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Technical Report 10-06

DMI Daily Climate Data Collection 1873-2009, Denmark, The Faroe Islands and Greenland

- including Air Pressure Observations 1874-2009 (WASA Data Sets)

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Colophon

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Front Page:
The setting sun illuminates a cumulonimbus cloud. Photo: Hans Chr. Kalberg Olrik Thoft.

Content:

Abstract

This report contains the available long daily DMI data series 1873-2009 for Denmark and Greenland. Air Pressure Observations 1874-2009 (WASA Data Sets) from five stations in Denmark, The Faroe Islands and Greenland are included.

Resumé

Denne rapport indeholder tilgængelige lange daglige serier af data 1873-2009 for Danmark og Grønland. Observationer af lufttryk 1874-2009 (WASA data) fra fem stationer i Danmark, på Færøerne og i Grønland er inkluderet.

1. Introduction

The purpose of this report is to publish available long *daily* DMI data series 1873-2009 for Denmark and Greenland. The data parameters include minimum and maximum temperature, mean sea level air pressure, precipitation and cloud cover. Additionally mean sea level air pressure observations 1874-2009 from five stations in Denmark, The Faroe Islands and Greenland are published.

According to the intensions to update regularly, preferably every year, this particular report contains an update (2009 data) of the "DMI Daily Climate Data Collection" for the first time published in that form in DMI Technical Report 04-03 (Vaarby Laursen., 2004). A similar collection of long DMI *monthly* and *annual* climate data series can be found in DMI Technical Reports 10-05 and 10-04 (Cappelen (ed), 2010 and Cappelen, 2010). The five WASA data sets are updated versions of the Danish series originally published in DMI technical Report 97-3 (Schmidt et al., 1997).

The digitisation of a great part of the data of this report and also much of the station history presented are results of various projects. The WASA project[1], the ACCORD[2] project, the NACD[3] project and the Danish CD-ROM "Vejr & Vind"[4] have all contributed regarding the data from Denmark together with a digitisation during spring 1999 funded by the Danish Climate Centre, situated at the DMI. The old daily series of maximum temperature, minimum temperature and precipitation from 34360 Tasiilaq on the east coast of Greenland were digitised thanks to KVUG[5].

Climate change studies and the related analysis of observed climatic data call for long time series of daily climate data. In this context the report also serves as the DMI contribution of daily values to the European Climate Assessment & Dataset (ECA&D)[6]. ECA&D was initiated by the European Climate Support Network (ECSN[7]) and is a project within the Network of European Meteorological Services (EUMETNET[8]).

Please note that the digitisation of the observations only can be considered as the first step towards sensible utilisation of the observations for climate change studies. Next follows testing for homogeneity of the series, ensuring that any discovered trend are natural. Thus it must be stressed that the series presented here mostly consist of the values *as observed*, and that no testing for homogeneity has been performed on these daily observations. They are therefore not necessarily homogenized as such, and the report description of each series should therefore be read carefully before applying the data series for climate research purposes.

For the benefit of scientists that may wish to conduct such testing various metadata together with homogeneity test results on relevant series of *monthly* data as well as the results and remarks concerning observational pressure data have been included in the report. For supplementary metadata see also DMI Technical Report 03-24 (Laursen, 2003).

This report (pdf-format) and the matching data set can be downloaded from the publication part of DMI web pages. March 2009, John Cappelen

[1] WASA: 'The impact of storms on waves and surges: Changing climate in the past 100 years and perpectives for the future'. See (Schmith et al. 1997).
[2] EU project number ENV-4-CT97-0530: Atmospheric Circulation Classification and Regional Downscaling.
[3] EU project number EV5V CT93-0277: North Atlantic Climatological Dataset. See (Frich et al. 1996).
[4] Vejr & Vind. CD-ROM. Munksgaard Multimedia, Copenhagen 1997.
[5] The Commission for Scientific Research in Greenland: 'Kommissionen for Videnskabelige Undersøgelser i Grønland'
[6] Project homepage: http://eca.knmi.nl/
[7] http://www.eumetnet.eu/contecsn.html
[8] http://www.eumetnet.eu.org/

2. Data overview

2.1 Danish stations

As concerns Denmark this report contain daily precipitation, temperature, cloud cover and air pressure data from seven sites as shown on the two maps, figure 2.1 and figure 2.2.

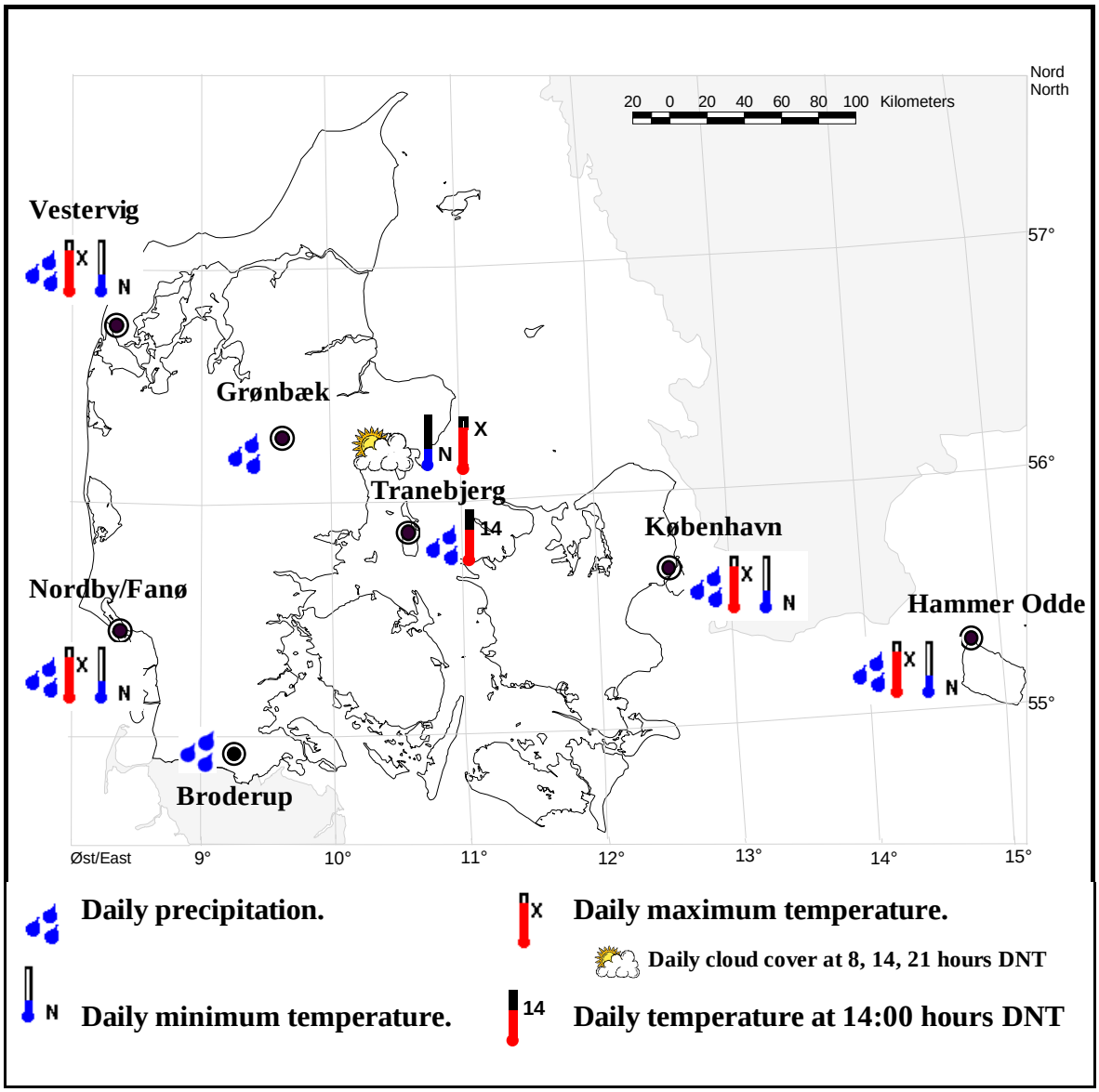

Figure 2.1. The seven Danish sites with digitised daily precipitation, temperature and/or cloud cover observations, 1874-2009. The stations representing each site are listed in the tables 3.1 – 3.5. For station co-ordinates confer with the station position file in the data files included. DNT refers to Danish normal time, which is the time in a given time zone in contrast to summer time, where 1 hour is added. In Denmark the normal time is UTC+1.

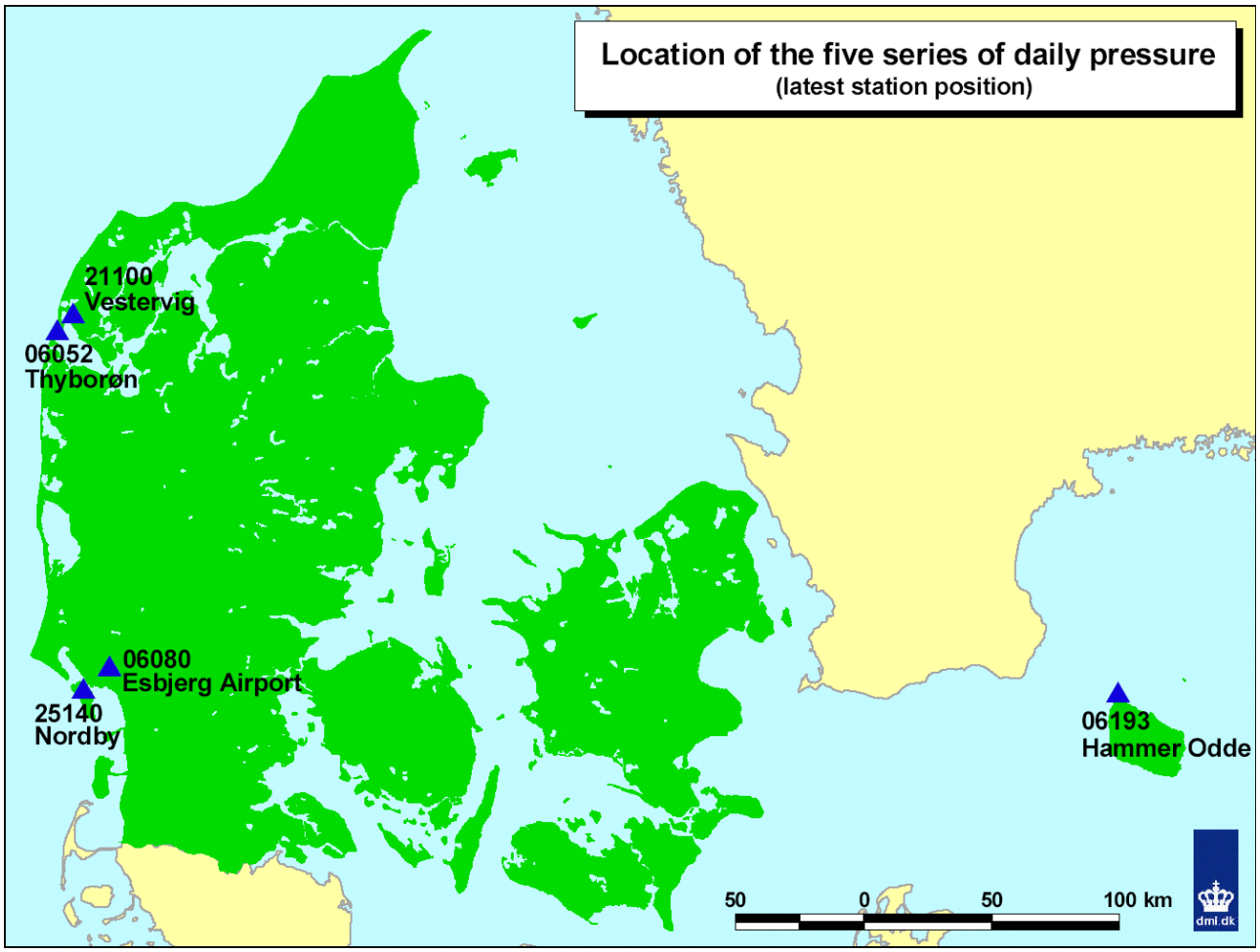

Figure 2.2. Location of the five series of daily air pressure. Together the five series cover three sites with data 1874-2009. The stations representing each site are listed in the table 3.6. For station co-ordinates confer with the station position file in the data files included.

2.2 Greenland stations

As concerns Greenland daily precipitation and temperature from two sites as shown on the map can be found in this publication, figure 2.3.

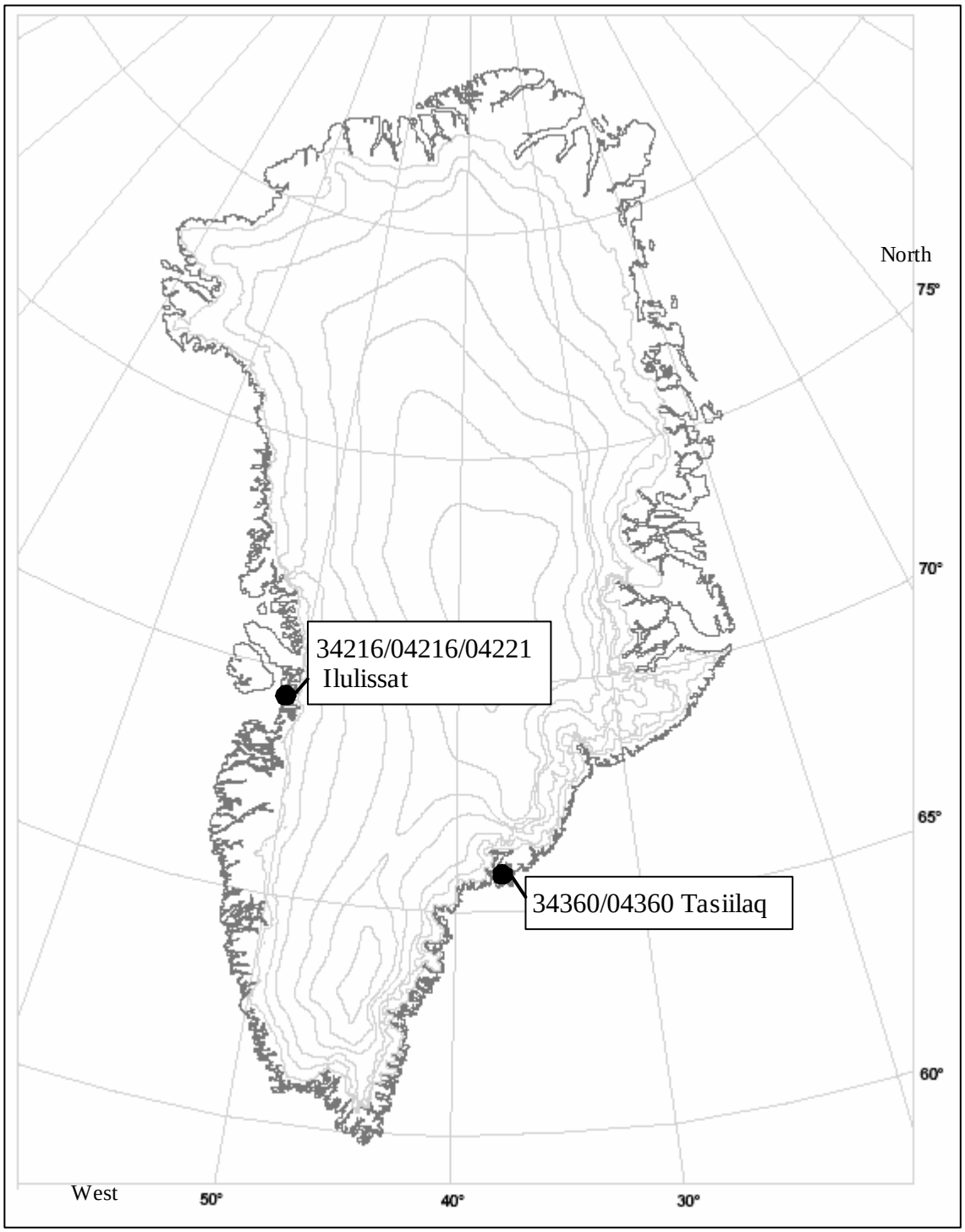

Figure 2.3. The location of the two Greenlandic sites with long daily data series: Ilulissat (formerly: Jacobshavn) on the West Coast and Tasiilaq (formerly: Angmagssalik) on the East Coast, 1873-2009. The stations representing each site are listed in the tables 4.1 – 4.3. For station co-ordinates confer with the station position file in the data files included.

3. Description of the data series - Denmark

3.1 Precipitation

Seven Danish sites have long series of daily precipitation. Table 3.1 presents an overview of the station data series (identified by the station name and number) making up the long series. Overlap periods have been included when available.

Site and period	Station	Start	End
Vestervig **1874-2009**	21100 Vestervig	1 January 1874	31 December 2009
Grønbæk **1874-2009**	21430 Grønbæk/ Allingskovgård	1 September 1874	31 December 2009
Nordby/Fanø **1874-2009**	25140/06088 Nordby	1 January 1874	31 December 2009
Broderup **1920-2009**	26410 Broderup/Bajstrup/ Gårdeby/Rødebæk/ Broderup Mark 26409 Tinglev 26400 Store Jyndevad	1 July 1920 1 June 1995 1 July 1987	30 June 1993 31 December 2006 31 December 2009
Tranebjerg **1872-2009**	27080 Tranebjerg 27082 Tranebjerg Øst	1 December 1872 02 August 2001	01 August 2001 31 December 2009
København **1874-2009**	30380 Landbohøjskolen 30210 Meteorologisk Institut 30210 Meteorologisk Institut 30370 Botanisk Have	1 January 1874 1 January 1875 1 January 1961 1 January 1961	1 October 1996 30 June 1922 31 December 1984 31 December 2009
Hammer Odde **1874-2009**	32030 Sandvig 32020 Hammer Odde Fyr 06193 Hammer Odde Fyr	1 January 1874 1 January 1961 1 January 1984	31 December 1970 30 June 1987 31 December 2009

Table 3.1. The Danish series of daily precipitation.

3.2 Minimum temperature

Five Danish sites have long series of daily minimum temperature. Table 3.2 presents an overview of the station data series (identified by the station name and number) making up the long series. Overlap periods have been included when available.

Site and period	Station	Start	End
Vestervig **1874-2009**	21100 Vestervig 06051 Vestervig	19 June 1874 02 October 2003	10 September 2003 31 December 2009
Nordby/Fanø **1874-2009**	25140 Nordby 06088 Nordby	1 May 1874 25 July 2003	18 July 2003 31 December 2009
Tranebjerg **1872-2009**	27080 Tranebjerg 06132 Tranebjerg	1 December 1872 21 August 2003	10 August 2003 31 December 2009
København **1874-2009**	30380 Landbohøjskolen 06186 Landbohøjskolen	1 January 1874 1 December 1995	30 June 1997 31 December 2009
Hammer Odde **1874-2009**	32030 Sandvig 32020 Hammer Odde Fyr 06193 Hammer Odde Fyr	1 January 1874 1 January 1971 1 January 1984	31 December 1970 24 June 1987 31 December 2009

Table 3.2. The Danish series of daily minimum temperature.

3.3 Maximum temperature

Five Danish sites have long series of daily maximum temperature. Table 3.3 presents an overview of the station data series (identified by the station name and number) making up the long series. Overlap periods have been included when available.

Site and period	Station	Start	End
Vestervig **1874-2009**	21100 Vestervig 06051 Vestervig	2 August 1874 02 October 2003	10 September 2003 31 December 2009
Nordby/Fanø **1874-2009**	25140 Nordby 06088 Nordby	2 May 1874 25 July 2003	18 July 2003 31 December 2009
Tranebjerg **1873-2009**	27080 Tranebjerg 06132 Tranebjerg	1 January 1873 21 August 2003	10 August 2003 31 December 2009
København **1874-2009**	30380 Landbohøjskolen 06186 Landbohøjskolen	1 January 1874 1 December 1995	30 June 1997 31 December 2009
Hammer Odde **1874-2009**	32030 Sandvig 32020 Hammer Odde Fyr 06193 Hammer Odde Fyr	2 April 1874 1 January 1971 1 January 1984	31 December 1970 24 June 1987 31 December 2009

Table 3.3. The Danish series of daily maximum temperature.

3.4 Air temperature at 14 hours DNT or 12 UTC

One Danish site has a long series of air temperature measured at 14 hours DNT (old part of the series) or 12 UTC (= 13 hours DNT, newer part of the series). Table 3.4 presents an overview of the station data series (identified by the station name and number) making up the long series. Overlap periods have been included when available.

Site and period	Station	Start	End
Tranebjerg 1872-2009	27080 Tranebjerg 06132 Tranebjerg	1 December 1872 21 August 2003	20 August 2003 31 December 2009

Table 3.4. The Danish series of daily air temperature at 14 hours DNT/12 UTC. DNT refers to Danish normal time, which is the time in a given time zone in contrast to summer time, where 1 hour is added. In Denmark the normal time is UTC+1. UTC is "Universal Time Coordinated" - a global indication of time, which refers to the mean solar time on the meridian of Greenwich, England, which is the conventional 0-meridian for geographic longitude.

3.5 Daily cloud cover at 8, 14 and 21 hours DNT

One Danish site has a long series of daily cloud cover at 8, 14 and 21 hours DNT. Table 3.5 presents an overview of the station data series (identified by the station name and number) making up the long series.

Site and period	Station	Start	End
Tranebjerg 1872-2000	27080 Tranebjerg	1 December 1872	31 January 2000

Table 3.5. The Danish series of daily cloud cover at 8, 14 and 21 hours DNT. DNT refers to Danish normal time, which is the time in a given time zone in contrast to summer time, where 1 hour is added. In Denmark the normal time is UTC+1.

3.6 Air pressure

This report presents air pressure data from five series covering three sites 1874-2009 as shown in table 3.6. It is common for all three sites that the air pressure measurements started 1874 at national climate stations. In Denmark measurements of air pressure was stopped at these manually operated climate stations in 1987. Therefore the air pressure series had to be continued from nearby synoptic stations measuring air pressure. One of the series, that of '06193 Hammer Odde Lighthouse', consists of data from stations sufficiently close that it was straightforward to present the data in one series, 1874-2009.

For the other two sites, the synoptic stations are a little further apart from the old climate stations and therefore these two synoptic stations are presented as independent series. In both cases there should nonetheless be sufficient overlap for it to be fairly straightforward for the reader to merge the data into long series for the old Vestervig and Nordby sites also, just as it was done for the pressure observations of the WASA project, see also chapter 3.7 (Schmidt et al., 1997).

Site and period	Station	Start	End
Vestervig **1874-2009**	21100 Vestervig 06052 Thyborøn	01 January 1874 02 March 1962	01 August 1987 31 December 2009
Nordby/Fanø **1874-2009**	25140 Nordby 06080 Esbjerg Airport	01 January 1874 29 March 1959	01 August 1987 31 December 2009
Hammer Odde **1874-2009**	32030 Sandvig **or** 32020 Hammer Odde Fyr 06193 Hammer Odde Fyr	01 January 1874 - 02 June 1987	- 1 June 1987 31 December 2009

Table 3.6. The Danish series of daily air pressure (at MSL, mean sea level). In the data files the Hammer Odde series is presented with the station number 06193, 1874-2009.

3.6.1 Daily averages

At DMI daily averages on observations are made (as a principle) for the meteorological day from (but not including) the previous day at 6 hours UTC until and including the actual day at 6 hours UTC and the meteorological day is given the date of the day it ends. The observation hours and observation frequencies varies for the station types used, therefore details on the number of observations forming part of the daily values are included below.

21100 Vestervig and 25140 Nordby (manually operated climate station, observing 8, 14 and 21 hours DNT):
The daily average (approximating the '6 hours UTC to 6 hours UTC' definition) is made from three measurements: 14 and 21 hours DNT the previous day and 8 hours DNT on the actual day (or at least two observations). The date of the daily value is the date of the day it ends. The observations were station level data and were reduced to MSL following the formulas described in the subsection 'reduction to MSL' below.

DNT refers to Danish normal time, which is the time in a given time zone in contrast to summer time, where 1 hour is added. In Denmark the normal time is UTC+1. UTC is "Universal Time Coordinated" - a global indication of time, which refers to the mean solar time on the meridian of Greenwich, England, which is the conventional 0-meridian for geographic longitude.

06052 Thyborøn (synoptical station at least observing 0,3,6,9,12,15,18 and 21 hours UTC):
The data are averaged over the meteorological day (6 to 6 hours UTC). The average was made from the available measurements at 9, 12, 15, 18, 21, 0, 3 and 6 hours UTC if at least four of these measurements were available. The data are MSL pressure.

06080 Esbjerg Airport (synoptical station at least observing 0,3,6,9,12,15,18 and 21 hours UTC):
The data are averaged over the meteorological day (6 to 6 hours UTC). The average was made from the available measurements at 9, 12, 15, 18, 21, 0, 3 and 6 hours UTC if at least four of these measurements were available. The data are MSL pressure. During the period 1964-1971 the station in the winter only has measurements during daytime and consequently many daily averages are missing during that period.

06193 Hammer Odde Fyr (synoptical station at least observing 0,3,6,9,12,15,18 and 21 hours UTC) and 32030 Sandvig/ 32020 Hammer Odde Fyr (manually operated climate station, observing 8, 14 and 21 hours DNT):
1 January 1874 – 1 June 1987 the data are from the climate stations 32030 Sandvig and 32020 Hammer Odde Fyr and the averaging follows that of 21100 Vestervig and 25140 Nordby (see above). The observations were station level data and were reduced to MSL following the formulas described in the subsection 'reduction to MSL' below. 2 June 1987 – 31 December 2009 the data are from 06193 Hammer Odde Fyr and the averaging follows that of 06052 Thyborøn.

3.6.2 Reduction to MSL

As part of the WASA project (Schmidt et al., 1997), selected DMI series of pressure observations 1874-1970 were digitised. The pressure observations were digitised from the meteorological year-books, which means that the observations were station level data corrected for index error, temperature and, since 1893, gravity.

Important note: For the present dataset, the pressure data from these "old" manually operated climate stations were reduced to mean sea level applying the formulas that can be seen in Appendix 1. Other adjustments (Appendix 2) have not been applied to the daily value dataset. This is the explanation for small differences between the daily series presented here in chapter 3.6 and the daily series that can be calculated using the homogenized air pressure observations (WASA) presented in chapter 3.7. It is advised for the reader to take this probable need of adjustment into account when using the daily value data set.

3.7 Danish Air Pressure observations (WASA data series)

This report also presents mean sea level air pressure observations - three Danish series covering various sites 1874-2009 as shown in table 3.7. The series are updated versions of the Danish series originally published in DMI technical Report 97-3: North Atlantic-European pressure observations 1868-1995 - WASA dataset version 1.0 (Schmidt et al., 1997). As part of this project, selected DMI series of pressure observations 1874-1970 were digitised. The pressure observations were digitised from the meteorological yearbooks, which means that the observations were station level data corrected for index error, temperature and, since 1893, gravity.

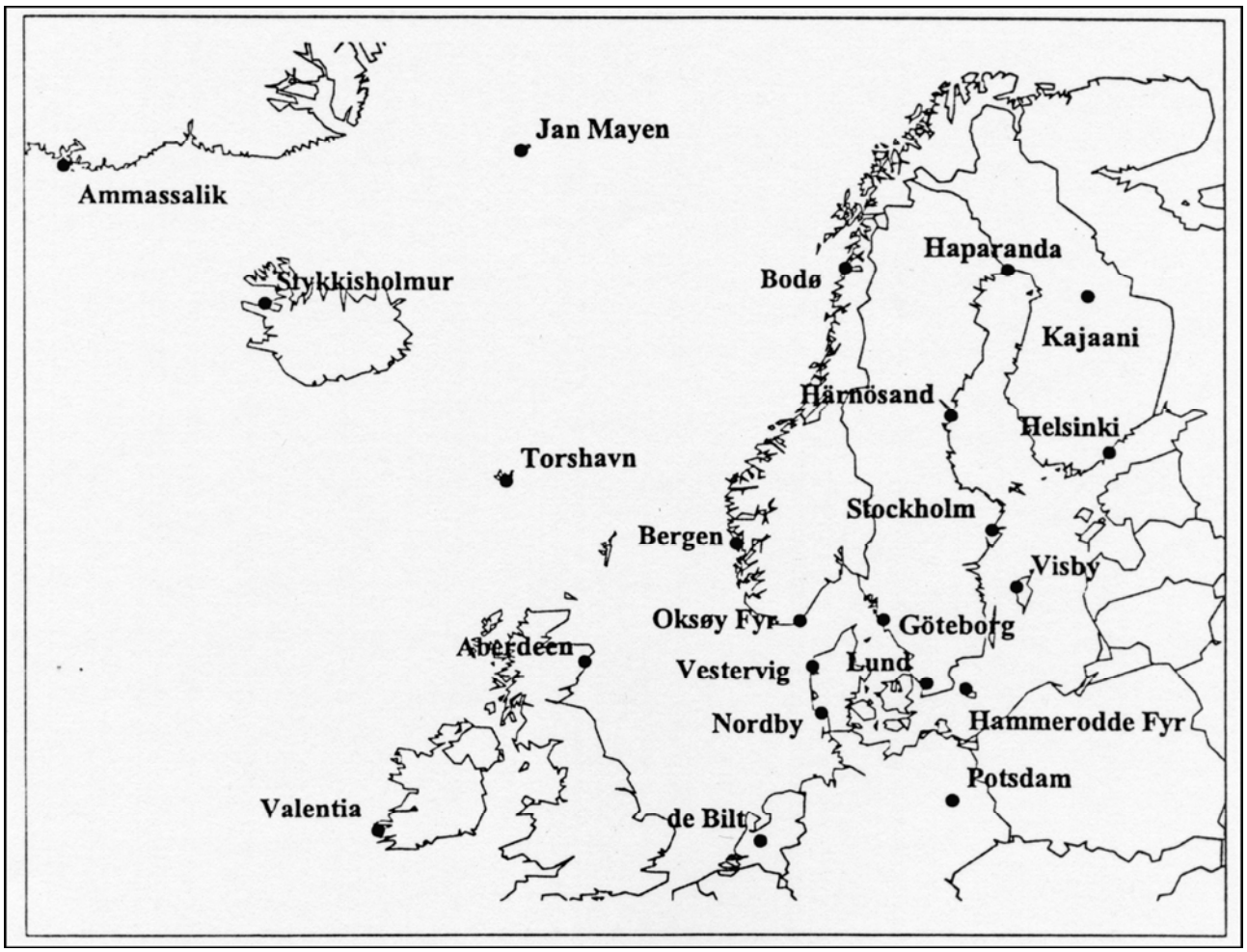

Figure 3.1. Location of the stations that originally provided air pressure observations to the WASA data set (Schmidt et al., 1997). In this report the 3 Danish series Hammer Odde Fyr, Nordby and Vestervig are presented together with Tórshavn, The Faroe Islands and Tasiilaq (Ammassalik), Greenland. The stations representing these sites are listed in the table 3.7. For station co-ordinates confer with the station position file in the data files included.

The air pressure measurements started 1874 at national climate stations. In Denmark measurements of air pressure were stopped at this manually operated climate stations in 1987. Therefore the air pressure series had to be continued from nearby synoptic stations measuring air pressure. In the WASA project the data were merged into long homogeneous series and the table indicates how the stations were merged and how many observations the series contains in the different parts.

Important note: Please be aware that the daily series of air pressure presented in chapter 3.6 are constructed using the digitised material mentioned above only applying the formulas that can be

seen in Appendix 1. Other adjustments (Appendix 2) have not been applied to the daily value dataset. This is the explanation for small differences between the daily series presented in chapter 3.6 and the daily series that can be calculated using the homogenized air pressure observations (WASA) presented here in this chapter. It is advised for the reader to take this probable need of adjustment into account when using the daily value data set.

Site and period	Station	Start	End	Obs. hours (utc)
Vestervig	21100 Vestervig	01 January 1874	31 July 1987	7,13,20
1874-2009	06052 Thyborøn	01 August 1987	22 November 2000	0,3,6,9,12,15,18,21
	06052 Thyborøn	22 November 2000	31 December 2009	0 – 23 every hour
Nordby/Fanø	25140 Nordby	01 January 1874	31 July 1987	7,13,20
1874-2009	06080 Esbjerg Airport	01 August 1987	10 September 2003	0,3,6,9,12,15,18,21
	06080 Esbjerg Airport	10 September 2003	31 December 2009	0 – 23 every hour
Hammer Odde	32030 Sandvig **or**			
1874-2009	32020 Hammer Odde Fyr	01 January 1874	31 May 1987	7,13,20
	06193 Hammer Odde Fyr	01 June 1987	30 August 2001	0,3,6,9,12,15,18,21
	06193 Hammer Odde Fyr	30 August 2001	31 December 2009	0 – 23 every hour

Table 3.7. The Danish series of air pressure observations (at MSL, mean sea level), also called the WASA series.

4. Description of the data series – The Faroe Islands

4.1 Tórshavn Air Pressure observations (WASA data series)

This report presents mean sea level air pressure observations - one series from Tórshavn, The Faroe Islands covering three sites 1874-2009 as shown in table 4.1. The series are an updated version of the series originally published in DMI technical Report 97-3: North Atlantic-European pressure observations 1868-1995 - WASA dataset version 1.0 (Schmidt et al., 1997), see also figure 3.1. As part of this project, selected DMI series of pressure observations 1874-1970 were digitised. The pressure observations were digitised from the meteorological yearbooks, which means that the observations were station level data corrected for index error, temperature and, since 1893, gravity.

The air pressure measurements started 1874 at a national climate station Tórshavn Skole, continued from 1925 in Hoyvík. Measurements of air pressure were stopped at this manually operated climate station in 1983. In the 1950s air pressure measurements were also started at a synoptic station in Tórshavn. In the WASA project the data were merged into a long homogeneous series and the table indicates how the stations were merged and how many observations the series contains in the different parts.

Site and period	Station	Start	End	Obs. hours (utc)
Tórshavn 1874-2009	33071 Tórshavn Skole	01 January 1874	31 March 1925	8,14,21
	33060 Hoyvík	01 November 1925	31 December 1957	8,14,21
	06011 Tórshavn	01 January 1958	01 January 1993	0,3,6,9,12,15,18,21
	06011 Tórshavn	01 January 1993	31 December 2009	0 – 23 every hour

Table 4.1. The Tórshavn series of air pressure observations (at MSL, mean sea level), also called the WASA series.

5. Description of the data series - Greenland

Two Greenlandic sites have long digitised daily series. The tables 5.1 to 5.3 present an overview of the station data series (identified by the station name and number) making up the long series. Overlap periods have been included when available. For station co-ordinates confer with the station position file in the data files included.

5.1 Precipitation

Site and period	Station	Start	End
Ilulissat, 1873-1991	34216 Ilulissat (Jacobshavn) 04216 Ilulissat	1 July 1873 2 January 1961	31 December 1960 12 October 1991
Tasiilaq 1897-2009	34360 Tasiilaq (Angmagssalik) 04360 Tasiilaq	1 October 1897 1 January 1958	30 September 1959 31 December 2009

Table 5.1. Greenlandic series of daily precipitation.

5.2 Minimum temperature

Site and period	Station	Start	End
Ilulissat, 1873-2009	34216 Ilulissat (Jacobshavn) 04216 Ilulissat 04221 Ilulissat Mittarfik	1 July 1873 1 January 1961 16 August 1991	31 December 1960 31 August 1992 31 December 2009
Tasiilaq 1894-2009	34360 Tasiilaq (Angmagsalik) 04360 Tasiilaq	15 October 1894 1 January 1958	30 September 1959 31 December 2009

Table 5.2. Greenlandic series of daily minimum temperature.

5.3 Maximum temperature

Site and period	Station	Start	End
Ilulissat, 1877-2009	34216 Ilulissat (Jacobshavn) 04216 Ilulissat 04221 Ilulissat Mittarfik	1 January 1877 2 January 1961 16 August 1991	31 December 1960 1 September 1992 31 December 2009
Tasiilaq 1897-2009	34360 Tasiilaq (Angmagssalik) 04360 Tasiilaq	1 October 1897 1 January 1958	30 September 1959 31 December 2009

Table 5.3. Greenlandic series of daily maximum temperature.

5.4 Tasiilaq Air Pressure observations (WASA data series)

This report presents mean sea level air pressure observations - one series from Tasiilaq, Greenland covering three sites 1894-2009 as shown in table 5.4. The series are an updated version of the series originally published in DMI Technical Report 97-3: North Atlantic-European pressure observations 1868-1995 - WASA dataset version 1.0 (Schmidt et al., 1997), see also figure 3.1. As part of this project, selected DMI series of pressure observations up to 1970 were digitised. The pressure observations were digitised from the meteorological yearbooks, which means that the observations were station level data corrected for index error, temperature and, since 1893, gravity.

The air pressure measurements started 1894 at a national climate station Angmagssalik. Measurements of air pressure were stopped at this manually operated climate stations in the 1950's. Therefore the air pressure series had to be continued from a nearby synoptic station measuring air pressure. In the WASA project the data were merged into a long homogeneous series and the table indicates how the stations were merged and how many observations the series contains in the different parts.

Site and period	Station	Start	End	Obs. hours (utc)
Tasiilaq	34360 Angmagssalik	01 November 1894	31 November 1956	8,11,17
1894-2009	04360 Tasiilaq	01 January 1958	05 August 2005	0,3,6,9,12,15,18,21
	04360 Tasiilaq	05 August 2005	31 December 2009	0 – 23 every hour

Table 5.4. The Tasiilaq series of air pressure observations (at MSL, mean sea level), also called the WASA series.

6. Metadata

Changes in station position, measuring procedures or observer may all significantly bias a time series of observations. For that reason metadata ("data on data") are important.

All available information on station positions and rain gauge exposure regarding the data published in this report is included in the data files attached to this publication, please see section 7.8 and section 7.9.

In Appendices additionally metadata can be found. In Appendix 1 information concerning air pressure data from old manually operated climate stations - reduction to mean sea level – can be seen. In appendix 2 more information concerning the series of air pressure are presented. In Appendix 3 dates for the introduction of the Hellmann rain gauge and for the introduction of Stevenson screens (thermometer screen) are listed and in Appendix 3 helpful information concerning corresponding monthly series for some of the stations are included.

Finally a compiled set of various metadata, covering aspects such as station position and relocations, change of instrumentation and observation units etc., that is essential to know when homogenizing time series of climate data can be found in DMI Technical Report 03-24 (Laursen, 2003). This publication contains information concerning a major part of the stations included in this report.

7. Data files description

19 fixed ASCII format data files named p<station number_period>.dat,
16 fixed ASCII format data files named tn<station number_period >.dat,
16 fixed ASCII format data files named tx<station number_period >.dat,
2 fixed ASCII format data files named t<station number_period >.dat,
1 fixed ASCII format data file named n27080_period.dat,
5 fixed ASCII format data files named pppp<station number_period >.dat,
5 fixed ASCII format data files named pppp_wasa_<station number_period >.dat,
2 fixed ASCII format files: st_ang.dat and st_pos.dat,

Formats and units can be seen in the sections 7.1 to section 7.9.

Data are only to be used with proper reference to the accompanying report: Cappelen, J. (ed), 2010: DMI Daily Climate Data Collection 1873-2009, Denmark, The Faroe Islands and Greenland - including Air Pressure Observations 1874-2009 (WASA Data Sets). DMI Technical Report 10-06. Copenhagen 2010.

7.1 Observed daily precipitation files

p<station number_period>.dat

The observation files contain observed daily precipitation. There are no missing dates between the start and the end date. Any missing observations are filled in by -9999.

File name	Station	Start date	End date
p06193_1984_2009.dat	06193 Hammer Odde Fyr	01-JAN-1984	31-DEC-2009
p21100_1874_2009.dat	21100 Vestervig	01-JAN-1874	31-DEC-2009
p21430_1874_2009.dat	21430 Grønbæk/Allingskovgård	01-SEP-1874	31-DEC-2009
p06088_1874_2009.dat	25140/06088 Nordby (Fanø)*	01-JAN-1874	31-DEC-2009
p26400_1987_2009.dat	26400 Store Jyndevad	01-JUL-1987	31-DEC-2009
p26409_1995_2006.dat	26409 Tinglev	01-JUN-1995	31-DEC-2006
p26410_1920_1993.dat	26410 Broderup/Bajstrup/Gårdeby/ Rødebæk/Broderup Mark	01-JUL-1920	30-JUN-1993
p27080_1872_2001.dat	27080 Tranebjerg	01-DEC-1872	01-AUG-2001
p27082_2001_2009.dat	27082 Tranebjerg Øst	02-AUG-2001	31-DEC-2009
p30210_1875_1922.dat	30210 Meteorologisk Institut	01-JAN-1875	30-JUN-1922
p30210_1961_1984.dat	30210 Meteorologisk Institut	01-JAN-1961	31-DEC-1984
p30370_1961_2009.dat	30370 Botanisk Have	01-JAN-1961	31-DEC-2009
p30380_1874_1996.dat	30380 Landbohøjskolen	01-JAN-1874	01-OCT-1996
p32020_1961_1987.dat	32020 Hammer Odde Fyr	01-JAN-1961	30-JUN-1987
p32030_1874_1970.dat	32030 Sandvig	01-JAN-1874	31-DEC-1970
p04216_1961_1991.dat	04216 Ilulissat	02-JAN-1961	12-OCT-1991
p04360_1958_2009.dat	04360 Tasiilaq	01-JAN-1958	31-DEC-2009
p34216_1873_1960.dat	34216 Ilulissat (Jacobshavn)	01-JUL-1873	31-DEC-1960
p34360_1897_1959.dat	34360 Tasiilaq (Angmagssalik)	01-OCT-1897	30-SEP-1959

*In the period 2 January – 13 June 2009 the daily accumulated precipitation from station 25140/06088 Nordby (Fanø) are interpolated values.

Format of all precipitation observation files:

Position	Format	Description
1-5	F5.0	Station no.
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-15	F2.0	Hour (Local time or, since 2001, (station 06193, 04216, 04221, 04360 whole period) UTC)
16-20	F5.0	Precipitation previous 24 hours (0.1 mm), -1 means more than 0 mm, but less than 0.1 mm, -2 means accumulation for several days up to the day where precipitation differs from 0, -9999 means missing value. **Please note:** Before 1931 the 'daily precipitation' for **station 21430** may in some cases be the precipitation accumulated for several days or for the whole month. For **station 34216** and **station 34360** the 'daily precipitation' may in some cases be the precipitation accumulated for several days.

7.2 Daily minimum temperature files

tn<station number_period>.dat

The observation files contain observed daily minimum temperature. There are no missing dates between the start and the end date. Any missing observations are filled in by -9999.

File name	Station	Start date	End date
tn06193_1984_2009.dat	06193 Hammer Odde Fyr	01-JAN-1984	31-DEC-2009
tn21100_1874_2003.dat	21100 Vestervig	19-JUN-1874	10-SEP-2003
tn25140_1874_2003.dat	25140 Nordby (Fanø)	01-MAY-1874	18-JUL-2003
tn27080_1872_2003.dat	27080 Tranebjerg	01-DEC-1872	10-AUG-2003
tn30380_1874_1997.dat	30380 Landbohøjskolen	01-JAN-1874	30-JUN-1997
tn06051_2003_2009.dat	06051 Vestervig	02-OCT-2003	31-DEC-2009
tn06088_2003_2009.dat	06088 Nordby	25-JUL-2003	31-DEC-2009
tn06132_2003_2009.dat	06132 Tranebjerg Øst	21-AUG-2003	31-DEC-2009
tn06186_1995_2009.dat	06186 Landbohøjskolen	01-DEC-1995	31-DEC-2009
tn32020_1971_1987.dat	32020 Hammer Odde Fyr	01-JAN-1971	24-JUN-1987
tn32030_1874_1970.dat	32030 Sandvig	01-JAN-1874	31-DEC-1970
tn04216_1961_1992.dat	04216 Ilulissat	01-JAN-1961	31-AUG-1992
tn04221_1991_2009.dat	04221 Ilulissat Mittarfik	16-AUG-1991	31-DEC-2009
tn04360_1958_2009.dat	04360 Tasiilaq	01-JAN-1958	31-DEC-2009
tn34216_1873_1960.dat	34216 Ilulissat (Jacobshavn)	01-JUL-1873	31-DEC-1960
tn34360_1894_1959.dat	34360 Tasiilaq (Angmagssalik)	15-OCT-1894	30-SEP-1959

Format of all minimum temperature observation files:

Position	Format	Description
1-5	F5.0	Station no.
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-15	F2.0	Hour DNT or UTC (since 2001 or stations starting with 04 or 06)
16-20	F5.0	Minimum temperature previous 24 hours (0.1°C).

7.3 Daily maximum temperature files

tx<station number_period>.dat

The observation files contain observed daily maximum temperature. There are no missing dates between the start and the end date. Any missing observations are filled in by -9999.

File name	Station	Start date	End date
tx06193_1984_2009.dat	06193 Hammer Odde Fyr	01-JAN-1984	31-DEC-2009
tx21100_1874_2003.dat	21100 Vestervig	02-AUG-1874	10-SEP-2003
tx25140_1874_2003.dat	25140 Nordby (Fanø)	02-MAY-1874	18-JUL-2003
tx27080_1873_2003.dat	27080 Tranebjerg	01-JAN-1873	10-AUG-2003
tx30380_1874_1997.dat	30380 Landbohøjskolen	01-JAN-1874	30-JUN-1997
tx06051_2003_2009.dat	06051 Vestervig	02-OCT-2003	31-DEC-2009
tx06088_2003_2009.dat	06088 Nordby	25-JUL-2003	31-DEC-2009
tx06132_2003_2009.dat	06132 Tranebjerg Øst	21-AUG-2003	31-DEC-2009
tx06186_1995_2009.dat	06186 Landbohøjskolen	01-DEC-1995	31-DEC-2009
tx32020_1971_1987.dat	32020 Hammer Odde Fyr	01-JAN-1971	24-JUN-1987
tx32030_1874_1970.dat	32030 Sandvig	02-APR-1874	31-DEC-1970
tx04216_1961_1992.dat	04216 Ilulissat	02-JAN1961	01-SEP-1992
tx04221_1991_2009.dat	04221 Ilulissat Mittarfik	16-AUG-1991	31-DEC-2009
tx04360_1958_2009.dat	04360 Tasiilaq	01-JAN-1958	31-DEC-2009
tx34216_1877_1960.dat	34216 Ilulissat (Jacobshavn)	01-JAN-1877	31-DEC-1960
tx34360_1897_1959.dat	34360 Tasiilaq (Angmagssalik)	01-OCT-1897	30-SEP-1959

Format of all maximum temperature observation files:

Position	Format	Description
1-5	F5.0	Station no.
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-15	F2.0	Hour DNT or UTC (since 2001 or stations starting with 04 or 06)
16-20	F5.0	Maximum temperature (0.1°C). The maximum temperature, covering the previous 24 hours, is read in the morning (the same as the minimum temperature). For the manual climate stations (21100, 25140, 27080, 30380, 32020, 32030, 34216 and 34360) **please note:** During the periods 1 Jan 1874 - 31 Dec 1912 and 2 Jan 1971 - 31 Dec 2000 the maximum temperature is listed on the date it has been read. During the period 1 Jan 1913 - 1 Jan 1971 the maximum temperature is listed on the previous day (where it most often occurs). This change in practice was only regarding the maximum temperature, not the minimum temperature. The result is repeated here in the data files as listed above. Because of the change back and forth in practise the data files (and DMI annals) hold no maximum temperature for the 24-hours period starting in the morning 31 Dec 1912 and ending in the morning 1 Jan 1913. And conversely the maximum temperature of the 24-hours that starts in the morning 1 Jan 1971 and ends in the morning 2 Jan 1971 is listed TWO times in the data files: With time stamp 1 Jan 1971 at 8 hours AND with time stamp 2 Jan 1971 at 8 hours, just as the change of practice dictates for those dates.

7.4 Daily air temperature at 14 hours DNT or 12 UTC files

t27080<_period>.dat

The observation files contain air temperature observed daily at 14 hours DNT or 12 UTC. There are no missing dates between the start and the end date. Any missing observations are filled in by -9999.

File name	Station	start date	End date
t27080_1872_2003.dat	27080 Tranebjerg	01-DEC-1872	20-AUG-2003
t06132_2003_2009.dat	06132 Tranebjerg	21-AUG-2003	31-DEC-2009

Format of the air temperature 1400 hours files:

Position	Format	Description
1-5	F5.0	Station no.
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-15	F2.0	Hour (until and including January 2000: DNT: Danish Normal Time. Starting 1 February 2000: UTC)
16-20	F5.0	Air temperature (0.1°C).

7.5 Daily cloud cover at 8, 14 and 21 hours DNT file

n27080<_period>.dat

The observation file contains cloud cover observed daily at 8, 14 and 21 hours DNT. There are no missing dates between the start and the end date. Any missing observations are filled in by -9999.

File name	Station	Start date	End date
n27080_1872_2000.dat	27080 Tranebjerg	01-DEC-1872	31-JAN-2000

Format of the cloud cover file:

Position	Format	Description
1-5	F5.0	Station no.
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-18	F5.0	Cloud cover at 8 (Please note change in units listed below)
9-23	F5.0	Cloud cover at 14 (Please note change in units listed below)
24-28	F5.0	Cloud cover at 21 (Please note change in units listed below)

Cloud cover units:

1872-1873:	0-4	(0= cloudless, 1= 1/4 part clouded,..., 4= overcast)
1874-1952:	0-10	(0= cloudless, 1= 1/10 part clouded,...., 10= overcast)
Since 1953:	0-8	(0= cloudless, 1= 1/8 part clouded,...., 8 = overcast)

7.6 Daily air pressure files

pppp<station number_period>.dat

The files contain observed daily average air pressure (MSL). There are no missing dates between the start and the end date. Any missing observations are filled in by -9999.

File name	Station	Start date	End date
pppp21100_1874_1987.dat	21100 Vestervig	01-JAN-1874	01-AUG-1987
pppp25140_1874_1987.dat	25140 Nordby	01-JAN-1874	01-AUG-1987
pppp06052_1962_2009.dat	06052 Thyborøn	02-MAR-196	231-DEC-2009
pppp06080_1959_2009.dat	06080 Esbjerg Airport	29-MAR-195	931-DEC-2009
pppp06193_1874_2009.dat	06193 Hammer Odde Fyr	01-JAN-1874	31-DEC-2009

Format of all air pressure observation files:

Position	Format	Description
1-5	F5.0	Station no.
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-15	F2.0	Hour (UTC)
16-20	F5.0	Air pressure reduced to MSL (0.1 hPa)
21-25	F5.0	No. of observations in daily average (-9999: Not available. Usually 8, at least 4 observations per day as concerns the newest part of the series)

7.7 Air pressure observation files (WASA)

pppp_wasa_<station number_period>.dat

The observation files contain observed air pressure (MSL). There **can** be missing dates/records between the start and the end date.

File name	Station	Start date	End date
pppp_wasa_04360_1894_2009.dat	04360 Tasiilaq	01-JAN-1894	31-DEC-2009
pppp_wasa_06011_1874_2009.dat	06011 Tórshavn	01-JAN-1874	31-DEC-2009
pppp_wasa_06052_1874_2009.dat	06052 Thyborøn	01-JAN-1874	31-DEC-2009
pppp_wasa_06080_1874_2009.dat	06080 Esbjerg Lufthavn	01-JAN-1874	31-DEC-2009
pppp_wasa_06193_1874_2009.dat	06193 Hammer Odde Fyr	01-JAN-1874	31-DEC-2009

Format of WASA air pressure observation files:

Position	Format	Description
1-5	F5.0	Station no.
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-15	F2.0	Hour (UTC)
16-20	F5.0	Air pressure reduced to MSL (0.1 hPa)

7.8 Station angles file st_ang.dat

The file contains the digitised information on the rain gauge exposure (only information for Danish stations). The information is expressed as the angle to the horizon in eight directions, as the summa-rising angle index and the exposure class. The information is only available for some of the stations and only through the recent years. The file has the following format:

Position	**Format**	**Description**
1-5	F5.0	Station no.
6-25	Datetime20	Start date (DD-MMM-YYYY HH:MM:SS)
26-45	Datetime20	End date (DD-MMM-YYYY HH:MM:SS)
46-51	F6.0	Angle towards N
52-57	F6.0	Angle towards NE
58-63	F6.0	Angle towards E
64-69	F6.0	Angle towards SE
70-75	F6.0	Angle towards S
76-81	F6.0	Angle towards SW
82-87	F6.0	Angle towards W
88-93	F6.0	Angle towards NW
94-99	F6.0	Angle index
100-177	A78	Remarks
178-178	A1	Exposure class

The following dependence of exposure class on angle index are used:

Exposure class	Description	Min. index	Max. index
A	Well sheltered	20	30
B	Moderately sheltered	6	19
C	Freely exposed, unsheltered	0	5
D	Overprotected, too well sheltered	>=31	

7.9 Station position file: st_pos.dat

The file contains the digitised information on the station positions and thereby on any removals of the stations during the operation period. The file has the following format:

Position	Format	Description
1-5	F5.0	Station no.
6-35	A30	Station name
36-45	A10	Station type (synop_dk and synop_gr = part of WMO synoptic net, clima_man = manual climate station, clima_aut = automatic climate station, precip_man = manual precipitation station)
46-56	Date11	Start date (dd-mmm-yyyy)
57-67	Date11	End date (dd-mmm-yyyy)
68-70	A3	UTM zone
71-81	F11.0	Eastings
82-92	F11.0	Northings
93-98	F6.0	Elevation (metres above mean sea level)
99-109	F11.0	Latitude, degrees N (dddmmss)
110-120	F11.0	Longitude, degrees E (dddmmss)

8. References

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NACD, North Atlantic Climatological Dataset. See (Frich et al. 1996).

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WASA: 'The impact of storms on waves and surges: Changing climate in the past 100 years and perpectives for the future'. See the project report: Schmith et al. 1997.

Previous reports

Previous reports from the Danish Meteorological Institute can be found on:
http://www.dmi.dk/dmi/dmi-publikationer.htm

Appendix 1. Information concerning air pressure data

The pressure data from the old manually operated climate stations were reduced to mean sea level by applying the formulas that can be seen in tables A1.1, A1.2, A1.3 and A1.4 (Schmith et al. 1997), (Brandt and Schmith, 1994).

Station 21100 Vestervig Reduction to mean sea level		
First (yyyy.mm)	Last (yyyy.mm)	Pressure reduced to mean sea level (0.1 hPa) =
.	1879.06	P * (1 - 0.00259 * cos(2 * 56.75 * 3.14/180)) * (1 + 9.82/287.04 * 47.4/(T/10+273.15))
1879.07	1883.09	P * (1 - 0.00259 * cos(2 * 56.75 * 3.14/180)) * (1 + 9.82/287.04 * 25.7/(T/10+273.15))
1883.10	1892.12	P * (1 - 0.00259 * cos(2 * 56.75 * 3.14/180)) * (1 + 9.82/287.04 * 25.0/(T/10+273.15))
1893.01	1924.06	P * (1 + 9.82/287.04 * 25.0/(T/10+273.15))
1924.07	1937.03	P * (1 + 9.82/287.04 * 19.3/(T/10+273.15))
1937.04	1946.03	P * (1 + 9.82/287.04 * 27.0/(T/10+273.15))
1946.04	1946.04	P * (1 + 9.82/287.04 * 19.0/(T/10+273.15))
1946.05	.	P * (1 + 9.82/287.04 * 19.6/(T/10+273.15))

Table A1.1. Formulas to obtain mean sea level pressure for station 21100 Vestervig from the data in the internal DMI database 'wasa' (1874-1970) and 'clima_man' (1971-1987). Until and including 1892 the formulas are also correcting the pressure for gravity. The formulas are stored in the database 'wasa_formula'. 'P' is the station level pressure (0.1 hPa) and 'T' is the temperature at station level (0.1ºC).

Station 25140 Nordby Reduction to mean sea level		
First (yyyy.mm)	Last (yyyy.mm)	Pressure reduced to mean sea level (0.1 hPa) =
.	1892.04	P * (1 - 0.00259 * cos(2 * 55.5 * 3.14/180)) * (1 + 9.82/287.04 * 5.5/(T/10+273.15))
1892.05	1892.12	P * (1 - 0.00259 * cos(2 * 55.5 * 3.14/180)) * (1 + 9.82/287.04 * 8.0/(T/10+273.15))
1893.01	1899.11	P * (1 + 9.82/287.04 * 8.0/(T/10+273.15))
1899.12	1928.07	P * (1 + 9.82/287.04 * 5.5/(T/10+273.15))
1928.08	1936.03	P * (1 + 9.82/287.04 * 10.5/(T/10+273.15))
1936.04	1944.11	P * (1 + 9.82/287.04 * 6.9/(T/10+273.15))
1944.12	1945.05	P * (1 + 9.82/287.04 * 7.0/(T/10+273.15))
1945.06	1955.11	P * (1 + 9.82/287.04 * 3.0/(T/10+273.15))
1955.12	1960.08	P * (1 + 9.82/287.04 * 9.7/(T/10+273.15))
1960.09	.	P * (1 + 9.82/287.04 * 6.7/(T/10+273.15))

Table A1.2. Formulas to obtain mean sea level pressure for station 25140 Nordby, Fanø from the data in the internal DMI database 'wasa' (1874-1970) and 'clima_man' (1971-1987). Until and including 1892 the formulas are also correcting the pressure for gravity. The formulas are stored in the database 'wasa_formula'. 'P' is the station level pressure (0.1 hPa) and 'T' is the temperature at station level (0.1ºC).

Station 32030 Sandvig Reduction of air pressure to mean sea level		
First (yyyy.mm)	Last (yyyy.mm)	Pressure reduced to mean sea level (0.1 hPa) =
-	1892.12	P * (1 - 0.00259 * cos(2 * 55.25 * 3.14/180)) * (1 + 9.82/287.04 * 15.1/(T/10+273.15))
1893.01	1942.08	P * (1 + 9.82/287.04 * 15.1/(T/10+273.15))
1942.09	1966.08	P * (1 + 9.82/287.04 * 11.0/(T/10+273.15))
1966.09	1969.12	P * (1 + 9.82/287.04 * 21.7/(T/10+273.15))

Table A1.3. Formulas to obtain mean sea level pressure for station 32030 Sandvig, Bornholm from the data in the internal DMI database 'wasa' (1874-1970) listed as '06193'. Until and including 1892 the formulas are also correcting the pressure for gravity. The formulas are stored in the database 'wasa_formula'. 'P' is the station level pressure (0.1 hPa) and 'T' is the temperature at station level (0.1ºC). The data from 1970 was already reduced to MSL.

Station 32020 Hammer Odde Fyr/Lighthouse Reduction of air pressure to mean sea level		
First (yyyy.mm)	Last (yyyy.mm)	Pressure reduced to mean sea level (0.1 hPa) =
1971.01	-	P * (1 + 9.82/287.04 * 10.9/(T/10+273.15))

Table A1.4. Formulas to obtain mean sea level pressure for station 32020 Hammer Odde Fyr, Bornholm from the data in the internal DMI database 'wasa' (1970) listed as '06193' and 'clima_man' (1971-1987). The formulas are stored in the database 'wasa_formula'. 'P' is the station level pressure (0.1 hPa) and 'T' is the temperature at station level (0.1ºC). The data from 1970 was already reduced to MSL.

Appendix 2. More information concerning the series of air pressure

The reduction formulas of tables A1.1 to A1.4 in Appendix 1 make use of the barometer heights listed in tables A2.1 to A2.5 below.

To homogenize the 21100 Vestervig air pressure and the 25140 Nordby air pressure observation series of the WASA dataset were additionally added the adjustments (units 0.1 hPa) listed in tables A2.4 and A2.5 (look for type '11' and '12'). **These adjustments have not been applied to the present daily value dataset, but available information on the adjustments is included in tables A2.4 and A2.5. It is advised for the reader to take this probable need of adjustment into account when using the data.**

Station 32030 Sandvig metadata			
Start	End	Type	Description
18721111	19660901	1	55 17'N 14 47'E
19660901	-	1	15 17'N 14 46'E (Strandgade 17)
18721111	19660901	2	H = 14 m
19660901	19660901	2	Hs = 12 m
19110112	19110112	2	Hb = 15.1 m
19420824	19420824	2	Hb = 15.1 m
19420825	19560101	2	Hb = 11 m
19560101	19620101	2	Hb = 22.0 m (but same observer)
19620101	19660914	2	Hb = 21.7 m (but same observer)
19660914	-	2	Hb = 11.7 m (Strandgade 17)
18721204	18880817	5	Kapplersk barometer no. 9
18880817	18971106	5	Bar. no. 2094
18971106	-	5	Bar. no. 1381
18730101	-	6	0.1 mm Hg – 7000
18730101	18930101	7	P = (p8+p14+p21)/3
18930101	19550601	7	P=(p8+p14+p21)/3 + corr. 45 N
19550601	-	7	P=(p8+p14+p21)/3 + corr. 45 N + red. sea level
18730101	18930101	10	P=4/3*(7000+p)*(1-k1*cos(2*Ø))*(1+Hb/k2/(k3+t))
18930101	19560101	10	P=4/3*(7000+p)*(1+Hb/k2/(k3+t)) in 0.1 hPa
19560101	-	10	P=4/3*(7000+p) in 0.1 hPa
-	18921200	10	P * (1 - 0.00259 * cos(2 * 55.25 * 3.14/180)) * (1 + 9.82/287.04 * 15.1/(T/10+273.15))
18930100	19420800	10	P * (1 + 9.82/287.04 * 15.1/(T/10+273.15))
19420900	19530800	10	P * (1 + 9.82/287.04 * 11.0/(T/10+273.15))
19530900	19550500	10	P * (1 + 9.82/287.04 * 21.7/(T/10+273.15))

Table A2.1. Meta data regarding pressure measurements at station 32030 Sandvig, Bornholm (used in the 06193 Hammer Odde pressure series) (from NACD and WASA projects, see list of references). Description type number: 2=regarding vertical position. 5=regarding the instrument. 6=units of original measurements and later changes. 7=Formula for calculating originally published monthly values. 8=environment. 9=Time series forming part of primary time series. 10= Formula. Calculations made after original publication, e.g. reduction of air pressure. 11= Test procedure, most important results by comparison with neighbouring stations. 12= Adjustment made after test, given as 12 monthly values (0.1 hPa).

Station 32020 Hammer Odde Fyr (lighthouse) metadata			
Start	End	Type	Description
19530301	19740701	1	55 18' N 14 46' E
19740701	-	1	55 18' N 14 47' E
19530301	19740701	2	Hs = 7 m
19740701	19800101	2	Hs = 11 m
19800101	19800101	2	Hs = 11.0 m
19530308	19550501	3	M.P. J..... (signature illegible)
19550501	19550601	3	J. Jensen
19550601	19661101	3	E. Due
19661101	19670301	3	J. Kyhn-Madsen
19670301	19700801	3	E. Due
19700801	19701001	3	Mogens Christensen
19701001	-	3	Pedersen
19530301	19530308	4	8, 14, 21 C.E.T.
19530308	-	4	8, 14, 21 C.E.T.
19530301	19720101	8	Source of data: Station book.
19720101	19740701	8	source of data: klima_man.
19740701	-	8	Therm. screen and prec. gauge moved
19540701	19800101	2	Hb = 11 m
19800101	19800101	2	Hb = 10.9 m
19540701	19620103	5	Barometer no. ?
19620103	-	5	Adie no. 2179
19540701	19710101	7	P = (p8+p14+p21)/3 + corr 45 N + red. sea level
19710101	-	7	P = (p8+p14+p21)/3 + corr. 45N
19540701	-	10	P = 4/3*(7000+p)
19710100	-	10	P * (1 + 9.82/287.04 * 10.9/(T/10+273.15))

Table A2.2. Meta data regarding pressure measurements at station 32020 Hammer Odde Fyr, Bornholm (used in the 06193 Hammer Odde pressure series) (from NACD and WASA projects, see list of references). Description type number: 2=regarding vertical position. 5=regarding the instrument. 6=units of original measurements and later changes. 7=Formula for calculating originally published monthly values. 8=environment. 9=Time series forming part of primary time series. 10= Formula. Calculations made after original publication, e.g. reduction of air pressure. 11= Test procedure, most important results by comparison with neighbouring stations. 12= Adjustment made after test, given as 12 monthly values (0.1 hPa).

Station 32025 Hammeren Fyr (Lighthouse) metadata			
Start	End	Type	Description
18800121	-	1	55 17'N 14 47'E 33U 6126.930 484.770
18800121	-	2	Hs = 77.4 m
19441130	19441130	8	Lighthouse evacuated
18880821	19110501	2	Hb = 80 m
19110501	19110501	2	Hb = 88 m
19550701	19550701	2	Hb = 76.51 m
18880821	19040806	5	Aneroidbarometer no. 16
19040806	19110501	5	Bar. no. 2571
19110501	19110501	5	Bar. no. 2571
19590601	19590601	5	Bar. no. 2571
19120101	-	6	0.1 mm Hg – 7000
19120101	-	7	P = (p8+p14+p21)/3 + corr. 45 N
18880821	19120101	8	No NACD-data until 1912
19120101	19170101	8	NACD-data from 1912 to 1916 except 1914
19170101	19530101	8	No NACD-data from 1917 to 1953
19530101	19530101	8	Data from 1953 not reduced to sea level
19120101	-	10	P=4/3*(7000+p)*(1+Hb/k2/(k3+t)) in 0.1 hPa
-	-	10	P * (1 + 9.82/287.04 * 76.5/(T/10+273.15))

Table A2.3. See caption for table A2.2.

Station 21100 Vestervig metadata			
Start	End	Type	Description
18730603	18790701	2	Hb = 47.4 m (Hurupvej 34)
18790701	18831001	2	Hb = 25.7 m (Lindalsminde skole)
18831001	18920816	2	Hs=18-19 m on map: Hb=25.0 m, disputed point!
18920816	19240630	2	Hs=22 m on map, Hb=25.0 m, matter of dispute!
19240630	19370413	2	Hb = 19.3 m (Vestergade 45)
19370413	19460401	2	Hb = 27.0 m (Margrethevej 6)
19460401	19810101	2	Hb = 19.6 m (Klostergade 20)
19810101	19810101	2	Hb = 19.6 m
18730603	18760722	5	Barometer (Kappler) no. 1188
18760722	18800324	5	no. 6
18800324	18800324	5	Barometer cleaned. Reduction changed.
18831001	18831001	5	Bar. No. 6
18920725	18930510	5	Barometer new. No number.
18930510	18930907	5	Bar. No. 2233
18930907	18970917	5	Bar. No. 2177
18970917	-	5	Bar. No. 2364
18731201	-	6	0.1 mm Hg – 7000
18731201	18930101	7	P = (p8+p14+p21)/3
18930101	19530101	7	P=(p8+p14+p21)/3 + corr. 45 N
19530101	19710101	7	P=(p8+p14+p21)/3 + corr. 45 N + red. sea level
19710101	-	7	P=(p8+p14+p21)/3 + corr. 45 N
18870819	18870819	8	New reduction table
18731201	18930101	10	P=4/3*(7000+p)*(1-k1*cos(2*Ø))*(1+Hb/k2/(k3+t))
18930101	19530101	10	P=4/3*(7000+p)*(1+Hb/k2/(k3+t)) in 0.1 hPa
19530101	19710101	10	P=4/3*(7000+p) in 0.1 hPa
19710101	-	10	P=4/3*(7000+p)*(1+Hb/k2/(k3+t)) in 0.1 hPa
19870800	-	9	6052
-	18790600	10	P * (1 – 0.00259 * cos(2 * 56.75 * 3.14/180)) * (1 + 9.82/287.04 * 47.4/(T/10+273.15))
18790700	18830900	10	P * (1 – 0.00259 * cos(2 * 56.75 * 3.14/180)) * (1 + 9.82/287.04 * 25.7/(T/10+273.15))
18831000	18921200	10	P * (1 – 0.00259 * cos(2 * 56.75 * 3.14/180)) * (1 + 9.82/287.04 * 25.0/(T/10+273.15))
18930100	19240600	10	P * (1 + 9.82/287.04 * 25.0/(T/10+273.15))
19240700	19370300	10	P * (1 + 9.82/287.04 * 19.3/(T/10+273.15))
19370400	19460300	10	P * (1 + 9.82/287.04 * 27.0/(T/10+273.15))
19460400	19460400	10	P * (1 + 9.82/287.04 * 19.0/(T/10+273.15))
19460500	19521200	10	P * (1 + 9.82/287.04 * 19.6/(T/10+273.15))
19710100	-	10	P * (1 + 9.82/287.04 * 19.6/(T/10+273.15))
-	19240600	11	97.5% significant break, station moved
-	18920800	11	97,5% significant break, station moved
-	19671200	11	97.5% significant break, not supported in meta data
-	19240600	12	-4.0-4.0-4.0-4.0-4.0-4.0-4.0-4.0-4.0-4.0-4.0-4.0
-	18920800	12	4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0
-	19671200	12	7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0

Table A2.4. Meta data regarding pressure measurements at station 21100 Vestervig (from NACD and WASA projects, see references). Description *type* number: 2=regarding vertical position. 5=regarding the instrument. 6=units of original measurements and later changes. 7=Formula for calculating originally published monthly values. 8=environment. 9=Time series forming part of primary time series. 10= Formula. Calculations made after original publication, e.g. reduction of air pressure. 11= Test procedure, most important results by comparison with neighbouring stations. 12= Adjustment made after test, given as 12 monthly values (0.1 hPa) to be added.

Station 25140 Nordby metadata			
Start	End	Type	Description
-	19940114	2	No barometer on this station
18711201	18740101	2	Hb = 5.5 m (Hovedgaden 101)
18740101	18740101	2	Hb = 5.5 m (Hovedgaden 101)
18920501	18991201	2	Hb = 8.0 m. (Nordby Realskole)
18991201	19030101	2	Hb = 5.5 m (Hovedgaden 101)
19030101	19030101	2	Hb = 5.5 m (Hovedgaden 101)
19050101	19050101	2	Hb= 5.5 m (Hovedgaden 103 ???)
19130101	19130101	2	Hb = 5.5 m (Hovedgaden 103)
19280806	19360405	2	Hb = 10.5 m (Vestervejen 43)
19360405	19441216	2	Hb = 6.9 m (Kallesbjergvej 1)
19441216	19450615	2	Hb = 7 m ? (situated on first floor?)
19450615	19551121	2	Hb = 3.0 m (moved to ground floor?)
19551121	19600822	2	Hb = 9.7 m Navigationsskolen, Vestervejen 1
19600822	19940114	2	Hb = 6.7 m (Bavnebjerg Toft 1)
-	19940114	5	No barometer
-	19420620	5	Barometer broken
18710723	18730601	5	Siphon barometer
18730601	18770326	5	Kappler mercury (cistern) barometer no. 4
18770326	18770627	5	Bar. no. 14
18770627	18780501	5	Bar. no. 12
18780501	18780501	5	Bar. no. ?
18801227	18801227	5	New reduction tabel.
18870501	18870501	5	Barometer needs cleaning
18870721	18870721	5	Barometer cleaned?
18870820	18950721	5	Bar. no. 2015
18950721	18950816	5	Bar. no. 3021
18950816	18950816	5	Some data unreliable
18980929	19001218	5	Bar. no. 2177
19001218	19360405	5	Bar. no. 2439
19360405	19361220	5	Barometer moved
19361220	19420620	5	Bar. no. 115521
19420929	19490510	5	Bar. no. 194704
19490510	19490510	5	Barometer no. ?
18720101	-	6	0.1 mm Hg – 7000
18720101	18930101	7	P=(p8+p14+p22)/3
18930101	19280806	7	P=(p8+p14+p22)/3 + corr. 45 N
19280806	-	7	P = (p8+p14+p21)/3 + corr. 45 N
19280801	19360405	8	Station moved to Vestervejen 23
19360405	19441216	8	Station moved to Kallesbjergvej 1
19441216	19530101	8	Station moved to Sparekassen, Hovedgaden ?
19530101	19530101	8	From 1953: data not reduced to sea level
18720101	18930101	10	P=4/3*(7000+p)*(1-k1*cos(2*Ø))*(1+Hb/k2/(k3+t))
18930101	-	10	P=4/3*(7000+p)*(1+Hb/k2/(k3+t)) in 0.1 hPa
19420600	19420900	9	25100
19520900	19520900	9	25150
19521100	19521100	9	25150
19870800	-	9	6080
-	18920400	10	P * (1 - 0.00259 * cos(2 * 55.5 * 3.14/180)) * (1 + 9.82/287.04 * 5.5/(T/10+273.15))
18920500	18921200	10	P * (1 - 0.00259 * cos(2 * 55.5 * 3.14/180)) * (1 + 9.82/287.04 * 8.0/(T/10+273.15))
18930100	18991100	10	P * (1 + 9.82/287.04 * 8.0/(T/10+273.15))
18991200	19280700	10	P * (1 + 9.82/287.04 * 5.5/(T/10+273.15))
			table continues……
			…….table continued
19280800	19360300	10	P * (1 + 9.82/287.04 * 10.5/(T/10+273.15))
19360400	19441100	10	P * (1 + 9.82/287.04 * 6.9/(T/10+273.15))
19441200	19450500	10	P * (1 + 9.82/287.04 * 7.0/(T/10+273.15))

Station 25140 Nordby metadata			
Start	End	Type	Description
19450600	19551100	10	P * (1 + 9.82/287.04 * 3.0/(T/10+273.15))
19551200	19600800	10	P * (1 + 9.82/287.04 * 9.7/(T/10+273.15))
19600900	-	10	P * (1 + 9.82/287.04 * 6.7/(T/10+273.15))
-	19420900	11	97,5% significant break, barometer broken
-	19360400	11	97,5% significant break, station moved
-	19661200	11	97.5% significant break, not supported in meta data
-	19040200	11	97,5% significant break, station moved
-	19441200	11	97,5% significant break, station moved
-	19420900	12	12.012.012.012.012.012.012.012.012.012.012.0
-	19360400	12	3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0
-	19661200	12	6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0
-	19040200	12	5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0
-	19441200	12	-21 -21 -21 -21 -21 -21 -21 -21 -21 -21 -21 -21

Table A2.5. Meta data regarding pressure measurements at station 25140 Nordby, Fanø (from NACD and WASA projects, see references). Description *type* number: 2=regarding vertical position. 5=regarding the instrument. 6=units of original measurements and later changes. 7=Formula for calculating originally published monthly values. 8=environment. 9=Time series forming part of primary time series. 10= Formula. Calculations made after original publication, e.g. reduction of air pressure. 11= Test procedure, most important results by comparison with neighbouring stations. 12= Adjustment made after test, given as 12 monthly values (0.1 hPa) to be added.

Appendix 3. Introduction of the Hellmann rain gauge and Stevenson screens

Some events like replacement of rain gauges and thermometer screens can sometimes cause serious "break points" in the time series. In table A3.1 is listed relevant information on dates (it took place from app. 1910 – 1925) for introduction of the Hellmann rain gauge and for introduction of Stevenson screens concerning the stations in this report. The information originates from DMI Technical Report 94-20 (Brandt, 1994).

Station No.	Name	Fjord gauge replaced by Hellmann	Stevenson screen mounted
21100	Vestervig	~1915	1924.07
21430	Grønbæk/Allingskovgård	N/A	
25140	Nordby, Fanø	~1913	1928.08
26410	Broderup/Bajstrup/Gårdeby /Rødebæk/Broderup Mark	N/A	
27080	Tranebjerg	1911.09	1919.08
30210	Meteorologisk Institut	N/A	
30380	Landbohøjskolen	Before 1922	1919.09
32030	Sandvig	1911.09	1913.09
34216	Ilulissat (Jacobshavn)	1923.08	N/A
34360	Tasiilaq (Angmagsalik)	1920.10	N/A

Table A3.1. Information on station instrumentation concerning rain gauge and Stevenson screen (thermometer screen). From 'table 6' in (Brandt, 1994)

Appendix 4. Information about corresponding monthly series

No test for homogeneity has been performed on the series of daily observations presented in this report.

But as part of the NACD project (see section 1: Introduction) the corresponding *monthly* series for some of the stations and elements were tested, adjusted and published in (Frich et al. 1996). The quality codes of these series of monthly data are shown in table A4.1 together with comments on the adjustments made. Element numbers and quality codes are explained in tables A4.2 and A4.3.

Station No.	Element No.	Period	Quality	Comments
21100	101	1890.01-1995.12	H	No adjustments made
21100	111	1890.01-1995.12	T	Adjusted 1890.01-1953.12 due to new observation procedure
21100	112	1890.01-1995.12	T	Adjusted 1890.01-1953.12 due to new observation procedure
21100	121	1890.01-1995.12	T	Adjusted 1890.01-1924.03 due to introduction of Stevenson screen 01 Apr. 1924. Adjusted 1890.01-1946.03 due to relocation of screen 01 Apr. 1946
21100	122	1890.01-1995.12	T	Adjusted 1890.01-1924.03 due to introduction of Stevenson screen 01 Apr. 1924. Adjusted 1890.01-1946.03 due to relocation of screen 01 Apr. 1946
21100	601	1873.10-1995.12	H	No adjustments made
21430	601	1862.08-1994.12	N	No adjustments made
25140	101	1890.01-1995.12	H	No adjustments made. Values from station 25150 inserted 1942.06-1942.09, 1952.09 and 1952.11
25140	111	1890.01-1995.12	T	Adjusted 1890.01-1899.11 due to relocation of screen 1 Dec. 1899. Adjusted 1890.01-1928.07 due to introduction of Stevenson screen August 1928
25140	112	1890.01-1995.12	T	Adjusted 1890.01-1899.11 due to relocation of screen 1 Dec. 1899. Adjusted 1890.01-1928.07 due to introduction of Stevenson screen August 1928. Adjusted 1914.12-1928.07 cause of break unknown
25140	121	1890.01-1995.12	T	Adjusted 1890.01-1904.03 due to relocation of screen 7 Apr. 1904 and new screen. Adjusted 1890.01-1995.12 due to introduction of Stevenson screen 6 Aug. 1928. Adjusted 1890.01-1936.03 due to relocation of screen 5 Apr. 1936. Adjusted 1890.01-1944.12 due to relocation of screen 16 Dec. 1944. Adjusted 1890.01-1960.08 due to relocation of screen 22 Aug. 1960
25140	122	1890.01-1995.12	T	Adjusted 1890.01-1928.07 due to introduction of Stevenson screen 6 Aug. 1928. Adjusted 1890.01-1944.12 due to relocation of screen 16 Dec 1944. Adjusted 1936.03-1958.07 due to relocation of screen 5 Apr. 1936 and painting of screen 2 Aug. 1958
25140	601	1871.12-1995.12	H	No adjustments made
26410	601	1894.11-1990.12	N	No adjustments made
27080	101	1890.01-1994.12	H	No adjustments made
27080	111	1890.01-1995.12	T	Adjusted 1890.01-1918.05 due to relocation and new Stevenson screen 01 Jun. 1918. Adjusted 1890.01-1972.11 due to relocation 16 Nov. 1972
27080	121	1890.01-1995.12	T	No adjustments made
27080	601	1872.12-1995.12	H	No adjustments made
27080	801	1890.01-1995.12	H	Adjusted 1890.01-1918.08 due to new observer Adjusted 1890.01-1963.08 due to new observer
30380	101	1751.01-1889.12	T	No adjustments made

30380	101	1890.01-1997.03	E	No adjustments made
30380	111	1896.01-1995.12	T	Adjusted 1896.01-1919.08 due to new Stevenson screen 1919/08/20. Adjusted 1894.01-1984.12 due to urban warming
30380	112	1890.01-1995.12	T	Adjusted 1890.01-1919.08 due to new Stevenson screen 1919/08/20. Adjusted 1890.01-1977.12 due to urban warming.
30380	601	1861.01-1995.12	H	No adjustments made
06193	101	1890.01-1995.12	H	Series consists of stations 32030, 32020 and 06193. No adjustments made
06193	111	1890.01-1995.12	T	Series consists of stations 32030, 32020 and 06193. Adjusted 1890.01-1913.09 due to introduction of Stevenson screen. Adjusted 1890.01-1953.08 due to relocation of screen
06193	112	1890.01-1995.12	T	Series consists of stations 32030, 32020 and 06193. Adjusted 1890.01-1913.09 due to introduction of Stevenson screen
06193	121	1890.01-1995.12	T	Series consists of stations 32030, 32020 and 06193. Adjusted 1890.01-1913.09 due to installation of Stevenson screen 17 Sep. 1913
06193	122	1890.01-1995.12	T	Series consists of stations 32030, 32020 and 06193. Adjusted 1890.01-1970.12 due to relocation 31 Dec. 1970
06193	601	1890.01-1995.12	H	Series consists of stations 32030, 32020 and 06193. No adjustments made

Table A4.1. Quality of series of monthly values published in (Frich et al. 1996).

Element no.	Description	Unit	Method
101	Average temperature	0.1 °C	Mean
111	Average maximum temperature	0.1 °C	Mean
112	Absolute maximum temperature	0.1 °C	Max
121	Average minimum temperature	0.1 °C	Mean
122	Absolute minimum temperature	0.1 °C	Min
601	Precipitation sum	0.1 mm	Sum
801	Average cloud cover	%	Mean

Table A4.2. Explanation of element numbers used in table A4.1.

Quality code	Description
H	Homogeneous, rigorously tested and possibly adjusted
T	Tested, possibly adjusted but not perfectly homogeneous
E	Environmental changes prevent climatic change studies
I	Inhomogeneous series which is presently not adjustable
N	Not tested, but not necessarily inhomogeneous

Table A4.3. Explanation of quality codes used in table A4.1.