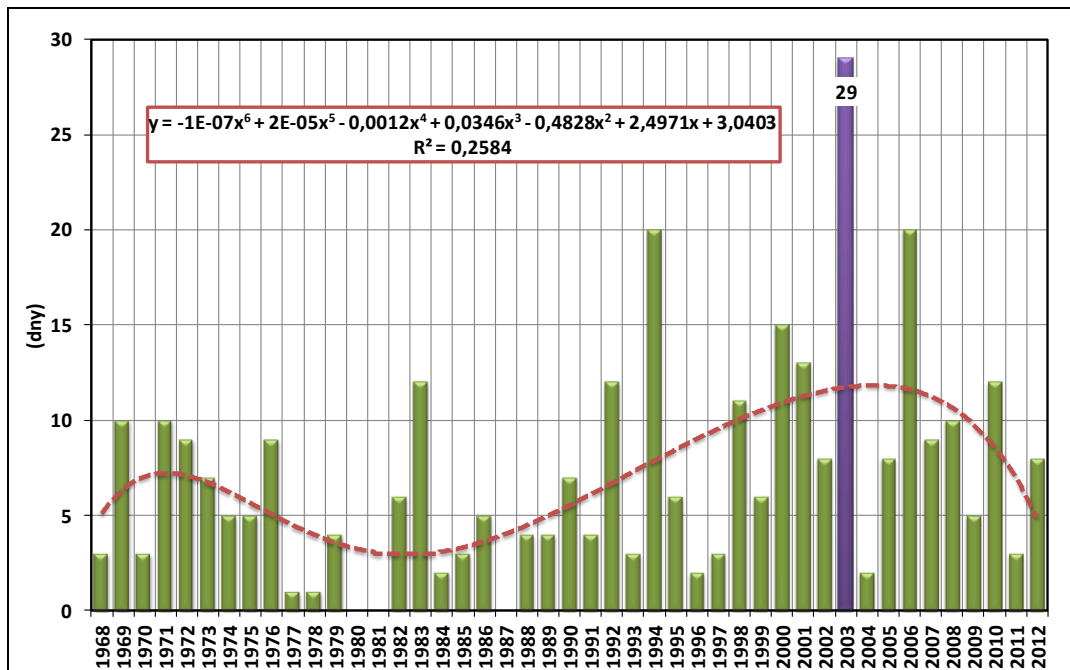


Figure 6. Number of tropical days

Basic statistical characteristics of number of tropical days in the year are given in Table 2.

Fiala (2006) investigated the drought occurrence at Vráž station in the period 1961–2004 using the method of cumulative series. There have occurred 962 drought periods (7 438 days, i.e. 46.3 % of all days) and only 2 461.8 mm of precipitation was measured, i.e. 9.9 % of all precipitation. The drought periods were nearly at the same years 1976, 2003 and 1991 on both stations (Tušimice and Vráž) and in the year 1985 it was nearly the same – the drought period at Vráž station was recorded from 9th September 1985 to 30th October 1985, it has lasted 51 days, the sum of air temperature was 529.9 °C, precipitation total was 10.4 mm and criterion S was 27.02. The spell of drought occurrence at Tušimice station is given in table 3.

Table 2. Basic statistical characteristics of tropical days in the year.

Characteristic	Value
mean	7.1
maximum	29
<i>year</i>	2003
minimum	0
<i>year</i>	1980, 1981, 1987
first decile	1.4
lower quartile	3.0
median	6.0
upper quartile	10.0
ninth decile	12.6
quartile deviation	5.0
standard deviation	5.8
coefficient of asymmetry	1.6
coefficient of kurtosis	3.7

Table 3. The spells of drought occurrence.

	from	to	duration (days)	Σ temperat. (°C)	Σ precipit. (mm)	daily mean	criterion S
1	26.2.1976	12.7.1976	136	1522.0	89.1	0.66	63.92
2	28.7.1973	9.10.1973	73	1187.5	105.1	1.44	57.00
3	31.7.2003	31.12.2003	153	1455.2	67.8	0.44	56.75
4	10.8.1991	31.10.1991	82	1019.0	19.7	0.24	35.66
5	13.9.2001	31.12.2001	109	675.6	100.0	0.92	34.45
6	3.1.2003	6.5.2003	123	536.2	35.8	0.29	33.24
7	22.3.1998	23.5.1998	62	694.6	17.5	0.28	22.91
8	9.9.1985	3.11.1985	55	569.6	5.3	0.10	22.78
9	2.7.1971	19.8.1971	48	949.7	16.9	0.35	20.89

Conclusion

The study provides an evaluation of the selected agroclimatological conditions at the Tušimice observatory in 45-year-observation (1968–2012), one of the longest continuous observation periods in Podkrušnohorská pánev (the North Bohemian Basin). There were 35 heat waves in total (June – 6; July -17; August - 10) within the 45 years period. The longest heat wave in July has lasted 11 days and it was recorded from July 18th to July 28th 2006. Tropical days occur 7.1 days per year on average with extreme values 29 days in 2003. The longest drought occurrence was

registered from 31st July to 31st December 2003 (123 days) with sum of air temperature 536.2 °C and precipitation total 35.8 mm.

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Summary

Observatoř Tušimice se nachází v Mostecké pánvi v povodí řeky Ohře (50°22'36" s. š.; 13°19'41" v. d., 322 m n. m.), byla založena 1. dubna 1967. Od 30. 11. 2001 byla zařazena mezi profesionální stanice s celodenní obsluhou (AMS) a od 8. 12. 2010 až dosud patří mezi profesionální stanice kombinovaného typu (AMS1).

V příspěvku byly zpracovány vybrané agroklimatické charakteristiky doporučené v jednotlivých blocích podle metodiky WMO (Kožnarová a Klabzuba, 2010) – výskyt horkých vln, počet tropických dní a výskyt sucha. Meteorologická data (denní, měsíční, roční) byla exportována z klimatologické databáze ČHMÚ CLIDATA. Statistické vlastnosti agroklimatických charakteristik jsou popsány veličinami: aritmetický průměr, absolutní maximum a minimum a roky jejich výskytu, medián, horní a dolní kvartil, první a devátý decil, směrodatná odchylka, kvartilová odchylka, koeficient asymetrie a koeficient špičatosti. Vyhodnocení změny trendu jednotlivých prvků a fenologických charakteristik bylo provedeno pomocí rovnice polynomu 6. stupně: $y = b + c_1x + c_2x^2 + c_3x^3 + c_4x^4 + c_5x^5 + c_6x^6$. Četnost výskytu sucha byla vyhodnocena metodou součtových řad (Sládek, 2001). Celkem bylo na stanici za 45leté období zaznamenáno 35 horkých vln, z toho v červnu 6, v červenci 17 a v srpnu 10. Nejdelší horká vlna v červenci trvala 11 dní (2006) a nejdelší horká vlna v srpnu 8 dní (2003). V průměru se na stanici vyskytne 7,1 tropických dní (maximální teplota vzduchu 30 °C a více) za rok. Nejvyšší počet tropických dní byl zaznamenán v roce 2003 (29 dní), naopak v letech 1980, 1981 a 1987 nebyl zaznamenán žádný tropický den. Nejdelší období sucha bylo podle metody součtových řad zjištěno v roce 2003 (od 31. 7. do 31. 12.), celkem trvalo 123 dní, suma teploty vzduchu činila v tomto období celkem 536,2 °C a úhrn srážek byl v daném období 35,8 mm.