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The Lund instrumental record of air pressure 1780–1997

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0 Abstract

Long meteorological records are important means for understanding climate variability. In Lund, southern Sweden, meteorological instrument observations commenced in 1740, which makes it one of the longest records in Scandinavia. Observations of air temperature, air pressure, wind strength and direction, precipitation, cloudiness and general observations regarding the weather were made on a regular basis three times a day. Within the European project ADVICE, instrument readings of air pressure and air temperature have been digitised for the period 1780–1863 and the station history has been compiled. To construct a complete pressure record (1780–1997) modern data were also obtained from the WASA-project, the Swedish Meteorological Institute (SMHI) and from the nearby SYNOP station Falsterbo. Standard instrument corrections were applied to the record if uncorrected in the original data. By means of grid and interstation comparison we have reconstructed the monthly mean pressure for more than 200 years. This is a record without any major inhomogeneities containing more than 234 000 observations.

1 Introduction

In the 19th century, pressure observations from the emerging meteorological station networks began to be systematically organised to produce manually drawn synoptic maps showing the regional pressure pattern. This required consistent physical corrections of the barometric readings; for differences in barometer temperature and local gravitation and also, more difficultly, altitude. These pressure maps have been digitised and converted to gridded mean sea-level data that are included in various data sets. Observations from a sufficient number of stations must be available to allow calculation of reliable grid-point values. From the 1870's the station networks became widespread enough to allow for reconstruction of global pressure patterns that now are available form various data archives, e. g. the United Kingdom Meteorological Office (UKMO; global, 5 by 10 degrees, 1873–; Basnett & Parker, 1997) or from the National Center for Atmospheric Research (NCAR; northern hemisphere, 5 by 5 degrees, 1899–). Reconstructions extending further back in time are limited to regions with a dense coverage of instrumental data. Using long instrumental records Jones et al. (1987) reconstructed monthly grid-point pressure for Europe back to 1780. By including new station series – among others the Lunds air pressure record – this reconstruction has now been improved within the ADVICE (Annual to Decadal Variations In Climate In Europe) project (Jones et al., 1998).

The purpose here is to describe our work with the air pressure series of Lund. The paper is based on progress reports (Bärring & Jönsson, 1996, 1997a, 1997b) for three workshops held within the ADVICE project. We outline the construction of the air pressure data base, the compilation of the station history and describe the steps required to attain a homogeneous pressure record which has been included in the updated grid.

2 The Lund pressure record

The Lund (55°42'N, 13°12'E) record of regular instrument observations commenced already in 1740. It is thus one of the longest meteorological records in Sweden, and even in Europe. It is comprised of an almost unbroken record of observations two or three times a day. An early summary of the Lund record was carried out by Tidblom (1876), who presents descriptive summaries of various variables and a brief review of parts of the station history. Some of the information he presents regarding the station history and the observational procedures was provided personally by the observers in charge during the latter part of the Early Instrumental Period (EIP; 1780–1860). Otherwise, the EIP of the record has remained basically untouched until recent analyses of wind directions by Jönsson & Holmquist (1995) and Jönsson & Fortuniak (1995).

The very long and high-resolution series of pressure observations in Lund (1780–1997) is a composite from six different data sources (Table 1). Digitisation of data for the period 1780–1863 has been done within ADVICE (Bärring & Jönsson, 1996) and is treated in detail in Section 3. It was also necessary to digitise later periods where full observation resolution was lacking (Period no. 4 and no. 5 in Table 1). Furthermore, because a broken barometer was never replaced it was necessary to synthesise data by using pressure values from a nearby station (Falsterbo, 50 km SW of Lund) corrected to Lund pressure for the period after 1977 (and a short period in 1965; Period no. 6).

Table 1. Data sources for the Lund pressure series 1780–1997

Number in Fig. 2	Time period	Data source
1	1780 01 01–1863 12 31	Data digitised from the observation journals
2	1864 01 01–1878 12 31	Data from the Swedish Meteorological and Hydrological Institute (SMHI)
3	1879 01 01–1950 12 31	Data from WASA (Schmith et al., 1997)

4	1951 01 01–1959 06 30	Data digitised from SMHI Year Books
5	1959 07 01–1959 12 31	Data digitised from the original observation sheets
4	1960 01 01–1960 12 31	Digitised values from SMHI Year Books
3	1961 01 01–1965 02 10	Data from WASA (Schmith et al., 1997)
6	1965 02 11–1965 03 09	Data from the Falsterbo SYNOP station and adjusted to Lund average pressure
3	1965 03 09–1977 12 31	Data from WASA (Schmith et al., 1997)
6	1978 01 01–1997 05 31	Data from the Falsterbo SYNOP station and adjusted to Lund average pressure

2.1 The time prior to 1780

Daniel Menlös (professor in mathematics 1732–1743) pioneered systematic meteorological observations in 1740. As in many places, weather observations were conducted in parallel with the astronomical observations. Initially three observations were made each day, but not at fixed times. In 1743, N. Schenmark took responsibility of the observations. For unknown reasons there is a gap in the records from May 1746 to June 1747. After this gap, precipitation measurements by means of an "*ombrometer*" were added. In 1751, Schenmark was on an expedition to northern Sweden. He obviously brought the instruments with him because there is another gap in the record from February 1751 to September 1752. New instruments calibrated to those in Uppsala were installed in 1752. The Astronomical Observatory moved in 1753 to a newly built top floor in the "*Kungshuset*", which at that time was the only major building of the university. The building was surrounded by a garden to the north and a park, established in 1747, to the south. When Schenmark was appointed professor in 1763 O. Nenzelius became observer. During his period as observer successively better thermometers and barometers were procured. In 1775 Nenzelius was succeeded by A. Lidtgren and his assistant P. Tegman.

Little is known about the early instruments and their locations. Some scattered notes do however exist: In 1765 (and before), the thermometer was placed in a cupboard south of the Cathedral. The ombrometer was fixed to a fence (or wall) in the garden but in 1775 was placed on the terrace of the *Kungshuset*. After a severe snow storm in December 1779 the barometer was moved from the church wall to the upper room in the Observatory in *Kungshuset* (61 m above sea level). Earlier the same year, the thermometer had also been moved to the upper room.

2.2 The early instrumental period (EIP 1780–1860)

In the beginning of the EIP the following observations were routinely carried out:

- air pressure (barometer graded in Swedish inches (1 Sw. inch = 29.69 mm);
- temperature;
- wind strength on a scale 0–4;

- wind direction (16 directions);
- precipitation (*ombrometer*; measurement unit is "*pariser-linie*" = 2.26 mm) and
- cloudiness and general observations regarding the weather situation.

Generally, three observations were made each day. The times of observations are noted in the records, but not fixed to specific clock hours until 1850. During some periods the observation frequency may be less intense (Figure 1).

During the EIP the instruments were moved several times, often prompted by the appointment of new observers or renovations of the *Kungshuset.* In all, the Lund record during EIP involves 24 instrument relocations between 10 different places.

In 1800–1801 a building was erected east of the *Kungshuset* and in 1802 the trees in the surrounding park were cut down to 3–4 meters above the ground. Subsequent cuttings were made several times during the 1800’s but none as radically as in 1802. Due to renovations and other circumstances, the instruments could not be kept in the upper room of the Observatory, which most probably remained unheated until the 1830’s. All movements that will be mentioned below are inside the small city centre (within a radius of about 200 m from the *Kungshuset*), and an altitude span of about 25 metres. The instruments were moved several times in 1804. The barometer was moved outdoors to *Sylwans gård* in April. For a few months, beginning in July, the instruments were located in (or just outside) the ground floor of the *Kungshuset*. In October 1804 the barometer was moved to the nearby *Someliusgården.*

Meta-data from primary sources are rather scarce during the period 1805–1821. Probably the instruments were relocated to the upper room in the Observatory before, or by the time J. Brag became observer in 1806 after a short period of C. A. Tiliander. Brag held this position until 1813 (but he was involved in the meteorological observations until the beginning of the 1830’s). During that period the instruments were most probably kept in the upper room of the Observatory. By the time A. F. Knieberg became observer in 1813 (–1821), the instruments were, according to Tidblom (1876) also located at his home on the street *Mårtensgatan,* but this has not been confirmed. Thus, the location of the instruments is uncertain during this period, but it is a fair assumption that the instruments were placed in the upper room of *Kungshuset*.

From the beginning of 1821 C. F. Danielsson Hill made the observations and it is postulated that he kept the instruments permanently in the upper room in the Observatory, except when they were located at *Lundvalls gård* between February and June 1822. In the following years the instruments had several different locations in the vicinity of the *Kungshuset* besides the upper room in the Observatory: in September 1824 at *Lundstens gård* (and in January 1825), at *Lundbergs gård* (June 1825–August 1826). During Hill’s absence (1827–1828), the observations were carried out by assistants Rosenschöld, Gräs and Berlin. In February 1828, the barometer was moved to *Sjöströms gård* a building commonly known as "*No. 21*", (with a short intermission in the upper room of the Observatory in July 1828) and back again to the upper room at the *Kungshuset* for two months in 1829 and then in October 1829 the instruments were most probably moved to Hill’s residence in *Lundbergs gård*.

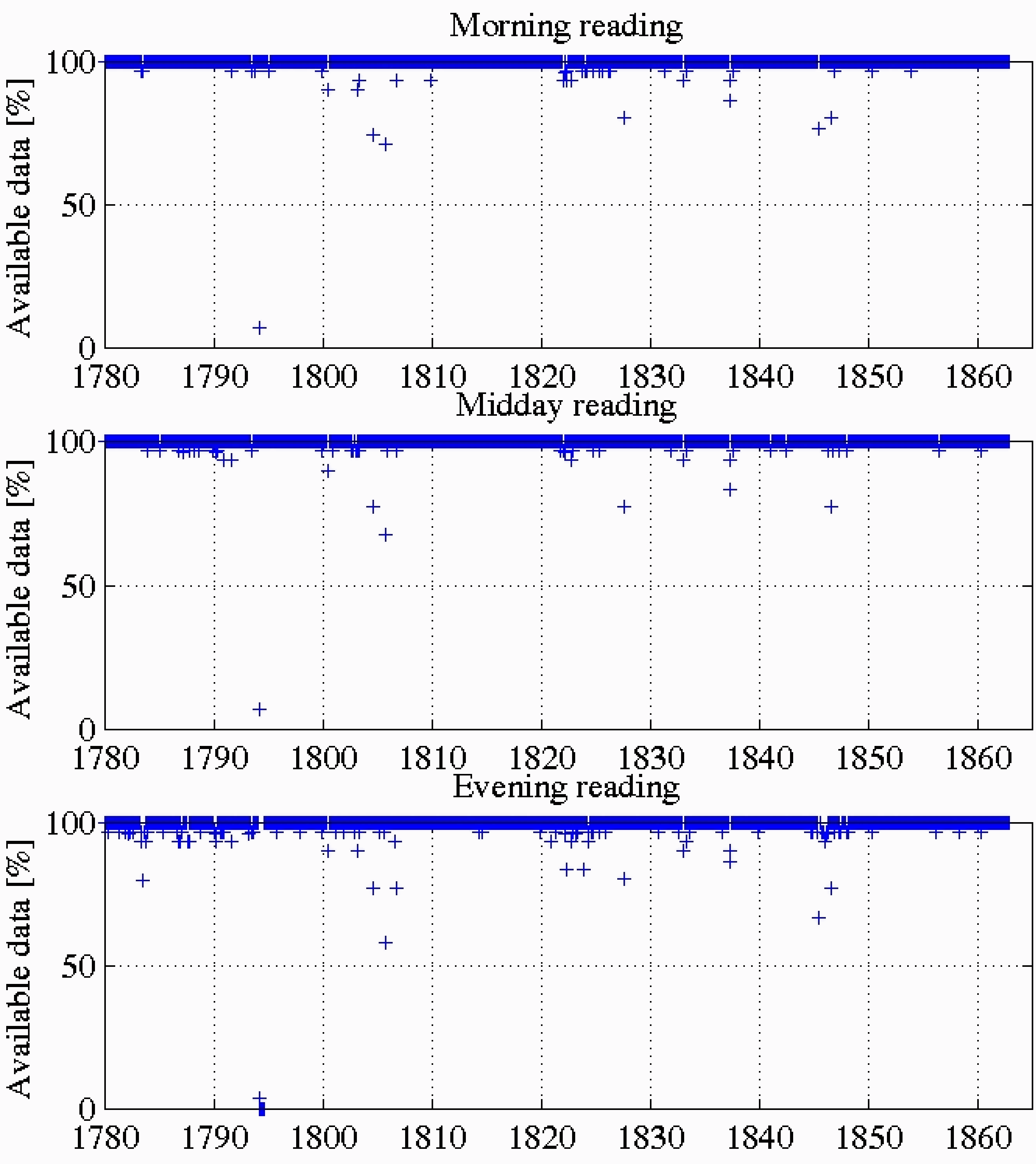

Figure 1. Percentage of observations available for each month during the period 1780 to 1863.

A. W. Ekelund (observer 1833–1840), brought the instruments to his various residences: first to *Someliusgården* in June 1833 and then to the upper room of *Thomanders gård* in October 1833 and further on to *Benets gård* in February 1834 and then back again to the upper room in *Someliusgården* (July 1835). In 1834, the old thermometer was replaced by a new one. Starting in 1835, the temperature of the barometer is noted in the written records for the first time, even though there was a thermometer by the barometer already at the beginning of the EIP.

The next time any location of the instruments is documented is in 1846. At this time the instruments are once again located in the *Kungshuset* by a window facing east (and a thermometer outside) on the ground floor, probably since J. M. Agardh became new observer in 1840. During his absence, from 1843 and onwards, Ahlander took over the observation duties. Probably, a new barometer (graded in mm Hg) was used since 1842, with an intervening period when the old one, graded in Swedish inches, was used 1846–1849. The instruments stayed on the ground floor in the *Kungshuset* until Blomstrand took over the responsibility of the observations in January 1848. He most probably moved the instruments to the nearby *No. 21* where they stayed until March 1849 when they were again moved back to the ground floor in the *Kungshuset*. In 1850 the *castellan* (warden) of the Observatory became responsible for the meteorological observations. The last relocation during EIP was made in December 1851 when the instruments were moved back to *No. 21* where they were placed in a shed and Ljunggren and others being the observers from 1858. The instruments were situated there until August 1867 when they moved to the newly built Astronomical Observatory (outside the city centre) where they were kept for the following 90 years. An overview is given in Table 2 concerning the altitudes of the instrument locations sites.

Table 2. Altitudes of the barometer in Lund 1780–1860.

From	To	Altitude (m)	From	To	Altitude (m)
1780 01 01	1804 04 03	61	1828 02 26	1828 07 12	46
1804 04 04	1804 07 05	44	1828 07 13	1828 07 30	61
1804 07 12	1804 10 19	47	1828 07 31	1829 08 14	46
1804 10 20	1805 12 31	44	1829 08 15	1829 10 12	61
1806 01 01	1822 02 14	61	1829 10 13	1833 06 23	39
1822 02 14	1822 06 28	34	1833 06 24	1833 10 15	47
1822 06 29	1824 09 09	61	1833 10 16	1834 02 03	51
1824 09 09	1824 09 10	49	1834 02 04	1835 07 07	39
1824 09 11	1825 01 10	61	1835 07 08	1847 12 31	47
1825 01 11	1825 01 26	39	1848 01 01	1849 02 28	46
1825 01 27	1825 06 28	61	1849 03 01	1851 11 30	47
1825 06 29	1826 08 07	39	1851 12 01	1860 12 31	46
1826 08 08	1828 02 25	61			

3 Data base compilation 1780–1863

This section deals with the building of the air pressure data base. In order to obtain a corrected pressure series five consecutive working steps were carried out. Special care was applied to physical based corrections (i.e. reduction to temperature, standard gravity and altitude).

3.1 Building a data base of the Lund record of instrumental observations

The original hand-written documents are divided into three series; *Observationsjournaler* (observation records) *Conceptobservationer* (manuscript records) and *Dubletter* (duplicate records) that have been collected together into tomes covering various periods. The records are archived at the Lund University Library, Dept. of Manuscripts and Special Collections.

The work of developing a data set of high quality out of these records has been divided into the following steps:

1) Document inventory;

2) Microfilming, photocopying and data entry;

3) Basic data base controls and unit conversions;

4) Meta-data compilation.

1) Document inventory

Because the hand-written records were divided into three overlapping series, the first step was to carry out a detailed inventory of the information available in each series. Based on this inventory we decided which tomes to microfilm and photocopy. During this inventory numerous comments regarding the instrument status, their calibration, location and so on were found. This information was fed into the meta-data collection.

2) Microfilming, photocopying and data entry

The original documents were microfilmed and the microfilms were photocopied to approximately original size. The photocopies were used for entering the data into a data base system (Microsoft Access).

3) Basic data base controls and unit conversions

This step involved various basic controls of the raw data base, for example:

- ensure that all data has been entered, and that it has not been entered more than once;
- identify and correct gross typing errors by inspection in data file of extreme values as shown in plots;
- carry out appropriate conversions to hPa and °C from the original units;
- check pressure differences larger than 15 hPa between two successive observations and

where applicable also correct for several erroneous entries in the original observation records;

- check the correctness of the entered temperature units (°R and °C) by inspection of plots of mean July midday temperatures versus its standard deviation.

4) Meta-data compilation

In parallel with the work on the observations, the station history of Lund has been compiled from various primary sources (the observation records, other original documents and old maps) and secondary ones (historical accounts of scientific activities at the Lund University; mainly Tidblom, 1876, and Schalén *et al*., 1968). Movements of the instruments, changes of instruments or observers and general descriptions of the instrument site and its surroundings were tracked down as precisely as possible. All meta-data were collected in a data base (Microsoft Access).

The pressure observations are promising since few barometer substitutions have been made during the EIP (one or possibly two are documented) and the record is almost complete. Figure 1 gives an overview of the percentage of available observations per month. The nature of barometer readings makes them rather insensitive to relocation; if the height and temperature of the barometer are known accurate figures can be obtained. Precise information about the location and quality of the thermometers is not at hand for the entire period, which makes the reconstruction of the temperature series more difficult because of change of instruments and the possibility of mixed indoor/outdoor readings together with a less intensive observation frequency (compared to the barometer readings).

3.2 Physical corrections

In Lund, corrections for the barometer temperature were not done during the period 1780 to 1840. From 1835 onwards the barometer temperature is available but it was not until 1840 that the temperature correction of the pressure readings was carried out. That is, the temperature reduction had to be done on all observations prior to 1840. For the period 1780 to 1840 the indoor temperature had to be estimated. This was achieved by filtering the outdoor temperature data series using an exponential filter with a lag of 21 observations (7 days) to mimic the thermal inertia of the thick brick walls of the unheated part of the buildings where the barometer was housed.

The following straightforward equation was used:

$$P_0 = (1 - \tau\, T_B)\, P$$

where:

P_0 = temperature corrected pressure (hPa)

P = observed pressure (hPa)

τ = the thermal expansion coefficient (0.0002173 hPa °C^{-1})

T_B = temperature of the barometer (°C)

Furthermore, the temperature corrections carried out between August 21, 1846 and February 11, 1849 were erroneous because an old barometer (graded in Swedish decimal inch and °R) was used, while the correction table was for a newer barometer (graded in mm Hg and °C). Thus, the temperature correction had to be recalculated. To rectify this error we inverted the temperature correction the observers did and then applied it again with the correct units. This results in the following equation for the temperature correction:

$$P_0 = (1 - \tau T_B) / (1 - c \tau d T_B) P$$

where:

c = conversion factor from hPa to Swedish decimal inches (0.025263)

d = conversion factor from °C to °R (0.8)

Next, the temperature corrected pressure reading P_0 should be corrected to standard gravity according to the following equation:

$$P_{STN} = (g_{Lund}/g) P_0$$

where:

P_{STN} = the temperature and gravity corrected pressure

g = the standard gravity (9.80665 ms^{-2})

g_{Lund} = the gravity at the latitude of Lund (9.81574 ms^{-2})

The height of each instrument site has been identified (Table 2) in order to carry out the corrections of barometer readings to sea level pressure (P_{MSL}) calculated by:

$$P_{MSL} = P_{STN} [1 + (gH)/(RT)]$$

where:

P_{STN} = temperature and gravity corrected pressure

H = height of the station above sea level (Table 2)

R = gas constant for air (287.04 J kg^{-1} K^{-1})

T = outdoor temperature (K) for each observation on the barometer

With these physical corrections the digitised pressure record is compatible with modern pressure data (1860–onwards). This composite pressure series corresponds to data set "A" in Figure 2.

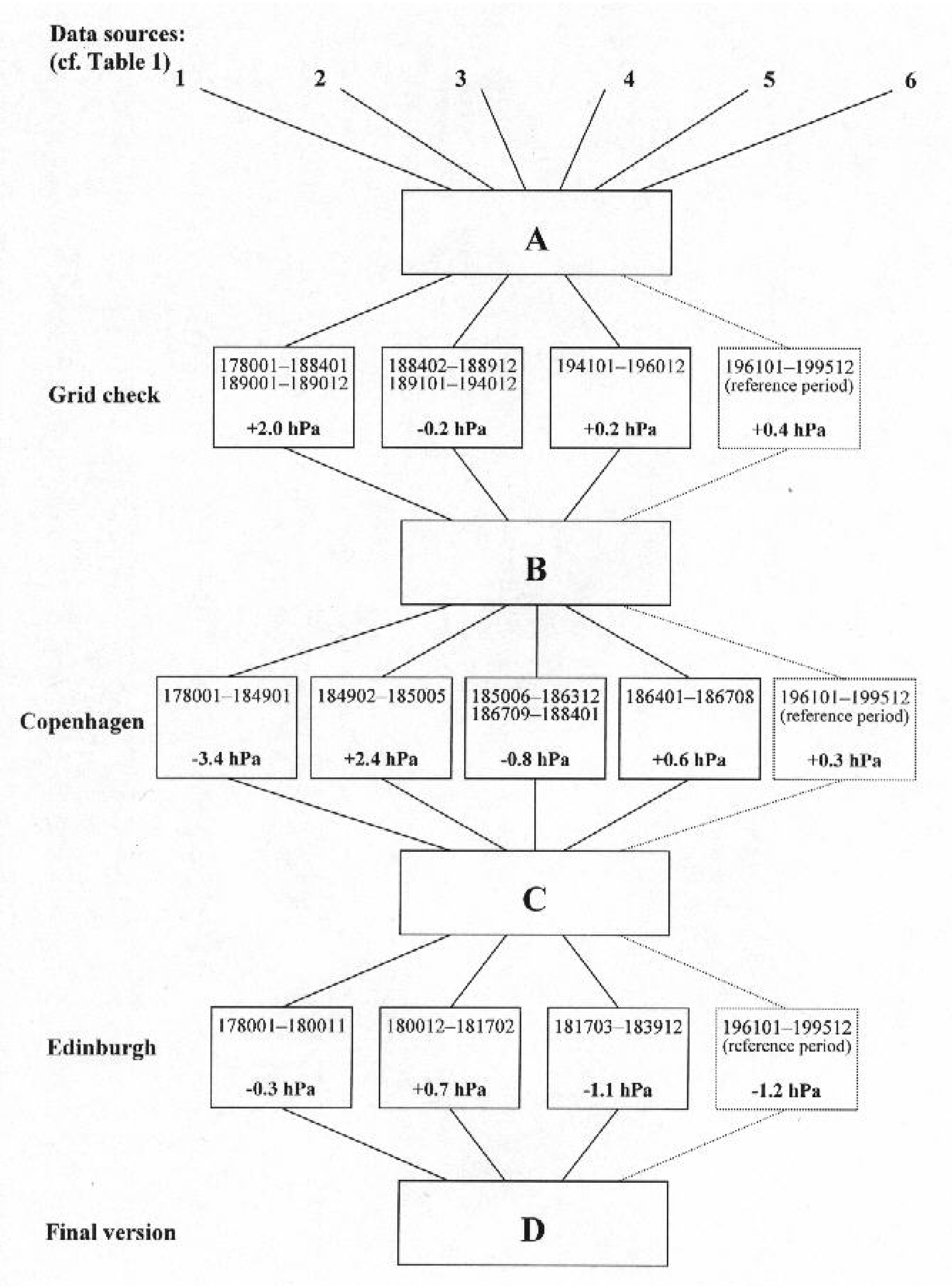

Figure 2. Flow chart of the grid and interstation correction procedure of the Lund pressure series. Numbers 1–6 refer to the different data sources (Table 1), and letters A–D refer to the different data sets which are parallel to the homogenisation steps. Small boxes show the beginning and end (year and month) of a correction period (top); homogenisation constants (annual averages) are at the bottom.

4 Homogenisation

4.1 Grid data comparison and homogenisation

Comparison of the observation data (data set "A") with the UKMO gridded database was done for the period 1873–1995 (although uncertainties about the data quality of the early UKMO-grid gives 1881 as a more reliable first year). Monthly station values for Lund were estimated by a weighted average of the four surrounding grid-points. The "A" series was then subtracted from the new series estimated from the UKMO grid. An annual average difference of +0.4 hPa (that is, "A" having lower values) was recorded for the reference period (1961–1995) although the individual months differed between +0.1 and +0.6 hPa. These are the reference pressure differences between the observed series and the grid series that should be consistent throughout the whole comparison period.

Three periods deviated from the reference pressure differences and were corrected for on a monthly basis. The final correction constants were obtained by smoothing the individual monthly corrections to exclude abrupt jumps. The final monthly correction constants were added to series "A" thus creating the new data series "B". The average annual corrections for the three periods leading up to data set "B" are shown in Figure 2. The corrections for the earliest period, 187301–188401, were applied all the way back to 1780. A visual comparison of monthly plots of series "B" and the grid-estimated station series gave satisfactory results.

4.2 Interstation comparison and homogenisation

Copenhagen (1842–) and Edinburgh (1770–) were chosen among the stations with long pressure records and acknowledged homogeneity (monthly data were provided by Climatic Research Unit, CRU, at the University of East Anglia). St. Petersburg (1822–) and Paris (1764–) were occasionally used to confirm the Lund–Edinburgh interstation comparison. However, the seasonal co-variation between Lund and these two stations were hard to interpret and they could therefore not be used as firm quantitative alternatives to Edinburgh.

4.3 Copenhagen

Copenhagen is an obvious station because of the proximity (30 km W) to Lund. The parallel series allows comparison back to 1842.

The annual cycle of differences between the stations during the reference period (1961–1995) was calculated; the annual average difference Copenhagen minus Lund amounted to +0.3 hPa and the monthly differences ranged between ± 0.0 hPa to +0.6 hPa. Four periods with deviating differences compared to the reference period were detected and corrected for (Figure 1) on a smoothed monthly basis. Correction constants for the first period (184301–184902) were extended back to 1780. The very first year, 1842, resisted to fit with the Copenhagen series. A new data set (series "C" in Figure 1) was created from these corrections of series "B" and finally checked again with the Copenhagen series to ensure that the corrections were properly conducted.

Station history and differing data sources can explain these four separate correction periods. On August 11, 1867 the barometer was moved together with the other instruments to the newly erected Astronomical Observatory. This is a likely reason for the jump in the pressure series during this month. The period for which data was digitised by us ends at the turn of the year

1863; different data sources may be responsible for this break. On May 20, 1850 there are some unclear notes about the barometer in the observation journal (coinciding with an abrupt change in the comparison with Copenhagen). Probably the barometer was substituted or cleaned at that time because the evening observation on May 20 and the morning observation on May 21 are missing. The next detected deviation coincides with the substitution of barometers (mentioned in the section *Physical corrections*) which was done on February 12 1849, when the old barometer graded in Swedish inches was again replaced with a new one graded in mm.

4.4 Edinburgh

Few pressure records exist for the early part of the EIP; the record from Edinburgh was after all the best one suited for interstation comparison for the period before 1842.

Edinburgh is situated almost 1 000 km W of Lund. Because of the distance, the pressure difference between the two stations during the reference period (1961–1995) is also rather large: the annual average difference is -1.2 hPa, where Lund has the higher annual average. The seasonal variation of the difference is quite large as well: -3.6 hPa– +1.3 hPa. With the objective to keep these differences during the reference period valid, also for the hitherto uncorrected part of the EIP (the period 1780–1842), three periods showed up as deviating (Figure 1). These three periods were corrected for on a monthly basis using the same smoothing technique as applied before in the grid and Copenhagen comparisons. Still, 1842 did not fall into a reasonable pattern. Neither did the two preceding years, which we were not able to correct for, probably due to erroneous corrections for temperature made in Lund during this period. Since the manuscript records (the originals to the observation journals) could not be found for the period in question, these three years seem to be lost. Thus missing data have to be accepted for the period 1840–1842 (see Table 3). The homogenisation constants were added to data set "C" in Figure 1 creating a new set (series "D"). This data series was visually compared with the Edinburgh series and accepted, thus giving data set "D" status as the final one.

In the station history the support for the three periods is very meagre. Only the first jump, on December 12, 1800, is weakly supported as a missing observation, which has been interpreted as the first break-point. Whether it is due to a barometer substitution, cleaning or (more unlikely) movement is not revealed in the original observation journal. The jump in 1817 is not found at all in the station history, but it is corroborated in a comparison with the Paris record. Since it was not possible to pin-point the exact date, the break-point is assigned to the turn of the months February-March 1817.

5 Test of homogeneity

The Standard Normal Homogeneity Test (Alexandersson, 1986; Alexandersson & Moberg, 1997) of the Lund pressure series (series "D" in Figure 2) was performed using a MS-Windows based program (Steffensen, 1996) to detect single or double breaks, or trend sections where Copenhagen and Edinburgh act as reference series. Omitting detected inhomogeneities very near the beginning and end of the series, the only possible inhomogeneity, a single break-point (t-value 15.9; critical t-value 13.3 for α =97.5 %), was detected in spring 1821 (the other seasons are without significant (α <90%) breaks for this particular time). Since neither a physical explanation nor any support in the station history were at hand, together with the fact that only one season was affected, we judge this indication of a break-point as less reliable. Thus, no further corrections were performed on the Lund pressure series "D".

6 The Lund pressure series 1780–1997

The final version of the very long series of pressure observations (more than 230,000 observations) in Lund is almost unbroken on a monthly basis. Missing monthly averages (a total of 40), where the observations are either totally lacking or too few to calculate a reasonable monthly average, are as follows: February 1794; January 1840 – December 1842; June and July 1874; and May 1980. The three complete years in the 1840's were discarded because of inconsistent data, probably owing to erroneous temperature corrections during that time period (which became evident in the interstation comparison). The final version is shown as annual pressure averages in Figure 3; the year 1820 having the highest value and 1836 the lowest value.

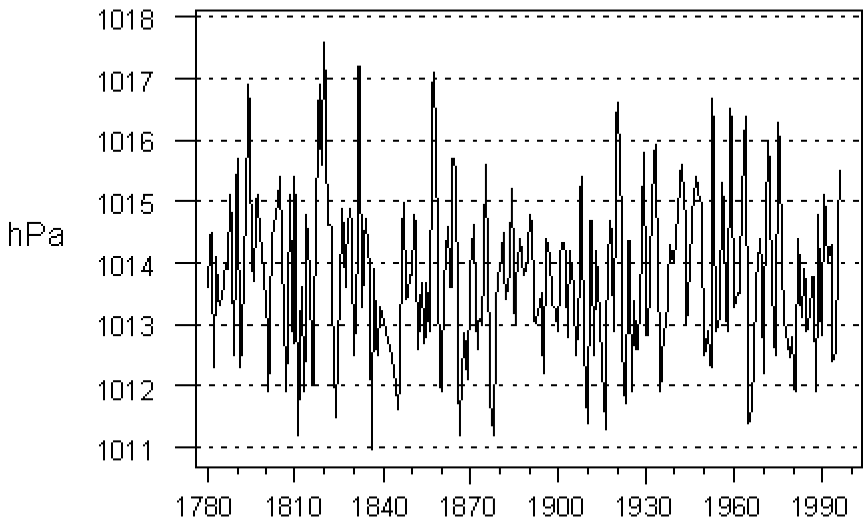

Figure 3. The annual mean pressure in Lund 1780–1997.

Monthly homogenisation totals (the sum of the correction constants given by all grid and interstation comparisons) are presented in Table 3. For each period the table shows how large the homogenisation constant was between data set "A" and "D" in Figure 2.

Table 3. Monthly homogenisation constants. Column "Ann" is the annual average.

Start date	End date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
1780 01 01	1800 12 12	-1.9	-2.1	-2.0	-1.7	-1.5	-1.6	-1.6	-1.6	-1.3	-1.5	-1.8	-2.0	-1.7
1800 12 13	1817 02 28	-1.5	-1.5	-1.2	-0.7	-0.2	0.0	0.2	0.0	0.0	-0.5	-1.2	-1.7	-0.7
1817 03 01	1839 12 31	-3.1	-3.0	-2.7	-2.1	-1.7	-1.8	-1.8	-2.0	-2.2	-2.4	-3.2	-3.7	-2.5
1840 01 01	1842 12 31	*	*	*	*	*	*	*	*	*	*	*	*	*

1843 01 01	1849 02 11	-1.6	-1.8	-1.7	-1.4	-1.2	-1.3	-1.3	-1.3	-1.0	-1.2	-1.5	-1.7	-1.4
1849 02 12	1850 05 20	4.2	3.9	4.1	4.2	4.3	4.4	4.7	4.8	5.0	4.8	4.5	4.2	4.4
1850 05 21	1863 12 31	1.1	0.9	0.9	1.2	1.4	1.3	1.3	1.4	1.4	1.3	1.1	1.0	1.2
1864 01 01	1867 08 11	2.5	2.4	2.4	2.5	2.6	2.6	2.6	2.6	2.8	2.8	2.6	2.4	2.6
1867 08 12	1884 01 31	1.1	0.9	0.9	1.2	1.4	1.3	1.3	1.4	1.4	1.3	1.1	1.0	1.2
1884 02 01	1889 12 31	-0.5	-0.8	-0.7	-0.4	-0.2	0.0	0.1	0.2	0.2	0.0	-0.2	-0.3	-0.2
1890 01 01	1890 12 31	2.0	1.7	1.6	1.7	1.9	1.9	2.1	2.2	2.4	2.4	2.2	2.0	2.0
1891 01 01	1940 12 31	-0.5	-0.8	-0.7	-0.4	-0.2	0.0	0.1	0.2	0.2	0.0	-0.2	-0.3	-0.2
1941 01 01	1960 12 31	0.1	-0.2	-0.1	0.0	0.1	0.2	0.2	0.3	0.5	0.4	0.2	0.2	0.2
1961 01 01	1997 05 31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

7 Conclusions

We have described here the final steps in creating a homogeneous data series of the pressure observations in Lund. The series covers the period January 1780 to June 1997 and is a compilation of data from different sources (cf. Table 1). The observations were carried out three times per day and the record is almost complete: 234,070 observations out of 238,227 observations were available and accepted, i.e. more than 98 %. The major remaining gap is the period 1840–1842 where the observations are available but not consistent.

Relocations and other alterations to the Lund station produce several inhomogeneities in the observation series. But documentation of the station history enables us to compensate for most of these inhomogeneities by applying standard barometer corrections to the individual observations. The remaining inhomogeneities were adjusted for in the homogenisation procedure where gridded data together with station records for Copenhagen and Edinburgh were used as homogeneous reference series. A statistical test for homogeneity (SNHT) indicated that no major inhomogeneities are present in the final version.

In studies of atmospheric processes underlying climate fluctuations in northern Europe the very long series of pressure data from Lund will be an important source of information covering the last 200+ years. The daily data will serve as an important tool for analysing atmospheric events with a rather short persistence, such as the frequency of cyclone passages over southern Scandinavia. Such a long unbroken pressure series as this will also be a quite useful reference when compiling and analysing shorter records.

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