Clima von Bremen

H. W. M. Olbers' measurements of air temperature in Bremen from 1803 to 1821

Birte Heinze, Dirk Olbers and Gert König-Langlo

Alfred Wegener Institute for Polar and Marine Research, 27515 Bremerhaven, Germany

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1 Introduction

The physician and astronomer Heinrich Wilhelm Olbers (1758-1840) measured the temperature and air pressure in Bremen continuously from 1803 to 1821 and wrote several manuscripts about meteorological topics. Only few got published (e.g. Olbers 1851), while others have been forgotten. Meteorology was still in its infancy, and though the research themes appear quite modern (e.g. Olbers IV Ol 35: Über die Vorhersagung der Witterung), major concepts of physics and meteorology where not yet discovered: there was the search for long periods (18 and 100 years) in observed data and reports on climate variations, the predictability of climate from the motion of planets and the moon, and the somehow mystic idea of warmth (temperatures above the freezing point) and cold as opposing forces making the weather and climate (see e.g. Müller 1823).

We have rediscovered some of Olbers' meteorological works in the estate of Wilhelm Olbers at SUUB (Staats– und Universitätsbibliothek Bremen). These include tables of monthly means (taken three times a day at 7 am, 2 pm and 10 pm) with maximum and minimum values for the first 11 years and similar data for the following 7 years. A mean of the three time series, which Wilhelm Olbers calculated simply by taking the mean of the three values. Unfortunately Olbers has not handed down the daily values. All data of the year 1814 are missing for unknown reason.

Several considerations and tables, which compare values of observations with other places are part of the Olbers' estate. Cornelia Lüdecke (Lüdecke 2001) has compiled a detailed highlight collection of Olbers meteorological works at the exposition 'Neue Welten – Wilhelm Olbers und die Naturwissenschaften um 1800' (New Worlds – Wilhelm Olbers and the natural science around 1800, Braunschweig 2000, Biegel *et al.* 2001).

In the following we will analyze the temperature measurements, which we got from the estate of Olbers in the SUUB in Bremen and from one publication of Olbers' great grandson Wilhelm Olbers Focke. We have digitized the time series of Olbers, converted the data from Fahrenheit into Celsius, and we will discuss the tendency of the climate. Our aim is to make these data available for further research.

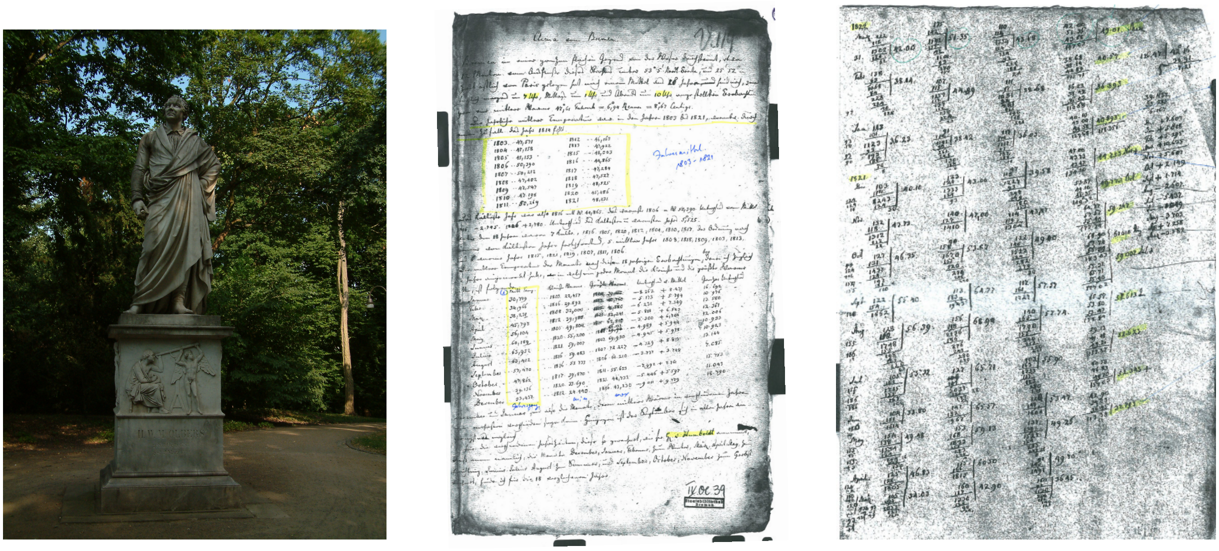

Figure 1: Left: The Olbers‘ memorial in Bremen. Middle: The first page of Olbers’ manuscript ’Clima in Bremen’. Right: Page from ’Temperaturmessungen, Barometerbeobachtungen’ showing Olbers’ computations.

2 Data researches

Wilhelm Olbers measured the temperature outside the window of his workroom, which was situated in Bremen, Sandstraße 15 (53°04’30,40’ N, 08°48’39,47’ E) and is up to 16 m above the zero mark at the Weserbrücke. The time of observations at midday fluctuated between 1 and 2 pm. Wilhelm Olbers Focke described Olbers’ instruments as the finest ones (Focke 1871). The place for the measurements lay in the shade at all time. Various papers in the Olbers estate proves that Olbers himself calibrated his instruments.

We got the data of the first 11 years of measurements from the publication of Wilhelm Olbers Focke. The remaining data we found on handwritten papers in the estate of Wilhelm Olbers (Olbers IV Ol 39 and 40). The temperature from the years 1815–1819 stood in neatly set tables consisting of 3 columns, labeled with the year and the corresponding month. We assumed that the 1st column stood for the 7 am values, the 2nd for the 1–2 pm values and the last column for the 10 pm values.

We have discovered the data of the last 2 years, 1820 and 1821, (and the first three months of 1822) in some columns on papers of the Olbers’ estate which Wilhelm Olbers had used to calculate his monthly means. These data were badly labeled. The year and the corresponding month were sometimes missing or unreadable. To ensure the data, we calculated the seasonal mean and compared the values with well-labeled seasonal means of the same year, which we found elsewhere in Olbers’ papers.

The way Olbers calculated the monthly means is antiquated. Computers are able to measure the temperature 4 times a day: at 6 am, 12 am, 6 pm and at 12 pm. If volunteers measure they omit the temperature observation at night and take in twice the 10 or 12 pm value in the calculation for the daily mean and divide the sum of the two day values and the doubled evening value by 4. We applied this method in this study, too.

Several influences may have an effect on the temperature. To secure the data from urban heating, temperature is taken two meters above ground level on a lawn. Olbers, of course, disregarded this rule, so that we must assume that the data is manipulated by urban heating. This manipulation has probably an unknown constant bias.

Other influences on the measurements could have had infected the data as well. Although Olbers used 'the finest instruments', as his great grandson wrote, these instruments could have had some errors or Olbers could have gauged them erroneously. Another small difference in the resulting temperature usually occurs when the measuring individual changes. This is not the case here. Olbers continuously measured the temperature himself at the same place everyday. The measurements fluctuated at midday between 1 and 2 pm, but the resulting changes in temperature are too small to result in serious errors. The gauging of his thermometer was done elaborately, as described in Olbers (IV Ol 17: 'Über mein Thermometer').

A more gravely potential source of missing homogeneity is a change of instruments. From 1814 on Olbers might have used a new thermometer. We calculated the mean of the years 1803–1813 and the mean of the years 1815–1821, the difference is about 0.444°C. We applied these method on the homogenized data of Bätjer and Heinemann (1980) described below, to be able to compared the values. We found out that some differences were larger while other were smaller, so that we came to the conclusion that the 0.444°C difference is due to the normal fluctuations. Also there are no visible perfidious hints for inhomogeneity. The visual check of the temperature helps as well, to find inhomogeneities. Figure 2 shows the monthly means over the whole range of the 18 years of measurements. By visual examination no irregularities are identifiable.

3 Analysis

To analyze the data, we present several figures in which temperature trends should be easily observable. Figure 2 shows the daily mean temperature for the whole time series. The normal fluctuation over the years is discernible in the graph. In the warmest month, August 1806, a mean of 21.8°C was measured. The coldest month was January 1803 when Olbers started his time series. That month had a mean of -5.3 °C.

To see trends more clearly, we plotted in Figure 3 the yearly mean temperature for 1803 to 1821 (calculated by adding the means of each month from January till December and divided it by twelve). The graph fluctuates with 3°C between 6.9 and 9.9°C and shows a slight trend towards cooling with a rate of approximately -0.035°C each year. The years 1805, 1812 and 1816, which were very cold and the years 1806, 1807 and 1811, which were quite hot, stand out of the left panel of Figure 3. The cold temperature for the year 1816 is likely due to a major volcano eruption: in April 1815 the volcano Tambora in Indonesia erupted. The explosion was 6-7 on the Volcanic Explosivity Index and ejected

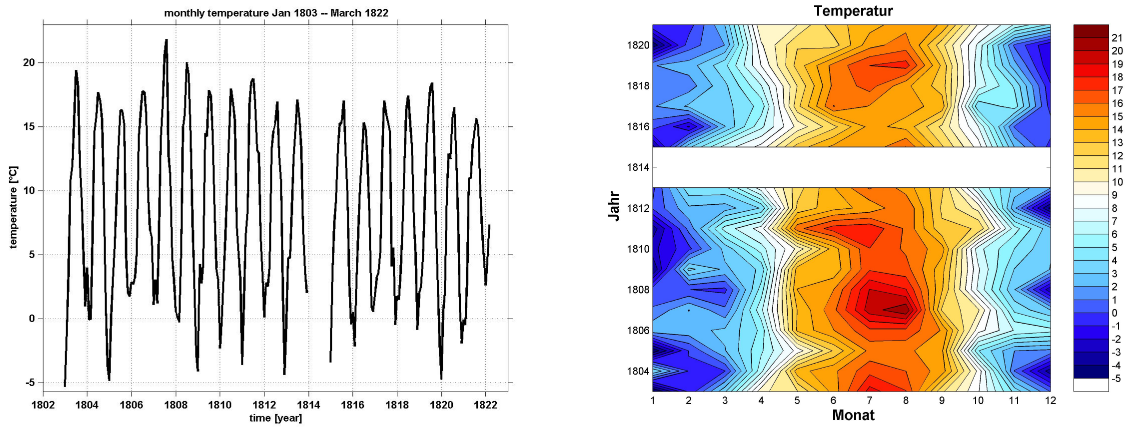

Figure 2: Monthly means from January 1803 to March 1822.

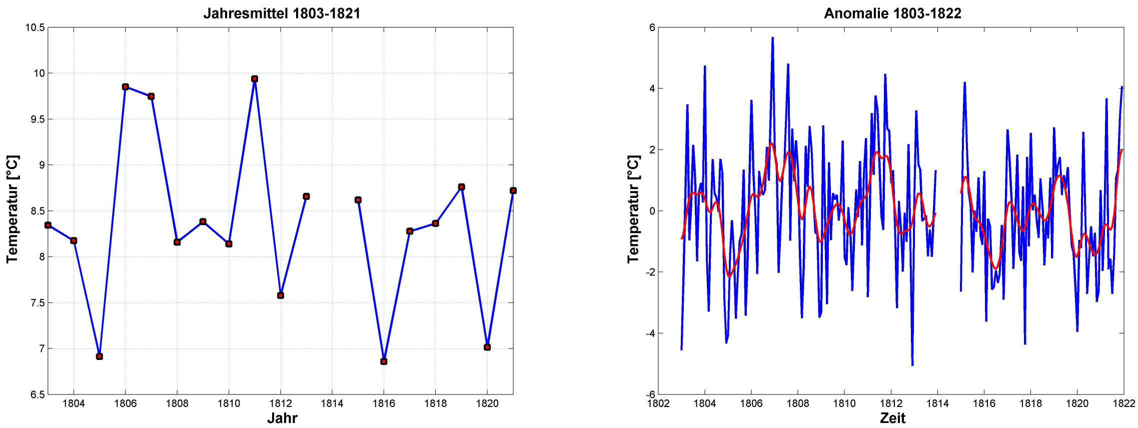

Figure 3: Left: Means of each year 1803–1821. Right: Anomaly.

approximately 100 cubic km of rocks, ashes and dust. Influence on the global climate is documented in many climate indices.

In the right panel of Figure 3 we plotted the anomaly: for each month the corresponding mean month is subtracted. The anomaly confirms the notion that the temperature remained almost the same during the time of measurements, apart from a very slight trend towards cooling. However it needs at least 30 years of measurements to be able to determine a significant climate trend with justification.

The seasonal cycle for 1803-1821 in Figure 4 shows that the values of the 10 pm and the 7 am measurement are close to each other in summer, but drifting apart in spring, autumn and winter.

To be able to see a seasonal trend, we present in the right panel of Figure 4 the gradients

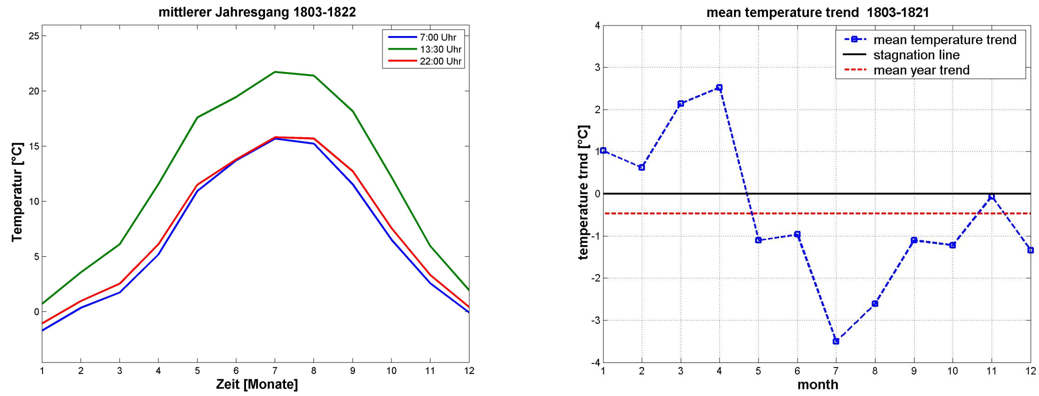

Figure 4: Left: Seasonal cycle from 1803–1821. Right: Mean temperature trend for each month.

of the linear regression for each month during the years from 1803 to 1821. The result states that January till May the temperatures were increasing and after May the temperature abated. The mean year trend is slightly negative.

The earliest time series of Bremen, edited and homogenized so far (Bätjer and Heinemann 1980), begins in 1829 and goes up to now,. To get a survey we additionally took this time series, but a gap from about 7 years remains from 1822 to 1828. Figure 5 shows the changes in temperature over the years.

The total time series is deceptive, because we did not homogenize Olbers' data with the time series of Heinemann. Olbers measured in a town, so that his measurements had been exposed to the urban warming, nevertheless his temperatures are cooler than the Heinemann data. This could be caused by the global warming, which is a result of the industrialization, which began in Great Britain in the 18^{th} century and followed in Germany in the century afterwards. Or maybe this apparent antagonism is just due to the short time of Olbers' observation and to the missing homogeneity between the measurements of Olbers and the Bätjer–Heinemann time series or even between the measurements of Olbers before and after the year 1814.

4 Outlook

A future task should be to homogenize the data from Wilhelm Olbers with the later time series and to fill the gap from 1822–1828. Wilhelm Olbers kept going on measuring the temperature as it emerged from a letter, which he wrote to the astronomer Friedrich Bessel. He referred to a measurement from the 23^{rd} January 1823 at 8:30 when he measured -27.3°C. Perhaps these later data could be found. On the other hand, it is possible that the data are lost for ever. W.H.M. Olbers died March 2^{nd} in 1840 after a longer period of illness.

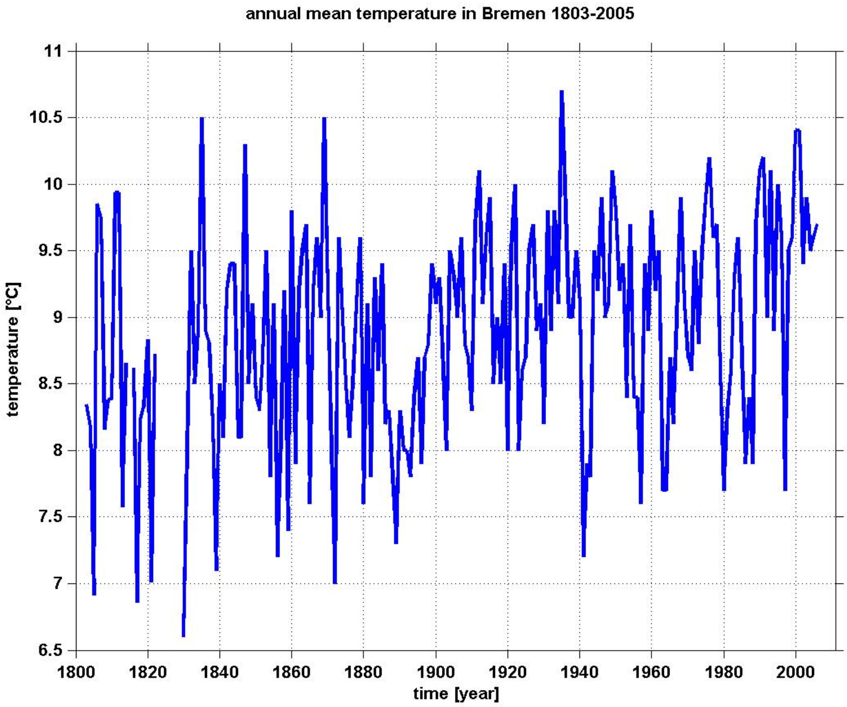

Figure 5: Temperature data for each month, 1803–2005.

5 Summary

We rediscovered a temperature time series from Wilhelm Olbers, which he measured in Bremen, Sandstraße 15 (53°04'30,40' N, 08°48'39,47' E) in Germany from January 1803 to March 1822 three times a day (7 am, 1-2 pm and 10 pm) at his window of his workroom, which is up to 16 m above the zero marking at the Weserbrücke. The temperature values from 1814 are missing. We got the temperature values from different sources in the Olbers estate at SUUB.

We calculated the daily mean and analyzed the data in various plots. A very small trend towards cooling is apparent in the data which might be insignificant. But a clear seasonal trend was identifiable: the late winter and the early spring were becoming warmer, while the summer and early autumn became cooler. The average temperature in Bremen was 8.4°C at that time. Additionally we combined the newly discovered Wilhelm Olbers temperature data and the Heinemann and Bätjer data to see whether there are great differences between these two time series. Although the temperatures of Olbers are in general cooler than the Heinemann and Bätjer data they fit together. The data can be obtained from the data bank PANGAEA (Heinze *et al.* 2006, Heinemann 2006).

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References

Bätjer, D., und H.–J. Heinemann. Eineinhalb Jahrhunderte meteorologische Beobachtungen in Bremen. *Abh. Naturw. Verein Bremen*, 39:185–261, 1980.

Biegel, G., Oestmann, G., und K. Reich. *Neue Welten Wilhelm Olbers und die Naturwissenschaften um 1800.* Braunschweiger Landesmuseum, 2001.

Focke, W. Olbers. Beobachtungen über Lufttemperatur und Luftdruck, angestellt zu Bremen in den Jahren 1803 bis 1813, durch Dr. H. W. M. Olbers. *Abhandlungen herausg. v. naturwissenschaftlichen Verein zu Bremen*, II Band:141–154, 1871.

Focke, W. Olbers. Die Jahresmittel, Maxima und Minima aus den bisher in Bremen angestellten thermometrischen und barometrischen Beobachtungen. *Abhandlungen herausg. v. naturwissenschaftlichen Verein zu Bremen*, VII Band:367–374, 1882.

Heinemann, H.–J. Homogenisierung der Säkularreihe der Jahresmitteltemperaturen in Bremen. *Meteorologische Zeitschrift*, 3/1:35–38, 1994.

Heinemann, H.–J. Ein Beitrag zur Entwicklung des Klimas in den letzten Jahrzehnten des 20. Jahrhunderts. *Abh. Naturw. Verein Bremen*, 45/2:191–209, 2003.

Heinemann, H.-J. Monthly and yearly mean air temperature from 1829 to 2005 calculated from meteorological observations at different locations in Bremen, northern Germany [supplementary data to the reference given]. In *PANGAEA, doi:10.1594/PANGAEA.510837.* Deutscher Wetterdienst, Hamburg, 2006.

Heinze, B., Olbers, D., König-Langlo, G., Olbers H.W.M. (1758-1840). H.W.M. Olbers measurements of air temperature in Bremen from 1803 to 1822. In *PANGAEA, doi:10.1594/PANGAEA.494520.* Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, 2006.

Lüdecke, C. Die meteorologischen Untersuchungen des praktischen Arztes und Astromonem Wilhelm Olbers in Bremen zu Beginn des 19. Jahrhunderts. In Biegel, G. u.a., editor, *Neue Welten Wilhelm Olbers und die Naturwissenschaften um 1800*, pages 134–141. Braunschweiger Landesmuseum, 2001.

Müller, W. C. *Ausserordentliche Wärme und Kälte in den Sommern und Wintern seit fünfhundert Jahren, nach Bremer, Hamburger und Oldenburger Chroniken und mehreren anderweitigen Thermometerbeobachtungen seit 100 Jahren.* Carl Schünemann, 1823.

Olbers, Heinrich Wilhelm. Clima von Bremen. IV Ol 39, Staats– und Universitätsbibliothek Bremen.

Olbers, Heinrich Wilhelm. Temperaturmessungen, Barometerbeobachtungen. IV Ol 40, Staats– und Universitätsbibliothek Bremen.

Olbers, Heinrich Wilhelm. Über die Vorhersagung der Witterung. IV Ol 35, Staats– und Universitätsbibliothek Bremen.

Olbers, Heinrich Wilhelm. Über mein Thermometer. IV Ol 17, Staats– und Universitätsbibliothek Bremen.

Olbers, H.W.M. Über die mittlere Wärme in Bremen (1803–1813). *Astronom. Nachr.*, XXXI, 1851.