

## Meteorological measurements in the St.Thomas's Abbey in Brno

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### Abstract

The above work describes the previous and contemporary history of meteorological measurements in the St Thomas's Abbey in the Old Town Brno. The measured temperatures are compared with temperatures from the same time period determined in Prague Klementinum. It turns out that the temperature difference in case of measurements made from the window is virtually zero, after homogenization or in case of a Stevenson screen placed 2 m above grass cover in the Abbey, the temperature differences lie in the interval of 0.7 and 1.1 °C, with Klementinum being warmer. The yearly pattern of average monthly differences shows variable thermal continentality of both locations and in the colder half-year the differences become more significant.

**Key words:** temperature, urban heat island, St Thomas's Abbey Brno, Klementinum Prague

### Introduction

Meteorological observations in Brno have a relatively long tradition, dating as far back as the end of 18<sup>th</sup> century. The work of Brázdil et al (2005) gives a time series of meteorological measurements prepared from various sources from the 1801-1950 period. Documented continuous measurements then start in 1848 thanks to Dr. Olexík, a senior doctor at the St.Anne's Hospital on Pekařská Street in Brno. His measurements were continued for several years by G. J. Mendel at the St Thomas's Abbey located in Old Town Brno. These measurements are relatively well described in some of his biographies, especially those, in which also meteorologists contributed, for example the compilation from Kolektiv (1965), where M. Nosek evaluated the significance of Mendel in this field. The fact that the meteorological

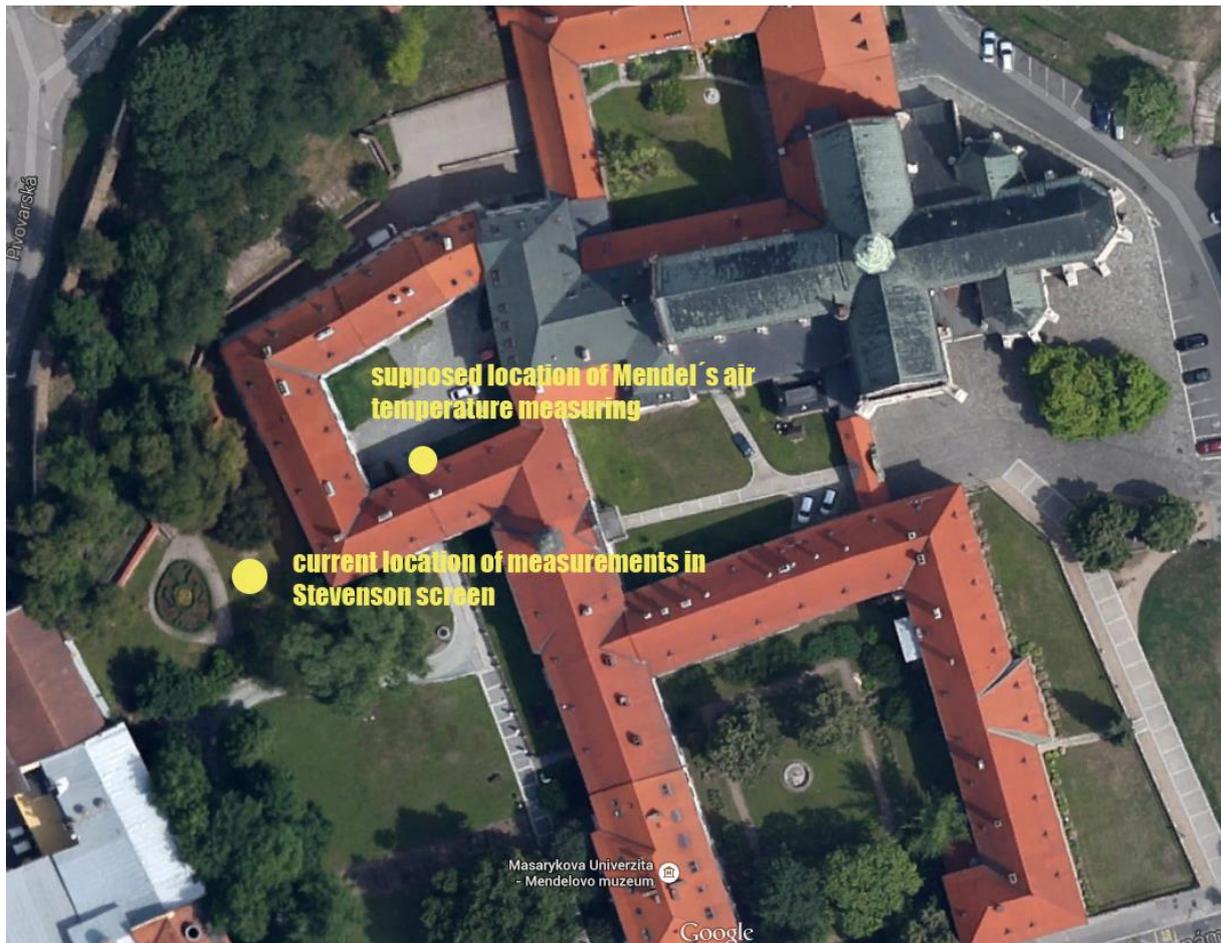
station was placed in a city built-up area was quite common at that time. It was only later with the gradual standardization of measurements in the 20<sup>th</sup> century that climatological stations were moved to open air areas outside city centers. A good example of such station in Brno is the climatological station on Květná Street, not far from the Abbey, where measurements were performed until 1971. With respect to the planned climate research of the city of Brno within the project “Multilevel analysis of the urban and suburban climate taking medium-sized towns as an example”, an automated meteorological station was set up in the area of the Abbey in 2005, which sends measured data at regular intervals to a remote web server. The measured values are then used to study the effects of urban development on meteorological and bioclimatological parameters compared to open landscape. This means that in the upcoming year there will be a decade-long time series of contemporary measurements available.

## **Materials and Methods**

G. J. Mendel performed his measurements in the Abbey in the period from July 1878 to July 1883. From August 1883 until November 1883 the meteorological measurements were continued by the monk Leo Ledwina. There is no data for the following month of December 1883 and the observations in Brno then follow from January 1884 thanks to Alfred Lorenz, the head imperial engineer and a professor of railway, road and water constructions at the Brno University of Technology. This is the end of the history of Mendel’s meteorological observations. As Nosek (Kolektiv, 2005) writes, a detailed description of the location of the devices is given by Josef Liznar 1886 based on his inspection, which he performed at Mendel’s meteorological station as a clerk of the imperial Central Institute for Meteorology and Geodynamics in Vienna in 1881. He states that “Thermometers were placed on the Northern side of the wing parallel to the church on the first floor. This and two other wings together with the church enclose a rectangular courtyard, longer side of which (east-west) is 30 to 35 m long and the shorter one (north-south) measuring approximately 25 m. The maximum and minimum thermometer was placed in a “bee garden”, hanged on a pillar of a pavilion facing North and well-exposed, however from the North quite close to a relatively steep hillside of the Žlutý hill. The rain gauge was in the “prelate

garden”, with the retaining flask being one meter above the ground. Wind direction was determined based on observing numerous chimneys that were in the surrounding area (and also on the Špilberk castle)”.

This description corresponds to the temperature measuring areas highlighted in Fig. 1. Measurements were performed using a pair of thermometers from the Kappeller Company, placed in a metal booth approximately 6 m above the ground (fig. 2).



**Fig. 1** St Thomas’s Abbey with Mendel’s and contemporary place of measurements marked.

Contemporary measurements have begun on 7<sup>th</sup> March 2005 using an automated meteorological station in a classical Stevenson screen placed in an open space on the Abbey grounds (fig. 1, fig. 3). Apart from the automated station, there are also devices, which until recently, represented the standard voluntary climatological station equipment, i.e. August psychrometer, thermograph, hygrograph, hair tension hygrometer, maximum and minimum thermometer. The door is, according to

regulation, oriented north and made from Perspex blinds, so museum visitors can see inside and get to know the devices that have been used for gathering data about the climate for many decades. With respect to the location of the station, the following meteorological parameters are measured: air temperature and humidity, precipitation and soil humidity. Data from the station were analyzed in several works, for example one from Litschmann and Rožnovský (2009), Litschmann and Rožnovský (2012) etc., which focused on the effects of urban heat island phenomenon on selected bioclimatological factors – in other words the effects of what Mendel pointed out already in 1863 (Munzar, 1994).



**Fig. 2** Metal booth with thermometers from the Kappeller Company, most likely used by G. J. Mendel

Taking into consideration the fact that the measurements are performed in an urban area of the Abbey, it is sensible to compare the data with another similar meteorological station in Prague Klementinum. This station is also placed on a first floor of a wing, which together with 3 other wings encloses a rectangular space (fig. 4, fig. 5). The window with the thermometers is also facing north. The thermometers were moved several times in the past (Pejml, 1975), however they were always in a window facing north, alternating between the first and second floor. Jírovský (1976) says however, that “Thermometers are right from the beginning of observations placed in a metal booth approximately 1 m from the northern wall of the building, 10 m above the courtyard. In order to maintain homogeneity, the position has been kept the same until today.”

We therefore compared monthly air temperature values from various time periods at both locations including two other homogenized series for Brno and assessed the differences in monthly intervals.



**Fig. 3** Stevenson screen with automated station including standard equipment for demonstration purposes



**Fig. 4** Detail of the placement of the thermometers at the station in Prague Klementinum



**Fig. 5** Klementinum area with the position of current meteorological station marked

## Results and Discussion

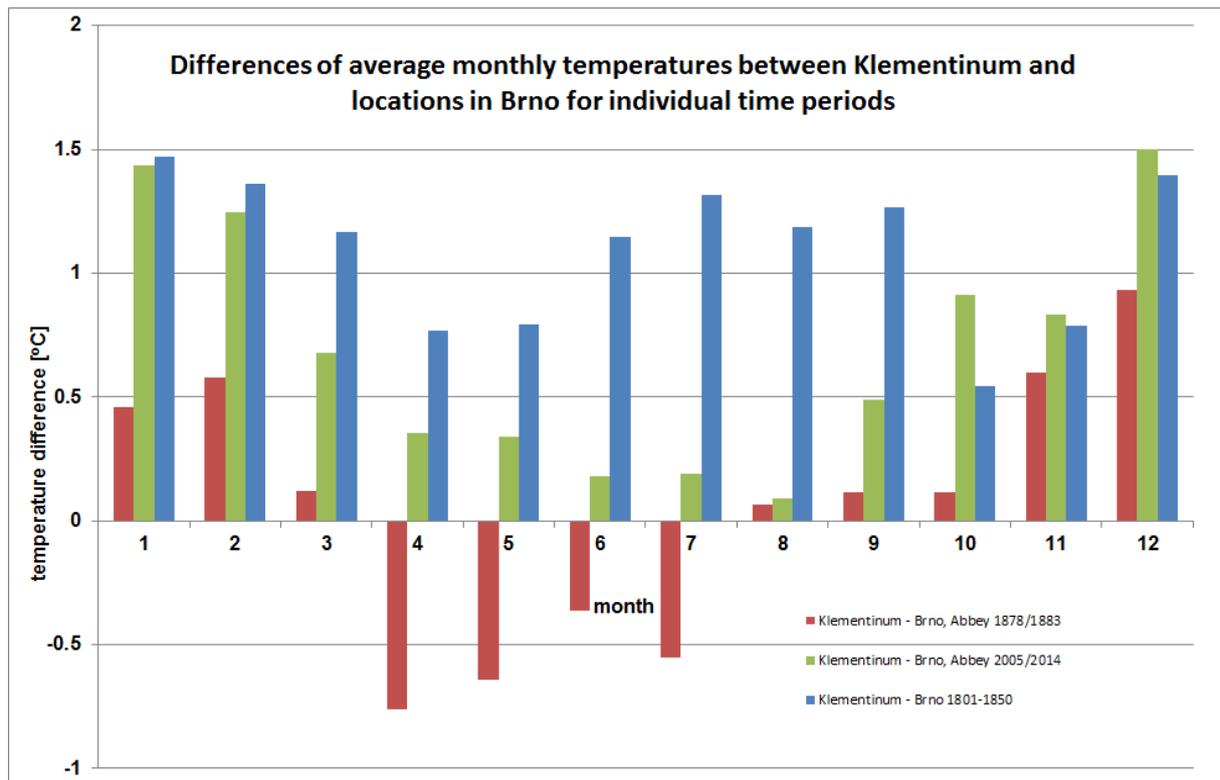
The results of the temperature comparison for the individual time periods are given in Table 1 and Figure 6. It is worth noting that the average temperature measured by G. J. Mendel in his “window observatory” agrees with the average temperature measured with approximately similar radiation shield in the window in Klementinum. After homogenization of this data performed by the CHMI, the temperature for Brno is 0.9 °C lower. An approximately equivalent difference also applies for comparison of data from Klementinum and homogenized series of Brázdil et al (2005) from the first half of 19<sup>th</sup> century in Brno. In the period measured by us between 2005 and 2014, the determined temperature is 0.7 °C lower than in Prague Klementinum.

**Table 1** Average temperature from the individual time periods and differences in comparison to Prague Klementinum

Location	Time period	Average [°C]	Difference [°C]
Klementinum	I.1801 – XII.1850	9.5	
Brno (homogenized data based on Brázdil, 2005)	I.1801 – XII.1850	8.4	1.1
Klementinum	VII.1878 – XI.1893	9.1	
Brno, Abbey (Mendel’s observations)	VII.1878 – XI.1893	9.1	0.0
Brno (CHMI homogenized data)	VII.1878 – XI.1893	8.2	0.9
Klementinum	IV.2005 – XII.2014	11.4	
Brno, Abbey (aut. station measurements)	IV.2005 – XII.2014	10.7	0.7

Figure 6 is a detailed comparison of the differences for individual months during the analyzed time period. What is common for the measurements performed in the Abbey is the fact that the differences are smaller during the summer; in case of Mendel’s measurements there are even higher temperatures in Brno than in Klementinum, while in the colder half-year, the differences get more apparent. This can be explained by the different thermal continentality of both locations, because as we have found out, the temperature difference between Klementinum and a station in

Doksany, located in approximately the same climate area, but outside urban development, do not show any regular pattern during the year and are almost same during the entire year. The yearly pattern of differences is disrupted in the summer months in the case of the homogenized series from 1801 to 1850, but taking into consideration that this time series was generated from measurements performed at several locations in Brno, this discrepancy of just several tenths of a degree are understandable.



**Fig. 6** Differences of average monthly temperatures between Klementinum and locations in Brno for individual time periods

## Conclusion

Based on the comparison of temperatures in Prague Klementinum and several temperature series from Brno from various time periods it turned out that for measurements that were not performed directly in the “window observatory”, or homogenized measurements, the difference is within the interval of 0.7 and 1.1 °C, with Prague Klementinum being warmer. This can lead to the conclusion that:

- the extent of urban heat island in both of the cities analyzed is increasing at an approximately same rate and it cannot be proved that the temperature increase would be more significant in the Prague city center than in Brno
- temperature measurements performed in the vicinity of a building wall can be to a certain extent biased with the measured values being slightly higher in comparison to measurements from opened areas.
- if the observations performed at the St Thomas's Abbey continued even after Mendel's death in the "window observatory", it is quite likely that the "warmest place of the Czech Republic" would not be just Klementinum, but also the Abbey in Brno. However, it must be said that nobody competent would probably consider such measurements as regular measurements of a climatological station.

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## Summary

V práci je popsána starší i novodobá historie meteorologických měření v areálu augustiniánského kláštera na Starém Brně. Naměřené hodnoty teplot jsou porovnány s teplotami za stejné období zjištěné v pražském Klementinu. Ukazuje se, že teplotní odchylka v případě měření za oknem je prakticky nulová, po homogenizaci anebo v případě měření v žaluziové budce 2 m nad travnatým povrchem v areálu opatství

se teplotní odchylky zvětšují na 0,7 až 1,1 °C ve prospěch Klementina. Roční chod průměrných měsíčních odchylek ukazuje na rozdílnou termickou kontinentalitu obou lokalit, v chladném půlroce se odchylky zvětšují.

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