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MINISTRY OF TRANSPORT

**———— TECHNICAL REPORT ————**  
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**Årlige landstal af temperatur, nedbør, solskinstimer  
og skydække for Danmark; 1873-2003**

**Yearly Temperature, Precipitation, Hours of Bright  
Sunshine and Cloud Cover for Denmark as a whole;  
1873-2003**

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## Introduktion

Formålet med denne rapport er at publicere årlige landstal for temperatur, nedbør, solskinstimer og skydække for Danmark; 1873-2003.

Årsværdier af disse landstal indgår regelmæssigt (grafisk) i årbøgerne "Danmarks Klima" samt i forskellige andre publikations-sammenhænge.

Igennem tiderne er instrumenterne til registrering af solskinstimer ændret. I 2002 gik DMI over til en ny, automatisk og mere præcis målemetode. Dette betød et meget stort brud i forhold til de gamle målinger og i forbindelse med overgangen benyttede man lejligheden til at korrigere alle gamle landstalsmånedsværdier af solskinstimer således at de nu er sammenlignelige på det nye niveau.

Det er dette nye talsæt for solskinstimer, fra 1920 og op til i dag, der er med i denne rapport.

Rapport (pdf-format) og tilhørende data kan hentes på DMI's Internetsider under "DMI - publikationer".

## Introduction

The purpose of this report is to publish yearly temperature, precipitation, hours of bright sunshine and cloud cover for Denmark as a whole; 1873-2003.

Yearly values of these parameters regularly forms part (graphical) of the yearly publications "Danmarks Klima", as well as other publications.

Looking back in history the instruments for registration of hours of bright sunshine have been changed several times. In 2002 DMI converted to a new, automatic and more precise measuring method. That introduced a very large gap between old and new measurements. At the same time the opportunity to correct all the "old" sunshine values also was exploited in such a way so the time series of hours of bright sunshine now can be compared from 1920 to now. The report contains this new data set of hours of bright sunshine.

The report (pdf-format) and the matching data set can be downloaded from the publication part of DMI web pages.

## Årlige landstal for temperatur, nedbør, solskinstimer og skydække for Danmark

Landstal for Danmark er månedsvist blevet publiceret siden Danmarks Meteorologiske Institut's oprettelse i 1872. Således er der hvert år siden 1873 beregnet landsgennemsnit på basis af et antal udvalgte stationer.

I denne rapport er medtaget årsværdier af landstal for følgende meteorologiske parametre:

| Parameter  | Startår |
|------------|---------|
| Temperatur | 1873    |
| Nedbør     | 1874    |
| Soltimer   | 1920    |
| Skydække   | 1874    |

Landstallene er igennem tiderne beregnet på det til enhver tid eksisterende stations- og datagrundlag og der er benyttet forskellige vægtninger af data.

Stationsgrundlaget og de forskellige beregningsmetoder er ikke publiceret eller rapporteret særligt godt og det er derfor ikke muligt at afdække, hvordan landstallene nøjagtigt er fremkommet.

Siden engang i 1950'erne vides det dog, at man har benyttet data og metoder, således at areal-vægtningen nogenlunde har lignet den nuværende - data fra Jylland vægtes med 7/10 og data fra Øerne med 3/10.

## Yearly temperature, precipitation, hours of bright sunshine and cloud cover for Denmark as a whole

Meteorological parameters for Denmark as a whole have been published on a monthly basis since the start of the Danish Meteorological Institute in 1872. Every year since 1873 meteorological means for Denmark as a whole have been calculated using a selection of stations.

In this report yearly values for Denmark as a whole and for the parameters mentioned below are included:

| Parameter                | First year |
|--------------------------|------------|
| Temperature              | 1873       |
| Precipitation            | 1874       |
| Hours of bright sunshine | 1920       |
| Cloud cover              | 1874       |

Looking back in history the calculations of the different parameters always have been based upon the existing station- and data availability at that specific time. Furthermore different methods of data weighting have been used.

The selection of stations back in time and the different methods of the calculations have never been published and for that reason the exact details concerning the meteorological parameters for the country as a whole partly are unknown.

Since 1950s it is however known, that methods and data more or less look like today what concerns the area weighting - data from Jutland are weighted with 7/10 and data from the islands with 3/10.

De sidste 10-15 år er datagrundlaget for landstallene endvidere kendt og velbeskrevet.

I "Danmarks Klima 1991", udgivet af DMI i 1992, er på side 40 beskrevet en undersøgelse af landstal for temperatur i kapitlet "Danmarks middeltemperatur i perspektiv".

Det blev i denne artikel påpeget, at for at sammenligne landstal af temperaturer tilbage i tiden, er det nødvendigt at korrigere den beregnede landsmiddeltemperatur i de år, hvor stationsgrundlaget ikke svarer til det udvalg af stationer, der anvendes i dag.

For årene 1873-1956 er landsmiddeltemperaturen beregnet ud fra 25 velfordelte stationer, hvoraf ca. halvdelen lå i Jylland og resten lå på Øerne, dvs. tallene blev så at sige vægtet med 5/10 for Jylland og 5/10 for Øerne. I 1957 ændredes stationsudvalget således, at der indgik 20 stationer i Jylland og 10 stationer på Øerne. Dette stationsgrundlag anvendtes frem til og med 1975.

I årene 1976-1986 blev landsmiddeltemperaturen beregnet på grundlag af ca. 100 stationer, hvor Jyllands middeltemperatur blev vægtet 7/10 i forhold til Øernes middeltemperatur, der blev vægtet 3/10. Denne vægtning afspejlede, at Jyllands areal udgør ca. 7/10 af Danmarks samlede landareal.

Siden 1987 er der igen anvendt ca. 20 stationer i Jylland og 10 stationer på Øerne.

Til trods for at stationsudvalget ikke har kunnet holdes konstant, konkluderede den ovenfor beskrevne undersøgelse, at kun ændringen i 1957 krævede korrektion.

The last 10-15 years the methods and data are well known and described in details.

In the report "Danmarks Klima 1991", published by DMI in 1992, an examination of temperature for Denmark as a whole is described on page 40 in the chapter "Danmarks middeltemperatur i perspektiv".

The examination pointed out, that in order to compare values of that parameter on a time scale, it would be necessary to correct the values in periods where a different area weighting has been used.

In the period 1873-1956 the mean temperatures for Denmark as a whole have been calculated using 25 well distributed stations, one half in Jutland and the rest on the Islands. Thus the area weighting at that time was 5/10 for both Jutland and the Islands.

In 1957 there was a change. From that year and until 1975; 20 stations was used in Jutland and 10 from the Islands.

In the period 1976-1986 the basis was about 100 stations, where Jutland was weighted with 7/10 and the Islands 3/10. This area weighting reflects that the area of Jutland accounts for about 7/10 of Denmark.

Since 1987 a area weighting using about 20 stations in Jutland and 10 stations on the Islands once more have been used.

Nevertheless the examination described above concluded that only the change in 1957 requires a correction.

En sammenligning af stationsudvalget før og efter 1956/57 gav korrektionsfaktorer ( $^{\circ}\text{C}$ ), der kan påføres landstal af temperatur i perioden 1873-1956 (se nedenstående tabel).

Disse korrektioner er siden blevet påført landstals-serien af temperatur i nogle sammenhænge, men ikke alle.

Det har bevirket, at landstal af temperatur i en årrække har eksisteret i 2 versioner - en med korrektioner og en uden korrektioner.

Generelt er korrigerede data blevet anvendt ved alle præsentationer af udviklingen i landsmiddeltemperatur fra 1873, mens de ukorrigerede data er blevet anvendt, hvor det har været vigtigt, at temperaturerne kunne sammenholdes med allerede publicerede data gennem tiderne.

I denne rapport er begge landstal-serier af temperatur medtaget. Det må anbefales, at der i fremtiden klart markeres, hvilke sæt af landsmiddeltemperaturer, der i en given situation bruges.

Udover landstal af temperaturer er også landstal af solskinstimer korrigeret i forhold til tidligere publiceret materiale. Korrigering af soltimer er beskrevet i detaljer i DMI Teknisk Rapport 03-19, 2003.

På de næste sider er rapportens datamateriale (periode 1873-2003) vist grafisk.

By comparing the figures before and after 1956/1957, correction factors (in degrees celsius) was given, which can be added to mean temperatures for Denmark in the period 1873-1956 (see the table below).

The correction factors have been added to the temperature series in some cases, but not all. Consequently the Danish temperature series from 1873 since the beginning of the 1990s have existed in 2 versions - one with correction and one without.

In general corrected data have been used in all presentations of the temperature series on a time scale, while the uncorrected data have been used in all the cases, where it was important to compare the values with already published data in yearbooks back in time.

In this report both the corrected and the uncorrected temperature series have been included. In the future it is strongly recommended that it is clearly marked, which data set has been used.

Besides the temperature series also the sunshine series have been corrected compared to earlier published material.

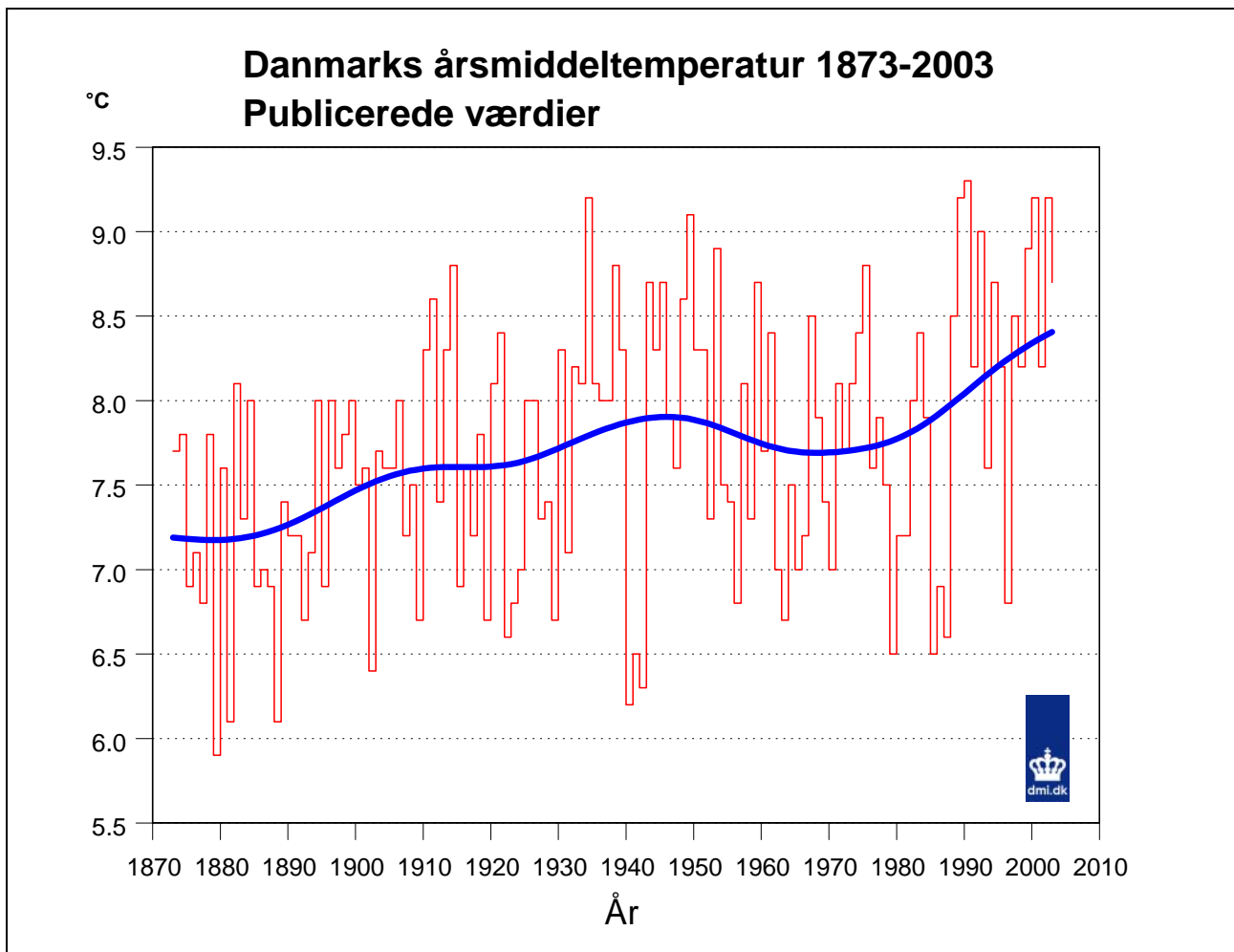
The correction of hours of bright sunshine are described in details in DMI Technical Report 03-19, 2003.

On the next pages the different time series in this report (period 1873-2003) are shown as graphs.

| jan   | feb   | mar   | apr   | may   | Jun   | jul   | aug   | sep   | Oct   | nov   | dec   | Year  |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| -0,06 | -0,01 | -0,04 | -0,07 | -0,09 | -0,20 | -0,21 | -0,18 | -0,14 | -0,15 | -0,14 | -0,15 | -0,12 |

*Korrektionsfaktorer ( $^{\circ}\text{C}$ ), der kan påføres landstal af temperatur for Danmark i perioden 1873-1956.*

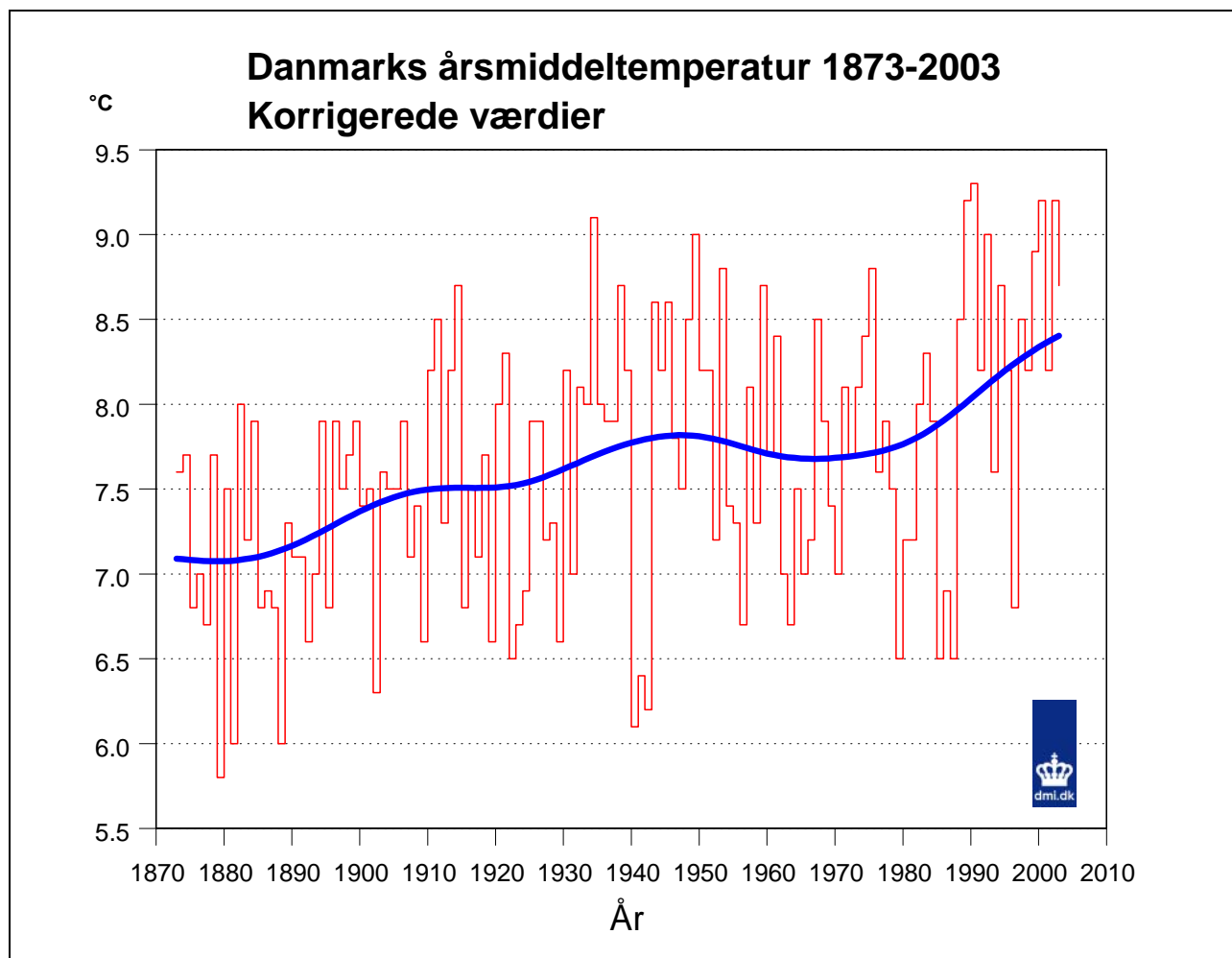
*Correction factors (in degrees celsius), which can be added to the mean temperatures for Denmark in the period 1873-1956.*



Årsmiddeltemperatur for Danmark 1873-2003, publicerede værdier.  
 Et gaussfilter med filterbredden (standardafvigelse) 9 år er anvendt til den "fede" udjævnede kurve. Et gaussfilter med standardafvigelse på 9 år, der nogenlunde kan sammenlignes med 30 års glidende gennemsnit, er god til at vise den tidlige udvikling. Gaussfiltret udjævner mere end et glidende gennemsnit, da værdier i midten af filteret får større vægt end i udkanten af filteret. Værdierne i tidsseriens ender bliver også filteret, dog med et ensidigt filter. Ved fremtidig opdatering vil filterværdierne i slutningen af tidsserien derved ændres.

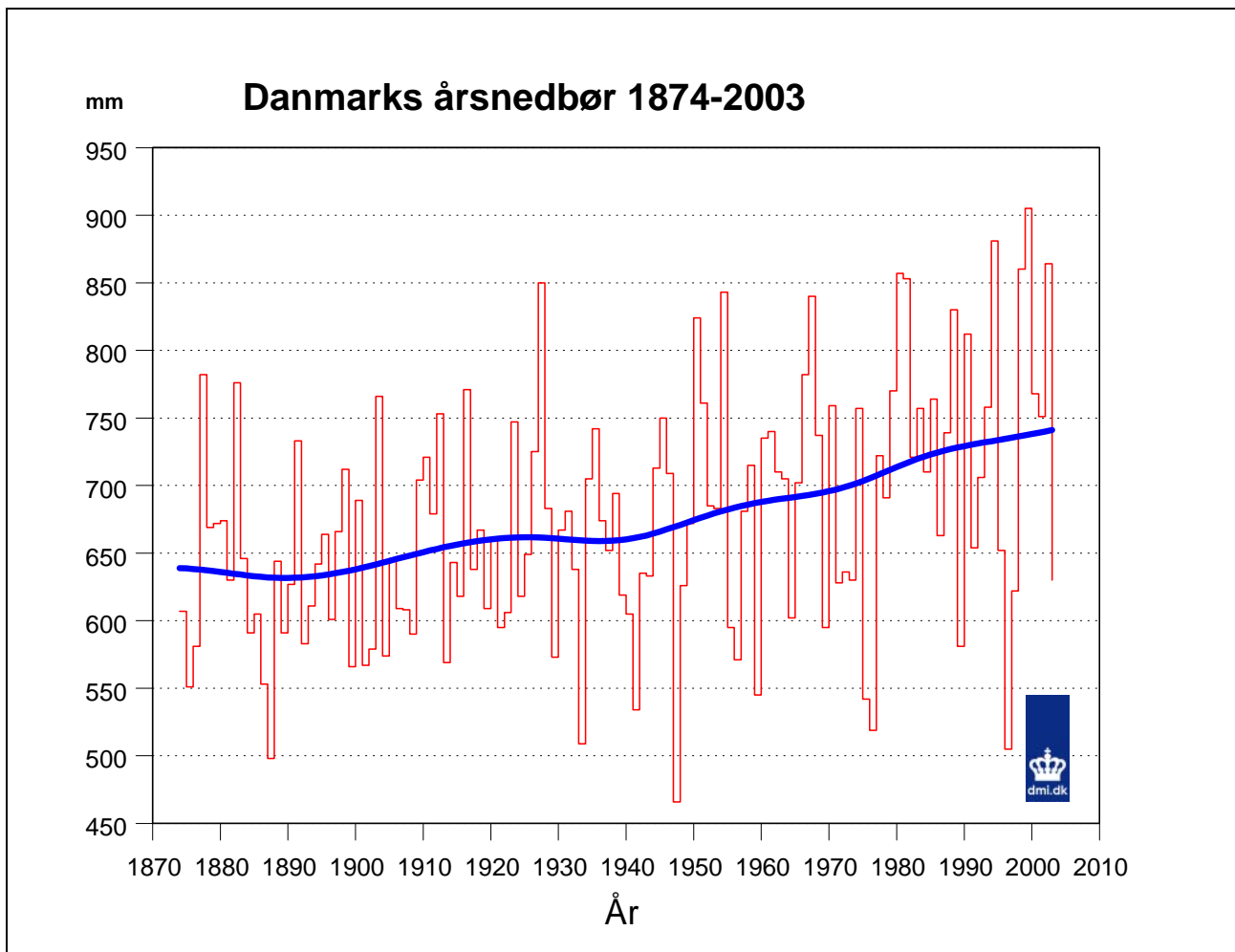
Yearly mean temperature for Denmark 1873-2003, published values.  
 A Gauss filter with filter width (standard deviation) 9 years have been used to create the "bold" smooth curve. A Gauss filter with standard deviation 9 years are comparable to a 30-years running mean. However, the filter gives a more smooth curve than a running mean, as temperatures from central years are given larger weight than temperatures from periferal years. Filter values are also calculated for the years at either end of the series. It should be noted that theses values are computed from one-sided Gauss filters, and that values from later years will change when the series is updated.





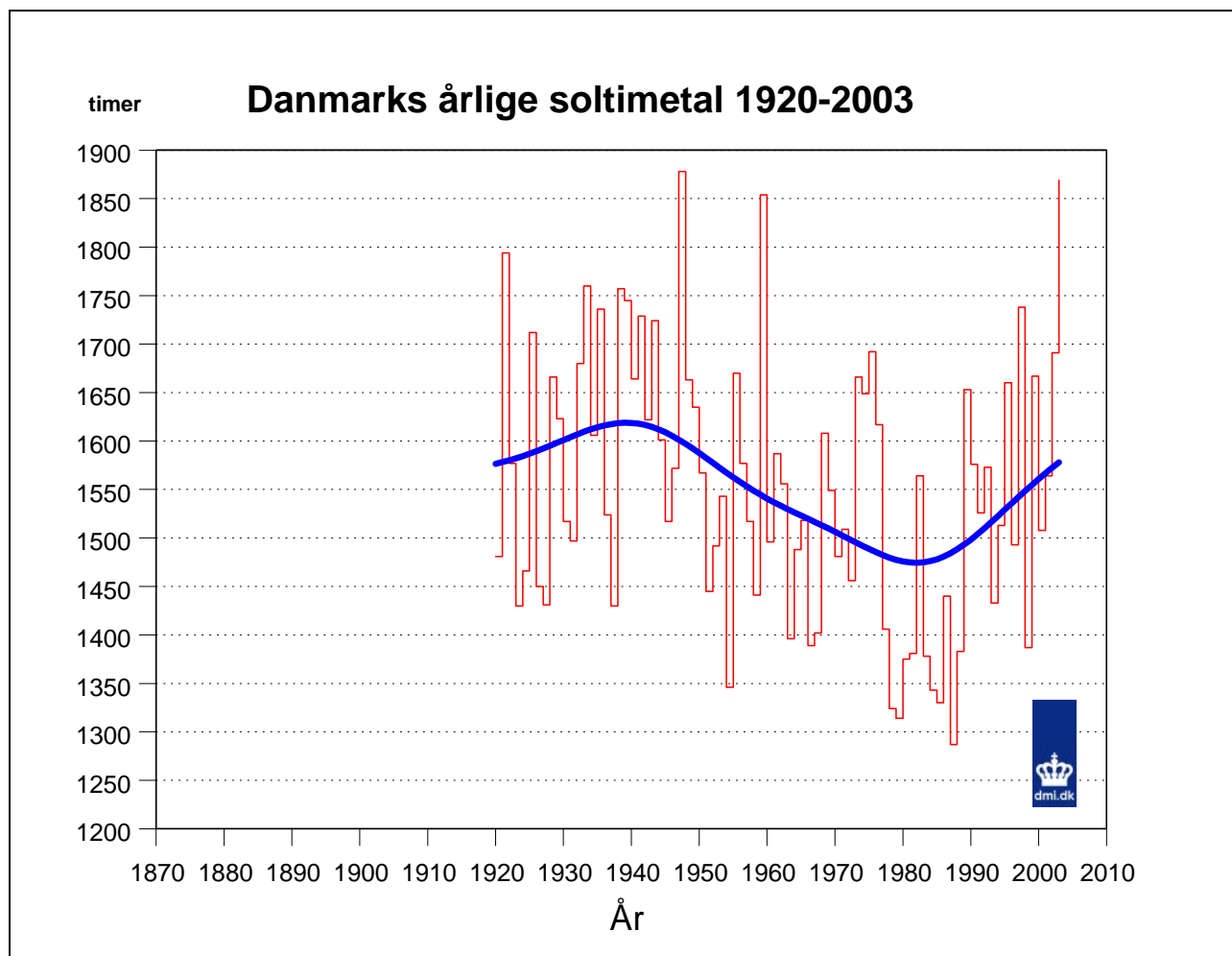
*Årsmiddeltemperatur for Danmark 1873-2003, korrigerede værdier.*

*Yearly mean temperature for Denmark 1873-2003, corrected values.*



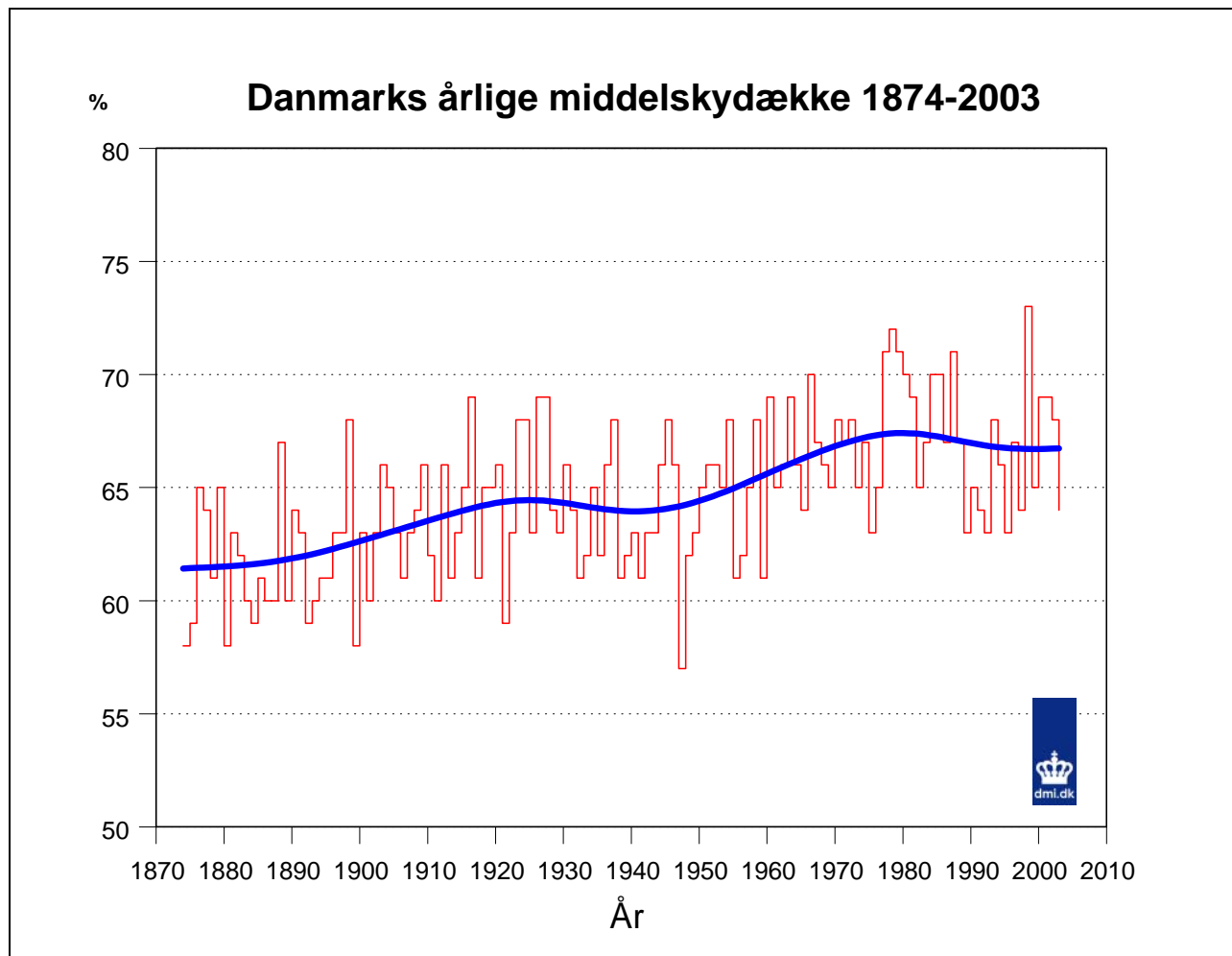
*Danmarks årsnedbør 1874-2003.*

*Yearly precipitation for Denmark 1874-2003.*



*Danmarks årlige soltimetal 1920-2003. DMI er fra 2002 begyndt at observere antallet af solskinstimer ved hjælp af globalstrålingsmåling i stedet for ved hjælp af solautograf. Den nye metode er mere præcis, men betyder samtidig at nye og gamle solskinstimemålinger ikke direkte kan sammenlignes. I denne rapport er solskinstimetallet i hele perioden fra 1920 korrigeret til det nye niveau. Se DMI Teknisk Rapport 02-25, 2002 og DMI Teknisk Rapport 03-19, 2003.*

*Yearly hours of bright sunshine for Denmark 1920-2003. From 2002 DMI has started to observe the hours of bright sunshine using measurements of global radiation instead of measurements from a traditional Campbell-Stokes sunshine recorder. The new method is without question more precise than the old one, but implies at the same time that "new" and "old" hours of bright sunshine not directly can be compared. In this report the hours of bright sunshine in the period from 1920 are given according to the new level. See DMI Technical Report 02-25, 2002 and DMI Technical Report 03-19, 2003.*



*Danmarks årlige middelskydække 1874-2003.*

*Yearly mean cloud cover for Denmark 1874-2003.*

## Format for de medfølgende datafiler

Datamaterialet medfølger denne rapport i et EXCEL regneark og i en ASCII fil.

Udover årstal indeholder filerne:

1. *ukorrigerede landstal af årsmiddeltemperatur* i grader celsius med 1 decimal (variablen er angivet med et "T" efterfulgt af et "DK") og en Gauss-filtreret værdi med 2 decimaler (variablen er angivet med et foranstillet "F").
2. *korrigerede landstal af årsmiddeltemperatur* i grader celsius med 1 decimal (variablen er angivet med et "T" efterfulgt af et "DK" og et "K" for korrigeret) og en Gauss-filtreret værdi med 2 decimaler (variablen er angivet med et foranstillet "F").
3. *landstal af den akkumulerede årsnedbør* i hele millimeter (variablen er angivet med et "P" efterfulgt af et "DK") og en Gauss-filtreret værdi med 2 decimaler (variablen er angivet med et foranstillet "F").
4. *landstal af det akkumulerede soltimeantal* i hele timer (variablen er angivet med et "S" efterfulgt af et "DK") og en Gauss-filtreret værdi med 2 decimaler (variablen er angivet med et foranstillet "F").
5. *landstal af det årlige middelskydække* i % (variablen er angivet med et "C" efterfulgt af et "DK") og en Gauss-filtreret værdi med 2 decimaler (variablen er angivet med et foranstillet "F").

Nedenfor kan ses en beskrivelse af formatet.

| Variable | Type   | Start | End | Format |
|----------|--------|-------|-----|--------|
| YEAR     | YEAR   | 1     | 4   | F4.0   |
| T_DK     | TEMP   | 5     | 12  | F8.1   |
| FT_DK    | FILTER | 13    | 20  | F8.2   |
| T_DK_K   | TEMP   | 21    | 28  | F8.1   |
| FT_DK_K  | FILTER | 29    | 36  | F8.2   |
| P_DK     | PREC   | 37    | 44  | F8.0   |
| FP_DK    | FILTER | 45    | 52  | F8.2   |
| S_DK     | SUN    | 53    | 60  | F8.0   |
| FS_DK    | FILTER | 61    | 68  | F8.2   |
| C_DK     | CLOUD  | 69    | 76  | F8.0   |
| FC_DK    | FILTER | 77    | 84  | F8.2   |

## File formats

Data are included in this report as an EXCEL worksheet and an ASCII file.

Besides years the files contain:

1. *uncorrected yearly mean temperature for Denmark as a whole* in degrees celsius to one decimal place (the variable is specified with a "T" followed by a "DK") and a gaussian filtered value to 2 decimal places (the variable is specified with a "F").
2. *corrected yearly mean temperature for Denmark as a whole* in degrees celsius to one decimal place (the variable is specified with a "T" followed by a "DK" and a "K") and a gaussian filtered value to 2 decimal places (the variable is specified with a "F").
3. *yearly accumulated precipitation for Denmark as a whole* in millimetres (the variable is specified with a "P" followed by a "DK") and a gaussian filtered value to 2 decimal places (the variable is specified with a "F").
4. *yearly accumulated hours of bright sunshine for Denmark as a whole* in hours (the variable is specified with a "S" followed by a "DK") and a gaussian filtered value to 2 decimal places (the variable is specified with a "F").
5. *yearly mean cloud cover for Denmark as a whole* in % (the variable is specified with a "C" followed by a "DK") and a gaussian filtered value to 2 decimal places (the variable is specified with a "F").

A description of the data format can be seen below.

| Variable | Type   | Start | End | Format |
|----------|--------|-------|-----|--------|
| YEAR     | YEAR   | 1     | 4   | F4.0   |
| T_DK     | TEMP   | 5     | 12  | F8.1   |
| FT_DK    | FILTER | 13    | 20  | F8.2   |
| T_DK_K   | TEMP   | 21    | 28  | F8.1   |
| FT_DK_K  | FILTER | 29    | 36  | F8.2   |
| P_DK     | PREC   | 37    | 44  | F8.0   |
| FP_DK    | FILTER | 45    | 52  | F8.2   |
| S_DK     | SUN    | 53    | 60  | F8.0   |
| FS_DK    | FILTER | 61    | 68  | F8.2   |
| C_DK     | CLOUD  | 69    | 76  | F8.0   |
| FC_DK    | FILTER | 77    | 84  | F8.2   |