Weber, J., Y. Brugnara, and S. Brönnimann (2020) Two Meteorological Series from Herisau, 1821-1844. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 73–85, DOI: 10.4480/GB2020.G96.06.

Two Meteorological Series from Herisau, 1821–1844

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Abstract

This article describes two meteorological series from Herisau, Appenzell, covering the period 1821 to 1844. The two series were taken by Johann Ludwig Merz (1821–1831) and Johann Jakob Nef (1822–1844). Due to the long overlap, the data can be quality checked and compared in detail. This article discusses the series and metadata and presents the results of the quality assessment. The main unknown factors of both series remain the exact measurement locations and hence the precise altitude of the barometer. Apart from that, the series are of generally high quality and can be used for further meteorological analyses.

1. Introduction

While in many parts of Switzerland meteorological measurements already started in the 18th century (see Pfister et al., 2019, for an overview and inventory of all series), this is not the case for Appenzell and St. Gall. The first series from St. Gall dates back to 1812 (Hürzeler et al., 2020). The first meteorological measurements taken in the Cantons of Appenzell are two series from Herisau. They were taken by Johann Ludwig Merz from 1821 to 1831 and Johann Jakob Nef from 1822 to 1844.

This paper provides information on the series, observers, instruments, and station histories. It presents the processing of the data as well as results from the quality control procedure and analyses of the two series. The imaged data sheets are available from: https://zenodo.org/record/3066836#.XVv-fGRS8-U. The digitised data are published in Brugnara et al. (2019) and available from https://doi.pangaea.de/10.1594/PANGAEA.909141, from MeteoSwiss, and from the EURO-CLIMHIST database (Pfister et al., 2017), and they

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will be made available through the Copernicus Climate Change Services (C3S) surface data repository (Thorne et al., 2017).

The paper is organised as follows. Section 2 describes the series of Johann Ludwig Merz, Section 3 the one of Johann Jakob Nef. Each Section includes information about the instruments, locations, and procedures as far as this is known. In Section 4 the processing and quality control of the two series is presented, the series are briefly analysed and then mutually compared. Conclusions are drawn in Section 5.

2. The series of Johann Ludwig Merz

2.1. Biography

Johann Ludwig Merz (Fig. 1) was born on 30 October 1772 as the son of Johann Jakob and Anna Katharina Merz (for the following biographical notes see Frehner, 1955; Fuchs, 2009). As a young man he served as captain and company commander for the Sardinian-Piedmont army. In 1776 Merz returned to Switzerland and worked for his uncle as an accountant, who later bequeathed his business to him. From 1799 Merz took part in various military operations of the federal army and was appointed lieutenant-colonel as well as contingent commander in 1809. Merz ended his military career in 1817.

In 1803 Merz married Johanna Jakob Tanner who died eleven years later. After the death of his first wife in 1814 Merz married Sophie Müller the same year. Merz thus had nine daughters and seven sons (six children form the first marriage and ten from the second).

On 15 December 1820 Merz acquired the house "Hinter der Linde" No. 17 A in Oberdorf (Fig. 1) where he lived until his death. It is conceivable that Merz carried out his

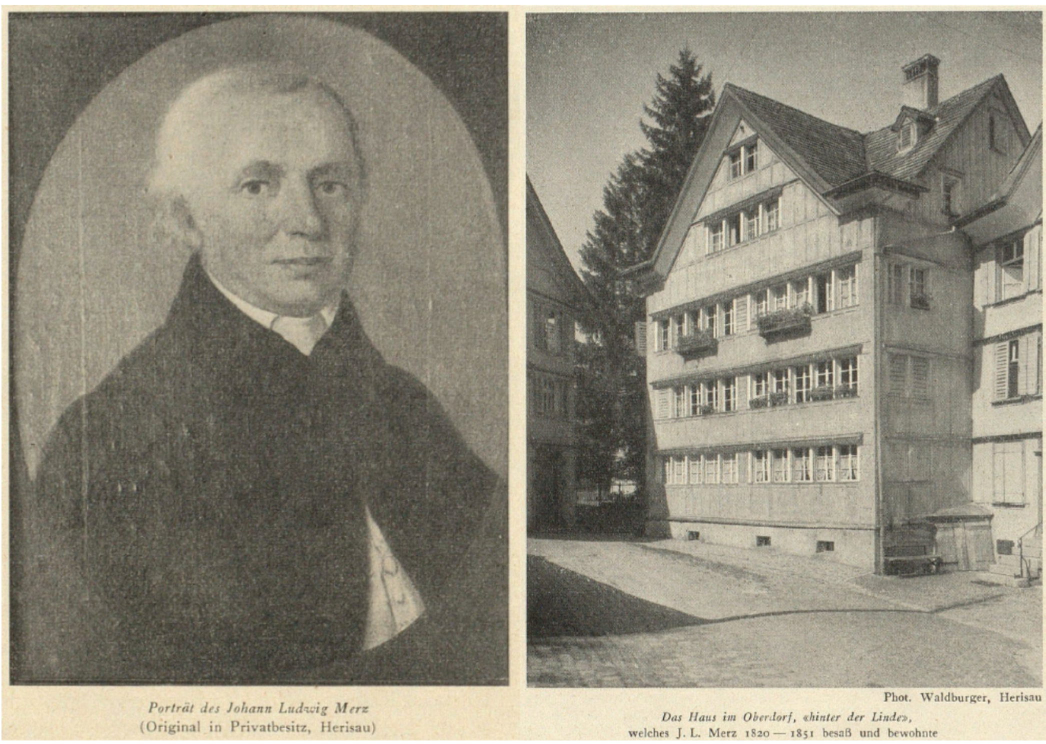


Figure 1. (left) Portrait of Johann Ludwig Merz, (right) house of Johann Ludwig Merz (from Frehner, 1955).

meteorological observations in this house. In 1822 Merz became a Member of the Council of the Canton of Appenzell Ausserrhoden. However, only one year later he resigned from this office and devoted himself to mathematics, topography and cartography. He started to make trigonometric measurements and create maps of his immediate vicinity. These various maps of Herisau and its surroundings were known for their accuracy. In addition, Merz made meteorological observations from 1821 to 1841 and it is plausible that his less known meteorological observations are just as accurate as his maps. At the age of 78 Merz died on 16 February 1851 (Frehner, 1955).

2.2. Data

The series of Johann Ludwig Merz cover the period from 1 October 1821 to 30 June 1831 and are distributed over five books that can be found in the Swiss Federal Archive. The first and the second book (October 1821 to May 1826, an example sheet is shown in Fig. 2) contain notes of measurements on air pressure and two different temperatures. The measurement times were 08:00, 12:00 and 17:00 local time. The third book (June 1826 to January 1827) also contains notes of the daily measurements of pressure and two different temperatures, but measured at 09:00, 12:00 and 15:00 local time. The fourth and fifth books also contain information on air pressure and temperature at 09:00, 12:00, and 15:00 local time, but only with one temperature indication.

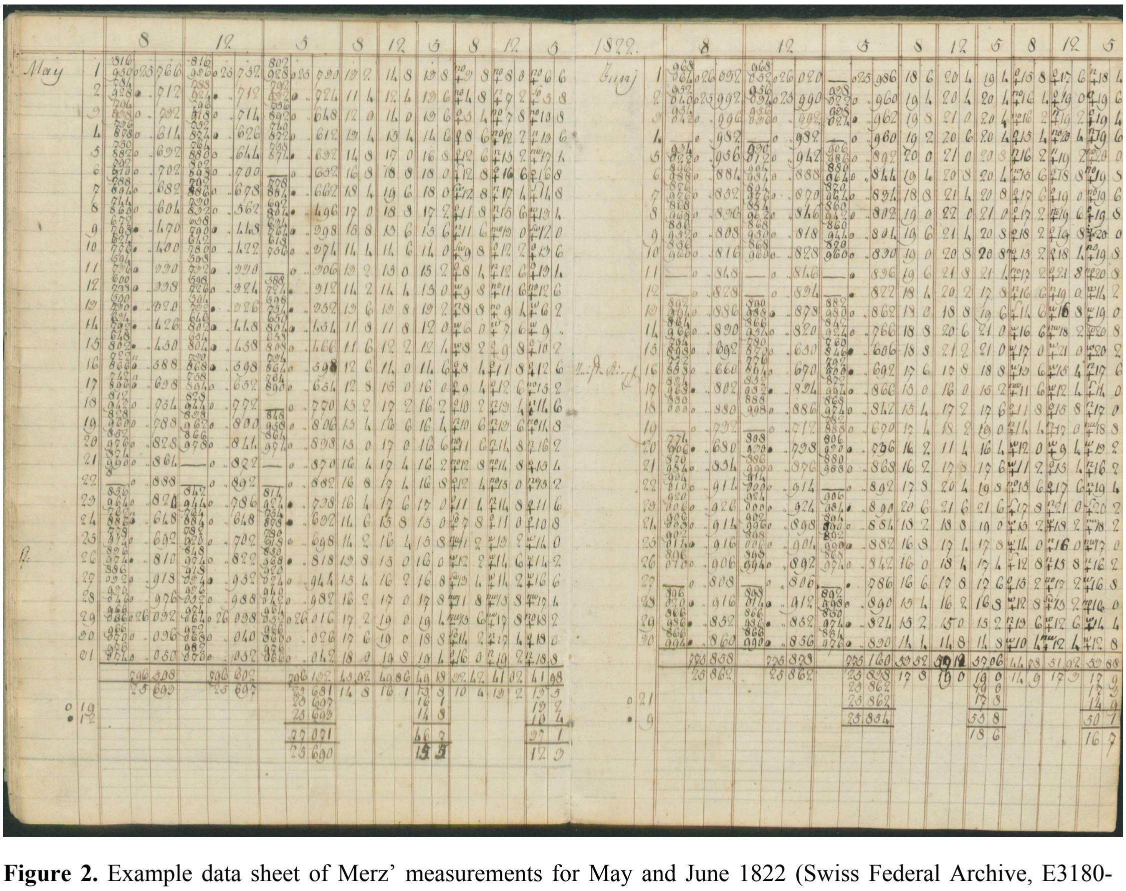


Figure 2. Example data sheet of Merz' measurements for May and June 1822 (Swiss Federal Archive, E3180-01#2005/90#179*).

From 1 January 1827 to 31 May 1827, the data for the air pressure and temperature measurements of Merz are available twice with differing values. These measurements are written down in two different books. One book contains data until 31 May 1827 and the other book from 1 January 1827 onward. In the book containing data up to 31 May 1827, on the page for the month of May the location name “Egelshofen” is written in the upper left corner. Further, for the month of February 19 values and the pages for the months of March and April are completely missing.

Since the book that contains the measurements until 31 May 1827 has the heading “Egelshofen” for the month of May, it is conceivable that the data of this book from January onward refer to Egelshofen (near Kreuzlingen). Furthermore, the data of the measurements of Herisau for the new year also begin with the new book. Therefore, and additionally because the data of the first mentioned book are incomplete, the data from January to May 1827 contained in the first mentioned book were excluded from further analyses.

Between 1821 and 1826, Merz measured two different temperatures three times a day. The metadata does not identify the exact position and which temperature was measured. The comparison of the monthly averages of both temperature series shows that one measurement series resulted in higher temperatures than the other, particularly in the winter months (Fig. 5). Therefore, it is likely that one measurement corresponds to an inside temperature and the other to the outside temperature. From 1827 onwards, the outside and not the inside temperature measurements were continued.

Figure 3. Map of Herisau (from Merz, 1841).

Figure 4. Map of Herisau from Merz (no year).

Information on the instruments was obtained from manuscripts by Merz, which are kept in the State Archive, Appenzell Ausserrhoden. The barometer and thermometer used by Merz were manufactured by Oeri in Zurich. Instruments made by Oeri were known for their accuracy and were also used by Natural Sciences Society of Bern (Alb, 1864). For his temperature measurements Merz used a mercury thermometer with a Réaumur scale facing north. For the air pressure measurements, he used a barometer with a scale in Paris inches subdivided in thousands. This barometer was located a height of seven French feet (2.27 m) above the road. As this road could not be irrefutably identified, the absolute height of the measurements remains unknown. An altitude of 770 m asl (historic village centre of Herisau, see Figs. 3 and 4) can be assumed, but is subject to uncertainties. Merz reduced all air pressure measurements to 10 °R.

3. The series of Johann Jakob Nef

3.1. Biography

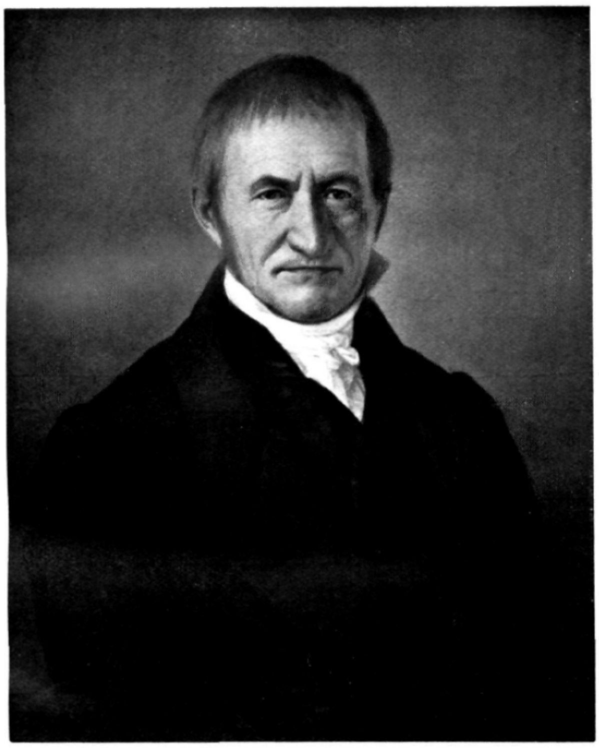
Johann Jakob Nef (Fig. 5) was born on 31 October 1784 in Herisau as the son of the schoolmaster and orphan Hans Jakob Nef (for the following see Alder, 1930; Fuchs, 2010). He went to school in Hundwil and supported his father in teaching at the age of eleven. At the age of 14 he moved with one of his father’s acquaintances to Aarau to fair-copy minutes of meetings in the office of the Grand Council of the Federal State Government.

After a three-week stay in Aarau, the government relocated its headquarters to Lucerne and accordingly, also Nef moved to Lucerne. There he witnessed the devastation of Nidwalden during the war against the French army. Subsequently the national government, including Nef, moved to Bern on 29 May 1799. Fourteen months later Nef moved back to his parents in Herisau. There he worked at the bookstore J. G. Merz & Co. copying letters. During the years from 1802 to 1819 Nef served the military, among other things as lieutenant colonel. Following his military career, Nef was also politically active and successful as a Landammann (head of the cantonal government) and councilor.

On 25 September 1804, Johann Jakob Nef married Anna Barbara Würzer and soon afterwards became self-employed by manufacturing and selling fabrics. In 1812 Nef built a house on Bachstrasse in Herisau, where he lived as a successful businessman with his wife and seven children until his death in 1855. It is likely that Nef made his meteorological measurements in this house. Nef was known already during his lifetime for his charity and his scientific and journalistic activities. He is also known for his meteorological observations and measurements (Alder, 1930).

3.2. Data

Nef's meteorological measurements can be found in two books. One contains data from January 1822 to December 1832 (see example sheet in Fig. 7) and the other from January 1833 to December 1844. Each double page contains a heading comprising the month and year. Similar to Merz, Nef divided the double pages into tables with rows for the days and columns for barometer and thermometer measurements. These columns are then subdivided by the time of measurement. The measurement times of Nef correspond to those of Merz. In other words, until June 1826 the measuring times were 08:00, 12:00 and 17:00 local time and from June 1826 on, 09:00, 12:00 and 15:00 local time.



Landammann und Oberstleutnant Joh. Jakob Nef †
1784 – 1855
Nach einem Oelgemälde von J. L.

Figure 5. Portrait of Johann Jakob Nef (from Alder, 1930).

In addition to the outdoor temperature and air pressure measurements, Nef also recorded the daily weather. From September 1822 to December 1825 Nef extended his measurements by an inside temperature measure and from January 1831 onward by wind direction, rain or snow and moon phase. However, all these additional data are not taken into account in this work. At the end of each year Nef created a yearly overview with the maximum and minimum levels of barometer and thermometer of each month. These pages contain valuable metadata on the records.

From the headings of the double pages and the headings of the annual overviews it can be obtained that the barometer used by Nef was seven French feet (2.27 m) above the road and the thermometer was outside. Further the air pressure was measured in inches, lines and hundreds of lines and the temperatures in degrees and tenths of degrees. For the handling of these measurements in this study it was assumed that these are Parisian inches and lines and that the degrees are Réaumur. These are the most frequently used units in the non-English-speaking countries during the period of the measurements (Brugnara et al., 2015, 2020).

Similar as the exact measurement locations of Merz, the exact placement of the measuring instruments on Nef could not be ascertained. Therefore, to reduce the barometric measurements to sea level, again the height of the historic village centre of Herisau of 770 m asl was assumed. The air pressure measurements from January 1822 to September 1822 were not reduced to 0 °C due to missing inside temperatures for this period. From October 1822 to December 1824 the inside temperature was used. From January 1825 onward Nef himself reduced the air pressure values to 10° Réaumur.

4. Data processing and analysis

The Herisau data from both observers were processed as indicated in Brugnara et al. (2019). In the Merz pressure series, the quality control routines flagged 95 values out of 10,563. This

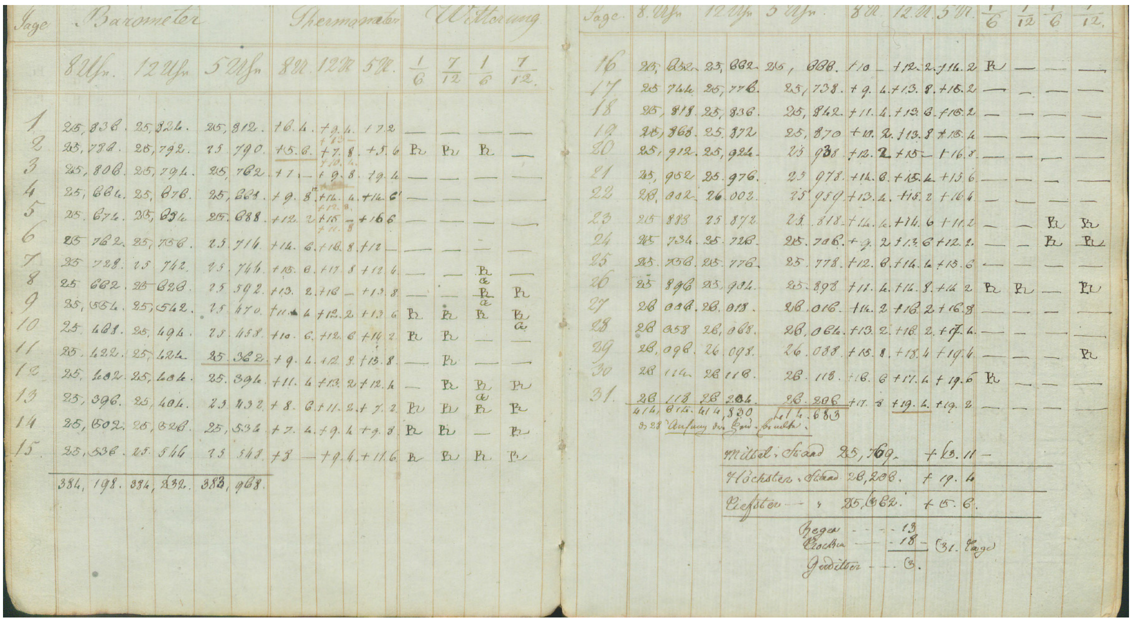


Figure 6: Example data sheet of Nef's measurements for May 1822 (Swiss Federal Archive E3180-01#2005/90#204*).

corresponds to 0.9%. A comparison of the series from different times of day (Fig. 7) shows a good agreement, with correlations between 0.97 and 0.99. Climatologically, minimum pressure values are reached in December, January and April; negative outliers predominate over positive ones (Fig. 7). A few extreme cases with very low pressure are confirmed in the mutual comparison.

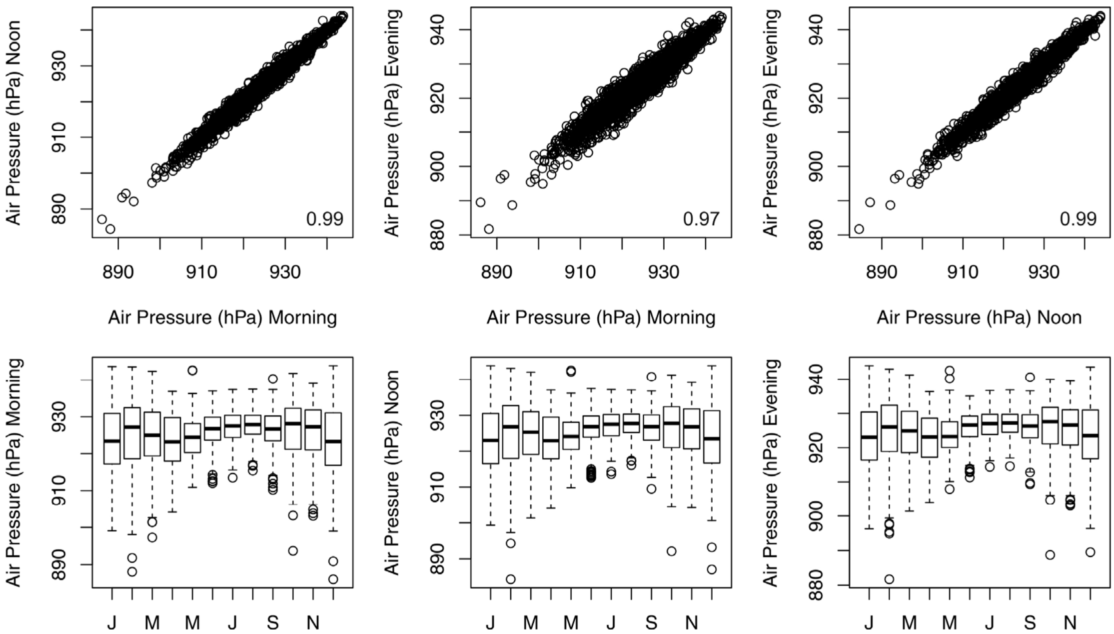


Figure 7. Analysis of pressure data from the Merz series. The top row shows mutual comparisons of morning, noon, and evening series (the number in the bottom right corner indicates the Pearson correlation coefficient), the bottom row shows box plots for pressure in the morning, at noon, and in the evening as a function of calendar month (box indicates quartiles and median, whiskers extend to at most 1.5x the interquartile range from the box).

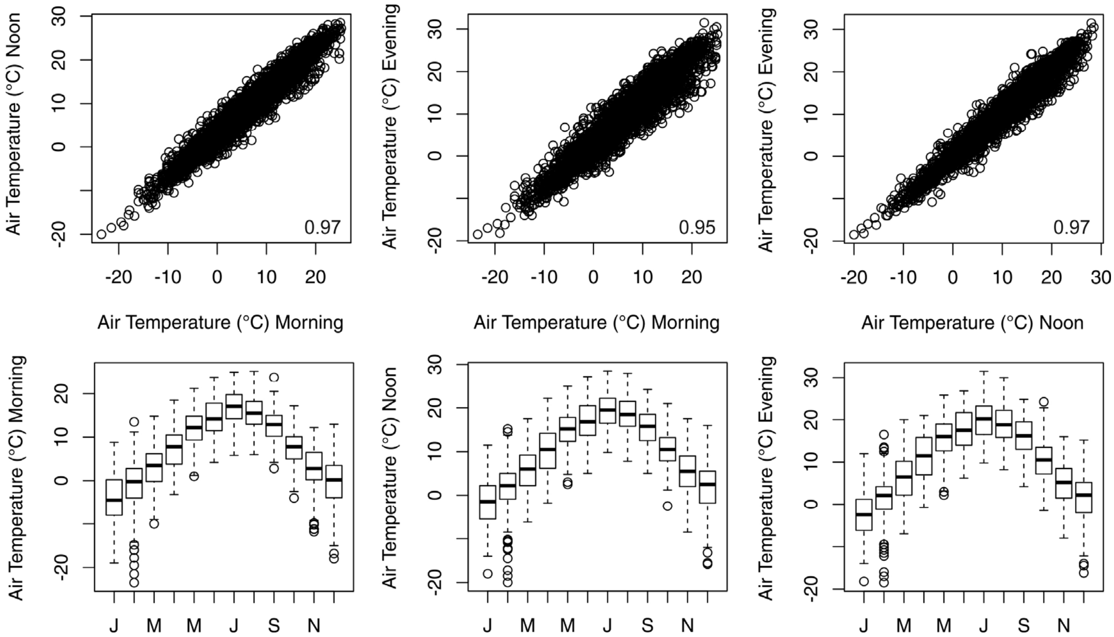


Figure 8. Analysis of temperature data from the Merz series. The top row shows mutual comparisons of morning, noon, and evening series (the number in the bottom right corner indicates the Pearson correlation coefficient), the bottom row shows box plots for temperature in the morning, at noon, and in the evening as a function of calendar month (box indicates quartiles and median, whiskers extend to at most 1.5x the interquartile range from the box).

The same analysis for temperature (Fig. 8) led to 51 flagged values out of 10,561 (or 0.5%). Correlations are again high, pointing to a high quality of the series. Noteworthy is a series of anomalously cold days in February.

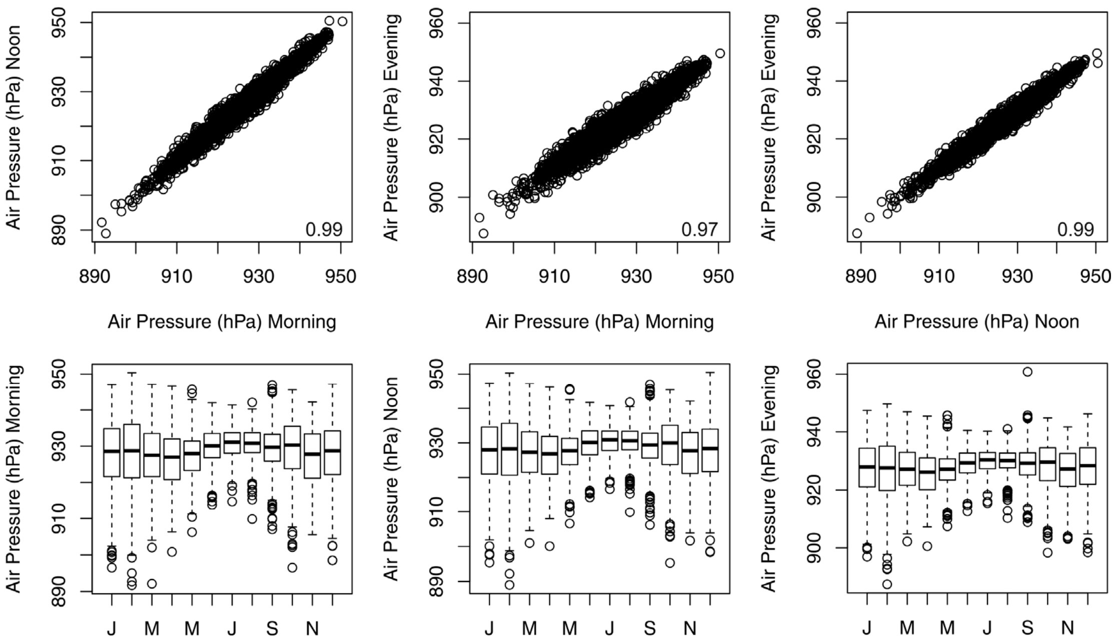


Figure 9. Analysis of pressure data from the Nef series. The top row shows mutual comparisons of morning, noon, and evening series (the number in the bottom right corner indicates the Pearson correlation coefficient), the bottom row shows box plots for pressure in the morning, at noon, and in the evening as a function of calendar month (box indicates quartiles and median, whiskers extend to at most 1.5x the interquartile range from the box).

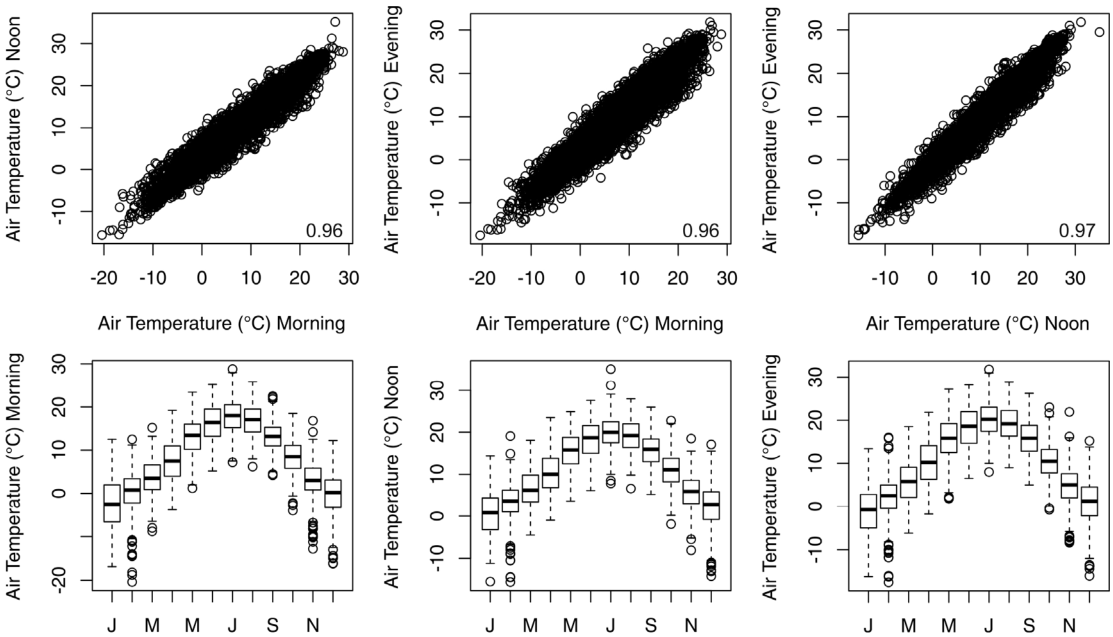


Figure 10. Analysis of temperature data from the Nef series. The top row shows mutual comparisons of morning, noon, and evening series (the number in the bottom right corner indicates the Pearson correlation coefficient), the bottom row shows box plots for temperature in the morning, at noon, and in the evening as a function of calendar month (box indicates quartiles and median, whiskers extend to at most 1.5x the interquartile range from the box).

Results are very similar for the Nef series. In the case of pressure, 214 values out of 22,112 are flagged, *i.e.,* 1.0% of all values. Plotting pressure data for different times of the day against each other (Fig. 9) shows again very high correlations between different times of day, pointing to a high internal consistency. Interestingly, the annual cycle no longer shows the low values in December and January.

Processing the temperature data (Fig. 10) revealed 151 suspicious values out of 22,170 (thus 0.7% flagged data). Correlations are again high, with a very similar behavior as the Merz data. Noteworthy are again the negative outliers in February.

Figure 11 shows the comparison of the mean temperature values at the different observation times with the diurnal cycle of the modern MeteoSwiss station at St. Gall, 1981-2010 (1 °C was subtracted to take global warming into account). Here differences in data quality between the two records are more evident than in the scatter plots. In January, the data from Nef show an unrealistic temperature range. The data from Merz look somewhat better, although his noon observation is probably overestimated. Both records are on average much colder than expected, which might indicate micro-climatic differences between Herisau and St. Gall and/or that winters in the 1820s and 1830s were particularly harsh. In July, the two records are very similar; both show a positive radiative bias for most observation times. The morning observation of Merz, however, is less biased than that of Nef. In summary, Merz's measurements look slightly more reliable than those of Nef, although both records seem affected by radiative biases.

Next, we compared the two series during their long, overlap (Fig. 12). Correlations are excellent, particularly for temperature, pointing to a high consistency of the data (despite possible radiation biases, as discussed above). An offset in pressure is found, which could be due to the unknown altitude. Temperature also fits well with respect to absolute values between the two series, although differences are apparent from an analysis of the diurnal cycle (Fig. 11).

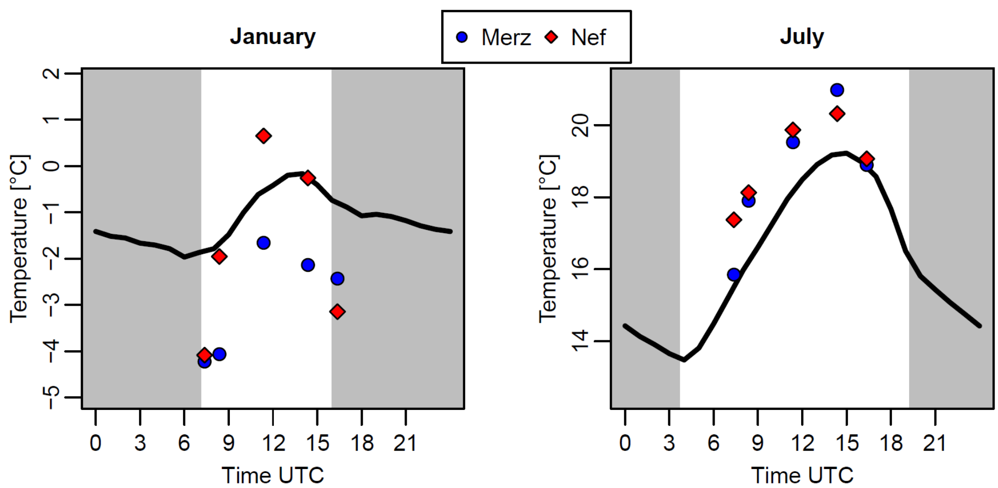


Figure 11. Diurnal cycle of temperature in January (left) and July (right) in present-day MeteoSwiss data (thick black line) as well as in the series from Merz and Nef (grey shading indicates nighttime).

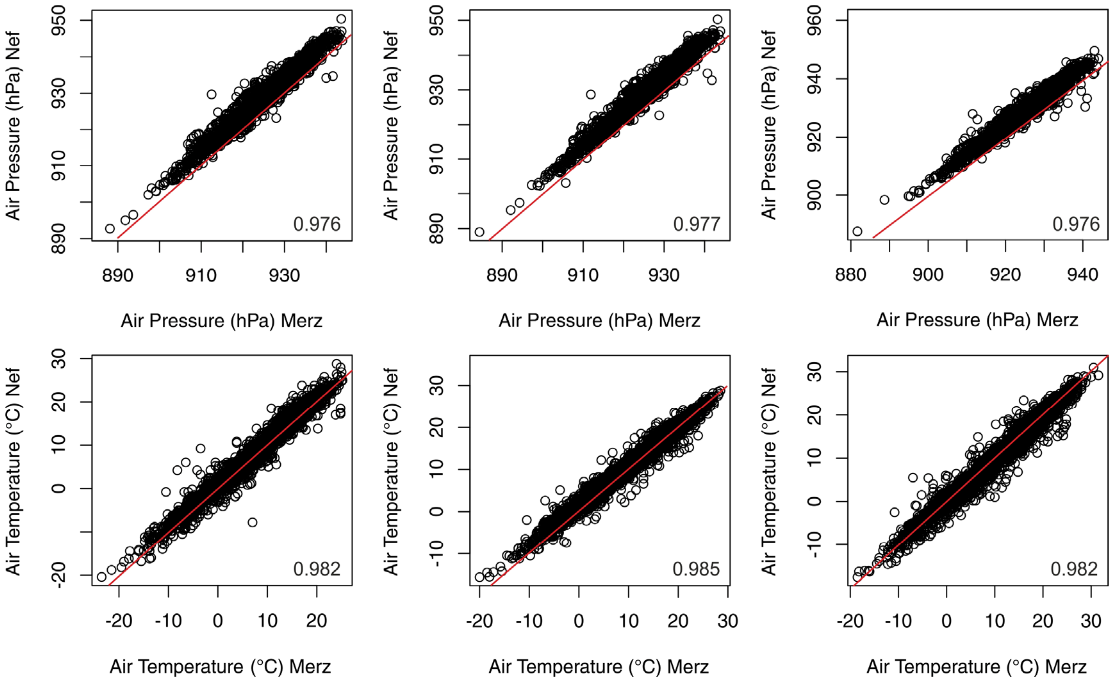


Figure 12. Comparison of pressure (top) and temperature (bottom) series of Merz and Nef for (left) morning, (middle) noon and (right) evening (numbers indicate the Pearson correlation coefficient). The 1:1 line is shown in red.

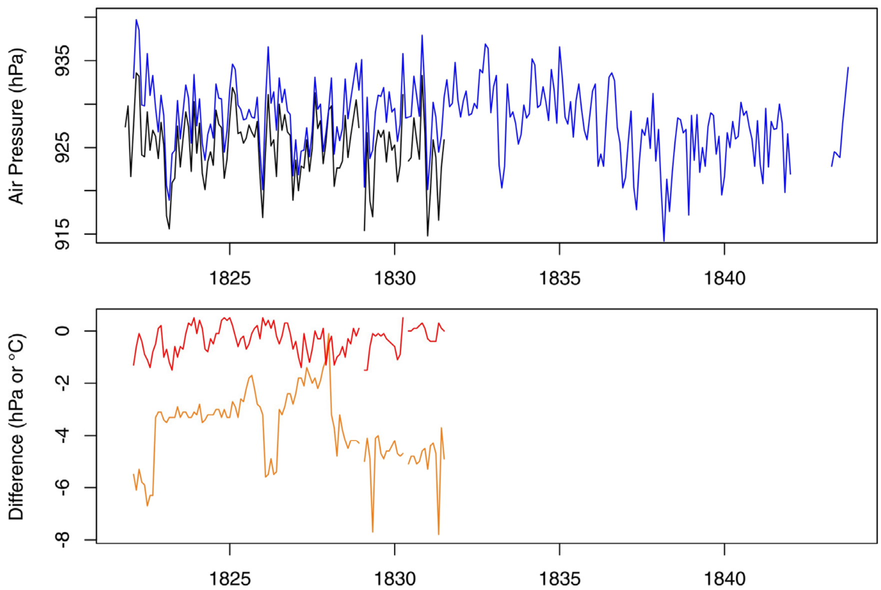


Figure 13. (top) Time series of monthly mean pressure from Merz (black) and Nef (blue). (Bottom) difference series (Merz minus Nef) of monthly mean temperature (red) and pressure (orange).

Finally, we also analysed monthly mean time series (Brugnara et al., 2020). Results for pressure (Fig. 13) show a good agreement, albeit with offsets (orange line, bottom panel). The differences in 1822 are due to the fact that Nef's pressure data were not reduced to 0 °C. However, offsets also occur later. The low pressure values in Nef's series in the 1830s and 1840s are likely real and are also found in St. Gall (see Hürzeler et al., 2020). Further homogenisation work will analyse these shifts in more detail. A generally good agreement was found for monthly temperature series (red line, Fig. 13, bottom), where no obvious break can be identified.

5. Conclusions

This paper describes two meteorological series from Herisau, Appenzell, measured by Johann Ludwig Merz (1821–1831) and Johann Jakob Nef (1822–1844). We provide information on the observers, discuss the series and present the results of the quality assessment. Due to the long temporal overlap, detailed comparisons are possible.

Despite some obvious deviations of temperature from its expected behaviour in winter, both series seem to be of high internal consistency, with high correlations between series for different times of day and high mutual correlations. The long term stability yet needs to be tested. Together, the two series provide detailed information on the weather over a 24 year period, which includes the extremely cold winter 1829/30 as well as other interesting events and thus will provide further information weather and climate in the first half of the 19th century.

The paper accompanies the publication of the inventory of early Swiss meteorological series (Pfister et al., 2019), of the data sheets https://zenodo.org/record/3066836#.XVv-fGRS8-U and of the digitised data (Brugnara et al., 2019). The latter can be downloaded from https://doi.pangaea.de/10.1594/PANGAEA.909141, from MeteoSwiss and from EURO-CLIMHIST (Pfister et al., 2017). In the future, they will also be available from Copernicus Climate Change Services (C3S) data repository (Thorne et al., 2017).

Acknowledgements

The work was supported by the Swiss National Science Foundation (project CHIMES 169676), by the European Commission (ERC grant PALAEO-RA, 787574), by Copernicus Climate Change Service (C3S) 311a Lot 1, by GCOS Switzerland (project "Long Swiss Meteorological Series"), and by EURO-CLIMHIST.

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