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Four Meteorological Series from Zurich Covering 1756–1802

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Abstract

Meteorological measurements have been performed in Zurich since the early 18th century. Here we present four series that together cover the period 1756-1802. We describe the station histories, exact locations, and instruments. We also discuss the data processing and quality control of the data. The paper accompanies the publication of the imaged data and the data collection of early Swiss instrumental series.

1. Introduction

The first instrumental meteorological measurements in Switzerland were performed by Johann Jakob Scheuchzer in Zurich in 1708 (Boscani Leoni, 2018). Since then, measurements have been performed in Zurich most of the time, although some series could not be found. Only the data since 1864 have been re-evaluated (except for monthly means presented by Gisler, 1983), but Zurich potentially provides the longest meteorological series of Switzerland. Scheuchzer's observations are summarised in a separate paper, those by Jakob Gessner, 1740-1753, have been searched in vain by many others and also could not be found by us (only monthly mean precipitation data survive). In this study we discuss four series covering 1756-1802, a period during which observations started to become more frequent all across Europe (Brönnimann et al. 2019). The described series are from merchant, agronomist and botanist Johann Jakob Ott, who measured on his farm in Rötel (Wipkingen), 1756-1769, from hospital master Hans Conrad Meyer in the old hospital of Zurich, 1759-1765, from writer and city doctor Hans Caspar Hirzel, 1759-1802, and from guild master Daniel von Muralt in the city centre, 1760-1793. These four series, together with many later series, could help to build a long Zurich series, though with long gaps.

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We describe the sources and the processing of the four series. The paper accompanies the publication of the metadata of all early Swiss series in the form of an inventory (Pfister et al., 2019). 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 summary of the station histories and observers. Section 3 describes the results of the quality assurance and presents the data. Conclusions are drawn in Section 4.

2. Data

2.1. Overview

All observation locations are shown in Fig. 1 on a contemporary map. At that time, Zurich had about 1300 houses with 10,000 residents (Gessner, 1747). Table 1 summarises the series. In the following the series are discussed individually.

Figure 1. (left) Measurement locations of Meyer, Hirzel and Muralt on a contemporary map (Müller, 1793; source: City of Zurich), (right) Measurement locations of Ott, Meyer, Hirzel and von Muralt on a map by Wild (ca. 1850) (source: maps.zh.ch).

2.2. The series of Johann Jakob Ott

Observer

Johann Jakob Ott (1715-1769), son of Felix Ott and Dorothea Werdmüller von Elgg (see Wolf, 1859 for the following) belonged to a distinguished Zurich family and enjoyed an excellent education. He was taught mathematics and the natural sciences by Johannes Gessner and learned music. He entered his father's trading business and worked as a merchant. In 1737, he married Anna Gossweiler, the couple had three children.

Table 1. Summary of meteorological measurement in Zurich, 1756-1802. Obs. = Observer, Alt. = altitude in m asl, n = measurements per day, MdC = Micheli du Crest, b. = barometer, StAZH: Zurich State Archive

Period (Variable)	Obs.	Coordinates	Alt.	Location	Instrument	*n*	Source
7/1756-7/1766 (T) 3/1768-6/1769 (T) 7/1756–2/1762 (P) 4/1764-10/1769 (P)	J. J. Ott	47.39558° N 8.53264° E	455-470	Rötel	MdC therm. Kriss b.	1-6	StAZH: B IX 279.1; B IX 279.2; B IX 279.3
6/1761-12/1762 (T,P) 6/1759-3/1765 (T,P)	H. C. Meyer	47.37396° N 8.54510° E	415-418	old hospital	MdC therm. Mercury b.	1-4 1-4	StAZH: B IX 280.1; B IX 280.2, B IX 282.1; B IX 298.6
1/1761-12/1762, 4/1767-12/1786[+] (T,P) 1/1795-9/1802 (T)	H. C. Hirzel	47.37209° N 8.54034° E	417-422	Haus zum Sonnenberg (until 1786)	MdC therm., unknown b.	1-3	StAZH: B IX 278.1; B IX 278.2; Hirzel (1762, 1763)
1/1760-4/1769* (T,P) 1/1781-4/1793[§] (T,P) 1/1760-4/1793[‡] (T)	D. von Muralt	47.37380° N 8.53797° E	413-417	Haus zum Brünneli	MdC therm., unknown b.	1-4	StAZH: B IX 281.1, B IX 257; B IX 281.2

*1760-1768 without Mar-Jun, 1767 without Sep, 1769 without May-Aug
[+]1785 without Apr-Dec
[§]1786 missing
[‡]Morning, 1781 without Jan-Mar, 1766-1792 without May, all years without Jun-Dec, 1780 and 1786 missing

Ott was a founding member of the Physical Society of Zurich (PSZ) in 1746. He remained one of its most active members until the end of his life and gave numerous presentations (Wolf, 1859; Rudio, 1896). Within the PSZ, he led the Economic and the Botanical Commissions. The Economic Society of Bern elected him as an honorary member. He was also active in politics as a member of the Zurich Grand Council.

In 1754, Ott bought an estate in Rötel (Figs. 1 and 2) where he carried out agricultural experiments (Wolf, 1859; Rudio, 1896; Balmer, 1984). These activities triggered his interest in meteorology. Ott also headed the Meteorological Commission of the PSZ, which was founded in 1758 (Wolf, 1859). Ott himself made meteorological observations from 1756 until his death in 1769.

Location and instruments

In 1749, Ott set up a small observatory at his house “in der Schipfe” (Wolf, 1859; Rudio, 1896), but measurements do not survive. After acquiring Rötel, Ott started to design a new observatory and began measurements in 1756. In his notes, comparisons of barometers and thermometers between his estate and places in the city are mentioned. It can be assumed that he read the temperature both in the city and at Rötel.

Figure 2. The surroundings of the Rötel estate (probably Ott’s) between 1770 and 1790 (Kuhn, J., Prospect von einem Landgut genannt im Röttel ohnweit Zürich. Zentralbibliothek Zürich, Graphische Sammlung und Fotoarchiv).

Ott noted in 1766 that he used a Micheli Du Crest thermometer, which we assume for the entire time. In 1762, Ott commissioned five Micheli du Crest thermometers filled with spirit of wine for soil temperature measurements (Ott, 1768), probably the earliest systematic measurements of this kind. Ott made his observations two to six times a day at irregular times, often early in the morning and several times at night. The exact siting of the thermometer in Rötel is not known. However, Ott was well aware of the influence of sunrays on the thermometer. He wrote instructions that when reading the thermometer in the shade, the exact observation time, the position of the barometer, the purity of the air and the amount of clouds should be taken into account and he recommended parallel measurements with a mercury and a spirit of wine thermometer (Ott, 1768). He knew Michel du Crest personally and corresponded with him during his lifetime (Wolf, 1859; Talas, 2002). He also corresponded with Johann Heinrich Lambert, who used Ott's soil temperature measurements in his Pyrometrie (Lambert, 1779). In 1754 he established contact between Du Crest and mechanic Brander (Talas, 2002). Little is known about the barometer, a "regilierter Kriss Barometer" with a scale in Paris inches. Ott was aware of the effect of siting as studied barometer installations in various countries (Ott, 1768).

Original records

Ott's observations from June 1756 to March 1769 are available from four sources:

- *Observationes meteorologico-botanico, Bodentemperaturmessungen, von 1756-1762. Von J. J. Ott* (StAZH: B IX 279.1), consisting of four notebooks with tables of air pressure and temperature as well as wind and weather descriptions (Fig. 3 left). Temperature is noted with positive and negative numbers in Du Crest degrees (°DC). Pressure is given in Paris inches and lines. Weather notes include symbols (a legend is provided) and text.
- *Bodentemperaturmessungen, von 1762-1766. Von J. J. Ott* (StAZH: B IX 279.2, Fig. 3 middle). Temperature is noted with positive and negative integers and fractions in °DC. Informations about the weather are given in the form of symbols. Various soil temperatures are also given. Monthly summaries are added and often further commented.
- *Meteorologische Beobachtungen von Johann Jakob Ott mit Bemerkungen von Johann Heinrich Lambert. 1762-1768.* (UB Basel, L la 909), which seems to be a copy of the former in clear hand writing. A continuous analysis and comparison of the two sources shows that the values are identical (but the latter also contains river temperature).

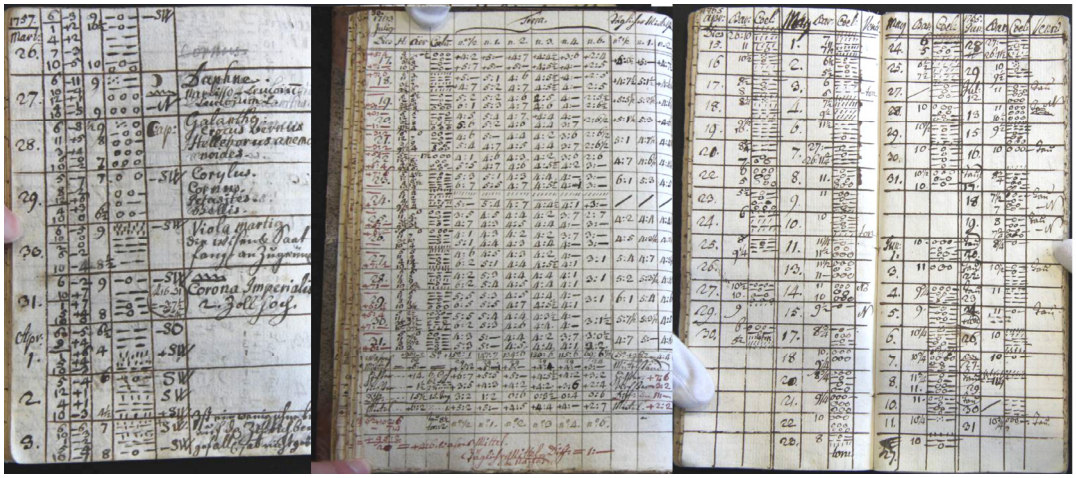

Figure 3. Extracts from Ott's notebooks: (left) March 1757 (StAZH: B IX 279.1), (middle) July/August 1763 (StAZH: B IX 279.2), (right) April-June 1765 (StAZH: B IX 279.3).

- *Bodentemperatur- und Barometermessungen, von 1762-1769. Von J. J. Ott* (actually covering 1764-1769), a narrow notebook. This sources gives observations of air pressure, weather and wind once or twice a day (unfortunately without observation times).

2.3. The series by Hans Conrad Meyer

Observer

Hans Conrad Meyer (1693-1766) originated from the "Rosen-Meyer" dynasty of councillors, which, although never part of nobility nor of the wholesale trade, was a very influential family (Fuchs, 2001). He grew up in Zurich. In 1720 he married Esther Wyss zur Gilgen, they had three children. Hans Conrad Meyer dedicated his life to science and civil service. Like his father, he became a Twelve of the Guild of Shoemakers in 1727 (Rudio, 1896). Three years later he took the office of bailiff of Birmensdorf and replaced his father as guild master. When he resigned in 1735, he became a bailiff of Rüti (Rübel, 1947) and he was a member of the grand council (Meyer, 1761). In 1749 he became hospital master (Rübel, 1947) and therefore lived at the hospital (Fig. 4). It is not clear whether or not he held this position until his death.

In 1746 he was founding member of the PSZ, served as its secretary 1746-1759 (followed by Hans Caspar Hirzel) and was active in the initial phase (Rudio, 1896; Rübel, 1947), giving lectures and taking care of the first botanical garden in Zurich. He was considered an expert for scientific instruments (Rudio, 1896). Meyer made meteorological observations from 1759 to 1765, parts of which he published, *e.g.,* in the *Abhandlungen der Naturforschenden Gesellschaft in Zürich*.

Location and instruments

The notes attached to Meyer's meteorological observations show that he carried out his measurements in his residence in the old hospital, *i.e.,* the Heiliggeistspital am Wolfbach, which stood on the land of the Grossmünsterprostei (Fig. 4; building no longer exists). The hospital

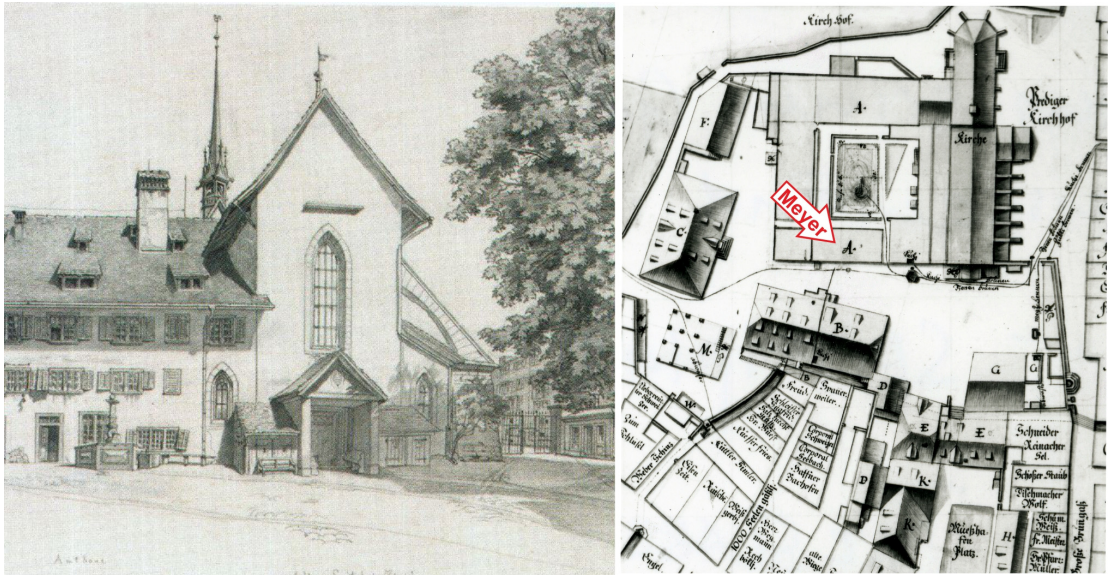

Figure 4. (left) Courtyard of the old hospital of Zurich with a view on the Amtshaus with the residence for the hospital master Hans Conrad Meyer (Werdmüller, 1871, Stadtarchiv Zürich) (right) Floor plan of the old hospital in Zurich in 1784 with Meyer's likely residence (Müller, 1784; Baugeschichtliches Archiv Stadt Zürich).

was located at the northern end of the oldest city centre in Zurich. Given his professional position as hospital master, his likely residence, where he probably also carried out his measurements, can be derived (Maurer, 1917).

Meyer used two thermometers, one constructed by Georg Friedrich Brander in Augsburg and one by Carl Perlasca, both with a Micheli du Crest scale (Meyer, 1761). Most likely Meyer set up his thermometers facing southwest or northwest. Whether they were located in direct sunlight or in the shade around noon is uncertain. Some of the windows could have been in the shade of the roof at noon. Meyer measured pressure with a mercury barometer (Meyer, 1761) with a scale in Paris inches; no barometer temperature is indicated.

Original records

Meyer's data were taken from two sources:

- *Meteorologische Beobachtungen, Auszüge, von 1759-1761, von Spitalmeister Meyer* (StAZH: B IX 282.1) and *Auszüge alter Messungen, von 1763-1763, von Meyer, Wolf und Horner* (StAZH: B IX 298.6). The former are four double-sided sheets of paper. The values are most likely daily averages. A comparison of handwriting as well as the print layout leads to the conclusion that Meyer is most likely not the author of this source, but rather Johann Rudolf Wolf, who most likely calculated daily mean and converted temperature into (then uncommon) degrees Celsius (using the conversion °C = 9.4 ± 0.91 °DC, + calor, - frigus) and pressure into mmHg. Wolf writes that Meyer had always carried out his observations at fixed observation hours. The latter source is a continuation of the former in the form of a one-sided and three double-sided sheets.
- *Observationes Meteorologigae Tigurinae, von 1761, vermutlich von Meyer* (StAZH: B IX 280.1), and *Observationes Meteorologigae Tigurinae, von 1762, vermutlich von Meyer* (StAZH B IX 280.2). The former containing seven vertical parchment sheets, glued onto larger paper sheets (Fig. 5 left), each showing pre-printed tables in which Meyer filled in date and time (usually around 7 AM, 12, 3, and 9 PM). Pressure and temperature readings are plotted graphically as dots onto a coordinate system (for pressure covering 17 lines from 25/10 to 27/2 in Paris inches, for temperature covering 44 °DC (22 frigus, 22 calor). He described precipitation and weather in text and symbols (a legend is provided). The latter source is a continuation of the former, with twelve sheets of paper glued onto larger paper sheets. Whether Meyer is the author of these two sources from 1761 to 1762 cannot be said with certainty.

2.4. Hans Caspar Hirzel

Observer

Hans Caspar Hirzel (1725-1803) was educated at the Carolinum in Zurich. Among his teachers were Gessner, Bodmer, and Breitinger. At the age of 20, Hirzel sudied medicine in Leiden, which he completed in the following year. In 1747 Hirzel returned to Zurich, where he pursued his interests in natural sciences and joined the PSZ. Throughout his life, he was committed to the agricultural subdivision of PSZ and supported the concerns of farmers. In 1748 he married Anna Maria Ziegler (Keller-Escher, 1899; Hirzel, 1916; Hirzel, 1804). His meteorological interests grew and he provided his observations in the "monthly news" as

Figure 5. Extract from (left) Meyer's records for Aug. 1761 (StAZH: B IX 280.1) and (right) von Muralt's for Feb. 1760 (StAZH: B IX 281.1).

early as 1750 (Schulthess, 1803); unfortunately, these observations could not be found. Only from 1759 onwards we find his records; they continue to 1802. In 1751 Hirzel became a Poliater and later Archiater (second and first doctor of the city) of Zurich (Hirzel, 1804; Keller-Escher, 1899). In this function he reformed the hospital system (Balmer, 1984).

Hirzel was active within the PSZ, held lectures and in 1759 replaced Hans Conrad Meyer as secretary (a position he held for the next 31 years). He was part of the Economic Commission (Rudio, 1896), which he led from 1769 onward following Johann Jakob Ott (Hirzel, 1804; Leu, 1788). In 1761 Hirzel wrote the famous book “Die Wirthschaft eines philosophischen Bauers”. After the death of his mentor Johannes Gessner in 1790, Hirzel became president of the PSZ. Hirzel also was a member of the Grand Council and later the Small Council and among other functions held the position of bailiff (Keller-Escher, 1899).

Location and instruments

A source from 1756 stated that Hirzel lived in the “Haus zum Sonnenberg” (today Glockengasse 8; the house no longer exists) in the city centre, and he is listed as house owner in 1762, 1769, 1780 and 1790. We assume that he lived there for the entire period (Hirzel, 1916; Keller-Escher, 1899). The available meteorological measurements began in 1759. He probably did not leave this home until 1791 when he moved to the estate of his second wife Regula Leu to find rest in his old age (Hirzel, 1804).

Some information about the measuring instruments can be found in Hirzels notes (StAZH: B IX 278.1) and publications (Hirzel, 1762, 1763). The thermometer is described as a "reglierter Michel du Crest Thermometer" (Hirzel 1762, 1763). His diary of weather observations in 1762 shows that the instrument was filled with coloured, rectified spirit of wine; thus the alcohol was more likely to undergo a change. 100 degrees (°DC) on this scale corresponds to the temperature of boiling water at an external pressure of 27 inches and 9 lines, the freezing point was at 10 2⁄3 degrees of cold (°DC) (Hirzel, 1762, 1763).

In July 1759, Hirzel compared two thermometers on different positions around noon, one in a window on his oriel and one near the window on the barometer board in the shade of his room. From this he drew the conclusion that the thermometer on the oriel provides slightly too high readings due to the sun. Most likely, the window front on which Hirzel had placed his thermometers was southwest facing. This can be seen from the basic plans and old pictures of the building at Glockengasse 8 and is confirmed by Hirzel's statement, that his thermometer was in the sun at noon (Fig. 1). Being a careful observer it can be assumed that Hirzel often checked and evaluated his instruments. We find evidence of further intercomparisons. Arguably he was aware of the influence of the sun's rays on the thermometer, and it can be assumed that he did not expose his thermometer to direct sunlight. However, whether he set up his thermometer outdoors or indoors cannot be answered.

In 1759 Hirzel mentions a barometer board next to the open window in his living room which is in the shadow at noon. Presumably he also set up his barometer there for his later measurements of air pressure. Hirzel used different barometers over the course of time. The first is described as a straight and transparent barometer, 1¼ lines width. There is evidence that he compared it with other barometers and found it inaccurate. In 1762, he changed the instrument to a phosphoric barometer with a ball and a bent tube; it was larger and more sensitive than the old one (Hirzel, 1763). The ball inside the bent part had a diameter of 9 lines (20.34 mm), the tube was 34 inches long (92.208 cm) and one line wide (2.26 mm). Hirzel describes the error range of the instrument as ¼ of a line (0.565 mm). Hirzel gathered the amount of rainfall with a tin vessel. He had set it up in a garden away from the houses and exposed it to the open air (Hirzel, 1763).

Original records

Hirzel's observations were taken from three sources:

- *Meteorologische Aufzeichnungen von Thermometer, Barometer, Wind und Witterung, von 1759-1802, von Hans Caspar Hirzel* (StAZH: B IX 278.1) is the largest source. It is not entirely certain whether Hirzel is actually the author of all contributions in this volume. Different handwritings can be recognized, some remarks were likely added afterwards and parts of the pages were cut or pasted over. Apparently, date marks were assigned and added later. Particularly in the early years, short descriptions about instruments and observation procedures are given in Latin, French, and German. The data are structured in tabular form, The observation hour is sometimes indicated in numbers, sometimes only as morning, noon or evening. Pressure is given in Paris inches and lines, temperature in °DC. Occasional dashes indicate repeated values (confirmed by comparison with the source below). Further information includes the water level of the river Limmat as well as weather notes. The years 1767 and 1768 are not in order, and part of the information is

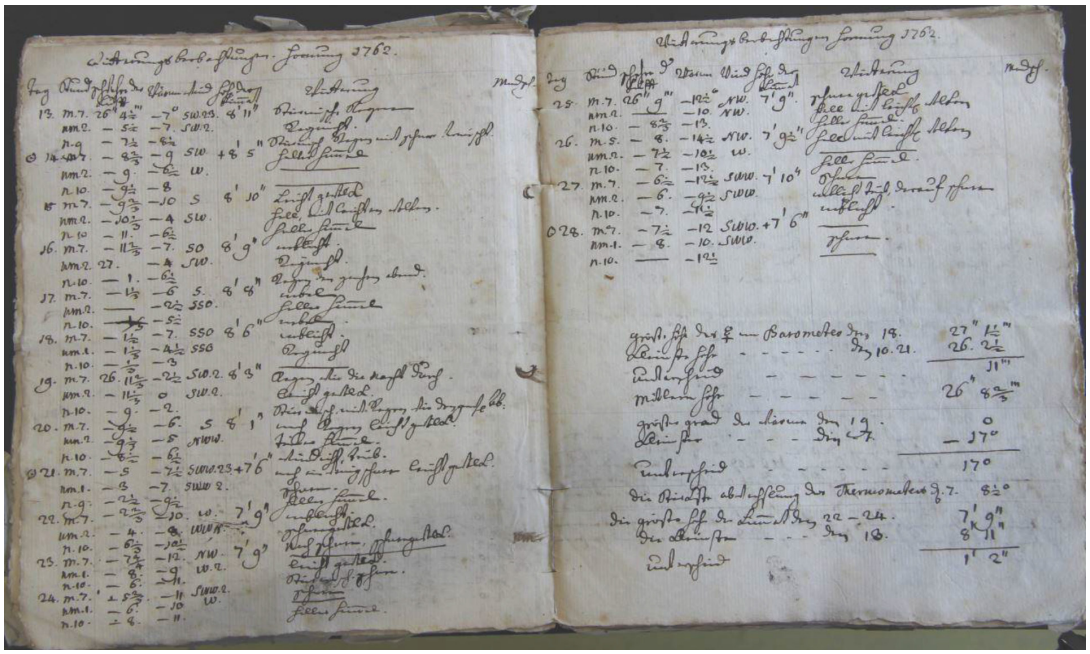

Figure 6. Extract from Hirzel's records – February 1762 (Source: StAZH: B IX 278.2).

missing. The years 1795 to 1802 are written in different handwriting and with a different structure; moreover, only temperature is given in those late years.

- the *Diarium Meteorologicum, von 1761-1762* (StAZH: B IX 278.2) is a portrait-format, rather provisionally bound booklet (Fig. 6) starting in August 1761. This is a part of Hirzel's diary, which he published in 1762 and 1763. The records are listed in the same tabular arrangement as in the previous source, with a small summary at the end of the month.
- *Tag-Buch der Witterungs-Beobachtungen durch das Jahr MDCCLXI und MDCCLXII* is a published diary of observations from 1761 and 1762 (Hirzel, 1762, 1763). The measurements from Aug. 1761 to Dec. 1762 are the same as in the source above (but include one missing month). It is unclear whether the data from Jan. 1761 to Jul. 1761 (missing in the above source) are his own; in any case he did not simply copy them from Ott.

2.5. Daniel von Muralt

Observer

Daniel von Muralt (1728-1793) descended from the Muralt dynasty originating from Locarno. His father was a silk industrialist and merchant, shareholder of the “Haus Muralt an der Sihl” and director of the Grand Council of the Saffran Guild (Muralt, 1926; Schulthess, 1944; Peyer, 1969). His mother was Regula Lavater. In 1737 his father founded the silk house “Daniel von Muralt und Söhne” and built or bought the house “zum Brünneli”. Together with his brother, Daniel von Muralt was a merchant and co-owner of this silk house. He lived with his sister Anna Barbara in the “Haus zum Brünneli” (Muralt, 1926; Schulthess, 1944).

It can be assumed that Daniel von Muralt had good financial position (Schulthess, 1944). In 1757 he took over the post of captain in Höngg (Muralt, 1926) and in 1769 succeeded his father as director of the “Kaufmännischen Direktorium” and member of grand council of the guild to the Saffran (Muralt, 1926), from 1776 on guild master and chief bailiff of Bülach (Muralt, 1926; Schulthess, 1944).

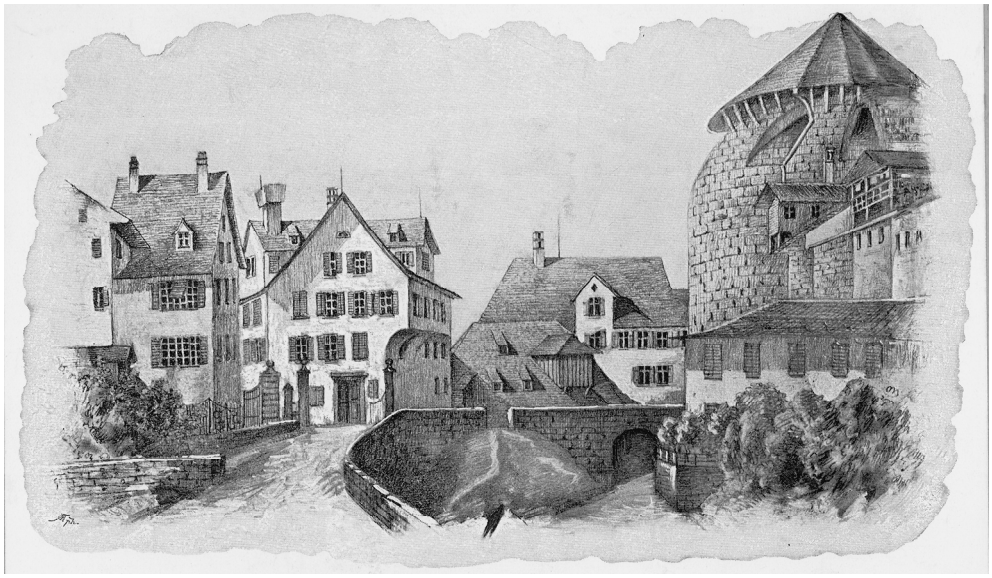

Figure 7. View on "Haus zum Brünneli" at the Bahnhofstrasse 67 around the first half of the 19th century (Source: Baugeschichtliches Archiv Stadt Zürich).

In addition to his commercial and political activities, Daniel von Muralt also had an interest in the observation and measurement of meteorological quantities. During a major part of his life, from 1759 to 1793, Daniel von Muralt systematically observed and measured meteorological variables (Wolf, 1879).

Location and Instruments

Daniel von Muralt carried out his measurements and observations in his apartment in the "Haus zum Brünneli" at an altitude of about 9-10 meters above Lake Zurich. The house was located at the Fröschengraben opposite to the Rennwegtor (Fig. 1 and 7); it no longer exists. It is unclear on which side of the building he measured. The notes show that von Muralt used a Micheli du Crest thermometer filled with spirit of wine. The barometer had a scale in Paris inches; the type is unknown.

Original records

Von Muralt's data were taken from three sources:

- *Meteorologische Beobachtungen, 1760-1769, von Zunftmeister Von Muralt* (StAZH BIX 281.1), consisting of 79 high format parchment sheets. Several months are missing. Each sheet represents a table, into which von Muralt added date and time (only for the morning measurement, but it is clear at which point in the day - noon or evening - he took measurements) and, graphically, the measurements (Fig. 5 right, same table as for Mayer). It can be assumed that von Muralt measured temperature and the pressure 1-4 times a day but then entered also dashes between the measurements. He further described the weather using text and symbols (a legend is provided) and wind direction.
- *Meteorologische Beobachtungen - Observationes meteorologicae Tigurinae* (StAZH B IX 257), containing the observations for the years 1781-1793 in the same format.
- *Beobachtungen des Thermometers, von 1760-1793, von Zunftmeister Von Muralt* (StAZH BIX 281.2): large double-sided paper sheets with handwritten tables. The months of June

to December are missing. Only the morning temperature is given (in °DC), which von Muralt measured usually at 7 AM. The minus sign is only written the first day of the month or when the sign changed. This was an attempt made in 1864 of transcribing the original observations (which are in graphical form) that unfortunately could not be completed. The original observations for the years 1770-1780 have not been found.

3. Processing and quality control

The data from Zurich were processed as described in Brugnara et al. (2020a). In the following, we present the results of the quality control procedure for each series and then focus on the overlap between the series.

Since the series of Ott and Meyer share a long overlapping period, we analyse the two series together. Correlations between neighbouring measurement times in each series (Fig. 8) and between the series at the same time of day (Fig. 9) show a generally good agreement. The former provide some information on the internal consistency. In these analyses, Ott's measurements (black) show a larger scatter than those of Meyer (blue), which might be due to the fact that Ott's series is longer and thus might be affected by more changes in instrumentation, observing times and procedures than that of Meyer. However, all correlations are above 0.9, indicating a generally good quality.

Correlations between the two series at the individual times of day (Fig. 9) show an excellent agreement for temperature, with correlations exceeding 0.97. For pressure, a specific pattern appears at all three times of day, indicating a shift in one of the two records that needs to be dealt with in the homogenisation. Ott's first years of measurements could be too low, but from this plot alone, it is not possible to say which of the records is affected.

The von Muralt series spans from 1760 to 1793, thus also overlaps with the Ott and Meyer series. The entire series is shown in Figure 10. Based on this figure and Table 1, four phases can be distinguished: 1760-April 1769, Sept. 1769 to April 1778 (this part has no pressure data and only morning temperatures during winter), 1781 to 1785, and 1787-1793 (note

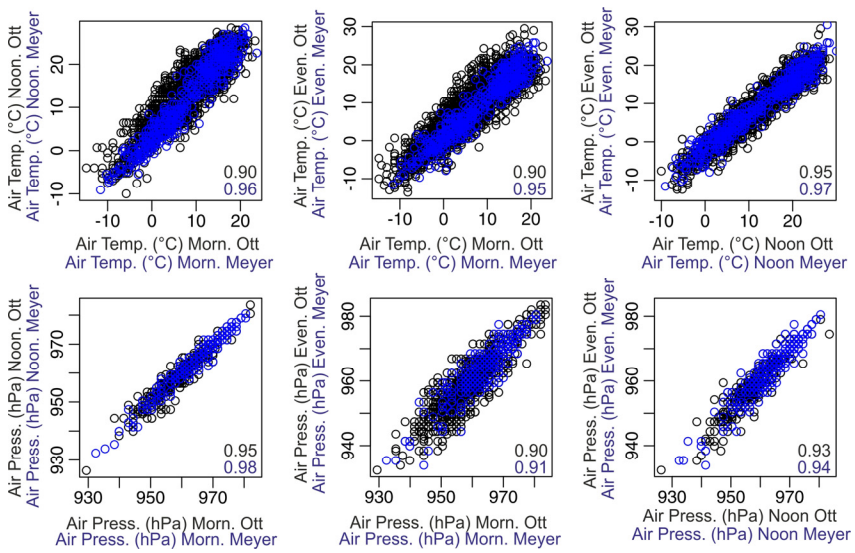

Figure 8. Mutual comparisons of morning, noon, and evening series (the number indicates the Pearson correlation coefficient) of temperature (top) and pressure (bottom) in Zurich in the series from Ott (black) and Meyer (blue).

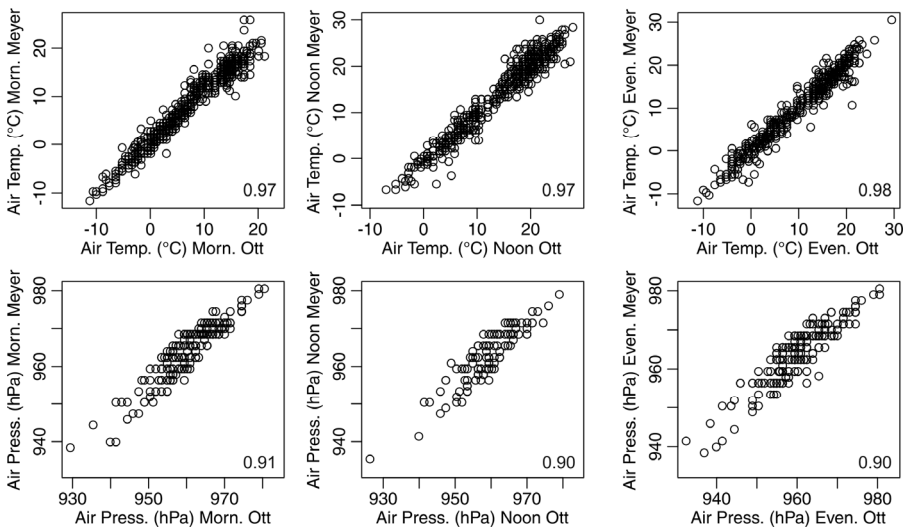

Figure 9. Comparisons of the series of Ott and Meyer in the morning, at noon, and in the evening (the number indicates the Pearson correlation coefficient) for temperature (top) and pressure (bottom).

that the year 1786 is missing). The pressure data during the period 1781 to 1785 are obviously anomalous when compared to the neighbouring periods (these pressure data were excluded from the following figures). There is also a change in resolution, which could point to a change in the instrument or procedure.

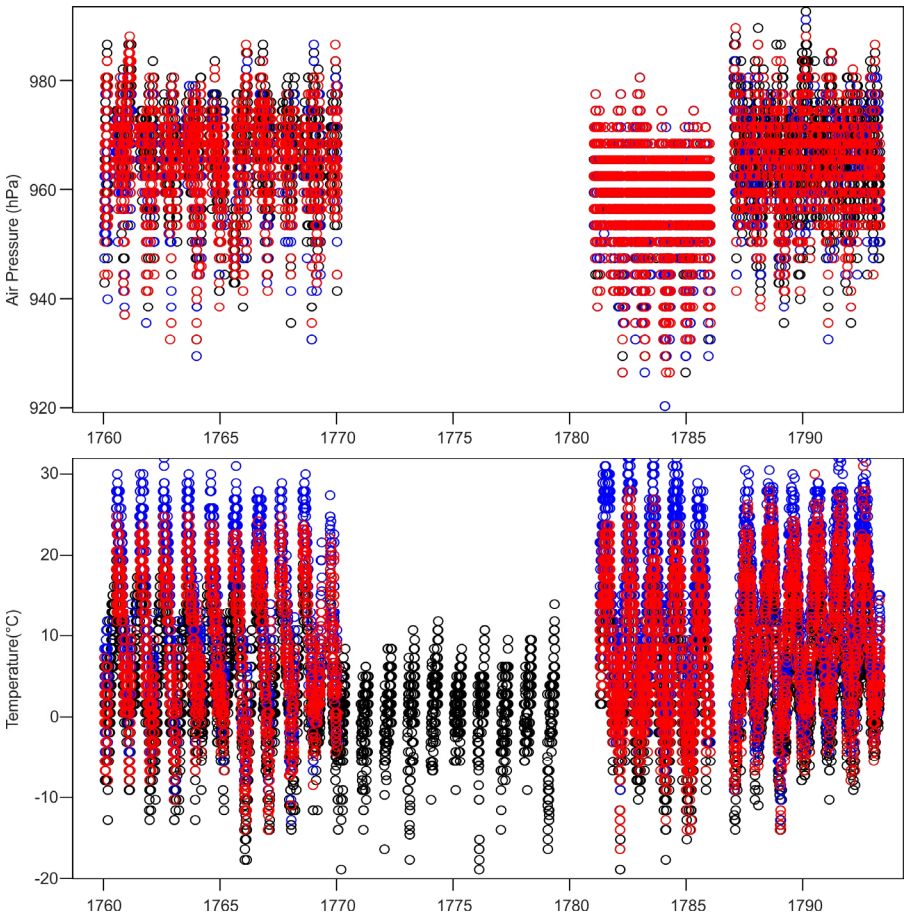

Figure 10. Pressure (top) and temperature of the von Muralt record 1761 to 1793 in the morning (black), at noon (blue) and in the evening (red).

In the following plots we analyse von Muralt's and Hirzel's data and again compare neighbouring measurement times at each series (Fig. 11) and mutual comparisons of the two series at the same time of day (Fig. 12).

Correlations between variables at different times of day within one series are again relatively good. The scatter is smaller and correlation better for Hirzel's as compared to von Muralt's series. The mutual correlations of the series are however relatively low (Fig. 12). The scatter is particularly large in the morning and evening in spring to fall, which could point to an effect of radiation. Note that the scatter is mainly due to the period 1767-1785, for which no third series is available for cross-checking. A large scatter is also observed for pressure, which requires further attention.

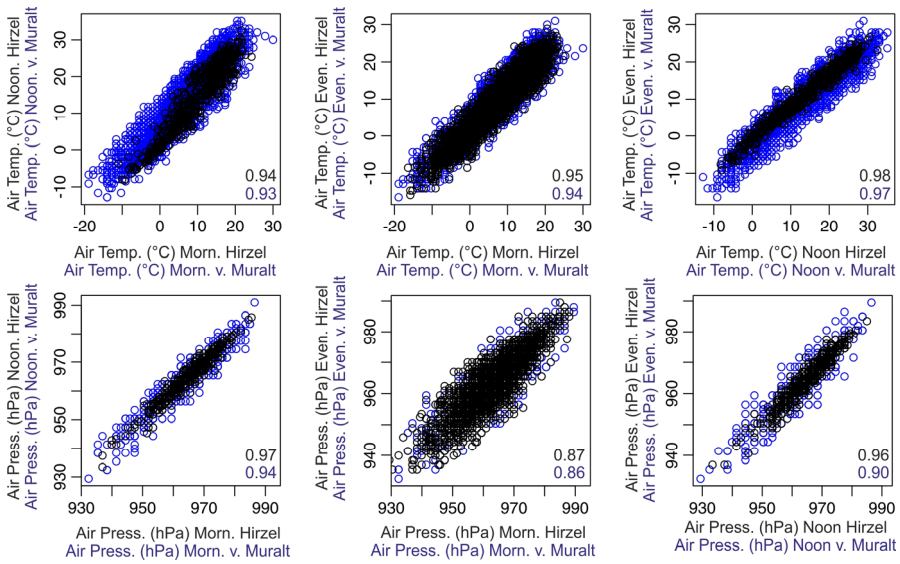

Figure 11. Mutual comparisons of morning, noon, and evening series (the number indicates the Pearson correlation coefficient) of temperature (top) and pressure (bottom) in Zurich in the series from Hirzel (black) and von Muralt (blue).

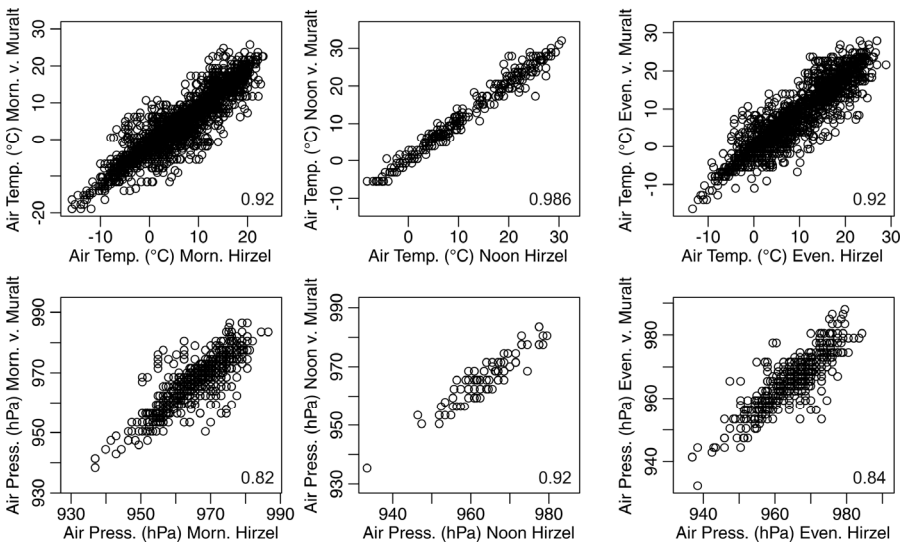

Figure 12. Comparisons of the series of Hirzel and von Muralt in the morning, at noon, and in the evening (the number indicates the Pearson correlation coefficient) for temperature (top) and pressure (bottom).

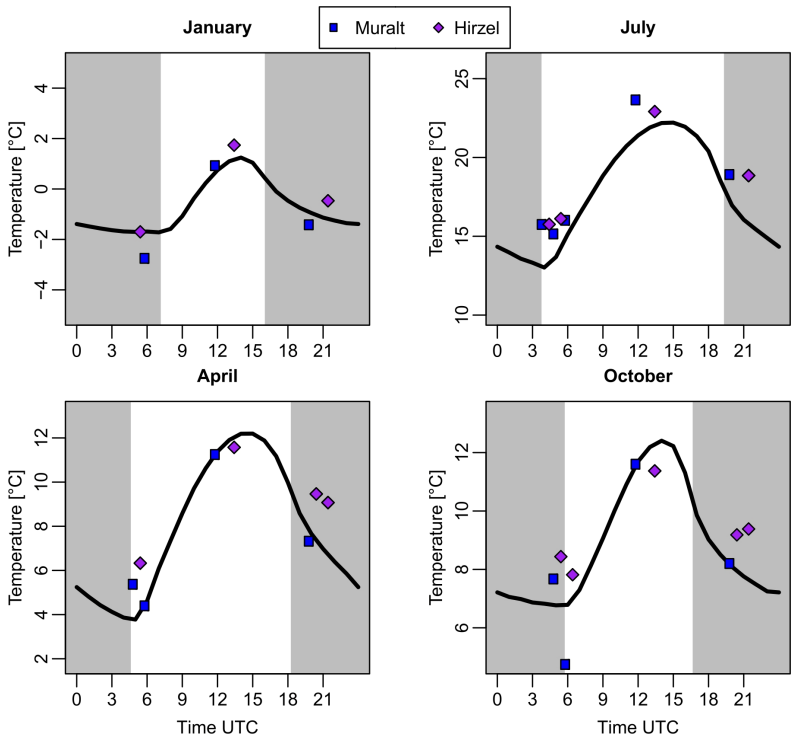

Figure 13. Average temperature values for different observation times in January, April, July and October in the Muralt and Hirzel series compared with the mean diurnal cycle at Zurich (Affoltern) during 1981-2010 (1°C has been subtracted). Gray areas indicate nighttime.

A comparison of the diurnal cycle with present-day data (1 °C was subtracted) shows a generally good agreement. Von Muralt's series might be warm biased in summer at noon, Hirzel's series in the evening from spring to fall. Finally, Figure 14 plots monthly means of the temperature and pressure series from Ott and Hirzel. Pressure shows lower values during the first four years, which needs to be analysed in a dedicated homogenisation study. For temperature, a very good agreement between the stations is found. Although there are gaps, some of which can be filled with the data from Mayer and von Muralt, this figure shows that temperature and pressure series for Zurich can be produced back to the mid-18th century.

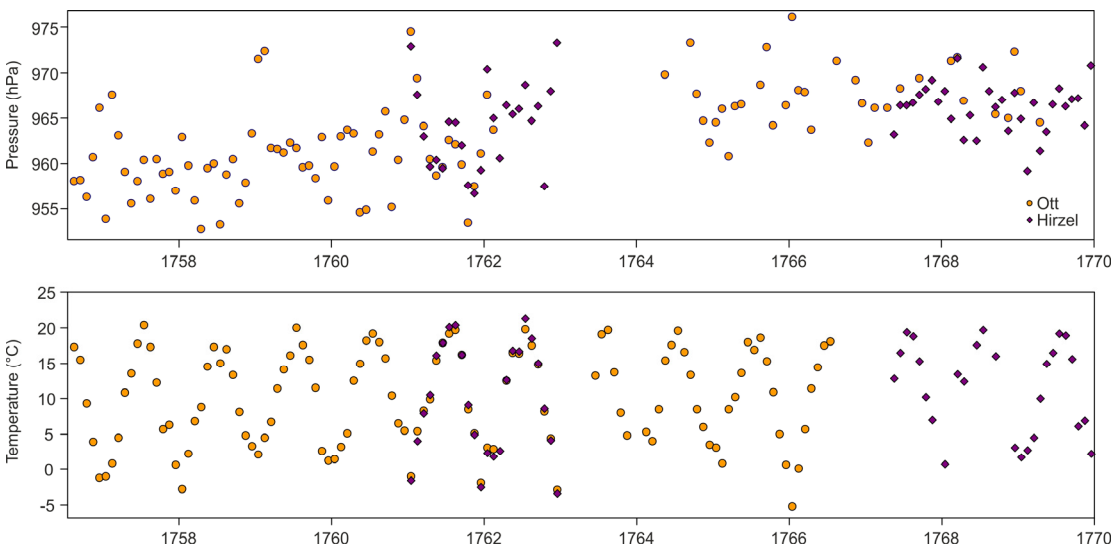

Figure 14. Monthly averages of pressure and temperature from the series Ott and Hirzel series.

4. Conclusions

The meteorological series from Zurich could provide, together with those of Geneva and Basel, a third, long meteorological record reaching back to the mid-18th century, albeit less complete and composed of many segments. This paper describes the data in the period 1756-1802, based on series from four observers. The observers were Johann Jakob Ott, Hans Conrad Meyer, Hans Caspar Hirzel, and Daniel von Muralt. All four were brought up in distinguished families, were well educated and (founding) members of the Physical Society of Zurich. They were active in the city of Zurich and held political functions. Two of them (Meyer and Hirzel) were doctors, which is not uncommon for that time period. Doctors were typically well educated, had a good personal network, social status, were familiar with scientific practice and the use of instruments. Moreover, illnesses were often related to environmental factors such as climate (see also Brönnimann and Wintzer, 2019, for the role of context of climate observations). All four observers were well networked and used state-of-the art instrumentation and procedures.

The data are of generally useful quality, although work remains to be done to homogenize individual segments. The series of von Muralt seems to be of somewhat lower quality, and also the Hirzel series might be affected by radiation biases. However, the data from the four observers will be valuable as segments of a (yet to be constructed) long Zurich series. Other segments are described in further papers in this volume.

The Hirzel, Ott, and Meyer data were part of the CHIMES collection published in Brugnara et al. (2020b) and can be downloaded from https://doi.pangaea.de/10.1594/PANGAEA.909141. Together with the von Muralt data, they are made publicly available by MeteoSwiss and 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.

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