Brugnara, Y., L. Pfister, and S. Brönnimann (2021) Zurich's Many 19th Century Meteorological Records. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 183-197, DOI: 10.4480/GB2020.G96.14.

Zurich's Many 19th Century Meteorological Records

Yuri Brugnara, Lucas Pfister, and Stefan Brönnimann*

Oeschger Centre for Climate Change Research and Institute of Geography, University of Bern, Switzerland

Abstract

Meteorological measurements have been performed in Zurich since the early 18th century and with only few gaps until the present. Although some series are likely to be lost, a long record could be generated. It is therefore surprising that no long Zurich record has so far been compiled. In this and accompanying papers we describe the available segments. This paper summarises nine segments from the 19th century. They comprise observations by Feer (covering 1807-1827), Horner (1812-1834), Escher (1816-1820), Weiss (1823-1835), the Swiss Natural Sciences Society (1830-1832), Hofmeister (1834-1849), the Zurich Natural Sciences Society (1836-1852), Beyel (1841-1863, on Uetliberg), and Brügger (1860-1866). We describe observers, stations, and instruments, where this information is available. We also discuss data processing and quality control. The paper accompanies the publication of the imaged data and the digitised measurements.

1. Introduction

Although meteorological measurements have been performed in Zurich since the early 18th century and discussed in the literature (Wolf, 1879; Maurer, 1917), the currently electronically available record reaches back only to 1864, the start of the Swiss national meteorological network (Hupfer, 2019). This situation is typical also for other countries (see Brönnimann et al., 2019, for a global overview). Only relatively few, long series have so far been evaluated, while a substantial body of shorter series has not been digitised, although data have been compiled in the 19th century, when many national weather services were established. In Switzerland, daily mean data from several older records were published in printed form in the "Supplementary Volumes" of the Annals (Schweizerische Meteorologische Beobachtungen,

* Corresponding author: Stefan Brönnimann, University of Bern, Institute of Geography, Hallerstr. 12, CH-3012 Bern, Switzerland. E-mail: stefan.broennimann@giub.unibe.ch.

1867). This includes daily data for Uetliberg near Zurich, which were digitised in the EMULATE project and incorporated in a European daily pressure reconstruction (Ansell et al., 2006). Although several long Swiss series were re-digitized in the framework of the DIGIHOM III project (Füllemann et al., 2011), the Zurich series were not among them. Here we present some of the earlier series.

Over the past years we have compiled, digitised and re-evaluated many series from Zurich covering the 18th and 19th century up to the start of the national network. The 18th century series are documented in two contributions in this volume (Brugnara et al., 2021; Fritze et al., 2021). In this contribution we present the Zurich series from 1807 to 1864. Together with the 18th century data and the official record starting in 1864, a long Zurich series can possibly be generated. The series discussed here comprise observations by Feer (1807-1827), Horner (1812-1835), Escher (1816-1820), Weiss (1823-1835), the Swiss Natural Sciences Society (SNSS, 1830-1832), Hofmeister (1834-1849), the Zurich Natural Sciences Society (ZNSS, 1836-1852), Beyel (1841-1843, on Uetliberg) and Brügger (1860-1866).

We describe the sources and the processing of the nine series. The paper accompanies the publication of the metadata of all early Swiss series in the form of an inventory (Pfister et al., 2019). Many of the Swiss series were published by Brugnara et al. (2020a). Images will be made available via a repository, the digitised data will be available from 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 brief overview of the station histories and observers. Not much information could be found about some of the series. Section 3 describes the processing and quality control. Conclusions are drawn in Section 4.

2. Data

2.1. Overview

Table 1 summarises the series analysed. All known observation locations are shown in Figs. 1 and 2 on contemporary maps. Information on locations and observers from the observation manuscripts was complemented with data from the directory of citizens of the city of Zurich ("Verzeichniß der Bürger der Stadt Zürich", see Favre et al., 2018).

2.2. The series of Feer

The Feer series covers the period 1807-1827 and is thus one of the longest considered in this paper. However, we know very little about the series. Almost certainly the data are from Johannes Feer (1763-1823), also sometimes spelled "Fehr". He was the son of a priest and studied architecture and engineering in Germany and France before returning to Zurich (Wolf, 1879). In 1781 he became a member of the Physical Society of Zurich, where he met Hirzel and other natural scientists that performed meteorological measurements (see Fritze et al., 2021). He was tasked by the society to reinstall the astronomical observatory. He also performed geodetic work in Switzerland. In 1798 he left Zurich again to work as a building and construction inspector and returned in 1805 as an engineer. The start of the series would fit well with his return to Zurich. He lived at "Unter Graben" (today "Hirschengraben", Fig. 2). However, the series continues until 1827, whereas Feer died in 1823. It is therefore unknown who performed the measurements in 1823-1827.

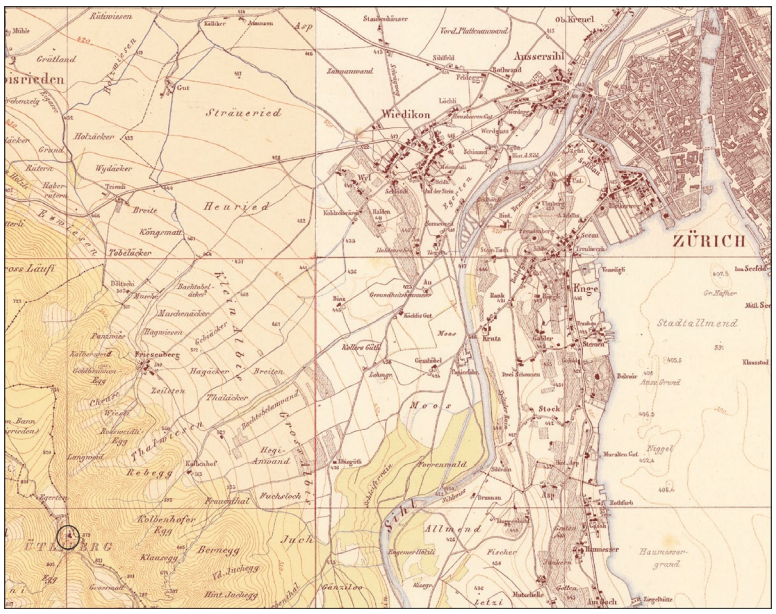

Figure 1. Zurich and Uetliberg (where Beyel performed measurements) on a map by Johannes Wild (PLAN A 4 Topographische Karte des Kantons Zürich, ca. 1852-1867).

Gottfried von Escher (1846) states that Feer performed a careful series of measurements. After his death, the data were passed on by his family to the Natural Sciences Society. The data sheets can be found today in the Cantonal Archive of Zurich (StAZH) (Fig. 3, left). A second, short series attributed to Feer in the same archive covering the year 1838 is in fact identical with the data from Hofmeister and Ulrich (Sect. 2.6 and 2.7) and thus misattributed.

Figure 2. The measuring locations on a contemporary map ("Grundriss der Stadt Zürich in der Mitte des Jahres 1838", PLAN C 35, https://suche.staatsarchiv.djiktzh.ch/detail.aspx?ID=313710). B Brügger, E: Escher, F: Feer, H: Hofmeister, Hor: Horner, K: Kantonsschule (Ulrich), M: Meyer, N: Nüscheler W: Weiss, Z: Zurich Natural Sciences Society (ZNSS). Large circles: Precise location unknown. Not on map: Paur.

Table 1. Summary of meteorological measurement in Zurich, 1807-1866; p = pressure, T = temperature, rH = relative humidity, wdir = wind direction, Wn = wind speed, c = clouds, n = measurements per day, SNSS = Swiss Natural Sciences, StAZH: Zurich State Archive, BBB = Burgerbibliothek Bern, StAGR = Grisons State Archive

Period	**Observer**	**Location**	**Variables**	***n***	**Source**
1807-1827	Johannes(?) Feer	unknown	p, T, rh, wdir, Wn	1-4	StAZH: B IX 258, B IX 259, B IX 260, B IX 261, B IX 262
1812-1834 (incomplete)	Johann Kaspar Horner	Haus zum Schönenberg, Haus zum Mühlestein, kleine Stadt (from 1823 onward), Bleycherweg (2 weeks in 1825)	p, T, rh, wdir, Wn	up to 16 (aver. 4)	StAZH: B IX 308.1 (1813-35), B IX 310.1 (1812-32), B IX 310.7 (1812-21), B IX 310.10 (1831-34); BBB: Mss.h.h.XXVI.22.1 (1827/1-1831/8)
1816-1820 (incomplete)	Hans Caspar Escher	Haus 361, kleine Stadt	p, T, rH, wdir, Wn	4	Escher (1822)
1823-1824; 1835	Heinrich(?) Weiss	Haus zum Bracken	p, T, Wn	up to 12 (aver. 5)	StAZH: B IX 308.3 (1823-1824)
1830-1832	SNSS (F. Meyer, J.F.C. Paur, A. Nüscheler)	Haus 12, Haus 234, Haus 414	p, T, rH, wdir	3	BBB: Mss.h.h.XXVI.22.1
1834-1841 (until 1849 in graphical form)	Rudolf Heinrich Hofmeister	oberer Hirschengraben	p, wdir (T)	6	StAZH: B IX 303.2, B IX 304, B IX 261
1836-1842 1843-1852	Melchior Ulrich, Rudolf Heinrich Hofmeister, unknown (rain gauge) (unknown), Johann Georg Oeri (rain gauge)	oberer Hirschengraben, Tmin/Tmax, rh in 1841/2: Zeltweg Kantonsschule, Neustadt (rain gauge)	p, T, rh, Pr, c, wdir, Wn,	4	StAZH: B IX 298.1 (1836), Bibliothèque universelle de Genève (1836), Meteorologische Beobachtungen angestellt auf Veranstaltung der naturforschenden Gesellschaft Zürich (from 1837 on)
1841-1863	Friedrich Beyel	Uetliberg	p, T, Tp, wdir	4	StAZH: B IX 300.2 (1841-55), B IX 300.3, B IX 300.4 (1856-61), B IX 300.5 (1862-63)
1860-1866	Christian Gregor Brügger	old botanical garden	p, T, wdir, Wn	1-3	StAGR B 1087

2.3. The series of Horner

Johann Kaspar Horner (1774-1834) was professor of mathematics at Carolinum in Zurich and a politician (Grossrat). He was a member of the ZNSS (and thus knew Johannes Feer) and was also a member of the St. Petersburg academy. Horner measured from 1812 until 1834. However, the data are scattered over different archives and are incomplete. We found data for the years 1812-1821, 1823, 1825, 1827, 1829, 1830-1835 (Zurich State Archive), and 1827-1831 (Burgerbibliothek Bern). An example sheet from the year 1812 is given in Figure 3 (right). The series is very incomplete. Horner's observations stop at beginning of July 1834, but the published daily data cover 1830-1839 as the publication (Schweizerische Meteorologische Beobachtungen **3** (1866), 274-684) merges data from Horner with those from the ZNSS (Sect. 2.8). From 1826 to 1830, data publication for this station was an activity of the SNSS (Sect. 2.6).

Horner measured at many different locations, including Haus "zum Schönenberg", "Haus zum Mühlestein Nr. 421", "kleine Stadt" (from 1823 onward), and "Bleycherweg". Not all locations could be identified precisely (Fig. 2). Pressure data are available from two barometers, sometimes read in parallel: a "Reisebarometer" (probably a portable siphon barometer) and a cistern barometer. The latter was the primary instrument until 1823. From 1825 onward only the "Reisebarometer" is used.

2.4. The series of Johann Kaspar Escher

A short series is preserved from Johann Kaspar Escher (1744–1829), who originated from the family "Escher vom Glas". He studied theology until 1765. In 1768 he took on the position as a Ratssubstitut (council clerk), 1774 Unterschreiber (second town clerk) and 1783 District magistrate ("Amtmann") in Küssnacht. He was part of a circle of political reformers around Johann Heinrich Pestalozzi, Heinrich Füssli and others (including Johann Kaspar Hirzel and Heinrich Weiss, who also performed meteorological measurements).

Escher observed from 1807 to 1821 (see location in Fig. 2, although house 361 was not registered to Escher). However, of the original observations only 7 months could be found (June-December 1816, thus covering the "Year Without a Summer", which is an extremely interesting period, see Auchmann et al., 2012). Another four years of data are available as monthly means.

2.5. The series of Weiss

Observation sheets are available from observer "H. Weiss", originally covering the years 1823 to 1835, although the data for 1825-1834 were not found. Measurements were taken at the "Haus zum Bracken" (see Fig. 2), 60 feet above lake level. The observer could either have been Hans Heinrich Weiss (1765-1857) or his son Oberst (Colonel) H. Weiss (1798-1870), both were merchants of the merchant house Bracken (Alther, 1962). Father Hans Heinrich Weiss was part of the above mentioned circle (see Sect. 2.4), but we have no evidence by whom the measurements were made. A sample sheet of the data is shown in Figure 4, left. We have no information on the instruments used.

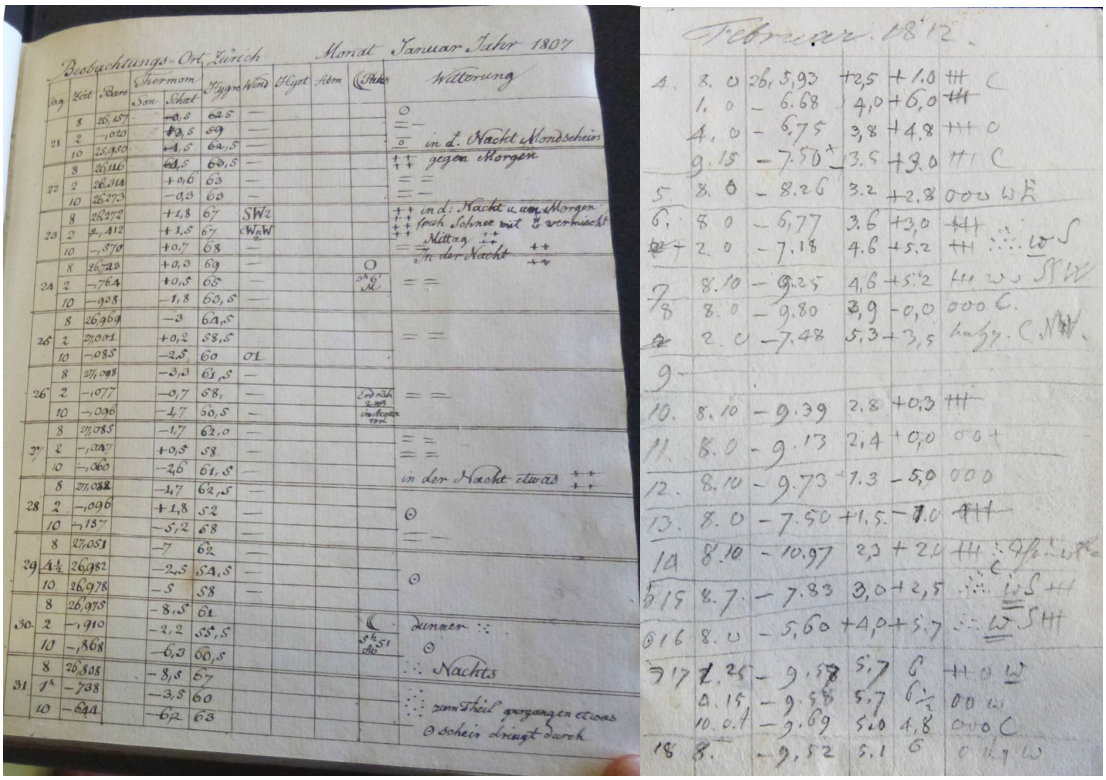

Figure 3. Example data sheets of the Feer (left, StAZH: B IX 258) and Horner (right, StAZH, B IX 310.1) series.

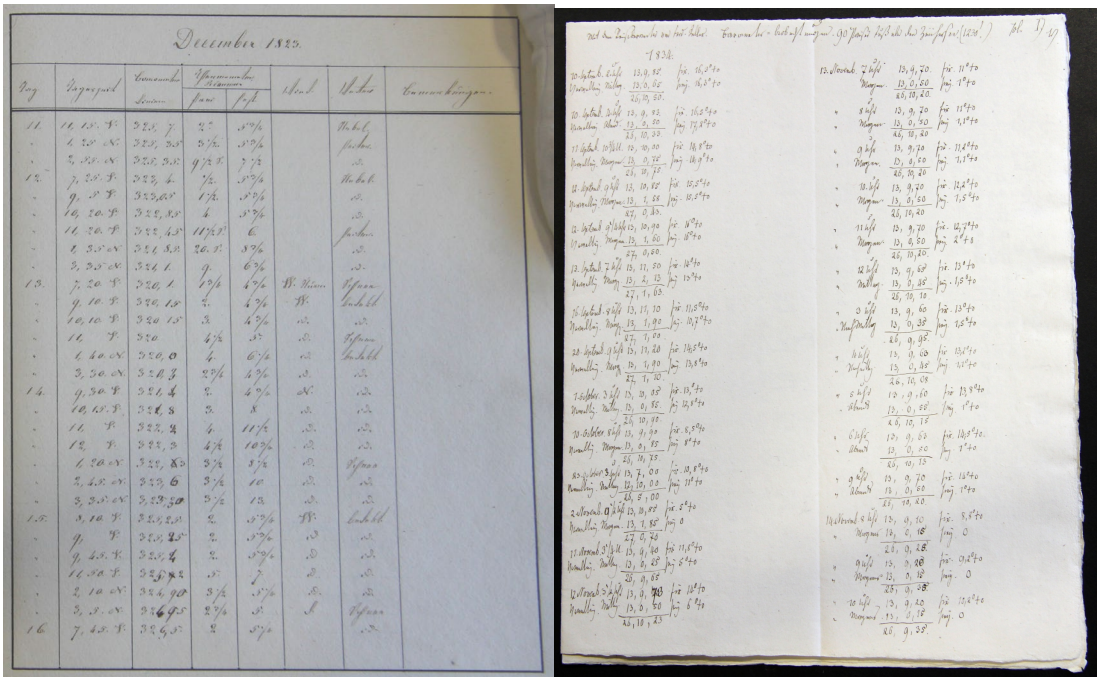

Figure 4. Example observation sheets of Weiss (left, StAZH: B IX 308.3) and Hofmeister (right, StAZH: B IX 303.2).

2.6. The series of the Swiss Natural Sciences Society (SNSS)

The SNSS was founded in 1815. Among the early activities was a prize question on recent climate deterioration (Bodenmann et al., 2012). The idea of a meteorological network grew during the early 1820s, and a "Meteorological Commission" was established (Riggenbach, 1891), consisting of Marc Auguste Pictet (observer in Geneva, see Brönnimann et al., 2020), Augustin-Pyramus de Candolle, Friedrich Trechsel (observer in Bern, see Flückiger et al., 2020), Johann Kaspar Horner, Karl Kasthofer, Johann Gottfried Ebel, and Heinrich Zschokke (observer in Aarau, see Faden et al., 2020). Initially, observations were planned in Aarau, Basel, Bellinzona, Bern, Chur, St. Gall, Geneva, Lausanne, Lucerne, Schaffhausen, Solothurn, and Zurich. The focus of many of these observations was more on barometric altimetry. Only the observers in Bern (Trechsel), Basel (Merian; Brönnimann et al. 2020), St. Gallen (Meyer; Hürzeler et al., 2020) and Zurich (Horner, Sect. 2.3) continued (Riggenbach, 1891).

Data for several stations, including Horner's data after 1826, were published under the umbrella of the SNSS. Horner was however not the only observer. In 1830 and 1831, the series was relocated three times to the houses of Arnold Nüscheler (1827-1832), Franz Meyer (1830), and J. F. C. Paur (1830/31, see Fig. 1). An example sheet is shown in Figure 5. We have no information on the instruments used.

2.7. The series of Hofmeister

A segment of observations covering 1834-1849 might possibly stem from Rudolf Heinrich Hofmeister. Hofmeister (1814-1887) was one of the first students of the University of Zurich. He was teacher and rector of several schools, physics teacher and later lecturer and eventually extraordinary professor at University of Zurich. Tabulated measurement cover 1834-1841 (see Fig. 4, right). Some data are available only in graphical form. His measurements are in

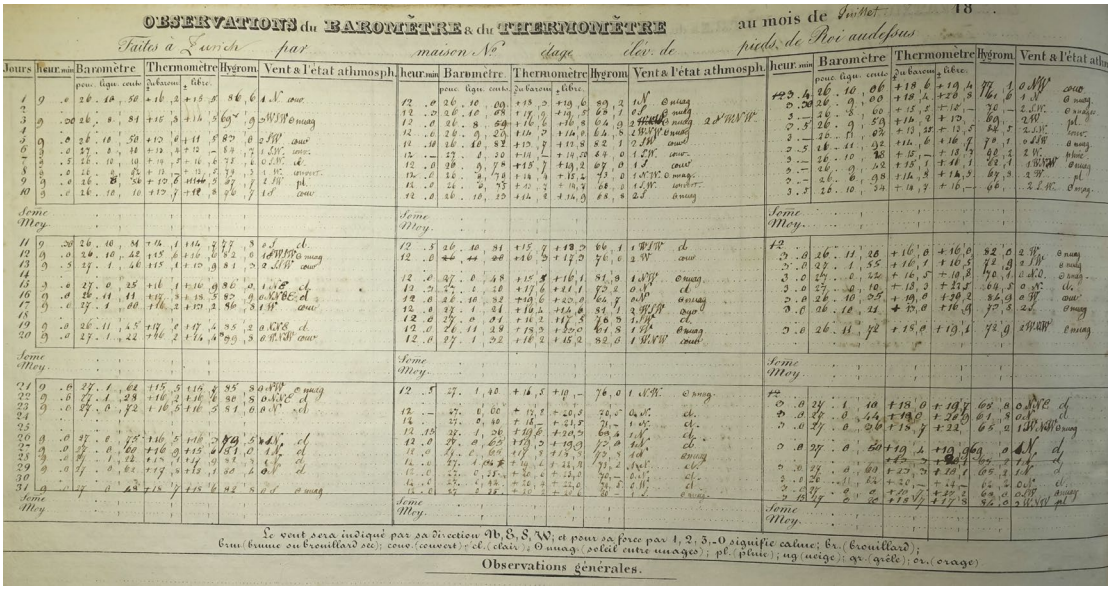

Figure 5. Observations published by the SNSS (Burgerbibliothek Bern: Mss.h.h.XXVI.22.1).

large part identical to those published by the ZNSS, except that he measured more frequently. Therefore, he must have been the observer for the Society together with Ulrich (sect. 2.6), of whom he was a neighbour. In fact, one of the given reasons for the relocation to the Kantonsschule in 1842 was that before it had not been possible to keep all instruments in one place. Figure 2 shows two houses Hofmeister lived in during the period. Note that in 1836 he spent time in Vienna and Berlin and therefore cannot have been the observer (indeed, the handwriting during this period differs from the rest of the source).

In 1842 Hofmeister took on a position in Lenzburg where he also performed a measurement series. A series from Lenzburg is published in the journal of the SNSS.

2.8. The series of the Zurich Natural Sciences Society (ZNSS)

The ZNSS ("Naturforschende Gesellschaft in Zürich", successor organisation of the Physical Society of Zurich, which was instrumental in establishing meteorological observations in the 18th century; Fritze et al., 2021) also was active in promoting meteorological measurements in the 19th century. One of the observers was Melchior Ulrich (1802-1893), who was lecturer and professor of theology at the University of Zurich from the year of its foundation, 1833. He was probably assisted by Hofmeister (see Sect. 2.7).

According to Maurer (1917) measurements by Ulrich in Zurich should exist from 1828 on, but only from 1835 they are verifiably from Ulrich. The measurements were officially endorsed by the ZNSS from 1836 onward. He continued observations until 1842 (see note above). The series was then continued at the Kantonsschule by an unknown observer until 1852 (see Fig 2). Ulrich himself measured at the Oberer Hirschengraben (Fig. 2); Figure 6 shows a contemporary drawing of the area around 1830. In 1841 and 1842, minimum and maximum temperature as well as humidity were measured at Zeltweg.

We have digitized the data from 1836-1852. In addition to temperature and pressure we also have precipitation and (only until 1848) maximum and minimum temperature. All instruments were of the highest quality for the time. The barometer was made by Oeri, a large

Figure 6. "Oberer Hirschengraben, 1830 bei der Florhofgasse", Aquarell von J. Suter (?), Wikimedia. The image approximately the location where Ulrich measured.

cistern barometer with a 20 mm wide tube. The thermometer with Celsius scale allowed readings to 0.1°C precision and was carefully calibrated. Until November 1836, however, temperature in the raw readings by Hofmeister is given in degrees Réaumur, meaning that another thermometer must have been used in the first few months. After the relocation in 1842 an even better thermometer was acquired, with a declared resolution of 0.05°C (the actual resolution of the scale was, however, 0.2°C). The hair hygrometer was made by Gourdon and was constantly verified against a second, identical instrument. The rain gauge had an opening of 0.33 m^2, allowing for a resolution of 0.01 mm. In 1842 it is mentioned that it had been for many years at the Haus zum Grundstein (Neustadtgasse?) and was then moved to the nearby garden of the instrument-maker Oeri. Finally, the maximum and minimum thermometer were standard ones, filled with mercury and alcohol, respectively. Before the relocation to the Kantonsschule, it was often mentioned that the exposure of the max/min thermometers was not ideal (Meteorologische Beobachtungen angestellt auf Veranstaltung […], 1837-1842).

2.9. The series of Beyel

Friedrich Beyel was an innkeeper. In 1840 he opened a restaurant on Uetliberg, a peak of 869 m altitude near Zurich (Fig. 1). He performed meteorological observations from 1841 until 1863. Friederich Beyel died in 1866.

The daily Uetliberg data have been published in the Annals of the Meteorological Bureau of the SNSS (which later became MeteoSwiss). Daily means have been digitized in the EMULATE project (Ansell et al., 2006). In our project we have digitised the original data, which were available at the Zurich State Archive. An example sheet is shown in Figure 7. We do not know which instruments were used.

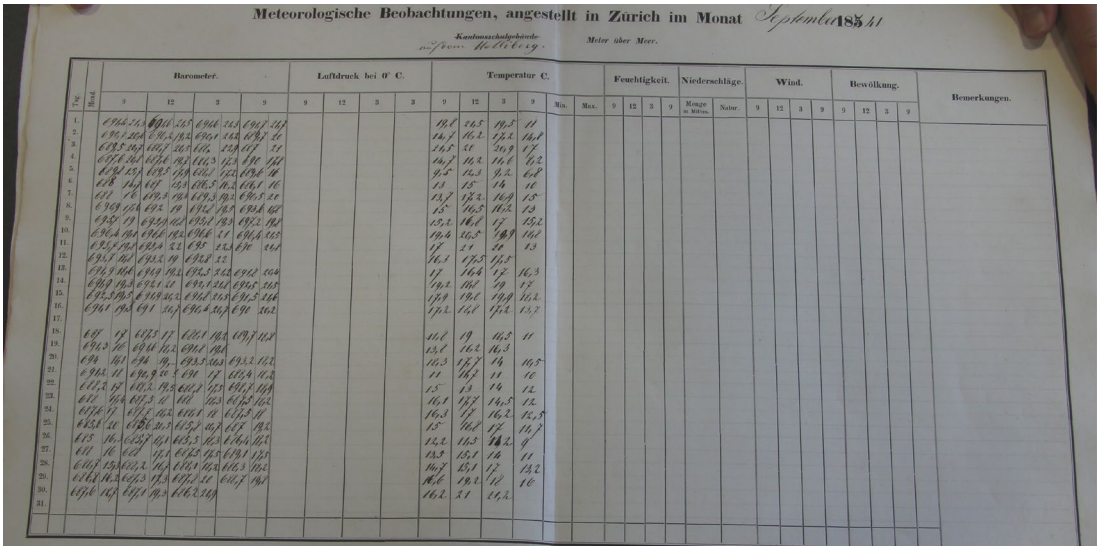

Figure 7. Observation sheet by Beyel (StAZH: B IX 300.2).

2.10. The series of Brügger

The last of the series discussed in this paper is that by Christian Gregor Brügger (1833-1899), covering the period 1860-1866. Brügger was a natural scientist who started, at his own initiative, a dense meteorological network in the Canton of Grisons in 1857 (see Hupfer, 2015, for the following). The network included as many as 37 stations in 1858. However, in 1859 Brügger took on a position as curator of the botanical collection of the Polytechnikum (today ETH Zurich). During his time in Zurich he performed his own measurements at the old botanical garden (Fig. 2), which we analyse here, while the Grisons network deteriorated quickly. Brügger returned to the Grisons ten years later to become high school teacher. We have digitized the data sheets from the Grisons state archive. No information on the instruments is available.

Further observers made instrumental measurements in Zurich in the period of interest, *i.e.,* 1807-1864. However, the 1833-1856 series by J.C. Denzler as well as the short series by Freudweiler, J. Dändliker and Ernst (1859-1863) could not be found.

3. Processing and quality control

The data from Zurich were processed as described in Brugnara et al. (2020b). In addition to tests at individual stations (*e.g.,* comparing different times of day) we also compared overlapping segments of neighbouring series. In the following, we present the results of the quality control procedure for all series together.

An overview of the series can be gained by showing all pressure series on a common plot (Fig. 8). We can see that the period from 1807 to the start of the Swiss National Network in December 1863 is well covered, with only few gaps. At the same time, the figure also shows that there are four main segments, on which a consolidated series needs to rely (Feer, Horner, ZNSS, and Beyel), while the other series (Escher, Weiss, SNSS, Hofmeister, and Brügger) mainly serve to fill gaps and to double check the quality and homogeneity of the longer segments. Unfortutunately, as we will see, the long segments are not necessarily those of the highest quality. Figure 8 already shows differences between two of the long segments in their

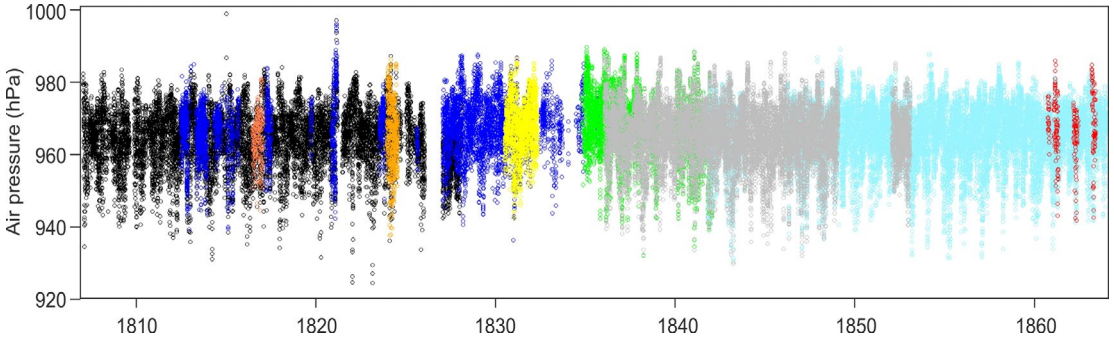

Figure 8. Pressure measurements from all series discussed in this paper. Black: Feer, dark blue: Horner, dark orange: Escher, orange: Weiss, yellow: SNSS, green: Hofmeister, grey: ZNSS, light blue: Beyel (Uetliberg, shifted by 50 hPa), red: Brügger

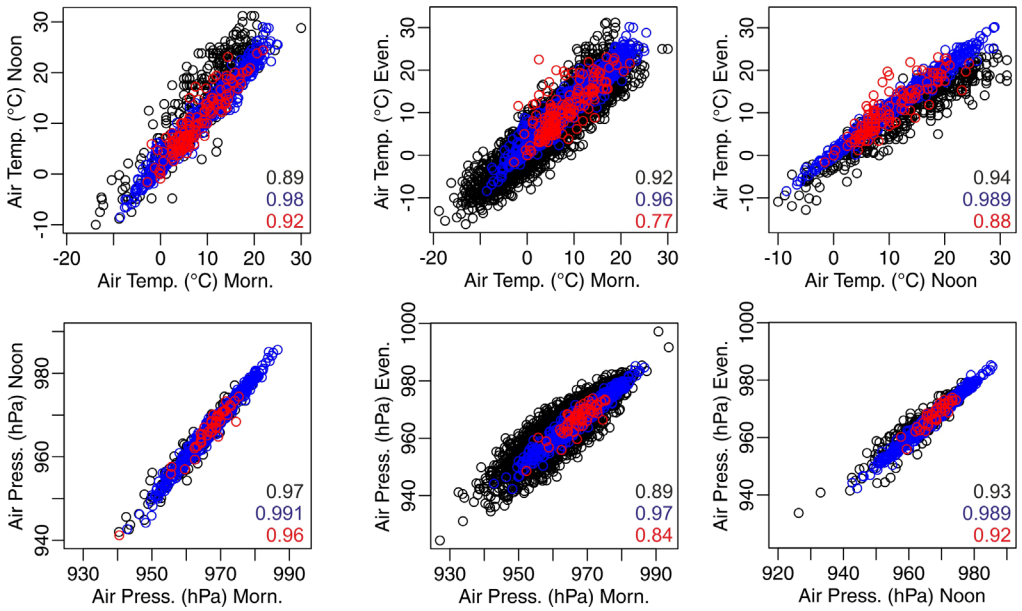

Figure 9. Comparisons of measurements at different times of the day for the series of Feer (black), SNSS (blue) and Weiss (red) for temperature (top) and pressure (bottom). Numbers indicate the Pearson correlation coefficient.

overlapping period. Feer's pressure data in 1827 are lower than his earlier data and not in agreement with the parallel series of Horner, so these data were omitted from the further plots.

Analysing the agreement of measurements at different time of the day (Fig. 9), we find that the overall best agreement is found for the SNSS data. Clearly worse agreement is found for the series of Feer and Weiss.

Mutual comparisons were performed for the series of Feer and SNSS with the Horner series (Fig. 10). Again, the SNSS data show clearly better correlations than the Feer series, indicating that the long segment of Feer might be of comparably lower quality. This is especially the case for temperature, while all correlations are good for pressure. We also tested the second barometer of Horner (red), which is in good agreement with the first barometer.

Similar analyses were also performed for the second half of the period. Figure 11 shows comparisons of measurements at different times of the day in the series of ZNSS, Hofmeister, and Brügger (only temperature). In the temperature comparison, the Brügger data exhibit a lower correlation than the other series. For the Hofmeister data, the plot comparing noon and

evening data shows two distinct relations, one for the 1834-1835 data and one for the later data. However, this can be explained by the fact that Hofmeister observed several times per day and the evening observation shifted to later hours after 1836. Correlations for pressure are high and show now obvious errors.

Mutual comparisons were then done for the Hofmeister and Beyel data against ZNSS. A first comparison showed that for the years 1838-1841, the data from Hofmeister and ZNSS were extremely well correlated (>0.999). This very strongly indicates that one is a copy of the other, with some small corrections applied. Temperature data are 98% identical except February-April 1836, a few days in July 1838, and occasional typos. Pressure data are almost identical, the main difference being that they were reduced to 0°C differently, aside from some

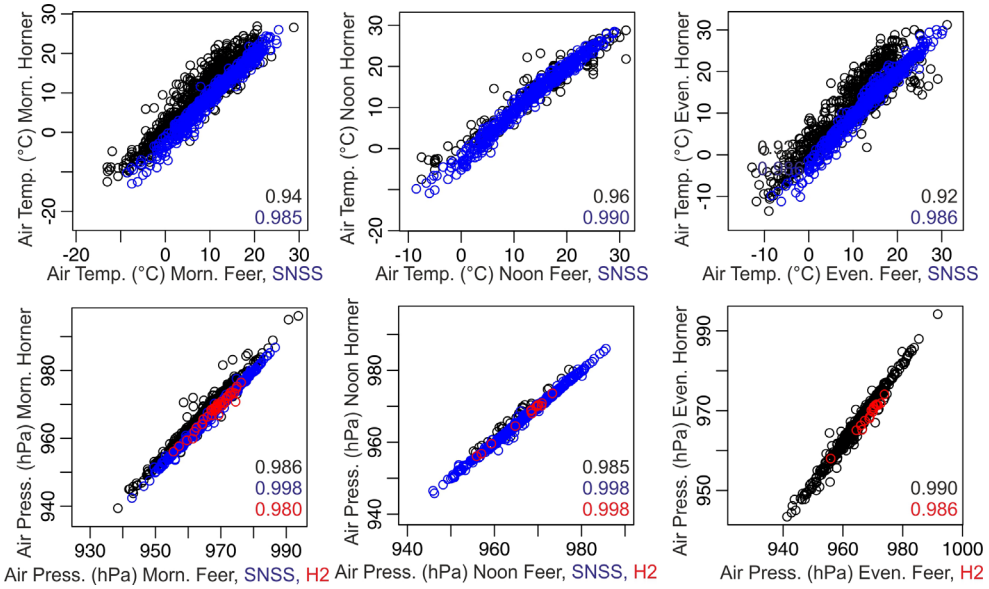

Figure 10. Mutual comparisons of morning, noon, and evening series (numbers indicate the Pearson correlation coefficient) of temperature (top) and pressure (bottom) in Zurich in the series from Feer (black), SNSS (blue) and Horner's second barometer (red) against the Horner series. Numbers indicate the Pearson correlation coefficient.

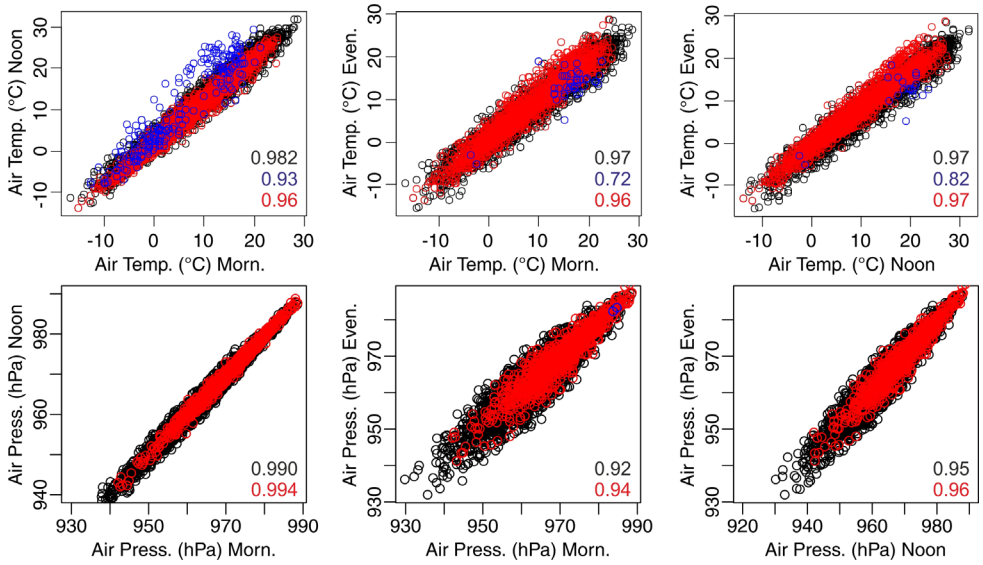

Figure 11. Comparisons of measurements at different times of the day for the series of ZNSS (black), Hofmeister (red) and Brügger (blue). Numbers indicate the Pearson correlation coefficient.

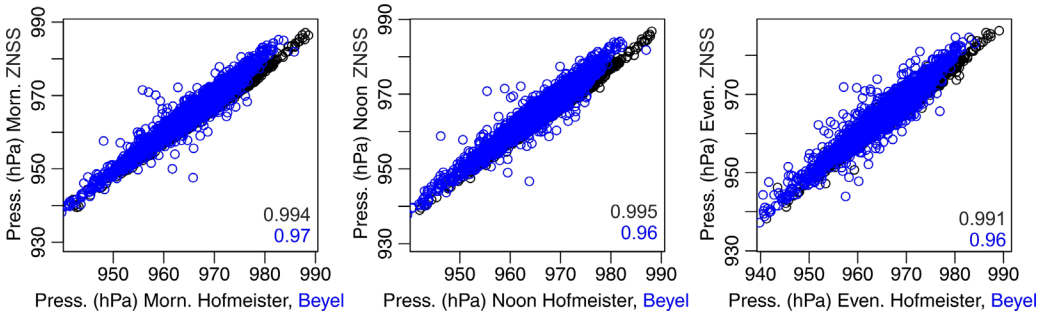

Figure 12. Mutual comparisons of morning, noon, and evening series (the number indicates the Pearson correlation coefficient) of pressure in Zurich in the series from Hofmeister (black) and Beyel (blue) against the ZNSS series. Numbers indicate the Pearson correlation coefficient.

constant correction. These data were then excluded from the comparison. Results (Fig. 12) show generally high correlations. The Hofmeister and ZNSS series compare particularly well; even after removing the obviously identical data the correlation is >0.99. It cannot be excluded that the data contain further (less obvious) copied segments. However, also the Beyel series is in good agreement with the ZNSS series. Overall, it seems possible from this comparison that a high quality pressure series can be generated for Zurich after the 1830s. The Beyel series might have remaining outliers.

Finally, we analysed the diurnal cycle in the temperature measurements from Feer and Horner (Fig. 13). In this case, the Feer data (despite the lower correlations found above) show an excellent agreement of the diurnal cycle with that from present day data (after subtracting 1 °C). The Horner data also agree in terms of the diurnal cycle, but a negative bias is seen for all times of the day in January. This might be explainable by local conditions, but nevertheless requires attention when merging series. Spring to fall agreement is good for both series and all times of the day.

4. Conclusions

The meteorological series from Zurich could provide the longest Swiss long meteorological record, though with several gaps, reaching back to the early 18th century. This volume comprises three papers related to the Zurich series; this paper describes many data segments from the 19th century, which together provide (especially for pressure) an almost complete record. Any such concatenation would strongly rely on four long segments (Feer, Horner, ZNSS, Beyel), while shorter records can help to fill gaps or assess and augment the quality of the longer segments.

The data are found to be of generally good quality except in some aspects the long series of Feer, which however is the dominant source of information prior to 1825. Possible seasonal biases in temperature (*e.g.,* in the Horner series) need to be further assessed. A long, good-quality pressure record seems however, possible.

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 EUROCLIMHIST (Pfister et al., 2017). The images can be downloaded from https://zenodo.org/record/3066836#.XVv-fGRS8-U.

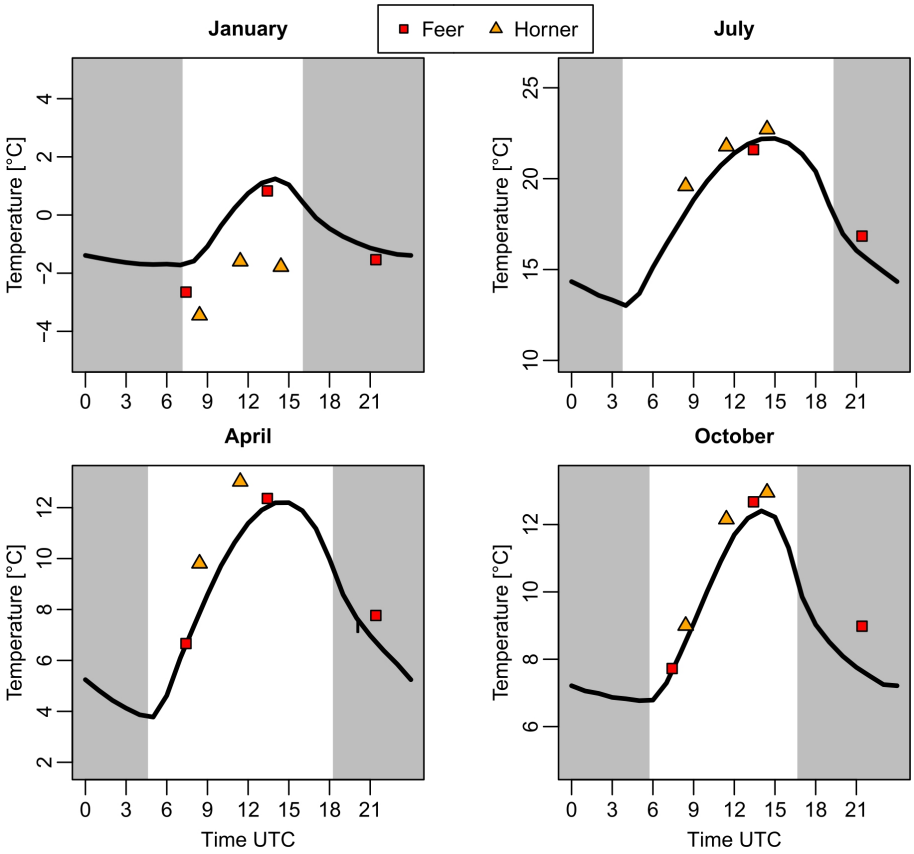

Figure 13. Average temperature values for different observation times in January, April, July and October in the Feer and Horner series compared with the mean diurnal cycle at Zurich (Affoltern) during 1981-2010 (1°C has been subtracted). Gray areas indicate nighttime.

Acknowledgements

The work was supported by the Swiss National Science Foundation (project WeaR, 188701), by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme grant agreement No 787574 (PALAEO-RA), by Copernicus Climate Change Service (C3S) 311a Lot 1, by GCOS Switzerland (project "Long Swiss Meteorological Series"), and by EURO-CLIMHIST. We thank Marc Pfister for his help with locating the observers in the historical directories of citizens of the city of Zurich.

Sources

Escher, J. K. (1822) Einige Nachrichten und Bemerkungen météorologischen Inhaltes. http://dx.doi.org/10.3931/e-rara-32542

Schweizerische Meteorologische Beobachtungen 3 (1866), p. 274-684.

Schweizerische Meteorologische Beobachtungen 4 (1867), p. V.

Staatsarchiv Zürich, StAZH: B IX 258, B IX 259, B IX 260, B IX 261, B IX 262.

Staatsarchiv Zürich, StAZH: B IX 308.1 (1813-1835), B IX 310.1 (1812-1832), B IX 310.7 (1812-1821), B IX 310.10 (1831-1834); BBB: Mss.h.h.XXVI.22.1 (1827/1-1831/8).

Staatsarchiv Zürich, StAZH: B IX 308.3 (1823-1824).

Burgerbibliothek Bern, BBB: Mss.h.h.XXVI.22.1.

Staatsarchiv Zürich, StAZH: B IX 303.2, B IX 304, B IX 261.

Staatsarchiv Zürich, StAZH: B IX 298.1 (1836), Bibliothèque universelle de Genève (1836), Meteorologische Beobachtungen angestellt auf Veranstaltung der naturforschenden Gesellschaft Zürich (from 1837 on).

Staatsarchiv Zürich, StAZH: B IX 300.2 (1841-1855), B IX 300.3, B IX 300.4 (1856-1861), B IX 300.5 (1862-1863).

Staatsarchiv Graubünden, StAGR B 1087.

References

Ansell, T., P. D. Jones, R. J. Allan, D. Lister, D. E. Parker, M. Brunet, A. Moberg, J. Jacobeit, P. Brohan, N. A. Rayner, E. Aguilar, H. Alexandersson, M. Barriendos, T. Brandsma, N. J. Cox, P. M. Della‐Marta, A. Drebs, D. Founda, F. Gerstengarbe, K. Hickey, T. Jónsson, J. Luterbacher, O. Nordli, H. Oesterle, M. Petrakis, A. Philipp, M. J. Rodwell, O. Saladie, J. Sigro, V. Slonosky, L. Srnec, V. Swail, A. M. García‐Suàrez, H. Tuomenvirta, X. Wang, H. Wanner, P. Werner, C. Wheeler and E. Xoplaki (2006) Daily mean sea level pressure reconstructions for the European‐North Atlantic region for the period 1850–2003. *J. Clim.,* **19,** 2717–2742.

Auchmann, R., S. Brönnimann, L. Breda, M. Bühler, R. Spadin, and A. Stickler (2012) Extreme climate, not extreme weather: The summer of 1816 in Geneva, Switzerland. *Clim. Past*, **8,** 325-335.

Bodenmann, T., S. Brönnimann, G. Hirsch Hadorn, T. Krüger, and H. Weissert (2011) Perceiving, understanding, and observing climatic changes: An historical case study of the "year without summer" 1816, *Meteorol. Z.*, **20,** 577-587.

Brönnimann, S., R. Allan, L. Ashcroft, S. Baer, M. Barriendos, R. Brázdil, Y. Brugnara, M. Brunet, M. Brunetti, B. Chimani, R. Cornes, F. Domínguez-Castro, J. Filipiak, D. Founda, R. García Herrera, J. Gergis, S. Grab, L. Hannak, H. Huhtamaa, K. S. Jacobsen, P. Jones, S. Jourdain, A. Kiss, K. E. Lin, A. Lorrey, E. Lundstad, J. Luterbacher, F. Mauelshagen, M. Maugeri, N. Maughan, A. Moberg, R. Neukom, S. Nicholson, S. Noone, Ø. Nordli, K. B. Ólafsdóttir, P. R. Pearce, L. Pfister, K. Pribyl, R. Przybylak, C. Pudmenzky, D. Rasol, D. Reichenbach, L. Řezníčková, F. S. Rodrigo, R. Rohde, C. Rohr, O. Skrynyk, V. Slonosky, P. Thorne, M. A. Valente, J. M. Vaquero, N. E. Westcottt, F. Williamson, P. Wyszyński (2019) Unlocking pre-1850 instrumental meteorological records: A global inventory. *B. Amer. Meteorol. Soc.* **100,** ES389–ES413

Brönnimann, S., M. Bühler, and Y. Brugnara (2020) The Series from Geneva, 1798–1863. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series*. Geographica Bernensia G96, p. 47–59, doi: 10.4480/GB2020.G96.04.

Brugnara, Y., L. Pfister, L. Villiger, C. Rohr, F. A. Isotta, and S. Brönnimann (2020a) Early instrumental meteorological observations in Switzerland: 1708–1873. *Earth Syst. Sci. Data,* **12,** 1179–1190.

Brugnara, Y., J. Flückiger, and S. Brönnimann (2020b) Instruments, procedures, processing, and analyses. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 17–32, DOI: 10.4480/GB2020.G96.02.

Brugnara, Y., S. Brönnimann, and L. Pfister (2021) The First Swiss Meteorological Record: Scheuchzer's Series from Zurich 1708–1733. In: *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 157-167, DOI: 10.4480/GB2020.G96.15.

Faden, M., L. Villiger, Y. Brugnara, and S. Brönnimann (2020) The Meteorological Series from Aarau, 1807–1865. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series*. Geographica Bernensia G96, p. 61–72, doi: 10.4480/GB2020.G96.05.

Favre, G., J. Floris, and U. Woitek (2018) Intergenerational Mobility in the 19th Century: Micro-Level Evidence from the City of Zurich. *Working Paper Series, Department of Economics, University of Zurich,* **274**, 41 pp.

Flückiger, J., A.-M. Burgdorf, Y. Brugnara, and S. Brönnimann (2020) Two Meteorological Series from Bern from Trechsel, 1826–1849, and Benoit, 1837–1853. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series*. Geographica Bernensia G96, p. 97–108, doi: 10.4480/GB2020.G96.09.

Fritze, R., Y. Brugnara, and S. Brönnimann (2021) Four Meteorological Series from Zurich Covering 1756–1802. In: Brönnimann, S. (Ed.) *Swiss Early Instrumental Meteorological Series.* Geographica Bernensia G96, p. 139-155, DOI: 10.4480/GB2020.G96.13.

Füllemann, C., M. Begert, M. Croci-Maspoli, S. Brönnimann (2011) Digitalisieren und Homogenisieren von historischen Klimadaten des Swiss NBCN – Resultate aus DigiHom. *Arbeitsb. MeteoSchweiz* **236**, 48 pp.

Hupfer, F. (2015) Das Wetter in Tabellen. Christian Gregor Brügger und die Institutionalisierung der Meteorologie. In: Kupper, P. and B. C. Schär (ed.) *Die Naturforschenden: Auf der Suche nach Wissen über die Schweiz und die Welt 1800–2015,* p. 51-67.

Hupfer, F. (2019) *Das Wetter der Nation.* Chronos, Zürich.

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.

Maurer J. (1917) Unsere alten Zürcher Witterungsregister. *Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich*, **62,** 470-487.

Meteoswiss (1867)

Pfister, C., C. Rohr, and A. C. C. Jover (2017) Euro-Climhist: eine Datenplattform der Universität Bern zur Witterungs-, Klima- und Katastrophengeschichte. *Wasser Energie Luft,* **109,** 45–48.

Pfister, L., F. Hupfer, Y. Brugnara, L. Munz, L. Villiger, L. Meyer, M. Schwander, F. A. Isotta, C. Rohr, and S. Brönnimann (2019) Early instrumental meteorological measurements in Switzerland. *Clim. Past,* **15,** 1345–1361.

Riggenbach, A. (1892) *Die Gesehichte der meteorologischen Beobachtungen in Basel.* Wissensch. Beil. Bericht Gymnas. 1891/92. Basel.

Thorne P. W., W., R. J. Allan, L. Ashcroft, P. Brohan, R. J. H. Dunn, M. J. Menne, P. Pearce, J. Picas, K. M. Willett, M. Benoy, S. Brönnimann, P. O. Canziani, J. Coll, R. Crouthamel, G. P. Compo, D. Cuppett, M. Curley, C. Duffy, I. Gillespie, J. Guijarro, S. Jourdain, E. C. Kent, H. Kubota, T. P. Legg, Q. Li, J. Matsumoto, C. Murphy, N. A. Rayner, J. J. Rennie, E. Rustemeier, L. Slivinski, V. Slonosky, A. Squintu, B. Tinz, M. A. Valente, S. Walsh, X. L. Wang, N. Westcott, K. Wood, S. D. Woodruff, and S. J. Worley (2017) Towards an integrated set of surface meteorological observations for climate science and applications. *B. Amer. Meteorol. Soc.,* **98,** 2689–2702.

von Escher, G. (1846) *Denkschrift zur Feier des hundertjährigen Stiftungsfestes der Naturforschenden Geslelschaft in Zürich am 30. November 1846.* Zürich, Zürcher & Furrer.

Wolf, R. (1879) *Geschichte der Vermessung in der Schweiz. Als Historische Einleitung zu den Arbeiten der schweiz. Geodätischen Commission bearbeitet von Rudolf Wolf.* Zürich.