

## ***Interactive comment on “The climate in south-east Moravia, Czech Republic, 1803–1830, based on daily weather records kept by the Reverend Šimon Hausner” by Rudolf Brázdil et al.***

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Interactive comment on “The climate in south-east Moravia, Czech Republic, 1803–1830, based on daily weather records kept by the Reverend Šimon Hausner” by Rudolf Brázdil et al.

Anonymous Referee #1 Received and published: 21 April 2019

The paper presents a very detailed analysis of weather and climate in south-east Moravia in the years 1803–1830 based on a newly-discovered daily weather diary from Buchlovice written by Šimon Hausner, a priest in Buchlovice. Although meteoro-

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logical observations exist for this time period for some stations in the Czech Republic, including the closest station in Brno, the value of such long series of visual observations is very important, not only for improving the climate knowledge of the region, but even more for estimation of the usefulness of that kind of weather excerpts for climate reconstruction, including estimation of its uncertainty. RESPONSE: We would like to thank the reviewer for many very important comments to which we are trying respond below.

The main weakness of the paper, which necessarily must be supplemented, is a lack of information concerning the way that air temperature and precipitation values are attributed to a specific index in the 7-degree scale. In Section 3.2 there should be information about threshold values used in the process of indexation based on monthly frequencies of warm or cold days in case of temperature and number of days with precipitation in case of precipitation. Do you use data from Brno station for this purpose, e.g. number of days with precipitation? RESPONSE: The methodology of interpretation of temperature and precipitation indices was described in Section 3.2 in more detail as follows: “With respect to the character of Hausner’s daily weather records, it became impossible apply some new quantitative approaches to interpret monthly temperature and precipitation indices (see e.g. Fernández-Fernández et al., 2017; Filipiak et al, 2019). From this reason we used a broadly applied approach of Pfister (1992), combining different kinds of sources and their expert evaluation. Information related to temperature patterns was used to interpret monthly temperature indices by expression on a 7-degree scale: –3 extremely cold, –2 very cold, –1 cold, 0 normal, 1 warm, 2 very warm, 3 extremely warm (Pfister, 1992). Interpretation of temperature indices took into account the broad scale of indicators derived from Hausner’s records: the monthly frequencies of cold days (severe frost, frost, cold, very cold) and warm days (warm, very warm, hot, very hot, mild), warm and cold winds, monthly summary reports, early and late beginnings of certain phenophases and agricultural work and also, to some extent, cloudiness (e.g. clear and overcast days) and precipitation (state of precipitation, monthly temperature–precipitation relationships). Own interpretation was realised in

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following iterations: (i) Pfister (1992) recommended attribution of regularly distributed 7-degree indices to dataset ordered from the lowest to the highest values: index -3 he used for 8.3% lowest values, -2 for 16.6% following values, further with always 16.6% of values for each following indices (-1, 0, 1, 2) up to 8.3% of highest values attributed to index 3. This approach was applied separately to the monthly frequencies of cold days and warm days in 1803–1830, which allowed attribute any index to each of months, when in indexing of the month of winter half-year rather cold days and in the months of summer half-year rather warm days were preferred. (ii) Monthly indices from point (i) were further evaluated with respect to the structure of cold and warm days looking on their intensity, based on which the corresponding month could be moved to the neighbour category. For example, higher portion of hot or very hot days was a reason for moving to “warmer” category (e.g. from index 1 to index 2), similarly as higher portion of weak frosts or cold days compare to severe frosts and very cold days (e.g. from index -2 to index -1), and opposite. Also indication of warm and cold winds as expression of character of air advection was considered. (iii) All indices from iteration (ii) were further considered with respect to monthly temperature summaries and earlier/later onset of phenophases, indicating cooler or warmer patterns of preceding months. As additional parameter also information about cloudiness was used (days with higher sunshine duration are warmer compared to cloudy days). Also occurrence of snowfall or snow cover indicated cooler patterns. For months of the summer half-year also relationship warm/dry and cold/wet month was considered. Described facts could again cause moving of some months to another neighbour category. Corresponding indices, fixed after the third iteration, were then used as a final version of weighted monthly temperature indices. Also precipitation indices were interpreted in similar fashion: -3 extremely dry, -2 very dry, -1 dry, 0 normal, 1 wet, 2 very wet, 3 extremely wet (Pfister, 1992). The interpretation of monthly precipitation indices was based again on several indicators Hausner’s records: monthly frequencies of precipitation days, with particular reference to type of precipitation (e.g. snow, drizzle, rain, snow with rain), to precipitation intensity and duration of precipitation spells

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(as specified in daily records) and to summary monthly reports as well as other indications of wet or dry patterns (e.g. effects on agricultural crops or work in the fields). The own interpretation included three iterations: (i) The numbers of monthly precipitation days of the given months in 1803–1830 (28 years) was ordered from the lowest to the highest numbers. Following the above percentage distribution by Pfister (1992), corresponding 7-degree indices between -3 and 3 were formally added to individual months. (ii) Based on additionally reported type, intensity and duration of precipitation, the corresponding months remained in preliminary defined degree from point (i) or it was moved to any neighbour degree. For example, more days with drizzle, short or small precipitation were favourable to adding “more dry” index (e.g. from index 2 to index 1) or days with the whole-day rain or heavy precipitation during thunderstorms could be favourable for opposite attribution of “more wet” index (e.g. from index -1 to index 0). (iii) All indices from point (ii) were further evaluated from point of view of summary information of precipitation character of the months or any other precipitation-sensitive information. Similar as in the previous iteration (ii), some months could be moved to other degree. After these three iterations corresponding monthly precipitation indices were considered as final.” It means, that we combined quantitative approach (based on distribution of corresponding data and number of days with some characteristics) with an expert approach based on expert knowledge of climate in the Czech Lands. There is clear that final version of monthly indices is influenced by character of basic data, their interpretation and climatic experience of the researcher. But having no measured data we cannot expect more. Some tests of a quality of indices interpreted can be the high and statistically significant correlation coefficients of our indices with measured temperatures/precipitation series in Brno (Section 5.3). Based on it we believe that our rather subjective interpretation express quite well corresponding temperature and precipitation variability (fluctuations) following from the meteorological measurements of the Brno station. Replying to your question on the instrumental data of the Brno station, we did not use them in the interpretation of indices from Hausner’s data, i.e. temperature and precipitation measurements in Brno are independent. Brno series

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were used only for comparison with Hausner's indices in Section 5.3.

Why did you not make daily indexation using e.g. a 3-degree scale? Does Hausner's weather diary allow for such indexation or not? RESPONSE: We are really sorry, but Hausner's records did not allow us to do any systematic daily indexation as used, for example, in the paper by Filipiak et al. (2019). From this reason we could not use also an indexation approach, which was applied in this important reported paper.

When he started weather observations, Hausner was a mature man, thus probably his weather descriptions concerning its extremity were related to his weather experience in the late 18th century, a period which was warmer than 1803–1830. This is probably the reason why your indexation revealed significantly more months described as extremely cold and very cold compared to extremely warm and very warm, in particular in winter months (Table 1). For the entire year the statistic is the following: for -3 and +3 (13 and 4, respectively), and for -2 and +2 (37 and 23). RESPONSE: Each description of weather, which is not based on instrumental measurements, has a subjective feature and is influenced by many factors, including the observer's experience. We may only speculate how much he was influenced by the experience from the previous period. But why we should primarily expect, that the number of corresponding negative and positive extremes should be more or less the same, i.e. to be in agreement with any "normal" patterns? It would be more or less same, when we would stop creation of corresponding indices after the first iteration (see Section 3.2). But from Fig. 10 clearly follows, that the 1803-1830 period, belonging to the last part of the LIA, was much cooler compared to more recent time, influenced by a global warming. In our opinion, it implies that the number of negative extremes should be higher than the number of positive extremes. It is also confirmed, for example, by the fact that Büntgen et al. (2015) spoken of the 1810s as the coolest decade in central Europe in the past three centuries. Cole-Dai et al. (2009) referred even to this time as probably the coldest decade in the last 500 years or more in the Northern Hemisphere.

The second possibility is that the person who made the indexation compared Hausner's

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descriptions of weather with the present period, which is also warmer. RESPONSE: We do not think that it was particularly this case. On the other hand, each kind of interpretation of "descriptive" daily weather records bears some subjective features. From this reason interpretations of indices based on Hausner's records were compared with measured temperatures/precipitation from Brno (see Section 5.3) which showed quite a good agreement in character of fluctuations in both types of series.

My next doubt concerns the reference period: why did you not use the latest normal period 1981–2010, as recommended by the WMO? Such comparison will give a better estimate of climate change and variability between historical and present periods. RESPONSE: The reason for the use of the 1961–1990 reference period are following: (i) in the quoted WMO material, the period from 1961 to 1990 has been retained as a standard reference period for long-term climate change assessments; (ii) majority of climatological papers up to now is using the standard reference period 1961–1990, i.e. from point of view of possible comparisons it is better to preserve this period; (iii) the 1961–1990 period is not so strongly influenced by recent global warming as the 1981–2010 period; (iv) according to Czech representative in WMO Dr. R. Tolasz, who participated in preparation of this material, "30-year period out of standard normals should be used rather for evaluation of more recent deviations (e.g. on the monthly level)".

Minor remarks: 1. Page 1, last line – I suggest to add here for the 18th century the recently published paper by Filipiak et al.(2019) presenting results for Gdansk for the period 1721–1786 based on Reyger's weather observations (<https://doi.org/10.1002/joc.5845>), RESPONSE: Accepted and included into the manuscript.

2. Quite a lot of shortcomings which exist in the paper should be supplemented, e.g. p. 10, lines 18-19: "With the exception of February and March, all months were also more variable in terms of standard deviation than the reference period", RESPONSE: Accepted and corrected as: "With the exception of February and March, all months

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were also more variable according to standard deviation than in the reference period.”

p. 10, lines 39-40: “Despite generally close agreement between the Hausner series (ref. comm.: there are a lot of variables analysed in the paper: does the statement concern all variables or only temperature and precipitation?) and those for Brno, some instances of greater or smaller disagreement appear”, etc. RESPONSE: Accepted and corrected as: “Despite generally close agreement between the Hausner temperature and precipitation series and those for Brno, some instances of greater or smaller disagreement appear.” We are sorry, but other shortcomings in the manuscript are not specified, i.e. there is difficult to respond. The manuscript was corrected for English style by a native speaker.

3. Fig. 13 – I suggest more contrastive colours be used to show data from Brno and Stare Mesto. It is difficult to guess which of the mentioned stations the data in Fig. c represents, RESPONSE: Accepted and corrected.

4. Fig. 13 – in the caption there is information that strong winds were estimated as those with force  $\dot{\text{I}}\text{A}\text{C}\ \dot{\text{I}}\text{g}\text{s}\ 7\text{oB}$ . In Section 3.1 there is no information on how this was estimated based on Hausner’s weather descriptions. I suggest this information be added, RESPONSE: To specify the interpretation of days with strong winds according to Hausner’s observations, following sentence was added as the second on the beginning of Section 4.1.4: “As days with strong winds were interpreted those in which Hausner mentioned strong or very strong wind, very windy weather, “awful” wind, extraordinary wind, windstorm or blizzard (see Section 3.1, point (iv)).”

5. The authors should maybe reconsider the presentation of Section 3.1 (or part of it) in the form of a Table, in particular for temperature and precipitation. It seems to me that the text will then be more clear for readers. RESPONSE: We have some doubts, that creation of the table would be more simple for readers than presentation of terminology used in descriptive form because the table should be relatively large and complicated. Moreover, it would be inconsistent to do a table only for temperature and precipitation

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terminology. From this reason we would be more happy to let it in the recent form. We believe that reader interested in topic will be able to go via this well-structured text without any troubles.

I can recommend acceptance of the paper for publication in the *Climate of the Past* journal only on the condition that the listed remarks and suggestions will be satisfactorily taken into account. RESPONSE: We tried to respond to every of your important comments in the best possible way with a hope that responses could be taken by you as satisfactorily.

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