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# TRENDS IN AIR TEMPERATURE AND PRECIPITATION IN SOUTHEASTERN CZECH REPUBLIC, 1961–2020

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## ABSTRACT

This study presents a summary of sixty years of air temperature and precipitation measurements at the Žabčice weather station, located in the southeastern Czech Republic and operated by Mendel University in Brno. An instrumental dataset spanning two climatological normal periods (1961–1990 and newly established 1991–2020) is analyzed for long term linear trends with monthly data presented in full span in Appendices. In the new climate normal period, the mean annual temperature increased from 9.3 °C to 10.3 °C with growing trend of 0.34 °C/10 years ($p < 0.001$). Every calendar month of year is warmer, with the highest and fastest increase in August (+2.0 °C, 0.64 °C/10 years, $p < 0.001$) and the lowest in October (+0.2 °C). Annual precipitation sum increased negligibly (+11.1 mm), however, the quarterly distribution significantly changes towards drier second quarter (-22.9 mm, $p < 0.05$) and wetter third quarter (+37.1 mm, $p < 0.05$). Number of tropical days (maximum daily air temperature > 30 °C) significantly increased (+4.44/10 years, $p < 0.001$), whereas number of frost days is negligibly decreasing (-0.88/10 years). Temperature derived Huglin index for vineyards increased by 369 °C to a seasonal sum 2062 °C (+84 °C/10 years, $p < 0.001$). This study provides evidence of the rate of changing climate at this southern Moravia lowland site.

Keywords: climatological normal, long-term trend, climate change, air temperature, precipitation, Moravia, Žabčice

## INTRODUCTION

Accurate and long term meteorological measurements represent vital tool for climate and agricultural research and practice. The Žabčice weather station is situated on the property of the Žabčice training farm - an agricultural research area owned and managed by Mendel University in Brno. First field experiments and research activities at this site were established in 1928 under the administration of University of Agriculture Brno (predecessor of Mendel University in Brno) and since 1961 onwards the weather station provides meteorological data for scholars, students and scientific public (Žalud *et al.*, 2013). The site is located in the middle of an important agriculture area, representing a typical lowland landscape of southern Moravia (179 m a. s. l.) with high portion of arable land and dispersed vineyards and orchards close by. The Žabčice cadaster itself (by year 2007) comprised of 57% of arable land, 3.9% of forests, 2% of permanent grassland. The extent of vineyards increased in time from 1.5% (1953), through 8.6% (1990) to 13.6% (2007), representing 12.2 ha (Fukalová and Pokladníková, 2014), out of which at least 6.8 ha is owned and managed by the Mendel University in Brno. This study builds on the dataset put together by our predecessors, who collected data in the period 1961–2010 and published previous studies, summaries and reports from this site (Rožnovský and Svoboda, 1995; Svoboda and Brotan, 2006; Žalud *et al.*, 2013). The current work extends their legacy by another 10 years of measurements. The added value of current study is the establishment of the new climatological normal period 1991–2020, including its comparison with the preceding period 1961–1990. The substantial length of the dataset facilitated a robust analysis of linear trends and evaluation of selected temperature-related agroclimatic indices. For the sake of further use by research community, the appendices present data on mean air temperature and precipitation sums for the entire period 1961–2020 in a monthly aggregation.

## MATERIALS AND METHODS

The Žabčice experimental site is located in the southern Moravia region, between Žabčice and Židlochovice, approximately 25 km southern from Brno (49°1’18.48”N and 16°36’56.16”E), 179 m a. s. l. In 1961, continual meteorological observation started in the area of university training farm. The main measuring instruments until 1995 were the station rain gauge, minimum and maximum thermometer, psychrometer, thermograph, and hygrograph (Žalud *et al.*, 2013), with manual reading at 7:00, 14:00 and 21:00 o'clock local time. Since 1995, the measurements were converted to an automated data collection system described in detail in Svoboda and Brotan (2006), which is still operational. Since 2010, another weather station was added at the site for robustness, redundancy and cross-validation of measured data. The air temperature and humidity is measured by sensor Vaisala HMP155A installed in RAD14 radiation shield at the height of 2 m. Precipitation is monitored by tipping-bucket rain gauge Met One 370 with upper rim at 1 m above ground. The measurement frequency is every 30 seconds. Data processing and all plots and statistics were done using software R 4.0.4 (R Core Team, 2021). Series of mean monthly air temperature and precipitation data covering whole 1961–2020 period were analyzed using linear regression. The statistical significance of emerging trend was evaluated according Man-Kendall statistical test (Mann, 1945; Kendall, 1975) at significance level of 0.05. Asterisks refer to p-value represent significance of particular trend with *) $p < 0.05$, **) $p < 0.01$, ***) $p < 0.001$. The statistical analysis was complemented with standard deviation as a measure of variability of input data. The Man-Kendall statistical test was calculated using the wq package (Jassby and Cloern, 2015), Walter-Lieth climate diagrams were calculated and plotted using the climatol package (Guijarro, 2019), the extreme heat exposure (EHE), Huglin index and number of frost days (maximum daily air temperature < 0.0 °C) and tropical days (maximum daily air temperature > 30.0 °C) were calculated using the agroclim package (Serrano-Notivoli, 2020). The EHE events evaluate high temperature related risks on wheat and barley. The event is triggered when the maximum daily temperature ($T_{max}$) is above 35.0 °C for at least three days during the period from five days after anthesis (supposed to be May 1st) to maturity (supposed to be July 31st). Huglin Heliothermal Index (HI) represents a cumulative temperature sum above the threshold of 10.0 °C and it is calculated for all days from beginning of April to end of September (Huglin, 1978).

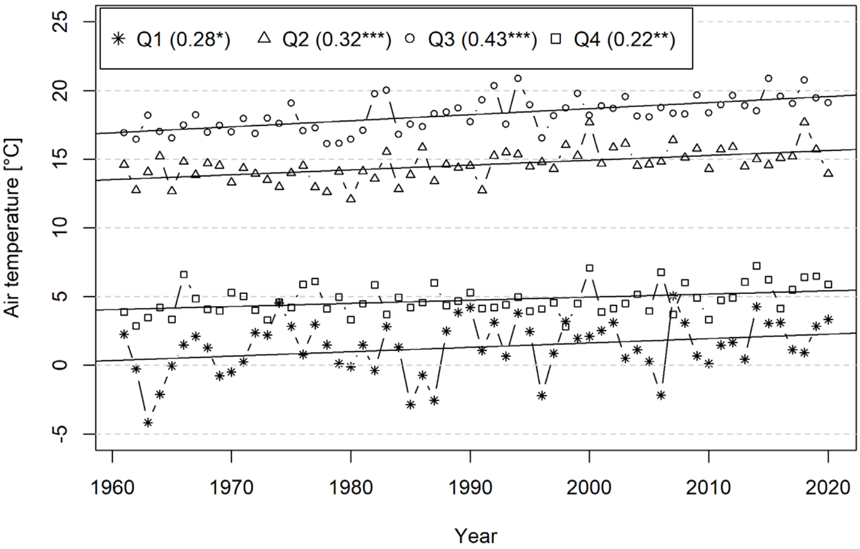
I: *Overview of mean monthly air temperature (°C) and precipitation sums (mm) for climatological normal periods 1961–1990 and 1991–2020, with trend analysis covering full period 1961–2020. Asterisks denote significance of particular trend with *) p < 0.05, **) p < 0.01, ***) p < 0.001.*

| | Mean air temperature | | | | | | Mean monthly precipitation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Period | 1961–1990 | 1991–2020 | diff. | Trend 1961–2020 | Man-Kendall p-value | SD | 1961–1990 | 1991–2020 | diff. | Trend 1961–2020 | Man-Kendall p-value | SD |
| Month | °C | °C | °C | °C/10 years | | | mm | mm | mm | °C/10 years | | |
| JAN | -2.0 | -0.7 | 1.3 | 0.38 | 0.077 | 2.77 | 24.8 | 21.1 | -3.7 | 0.24 | 0.745 | 15.96 |
| FEB | 0.2 | 0.9 | 0.7 | 0.23 | 0.293 | 2.74 | 24.9 | 20.4 | -4.5 | 0.52 | 0.623 | 16.71 |
| MAR | 4.3 | 5.1 | 0.8 | 0.36 | 0.061 | 2.14 | 23.9 | 29.9 | 6.0 | 0.29 | 0.789 | 18.01 |
| APR | 9.6 | 11.0 | 1.4 | 0.32* | 0.011 | 1.69 | 33.2 | 27.8 | -5.5 | -2.00 | 0.189 | 19.07 |
| MAY | 14.6 | 15.6 | 1.0 | 0.31* | 0.022 | 1.62 | 62.8 | 52.2 | -10.6 | -3.57 | 0.099 | 26.62 |
| JUN | 17.7 | 19.2 | 1.5 | 0.38*** | < 0.001 | 1.41 | 68.6 | 61.7 | -6.9 | -2.15 | 0.444 | 29.55 |
| JUL | 19.3 | 20.9 | 1.6 | 0.47*** | < 0.001 | 1.62 | 57.1 | 68.9 | 11.8 | 0.95 | 0.683 | 42.11 |
| AUG | 18.6 | 20.6 | 2.0 | 0.64*** | < 0.001 | 1.74 | 54.3 | 61.1 | 6.8 | 1.89 | 0.422 | 34.48 |
| SEP | 14.7 | 15.4 | 0.7 | 0.23* | 0.032 | 1.45 | 35.5 | 53.9 | 18.4 | 4.71* | 0.009 | 30.63 |
| OCT | 9.5 | 9.7 | 0.2 | 0.19 | 0.101 | 1.47 | 31.8 | 37.0 | 5.2 | 1.41 | 0.436 | 24.43 |
| NOV | 4.1 | 4.9 | 0.8 | 0.26 | 0.058 | 1.81 | 36.8 | 31.4 | -5.4 | -2.23 | 0.096 | 20.25 |
| DEC | 0.0 | 0.3 | 0.3 | 0.27 | 0.105 | 2.00 | 26.3 | 25.7 | -0.6 | 0.06 | 0.939 | 13.35 |

## RESULTS

Over the last six decades the air temperature at Žabčice locality has been rising (Fig. 1, Fig. 2A). The mean annual air temperature as defined by the climatological normal increased from 9.3 °C (1961–1990) to 10.3 °C (1991–2020). The mean monthly air temperature increases in each calendar month of year (Tab. I). The linear warming trend is significant in each month between April to September, accelerating from June (+1.5 °C, trend 0.38 °C/10 years***) towards August (+2.0 °C, 0.64 °C/10 years***). Thus, the fastest warming takes place in climatological summer (JJA) (+1.7 °C, 0.48 °C/10 years***). Contrarily, the smallest change in air temperature takes place in October (+0.2 °C, 0.19 °C/10 years). Considering quarterly means of air temperature (Fig. 1, Tab. II), all calendar quarters exhibit temperature increase of 1.0, 1.2, 1.5 and 0.5 °C for Q1–Q4, respectively. The warmest quarter would be Q3 (+1.5 °C, 0.43 °C/10 years***), followed by Q2 (+1.2 °C, trend 0.32 °C/10 years***), Q1 (+1.0 °C, trend 0.28 °C/10 years*) and Q4 (+0.5 °C, trend 0.22 °C/10 years**).

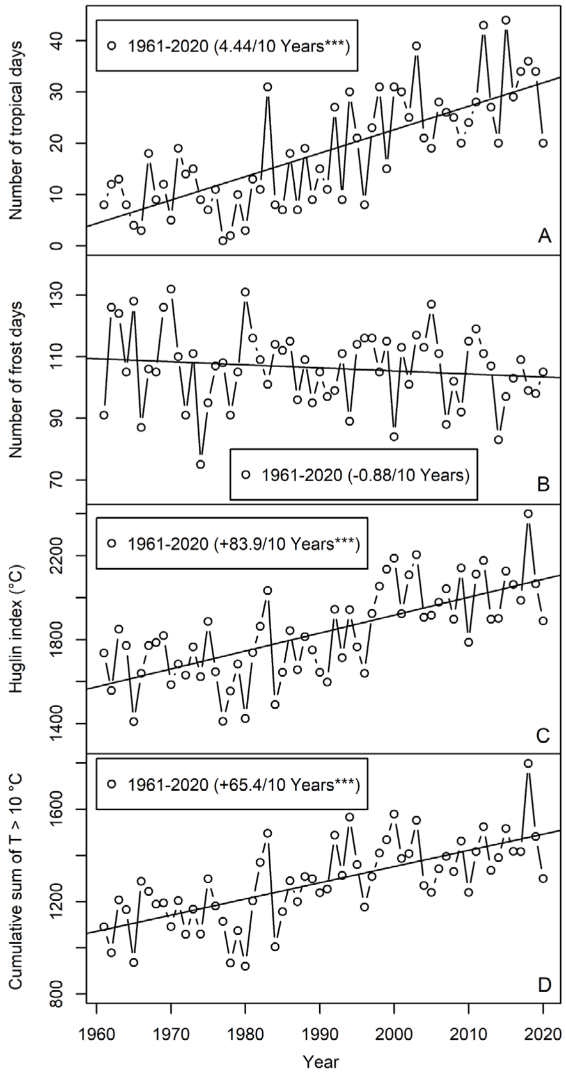
The slower pace of warming in Q4 can be seen in decreasing annual sum of frost days (-0.88/10 years, Fig. 2B). On the other hand, the increasing




1: *Quarterly trends and inter-annual variability of air temperature during the period 1961–2020. Note, that values within parenthesis represent the rate of change in degrees Celsius per decade. Asterisks denote significance of particular trend with *) p < 0.05, **) p < 0.01, ***) p < 0.001.*

II: *Overview of mean air temperature (°C) and precipitation sums (mm) for different sub-annual timescales. Data represent climatological normal periods 1961–1990 and 1991–2020, with trend analysis covering full period 1961–2020. Asterisks denote significance of particular trend with *) p < 0.05, **) p < 0.01, ***) p < 0.001.*

| | Mean air temperature | | | | | | Mean monthly precipitation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Period | 1961–1990 | 1991–2020 | diff. | Trend 1961–2020 | Man-Kendall p-value | SD | 1961–1990 | 1991–2020 | diff. | Trend 1961–2020 | Man-Kendall p-value | SD |
| | °C | °C | °C | °C/10 years | | | mm | mm | mm | mm/10 years | | |
| Year | 9.3 | 10.3 | 1.0 | 0.34*** | < 0.001 | 0.91 | 480.0 | 491.1 | 11.1 | 2.78 | 0.71 | 80.72 |
| Apr.–Sep. | 15.8 | 17.1 | 1.3 | 0.36*** | < 0.001 | 1.03 | 311.5 | 325.6 | 14.1 | 2.48 | 0.66 | 68.34 |
| Q1 (JFM) | 0.8 | 1.8 | 1.0 | 0.28* | 0.036 | 1.95 | 73.6 | 71.4 | -2.2 | 0.45 | 0.78 | 35.33 |
| Q2 (AMJ) | 14.0 | 15.2 | 1.2 | 0.32*** | < 0.001 | 1.15 | 164.6 | 141.7 | -22.9 | -7.90* | 0.01 | 44.14 |
| Q3 (JAS) | 17.5 | 19.0 | 1.5 | 0.43*** | < 0.001 | 1.21 | 146.9 | 184.0 | 37.1 | 8.84* | 0.02 | 53.72 |
| Q4 (OND) | 4.5 | 5.0 | 0.5 | 0.22** | 0.005 | 1.06 | 94.9 | 94.0 | -0.9 | -2.14 | 0.59 | 34.69 |
| MAM | 9.5 | 10.5 | 1.0 | 0.31*** | < 0.001 | 1.17 | 119.9 | 109.9 | -10.0 | -2.86 | 0.29 | 33.22 |
| JJA | 18.5 | 20.2 | 1.7 | 0.48*** | < 0.001 | 1.25 | 180.0 | 191.8 | 11.8 | 0.96 | 0.82 | 60.19 |
| SON | 9.4 | 10.0 | 0.6 | 0.23** | 0.004 | 1.00 | 104.1 | 122.2 | 18.1 | 3.38 | 0.22 | 41.80 |
| DJF | -0.6 | 0.1 | 0.7 | 0.27* | 0.028 | 1.72 | 76.0 | 67.2 | -8.8 | 0.49 | 0.66 | 28.64 |




2: *Number of tropical days (A), frost days (B), Huglin index (C) and cumulative sum of daily mean temperature above 10 °C (D), for particular year with linear trend representing the full period 1961–2020. Note, that values within parenthesis denote rate of change per decade. Asterisks represent significance of particular trend with *) p < 0.05, **) p < 0.01, ***) p < 0.001.*

temperature in summer months is reflected in growing number of tropical days (+4.44/10 years***, Fig. 2A), from nine days per year (1961–1970 decade mean value) to 32 tropical days (2011–2020 decade mean value). Huglin index for vineyards (HI), it increased by 369 °C, from temperature sum of 1693 °C (1961–1970 decade mean value) to 2062 °C (2011–2020 decade mean value), with the rate of change to +83.9 °C/10 years*** (Fig. 2C) over the period 1961–2020. Similarly, the cumulative sum of air temperature above 10 °C increased by 321 °C from temperature sum of 1138 °C (1961–1970 decade mean value) to 1460 °C (2011–2020 decade mean value), with the rate of change to +65.4 °C/10 years*** (Fig. 2D) over the same period. Regarding EHE, in total, 10 EHE events were identified during 1961–2020, with eight EHE events occurring after year 2000 (Tab. III). The incidence is increasing in recent years, moreover, in years 2015 and 2019 the EHE event was identified twice in a single year.

III: *Incidence of extreme heat exposure events* during period 1961–2020. *(Tmax > 35.0 °C achieved in three days out of five consecutive days within period April to July)*

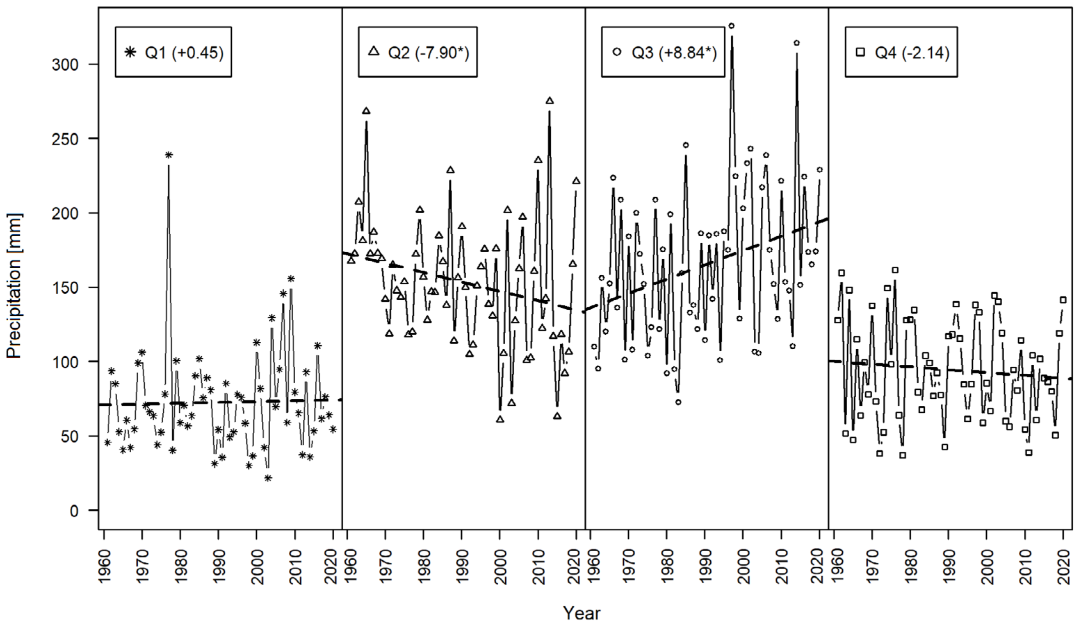
| Year | DOY |
|---|---|
| 1983 | 200 |
| 1998 | 158 |
| 2000 | 164 |
| 2007 | 196 |
| 2010 | 193 |
| 2012 | 181 |
| 2015 | 186, 200 |
| 2019 | 177, 207 |

Analysis of mean annual precipitation revealed minor increase from 480 mm (1961–1990) to 491 mm (1991–2020), with rather negligible linear trend 2.8 mm/10 years. However, significant changes in temporal distribution of precipitation in different parts of a year has been observed (Tab. II). Generally, there is an apparent decrease in precipitation during the first part of growing season (most pronounced in May -3.6 mm/10 years), followed by an increase in the rest of growing season (most pronounced in September +4.7 mm/10 years, p < 0.01) with little or no change in winter months (Fig. 3, Tab. I). Considering the quarterly precipitation sums, the Q1 shows negligible change in precipitation (-2.2 mm, trend 0.45 mm/10 years), followed by Q2 with the largest and fastest decline in precipitation (-22.9 mm, trend -7.9 mm/10 years*). Contrarily, the Q3 is getting wetter (+37.1 mm, trend 8.8 mm/10 years*). The last quartile Q4 shows rather negligible decrease (-0.9 mm, trend -2.1 mm/10 years).

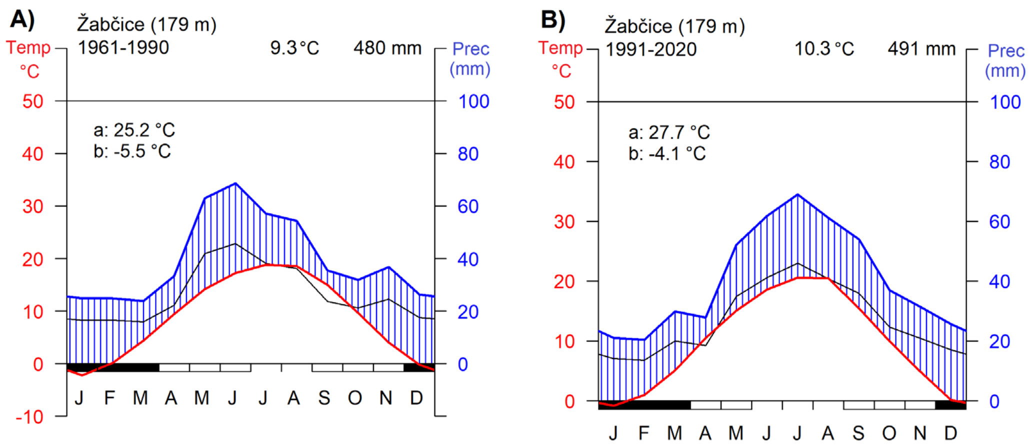
For convenience, different quarter timescales, such as climatological spring (MAM), summer (JJA), autumn (SON) and winter (DJF) were analysed as well (Tab. II). The change in patterns of monthly temperature and precipitation is illustrated with Walter-Lieth climate diagrams, each one characterizing climatological normal periods 1961–1990 (Fig. 4A) and 1991–2020 (Fig. 4B). The peak annual precipitation month moved from June to July and the semi-arid conditions moved from late summer to early spring (when the black solid precipitation line (scale P = 3T) lies below the temperature line; in this case the period in which 3T > P > 2T is considered semi-arid.

## DISCUSSION

In an earlier study evaluating the annual mean air temperature during period 1961–1990 from Žabčice, it was found that the warmest decade was the last




3: *Quarterly trends of precipitation during the period 1961–2020. Note, that values within parenthesis denote rate of change in (mm) per 10-year time window. Asterisks represent significance of particular trend with *) p < 0.05, **) p < 0.01, ***) p < 0.001.*




4: *Walter-Lieth climate diagram depicts the standard periods of 1961–1990 (A) and 1991–2020 (B). Letter "a" inside the plot stands for daily maximum mean temperature of the hottest month and letter "b" stands for daily minimum mean temperature of the coldest month. Black bars below the x-axis show months with mean daily minimum temperature below -0.1 °C. The white bars show probable frost months, where frosts can occur (when absolute monthly minimums are equal or lower than 0 °C). Note, that when the precipitation graph lies above the temperature graph (P > 2T) it is considered as a wet period (filled in dotted blue vertical lines). The black solid line draws a precipitation with a scale P = 3T; in this case the period in which 3T > P > 2T is considered semi-arid.*

one (1981–1990) and the warmest five-year period was again the last one (1986–1990) (Rožnovský and Svoboda, 1995). The trend of increasing annual mean air temperature in the Czech Republic was already spotted by e.g. Kalvová and Nemešová (1997) who reported an increase in air temperature by 0.22 °C/10 years for the period 1961–1990. The rise of annual mean air temperature based on instrumental data from the Žabčice locality was mentioned by Svoboda and Brotan (2006) as well. They found an increase by 0.8 °C in period 1991–2005, compared to climatic normal period 1961–1990. Our results showed an increase in annual mean air temperature by 1.0 °C to 10.3 °C for period 1991–2020 relative to the previous period 1961–1990. Moreover, there is an expectation that this rising trend at this location is likely to continue in future reaching 10.6 °C (2021–2050) and 12.4 °C (2071–2100) (Fukalová *et al.*, 2014). Our trend analysis showed rate of increase similar (0.34 °C/10 years) to findings of Zahradníček *et al.* (2021) who evaluated almost identical period

(1961–2019) based on an independent dataset and found warming trend of 0.37 °C/10 years for Czech Republic lowlands (< 300 m a. s. l.). In general, the fastest warming trends are observed in summer months (June to August) and the slowest in autumn (September to November) and winter (December to February) months. Rising air temperature is accompanied with increasing incidence of heat waves, what is indicated by an increasing incidence of EHE events. In the near future (2020–2049), heat waves in the Czech Republic are projected to be nearly twice as frequent and the increase is even larger for severe heat waves (Lhotka *et al*., 2018). Moreover, the manifestations of extreme weather are expected to be more pronounced in the Czech Republic compared to the rest of Central Europe for the period 2021–2050 (Sedlmeier *et al*., 2018). Regarding the Huglin heliothermal index for vineyards, the increase in cumulative temperature sums is particularly marked in 1991–2000 and 2011–2019, while the rise in the 2001–2010 decade was far weaker (Zahradníček *et al*., 2021). The increasing air temperature cause a migration of agroclimatic zones toward the North, with Pannonian zone progressing 70 km per 10 years (Ceglar *et al*., 2019). This leads to a shift of agroclimatic conditions at southern Moravia from less temperature demanding grapevine varieties (Müller Thurgau, Riesling, Sauvignon) to more temperature demanding (Cabernet Franc, Cabernet Sauvignon, Merlot) (Van Der Schrier *et al*., 2012). Mean annual precipitation sum for climatological normal period 1991–2020 is 491 mm with negligible growing trend. Recent study made by Brázdil *et al*. (2021) evaluated spatiotemporal precipitation patterns over the territory of the Czech Republic of the 1961–2019 period and reported annual mean precipitation 588.9 mm with trend -2.3 mm/10 years for altitudes bellow 300 m a. s. l. This represents a difference of 97.8 mm compared to our site, which is, however, located in typically warm and dry area of the Czech Republic with low altitude (179 m a. s. l.). The comparison of Walter-Lieth climate diagrams (Fig. 4) for the periods of 1961–1990 and 1991–2020 indicate a clear shift of peak precipitation from late spring to mid-summer and a simultaneous decrease in April and increase in September (Tab. I). This change in precipitation seasonality was observed in the wider Central European region, where e.g. Hänsel *et al*. (2019) summarized precipitation trends in period 1951–2015 over Germany, the Czech Republic and Poland territory and concluded that the declining trend is evident mainly in April, while the strongest precipitation increase as well as a relatively low rise in temperature was observed in September, leading to distinct increases in the water balance in this month. Together with the rise of spring temperatures, the dry season starts to appear right at the beginning of vegetation. The change in seasonal distribution of precipitation, interacting with increasing temperature in Q2 may result in earlier drought propagation with consequences for agricultural production in future (Trnka *et al*., 2014). In accordance with our study, Brázdil *et al*. (2021) reported decreasing tendency in Q2 precipitation sums over 97% of the Czech Republic territory, with significant negative trend (-5.6 mm/10 years) for altitudes bellow 300 m a. s. l., whereas for Q3 they also confirm significant positive trend for low altitudes, which is, however, spatially restricted to the area of south Moravia, while not present in the rest of the country. In the past (1961–1990), these semi-arid conditions applied usually for late summer months (August–September), but more recently (1991–2020) it is most pronounced in early spring (April) and emerging in August again. The combination of increased air temperature and changes in the annual precipitation distribution are expected to further shift this area towards even dryer conditions in the near future (Trnka *et al*., 2021; Zahradníček *et al*., 2021). Trends in temperature reported (not only) within this study pose increasing challenges for farmers in the future. Although some useful adaptation practices and tools for farmers are already being developed (Trnka *et al*., 2020; Altieri and Nicholls, 2017), one can expect increasing demand for advanced management techniques and search for new opportunities to ensure sustainable agriculture production in this area for decades to come.

## CONCLUSION

This study provided a summary and trend analysis of instrumental air temperature and precipitation dataset measured at Žabčice locality during the period 1961–2020, supplemented with selected agroclimatic indices. The dataset was utilized to establish a new climatological normal for the period 1991–2020 and both normal periods 1961–1990 and 1991–2020 were compared. We can conclude, that the mean air temperature is increasing on monthly, quarterly and yearly timescales. The fastest warming trend was observed during the growing season, peaking in June–August. There is an evident increase in extreme heat waves and other temperature-related indices, such as the Huglin index, suggesting a further rise in air temperature in the near future. Annual precipitation sums increased negligible, however, we can confirm a change in temporal distribution on an annual scale, in terms of decrease in the second quarter and increase in the third quarter.

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# APPENDIXES

Appendix I: *Monthly mean air temperatures at Žabčice weather station listed for the period 1961–2020*

| Year/Month | Mean air temperature (°C) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January | February | March | April | May | June | July | August | September | October | November | December | Year |
| **1961** | -2.8 | 2.8 | 6.8 | 12.6 | 12.8 | 18.4 | 17.8 | 18.6 | 14.4 | 9.8 | 4.0 | -2.2 | 9.4 |
| **1962** | -0.5 | -0.8 | 0.6 | 10.8 | 11.7 | 15.7 | 17.4 | 18.9 | 13.0 | 8.3 | 4.2 | -3.9 | 8.0 |
| **1963** | -7.6 | -6.1 | 1.0 | 9.9 | 14.3 | 18.0 | 20.4 | 18.7 | 15.5 | 8.6 | 6.8 | -4.9 | 7.9 |
| **1964** | -6.3 | -0.7 | 0.6 | 11.2 | 14.6 | 19.8 | 19.6 | 17.2 | 14.1 | 8.5 | 5.1 | -1.0 | 8.6 |
| **1965** | -0.6 | -2.8 | 3.0 | 8.4 | 12.1 | 17.6 | 18.1 | 16.6 | 14.8 | 7.5 | 1.5 | 1.0 | 8.1 |
| **1966** | -4.3 | 4.7 | 4.4 | 11.5 | 14.7 | 18.3 | 19.0 | 18.2 | 15.2 | 13.3 | 4.4 | 2.0 | 10.1 |
| **1967** | -1.3 | 1.6 | 6.0 | 9.5 | 14.9 | 17.2 | 20.7 | 18.2 | 15.6 | 11.1 | 3.7 | -0.3 | 9.7 |
| **1968** | -3.1 | 1.7 | 5.3 | 11.2 | 14.3 | 18.6 | 18.8 | 17.4 | 14.6 | 9.3 | 5.8 | -2.7 | 9.3 |
| **1969** | -2.5 | -1.4 | 1.5 | 9.7 | 17.0 | 16.9 | 19.6 | 17.5 | 15.1 | 10.5 | 5.5 | -4.1 | 8.8 |
| **1970** | -2.3 | -1.7 | 2.5 | 8.5 | 13.1 | 18.4 | 18.7 | 18.5 | 13.7 | 8.7 | 6.5 | 0.8 | 8.8 |
| **1971** | -3.2 | 2.2 | 2.0 | 10.5 | 16.1 | 16.4 | 19.9 | 20.8 | 13.0 | 8.0 | 3.8 | 3.2 | 9.4 |
| **1972** | -2.2 | 2.9 | 6.5 | 9.3 | 14.2 | 18.4 | 20.1 | 17.8 | 12.4 | 7.5 | 4.3 | 0.2 | 9.3 |
| **1973** | -0.5 | 1.6 | 5.3 | 7.9 | 14.9 | 17.7 | 19.0 | 19.3 | 15.6 | 7.5 | 2.0 | 0.3 | 9.2 |
| **1974** | 1.7 | 4.2 | 7.6 | 9.6 | 13.9 | 15.5 | 17.6 | 20.5 | 14.7 | 6.2 | 4.2 | 3.4 | 9.9 |
| **1975** | 2.4 | 0.3 | 5.6 | 9.0 | 15.6 | 17.4 | 20.0 | 19.6 | 17.6 | 9.2 | 3.0 | 0.4 | 10.0 |
| **1976** | 0.8 | -0.4 | 1.9 | 9.8 | 15.2 | 18.6 | 20.7 | 17.3 | 13.0 | 10.7 | 6.2 | 0.7 | 9.5 |
| **1977** | -0.6 | 2.5 | 7.0 | 7.6 | 13.2 | 18.0 | 18.4 | 18.2 | 15.1 | 11.9 | 6.4 | 0.0 | 9.8 |
| **1978** | 0.4 | -1.9 | 5.7 | 8.4 | 12.9 | 16.4 | 17.1 | 17.1 | 14.1 | 10.1 | 2.1 | 0.1 | 8.5 |
| **1979** | -5.0 | -0.2 | 5.5 | 8.0 | 14.9 | 19.3 | 17.2 | 17.1 | 14.1 | 7.7 | 4.2 | 3.0 | 8.8 |
| **1980** | -4.0 | 0.9 | 2.8 | 6.8 | 12.3 | 17.1 | 17.8 | 17.8 | 13.6 | 8.3 | 2.0 | -0.4 | 7.9 |
| **1981** | -3.3 | 0.2 | 7.4 | 8.5 | 15.3 | 18.6 | 17.7 | 18.3 | 15.3 | 10.0 | 4.7 | -1.3 | 9.3 |
| **1982** | -5.0 | -1.1 | 4.9 | 7.4 | 14.9 | 18.5 | 20.7 | 20.1 | 18.4 | 10.9 | 4.6 | 2.0 | 9.7 |
| **1983** | 3.7 | -1.4 | 5.3 | 11.9 | 16.2 | 18.5 | 23.5 | 21.0 | 15.3 | 9.8 | 2.1 | -0.8 | 10.4 |
| **1984** | -0.1 | 0.1 | 3.9 | 8.9 | 13.6 | 15.9 | 17.7 | 18.3 | 14.3 | 10.2 | 5.1 | -0.4 | 9.0 |
| **1985** | -8.2 | -4.3 | 3.8 | 9.6 | 16.4 | 15.5 | 19.4 | 18.6 | 14.4 | 9.2 | 1.1 | 2.2 | 8.1 |
| **1986** | -0.5 | -5.7 | 3.5 | 11.8 | 17.5 | 18.2 | 18.9 | 19.1 | 13.9 | 9.4 | 4.9 | -0.6 | 9.2 |
| **1987** | -6.6 | -0.7 | -0.1 | 9.7 | 12.9 | 17.7 | 20.8 | 17.4 | 15.7 | 11.1 | 5.3 | 1.6 | 8.7 |
| **1988** | 1.9 | 2.3 | 3.2 | 9.7 | 16.6 | 17.4 | 20.5 | 19.3 | 15.3 | 10.5 | 0.4 | 2.1 | 9.9 |
| **1989** | -0.1 | 4.2 | 7.5 | 10.7 | 16.3 | 17.1 | 20.8 | 19.4 | 15.8 | 10.6 | 2.7 | 0.6 | 10.5 |
| **1990** | 0.2 | 4.3 | 8.1 | 9.0 | 16.1 | 19.5 | 19.6 | 20.1 | 13.3 | 10.2 | 5.5 | 0.2 | 10.5 |
| **1991** | -0.4 | -3.5 | 6.7 | 9.0 | 11.5 | 17.8 | 21.5 | 19.6 | 16.8 | 8.9 | 4.5 | -1.0 | 9.3 |
| **1992** | 1.0 | 3.0 | 5.3 | 10.2 | 16.0 | 19.5 | 21.5 | 23.8 | 15.6 | 8.3 | 4.3 | 0.0 | 10.7 |
| **1993** | -0.2 | -1.7 | 3.5 | 11.2 | 17.5 | 17.8 | 18.7 | 19.3 | 14.5 | 10.0 | 1.6 | 1.5 | 9.5 |
| **1994** | 3.2 | 0.5 | 7.4 | 10.9 | 15.8 | 19.3 | 23.8 | 21.6 | 17.1 | 7.7 | 6.1 | 1.1 | 11.2 |
| **1995** | -0.6 | 4.3 | 3.9 | 10.6 | 15.1 | 17.8 | 22.9 | 20.0 | 13.8 | 10.8 | 1.9 | -0.9 | 10.0 |
| **1996** | -3.5 | -4.0 | 0.7 | 9.5 | 16.0 | 18.9 | 18.5 | 19.1 | 11.8 | 10.4 | 5.6 | -3.7 | 8.3 |
| **1997** | -3.5 | 1.8 | 4.3 | 6.8 | 15.5 | 18.9 | 18.7 | 20.2 | 14.4 | 6.8 | 4.5 | 2.0 | 9.2 |

| Year/Month | Mean air temperature (°C) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January | February | March | April | May | June | July | August | September | October | November | December | Year |
| 1998 | 1.2 | 3.6 | 4.8 | 12.3 | 15.8 | 20.1 | 20.6 | 20.7 | 14.7 | 9.3 | 1.1 | -2.0 | 10.2 |
| 1999 | -0.7 | -0.1 | 6.5 | 11.6 | 15.8 | 18.2 | 21.2 | 19.5 | 18.6 | 10.2 | 3.4 | -0.2 | 10.3 |
| 2000 | -2.1 | 3.0 | 5.4 | 14.6 | 17.7 | 20.8 | 18.3 | 21.5 | 14.6 | 12.3 | 7.5 | 1.5 | 11.3 |
| 2001 | 0.2 | 1.5 | 5.8 | 9.3 | 17.6 | 17.0 | 21.2 | 21.6 | 13.6 | 12.1 | 2.9 | -3.4 | 10.0 |
| 2002 | -0.8 | 4.5 | 5.8 | 10.5 | 18.2 | 19.3 | 21.3 | 20.6 | 14.1 | 8.1 | 6.7 | -2.3 | 10.5 |
| 2003 | -1.5 | -2.3 | 5.1 | 9.5 | 17.4 | 21.4 | 20.6 | 22.6 | 15.2 | 7.2 | 6.1 | 0.2 | 10.1 |
| 2004 | -2.9 | 2.1 | 4.3 | 11.8 | 13.9 | 18.0 | 19.6 | 20.1 | 14.6 | 11.0 | 4.5 | 0.0 | 9.8 |
| 2005 | 0.1 | -2.0 | 2.6 | 11.0 | 15.0 | 17.9 | 19.9 | 18.1 | 16.1 | 9.9 | 2.8 | -0.9 | 9.2 |
| 2006 | -6.1 | -2.2 | 1.9 | 11.1 | 14.7 | 18.7 | 22.6 | 16.8 | 16.8 | 11.1 | 6.4 | 2.7 | 9.5 |
| 2007 | 3.8 | 4.1 | 7.1 | 12.2 | 16.7 | 20.3 | 20.9 | 20.8 | 13.2 | 8.6 | 2.8 | -0.2 | 10.9 |
| 2008 | 1.8 | 2.6 | 4.8 | 10.1 | 15.4 | 19.8 | 20.4 | 20.0 | 14.3 | 9.8 | 6.5 | 1.8 | 10.6 |
| 2009 | -3.3 | 0.4 | 5.0 | 14.5 | 15.6 | 17.3 | 20.7 | 21.1 | 17.2 | 8.9 | 5.7 | 0.1 | 10.3 |
| 2010 | -3.9 | -0.6 | 4.8 | 10.2 | 14.0 | 18.7 | 21.9 | 19.3 | 13.7 | 7.3 | 6.7 | -3.9 | 9.0 |
| 2011 | -0.4 | -0.9 | 5.5 | 12.4 | 15.3 | 19.4 | 19.2 | 20.5 | 17.1 | 9.3 | 2.6 | 2.2 | 10.3 |
| 2012 | 1.1 | -3.4 | 7.1 | 10.8 | 16.9 | 19.9 | 21.4 | 21.2 | 16.2 | 9.4 | 6.6 | -1.2 | 10.5 |
| 2013 | -1.1 | 0.6 | 1.9 | 10.6 | 14.7 | 18.2 | 21.8 | 20.6 | 14.1 | 10.3 | 5.6 | 2.3 | 10.0 |
| 2014 | 1.3 | 2.9 | 8.5 | 11.7 | 14.6 | 18.7 | 21.6 | 18.1 | 15.8 | 11.5 | 7.7 | 2.5 | 11.3 |
| 2015 | 1.9 | 1.7 | 5.5 | 10.0 | 14.6 | 19.1 | 22.9 | 23.5 | 16.1 | 9.6 | 6.2 | 2.9 | 11.2 |
| 2016 | -1.2 | 5.1 | 5.5 | 9.8 | 15.7 | 19.8 | 21.3 | 19.5 | 17.9 | 9.0 | 3.9 | -0.5 | 10.5 |
| 2017 | -5.8 | 1.5 | 7.7 | 9.0 | 15.8 | 20.8 | 21.1 | 21.7 | 14.1 | 10.4 | 4.6 | 1.4 | 10.3 |
| 2018 | 2.1 | -2.0 | 2.4 | 14.6 | 18.3 | 20.1 | 21.8 | 23.8 | 16.6 | 12.0 | 5.8 | 1.5 | 11.5 |
| 2019 | -0.9 | 2.4 | 7.0 | 11.8 | 12.6 | 22.8 | 21.0 | 21.7 | 15.6 | 10.6 | 7.2 | 1.7 | 11.2 |
| 2020 | -0.5 | 4.8 | 5.8 | 10.6 | 13.0 | 18.3 | 19.9 | 21.3 | 16.0 | 10.5 | 4.7 | 2.5 | 10.6 |
| 1961–2020 | -1.4 | 0.6 | 4.7 | 10.3 | 15.1 | 18.4 | 20.1 | 19.6 | 15.0 | 9.6 | 4.5 | 0.1 | 9.8 |
| 1961–1990 | -2.0 | 0.2 | 4.3 | 9.6 | 14.6 | 17.7 | 19.3 | 18.6 | 14.7 | 9.5 | 4.1 | 0.0 | 9.3 |
| 1991–2020 | -0.7 | 0.9 | 5.1 | 11.0 | 15.6 | 19.2 | 20.9 | 20.6 | 15.4 | 9.7 | 4.9 | 0.3 | 10.3 |

Appendix II: *Monthly precipitation sums at Žabčice weather station listed for the period of 1961–2020*

| | Precipitation sums (mm) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year/Month | January | February | March | April | May | June | July | August | September | October | November | December | Year |
| **1961** | 13.8 | 21.0 | 10.7 | 33.4 | 70.7 | 63.5 | 69.7 | 27.4 | 12.8 | 51.8 | 44.5 | 31.5 | 450.8 |
| **1962** | 20.9 | 25.1 | 47.6 | 40.7 | 111.1 | 20.8 | 29.5 | 31.6 | 33.9 | 49.7 | 86.2 | 23.7 | 520.8 |
| **1963** | 28.2 | 19.1 | 37.7 | 25.8 | 102.4 | 79.1 | 10.9 | 84.4 | 60.9 | 15.8 | 34.5 | 1.3 | 500.1 |
| **1964** | 2.1 | 11.8 | 38.8 | 30.2 | 90.7 | 60.5 | 48.8 | 62.1 | 9.1 | 109.6 | 9.9 | 28.7 | 502.3 |
| **1965** | 12.4 | 6.1 | 22.2 | 63.5 | 113.0 | 91.7 | 66.5 | 58.3 | 27.4 | 3.4 | 24.0 | 19.8 | 508.3 |
| **1966** | 4.7 | 43.7 | 12.1 | 24.7 | 69.4 | 78.6 | 134.9 | 64.2 | 24.2 | 24.5 | 39.5 | 50.9 | 571.4 |
| **1967** | 18.1 | 9.6 | 14.4 | 23.6 | 63.4 | 100.2 | 44.0 | 10.3 | 81.9 | 13.9 | 20.6 | 29.2 | 429.2 |
| **1968** | 26.7 | 15.9 | 11.9 | 34.2 | 76.7 | 62.0 | 83.3 | 105.9 | 19.4 | 25.9 | 58.5 | 15.1 | 535.5 |
| **1969** | 32.3 | 35.5 | 31.1 | 6.4 | 57.8 | 106.0 | 21.1 | 71.7 | 8.3 | 3.5 | 44.4 | 29.9 | 448.0 |
| **1970** | 7.9 | 60.3 | 37.9 | 34.6 | 25.0 | 82.3 | 92.5 | 74.6 | 16.8 | 47.9 | 71.3 | 18.4 | 569.5 |
| **1971** | 17.6 | 13.6 | 39.2 | 28.5 | 35.6 | 54.5 | 46.1 | 26.4 | 36.4 | 19.0 | 38.3 | 15.9 | 371.1 |
| **1972** | 31.6 | 25.2 | 9.2 | 69.2 | 56.8 | 39.0 | 138.8 | 38.6 | 22.4 | 9.5 | 24.9 | 3.8 | 469.0 |
| **1973** | 25.8 | 29.7 | 8.1 | 58.5 | 18.7 | 70.6 | 89.0 | 27.3 | 55.9 | 22.1 | 16.7 | 13.6 | 436.0 |
| **1974** | 25.2 | 13.5 | 5.3 | 1.9 | 41.6 | 99.8 | 96.1 | 35.0 | 20.8 | 61.8 | 39.2 | 48.4 | 488.6 |
| **1975** | 18.1 | 1.1 | 33.2 | 20.4 | 54.1 | 79.3 | 33.6 | 52.3 | 17.8 | 67.5 | 20.0 | 10.6 | 408.0 |
| **1976** | 51.5 | 18.7 | 7.8 | 17.8 | 69.0 | 31.3 | 24.5 | 55.0 | 43.6 | 55.0 | 71.5 | 35.0 | 480.7 |
| **1977** | 113.0 | 88.0 | 38.0 | 50.6 | 42.1 | 27.3 | 55.0 | 97.6 | 56.2 | 15.1 | 37.4 | 11.4 | 631.7 |
| **1978** | 16.1 | 15.0 | 9.2 | 38.4 | 66.6 | 67.2 | 61.4 | 46.4 | 13.8 | 18.3 | 1.0 | 17.6 | 371.0 |
| **1979** | 27.4 | 32.2 | 40.9 | 75.0 | 9.0 | 118.0 | 58.1 | 67.1 | 60.0 | 5.3 | 80.6 | 41.8 | 615.4 |
| **1980** | 22.6 | 19.1 | 17.1 | 54.3 | 34.3 | 68.3 | 30.9 | 28.0 | 33.0 | 58.4 | 41.2 | 28.4 | 435.6 |
| **1981** | 15.7 | 16.9 | 38.0 | 6.8 | 61.3 | 59.8 | 79.5 | 20.9 | 98.6 | 49.5 | 20.9 | 64.2 | 532.1 |
| **1982** | 27.7 | 0.6 | 28.3 | 7.2 | 70.2 | 69.7 | 56.7 | 21.6 | 16.3 | 24.1 | 16.8 | 38.5 | 377.7 |
| **1983** | 24.9 | 25.1 | 13.6 | 33.2 | 49.3 | 64.1 | 26.9 | 9.3 | 36.4 | 28.4 | 14.5 | 24.7 | 350.4 |
| **1984** | 29.0 | 32.3 | 29.1 | 38.6 | 115.0 | 31.1 | 67.9 | 24.5 | 67.1 | 31.0 | 51.3 | 21.7 | 538.6 |
| **1985** | 22.8 | 31.3 | 47.7 | 11.6 | 92.1 | 63.4 | 67.7 | 162.4 | 15.1 | 6.0 | 72.0 | 21.1 | 613.2 |
| **1986** | 26.0 | 27.4 | 22.2 | 11.6 | 71.5 | 54.8 | 29.6 | 77.3 | 25.8 | 24.6 | 23.9 | 28.3 | 423.0 |
| **1987** | 43.7 | 25.9 | 19.5 | 16.2 | 99.7 | 112.5 | 57.6 | 42.9 | 37.3 | 37.7 | 23.4 | 31.5 | 547.9 |
| **1988** | 25.4 | 37.9 | 17.5 | 14.8 | 32.3 | 66.8 | 30.5 | 49.3 | 42.0 | 20.1 | 11.5 | 46.0 | 394.1 |
| **1989** | 11.9 | 8.5 | 10.9 | 60.1 | 45.8 | 50.6 | 11.3 | 142.9 | 31.8 | 10.7 | 11.0 | 20.7 | 416.2 |
| **1990** | 1.3 | 36.0 | 16.8 | 66.3 | 40.3 | 84.2 | 51.2 | 13.3 | 49.7 | 44.4 | 54.0 | 18.5 | 476.0 |
| **1991** | 7.0 | 10.3 | 18.2 | 14.0 | 85.2 | 50.9 | 66.1 | 95.4 | 23.3 | 8.9 | 85.2 | 24.1 | 488.6 |
| **1992** | 8.4 | 11.5 | 65.4 | 35.5 | 24.1 | 45.1 | 24.7 | 70.2 | 47.0 | 61.9 | 44.3 | 32.4 | 470.5 |
| **1993** | 15.4 | 15.7 | 18.0 | 10.6 | 33.7 | 67.2 | 73.6 | 68.1 | 43.9 | 35.4 | 24.0 | 56.0 | 461.6 |
| **1994** | 19.4 | 13.1 | 20.1 | 53.8 | 76.0 | 21.1 | 23.0 | 55.4 | 22.5 | 42.1 | 13.4 | 29.1 | 389.0 |
| **1995** | 20.9 | 15.9 | 41.0 | 38.5 | 57.0 | 68.5 | 25.8 | 54.1 | 107.5 | 5.3 | 28.3 | 27.8 | 490.6 |
| **1996** | 24.8 | 30.5 | 20.4 | 49.8 | 50.1 | 75.7 | 43.4 | 89.3 | 42.4 | 45.4 | 23.4 | 16.0 | 511.2 |
| **1997** | 14.3 | 18.6 | 25.6 | 14.3 | 51.4 | 71.1 | 273.5 | 38.2 | 13.3 | 25.7 | 72.3 | 42.1 | 660.4 |
| **1998** | 12.0 | 2.8 | 15.3 | 39.3 | 20.2 | 71.4 | 53.8 | 37.6 | 133.2 | 95.0 | 27.4 | 10.8 | 518.8 |
| **1999** | 5.0 | 10.6 | 20.8 | 49.8 | 44.4 | 81.6 | 82.4 | 10.4 | 35.6 | 11.2 | 42.2 | 5.6 | 399.6 |

| | Precipitation sums (mm) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year/Month | January | February | March | April | May | June | July | August | September | October | November | December | Year |
| **2000** | 28.6 | 16.8 | 40.5 | 2.4 | 44.6 | 13.6 | 116.6 | 48.4 | 37.8 | 17.6 | 38.4 | 29.1 | 434.4 |
| **2001** | 25.3 | 9.5 | 46.0 | 31.6 | 31.8 | 42.0 | 68.6 | 57.6 | 107.0 | 10.6 | 41.2 | 14.8 | 486.0 |
| **2002** | 3.1 | 17.4 | 21.2 | 28.6 | 68.8 | 103.8 | 107.5 | 98.2 | 36.5 | 91.1 | 28.6 | 24.6 | 629.4 |
| **2003** | 18.2 | 1.9 | 3.0 | 18.2 | 42.2 | 11.6 | 48.6 | 29.6 | 28.2 | 57.6 | 31.6 | 51.0 | 341.7 |
| **2004** | 41.9 | 27.6 | 59.8 | 34.0 | 28.3 | 65.2 | 28.6 | 33.2 | 43.8 | 66.2 | 35.0 | 18.0 | 481.6 |
| **2005** | 19.4 | 44.4 | 5.8 | 49.5 | 66.8 | 46.2 | 103.1 | 80.7 | 33.2 | 6.2 | 23.4 | 30.2 | 508.9 |
| **2006** | 22.3 | 26.4 | 46.2 | 50.5 | 75.3 | 71.40 | 78.4 | 151.3 | 9.0 | 13.9 | 21.4 | 20.8 | 586.9 |
| **2007** | 22.7 | 42.2 | 80.8 | 4.4 | 24.8 | 71.7 | 31.6 | 39.5 | 103.8 | 37.9 | 30.5 | 26.0 | 515.9 |
| **2008** | 15.7 | 10.4 | 32.9 | 29.3 | 53.5 | 19.6 | 49.9 | 55.9 | 46.1 | 27.3 | 22.1 | 31.1 | 393.8 |
| **2009** | 20.0 | 57.6 | 78.1 | 3.6 | 42.4 | 114.7 | 74.0 | 29.6 | 24.7 | 21.2 | 55.4 | 37.6 | 558.9 |
| **2010** | 46.8 | 22.8 | 9.8 | 53.1 | 102.4 | 79.8 | 87.9 | 75.8 | 57.8 | 10.4 | 32.8 | 11.1 | 590.5 |
| **2011** | 21.4 | 4.6 | 39.3 | 33.2 | 46.2 | 42.9 | 79.8 | 42.4 | 31.1 | 22.6 | 1.6 | 14.6 | 379.7 |
| **2012** | 27.4 | 7.4 | 2.4 | 19.8 | 21.4 | 101.2 | 64.6 | 43.0 | 40.2 | 49.2 | 19.4 | 35.6 | 431.6 |
| **2013** | 15.0 | 40.8 | 37.1 | 19.8 | 108.4 | 146.8 | 4.0 | 43.6 | 62.8 | 35.0 | 20.2 | 5.4 | 538.9 |
| **2014** | 21.4 | 9.2 | 5.2 | 10.8 | 63.0 | 43.2 | 84.6 | 113.6 | 115.8 | 46.2 | 28.8 | 26.7 | 568.5 |
| **2015** | 19.2 | 6.8 | 27.2 | 8.8 | 32.2 | 22.0 | 22.0 | 105.8 | 23.4 | 48.0 | 24.6 | 16.2 | 356.2 |
| **2016** | 15.6 | 64.7 | 30.4 | 41.6 | 42.0 | 34.8 | 149.2 | 65.0 | 10.0 | 54.4 | 24.9 | 7.2 | 539.8 |
| **2017** | 32.1 | 10.7 | 18.7 | 42.4 | 24.0 | 25.8 | 68.2 | 22.4 | 83.0 | 35.8 | 23.8 | 20.4 | 407.3 |
| **2018** | 46.2 | 14.5 | 15.6 | 9.6 | 51.2 | 45.6 | 36.0 | 14.2 | 114.8 | 10.2 | 11.6 | 28.6 | 398.1 |
| **2019** | 27.0 | 24.4 | 12.6 | 19.2 | 79.0 | 67.2 | 55.4 | 72.4 | 46.0 | 35.0 | 38.0 | 46.0 | 522.2 |
| **2020** | 14.4 | 19.6 | 20.4 | 10.8 | 81.8 | 128.6 | 44.0 | 97.6 | 87.2 | 83.4 | 22.4 | 35.6 | 645.8 |
| **1961–2020** | 23.0 | 22.7 | 26.9 | 30.5 | 57.5 | 65.2 | 63.0 | 57.7 | 44.7 | 34.4 | 34.1 | 26.0 | 485.6 |
| **1961–1990** | 24.8 | 24.9 | 23.9 | 33.2 | 62.8 | 68.6 | 57.1 | 54.3 | 35.5 | 31.8 | 36.8 | 26.3 | 480.0 |
| **1991–2020** | 21.1 | 20.4 | 29.9 | 27.8 | 52.2 | 61.7 | 68.9 | 61.1 | 53.9 | 37.0 | 31.4 | 25.7 | 491.1 |