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A long meteorological series from Schaffhausen, 1794–1845

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Abstract

This article describes the arguably longest single-observer series of Switzerland, namely that by Johann Christoph Schalch. The series covers the years 1794–1845 and encompasses three times daily measurements of pressure and temperature. We have digitised and re-evaluated the series and found it to be of good quality. Further segments from Schaffhausen by other observers, which could possibly be used to produce a complete record until the start of the MeteoSwiss network in 1864, were not digitised or could not be found.

1. Introduction

Until recently, only two early instrumental series from Switzerland were electronically available that reached back to the 18th century: those of Basel and Geneva (Bider et al., 1958; Bider and Schüepp, 1961; Schüepp, 1961). Both have now been supplemented with additional segments in the context of the project "Long Swiss Meteorological Series" documented in this volume (Brugnara and Brönnimann, 2022; Brugnara et al., 2022a). Several further series reaching back to the 18th century were digitised and re-evaluated in this project, including series from Bern and Zurich (Brugnara et al., 2022b), Neuchâtel (Wyer et al., 2021) and Chur/Marschlins (Grimmer, 2019). Here we present another long series reaching back to the 18th century: Schaffhausen, 1794–1845.

The series was measured by Johann Christoph Schalch. With a length of 52 years, this is arguably the longest single-person record from Switzerland. It is slightly longer than the records by D'Annone (Basel) and Studer (Bern, Hari et al., 2022), both of which cover 49 years (though

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Studer measured at different locations). Worldwide, the chronicle by Gottfried Reyger for Gdańsk, Poland is longer and covers 65 years (Filipiak et al., 2019).

The Schalch series has been carefully checked and re-evaluated by Gisler (1984). Most of the metadata of our article are taken from this work. Gisler digitised the original observations but only published the monthly or seasonal means. Therefore, we went back to digitising the original records. Here we present a re-digitised and re-evaluated series from Schaffhausen. It complements the published early Swiss meteorological series (Brugnara et al., 2020b). The imaged data sheets of all series have been published in a repository, accompanied by a paper describing the inventory and metadata of the series (Pfister et al., 2019). The digitised data will be available from various sources, including MeteoSwiss, EURO-CLIMHIST (Pfister et al., 2017) and the Copernicus Climate Change Service (C3S) Global Land and Marine Observations Database (Noone et al., 2021).

The paper is organised as follows. Section 2 provides a historical overview of the observer and the measurements. Section 3 presents the results of the quality assurance. Conclusions are drawn in Section 4.

2. The series by Johann Christoph Schalch

The observer of the Schaffhausen series was Johann Christoph Schalch (1761–1846), son of Christoph Schalch, a tanner, and Barbara Sabine Schalch (Marti-Weissenbach, 2011). Johann Christoph studied medicine in Zurich, Göttingen and Vienna, where he worked as a doctor. In 1788, he returned to Schaffhausen and became city doctor in 1796. He not only measured the weather for several decades but also was active in the Swiss Natural Sciences Society and in the Schaffhausen Natural Sciences Society. Gisler (1984) assumes that he was an experienced and careful observer.

Gisler (1984) reconstructed the measurement locations of Schalch, these are also shown in Figure 1 and listed in Table 1. The period 1794–1845 can be subdivided into three periods. During the first period, 1794–1798, measurements were performed in his parents' house (Unterstadt 37). His father had died shortly before and the house came into the possession of Schalch's brother, while Johann Christoph Schalch, as city doctor from 1796 onward, was entitled to live in the Pfrundhaus within the premises of the monastery Allerheiligen. However, it seems that this house was not yet ready when Schalch became city doctor. From 1798 to 1804 measurements were taken at Moserstrasse 28, very close to the previous location, and only in 1805 the instruments were relocated to the Pfrundhaus.

Table 1. Measurement locations and observers in Schaffhausen, 1794–1893 (from Pfister et al., 2019)

Period	Location	Fig. 1	Observer	Variable
1794–1798	Untergries 88 (today Unterstadt 37)	1	Johann Christoph Schalch	p,T,rh,wdir,Wn, 3–4x daily
1798–1804	Unterer Wilder Mann (today Moserstrasse 28)	2	Johann Christoph Schalch	p,T,rh,wdir,Wn, 3–4x daily
1805–1845	Pfrundhaus, monastery Allerheiligen	3	Johann Christoph Schalch	p,T,rh,wdir,Wn, 3–4x daily
1808–1813	Unknown	-	Unknown	-
1833–1867	Haus zum Silbernen Brunnen (today Vordergasse 10)	4	Johann Jacob Schelling	T,wdir,Wn, 1–3x daily
1836–1893	Unknown	-	Ferdinand Ludwig Peyer	T,Wn, 3x daily
1836–1849	Schaffhausen or Lohn?	-	Johann Conrad Laffon	-

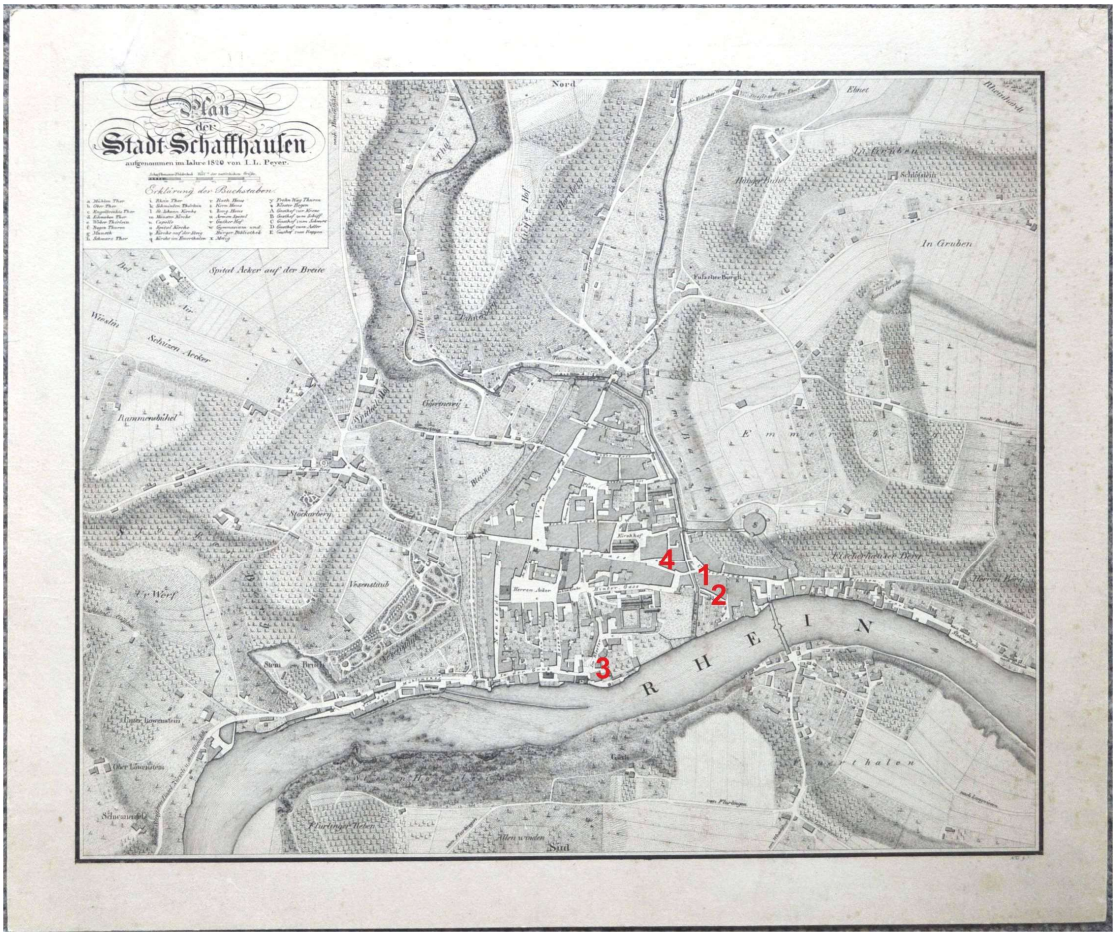

Figure 1. Contemporary map showing the city of Schaffhausen in 1820, by J. L. Peyer (Stadtarchiv SH, H 06/002b "Plan der Stadt Schaffhausen aufgenommen im Jahre 1820 von J. L. Peyer"). The numbers refer to Table 1.

Schalch had a thermometer that was manufactured by Georg Friedrich Brander and, from 1828 onward, a second thermometer labelled “Réaumur thermometer” (Gisler, 1984). According to Gisler (1984), the thermometric liquid was arguably spirit of wine in the former thermometer and mercury in the latter, but no evidence is shown. Brugnara et al. (2020b) contradict this statement based on comparing the parallel measurements and based also on a conversion equation found in the data sheets. The linearity of the relation suggests that also the Brander thermometer was filled with mercury. However, the Brander thermometer arguably had a shifted zero-point. Brugnara et al. (2020b) discuss the conversion of the Brander thermometer in Schaffhausen in more detail.

The barometer indicated pressure in Paris inches and lines. According to Gisler (1984) it might as well have been manufactured by Brander. It was located in Schalch’s office, in a window that opens to the north, at an altitude of 1200 Paris feet. Schalch read his instruments three times daily (the time of day, given in true solar time, is indicated). The series has relatively few gaps.

Schalch’s original observations can today be found in the Swiss Federal Archive. Figure 2 shows an example sheet. Gisler noted that there are two handwritings on the data sheets. Arguably Schalch was assisted by another observer. It further seems that this second person read the pressure differently as these values seem to be slightly lower. Qualitative precipitation data from Schalch’s notes are today in EURO-CLIMHIST (Pfister et al., 2017).

Several other series from Schaffhausen could be available and could possibly be used to generate a continuous series to the present. According to Wolf (1864), observations should be available for the period 1808–1813 by an unknown observer. Johann Jacob Schelling (1792–1867), merchant, in the house “Zum silbernen Brunnen” performed temperature measurements and wind observations from 1833 to 1867. During the first period (ca. 1833–1840), the sheets (kept at the Swiss Federal Archive) contain mainly weather notes and single wind direction and temperature indications. More regular temperature measurements start in December 1840 and were made usually twice daily from the mid-1840s onward (no measurements were found for 1850/1 and 1852–1856. Nevertheless, the data could help to extend the Schalch temperature series by several years.

Another series was measured by Ferdinand Ludwig Peyer (1814–1894); he was cantonal supervisor of roads and orphanages and was active as a politician. Peyer measured pressure and temperature. The data, kept at the Stadtarchiv Schaffhausen, cover the long period from 1836 to 1893. However, regular measurements only cover the period until 1843. Later manuscripts are incomplete and contain mostly weather notes, until irregular temperature measurements start again in the 1870s.

Finally, a series from Laffon is available that covers the period 1836 to 1849 and comprises temperature measurements and wind observations. The manuscript kept at the Swiss Federal Archive indicate Lohn as measurement location and “J. J. Laffon” as observer. According to Wetter and Pfister (2014), the data were communicated by pharmacist Johann Conrad Laffon (1801–1882), who lived in Schaffhausen but not in Lohn. These additional Schaffhausen data series could not be digitised.

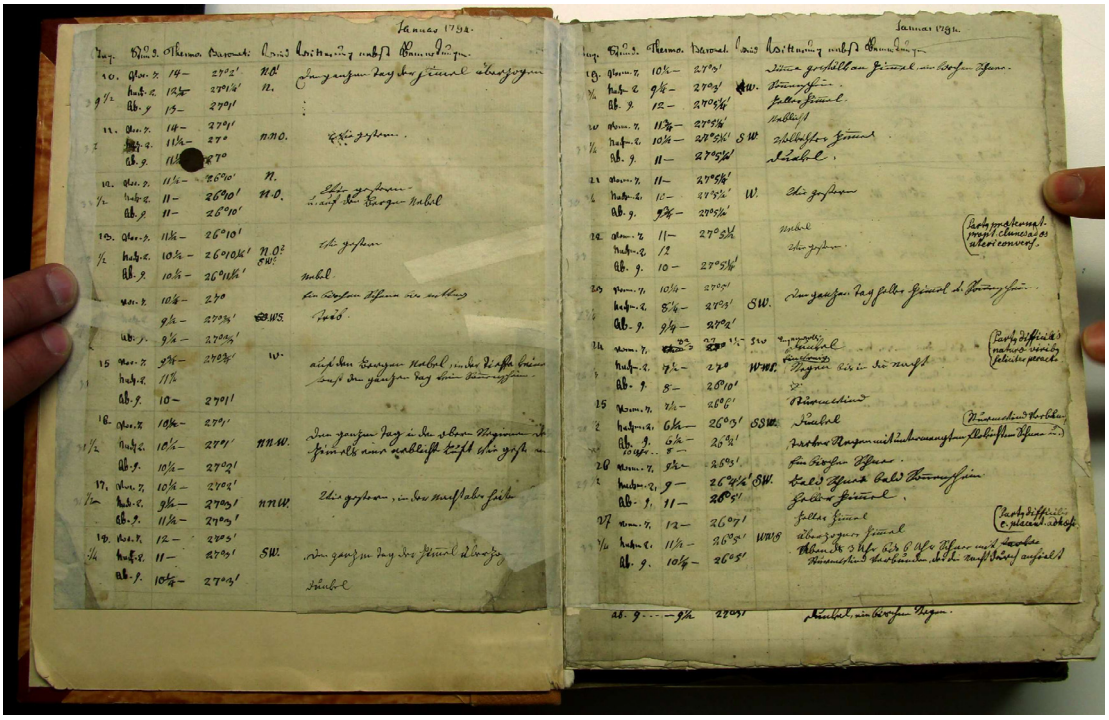

Figure 2. Example sheet of Schalch’s weather notes and measurements from the year 1794 from the Swiss Federal Archive (E3180-01#2005/90#195*).

3. Processing and quality control

The series from Schalch was re-scaled as detailed in Brugnara et al. (2020b), and further processing and quality control was performed as outlined in Brugnara et al. (2020a). Figure 3 shows the correlation of pressure and temperature measurements at different times of the day. Relatively high correlations are found for both variables. For 1828–1845, the comparison could also be made for the second thermometer, which shows an even slightly higher correlation.

The direct comparison between the two thermometers (Fig. 4) shows an excellent agreement and almost perfectly linear relation. Temperatures of the two thermometers provide correlation coefficients above 0.99. Only the evening comparisons shows few outliers. However, systematic differences appear from October 1842, indicating that at least one thermometer was probably relocated (see Brugnara et al., 2020b).

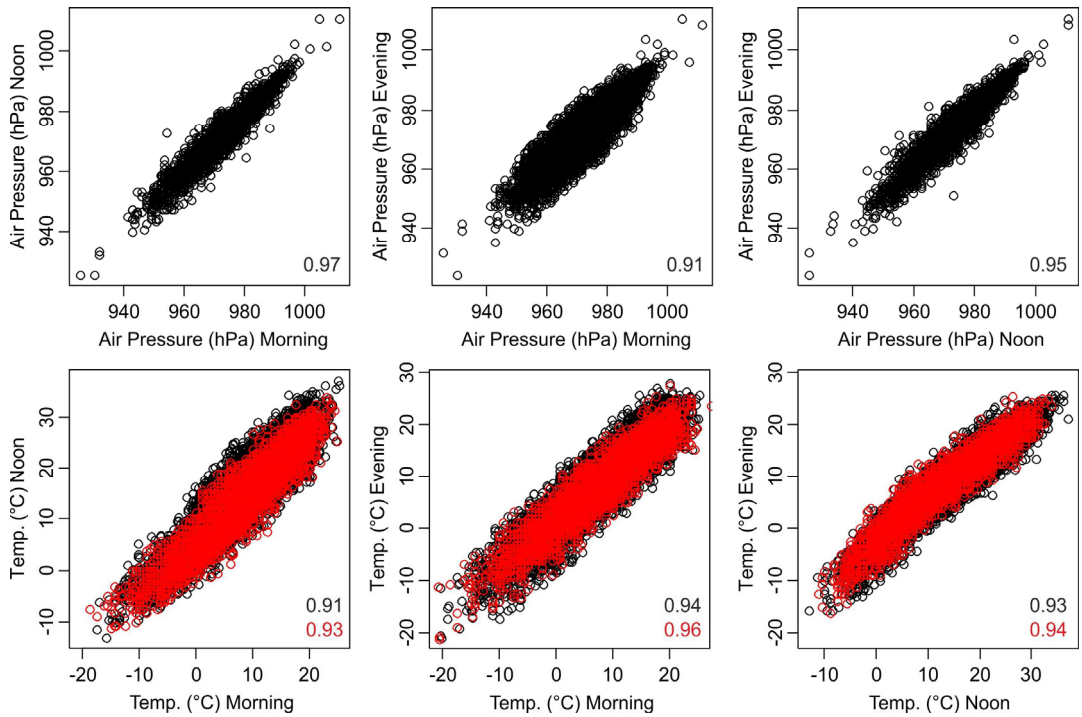

Figure 3. Comparisons of pressure (top) and temperature (bottom) measurements at different times of the day from the Schalch series in Schaffhausen. Red symbols indicate the analysis for the second thermometer. Numbers indicate the Pearson correlation coefficient.

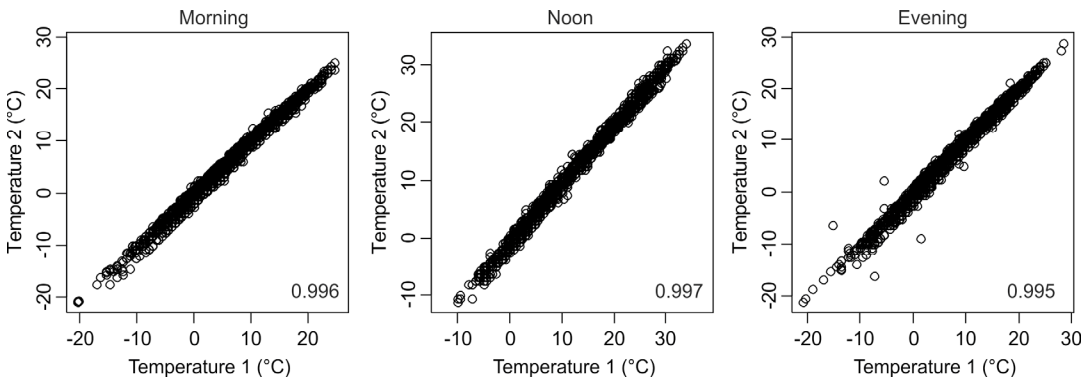

Figure 4. Mutual comparisons of morning, noon, and evening measurements between the first and second thermometer of the Schalch series. Numbers indicate the Pearson correlation coefficient.

Even though the temperature data show good internal consistency, the absolute values are generally higher than expected when comparing them with those from a modern-day MeteoSwiss station (Fig. 5). Given the good match between the parallel measurements, this is unlikely to be a conversion issue but is rather related to exposure. The temperature readings are particularly high in the afternoon suggesting a significant radiative bias. This problem seems to affect all measurement locations, although the data samples for the first two locations are rather small for robust results. It should also be noted that the MeteoSwiss station is located in a rather rural environment at about 40 m higher elevation than the city centre.

Finally, we also analysed the 50-yr time series. Monthly pressure data and seasonally averaged temperature data were compared to the data from the closest grid point in the reanalysis EKF400v2 (Franke et al., 2017; Valler et al., 2021). The agreement for pressure is not very good, with a Pearson correlation coefficient of 0.57 (Fig. 6, left). Most likely, Schalch did not reduce the pressure readings to a standard temperature. Moreover, there is a possible trend inhomogeneity in the 1810s and early 1820s and a clear offset in the mid to late 1820s. The pressure series thus needs more work. Seasonal temperature (Fig. 6) shows a very good agreement between the Schalch observations and EKF400v2, with correlations of around 0.88. The series clearly show the warm summers of the 1800s, which were followed by a temperature drop (Brönnimann, 2015), culminating in the cold summer of 1816 (Luterbacher and Pfister, 2015). The measurements also show the cold winter of 1829/30 (Pfister and Wanner, 2021).

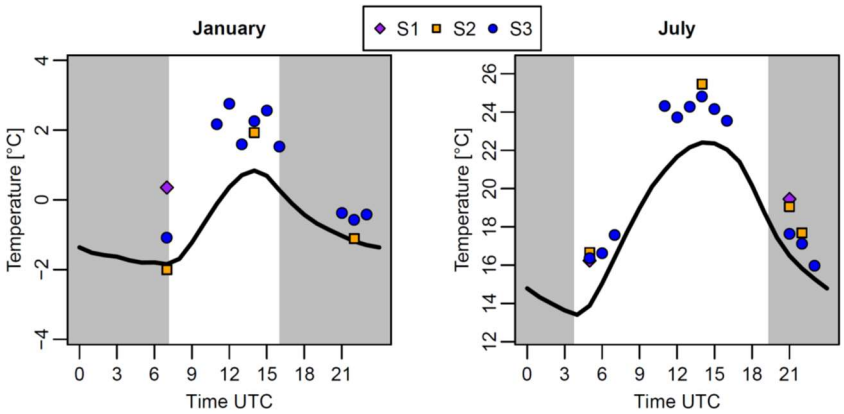

Figure 5. Diurnal temperature cycle in January (left) and July (right) in present-day (1981–2010, -1 °C to account for climate change) MeteoSwiss data from Schaffhausen (thick black line) and in the series by Schalch (Sx indicates the location, where x refers to the numbers in Fig. 1). Times have been rounded to the nearest hour. Grey shading indicates night-time.

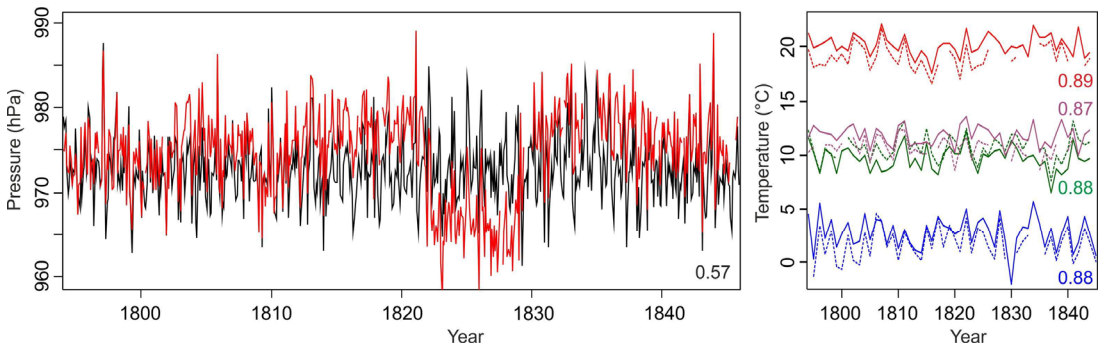

Figure 6. (left) Time series of monthly mean values of sea-level pressure from EKF400v2 (black, shifted by 45 haPa) and pressure from Schalch's observations (red). (right). Comparison of seasonal mean temperature in EKF400v2 (solid, upward shifted by 5 °C) and Schalch's observations (dashed) for Dec.–Feb. (blue), Mar.–May (green), Jun.–Aug. (red), and Sep.–Nov. (purple). Numbers indicate the Pearson correlation coefficient.

5. Conclusions

The Schalch series from Schaffhausen is one of few long Swiss early instrumental measurement series that reaches back to the 18th century and is the longest single-person record. It covers the period 1794 to 1845 and thus climatically interesting intervals such as the hot and dry summers of the late 18th and early 19th century, the subsequent temperature drop that culminated with the "Year Without a Summer" of 1816, and the cold winter of 1829/30. The series could be continued with a series by Schelling (though with gaps) and later MeteoSwiss data.

The Schalch series has been evaluated by Gisler (1984), and precipitation information is included in EURO-CLIMHIST. The metadata helped in our re-digitisation of the record. Our quality control of the series and comparison with other data sets shows that the pressure records exhibits inhomogeneities, while the temperature record appears to be of consistent quality, although it is arguably affected by a radiation bias in the early afternoon. Clearly, further work would be required to generate a homogenised, long record for Schaffhausen.

The data are made publicly available by MeteoSwiss. They will also be available from the C3S data Global Land and Marine Observations Database (Noone et al., 2021) and from EURO-CLIMHIST (Pfister et al., 2017).

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