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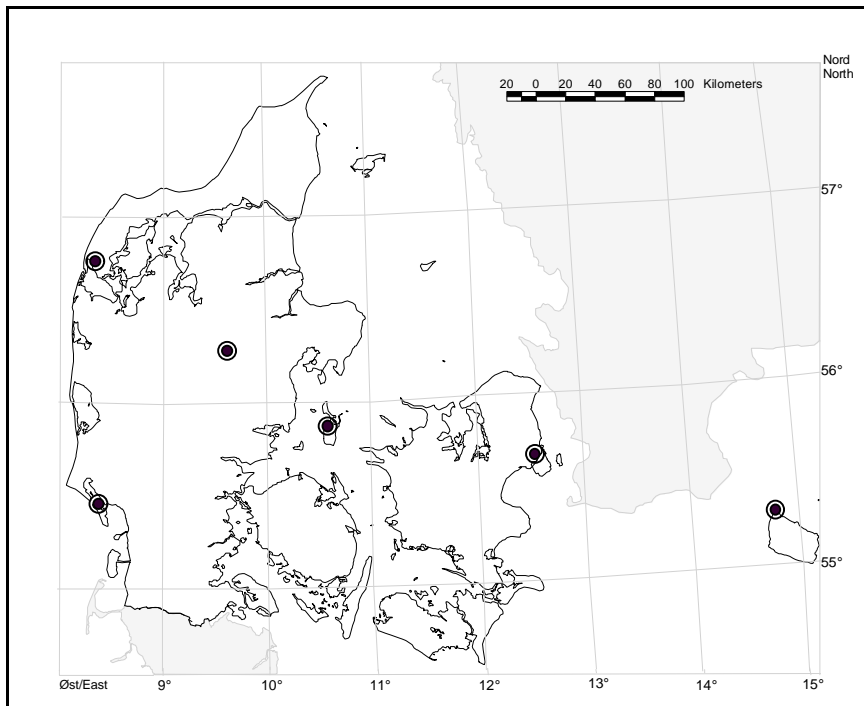
MINISTRY OF TRANSPORT

TECHNICAL REPORT

99-20

Observed Daily Precipitation & Temperature from Six Danish Sites, 1874-1998

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COPENHAGEN 1999

ISSN 0906-897X
ISSN (ONLINE) 1399-1388

This DMI Technical Report may be downloaded as a pdf-file from the Internet home site of the Danish Meteorological Institute: <http://www.dmi.dk/>

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1. Introduction

Increased focus on the analysis and modelling of climatic change and the related analysis of observed climatic data calls for long time series of climate data. Until recently many studies have been based on annual and monthly values. But many climatic extreme events with great impact on Society, e.g. maximum precipitation in 24 hours, may be hidden by the aggregation into monthly or annual values. And as climate change has been recognised also to affect climatic extreme events the demand for long time series of observed daily values has increased.

By the present DMI Technical Report, digitised Danish series of observed daily precipitation or temperature of length more than 100 years are made easily available to research.

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. Here should be mentioned the ACCORD¹ project, the NACD² project and the Danish CD-ROM “Vejr & Vind”³. Also should be mentioned that parts of the digitisation during spring 1999 was funded the Danish Climate Centre, situated at the DMI.

Digitisation of the observations is only 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 consist of the values *as observed by the Institute at the time*, and that no testing for homogeneity has been performed on these daily observations. But as help towards such testing, various meta data together with homogeneity test results on relevant series of *monthly* data (and references as to both) have been included in the report.

22 November 1999

Ellen Vaarby Laursen

Weather and Climate Information Division

¹ EU project number ENV-4-CT97-0530: Atmospheric Circulation Classification and Regional Downscaling.

² EU project number EV5V CT93-0277: North Atlantic Climatological Dataset.

³ Vejr & Vind. CD-ROM. Munksgaard Multimedia, Copenhagen 1997.

2. The observation data

2.1 Spring 1999: Selection of data for digitisation

Daily precipitation was required for the ACCORD project. As an addition, daily extreme temperatures were chosen to be digitised likewise as the climate elements most suitable for describing climate extremes.

Five Danish NACD stations: Vestervig, Nordby, Tranebjerg, København (Landbohøjskolen) and Hammer Odde and also the precipitation station Grønbæk were selected as stations with daily data series suitable for digitisation. The demands were: Still existing records, good data quality, not too many or long periods with missing observations and as few station relocations as possible.

As the means for digitising data was limited, limitations to the material were necessary.

Daily observations at 14:00 hours DNT (Danish Normal Time) and daily precipitation back to December 1872 from the station 27080 Tranebjerg had already been digitised due to the CD-ROM: 'Vejr & Vind' published by Munksgaard in 1997 in collaboration with the DMI. As Tranebjerg thus already could be said to be represented, the station was excluded from the present digitisation.

The NACD series of monthly mean temperature from Copenhagen (station 30380 Landbohøjskolen), 1890-1995, had in the NACD project been labelled with 'Environmental changes prevent climatic change studies' (see table 4.1). As the Copenhagen daily extreme temperature thus may be impossible to correct for urban warming it was at first decided only to digitise daily *precipitation* from Copenhagen. Later, considerations regarding the demand for daily temperature series in *other* studies than climatic change, e.g. water resources studies, caused also the extreme temperatures of Copenhagen (station 30380 Landbohøjskolen) to be digitised and included in the present report.

After the first selection of stations and climate elements, it was decided to lower the costs of digitisation further by having the digitisation firm digitise without their usual double or control copying. Instead the digitised series were to be scrutinised at the DMI, Weather and Climate Information Division, for the inevitable typing errors utilising both logical criteria and the relevant digitised *monthly* series. This manual elimination of errors from the series was successfully performed during summer 1999. By the process valuable information on the quality of the series was obtained as well.

2.2 Data overview for this report

The digitised data described above centre on the six sites marked on the map in figure 2.1. By this report these six sites are covered with daily observations of different kinds for periods up to and including 1998. To accomplish this, daily observations from 11 different DMI stations are presented. Where overlap periods were available they have been included in the presented series.

The observations consist of four types: daily precipitation, daily temperature minimum, daily temperature maximum, daily air temperature at 14:00 hours DNT. Not all types of observations are available from all six sites. The tables 2.1 - 2.4 make up a complete list of the start and end date of all series of observations for all of the 11 DMI stations (identified by their station number) presented in this report.

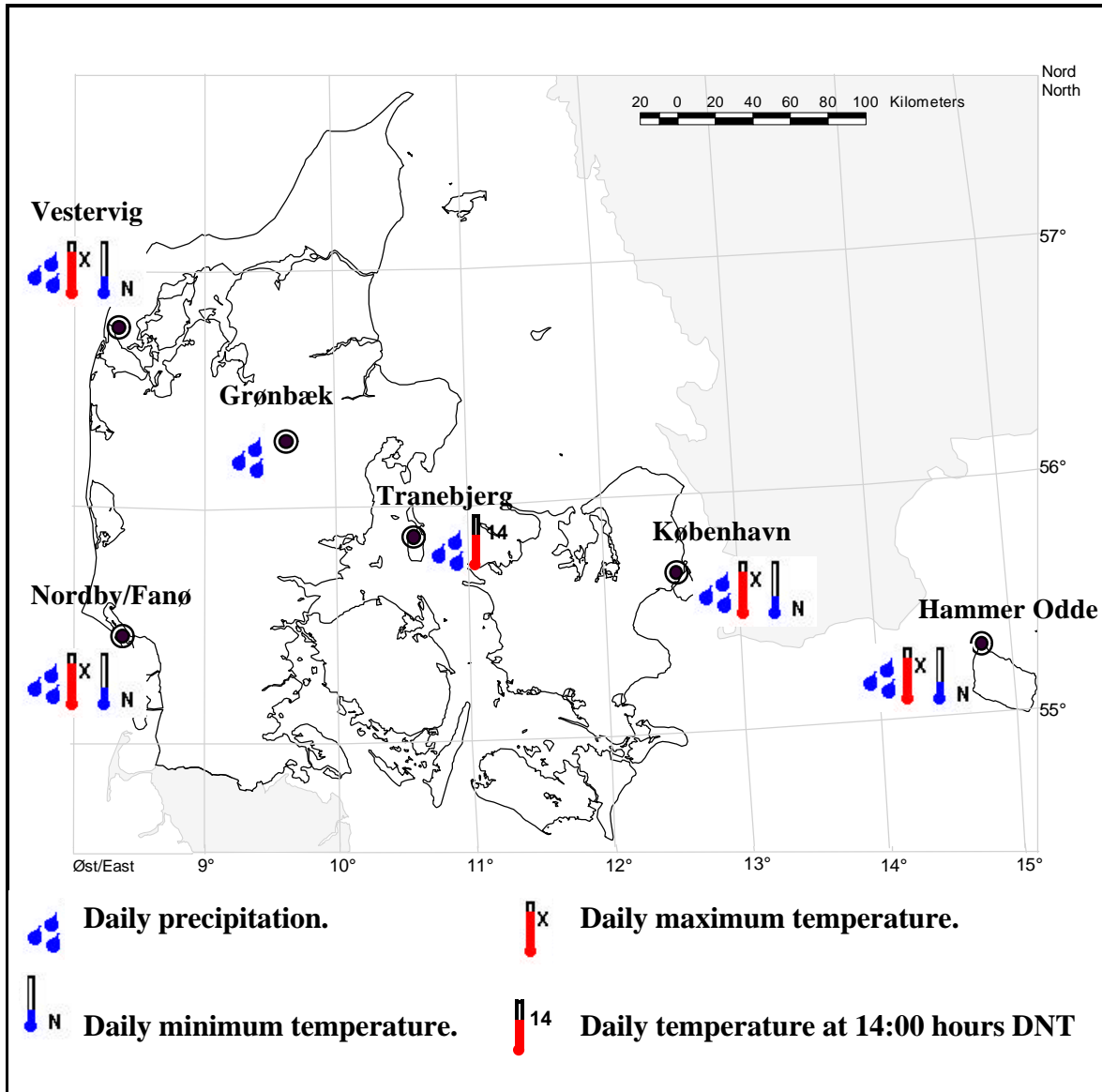


Figure 2.1. The six Danish sites with digitised daily observations, 1874-1998. The stations representing each site are listed in the tables 2.1-4. For station co-ordinates confer with the station position file on the CD-ROM included.



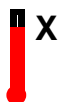
Site and period	Station	Start	End
Vestervig 1874-1998	21100 Vestervig	1 January 1874	31 December 1998
Grønbæk 1874-1998	21430 Grønbæk/ Allingskovgård	1 September 1874	31 December 1998
Nordby/Fanø 1874-1998	25140 Nordby	1 January 1874	31 December 1998
Tranebjerg 1872-1998	27080 Tranebjerg	1 December 1872	31 December 1998
København 1874-1998	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 1998
Hammer Odde 1874-1998	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 1998

Table 2.1. Series of daily precipitation 8:00 hours DNT (station 06193: 6:00 UTC).



Site and period	Station	Start	End
Vestervig 1874-1998	21100 Vestervig	19 June 1874	31 December 1998
Nordby/Fanø 1874-1998	25140 Nordby	1 May 1874	31 December 1998
København 1874-1998	30380 Landbohøjskolen 06186 Landbohøjskolen	1 January 1874 1 December 1995	30 June 1997 31 December 1998
Hammer Odde 1874-1998	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 1998

Table 2.2. Series of daily minimum temperature 8:00 hours DNT (station 06193: 6:00 UTC).



Site and period	Station	Start	End
Vestervig 1874-1998	21100 Vestervig	2 August 1874	31 December 1998
Nordby/Fanø 1874-1998	25140 Nordby	2 May 1874	31 December 1998
København 1874-1998	30380 Landbohøjskolen 06186 Landbohøjskolen	1 January 1874 1 December 1995	30 June 1997 31 December 1998
Hammer Odde 1874-1998	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 1998

Table 2.3. Series of daily maximum temperature 8:00 hours DNT (station 06193: 6:00 UTC).



Site and period	Station	Start	End
Tranebjerg 1872-1998	27080 Tranebjerg	1 December 1872	31 December 1998

Table 2.4. Series of daily air temperature at 14:00 hours DNT.

3. Meta Data

Changes in station position, measuring procedures or observer may all significantly bias a time series of observations. In Table 3.1 is listed information on dates for introduction of the Hellmann rain gauge and for introduction of Stevenson screens. A detailed investigation of the various older instruments and instructions for the observer may be found in (Brandt, 1994a (in Danish)). All available information on station positions and rain gauge exposure is included on the CD-ROM, confer with the file description in section 5: Contents of CD-ROM. See also the comments on the monthly series listed in section 4: Quality of series of monthly values.

Station No.	Name	Fjord gauge replaced by Hellmann	Stevenson screen mounted
21100	Vestervig	~1915	1924.07
25140	Fanø	~1913	1928.08
27080	Tranebjerg	1911.09	1919.08
30380	Landbohøjskolen	Before 1922	1919.09
32030	Sandvig	1911.09	1913.09

Table 3.1. Information on station instrumentation. From 'table 6' in (Brandt, 1994b).

4. Quality of series of monthly values

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 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 4.1 together with comments on the adjustments made. The latter information is obtained from the DMI, Weather and Climate Information Division database on time series. Element numbers and quality codes are explained in tables 4.2-4.3.

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
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
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 4.1. 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

Table 4.2. Explanation of element numbers used in table 4.1.

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 unadjustable
N	Not tested, but not necessarily inhomogeneous

Table 4.3. Explanation of quality codes used in table 4.1.

5. Contents of CD-ROM

The CD-ROM contains

- 1 pdf document named TR-99-20.pdf,
- 11 fixed ASCII format data files named P<station number>.dat,
- 7 fixed ASCII format data files named Tn<station number>.dat,
- 7 fixed ASCII format data files named Tx<station number>.dat,
- 1 fixed ASCII format data file named Ttt27080.dat,
- 3 fixed ASCII format files: St_ang.dat, St_instr.dat and St_pos.dat,
- 1 ASCII text format file: readme.txt,
- 1 WORD file: readme.doc.

Data from the CD-ROM may only be used with proper reference to the accompanying report (Laursen, Ellen Vaarby, Jesper Larsen, Kirsten Rajakumar, John Cappelen and Torben Schmith, 1999. Observed Daily Precipitation & Temperature from Six Danish Sites, 1874-1998. DMI Technical Report No. 99-20).

5.1 Observed daily precipitation files: P<station number>.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 and period (start and end date)		
P06193.dat	06193 Hammer Odde Fyr	01-JAN-1984	31-DEC-1998
P21100.dat	21100 Vestervig	01-JAN-1874	31-DEC-1998
P21430.dat	21430 Grønbæk/Allingskovgård	01-SEP-1874	31-DEC-1998
P25140.dat	25140 Nordby (Fanø)	01-JAN-1874	31-DEC-1998
P27080.dat	27080 Tranebjerg	01-DEC-1872	31-DEC-1998
P30210a.dat	30210 Meteorologisk Institut	01-JAN-1875	30-JUN-1922
P30210b.dat	30210 Meteorologisk Institut	01-JAN-1961	31-DEC-1984
P30370.dat	30370 Botanisk Have	01-JAN-1961	31-DEC-1998
P30380.dat	30380 Landbohøjskolen	01-JAN-1874	31-DEC-1998
P32020.dat	32020 Hammer Odde Fyr	01-JAN-1961	30-JUN-1987
P32030.dat	32030 Sandvig	01-JAN-1874	31-DEC-1970

Format of all 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 (station 06193) UTC)
16-20	F5.0	Precipitation previous 24 hours (0.1 mm), -1 means more than 0 mm but less than 0.1 mm, -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.

5.2 Daily minimum temperature files: Tn<station number>.dat

These 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 and period (start and end date)		
Tn06193.dat	06193 Hammer Odde Fyr	01-JAN-1984	31-DEC-1998
Tn21100.dat	21100 Vestervig	19-JUN-1874	31-DEC-1998
Tn25140.dat	25140 Nordby (Fanø)	01-MAY-1874	31-DEC-1998
Tn30380.dat	30380 Landbohøjskolen	01-JAN-1874	30-JUN-1997
Tn06186.dat	06186 Landbohøjskolen	01-DEC-1995	31-DEC-1998
Tn32020.dat	32020 Hammer Odde Fyr	01-JAN-1971	24-JUN-1987
Tn32030.dat	32030 Sandvig	01-JAN-1874	31-DEC-1970

Format of all 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 (stations 06186, 06193) UTC)
16-20	F5.0	Minimum temperature previous 24 hours (0.1°C).

5.3 Daily maximum temperature files: Tx<station number>.dat

These 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 and period (start and end date)		
Tx06193.dat	06193 Hammer Odde Fyr	01-JAN-1984	31-DEC-1998
Tx21100.dat	21100 Vestervig	02-AUG-1874	31-DEC-1998
Tx25140.dat	25140 Nordby (Fanø)	02-MAY-1874	31-DEC-1998
Tn30380.dat	30380 Landbohøjskolen	01-JAN-1874	30-JUN-1997
Tn06186.dat	06186 Landbohøjskolen	01-DEC-1995	31-DEC-1998
Tx32020.dat	32020 Hammer Odde Fyr	01-JAN-1971	24-JUN-1987
Tx32030.dat	32030 Sandvig	02-APR-1874	31-DEC-1970

Format of all 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 (stations 06186, 06193) UTC)
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). During the periods 1 Jan 1874- 31 Dec 1912 and 2 Jan 1971- 31 Dec 1998 the maximum temperature is listed on the date it has been read. During the period 1 Jan 1913- 1 Jan 1970 the maximum temperature is listed on the previous day (where it most often occurs).

5.4 Daily air temperature at 14:00 hours file: Ttt27080.dat

This observation file contains air temperature observed daily at 14:00 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 and period (start and end date)		
Ttt27080.dat	27080 Tranebjerg	01-DEC-1872	31-DEC-1998

Format of all 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: Danish Normal Time)
16-20	F5.0	Air temperature (0.1°C).

5.5 Station angles file St_ang.dat

The file contains the digitised information on the rain gauge exposure. The information is expressed as the angle to the horizon in eight directions, as the summarising 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
94-98	F5.0	Angle index
99-176	A78	Remarks
177-178	A2	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	127

5.6 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
1-8	F5.0	Station no.
9-16	A30	Station name
17-36	A10	Station type (synop_dk = part of WMO synoptic net, climate_man = manual climate station, precip_man = manual precipitation station)
37-38	Date11	Start date (dd-mmm-yyyy)
39-40	Date11	End date (dd-mmm-yyyy)
41-41	A3	UTM zone
42-44	F11.0	Eastings
45-46	F11.0	Northings
47-47	F6.0	Elevation (metres above mean sea level)
48-51	F11.0	Latitude, degrees N (dddmmss)
52-55	F11.0	Longitude, degrees E (dddmmss)

5.7 Station instrumentation file: St_instr.dat

The file contains the information contained in the table below: (From 'table 6' in Brandt, Marie Louise, DMI Technical Report 94-20 'Summary of Meta data from NACD-stations in Denmark, Greenland and the Faroe Islands 1872-1994', DMI København 1994).

Station No.	Name	Fjord gauge replaced by Hellmann	Stevenson screen mounted
21100	Vestervig	~1915	1924.07
25140	Fanø	~1913	1928.08
27080	Tranebjerg	1911.09	1919.08
30380	Landbohøjskolen	Before 1922	1919.09
32030	Sandvig	1911.09	1913.09

6. References

ACCORD, Atmospheric Circulation Classification and Regional Downscaling. See the Internet site <http://www.cru.uea.ac.uk/cru/projects/accord/> for particulars.

Brandt, Marie Louise, DMI Technical Report 94-19 'Instrumenter og rekonstruktioner. En illustreret gennemgang af arkivmateriale', DMI København 1994.

Brandt, Marie Louise, DMI Technical Report 94-20 'Summary of Meta data from NACD-stations in Denmark, Greenland and the Faroe Islands 1872-1994', DMI København 1994.

Danmarks Klimacenter, see <http://www.dmi.dk/dmi/> (in Danish).

Frich, P. (Co-ordinator), H. Alexandersson, J. Ashcroft, B. Dahlström, G. Demarée, A. Drebs, A. van Engelen, E.J. Førland, I. Hanssen-Bauer, R. Heino, T. Jónsson, K. Jonasson, L. Keegan, P.Ø. Nordli, Schmith, T. Steffensen, H. Tuomenvirta, O.E. Tveito, 1996: North Atlantic Climatological Dataset (NACD Version 1) -Final Report. DMI Scientific Report 96-1, 47 pp. A pdf-version of the report may be downloaded from the DMI Internet home site <http://www.dmi.dk/>.

Munksgaard Multimedia. CD-ROM "Vejr & Vind", Copenhagen 1997.

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