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The First Swiss Meteorological Records: Scheuchzer's Series from Zurich 1708–1733

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Abstract

The first meteorological measurements in Switzerland were performed in Zurich in 1708 by Johann Jakob Scheuchzer. Here we present this oldest Swiss meteorological record, covering the period 1708-1733 though with gaps. Although the record comprises temperature, pressure, and precipitation, only pressure and precipitation is analysed in this paper. The latter record is combined with later data from Hans Jakob Gessner from 1740 to 1753. We describe the data sources, metadata, data processing and quality control. Results are discussed with the aim of generating a long Zurich climate record. Further, we briefly discuss the cold winter 1708/9 in the observations of Scheuchzer and others. The paper accompanies the publication of the imaged data as well as the digitised data.

1. Introduction

The first instrumental meteorological measurements in Switzerland were performed by Johann Jakob Scheuchzer. He was among the first to use barometers for altimetry and made measurements on his 1705-1707 journey through the Swiss Alps (see also Boscani Leoni, 2018). He began daily meteorological measurements in Zurich after his return. Daily data after 1 January 1708 are preserved. This is early even in a European context (Brönnimann et al., 2019). He measured pressure, temperature (though with questionable quality), and precipitation and continued his observations until his death in 1733. He corresponded with many scholars of that time and sent his observations to others, contributing to the distribution of the data. Although only part of the original observations can be found today, it is surprising that

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these data have never been digitised and re-evaluated. In particular, Scheuchzer's pressure observations could be valuable for climate research. Together with later series from Zurich, as described in this volume by Fritze et al. (2021) and Brugnara et al. (2021), and the data from the Swiss Network after 1864, they could form the longest Swiss meteorological series, albeit with several long gaps. In this paper we thus describe this first Swiss meteorological series.

The next Swiss observer after Scheuchzer was Hans Jakob Gessner. His original measurements have not been found so far. Already Wolf (1879) noted that Gessner's data were most likely lost. Many have since searched in vain, including us. At least, however, we have monthly rainfall data, and these data are also briefly discussed in this paper. Merging Scheuchzer's and Gessner's data, a precipitation series for Zurich from 1708 to 1753 is presented, though with gaps.

The paper follows the publication of a metadata inventory of all early Swiss series (Pfister et al., 2019) and of the data from many digitised series (Brugnara et al., 2000b). Images of this project will also be made available via a repository, and the digitised data will be available from MeteoSwiss, EURO-CLIMHIST and they have been submitted to the Copernicus Climate Change Service (C3S) Global Land and Marine Observations Database (Thorne et al., 2017).

The paper is organised as follows. Section 2 provides a historical overview of the measurements made by Scheuchzer and Gessner. Section 3 describes the results of the quality assurance and presents the data. In this Section we also present a brief case study on the cold winter of 1708/9. Section 4 then presents the precipitation series. Conclusions are drawn in Section 5.

2. Data

2.1. Johann Jakob Scheuchzer

Johann Jakob Scheuchzer (1672-1733, Fig. 1) was a Swiss scientists of the enlightenment. He studied medicine in Nuremberg and Utrecht and returned to Zurich, where he took on the position as a city doctor. He also became director of the "Bürgerbibliothek" (public library) with its museum and he was active in scientist groups (see Boscani Leoni, 2010). Meteorology was only one of many fields of activity. Scheuchzer is perhaps mostly remembered for his palaeontological work, and he is sometimes ridiculed for his claim to have found human fossils from the deluge, thus proving the existence of the deluge. However, he was an influential scientist at a European level. In 1703 he was elected fellow of the Royal Society and had a vivid correspondence with many contemporary scientists.

Scheuchzer was in the possession of barometers since the early 1700s and used them on his famous voyage through the Alps. The pressure observations in Zurich starting in 1708 were performed in his house at Trittligasse 5 in today's neighbourhood Niederdorf. Figure 2 shows a view of the city from 1672, Scheuchzer's birth year, in which we marked his house (S) and the public library (Wasserkirche, W). Zurich was still relatively small at that time.

A Table of the Rain at Zurich *in* Switzerland, *at* Pisa, *and* Upminster, *in the Year* 1708. *All reduc'd to the Depth in English Inches, and Centesimals of an Inch.*

	January.							February.						
D. of M.	Rain at Zurich	Rain at Pisa.		Pisa Ra. reduc'd		Rain at Upm.		Rain at Zurich	Rain at Pisa.		Pisa Ra. reduc'd		Rain at Upm.	
	Inches.	l.	oz.	l.	dec	l.	dec.	Inches.	l.	oz.	l.	dec	l.	dec
1		5	8	5	20									
2	1							2 ½	3	3	2	98		
3														
4		7	2	6	58	0	97	1 ¾						
5	1					0	29	¾	0	10	0	76		
6						0	7	2					0	2
7														
8								2						
9		6	3	5	74	0	53		2	4	2	14		
10						2	48		1	8	1	53		
11						1	26							
12								2 ½	0	9	0	69		
13						1	91							
14		3	4	3	6	1	88							
15	4					0	4	½					0	18
16						0	92							
17		5	6	5	5			1 ¾						
18		2	9	2	52	1	26							
19								4 ⅓						
20	1 ½							⅙	2	1	1	90	0	54
21	1												0	51
22	4					0	91							
23	2								7	2	6	58	0	64
24	2	3	6	3	21									
25	1 ½					1	7						0	19
26						0	80							
27		4	1	3	75									
28									2	9	2	52		
29	½							½					0	22
30														
31		2	5	2	22									
Tot.	18 ½			37	33	14	39	18 ⅔			19	10	2	[illegible]
Dep	1 64			6	41	2	878	1 65			3	28	0	46

Figure 1. (Left) J. J. Scheuchzer, Physique sacree... Frontispiece, portrait of the author, Wellcome Library, London. Wellcome Images. (right) Table from Derham's paper (1708/9) comparing daily rainfall in Zurich, Pisa, and Upminster.

Figure 2. View of the city of Zurich around 1672 indicating Scheuchzer's house (S) and the Wasserkirche (W) (copper engraving by Conrad Meyer, Galerie Kämpf, Riazzino).

Scheuchzer regularly sent his data to others (Boscani-Leoni, 2018), including Maraldi (1709) and de La Hire (1710, 1711), who performed similar measurements at the Paris observatory (Cornes et al., 2012b). De La Hire compared Scheuchzer's data with those of Paris and annually published the results. The mercury barometer was in good agreement with that in Paris. The thermometer was most likely an Amonton's air thermometer (Camuffo, 2002) filled with mercury, which he seems to have calibrated with boiling water. However, already de La Hire (1710) did not analyse the data as they were not comparable to the his measurements in Paris even though he used a similar thermometer.

As Scheuchzer shared his results with many others, it is not surprising that one of the first studies that compared climate across different cites in Europe used Scheuchzer's pressure and rainfall measurements (Derham, 1708/9, Fig. 1, right), along with those from Upminster, England, and Pisa, Italy.

This publication is the source of the 1708 daily data, as original records from this early period have not survived. Of his measurements in the following years, we only have the summaries by Maraldi (1709) and de La Hire (1710-1712), mostly in the form of annual maximum and minimum pressure, but no continuous data are tabulated. Maurer (1917) lists all sources of Scheuchzer's data. The measurements from 1718 onward were published in the "Kanold collection" (Lüdecke, 2010; see also Brazdil et al., 2008), a Europe-wide collection of daily meteorological data published quarterly over many years by the Wroclaw pharmacist Johan Kanold. In this source, the Zurich data for 1719 are however missing. An example sheet from this source is shown in Figure 3. The collection was continued after the death of Kanold in 1729 by Büchner for a few years, but the data end in 1731. We digitized all data until 1731 exclusively from this source. Scheuchzer's pressure data are also found at the University library of Basel, covering the period 1720 to 1733. We digitised the data from 1732 and the first 6 months of 1733 from this source. Figure 4 shows an example sheet.

Scheuchzer's data would cover further periods. According to Maurer (1917), J. H. Denzler in the 19th century had daily data from 1708-1711 and 1717-1719. The same years were listed in Wolf (1865) with respect to precipitation. This means that our digitization is missing two or three years that could possibly still be available, even though no recent publication mentions the source.

Although Scheuchzer also measured temperature (and we also digitized the data), we did not attempt to reduce temperature as exact specifics of the thermometer and its scale are unknown. We did however convert pressure and precipitation to modern units.

2.2. (Hans) Jakob Gessner

The second record that is briefly discussed in this paper is that of Hans Jakob Gessner (1694-1754), often simply referred to as Jakob Gessner. He was a clerk ("Vorschreiber") and priest at the church St. Jakob in Zurich. Jakob Gessner was a relative of Johannes Gessner (1709-1790), a scholar of Scheuchzer, who in 1746 founded the Physical Society and was professor for mathematics and physics. Jakob Gessner performed meteorological observations from 1740 until shortly before his death on 1754, reportedly comprising temperature, pressure, and precipitation.

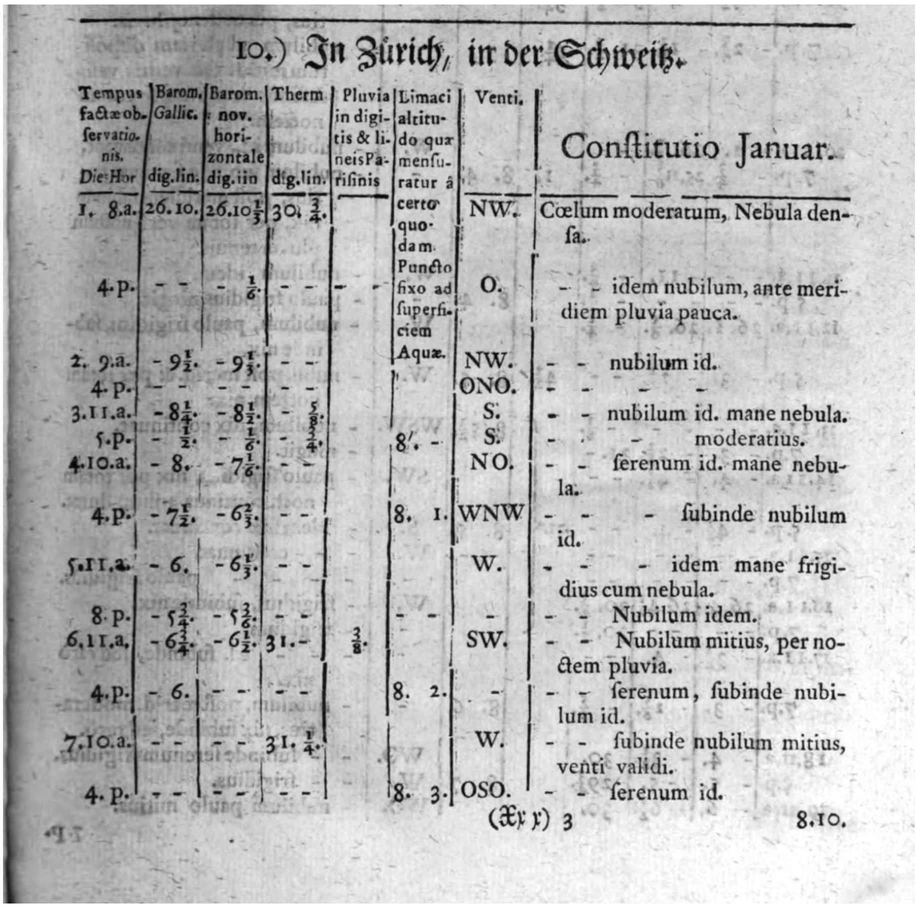

Figure 3. Sheet of Scheuchzer's data for 1718 from the Kanold compilation.

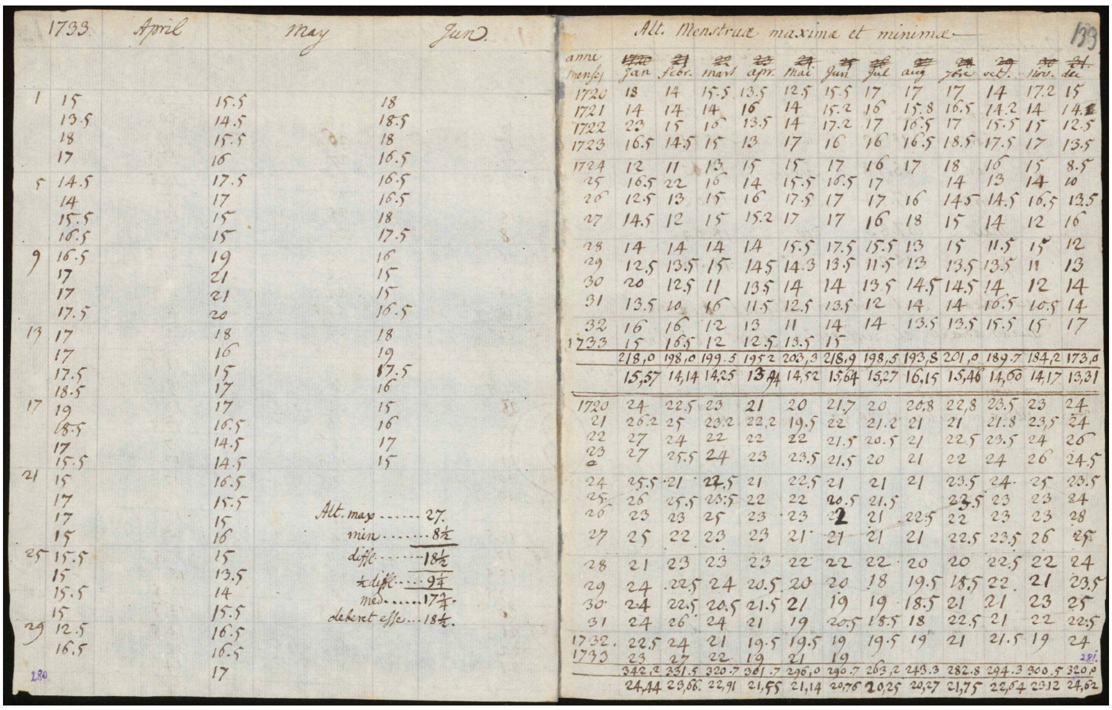

Figure 4. Last sheet of Scheuchzer's data from the University Library, Basel, covering the last three months of measurement as well as a compilation of monthly maxima and minima over the 1720-1733 period.

Only the precipitation data have survived and have been published in the "Meteorologische Beobachtungen II" (Wolf, 1865). The first part of the series, covering 1740-1746, is also found in the Zurich State Archive, together with a manuscript of a presentation he held on the results of these measurements. The "Meteorologische Beobachtungen II" also contain a later segment covering 1750-1753. Gessner's rainfall data were digitized and entered, together with those from Scheuchzer, the Global Historical Climatology Network (GHCN, Vose et al., 1992). However, in that data set an error affects this early Zurich period, as a block of data from the 1980s obviously was copied to the period 1725-1735 and shifted by one calendar month. We discovered this error only recently, such that the EKF400v2 data set (Valler et al., 2021), which is used below for comparison, assimilated this erroneous precipitation record.

3. Processing and quality control

The data from Zurich were processed as described in Brugnara et al. (2020a). However, apart from the generic outlier screening, we could not perform the same quality assessment as for the other series as the resolution (1.5 hPa) is too coarse to compare pressure during different times of day and we have no nearby station to assess outliers. We compared two barometers used by Scheuchzer during a brief period, and we compare his data with data from Paris and London, noting that the spatial distance precludes a detailed quantitative analysis. However, the agreement or disagreement with these records still helps to obtain a view of the quality of the record. Further, we compared his data with the ensemble mean of the climate reconstruction EKF400v2, which is based on assimilating historical instrumental data as well as documentary and proxy data into an ensemble of climate model simulations (Valler et al., 2021). In the following, we present the results.

As an overview, Figure 5 presents the daily surface pressure record from Scheuchzer, colour coded by source. Also shown is the monthly mean as well as monthly sea-level pressure data from EKF400v2. Note that EKF400v2 does not include Scheuchzer's pressure data and so is independent. We find a reasonable agreement between the two monthly records, with a correlation coefficient of 0.58 (not that EKF400v2 also has an error). Several prominent excursions are found in both data sets. However, it seems that the first segment of Scheuchzer's data in 1708 is too low when scaling the data such that surface and sea-level pressure match in the latter part of the series.

In 1718/9, two barometers are noted in the Kanold source. Figure 6 (left) shows the values as a scatterplot. The correlation between two instruments is 0.944, however, there are

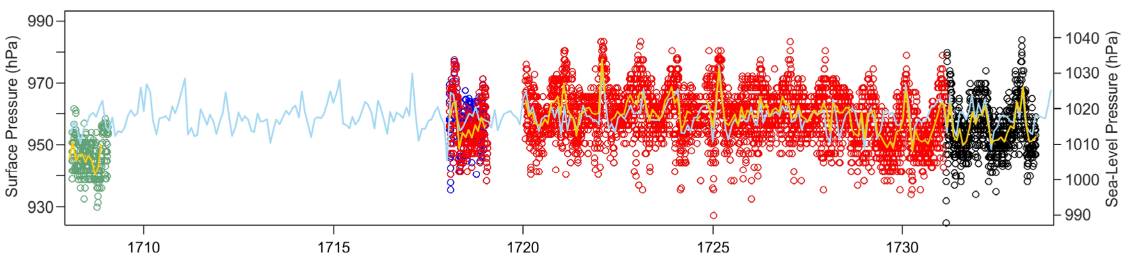

Figure 5. Daily pressure data from Scheuchzer from (green) Derham, (red) Kanold, (blue) Kanold, second barometer and (black) University Library Basel. The orange line shows the monthly mean observations, the light blue line shows pressure from EKF400v2.

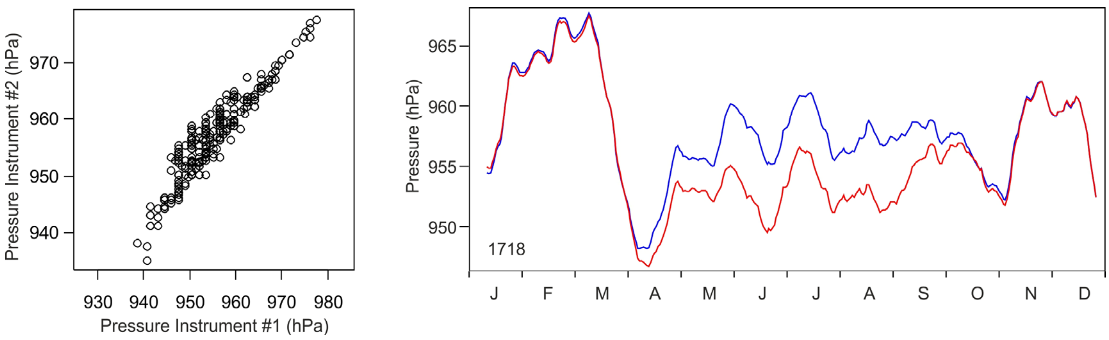

Figure 6. Pressure data from the two barometers from Scheuchzer in 1718 as (left) scatterplot and (right) as smoothed time series plot (right: instrument #1, blue instrument #2).

some deviations that appear systematic and concern summer only (Fig. 6, right). The difference amounts to about 5 hPa and shows how large the systematic error can be, although day-to-day variations agree very well. Note that pressure readings at the time of Scheuchzer were not reduced to a standard temperature, so they are influenced by the temperature of the barometer. In addition, as already mentioned, the barometers had a rather coarse resolution. For the period with two barometers, EKF400v2 seems to support the second barometer more than the first (Fig. 5).

Finally, we analyse, as a case study, the pressure record of the winter 1708/9. This was arguably the coldest winter of the last 350 years, especially January and February were cold (Luterbacher et al., 2004). This winter is therefore still a target for climate research, and with newly digitised data, a reconstruction of day-to-day weather during this winter comes into reach (see Lenke, 1964, for a detailed overview of temperature measurements). In Figure 7 we compare pressure measurements from Scheuchzer in Zurich with the series from Paris and London (Cornes et al., 2012a,b). Note that from Scheuchzer, we only have the 1708 data. For 1709 we only have sporadic information on extremes from de La Hire (1710). For instance, we know that the annual maximum pressure was reached on 19 January and the minimum was reached on 20 and 28 February. All data were converted to sea-level pressure (the Zurich data by adding a constant offset of 50.8 hPa except for 19 January where we also accounted for temperature, assuming -15 °C ,as in a letter to Johann Bernoulli, Scheuchzer mentions that the cold affected the barometer: https://ub-mediawiki.ub.unibas.ch/bernoulli/index.php/1709-01-27_Scheuchzer_Johannes-Bernoulli_Johann_I).

Overall we find a good agreement with the two series, as was already stated (for the case of Paris) by de La Hire (1710). The correlation with the London series amounts to 0.51, that with the Paris record even to 0.71. The maxima and minima are also in good agreement with the other two records. Interestingly, after converting to sea-level pressure, we also find that Zurich has much lower values than Paris or London. This supports the above finding that the data from 1708 are probably too low.

The lower part of the figure shows weather diary entries by Johann Heinrich Fries, professor at the Carolinum. He led a weather diary with almost daily entries from 1684 to 1718. The data can be found on EURO-CLIMHIST (Pfister et al., 2017). December was already cool, then an extreme cold wave started on the 9th of January, and the winter remained cool until the end of February. Many of the high-pressure situations coincide with sunny weather, cloudy and changeable weather occurs with lower pressure.

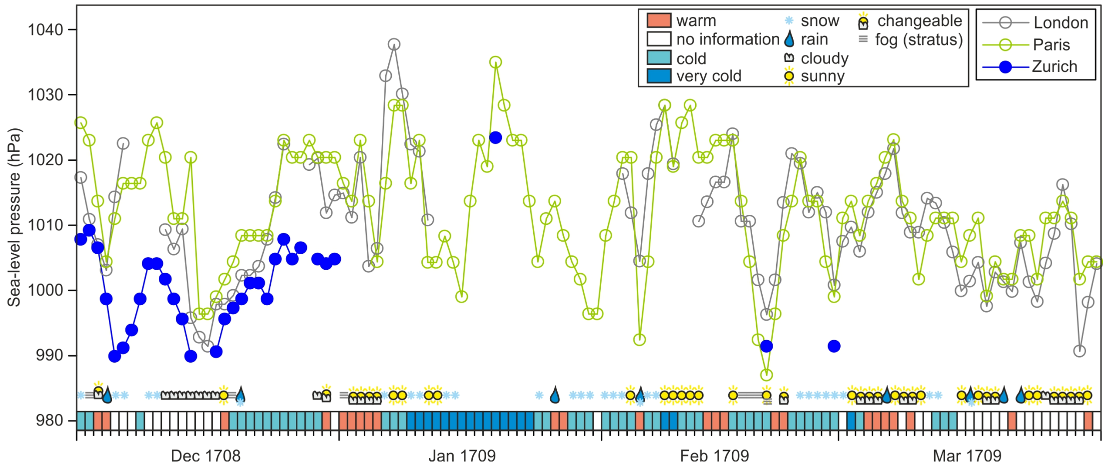

Figure 7. Daily sea-level pressure data for the winter 1708/9 from Scheuchzer as well as from London and Paris. Also shown are weather diary entries from Fries in Zurich (from EURO-CLIMHIST).

4. Rainfall: The Scheuchzer-Gessner series

In this section we analyse the precipitation series from Scheuchzer, together with that from Gessner, together covering 1708-1753 though with long gaps. Instrumental precipitation measurements from the early 18th century are rare and often sporadic. The two longest available records are those from Paris (starting 1688; Slonosky et al., 2002) and a concatenated series from Ireland starting in 1711 (Murphy et al., 2018). We compare the Zurich series with the former record in the form of monthly mean values (Fig. 8). Note, again, that the Zurich record in GHCN is erroneous and should not be used.

Paris has only ca. half the precipitation of Zurich, therefore the series are plotted on two different y-axes. Note that the Zurich precipitation values in this record are comparable to present day values, while for Paris they are much lower.

Overall we find a good agreement between the two records, with a correlation of 0.46, despite the spatial distance of 490 km (the correlation even increases to 0.55 when considering only Gessner's data). For comparison: The correlation of monthly mean precipitation between the two sites over the 20th century is 0.44. There is thus no indication that the data are of low quality, based on this very simple analysis.

Some of the outliers can be checked. For instance, according to Pfister (1999), the record rain amount in the summer of 1720 fell in the form of torrential thunderstorms in an otherwise dry period. The Zurich record, which can be continued with precipitation measurement by Ott (see Fritze et al., 2021), thus is a promising record for climatological analyses.

5. Conclusions

The first meteorological series of Switzerland was observed by Johann Jakob Scheuchzer in Zurich. He started regular measurements in 1708 and continued until his death in 1733. Combined with other records from Zurich (see Fritze et al., 2021, Brugnara et al., 2021), a long Zurich record could be generated, which, together with those from Geneva, Basel, and possibly Bern, could constitute another long Swiss meteorological record. Although there will

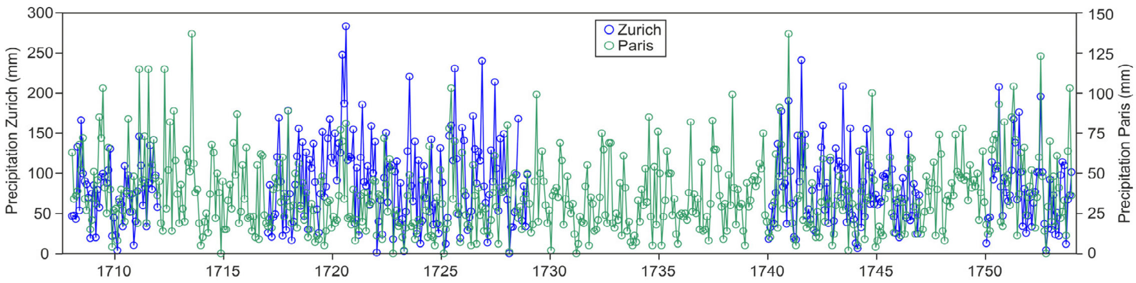

Figure 8. Monthly precipitation in Zurich (blue) from Scheuchzer (1708-1729) and Gessner (1740-1754). The green curve shows precipitation in Paris (Slonosky et al., 2002). Note the different scales.

be long gaps, this would be the series reaching farthest back in time. This paper describes the series from Johann Jakob Scheuchzer, which for precipitation was merged with that of Hans Jakob Gessner. Only pressure and precipitation are shown here; temperature readings were not found to be of sufficient quality as no information about the instrument or the scale is given.

The pressure data are found to be in agreement with independent records, although the earliest year might have too low pressure and later years also suffered from systematic biases, as a period with parallel observations from two barometer shows. Besides, the barometric readings were not corrected for temperature. A brief case study on the winter 1708/9 shows that we can expect the record to show the main features of day-to-day pressure variability. Monthly rainfall shows a high correlation with that in Paris, almost 500 km away.

The data are made publicly available by MeteoSwiss. 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).

Acknowledgements

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