EARLY INSTRUMENTAL METEOROLOGICAL OBSERVATIONS IN THE CZECH LANDS II: ANDREAS STERLY, JIHLAVA, 1816–1840 (1844)

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Systematic meteorological observations associated with the meteorological activities of the Imperial-Royal Moravian-Silesian Economic Society in Brno began in many parts of Moravia and Silesia in the first third of the 19th century. Outstanding amongst them were the activities of the magistrate councillor Andreas Sterly at Jihlava, whose daily observations are preserved (with gaps) for the years 1816–1826 and can be found in the archives of the Society. Monthly summaries for the period 1817–1840 (precipitation 1821–1844) appeared in Pokorny (1852). This current paper gives a detailed description of these measurements, including also the results of a statistical analysis of air pressure and temperature, precipitation, cloudiness, wind strength and direction, fog, hail and thunderstorms.

V návaznosti na meteorologické aktivity c. k. Moravskoslezské hospodářské společnosti v Brně začala na mnoha místech na Moravě a ve Slezsku v první třetině 19. století systematická meteorologická pozorování. Mezi nimi vynikají především pozorování magistrátního rady v Jihlavě Andrease Sterlyho, dochovaná na bázi denních pozorování (s mezerami) z let 1816–1826 v archivních materiálech Společnosti a na úrovni měsíčních hodnot z období 1817–1840 (srážky 1821–1844) v publikaci Pokorneho (1852). Práce podává podrobnou popisnou charakteristiku těchto měření a uvádí výsledky statistické analýzy tlaku a teploty vzduchu, srážek, oblačnosti, směru a síly větru, mlhy, krupobití a bouřek.

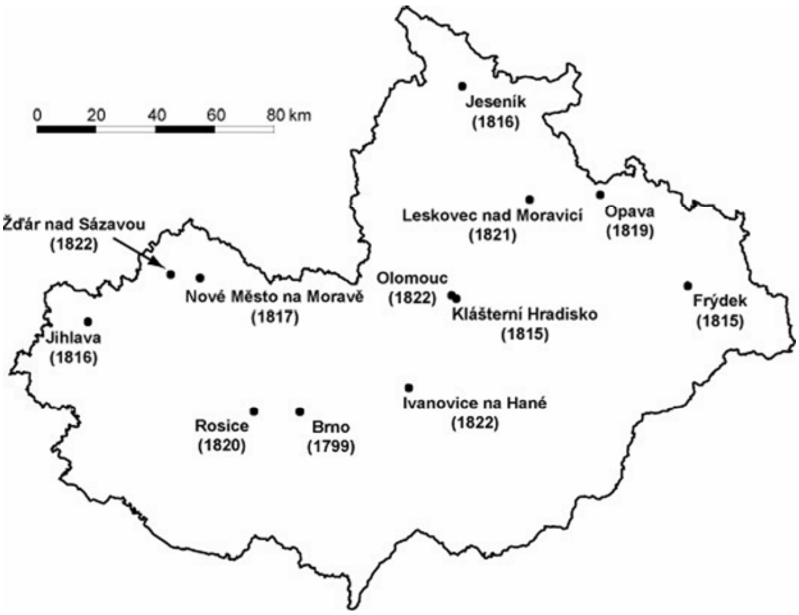
Key words: early instrumental measurements, pressure, temperature, precipitation, cloudiness, wind, meteorological phenomena, Andreas Sterly, Jihlava

INTRODUCTION

The activities of the Imperial-Royal Moravian-Silesian Economic Society were important for the development of early instrumental meteorological observations in Moravia and Silesia. The establishment of the Society's Meteorological Section in 1815 was a critical development in this respect. The Meteorological Section produced detailed printed instructions for observers and offered to buy barometers and thermometers for their use. In return, the observers were asked to send their observations to the Meteorological Section in Brno. Some of those records remain in the Society archives (see Meteorologická pozorování). According to those weather records, besides Brno observations (see Brázdil et al., 2005, 2006), other began to be made in some other places (Fig. 1):

- location – Frýdek, period of observations – July–December 1815, observer – Martin Ehrmann
- Klášterní Hradisko, August 1815–June 1816, Joseph Bayer, supervisor of the land cadaster
- Jeseník, January 1816–November 1818, Jungnikel, syndicus
- Jihlava, July 1816–December 1826, Andreas Sterly, magistrate councillor
- Nové Město na Moravě, June 1817–June 1824, Johann Merfort, economic director
- Opava, June 1819–December 1821, March 1823, Carl Biela, secondary school principal, and his son Franz Biela, builder
- Leskovec nad Moravicí, January 1821–June 1828, Anton Saliger, economist and school supervisor
- Rosice, January–March 1820, 1821–1822, 1824–1827, Johann Jurende, mining office supervisor
- Opava, 1822–1827, Robert Jeník, grammar school principal
- Uhřice, May 1822, an observer is not mentioned
- Olomouc, May–June 1822, Andreas Baumgartner, Professor of physics at the lyceum
- Ivanovice na Hané, June 1822–1825, Andreas Altmann, official
- Žďár nad Sázavou, November–December 1822, Anton Prziborsky (Přiborsky), higher administrative official (Brázdil et al., 2005).

Figure 1.
Meteorological stations in Moravia and Silesia, the readings from which were sent to the I.-R. Moravian-Silesian Economic Society. The first year of records is given in brackets. Uhřice is not shown due to uncertainties regarding its location (Brázdil et al., 2005).



Unfortunately, some of the above records are only limited to a few months and there is no reliable indication of the true length of period over which observations were made.

The present contribution links the analysis of meteorological observations of Ferdinand Knittelmayer in Brno of the years 1799–1812 (Brázdil et al., 2006) with that of meteorological observations of the magistrate councillor Andreas Sterly at Jihlava whose observations cover the longest span of those available. Sterly's daily records for the period 1816–1826 remained partly preserved in the Moravian Land Archives in Brno and for the period 1817–1840 (1844) are preserved in the form of monthly values published by Pokorny (1852).

ANDREAS STERLY

Andreas Sterly (Fig. 2) was, during his day, one of the most important meteorological observers (d'Elvert, 1853; Wurzbach, 1879; Schwab, 1935). He was born on 21 November 1779 at Jihlava. At the age of five his father sent him to the primary school and in 1790 to the secondary school, from where, in the same year, he passed to the grammar school for five years. After grammar school Sterly spent another five years at Vienna University, where for the first three years he devoted his time to philosophy and for the remaining two years to legal sciences. He also attended lectures as diverse as politics, heraldry and numismatics. At the same time he studied French, Italian, English and also Czech (in the last year of his studies at Olomouc). At the beginning of October 1803 he began his career at Jihlava as court probationer and from 1807 as secretary. He soon applied his knowledge of French during the occupation of Jihlava by Napoleon's army assisting in the negotiations concerning the community. In 1810 Sterly obtained a job at the town hall of Jihlava and three years later he was appointed magistrate councillor. In 1811 he got married and eventually became father of six children. In 1816 he started to devote his time to meteorology, astronomy and electricity. In the same year he began his regular meteorological observations, which he carried out for more than 24 years. In 1820 he became the principal of the provisional land tax office for the Jihlava region. At that time he developed an interest in mineralogy, history and geography, and began working on the history of the town of Jihlava. Between 1828 and 1840 he worked as economics official before retiring in 1845. The fruitful life of Sterly ended at Jihlava (Fig. 3) at the age of 73 on 26 December 1852.

Figure 2. Andreas Sterly (1779–1852) and his signature (reproduction, State District Archives, Jihlava).

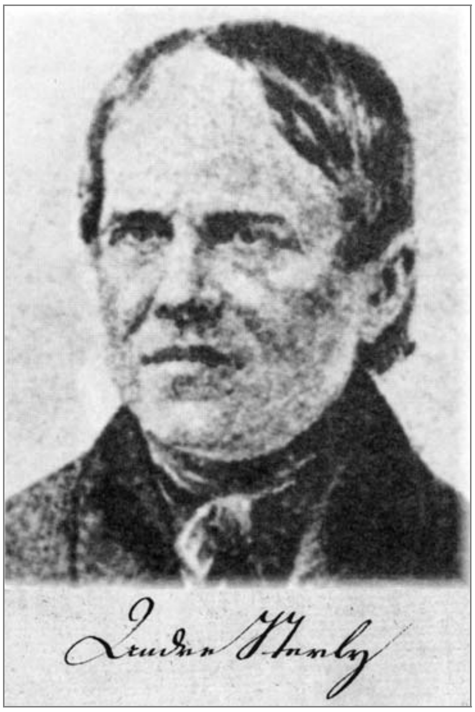
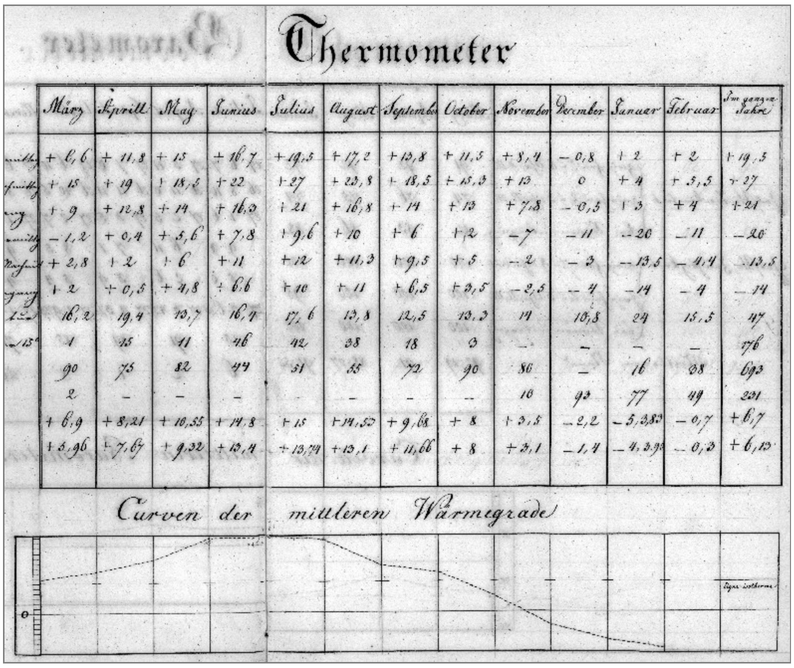


Figure 3.
A view of Jihlava from the south, 1849. Drawing and lithography J. W. Zwettler, steel engraving F. Zastiera, print J. Rippl Jihlava (State District Archives, Jihlava).



Thermometer

	März	Aprill	May	Junius	Julius	August	September	October	November	December	Januar	Februar	Im ganzen Jahre
	+ 6,6	+ 11,8	+ 15	+ 16,7	+ 19,5	+ 17,2	+ 13,8	+ 11,5	+ 8,4	- 0,8	+ 2	+ 2	+ 19,5
	+ 15	+ 19	+ 18,5	+ 22	+ 27	+ 23,8	+ 18,5	+ 15,3	+ 13	0	+ 4	+ 5,5	+ 27
	+ 9	+ 12,8	+ 14	+ 16,3	+ 21	+ 16,8	+ 14	+ 13	+ 7,8	- 0,5	+ 3	+ 4	+ 21
	- 1,2	+ 0,4	+ 5,6	+ 7,8	+ 9,6	+ 10	+ 6	+ 2	- 7	- 11	- 20	- 11	- 20
	+ 2,8	+ 2	+ 6	+ 11	+ 12	+ 11,3	+ 9,5	+ 5	- 2	- 3	- 13,5	- 4,4	- 13,5
	+ 2	+ 0,5	+ 4,8	+ 6,6	+ 10	+ 11	+ 6,5	+ 3,5	- 2,5	- 4	- 14	- 4	- 14
	16,2	19,4	13,7	16,4	17,6	13,8	12,5	13,3	14	10,8	24	15,5	47
	1	15	11	46	42	38	18	3	-	-	-	-	176
	90	75	82	44	51	55	72	90	86	-	16	38	693
	2	-	-	-	-	-	-	-	10	93	77	49	231
	+ 6,9	+ 8,21	+ 10,55	+ 14,8	+ 15	+ 14,53	+ 9,68	+ 8	+ 3,5	- 2,2	- 5,383	- 0,7	+ 6,7
	+ 5,96	+ 7,67	+ 9,32	+ 13,4	+ 13,74	+ 13,1	+ 11,66	+ 8	+ 3,1	- 1,4	- 4,393	- 0,3	+ 6,13

Figure 4.
An example of Sterly's records of air temperature and the graph of the variation of mean monthly temperatures for March 1819 to February 1820 (Moravian Land Archives, Brno).

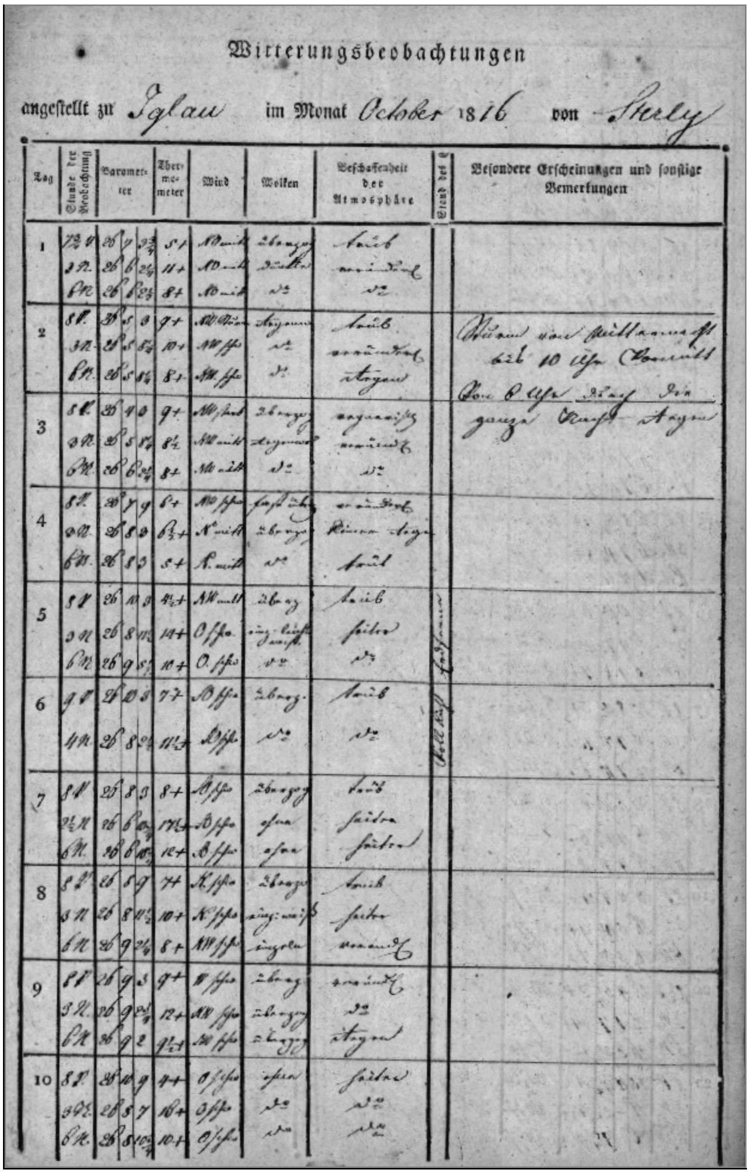
METEOROLOGICAL OBSERVATIONS BY ANDREAS STERLY

As noted already, Andreas Sterly's meteorological observations were connected with the activities of the Meteorological Section of the I.-R. Moravian-Silesian Economic Society in Brno, even though he was not mentioned among its original members, and only in 1819 did he become a corresponding member (Schwab, 1935; Brázdil et al., 2005). Sterly's meteorological records of Jihlava from 1818 had already been used by the head of the Meteorological Section Dr. Josef Steiner, together with the observations from Brno and Opava in a lecture for the plenary session of the I.-R. Moravian-Silesian Economic Society on 6 May 1819 (Steiner, 1819).

Sterly's meteorological observations are now preserved in the Moravian Land Archives in Brno and are stored in the section G 82 Economic Society Brno 1769–1937, sign. IV/3e, Meteorological observations (see Meteorologická pozorování). In the box number 206 the following items are deposited:

- monthly reports of daily meteorological observations for July and September–December 1816, March–June 1817, April–August 1818, January–February and July–October 1819, April–September and December 1820, complete years 1821, 1822, 1824, 1825 and 1826,
- annual text and tabulated weather overviews for the period 1 March 1819 to 29 February 1820, 1 March 1820–28 February 1821 with additional material for the years 1822 and 1824 to 1826 (completed tables and text and graphical summaries of the annual variation of mean air temperature, pressure and relative humidity also survive for the first mentioned period – Fig. 4),
- mean monthly values of air pressure and temperature for the period 1817 to 1820.

Figure 5. Monthly report of meteorological observations of Andreas Sterly of Jihlava, October 1816 (Moravian Land Archives, Brno).


Witterungsbeobachtungen

angestellt zu Iglau im Monat October 1816 von Sterly

Tag	Stunde der Beobachtung	Barometer	Thermometer	Wind	Wolken	Beschaffenheit der Atmosphäre	Stand des Mondes	Besondere Erscheinungen und sonstige Bemerkungen

data for wind direction and strength. The next column was devoted to the observation of clouds and the seventh to the state of the weather (e.g. rain, fog, variable). The form ended with columns for notes derived from observing the Moon, for special events and general notes and finally for other measurements such as precipitation and air humidity.

There is no doubt that Sterly observed not only in the months for which the monthly reports are now missing, but also for the period after 1826. According to Pokorny (1852) Sterly's observations should exist for the years up to 1840 as part of quarterly reports of the Jihlava regional physicist. Sterly himself published a summary overview of his meteorological observations in the journal 'Moravia' (Sterly, 1846). This analysis was partly taken over by d'Elvert (1850) in the description of the history of Jihlava and to a greater degree by Pokorny (1852), who not only stated that he was able to use the report by Sterly ("durch die gewohnte Liberalität des Herrn Sterly, der mir sein Elaborat zur freiesten Benützung überliess"), but also that he published monthly summaries of meteorological observations for 1817 to 1840 (1844).

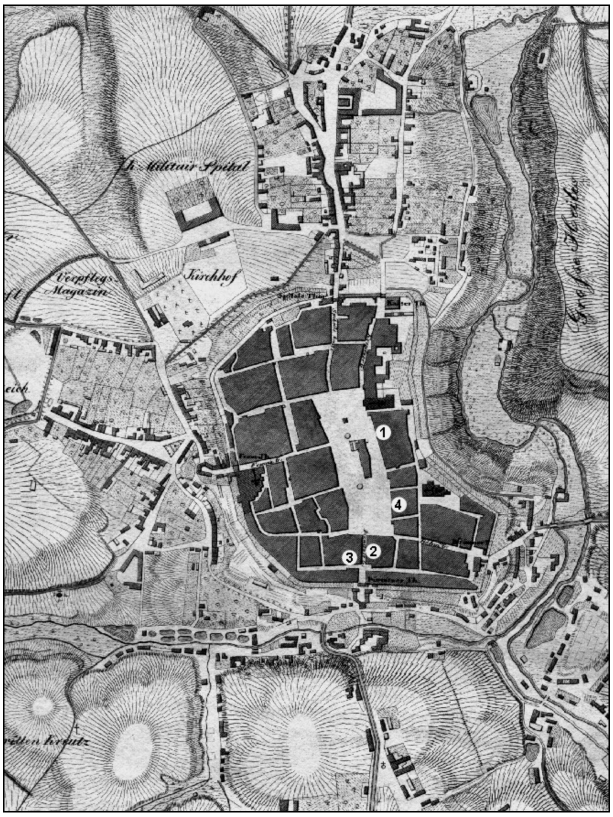
It can be deduced from Sterly's summary meteorological observations from 1 March 1819 to 29 August 1820 that he used an outdoor thermometer and the siphon barometer No. 34, made by Kassian Hallaschka to provide for the needs of the Meteorological Section (for details see Brázdil et al., 2005). According to the note in the monthly report, he first used these instruments on 13 December 1816. Sterly adds that an additional 80-part thermometer was placed in the shade in free air on the northern side of the building at a height of 4 ells (7.59 m) above the ground. In the summary of monthly observations for 1822 it is also possible to find a note making reference to the measurement of precipitation, which he found according to the volume of the caught water. Sterly, however, also measured the relative air humidity with the hair hygrometer according to Saussure's hundred-part scale, but these data have not survived in the form of a continuous series of monthly values.

It is not known whether the reports for those months of missing observations were sent to the Society or whether they were lost at a later date. Sterly states, however, in his autobiography (Schwab, 1935) that from 1817 he sent his observations to the Meteorological Section every month.

The monthly forms of meteorological observations conform largely to the structure recommended in the instructions of the Meteorological Section (Fig. 5). In the heading described as "Meteorologische Beobachtungen (Witterungsbeobachtungen), angestellt zu Iglau im Monate …" the word "Iglau" was initially completed in Sterly's hand, and from 1819 the heading was printed in its entirety. The first two columns of the form were set aside for the day in the month and the hour of observation. In the third column were written the values of the air pressure (later he also added the temperature at the barometer) and in the fourth air temperatures. The following column contained

As for the place where the observations were made, it can be assumed that it was either at the town hall or at Sterly's houses located close to the main town square (Fig. 6). In the above mentioned summaries Sterly described the properties of the surroundings of the point of observation as "old mountains rising to the height of 263–265 ells [499–503 m] above the sea, with visible forests on the southwest, west, northwest and north". At the same time he also stated latitude (49°23´29´´N) and longitude (33°16´00´´ east of Ferro, i.e. 15°36´14´´E).

***Figure 6.** Jihlava and its surroundings in the map of 1825 (State District Archives, Jihlava). The possible locations of Sterly's observatory: 1 – town hall (now Masaryk Square), 2 – house No. 145 (now Znojemská Street No. 5) where he stayed at the time of his marriage, 3 – house No. 261 (now Havířská Street No. 2, Sterly bought this property in 1821), 4 – house No. 65 (the house of Sterly's wife, now Masaryk Square No. 15).*



THE CHARACTER OF THE WEATHER AND CLIMATE IN JIHLAVA, 1817–1840

As the daily meteorological observations of Andreas Sterly cover only a part of the period 1816–1826, the summary of monthly values of meteorological elements and events for the period 1817–1840, published by Pokorny (1852) were used as the basis of this analysis. These summaries provide the following statistics:

- the highest, the lowest and the mean air temperature on the Réaumur scale
- the highest, the lowest and the mean air pressure in Vienna inches, lines and points
- the volume of precipitation in cubic inches and lines, but only for the period 1821 to 1844
- observations of cloud cover and the number of cases with fog, hail or thunderstorm
- observation of wind strength using the scale calm, weak, medium and strong
- wind direction on an eight-point compass.

From the point of view of statistical analysis of Sterly's observations, a disadvantage is provided by the variable time of observation, which, according to the instruction of the Meteorological Section should have been at sunrise (dependence of course on the season of the year and varying between 0400–0800 hours), at the time of its culmination (1200–1300 hours) and at sunset (1700–2100 hours). As a consequence in the years 1817 to 1819 observation times were 0800, 1500 and 2000 and/or 2100 hours but from July to the end of October 1819 the morning time changed by a quarter of an hour increments between 0700–0800 hours. The afternoon times varied between 1400 and 1500 hours, and the evening times drifted from 1954 to 1655 hours. In the years 1821 and 1822 the morning time of observation fluctuated between 0700 and 0800 hours, but in the period 1824 to 1826 it was consistently 0800 hours. The afternoon time, with the exception of 1330 hours during December 1821, was stabilised to 1400 hours, whereas the evening one shifted from 1800 (as a rule October–March) to 1900 (April, September) and 2000 hours (May–August).

The fluctuating times of observation distort the statistical picture created by the daily mean values for air pressure and temperature; the degree of distortion varying itself during the year and within the individual months. Therefore stations Prague-Klementinum, Brno and Vienna-Hohe Warte were selected to act as reference points with which Sterly's data were compared with the aim of removing such error values and consequently of homogenising the Jihlava series using the Standard Normal Homogeneity Test (SNHT) according to Alexandersson (1986).

Sterly's period from 1817 to 1840, when compared with the standard period 1961–1990, appears to be colder in the months of the winter half-year (particularly January to March), the summer months being only slightly warmer (Fig. 7). With the exception of the winter, all months had lower pressure in comparison with the standard period. The years 1821 to 1844 were drier in February and May but wetter in July and November to January. In other months the differences between the two periods are less distinct: in Brno wetter patterns prevailed from August to October, but in Prague these months with exception of September were drier.

Air pressure

The values of air pressure were given in Vienna inches, lines and points, and it was necessary to convert them to the SI units (1 inch = 12 lines = 26.34 mm, 1 line = 12 points = 2.195 mm). As Sterly also recorded the temperature at the barometer, it can be assumed that his values are reduced to the temperature of 0°C. The checking of the monthly values was based on the calculations of pressure differences with Prague, Brno and Vienna as well as on a comparison of the character of their annual variations year by year. Using these approaches it was possible to identify problematic monthly values taken from Pokorny (1852) which were consequently adjusted being calculated either from daily data or by use of linear regression methods. The Brno station was adopted as the reference data set because of the high correlation coefficients with those from Jihlava (Fig. 8b). After homogenisation the January pressure continued to present problems as a consequence of it providing the smallest correlation ($r = +0.45$) but no methods for improving Sterly's data were found. Conspicuously low correlations were also found in the data for May and June.

Figure 8a shows the annual variation of monthly means of the homogenized air pressure with a maximum in October and minimum in April. This behaviour is consistent with pressure fluctuations of the Přibyslav station (536 m a.s.l.) for the period 1961 to 1990, this site being selected for comparison (Míková, Coufal, 1999). Months from the winter-half year in comparison with the summer half-year show higher variability expressed by a greater range of maximum and minimum values.

Air temperature

The measured values of air temperature published by Pokorny (1852) were first converted from Réaumur degrees to degrees Celsius according to the relation 1°R = 1.25 °C. With a view to identifying and correcting erroneous observations Sterly's monthly and annual data were calibrated against those for the sites noted above. The source of such anomalous data can be a lower number of observations in that month, the different observation times, errors in calculation (such as neglecting the sign) or printing errors. An example of neglecting the minus sign is found in the mean temperature of January 1826 with the value 7.3 °C in Pokorny (1852), compared with values of –5.7 °C in Prague and –6.1 °C in Vienna.

As a result of high correlations for temperatures the Prague-Klementinum observatory was selected to provide the reference data set. Application of the SNHT procedures proposed by Alexandersson (1986) identified several months with inhomogeneities in 1823 and 1836 which were consequently adjusted. The homogenized Jihlava series shows high correlations with data from Prague-Klementinum with the lowest such value in September (Fig. 9b). But from comparison with the Jihlava series from 1901–1950 it is concluded that Sterly's temperatures are too high in all months of the year (Fig. 9a). Without any metadata for his measurements it is difficult to find reason for this disparity although the greater differences from April to September compared to months of winter half-year might indicate a radiation effect on the thermometer. Similarly the August maximum in the annual variations instead of usual July might reflect exposure and adjustment influences rather than genuine climatic change. From these reasons temperature data should be treated with caution.

Precipitation

As already stated, the volume of water from liquid or solid precipitation was measured in Vienna cubic inches and lines (1 cubic inch = 18.275 cm^3, 1 cubic line = 10.576 mm^3), although no reliable indication is given of the area of the collection orifice. Conversions of the original data based on Sterly's stated one Vienna square foot (999.07 cm^2) yield results in millimetre depths of precipitation that are clearly in error. For this reason monthly volumes were converted only to cm^3 and it is these values that are used for further analyses.

Figure 7. Differences in mean air temperature (a), pressure (b) and precipitation (c) for the years 1817 to 1840 (and 1821 to 1844 for precipitation) and the reference period 1961 to 1990 for Brno (precipitation), Prague-Klementinum (temperature and precipitation) and Vienna-Hohe Warte (temperature and pressure) stations.

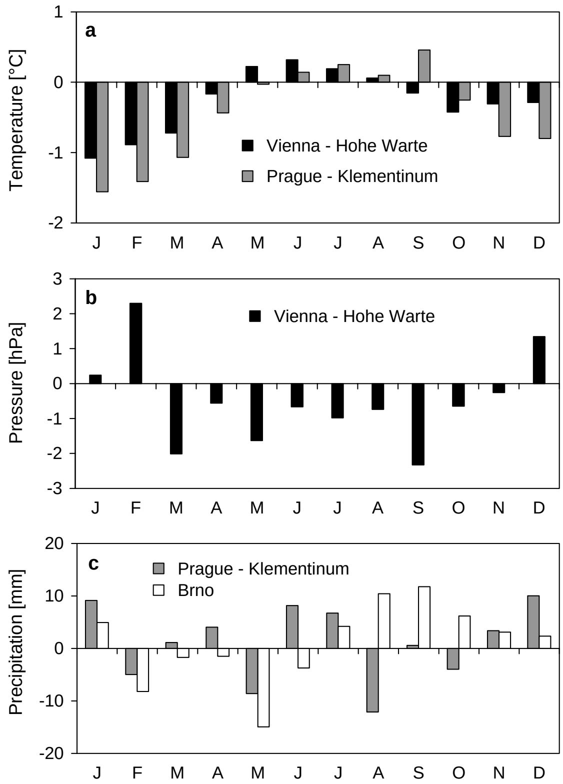


Figure 8. a) Comparison of the annual variation of mean air pressure in Jihlava according to Sterly's measurements (1) for the period 1817 to 1840 (3 – mean of absolute maxima/minima, 4 – absolute maximum/minimum) and the Přibyslav meteorological station (2) in the period 1961 to 1990; b) correlation coefficients between monthly pressure series of Jihlava and Brno for the period 1817 to 1840 (all values are statistically significant at α = 0.05).

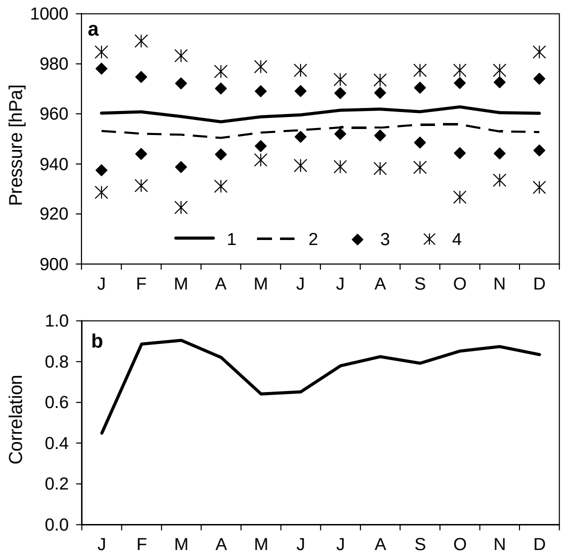


Figure 9. a) Comparison of the annual variation of mean air temperature in Jihlava according to Sterly's measurements (1) in the period 1817 to 1840 (3 – mean of absolute maxima/ minima, 4 – absolute maximum/minimum) and the Jihlava meteorological station (2) in the period 1901 to 1950; b) correlation coefficients between monthly temperatures in Jihlava and Prague-Klementinum over the period 1817 to 1840 (all values are statistically significant for α = 0.05).

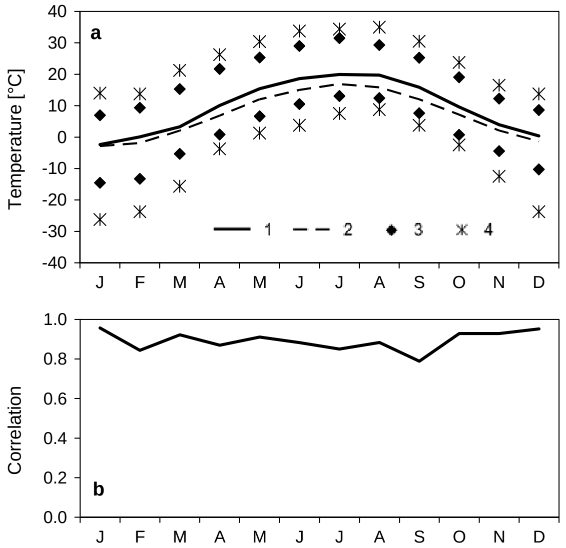


Figure 10. a) Comparison of the annual variation of relative precipitation for Jihlava according to Sterly's measurements (1) in the period 1821 to 1844 and the Jihlava composite series (2) in the period 1961 to 1990; b) correlation coefficients between the monthly precipitation series of Jihlava with Prague-Klementinum (3, 4) and Jihlava with Brno (5, 6) in the periods 1821 to 1844 (3, 5) and 1961 to 1990 (4, 6).

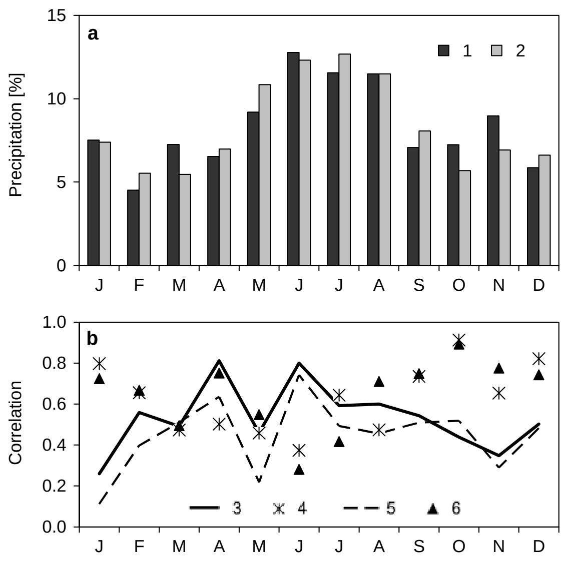


Figure 10a shows annual variation of mean relative monthly values calculated as a proportion of the monthly to annual total volumes. Over the period 1821 to 1844, Sterly's data indicate a principal maximum in June and minimum in February. Secondary precipitation maxima occurred in November, January and March, secondary minima in December, April and September. These results were compared with those for the standard period 1961 to 1990, compiled by reference to data from sites at Jihlava-waterworks (1961 to 1969), Jihlava-transmitter (1970 to October 1984) and Hubenov-dam (November 1984 to 1990). These precipitation series were integrated and the homogeneity checked using SNHT procedures (Alexandersson, 1986). Its consequent annual variation shows main maximum in July and main minimum in February and March. Secondary precipitation maxima occurred in January and November, minima in October and December.

Sterly's precipitation measurements can be further verified by reference to their correlation coefficients with series from Prague-Klementinum and Brno for 1821 to 1844 with same coefficients derived from the Jihlava series noted above and these two stations for the period 1961 to 1990 (Fig. 10b). When comparing the second series correlations with those above, correlation coefficients were higher in January–February, July and September–December for Prague and with exception of March, April, June and July were higher in all the other months for Brno. The greatest difference was found in the correlations for January.

Cloudiness

Sterly's cloudiness observations are based on a four-term vocabulary: clear ("heiter"), little cloud ("wenig bewölkt"), much cloud ("sehr bewölkt") and overcast ("trüb"), the frequencies of which can be counted and used as the basis for analysis. Whilst the categories 'clear' and 'overcast' demonstrate a general decrease in frequency over the study period, the remaining two, after an initial increase reveal a conspicuous break after 1827 (Fig. 11), when the number of cases classified as 'little cloud' dropped conspicuously. Such a pattern might suggest an inconsistency in the observational procedures.

The annual variation of cloudiness shows features typical of the Czech Republic (Fig. 12). However, in the case of clear sky, Sterly recorded an unexpected maximum in February, which replaced the conventional maxima that now occurs towards the end of the summer and in autumn (August to October). On the other hand, the maximum of overcast days noted for December and January, and the general tendency to more frequent overcast conditions in the winter half of the year is normal. Cases of partial cloud cover (little or much cloudy weather) dominate between March and October.

Sterly also observed the type of clouds, which he recorded at first using whole words but after July 1819 with the following abbreviations: Cr – Cirrus, Cm – Cumulus, St – Stratus, Cc – Cirrocumulus, CrS – Stratocumulus (in Sterly's terminology "Cumulostratus"), Nim – Nimbostratus (according to Sterly "Nimbus") and St/Cum – Cumulus below Stratus. In addition he also noted the state of the sky, the colour of clouds and direction of their movement. Cloud types were absent, obviously, when skies were clear ("heiter, schön") as well as when the weather record indicated rain, snow, fog or completely overcast sky ("trüb").

Figure 11.
The mean monthly frequency of cloudiness based on three daily observing times at Jihlava for the period 1817 to 1840:
1 – clear,
2 – little cloudy,
3 – much cloudy,
4 – overcast.

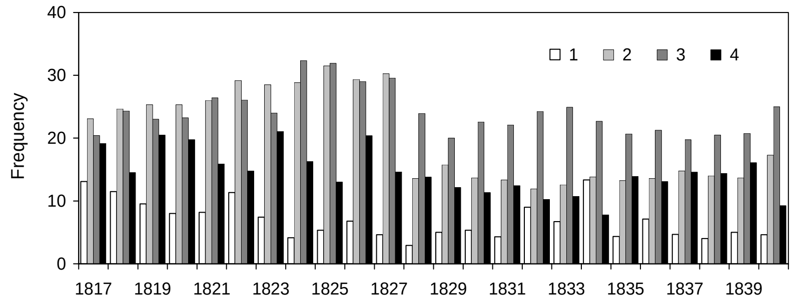
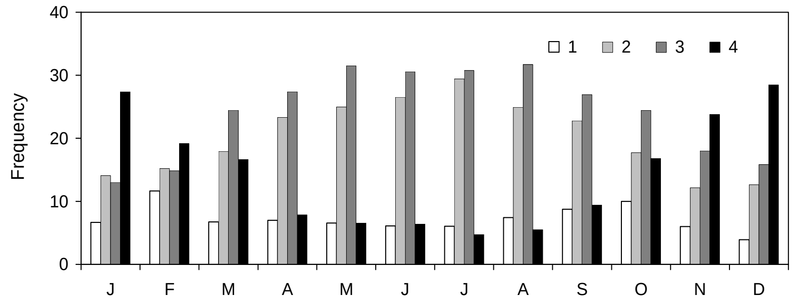


Figure 12.
The mean annual variation of the frequency of cloudiness based on three daily observing times for Jihlava in the period 1817 to 1840:
1 – clear,
2 – little cloudy,
3 – much cloudy,
4 – overcast.



An analysis was carried out of the frequencies of different cloud types at the morning, noon and evening observations. The data were categorised into the winter (October to March) and summer (April to September) half-years for the period 1820 to 1826 (although observations were missing for October to November 1820 and for all of 1823 and August to September 1826). The results are summarised in Figure 13. Cumulus clouds constitute the most abundant record with dominance in the summer half-year (65% of cases at noon and 49 % in the morning). In the winter half-year the frequencies varied between 51 % at noon and 39 % in the morning. The second most frequently recorded cloud type was that of stratocumulus (between 7.5 % and 11.1 % in the winter and between 7.4 % and 16.8 % in the summer half-year). Overcast skies were also frequently recorded, especially in the winter half-year.

Wind

In common with some other observations, those for wind strength (based on the simple scale of calm, weak, medium and strong) reveal a hiatus in the series in 1827 with a notable decrease in the frequencies (Fig. 14). Some individual events do, however, stand out amongst which is that of 4 March 1817. At half past six in the morning, according to Sterly, there appeared a heavy storm with dark clouds and rain, during which more than 500 trees were uprooted in the forests around Jihlava. Other cases of gales were described in daily records on several occasions, but without any similarly detailed accounts of the damage.

The analysis of the wind directions records provides clear evidence of two dominant sectors – the north-western and the south-eastern (Fig. 15). The former prevails in March, June, July and October, whereas in the other remaining months it is south-easterlies that dominate. These results correspond with the directional data for modern observations that also indicate a south-easterly dominance for the Českomoravská vrchovina Highlands (Brázdil et al., 2004).

Figure 13. Relative frequencies of the occurrence of types of clouds and the state of weather based on three daily observing times in the summer and in the winter half-years at Jihlava according to Sterly for the period 1820 to 1826: Cr – Cirrus, Cm – Cumulus, Cc – Cirrocumulus, CrS – Stratocumulus, Nim – Nimbostratus, St – Stratus; 1 – clear, 2 – nice, 3 – variable, 4 – overcast, 5 – fog, 6 – rain, 7 – snow; a – October–March, b – April–September.

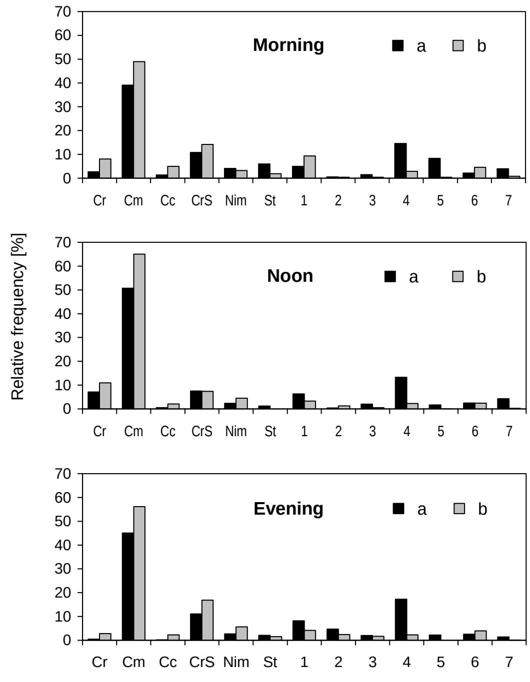


Figure 14.
Fluctuation of the mean monthly frequency of wind strength based on three daily observing times at Jihlava for the period 1817 to 1840:
1 – calm,
2 – weak wind,
3 – medium wind,
4 – strong wind.

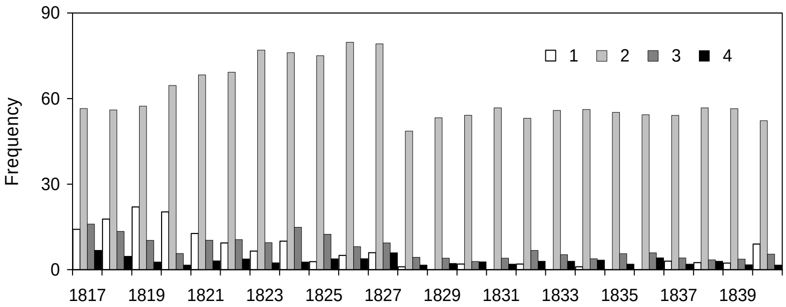
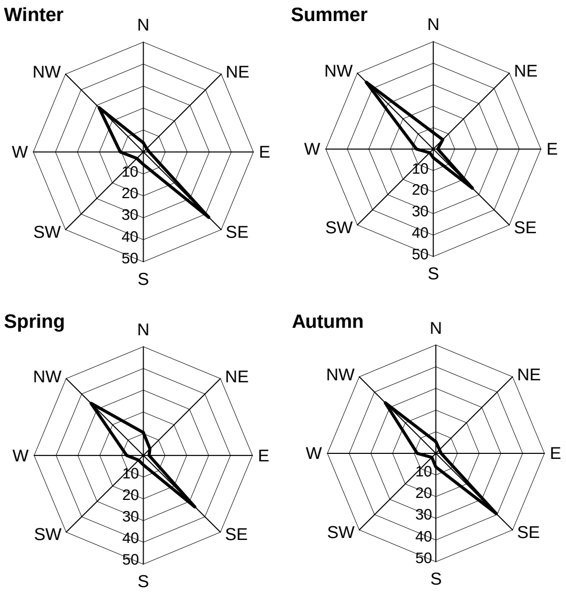


Figure 15. Seasonal wind roses (%) for Jihlava in the period 1817 to 1840.

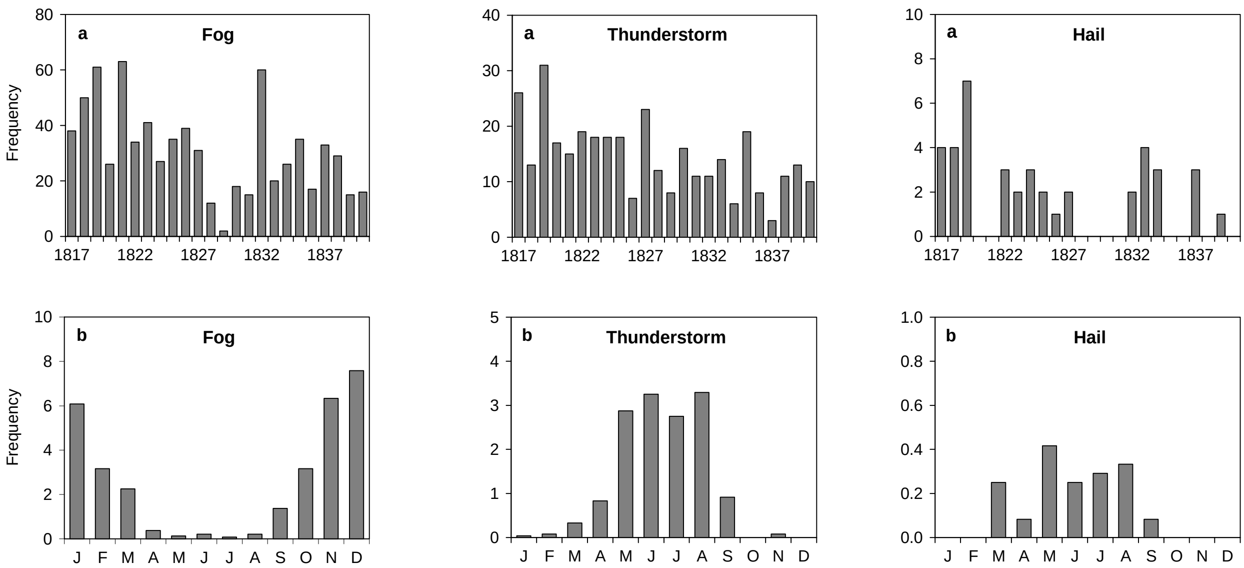


Meteorological phenomena

Sterly provides useful descriptions of phenomena and recorded the state of weather, giving an account of phenomena (such as fog, rain, hail and snow) or the state of the sky (clear and nice, changeable, overcast) at three observing times during the day. He also noted optical phenomena, such as the Moon's halo or light columns in the atmosphere. Sterly also included some phonological data such as the emergence of buds on trees, blossom dates or the beginning of the harvest. Under astronomical phenomena he mentioned the solar eclipse (he also described the course of the weather during the eclipse on 7 September 1820), falls of meteorites as well as a comet.

From such notes and records it is possible to determine the numbers of cases with fog, thunderstorm and hail. It needs, however, to be acknowledged (as is often the case) that such phenomena tend to be under-recorded. Furthermore, and in a manner noted already for other aspects of the record there exists a break in the observations after 1827, resulting in a systematic drop in the frequency with which phenomena were recorded (Fig. 16).

Figure 16. Fluctuation (a) and the mean annual variation (b) of the frequency of occurrence of fogs, thunderstorms and hail at Jihlava over the period 1817 to 1840.



With regard to the observations of fog, the data gathered by Pokorny (1852) raise some concerns regarding the frequencies of different phenomena when compared with the original observations. Thus, in January 1819 fog should have been observed in 26 occasions, but according to the available daily observations it was recorded only 23 times over 12 days. In December 1821 out of 32 observed times with fog the available daily records document indicates only 29 fogs, with one additional non-standard time entry but covering again 12 days. The numbers of fogs in the individual years fluctuate greatly, with, for example, 63 in 1821 but only two cases in 1829. In the annual rhythm the number of fogs decreases gradually from January to the period from May to August and then increases steadily to the annual maximum in December. The average number of fogs in November was higher than in January.

Attention must, however, be drawn to the disagreements between the thunderstorms collated by Pokorny (1852) and the original daily meteorological observations. Such differences suggest inaccuracies in the data processing procedures. Thus, out of 15 thunderstorms cited for August 1819 only 13 days are documented in the daily records. Moreover, the lightning records (e.g. on 15 August 1822), as well as that of thunder (e.g. on 11 December 1824) or distant thunderstorms (such as on 9 October 1826) were not included in the statistics for thunderstorms.

Sterly recorded days with hail at Jihlava but only in the months March to October. Nevertheless, within this limit some conclusions can be offered. There were seven hail days in 1819, whereas in 13 years there were as few as between 1–4 such days while 10 years passed with no record of hail. With regard to the annual patterns, the maximum hail incidence is in May followed by August. The frequency of hail in March is remarkable and is greater than in April and comparable to June. Out of five cases occurring in March only two can be wholly verified, because the daily observations of the cited three hailstorms of March 1818 are missing. Otherwise on 14 March 1817 hail is mentioned in conjunction with a thunderstorm, whereas on 25 March 1822 the observer recorded only rain with hail. The observation includes also a record of thunderstorm and rain mixed with hail on 22 May 1824 at Jihlava. Sterly noted that in the area between Telč and Batelov the hail was of extraordinary size. This, however, is the only reference in the extant to any possible damage.

CONCLUSIONS

Andreas Sterly belonged to that class of investigator whose contributions to meteorological observations and meteorology made this branch of science so important and durable in the Czech Lands. Even though the preserved daily observations do not cover the whole period 1816 to 1826, its extension based on monthly values up to 1844 gives them a matchless importance in extending our knowledge of climatic patterns in the first half of the 19th century, i.e. in the period before the building of the national network of meteorological stations. At Jihlava, Sterly's activities provided a foundation for later meteorological observations that began in the 1860s (January 1864 to February 1865) and 1870s (after 1873), the records of which are deposited in the Archives of the Brno branch of the Czech Hydrometeorological Institute, and in the State District Archives of Jihlava.

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