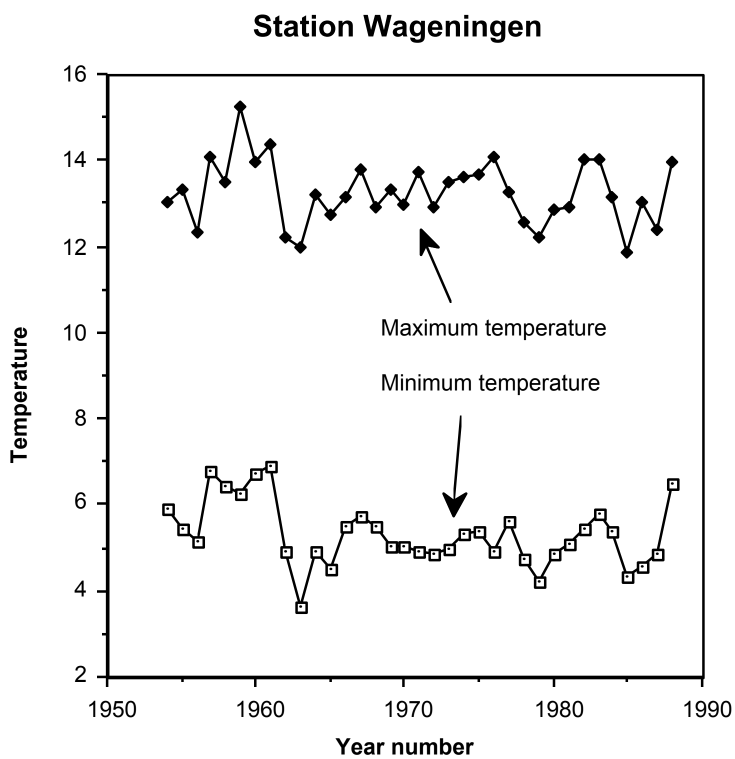
AB/TPE internal communication

User manual of AB/TPE Weather System

D.W.G. van Kraalingen, W. Stol, P.W. J. Uithol, M.G.M. Verbeek



A joint publication of

Research Institute for Agrobiology and Soil Fertility (AB-DLO)

and

Department of Theoretical Production Ecology, Wageningen Agricultural University

Wageningen, June 1991,
reissued September 1997

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Contents

1. General

This manual describes the weather information system version 4.2 developed jointly by the DLO-Research Institute for Agrobiology and Soil Fertility (AB-DLO) and the department of Theoretical Production Ecology (TPE) of the Agricultural University Wageningen. It is developed to provide in a simple way, access to daily historical weather data for any computer program that requires weather data, with particular reference to crop growth simulation models.

The system provides daily values for the following weather data:

Name		Unit
Global radiation	(daily total)	kJ/m2/d
Minimum air temperature		degrees Celsius
Maximum air temperature		degrees Celsius
Vapour pressure		kPa
Wind speed	(daily average)	m/s
Rain	(daily total)	mm/d

The weather system consists basically of two parts: the weather data files and a reading program to obtain data from the data files. For a definition of the data files see Chapter III, a description of the reading program is given in Chapter II. A selection of data files currently available is supplied in Chapter IV.

The data files are plain text files that can be edited by normal text editors and spreadsheet programs. A single data file can hold daily weather data from one meteorological station and for one particular year at the most. The country name (abbreviated), station number and year to which the data apply are reflected in the name of the data file. For instance the file name NLD1.983 applies to data from the Dutch (NLD) meteorological station in Wageningen (1) for the year 1983.

The reading program can be used by calls to two subroutines from within the user's main program. One call sets the station and year to be used whereas by a call to the second subroutine, weather data for a particular day are obtained. The way of implementation provides optimal flexibility for switching among different days, years and stations. These subroutines are written entirely in standard FORTRAN-77 and can easily be transferred to different computers and compilers.

The main advantages of this system compared to commercially available database programs are that this system provides flexibility and transferability of the data and the program code, whereas database programs can often not be called from FORTRAN, are not transferable from one computer system to another and often cannot deal with loose data file formats.

We want to encourage researchers who are collecting weather data from external sources for their own needs, to use the data file format and reading program developed for this system. Only by regular contributions to this system, different sets of weather data will become available from diverse geographical locations and climate types. The reading program and data files can be obtained by the DLO-Research Institute for Agrobiology and Soil Fertility (AB-DLO) P.O. Box 14, 6700 AA, Wageningen, e-mail: sps@ab.dlo.nl.

2. Reading program description

2.1. General use

Here we supply a general introduction into the use of the reading program. For a technical description you are referred to Sections 2.2, 2.3, and 2.4.

The reading program, written entirely in the standard FORTRAN-77 computer language, consists of a set of subroutines and functions only three of which are meant to be called by the user. The others are internal to the reading program.

By a call to the first subroutine (STINFO) the user defines the country, station code and year number he wants to use and the name of the directory where the weather data can be found. Also a control parameter should be supplied where possible messages of the system should be directed (screen and/or log file, see Section 2.2) and a name for the log file in case it should differ from the default name WEATHER.LOG. The subroutine STINFO will return the location parameters (longitude, latitude and altitude) of the selected meteorological station, two coefficients of the Ångström formula and the value of a status variable indicating a possible error or warning (e.g. the requested data file does not exist). The location parameters can be used subsequently to calculate daylength (from latitude) or average air pressure (from altitude).

After this initialization procedure, weather data from specific days can be obtained by calls to the second subroutine (WEATHR) with day number as input parameter. Output of WEATHR consists of the six weather data of that day and the value of a status variable indicating possible error or warning events (e.g. missing data, data obtained by interpolation, requested day is out of range, etc.). The six weather variables are total global radiation, minimum and maximum air temperature, vapour pressure, wind speed and rainfall. For a technical description of subroutine WEATHR and a list of units see Section 2.3. Note that the subroutine WEATHR always returns radiation although sometimes the data file contains sunshine hours.

Errors in general, are defined where it is impossible to return weather data to the user (e.g. of a non- existing data file). The reading program will then return the value of -99 for the relevant output variables (-199 for the longitude). Warnings are defined as events where it is possible to supply weather data, but one or more of the six values were not measured directly but obtained in some other way.

Neither errors nor warnings will terminate execution of the whole program. Whatever event occurs, execution is returned to the calling program which can then decide (through the value of the status variable ISTAT) what action to undertake.

STINFO can be called again at any time to change any of its input parameters. Even a call to STINFO with identical input parameters will not do any harm to the system. Similarly, WEATHR can be called repeatedly with any day number between 1 and 365 (or 366 in case of a leap-year).

So, in order to obtain weather data for a simulation model for a single year, in the initial section of the model subroutine STINFO should be called, whereas in the dynamic section, WEATHR should be called again each day. An example is shown below where Wageningen data are used of the year 1965 in a simple simulation loop:

```
*     initial section
      INTEGER ISTAT
      REAL LONG, LAT, ALT, A, B
      INTEGER IDAY
      REAL RAD, TMIN, TMAX, VAPOUR, WIND, RAIN

      CALL STINFO (1111, ' ', ' ', 'NLD', 1, 1965,
     &            ISTAT, LONG, LAT, ALT, A, B)

      IF (ISTAT.NE.0) THEN
         WRITE (*,'(A,I7)') ' ISTAT <> zero, ISTAT=',ISTAT
      END IF

*     dynamic section

10    IF (DVS.LE.2.) THEN

         CALL WEATHR (IDAY, ISTAT,
     &               RAD, TMIN, TMAX, VAPOUR, WIND, RAIN)

         IF (ISTAT.NE.0) THEN
            WRITE (*,'(A,I7)') ' ISTAT <> zero, ISTAT=',ISTAT
         END IF

         CALL PLANT (IDAY, LAT, RAD, TMIN, TMAX, DVS)
         <write output to file>
         IDAY = IDAY+1
         GOTO 10

      END IF
*     terminal section
```

In the example above the first line of the call to STINFO consists respectively of 1) the flag variable that indicates where errors and warnings should be directed (both to screen and log file in this case), 2) the directory where the weather data can be found (the current directory if the string consists of 1 or more blanks), 3) the name of the log file in case it should differ from the default name (WEATHER.LOG), 4) the abbreviated country name ('NLD' means the Netherlands), 5) the station number in the country (1 means Wageningen), 6) the year for which weather data are requested.

The return variable ISTAT

The variable ISTAT is an output parameter of both STINFO and WEATHR. Through the value of ISTAT the user is informed about errors or warnings that may have occurred. The user can select writing errors and warnings as text messages to the screen and/or to a log file but these text messages cannot be used by the main program to recognize errors and warnings. Therefore a status variable is supplied whose (integer) value is an indication of the event that occurred. In case no irregularity was encountered as is the case when the data file exists and the data for the requested day are all present, the value of ISTAT is zero.

The following general rules apply to the value of ISTAT:

Value of ISTAT	Meaning
ISTAT = 0	No message
-111111 < ISTAT < 0	An error occurred (see technical description)
ISTAT < -111111	One or more weather variables are missing and cannot be supplied.
ISTAT > 111111	One or more weather variables were obtained either by interpolation or were estimated in some other way.

Summarizing, if an error occurs (e.g. data file does not exist) the value of ISTAT is negative but greater than '-111111'. Less than '-111111' is reserved for cases where one or more variables are missing and cannot be obtained at all. Positive values of ISTAT larger than '111111' indicate situations where all weather variables could be supplied, but one or more values were obtained by interpolation or estimated in some way (see below).

Missing data

Missing data are treated differently depending on variable type and timing of occurrence. In general the reading program will try to estimate the missing data by interpolation between adjacent values. There are however, some exceptions. Rainfall is not interpolated because it is too erratic and the results of crop growth models are often very sensitive to rainfall. Interpolation is also not carried out if data on either side are missing as at the beginning and the end of the year.

There are, however, some situations where it is possible to provide better estimates of the missing data by careful estimation than by interpolation only. Sometimes data from stations in the vicinity are available so that missing data can be obtained from the other station. Sometimes missing data can be derived from long term averages for the period that is missing. The estimated data are given a special code in the data files so that the reading program can recognize them. For a detailed description of the procedure to add estimated data to the data file see Chapter III.

Summarizing, for each weather variable, four different cases can be distinguished (for rainfall three): the weather variable is 1) measured, 2) interpolated, 3) estimated or 4) not available (no interpolation or estimation possible).

This is reflected in the value of ISTAT if its value pertains to some status of the weather data (ISTAT < -111111 or ISTAT > 111111). The six digits of the value of ISTAT represent the six different weather variables, with the value of each of the digits representing the status of that particular weather variable.

Digit number	Variable
1	Radiation
2	Minimum temperature
3	Maximum temperature
4	Vapour pressure
5	Wind speed
6	Rainfall

The value of a digit can be between 1 and 4:

Digit value	Meaning
1	Measured
2	Interpolated
3	Estimated
4	Not available

Examples:

ISTAT value	Meaning
122111	Minimum and maximum temperature interpolated
113321	Maximum temperature and vapour pressure estimated, wind speed interpolated
-111114	Rainfall not available, NOTE: if one or more variables are missing the value of ISTAT is negative.

To facilitate the check on the ISTAT value in the user's program, ISTAT is zero if all weather variables are available from measurements. So if ISTAT is in fact '111111' it is set to zero.

Sunshine hours in relation to radiation

Weather data may be recorded in different ways with various instruments. Therefore often a unit conversion has to be applied to the data to transform them into the desired units for the data files. For conversion of relative humidity or wet bulb temperature to vapour pressure, standard equations can be applied that provide good accuracy.

Often daily sunshine duration is recorded using a Campbell-Stokes sunshine recorder rather than radiation by an integrating solarimeter. For the purpose of crop growth simulation however, daily incoming global radiation is needed. The conversion of sunshine duration to radiation is most often done by the Ångström formula using two site-specific regression constants (A and B). As often no local values of A and B are available, values from nearby stations or from comparable climates are used, which may lead to considerable error.

To easily allow for the use of more accurate estimates of A and B if becoming available, we have adopted the following approach. If the weather station recorded solar radiation directly, that is used in the data file and two zero or negative values for A and B are entered into the data file (these are passed to the calling program with their sign reversed). If the weather station recorded sunshine duration, these values are entered into the data file in combination with the best estimates for A and B (these are passed to the calling program unchanged). Because the reading program returns radiation instead of sunshine hours to the calling program, it converts while reading the data file. (Note: The reading program recognizes which of the two types of data are used by the values of A and B).

A possibility exists to replace the predefined A and B by values supplied by the user in the data file by a call to a special routine. Directly after a call to STINFO, a call to the subroutine SETAB with the new A and B values will replace the predefined values with the ones supplied by the calling program. Radiation values returned by WEATHR are now calculated using the new A and B. Note that this can only take place when radiation was recorded in the data file as sunshine hours. For a formal definition of SETAB see Section 2.4.

Leap years

Data for the 29th of February have, in cases they were available, not been omitted in the data files. Consequently, data files from leap-years consist of 366 records that are accessible with day number values between 1 and 366. If, by accident, the user requests data for day 366 and the year is not a leap-year, the reading program will report missing weather data and return the associated value (-99).

2.2. Technical description of the subroutine STINFO

Name:

SUBROUTINE STINFO

Purpose:

The subroutine STINFO is meant to be used in combination with the subroutine WEATHR to provide weather variables in standardized units to crop growth simulation programs. STINFO requires user variables to define the station information such as country, station number and year and some additional settings. Returned to the user are (if the search was successful) some station information such as location parameters (longitude, latitude and altitude).

Implementation:

```
CALL STINFO (list of 12 arguments)
```

Arguments:

Name	Type	Unit	Input or Output
IFLAG	INTEGER*4	-	Input
PATH	CHARACTER*(*)	-	Input
LOGF	CHARACTER*(*)	-	Input
COUNTR	CHARACTER*(*)	-	Input
ISTN	INTEGER*4	-	Input
IYEAR	INTEGER*4	-	Input
ISTAT	INTEGER*4	-	Output
LONG	REAL*4	Degrees	Output
LAT	REAL*4	Degrees	Output
ALT	REAL*4	m	Output
A	REAL*4	-	Output
B	REAL*4	-	Output

IFLAG

The value of IFLAG indicates where errors and warnings of STINFO are to be directed (screen and/or log file). The highest value that IFLAG may attain is '1111' but it should be considered as a sequence of four digits that can either be '1' or '0' (zero), each indicating a specific command. The commands specified are, 1) warnings to log file, 2) errors to log file, 3) warnings to screen, 4) errors to screen, defined from left to right in the four digit number. A '1' triggers the command a zero inactivates it. So, '1111' means warnings and errors to both log file and screen, '1001' means warnings to log file and errors to screen. As IFLAG is a value and not a string, '0011' (warnings and errors to screen) for example can be written as '11'.

Note: If a warning flag is on while a new weather file is requested, the header of the data file is sent to the screen or log file where the flag is pointing to. If a warning flag is 'switched' on while the weather file is not changed only warnings will be shown.

`PATH`

The string variable PATH contains the name of the directory in which the weather data are stored. If the string contains only blanks, the data will be searched on the current directory. For technical reasons, supply at least one space character ('<space>') if the current directory is wanted.

`LOGF`

The string variable LOGF, if not consisting of space characters, contains the name of the log file that replaces the default name 'WEATHER.LOG'. Similarly to PATH, supply at least one space character '<space>' .

`COUNTR`

This string variable contains the name or the abbreviation of the country from which weather data are wanted. The maximum length is 6 characters. For a list of currently available country names see Chapter IV. An example is 'BDESH' which is the acronym for Bangladesh.

`ISTN`

The integer variable ISTN refers to the station number of the meteorological station selected. Wageningen is assigned '1' and Swifterbant is assigned '2' for instance. The country name and the station number fully describe the station. The station number must be between '1' and '999'.

`IYEAR`

The integer variable IYEAR indicates the year for which weather data are requested. The value should be given as '19xx' (e.g. '1988').

`ISTAT`

ISTAT is a status variable that indicates the degree of success of the call to STINFO. ISTAT values and their interpretation are:

0	Normal situation,
-2	Wrong IFLAG value,
-3	IYEAR has wrong value,

-4	String size of COUNTR zero or more than six characters,
-5	Station code ISTN less or equal to zero or more than 99,
-12	Cannot open requested data file,
-13	Cannot open log file,
-14	Unexpected end of file,
-15	Error during reading of the data file,
-16	Cannot write to log file.

`LONG`

The longitude of the station, northern latitudes are positive. In case not available: -199.

`LAT`

The latitude of the station, east is positive. In case not available: -99.

`ALT`

Altitude of the station. In case not available: -99.

`A`

First coefficient of the Ångström formula. The value can be modified by a call to SETAB if radiation was recorded as sunshine hours (see Section 2.4). In case not available: -99.

`B`

Identical for second coefficient.

2.3. Technical description of the subroutine WEATHR

Name:

`SUBROUTINE WEATHR`

Purpose:

The subroutine WEATHR supplies weather variables from data files to crop growth simulation models. It supplies actual weather data in standard units only after station and year have been defined by a call to the subroutine STINFO.

Implementation:

```
CALL WEATHR (list of 8 arguments)
```

Arguments:

Name	Type	Unit	Input or Output
IDAY	INTEGER*4	d	Input
ISTAT	INTEGER*4	-	Input
RAD	REAL*4	$kJ/m^2/d$	Output
TMIN	REAL*4	Celsius	Output
TMAX	REAL*4	Celsius	Output
VAPOUR	REAL*4	kPa	Output
WIND	REAL*4	m/s	Output
RAIN	REAL*4	mm/d	Output

IDAY

Day number for which weather data are requested. The value of IDAY can vary between 1 and 365., in leap-years 366. An error will occur if the value of IDAY is outside this range.

ISTAT

ISTAT is a status variable that indicates the degree of success of the call to WEATHR. For a description of ISTAT see Section 2.1. ISTAT values and their interpretation are:

0	Normal situation,
-1	Wrong day,
-13	Cannot open log file,
-16	Cannot write to log file,
-21	WEATHR called without call to STINFO or error from STINFO.

In case ISTAT is less than '-111111' or larger than '111111', ISTAT refers to some abnormal situation with respect to the weather data. Each of the six digits of ISTAT now represents one of the variables. From left to right these are 1) radiation, 2) minimum temperature, 3) maximum temperature, 4) vapour pressure, 5) wind speed, 6) rainfall. A digit value of '1' indicates measured, '2' interpolated, '3' estimated, '4' not available. If one or more values are missing for a particular day, so that at least one of the digits is a '4', ISTAT assumes a negative value. Otherwise it is returned as a positive value.

RAD

Daily global radiation in $kJ/m^2/d$. If not available -99.

TMIN

Daily minimum temperature in degrees Celsius. If not available -99.

`TMAX`

Daily maximum temperature in degrees Celsius. If not available -99.

`VAPOUR`

Vapour pressure in kPa. If not available -99.

`WIND`

Average daily wind speed in m/s. If not available -99.

`RAIN`

Daily amount of rain in mm/d. If not available -99.

2.4. Technical description of the subroutine SETAB

Name:

`SUBROUTINE SETAB`

Purpose:

The subroutine SETAB enables the user to supply his or her Ångström A and B values in case radiation was given in sunshine hours in the data file. The use of this routine is provided to allow users to bypass the default A and B values in the data file. This routine should not be used when radiation was measured in the usual energy units (in that case A and B are both zero or negative). The call to SETAB should be done prior to any WEATHR call but after a STINFO call.

Implementation:

`CALL SETAB (list of 2 arguments)`

Arguments:

Name	Type	Unit	Input or Output
A	REAL*4	-	Input
B	REAL*4	-	Input

A

A value of Ångström formula

B

B value of Ångström formula

2.5. Implementation notes

When using the reading program it is useful to know that a call to the subroutine STINFO is relatively time consuming while calling the subroutine WEATHR is very fast. The reason is that STINFO reads all data and stores them in memory. After a (dynamic) call to WEATHR only six values are supplied from the data already available in memory. When implementing STINFO and WEATHR in a simulation environment with multiple seasons, countries or sites the organization should preferably be such that the number of calls to the subroutine STINFO is minimized.

2.6. Examples of the use of the weather system

2.6.1. Use of the reading program in a FORTRAN crop simulation model

See Section 2.1 for an example.

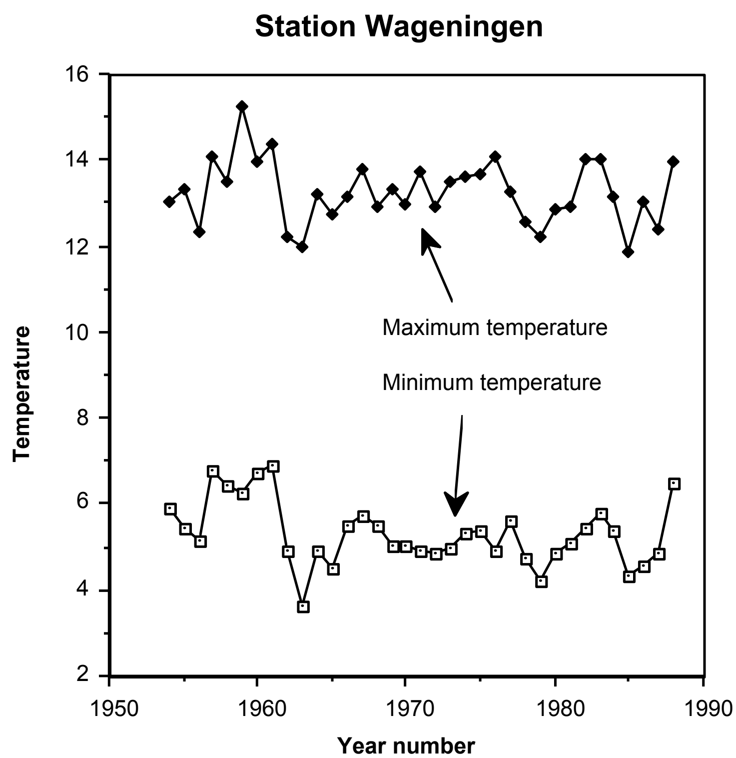
2.6.2. Generation of average annual minimum and maximum temperatures for a sequence of years.

This example demonstrates the use of the reading program.

```
*     This program calculates annual average minimum and maximum
*     temperatures for a sequence of years. Output is written to file.

      PROGRAM AVERAG
      IMPLICIT REAL (A-Z)
      INTEGER ISTN, IYEAR, I1, I2, IDAY, ISTAT
      CHARACTER COUNTR*80

*     Read country name, station number, start year, and end year
*     from the terminal.

      WRITE (*,'(A$)') ' COUNTRY:'
      READ (*,'(A)') COUNTR

      WRITE (*,'(A$)') ' STATION NUMBER:'
      READ (*,*) ISTN

      WRITE (*,'(A$)') ' START YEAR:'
      READ (*,*) I1

      WRITE (*,'(A$)') ' END YEAR:'
      READ (*,*) I2

*     open output file
      OPEN (40,FILE='RESULTS.DAT',STATUS='NEW')

*     loop over years and days. For each year each day is requested.
      DO 5 IYEAR=I1,I2

*        define station parameters
         CALL STINFO (1111,'C:\SYS\WEATHER\',' ',COUNTR,
     &                   ISTN, IYEAR,
     &                   ISTAT,  LONG, LAT, ALT, A, B)
         IF (ISTAT.NE.0) WRITE (*,'(A,I7)') ' ISTAT=', ISTAT

*        set average values to zero before executing calculations
         TMINAV = 0.
         TMAXAV = 0.

         DO 10 IDAY=1,365
```

```
*           request weather data
            CALL WEATHR (IDAY,ISTAT,
     &                     RAD, TMIN, TMAX, VAPOUR, WIND, RAIN)
            IF (ISTAT.NE.0) WRITE (*,'(A,I7)') ' ISTAT=', ISTAT

            TMINAV = TMINAV + TMIN
            TMAXAV = TMAXAV + TMAX
10       CONTINUE

*        calculate annual average
         TMINAV = TMINAV/365.
         TMAXAV = TMAXAV/365.

*        write output to file
         WRITE (40,'(I5,2(A,F8.2))') IYEAR, CHAR(9), TMINAV,
     &                               CHAR(9), TMAXAV
5     CONTINUE

      CLOSE (40)
      STOP
      END
```

When presented graphically, the following result for the Netherlands (Wageningen) appears:



2.6.3. Use of the reading program in CSMP

The example below shows the communication between a CSMP-main program and the AB/TPE weather system. In the initial section the variables IDAY, IYEAR, and ISTAT should be declared fixed (integer). The variables PATH, LOGF(ile) and COUNTR(y) are declared as character strings. The string PATH contains the logical name 'WEATHER_DATA:' This logical name is assigned by the system manager to a physical computer area where the weather data files are stored. The string LOGF instructs the reading program where to direct the log files (if wanted). If these strings are empty, the reading program reads from and writes to the current directory. The character string COUNTR contains the name of the country from which data are requested.

The call to subroutine STINFO should be placed in the initial section of the CSMP-program as demonstrated below. The (dynamic) call to the subroutine WEATHR should be placed in the dynamic section of the CSMP-program. As usual with calls to FORTRAN-subroutines from CSMP-main programs the output parameters of the subroutine are defined to the left of the equal sign which is followed by the name of the routine and the consecutive input variables. During the translation phase this is converted to a normal FORTRAN call.

```
TITLE SUCROS MAIZE
INITIAL
   FIXED IFLAG, IDAY, IYEAR, ISTAT

/       CHARACTER*80 PATH, LOGF
/       CHARACTER*6 COUNTR
/       DATA PATH /'WEATHER_DATA:'/
/       DATA LOGF /' '/, COUNTR/'NL'/
/       DATA IYEAR /1985/
/       DATA IFLAG /1111/
NOSORT
      CALL STINFO (IFLAG, PATH, LOGF, COUNTR, 1, IYEAR,...
                   ISTAT, LONG, LAT, ALT, A, B)
SORT

DYNAMIC
   IDAY = DAY
   ISTAT, RAD, TMIN, TMAX, VAPOUR, WIND, RAIN = WEATHR (IDAY)

*  Dry  weights  of  leaves(green  and  dead),stems,storage
organs,roots
* and total above-ground biomass (kg DM/ha) as integrals of
growth
* rates

      WLVG  = INTGRL (0.,GLV-DLV)
      WLVD  = INTGRL (0.,DLV)
      WLV   = WLVG + WLVD
      WST   = INTGRL (0.,GST)
      WSO   = INTGRL (0.,GSO)
      WRT   = INTGRL (0.,GRT)
<ETC.>
```

3. Data file description

Introduction

This section of the user-manual provides information on the organization of the data files. Although the data can be accessed through the reading program (see Chapter II), this information is useful for anyone who has collected his own weather data and wants to use the reading program to access them.

3.1. Available weather variables

The weather data files contain data for six meteorological variables: global radiation, minimum temperature, maximum temperature, vapour pressure, wind speed and precipitation, all stored in standard units. The variables that should be available, with their units, are given below:

VARIABLE	UNITS
global radiation	kilo Joule per square meter per day or hours sunshine per day
minimum temperature	degrees Celsius
maximum temperature	degrees Celsius
vapour pressure	kilo Pascal
wind speed	meters per second
precipitation	millimeters per day

All conversions applied to the originally recorded data are 'hard' (e.g. conversion from degrees Fahrenheit to degrees Celsius), except the conversion of daily sunshine duration to kilo Joule per square meter per day. Therefore, if sunshine hours were measured they should be entered in the data file as such and conversion to global radiation is effectuated by the reading program by applying the Ångström formula using two location-specific regression coefficients. Estimates of the latter should be supplied in the data file if sunshine duration is the basis of the solar radiation. Alternatively, if global radiation is measured and entered into the data file, these coefficients should be zero or negative (negative values are passed to the user's program but are not used for conversion). As conversion is executed in the reading program, the user can change the supplied coefficients at wish. (See Section 2.4).

3.2. Outline of a data file

A weather data file consist of four parts: a file header containing some explanatory text, one line with location parameters of the station, lines with measured data and, optionally, so-called status lines giving information on the way missing data should be handled by the reading program.

3.2.1. File header

The file header is a continuous block of lines that start with an asterisk ('*') in the first column. The file header contains general information about the data and their origin.

File headers of weather data files in the weather system contain: the name of the station, the author of the file, the original source, comments about missing or substituted data or possible conversions, the longitude and latitude of the site in degrees and minutes and the altitude of the site in meters above sea level. In addition an explanation is given of the placement of the variables in the columns.

As an example the file header from the file NLD1.986 (The Netherlands, Wageningen, 1986) is given below:

```
<beginning of file>
*---------------------------------------------------------*
* Station name: Wageningen (Haarweg), Netherlands
* Author: Peter Uithol                  -99.000: NIL VALUE
* Source: Natuur- en Weerkunde via Nel van Keulen
*
* Comments: Missing values are substituted with daily
*           weather data from synoptic station de Bilt,
*           Netherlands
*
* Longitude: 5 40 E, latitude: 51 58 N, altitude: 7 m.
* Column  Daily value
* 1       station number
* 2       year
* 3       day
* 4       irradiation                   (kJ m-2 d-1)
* 5       minimum temperature           (degrees Celsius)
* 6       maximum temperature           (degrees Celsius)
* 7       early morning vapour pressure (kPa)
* 8       mean wind speed               (m s-1)
* 9       precipitation                 (mm d-1)
*---------------------------------------------------------*
```

<location parameter line>

<weather data lines>

<end of file>

3.2.2. Location parameter line

Location parameters are stored in the data file in the first line following the file header. These data are provided to the user as output parameters after a call to the subroutine STINFO for that specific site. The line contains the values of longitude, latitude, altitude and coefficients A and B for the Ångström formula . If A and B are both positive, the radiation data are assumed to be measured as sunshine hours and A and B are used in the Ångström formula. If A and B are both zero or negative, the radiation data are assumed to be measured as kilo Joule per square meter per day. In that case are the values passed to the calling program with a positive sign.

For example, the location parameter line for Wageningen (meteorological station Haarweg) is;

```
5.67  51.97  7.00  0.00 0.00
```

The values should be separated by at least one space character and thus need not be written in a strict format. The representation of longitude and latitude is defined as 'n.m' where 'n' is in degrees and 'm' is in decimal degrees. So 28° 30' must be entered as 28.5.

3.2.3. Meteorological data line

Following the location line, the meteorological data are stored. The order of the variables on each line is station number, year number, day number, global radiation, minimum temperature, maximum temperature, vapour pressure, wind speed and precipitation. Day numbers range normally from 1 to 365, or to 366 in leap years. An example of part of a data file is shown below.

```
1 1986   1   670.  -7.0  -1.9   0.4   3.8   0.0
1 1986   2   940.  -2.7  -99.   0.6   3.9   4.2
1 1986   3   520.  -3.9  -99.   0.6   2.2   5.6
1 1986   4  2830.  -3.2  -99.   0.5   2.7   2.8
1 1986   5   490.  -0.7   0.8   0.6   3.8   3.3
```

Missing data are recognized by the reading program if they are coded with -99.

3.2.4. Status line

If data are not available but can be estimated from other stations, it is necessary to mark the estimated data in the data file. This is done by the status line that indicates the origin for each of the six variables. In the example below the fourth variable (vapour pressure) from day 117 onwards was not measured but estimated.

```
   1 1986 116  9340.   3.8  14.8   1.0   2.4   0.6
-999 1986 117     1      1     1     3     1     1
   1 1986 117  9020.   6.5  14.5   1.0   1.0   0.0
   1 1986 118 11960.   8.5  15.0   1.1   2.4   5.2
   1 1986 119 15400.   4.8  15.1   1.3   3.2   0.0
-999 1986 120     1      1     1     1     1     1
   1 1986 120 13540.   7.3  13.8   1.0   1.7   0.1
```

The status line begins with -999 and is followed by eight values. The first two are dummy values for year and station, the remaining six represent attributes for the weather variables. These attributes can have values between one and four. '1' : measured, '2': interpolated, '3': estimated from another meteorological station and '4': not available.

As shown in the example, the status line refers to the lines following it until it has been replaced by a new status line.

If all weather variables are missing on a day and no estimates can be made, complete lines with missing values can be left out. The reading program returns values of the variables on missing days by linear interpolation between available data (except for rainfall).

4. Selection of currently available data

Below is a selection of standardized data files that are currently available. Year number 1000 indicates long term average data.

Country name	Station name	Country code	Station code	Years
Austria	Wien	AUSTRI	1	2: 1985-1986
Bangladesh	Joydebpur	BDESH	1	3: 1983-1984, 1986
Belgium	Uccle	BELG	1	4: 1985-1987, 1000
China	Nanjing	CHINA	1	2: 1983-1984
Colombia	Palmira	COLOM	1	4: 1983-1986
Cyprus	Akhelia	CYPRUS	1	2: 1985-1986
Denmark	Thorshavn	DK	1	1: 1000
Denmark	Ålborg	DK	2	1: 1000
Denmark	København / Landbohojskolen	DK	3	1: 1000
Denmark	Roskilde	DK	4	2: 1985-1986
Egypt	Sakha	EGYPT	1	1: 1984
France	Marseille / Marignane	FRANCE	1	1: 1000
France	Nice / Côte d' Azur	FRANCE	2	1: 1000
France	Perpignan	FRANCE	3	1: 1000
France	Ajaccio / Campo del	FRANCE	4	1: 1000
France	Tours	FRANCE	5	1: 1000
France	Le Puy en Velay	FRANCE	6	1: 1000
France	Biarritz	FRANCE	7	1: 1000
France	Les Escaldes	FRANCE	8	1: 1000
France	Brest / Guipavas	FRANCE	9	1: 1000
France	Trappes	FRANCE	10	1: 1000
France	Paris / Le Bourget	FRANCE	11	1: 1000
France	Nancy / Essey	FRANCE	12	1: 1000
France	Strasbourg / Entzhe	FRANCE	13	1: 1000
France	Nantes	FRANCE	14	1: 1000
France	Bourges	FRANCE	15	1: 1000
France	Dijon	FRANCE	16	1: 1000
France	Limoges / Bellegard	FRANCE	17	1: 1000
France	Lyon / Bron	FRANCE	18	1: 1000
France	Bordeaux / Mérignac	FRANCE	19	1: 1000
France	Toulouse / Blagnac	FRANCE	20	1: 1000
France	Nîmes / Courbessac	FRANCE	21	1: 1000
France	La Minière (Versailles)	FRANCE	22	2: 1983-1984
France	Grignon (Versailles)	FRANCE	23	2: 1985,1987

France	Le Rheu (Rennes)	FRANCE	24	2: 1987-1988
France	Dijon	FRANCE	25	2: 1985-1986
France	La Revanche-Lectoure	FRANCE	26	4: 1986-1989
Germany	Schleswig	GERM	1	1: 1000
Germany	Hamburg / Fuhlsbutt	GERM	2	1: 1000
Germany	Emden-Nesserland	GERM	3	1: 1000
Germany	Hannover	GERM	4	1: 1000
Germany	Berlin / Tempelhof	GERM	5	1: 1000
Germany	Essen	GERM	6	1: 1000
Germany	Kassel	GERM	7	1: 1000
Germany	Geisenheim	GERM	8	1: 1000
Germany	Stuttgart / Cannstadt	GERM	9	1: 1000
Germany	Nürnberg	GERM	10	1: 1000
Germany	München / Riem	GERM	11	1: 1000
Germany	Zugspitze	GERM	12	1: 1000
Germany	Kahler Asten	GERM	13	1: 1000
Germany	Feldberg	GERM	14	1: 1000
Germany	Kiel	GERM	15	5: 1000, 1983-1986
Germany	Göttingen	GERM	16	2: 1985-1986
Germany	Höhenheim	GERM	17	2: 1985-1986
Greece	Thessaloniki / Mikr	GREECE	1	1: 1000
Greece	Kerkyra	GREECE	2	1: 1000
Greece	Athinai / Nat. Obs	GREECE	3	1: 1000
Greece	Athinai / Helleniko	GREECE	4	1: 1000
Greece	Kalamath	GREECE	5	1: 1000
Greece	Hiraklion / Crete	GREECE	6	1: 1000
Greece	Kawala	GREECE	7	1: 1000
Greece	Tricala	GREECE	8	1: 1000
Greece	Larisa	GREECE	9	1: 1000
India	Patancheru, ICRISAT	INDIA	1	10: 1975-1984
India	Bijapur, Karnataka	INDIA	2	10: 1971-1980
India	Coimbatore	INDIA	3	3: 1983-1985
India	Cuttack	INDIA	4	3: 1983-1985
India	Hyderabad	INDIA	5	2: 1983-1984
India	Kapurthala	INDIA	6	3: 1983-1985
India	Pattambi	INDIA	7	3: 1983-1985
Indonesia	Muara	INDON	1	2: 1983-1984
Indonesia	CRIFC/Sukamandi (West Java)	INDON	2	3: 1983-1985
Ireland	Belfast / Aldergrov	IRL	1	1: 1000
Ireland	Valentia Observat	IRL	2	1: 1000
Ireland	Cork (Airport)	IRL	3	1: 1000
Ireland	Shannon (Airport)	IRL	4	1: 1000

Ireland	Dublin (Airport)	IRL	5	1: 1000
Ireland	Belmullet	IRL	6	1: 1000
Ireland	Malin Head	IRL	7	1: 1000
Ireland	Carlow Dublin	IRL	8	2: 1985-1986
Israel	Gilat (Migda)	ISR	1	23: 1962-1984
Israel	Bet Dagan	ISR	2	1: 1988
Italy	Milano / Linate	ITALY	1	1: 1000
Italy	Verona / Villafranc	ITALY	2	1: 1000
Italy	Venezia / Tessera	ITALY	3	1: 1000
Italy	Trieste	ITALY	4	1: 1000
Italy	Pisa / S. giusto	ITALY	5	1: 1000
Italy	Pescara	ITALY	6	1: 1000
Italy	Roma / Fiumicino	ITALY	7	1: 1000
Italy	Napoli / Capodichin	ITALY	8	1: 1000
Italy	Brindisi	ITALY	9	1: 1000
Italy	Messina	ITALY	10	1: 1000
Italy	Trapani / Birgi	ITALY	11	1: 1000
Italy	Catania / Fontanaro	ITALY	12	1: 1000
Italy	Alghero	ITALY	13	1: 1000
Italy	Cagliari / Elmas	ITALY	14	1: 1000
Italy	Udine Rivolto	ITALY	15	1: 1000
Italy	Ancona	ITALY	16	1: 1000
Italy	L'Aquila	ITALY	17	1: 1000
Italy	Foggia	ITALY	18	1: 1000
Italy	Potenza	ITALY	19	1: 1000
Italy	Policoro	ITALY	20	3: 1986-1988
Kenya	Ahero	KENYA	1	1: 1986
Luxembourg	Clerveaux	LUX	1	1: 1000
Luxembourg	Luxembourg / Findel	LUX	2	1: 1000
Mali	Station du Sahel (Niono)	MALI	1	4: 1976-1979
Mali	Mopti-Sevare	MALI	2	32: 1000,1959-1989 [1]
Mali	Bankass	MALI	3	30: 1959-1988 [1]
Mali	Koro	MALI	4	30: 1959-1988 [1]
Mali	Djenne	MALI	5	30: 1959-1988 [1]
Mali	Douentza	MALI	6	30: 1959-1988 [1]
Mali	Hombori	MALI	7	30: 1959-1988 [1]
Mali	Niafunke	MALI	8	30: 1959-1988 [1]
Mali	Sarafere	MALI	9	5: 1965,1973,1986-1988 [1]
Mali	Tonka	MALI	10	2: 1961-1962 [1]
Mali	Samanko (Bancoumana)	MALI	11	4: 1983-1986

[1] Rainfall only

Mali	Samanko (Makandiana)	MALI	12	4: 1983-1986
Nepal	Parwanipur	NEPAL	1	2: 1983-1984
Netherlands	Wageningen (Haarweg)	NLD	1	38: 1954-1991,1000
Netherlands	Swifterbant	NLD	2	16: 1974-1989
Netherlands	De Kooy (Den Helder)	NLD	3	10: 1976-1985
Netherlands	De Bilt	NLD	4	1: 1000
Netherlands	Zuid Limburg (Beek airport)	NLD	5	2: 1987-1988
Netherlands	Eelde Airport	NLD	6	1: 1987
Netherlands	Lelystad (Exp. farm)	NLD	7	4: 1987-1990
Netherlands	Valthermond	NLD	8	1: 1988
Netherlands	Randwijk	NLD	9	2: 1980,1988
Netherlands	Vredepeel	NLD	10	1: 1986,1987
Netherlands	Vlissingen	NLD	11	3: 1986-1988
Netherlands	De Bilt	NLD	12	30: 1959-1988
New Zealand	Lincoln	NZ	1	4:1984-1987
Nigeria	Samaru	NIGIA	1	5: 1980-1984
Pakistan	Dokri	PAKIS	1	1: 1986
Peru	San Camilo	PERU	1	2:1981-1982
Philippines	IRRI wet station site	PHIL	1	11: 1979-1989
Philippines	IRRI dry station site	PHIL	2	11: 1979-1989
Philippines	Masapang	PHIL	3	1: 1984
Philippines	Los Baños (UPLB)	PHIL	4	26: 1959-1984
Portugal	Santa Maria / Acores	PORT	1	1: 1000
Portugal	Lisboa / Portela	PORT	2	1: 1000
Portugal	Porto / Pedras Ruba	PORT	3	1: 1000
Portugal	Faro	PORT	4	1: 1000
Portugal	Beja	PORT	5	1: 1000
Portugal	Penhas Douradas	PORT	6	1: 1000
Portugal	Braganca	PORT	7	1: 1000
Senegal	Nioro du Rip	SENEG	1	1: 1988
South Korea	Milyang	SKREA	1	2: 1983-1984
South Korea	Suweon	SKREA	2	2: 1983-1984
Spain	La Coruña	SPAIN	1	1: 1000
Spain	Valladolid	SPAIN	2	1: 1000
Spain	Madrid / Retiro	SPAIN	3	1: 1000
Spain	Mahon Menorca / SA	SPAIN	4	1: 1000
Spain	Badajoz	SPAIN	5	1: 1000
Spain	Barcelona	SPAIN	6	1: 1000
Spain	Palma De Mallorca	SPAIN	7	1: 1000
Spain	Ponta Delgada / AC	SPAIN	8	1: 1000
Spain	Santander	SPAIN	9	1: 1000
Spain	Leon	SPAIN	10	1: 1000
Spain	Soria	SPAIN	11	1: 1000

Spain	Zaragoza	SPAIN	12	1: 1000
Spain	Ciudad Real	SPAIN	13	1: 1000
Spain	Murcia	SPAIN	14	1: 1000
Spain	Cordoba	SPAIN	15	1: 1000
Spain	Granada	SPAIN	16	1: 1000
Spain	Malaga	SPAIN	17	1: 1000
Spain	Madrid Ciudad Universitaria	SPAIN	18	2: 1987-1988
Spain	San Esteban De Gomaz	SPAIN	19	1: 1988
Sri Lanka	Paranthan	SRILA	1	3: 1983-1985
Switzerland	Santis	SWIT	1	1: 1000
Syria	Breda	SYRIA	1	8: 1980-1986, 1988
Syria	Ghreriffe	SYRIA	2	2: 1985-1986
Syria	Jindiress	SYRIA	3	7: 1980-1986
Syria	Kafr Antoon	SYRIA	4	4: 1980-1983
Syria	Khanasser	SYRIA	5	7: 1980-1986
Syria	Tel Hadya	SYRIA	6	11: 1978-1986, 1989-1990
Syria	Homs	SYRIA	7	3: 1988-1990
Syria	Izra'a	SYRIA	8	3: 1988-1990
Taiwan	Pingtun	TAIW	1	3: 1983-1985
Thailand	Sanpatong	THAIL	1	4: 1983--1986
United Kingdom	Dalwhinnie	UK	1	1: 1000
United Kingdom	Lerwick	UK	2	1: 1000
United Kingdom	Stornoway	UK	3	1: 1000
United Kingdom	Aberdeen / Dyce	UK	4	1: 1000
United Kingdom	Tiree	UK	5	1: 1000
United Kingdom	Edurgh / Royal	UK	6	1: 1000
United Kingdom	Eskdalemuir	UK	7	1: 1000
United Kingdom	Valley	UK	8	1: 1000
United Kingdom	Manchester Airport	UK	9	1: 1000
United Kingdom	Waddington	UK	10	1: 1000
United Kingdom	Birmingham Airport	UK	11	1: 1000
United Kingdom	Glamorgan / Rhouse	UK	12	1: 1000
United Kingdom	London / Gatwick	UK	13	1: 1000
United Kingdom	Plymouth / Mount	UK	14	1: 1000
United Kingdom	Durnemouth / Hurn	UK	15	1: 1000
United Kingdom	Cambridge	UK	16	2: 1985-1986
United Kingdom	Cambridge	UK	16	4: 1985-1988
United Kingdom	Sutton Bonington	UK	17	6: 1980-1985
United Kingdom	Mlynefield	UK	18	3: 1985-1987
United Kingdom	Invergowree	UK	19	4: 1984-1987
United States	Hancock, Wisconsin	USA	1	3: 1985-1987
United States	Bakersfield, California	USA	2	1: 1988

United States	Davis, California	USA	3	1: 1000
United States	Ithaca, New York	USA	4	1: 1987
United States	Tulelake, California	USA	5	1: 1988