Hürzeler A., Y. Brugnara, and S. Brönnimann (2020) The Meteorological Record from St. Gall, 1812–1853. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 87–95, DOI: 10.4480/GB2020.G96.07.

The Meteorological Record from St. Gall, 1812–1853

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Abstract

A 40-year record of instrumental meteorological observations is available for St. Gall, covering the years 1812–1853. Combined with the data form MeteoSwiss, a new long series of more than 200 years could be generated. In this paper, we describe the station history and instruments as well as the data processing and quality control of the data. This paper accompanies the publication of the imaged data and the data collection of early Swiss instrumental series.

1. Introduction

Early meteorological measurements from the north-eastern parts of Switzerland are relatively rare. One of the longest and most continuous series is that from St. Gall. Pharmacist Daniel Meyer was the first to perform meteorological measurements there. His series starts in 1812 and ends in 1832, but was then continued by the Natural Sciences Society until 1853. Measurements started again in 1857 (see Pfister et al., 2019), although only part of these data have been found. The St. Gall station in the Swiss network then started in 1864.

In this paper we describe the meteorological series from St. Gall, 1812–1853. We provide details about the observer, location and instruments and discuss the processing and quality control of the series. This paper accompanies the publication of the metadata of all early Swiss series in the form of an inventory (Pfister et al., 2019), the images of data sheets (https://zenodo.org/record/3066836#.XVv-fGRS8-U), and the publication of the digitised data (Brugnara et al., 2019), which can be downloaded from https://doi.pangaea.de/10.1594/

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PANGAEA.909141, MeteoSwiss, EURO-CLIMHIST and the Copernicus Climate Change Service (C3S) Global Land and Marine Observations Database (Thorne et al., 2017).

The paper is organised as follows. Section 2 gives a summary of the station history. The data source is presented in Section 3. Section 4 describes the results of the quality assurance and presents the data. A comparison with other stations as well as a brief analysis of the cold winter 1829/1830 is shown in Section 5. Conclusions are drawn in Section 6.

2. Station history

The observer in St. Gall was Daniel Meyer. He was born on 11 January 1778 in St. Gall as a member of a distinguished family (Lienhard, 2007). He studied natural sciences in Halle and then pharmacy in Berlin. In 1803 he returned to St. Gall and founded the pharmacy "Zum Blauen Himmel" together with Dr. Caspar Tobias Zollikofer. In 1815 he joined the newly founded Swiss Society for Nature Research and took over the meteorological observations ordered by the Society for the St. Gall station (Wartmann, 1864). His observations go back even earlier, to 1 January 1813.

Daniel Meyer made the observations in his apartment above the pharmacy at Spisergasse 30 in St. Gall (Zollikofer, 1870). Figure 1 shows the location of Spisergasse 30 on a map section of St. Gall from 1850. He measured in an unheated room, 15 Paris feet above the street (Meyer, 1813). Spisergasse 30 is at an altitude of 670.1 m asl and 1 Paris foot corresponds to 32.48 cm, so that the barometer was arguably at 674.97 m asl. From January 1833 it is unclear where measurements were taken. It is not documented where the measurement location was and the altitude at which the measurements were taken.

Figure 1. Map section of the Dufour Map of St. Gall from 1850 with the red marked location of the pharmacy "Zum Blauen Himmel" at Spisergasse 30. Source: Bundesamt für Landestopografie.

Table 1: List of the measurements and observation hours at the St. Gall station. Numbers indicate local time, SR is sunrise, SS is sunset

Period	Pressure	Barometer temperature	Air temperature	Wind direction	Precipitation type	Humidity
1812–1816	SR/SS	SR/SS	SR/SS	AM/PM	AM/PM*	no obs.
1817–1826	SR/SS	no obs.	SR/14/SS	AM/PM	AM/PM	no obs.
1827-1832	09/12/15	no obs.	09/12/15	AM/PM	AM/PM	no obs.
1833–1837	09/12/21	09/12/21	09/12/21	no obs.	no obs.	no obs.
1838–1853	09/12/15/21	no obs.	09/12/15/21	09/12/15/21^{+}	daily	09/12/15/21

$^{+}$ from 1838–1841 only 09/21
* data start 1 Jan 1813

From 1 January 1813 to 31 December 1826, Daniel Meyer measured pressure with a siphon barometer of the "artist Loos in Büdingen", to which a centesimal thermometer was attached in order to achieve a reduction of the air pressure. Outside the window of the unheated room was another "free" thermometer of the "mechanic Mendelsohn in Berlin" (Meyer, 1813). From 1 January 1827 to 31 December 1832, Meyer used other instruments: a cistern barometer from "Deri in Zürich" and a "free" thermometer from "Gourdon in Geneva" (Meyer, 1827). From 1832 to 1853 it is unclear which instruments were used. No further records are available of how the measurements were performed.

The forty-year period can be divided into three periods: From 1 January 1813 to 31 December 1832, the observations were carried out by Daniel Meyer. He then stopped since "conditions no longer allow it" (Meyer, 1833). From 1 January 1838 to 7 June 1853 measurements were performed by the Natural Science Society in St. Gall. For the period in-between, 1 January 1833 to 31 December 1837, it is unclear who carried out the observations.

3. Data source

The original data examined are available as meteorological observations from 6 June 1812 to 7 June 1853. The observations can be found as handwritten notes in the Vadian Collection of the Cantonal Library of St. Gall. From 1 January 1813 to 31 December 1832, they were published monthly as a supplement in the political journal "Der Erzähler" (see Fig. 2). In addition to the air pressure, the temperature at the barometer, the outside temperature, the wind direction, the type of precipitation and the humidity were documented. Table 1 shows the time period, the type of measurement recorded and the times of day at which the measurements were taken.

In addition, monthly comments on the weather development and an overview of the meteorological development of the year at the end of the year were noted. The original data were digitised from 1 January 1813 to 7 June 1853. A total of 44,688 digitised air pressure measurements are available, an average of three per day.

4. Processing and quality control

From 1 January 1813 to 31 December 1816, Daniel Meyer did not reduce air pressure, but the temperature of the barometer is specified. From 1 January 1817 to 31 December 1832, he reduced pressure to 10° Réaumur. From 1833 to 1837, indoor temperature is indicated, so we

Meteorologische Beobachtungen. St. Gallen. Heumonat 1816.

	Bey Sonnen Aufgang.				Bey Sonnen Untergang.				Regen oder Schnee.		Himmelsbeschaffenheit.	
Juli.	Barometer.	festes Thermometer.	freyes Thermometer.	Wind.	Barometer.	festes Thermometer.	freyes Thermometer.	Wind.	Vormittag.	Nachmittag.	Vormittag.	Nachmittag.
1	25. 90	+ 12.2	+10. —	O	25. 86	+14. 4	+12. —	W	— —	Regen	schön	vermischt
2	25. 90	+12.—	+ 6. 4	W	25. 93	+11. 2	+ 7. —	W	Regen	Regen	trüb	trüb
3	25. 98	+12.—	+ 6. 2	W	26. 01	+10. 8	+ 8. 4	W	Regen	Regen	trüb	vermischt
4	26. 04	+10.4	+ 7. —	SW	26. 07	+12. 2	+ 9. 8	W	Regen	— —	trüb	schön
5	26. —	+10. 6	+ 7. 2	W	25. 99	+10. 4	+ 9. —	SW	Regen	Regen	vermischt	trüb
6	26. 05	+10.2	+ 7. —	O	26. 05	+12. —	+11 4	O	— —	— —	schön	schön
7	26. 02	+11. 2	+7. —	O	25. 97	+15. 2	+14. —	O	— —	Regen	schön	schön
8	25. 87	+12.—	+11.—	SW	25. 96	+14. 4	+ 13. 4	NO	— —	Regen	schön	vermischt
9	25. 97	+13. 6	+10.8	O	25. 96	+16. 8	+ 17 —	O	— —	— —	schön	schön
10	25. 96	+14. 8	+11. —	O	25. 94	+16. 8	+ 13. 2	W	— —	Regen	schön	vermischt
11	25 92	+15.—	+ 9 6	SW	25. 92	+12. 6	+ 9. —	SW	— —	Regen	schön	vermischt
12	25. 90	+12. 6	+ 6. 8	SW	25. 90	+12. 4	+ 7. 8	SW	Regen	Regen	trüb	trüb
13	26. 04	+11.4	+ 7. 4	SW	26. 09	+10. 4	+ 8. 4	SW	Regen	Regen	vermischt	vermischt
14	26. 10	+10. 4	+ 8. —	SW	26. 02	+13. —	+ 10. 4	NO	Regen	— —	vermischt	schön
15	25. 94	+11. 6	+ 6. 8	O	25. 91	+13. 4	+12. 2	W	— —	Regen	schön	vermischt
16	25. 93	+12. —	+ 7. —	O	25. 90	+11. —	+ 12 6	W	— —	Regen	schön	vermischt
17	25. 95	+12. 6	+ 5. 2	W	25. 95	+12. 4	+ 8 4	W	Regen	Regen	trüb	vermischt
18	25. 93	+11. 6	+ 8. 2	W	25. 97	+14. —	+13. —	O	— —	— —	schön	schön
19	26. 02	+12.8	+10. —	S	26. 05	+16. —	+15. 8	O	— —	— —	schön	schön
20	26. 08	+14. 4	+10. 6	O	26. 03	+17. 6	+18. —	O	— —	— —	heiter	heiter
21	25. 95	+14. 8	+12. —	S	26. 03	+17. 2	+16. 4	SW	— —	Regen	heiter	schön
22	26. 10	+16. —	+12. —	S	26. 08	+15. 2	+12. 4	SW	Regen	— —	trüb	vermischt
23	25. 98	+14. 2	+10. 4	SO	25. 95	+15. 2	+12. 6	W	— —	Regen	schön	vermischt
24	25. 93	+14. —	+10. 4	W	25. 93	+14. —	+11. 6	SW	Regen	Regen	trüb	vermischt
25	25. 96	+13. 8	+ 9. 2	SW	26. 02	+13. 2	+10. —	NO	Regen	Regen	trüb	vermischt
26	26. 04	+12. 2	+ 9. —	SW	26. 11	+12. 6	+ 9. —	SW	Regen	Regen	vermischt	vermischt
27	26. 16	+12.—	+ 9. —	W	26. 08	+13. 6	+ 13—	W	— —	— —	schön	schön
28	26. 02	+ 12—	+ 8. 6	W	25. 87	+15. 4	+ 14.8	W	— —	Regen	schön	vermischt
29	25. 81	+13. 2	+10. 2	W	25. 75	+14. 2	+12.6.	O	Regen	Regen	vermischt	vermischt
30	25. 70	+13.—	+ 5. 6	SO	25. 77	+11. 6	+ 7.8	SW	Regen	Regen	trüb	trüb
31	25. 78	+10. 8	+ 6. 2	SO	25. 69	+12. 2	+ 11.6	SO	— —	Regen	vermischt	trüb
Mittel	25. 97	+12. 6	+ .8 6	Mittel	25. 96	+13. 6	+11.7					

Figure 2: Data sheet for July 1816, *i.e.,* during the "Years without a Summer" of 1816. Only six days had no rain (from "Der Erzähler", no. 40/1816, p. 210).

assumed that pressure was not reduced. From 1 January 1838 to 7 June 1853, the air pressure was reduced to 0° Celsius. We reduced those pressure data that were not already reduced by Meyer to 0 °C as indicated in Brugnara et al. (2015, 2020) using the temperature at the barometer. From 1817 to 1833 we reduced the data from 10 °R to 0 °C. The pressure given in units of length was then converted to hPa as indicated in Brugnara et al. (2015, 2020).

The cistern barometer was the most widely used barometer of the early 19th century. It consists of an open cistern connected to a vertical glass tube with the upper end sealed. A correction is necessary that requires the diameters of cistern and glass tube. For the barometer used by Daniel Meyer the former is known, but the latter not, and it is not clear whether such a correction had already been done or is necessary at all (Meyer, 1827). The possible error introduced by this uncertainty is probably less than 1 hPa (Brugnara et al., 2015). The error caused by capillarity, typically the biggest source of error barometers at the beginning of the 19th century, could be larger than 1 hPa (Camuffo et al., 2006) but can be assumed to be constant over several years. Also, the temperature correction itself adds an uncertainty of a few tens of a hPa. The scale of the barometer can change physically, thermally, or due to the effect of the moisture on the wood of the scale holder. Other sources of error are the quality of the mercury or bubbles in the glass tube. Often the quality deteriorates over time.

Errors were arguably even larger for temperature. An official standard for outdoor temperatures did not exist. Nevertheless, there were some general rules, influenced by the French physicist Réaumur (Réaumur, 1732). Thermometers were normally installed at north-facing walls or windows to minimise the effect of direct and indirect sunlight (Camuffo, 2002).

All data subsequently underwent the quality control procedure described in Brugnara et al. (2020). This led to flags being set for 352 out of 44,688 pressure values (corresponding to 0.8%) and 141 out of 48,336 temperature values (0.3%). These are comparably low numbers.

We then compared measurements made during different times of the day separately for all sub-periods mentions in Table 1. For pressure (Fig. 3) correlations are generally high. However, there are differences between subperiods. Correlations are clearly lower during the first and second periods (1812-1816 and 1817-1826), and they are also lower during the period 1833-1837, which however seems to be due only to the evening measurement (morning and noon measurements correlate very well). All other correlations are excellent and point to a high reproducibility of the measurements.

The same results for temperature are shown in Figure 4. Correlation coefficients are generally lower, as is expected because of the larger diurnal cycle and thus larger changes between measurement times. None of the coefficients is below 0.9, which points to an overall good quality. Comparing the subperiods, we find the same qualitative features as for the pressure data. Comparisons are generally worse for the first two subperiods as well as for the period 1833-1837.

Figure 5 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). In July, the data from all records are very similar; in general, there seems to be a radiative bias that causes too high temperatures during the day, while the temperatures taken by Meyer at sunrise and sunset look more reliable. In January, all records have a too large amplitude of the diurnal cycle, which is expected from unshielded thermometers. The record of the Natural Science Society (1838-1853), however, is close to the modern climatology and can be considered the most reliable.

An analysis of time series of monthly mean pressure data (Fig. 6) also points to a good data quality. For comparison we plot the corresponding pressure series from Herisau measured by Nef (see Weber et al., 2020). The agreement is very good (correlation coefficient of 0.928). Some systematic differences are found in the late 1820s and after 1834.

The larger pressure difference in the years 1827 and 1828 could be caused by the new instruments that were introduced by Daniel Meyer in 1827. The larger pressure difference from 1833 to 1837 coincides with the period during which it is unclear who carried out the measurements but deviations continue to 1840. As metadata are not available for this period, our assumed altitude could be wrong. Homogenisation of the series will be attempted in a later step.

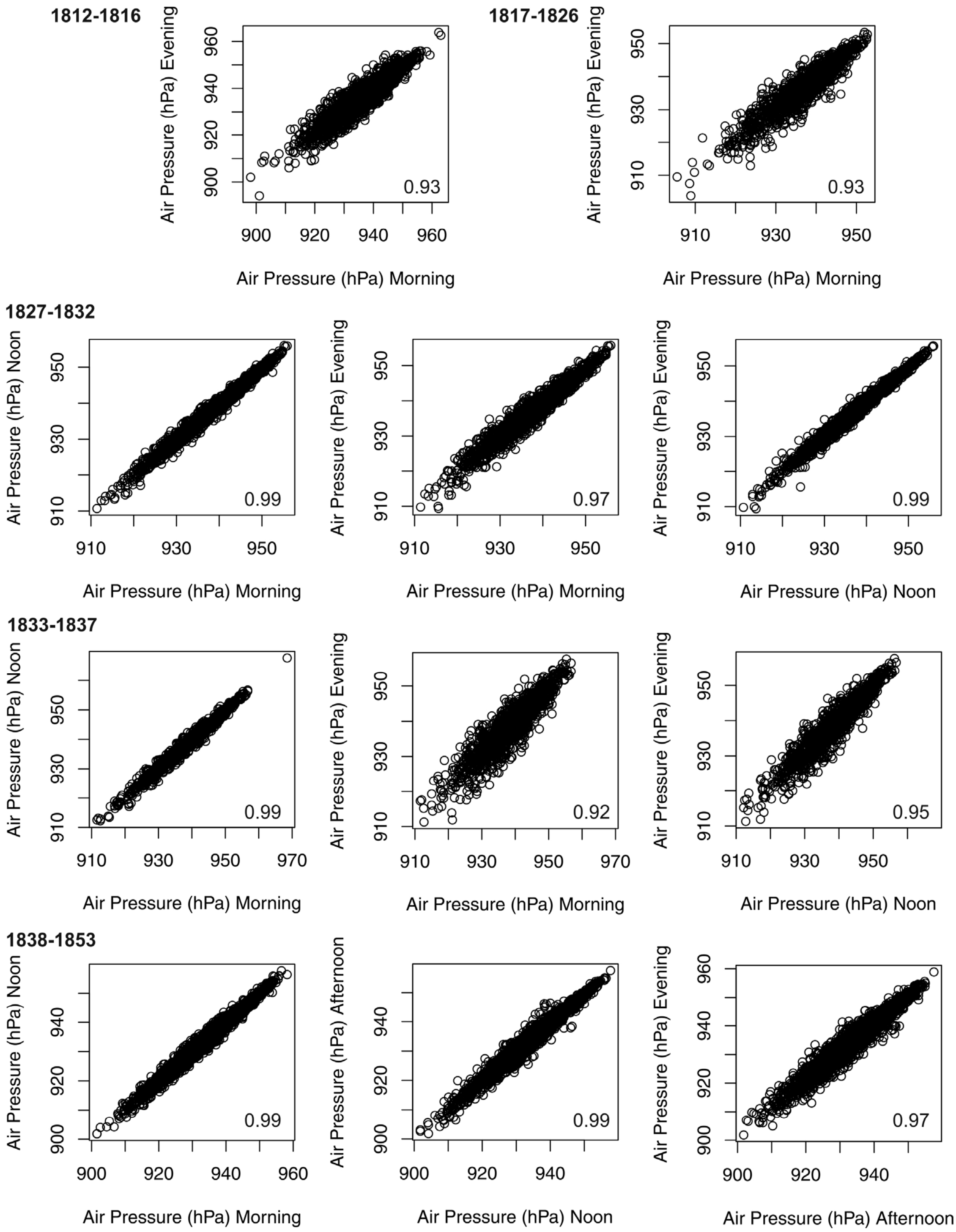

Figure 3. Mutual comparisons of morning, noon, and evening series of pressure in St. Gall (the number indicates the Pearson correlation coefficient). Each row shows one of the subperiods mentioned in Table 1.

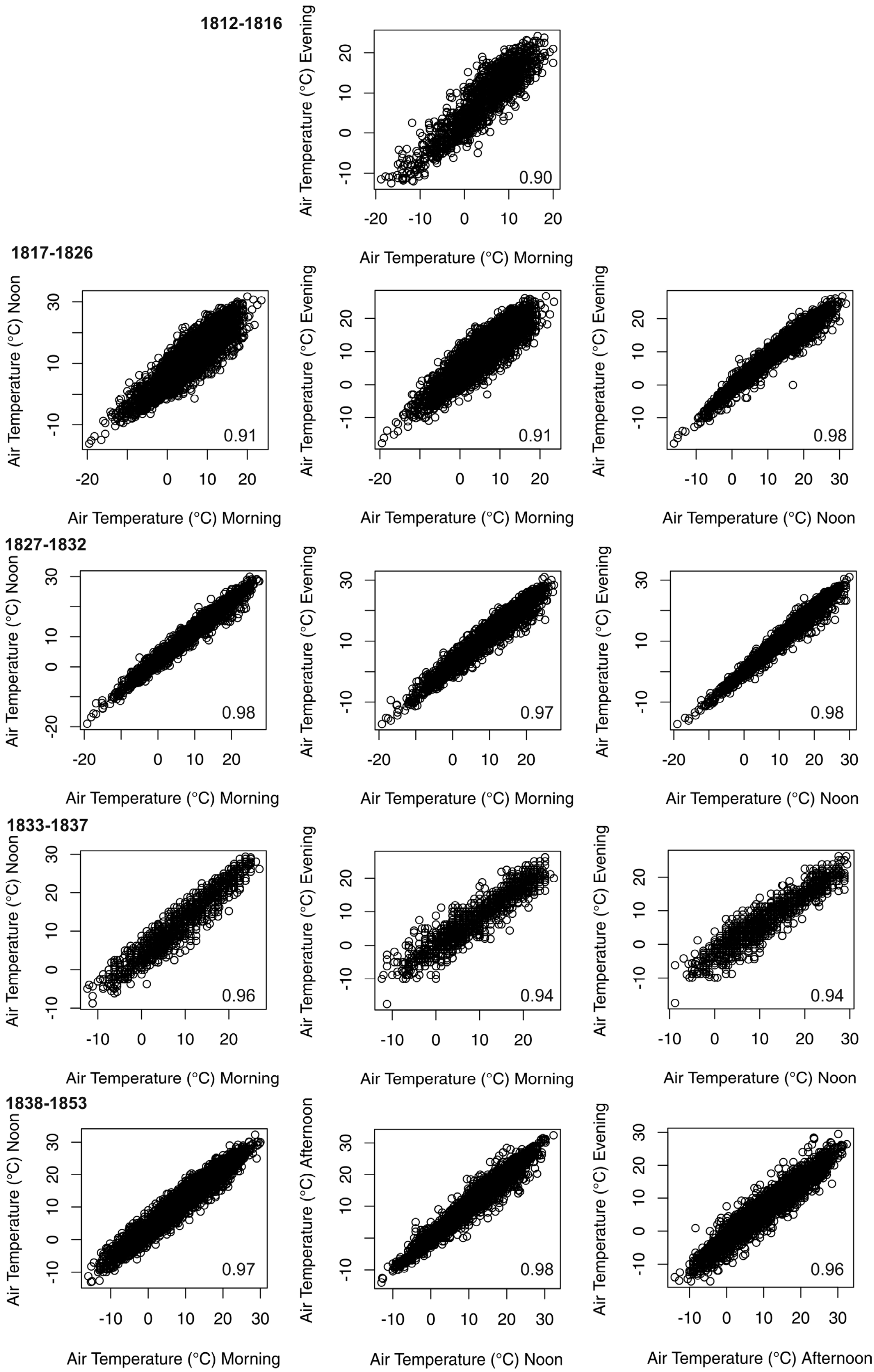

Figure 4. Mutual comparisons of morning, noon, and evening series of pressure in St. Gall (the number indicates the Pearson correlation coefficient). Each row shows one of the subperiods mentioned in Table 1.

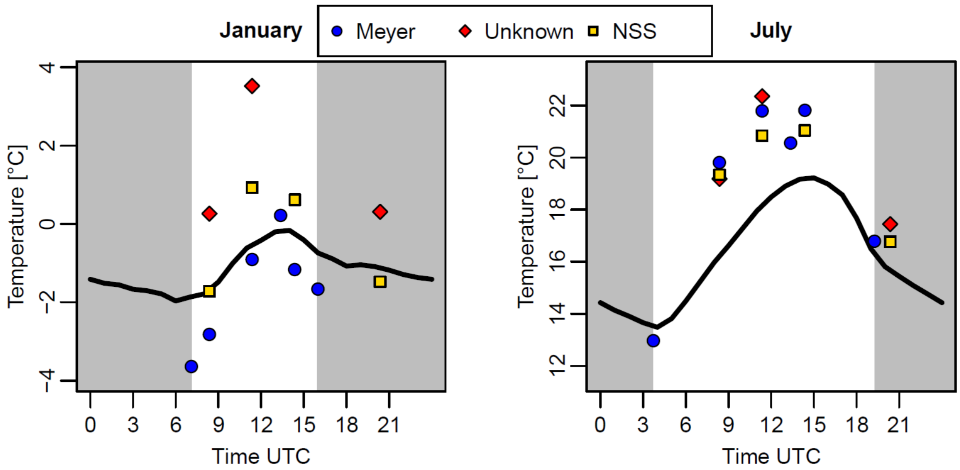

Figure 5. Diurnal cycle of temperature in January (left) and July (right) in present-day MeteoSwiss data (thick black line) as well as in the series from Meyer (1813–1832), the unknown observer (1833–1837) and the Natural Sciences Society (1838–1853). Grey shading indicates nighttime.

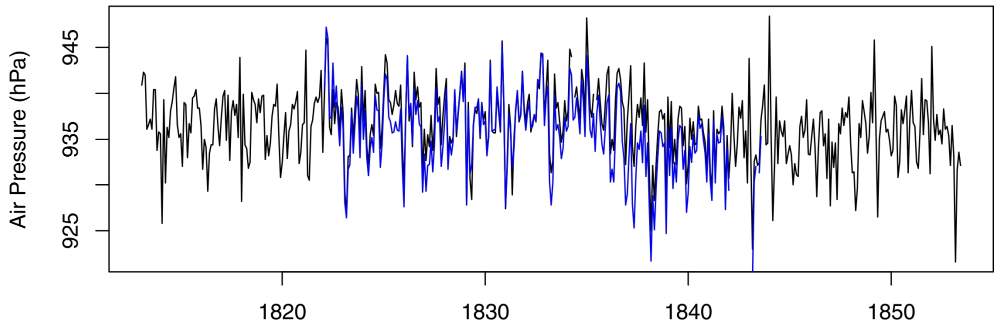

Figure 6. Time series of monthly mean pressure from St. Gall (black). Also shown is the monthly mean pressure series from Herisau measured by Nef (see Weber et al., 2020), shifted downward by 7.5 hPa for comparison purposes.

5. Conclusions

This work presents a 40-year meteorological record from St. Gall from 1812 to 1853. Despite some uncertainties, the series proves to be of relatively high quality. High correlations were found between time series for different times of day for both temperature and pressure, although there are differences between the subperiods. Possible pressure biases were found for parts of the record, which need to be further studied. Future work will attempt to homogenise the record. From 1864 onward, measurements were performed under the auspices of the Swiss Natural Sciences Society and integrated into the Swiss national network now run by MeteoSwiss. Another record is reported for 1857 to 1863 (Pfister et al., 2019), of which however, only 1857 and 1858 could be found. Combined, these series could provide a 207-year record for St. Gall, though with some gaps.

The data are made publicly available by MeteoSwiss and can be downloaded from https://doi.pangaea.de/10.1594/PANGAEA.909141. They will also be available from the C3S data Global Land and Marine Observations Database (Thorne et al., 2017) and from EURO-CLIMHIST (Pfister et al., 2017). The images can be downloaded from https://zenodo.org/record/3066836#.XVv-fGRS8-U.

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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