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Description of a software library for the calculation of surface fluxes

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INTRODUCTION

The surface fluxes of heat, water vapor and momentum determine to great extent the state of the atmospheric boundary layer. As such these fluxes are the principal boundary conditions for e.g. weather models, air pollution models and engineering applications (see e.g. [9] for a review). In principle, the surface fluxes can be measured. Often, however, such measurements are not available or not complete. At KNMI a number of parameterizations have been developed to estimate the surface fluxes from available routine weather observations. In this report a comprehensive set of Fortran-77 routines is described, which are based on these parameterization schemes. They can be applied to observations above land as well as over sea.

Four basic routines are available namely FLXLN1, FLXLN2, FLXLN3 and FLXSE1. These routines make use of a number auxiliary routines, which are also accessible to the user. FLXLN1 computes fluxes from profiles measured at two heights whereas FLXLN2 makes use of the procedures developed by Holtslag and Van Ulden[6] and requires routine weather observations only. FLXLN2 can be called with wind speed and cloud cover only, but also accepts measured short wave radiation as input. FLXLN3 should be used if the net radiation is measured directly. FLXSE1 uses routine weather observations over water (wind, air and water temperature).

The basic philosophy is to provide optimal results for any situation. The level of parameterization depends on the availability of observations. If profile measurements are available, a profile method is employed. If routine observations are the only available data, the full parameterization is used. The latter starts with the solar elevation and cloud cover, computes the short wave radiation, the net radiation, the Bowen ratio and outputs the surface fluxes of latent and sensible heat. If the short wave radiation is measured, the procedure skips over the first part. If the net radiation is measured it is recommended to employ FLXLN3, which uses the net radiation without modelling it.

Four demo programs show how to use FLXLN1, FLXLN2, FLXLN3 and FLXSE1 respectively. The Fortran routines are in three files: FLUXLIB1.FOR, FLUXLIB3.FOR and ZEROAB.FOR. The object code of all these routines is contained in library file FLUXLIB.LIB, which can be linked with user programs that are compiled with RM-Fortran on the IBM-PC. The source code can be used on any computer that accepts Fortran-77 code.

In Fig. 1 an example is given of the diurnal variation of the sensible and latent heat flux (H and λE) calculated with the full parameterization in comparison with observations. Here two days of May 1988 are used. It is seen that the agreement between calculations and observations is reasonable in general. For a more detailed comparison and a discussion of the problems associated with the parameterization we refer to [6,8,12].

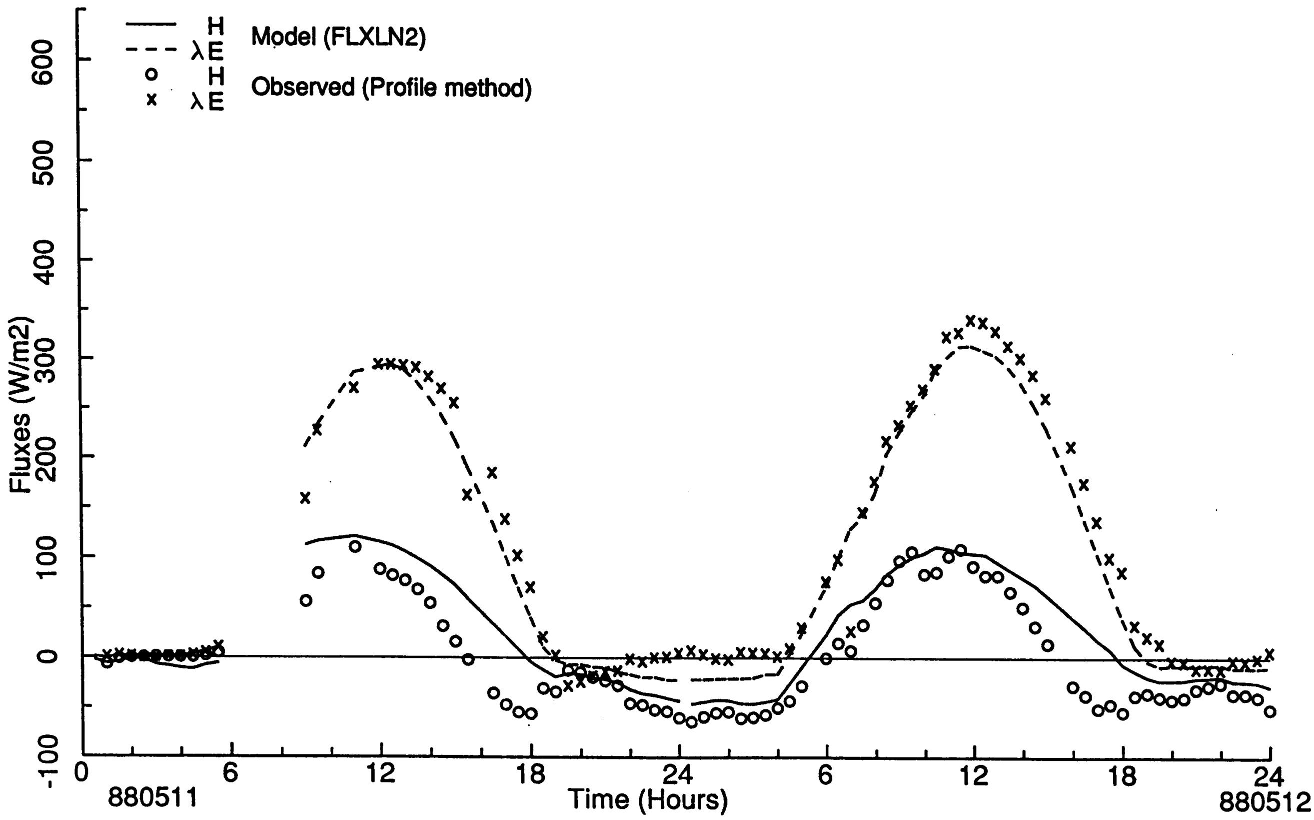

Fig. 1 Output of FLXLN2 compared with data of May 11 and 12, 1988 at Cabauw in The Netherlands. FLXLN2 uses the full parameterization with as input: wind speed at 10 m height, terrain roughness length and cloud cover.

GENERAL USER INFORMATION

- The routines in the library have been coded in Fortran-77 and can be used on any computer that supports F77. In general, the source code should be compiled and linked to the user-program. It is often convenient to put the compiled code into a library; in this way only those routines are linked to the user program that are actually needed.

- On an IBM (or compatible) personal computer (with co-processor) the executable code of the DEMO-programs can be run directly. If RM-Fortran is used, there is no need to recompile the subroutines; they already are available in library FLUXLIB.LIB. Any user program compiled with RM-Fortran can be linked with this library.

- The physical constants as air density, vaporization heat etc. are stored in common block FYSCOM. The parameters that are related to the characteristics of the surface and the soil are stored in common block SRFCOM. The library routines, that need these common blocks, call the initialization routine INTFYS or INTSRF to fill them with default values, valid for T=10 C and P=1005 mbar. The vegetation and surface parameters are valid for the Cabauw site in the Netherlands.The user can also call SETFYS to set the parameters for another temperature or pressure, or call SETSRF to specify other surface characteristics. To make sure that the common blocks remain memory-resident between subroutine calls it may be necessary on some computers to include the common block in the main program by means of the following statements:

```
      INTEGER  PRSET
      REAL     TR, PR, RO, CP, LAMBDA, GAMMA
      COMMON   /FYSCOM/ PRSET, TR, PR, RO, CP, LAMBDA, GAMMA
C
      INTEGER  PSSET
      REAL     R, D1, ALFA, AG, SZ0T
      COMMON   /SRFCOM/ PSSET, R, D1, ALFA, AG, SZ0T
```

LIST OF ROUTINES

LIST OF FILES

FLUXLIB1.FOR	- contains the subroutines FLXLN1, FLXLN2, FLXLN3, FLXSE1, FPSIM, FPSIH, OBUK, SUNHGH, RADIAT and TST2.
FLUXLIB2.FOR	- contains the subroutines ES, DES, BOWEN, DEWPNT, SPCHUM, SETFYS, SETSRF, INTFYS and INTSRF.
ZEROAB.FOR	- contains subroutine ZEROAB.
FLUXLIB.LIB	- library of all the subroutines (for RM-fortran on IBM personal computer with floating point chip only).
DEMOLN1.FOR	- example program for FLXLN1 (source code)
DEMOLN2.FOR	- example program for FLXLN2 (source code)
DEMOLN3.FOR	- example program for FLXLN3 (source code)
DEMOSE1.FOR	- example program for FLXSE1 (source code)
DEMOLN1.EXE	- example program for FLXLN1 (executable code)
DEMOLN2.EXE	- example program for FLXLN2 (executable code)
DEMOLN3.EXE	- example program for FLXLN3 (executable code)
DEMOSE1.EXE	- example program for FLXSE1 (executable code)

comment: The executable files will run on an IBM-PC with floating point hardware only.

FLXLN1 - FLUXLIB F77 library routine (KNMI)

1. Purpose

FLXLN1 calculates surface fluxes of momentum, sensible and latent heat flux over land by means of the profile method with measurements at two heights of wind (or at one height with zero velocity specified at z = Z0, where Z0 is the aerodynamic roughness length), temperature and humidity.

The basic philosophy is to provide an optimal estimate of the fluxes with a minimum of data. The results are most optimal if all input parameters are accurately measured, but the routine will still give output for the latent heat flux if no humidity profile is available. In the latter case the modified Priestley-Taylor formulation is used to estimate the Bowen-ratio.

The temperature profile can also be omitted (the error code -9999. has to be specified then), but no sensible and latent heat fluxes are computed now; the resulting momentum flux is a neutral approximation. If profile measurements for temperature and humidity are not available, it is recommended to apply FLXLN2.

2. Description

FLXLN1 uses the empirical surface layer profiles for wind, potential temperature and humidity. The stability corrections are specified in external routines (FPSIH and FPSIM) and can be modified by the user. The functions, specified in this library, are the Dyer and Hicks formulations for unstable situations [5] and the ones proposed by Holtslag and De Bruin [8] for stable situations. The latter have the usual behaviour for small stability corrections, but also perform reasonably well for more stable situations. In [7] and [8] it is shown that the empirical functions even apply in the outer part of the nocturnal boundary layer. In practice this means, that the profile method can be applied up to about 100 m in both day and night time situations.

When humidity measurements are not available, the modified Priestley-Taylor formulation is applied in the way it is described in [12]. This makes the parameterizations in this routine consistent with the ones in FLXLN2.

3. Specifications

```
SUBROUTINE FLXLN1  (U1, U2, ZU1, ZU2, T1, T2, ZT1, ZT2,
                    Q1, Q2, ZQ1, ZQ2,
                    UST, TST, QST, TAU, H, LE, L)

REAL U1, U2, ZU1, ZU2, T1, T2, ZT1, ZT2
REAL Q1, Q2, ZQ1, ZQ2
REAL UST, TST, QST, TAU, H, LE, L
```

4. Parameters

U1 - real (input)
wind speed at ZU1 (0. if Z0 is specified for ZU1) (m/s)

U2 - real (input)
wind speed at ZU2 (at 10 m height in most cases) (m/s)

ZU1 - real (input)
measuring height for U1 (Z0 is usually specified here) (m)

ZU2 - real (input)
measuring height for U2 (10. for most applications) (m)
(ZU2 > ZU1)

T1 - real (input)
temperature at ZT1 (C)

T2 - real (input)
temperature at ZT2 (C)

ZT1 - real (input)
measuring height for T1 (m)

ZT2 - real (input)
measuring height for T2 (ZT2 > ZT1) (m)

Q1 - real (input)
specific humidity at ZQ1 (g/kg)

Q2 - real (input)
specific humidity at ZQ2 (g/kg)

ZQ1 - real (input)
measuring height for Q1 (m)

ZQ2 - real (input)
measuring height for Q2 (ZQ2 > ZQ1) (m)

UST - real (output)
friction velocity (m/s)

TST - real (output)
temperature scale (K)

QST - real (output)
humidity scale (g/kg)

H - real (output)
sensible heat flux (W/m2)

LE - real (output)
latent heat flux (W/m2)

L - real (output)
Obukhov length (m)

General: The code -9999. is used for missing values. It can be specified for all profile measurements. This error code is also returned for the fluxes if not sufficient information is available or when the iteration does not converge.

```
if U1 or U2 is missing   --->  no results at all
if T1 or T2 is missing   --->  neutral estimate for UST and TAU
                               no results for sensible and latent
                               heat flux (use FLXLN2)
if Q1 or Q2 is missing   --->  latent heat flux from modified
                               Priestley-Taylor formulation.
```

6. Auxiliary routines

This routine calls the functions FPSIM, FPSIH, OBUK, ES, DES and uses the common block FYSCOM.

FLXLN2 - FLUXLIB F77 library routine (KNMI)

1. Purpose

FLXLN2 computes the friction velocity UST, the temperature scale TST, the specific humidity scale QST, the surface stress TAU the sensible heat flux H, the latent heat flux LE and the Obukhov length L from routine weather data. As input is needed:

- wind at two heights (or the wind at one height combined with roughness length).
- temperature (high accuracy is not needed here because the temperature is only needed for the slope of the saturation water vapor curve).
- cloud cover fraction from routine weather observation (N/8, where N is from SYNOP-code).
- solar elevation (can be computed with SUNHGH).
- short wave radiation is optional; better accuracy can be obtained by using observations.

2. Specification

```
SUBROUTINE FLXLN2 (U1, U2, ZU1, ZU2, T, NN, KIN, SINPHI,
                   UST, TST, QST, TAU, H, LE, L)

REAL U1, U2, ZU1, ZU2, T, NN, KIN, SINPHI
REAL UST, TST, QST, TAU, H, LE, L
```

3. Description

This routine is an implementation of the procedures developed by Holtslag and van Ulden (see [6] the for day-time scheme, [4] for a comparison with more complicated methods and [7,8] for the night-time scheme). Minor differences exist between the proposed schemes in the different papers. The version coded here follows [12], which is also a consistent approximation of the more complicated model in [8]. Problems with the transition hours, that were present in earlier formulations have been solved in the present formulation.

The routine goes through the following steps:

- If the incoming short wave radiation is not specified, it is estimated on the basis of solar elevation and cloud cover.
- The so called "isothermal net radiation" is computed[8,12].
- The parameterization of the surface heat flux is expressed as a functional dependence of TST on UST.
- Using the similarity form of the wind profile, UST is solved with an iteration procedure.

4. Parameters

U1 - real (input)
wind speed at ZU1 (0. if Z0 is specified for ZU1) (m/s)

U2 - real (input)
wind speed at ZU2 (at 10 m height in most cases) (m/s)

ZU1 - real (input)
measuring height for U1 (Z0 is usually specified here) (m)

ZU2 - real (input)
measuring height for U2 (10. for most applications) (m)

T - real (input)
temperture at screen height (e.g. at 2 m) (C)

NN - real (input)
cloud cover fraction ranging from 0. to 1.
(N/8. where N from synop code)

KIN - real (input)
downward short wave radiation (if measured). If this parameter is not available, -9999. has to be specified. (W/m2)

SINPHI - real (input)
sine of the solar elevation (can be computed with SUNHGH)

UST - real (output)
friction velocity (m/s)

TST - real (output)
temperature scale (K)

QST - real (output)
humidity scale (g/kg)

TAU - real (output)
surface stress (N/m2)

H - real (output)
surface sensible heat flux (W/m2)

LE - real (output)
surface latent heat flux (W/m2)

L - real (output)
Obukhov length (m)

General: The code -9999. is used for missing values. If it is specified for U1, U2, T or NN, the output parameters contain -9999. on exit. This error code is also returned for the fluxes when the iteration does not converge.

6. Auxiliary routines

This routine calls the functions FPSIM, FPSIH, OBUK, TST2, the subroutines ZEROAB and RADIAT and uses the common blocks FYSCOM and SRFCOM.

FLXLN3 - FLUXLIB F77 library routine (KNMI)

1. Purpose

FLXLN3 computes the friction velocity UST, the temperature scale TST, the specific humidity scale QST, the surface stress TAU the sensible heat flux H, the latent heat flux LE and the Obukhov length L from wind speed, temperature and net radiation. As input is needed:

- wind at two heights (or the wind at one height combined with the roughness length).
- temperature (high accuracy is not needed here because the temperature is only needed for the slope of the saturation water vapor curve).
- measured net radiation

2. Specification

```
SUBROUTINE FLXLN3 (U1, U2, ZU1, ZU2, T, QNET,
                   UST, TST, QST, TAU, H, LE, L)

REAL U1, U2, ZU1, ZU2, T, QNET
REAL UST, TST, QST, TAU, H, LE, L
```

3. Description

This routine uses the modified Priestley-Taylor formulation to partition the net radiation minus soil heat flux over latent and sensible heat flux. See [6] for details. This routine is fully compatible with FLXLN2, but skips over the radiation parameterization.

The routine goes through the following steps:

- The parameterization of the surface heat flux is expressed as a functional dependence of TST on UST, assuming that the net radiation is known. The dependence is expressed in function TST3.
- Using the similarity form of the wind profile, UST is solved with an iteration procedure.

4. Parameters

U1 - real (input)
wind speed at ZU1 (0. if Z0 is specified for ZU1) (m/s)

U2 - real (input)
wind speed at ZU2 (at 10 m height in most cases) (m/s)

ZU1 - real (input)
measuring height for U1 (Z0 is usually specified here) (m)

ZU2 - real (input)
measuring height for U2 (10. for most applications) (m)

T - real (input)
temperture at screen height (C)

QNET - real (input)
net radiation (W/m2)

UST - real (output)
friction velocity (m/s)

TST - real (output)
temperature scale (K)

QST - real (output)
humidity scale (g/kg)

TAU - real (output)
surface stress (N/m2)

H - real (output)
surface sensible heat flux (W/m2)

LE - real (output)
surface latent heat flux (W/m2)

L - real (output)
Obukhov length (m)

General: The code -9999. is used for missing values. If it is specified for U1, U2, T or QNET, the output parameters contain -9999. on exit. This error code is also returned for the fluxes when the iteration does not converge.

6. Auxiliary routines

This routine calls the functions FPSIM, FPSIH, OBUK, TST3, the subroutine ZEROAB and uses the common blocks FYSCOM and SRFCOM.

FLXSE1 - FLUXLIB F77 library routine (KNMI)

1. Purpose

FLXSE1 calculates surface fluxes of momentum, sensible and latent heat over sea by means of the profile method with standard observations as input. Wind speed at single height, air temperature, air humidity (optional) and sea water temperature have to be specified.

The basic philosophy is to provide an optimal estimate of the surface fluxes with a minimum amount of data. If the specific humidity has not been measured, the Priestley-Taylor formulation is employed to estimate the Bowen ratio.

The temperature observation can also be omitted (the error code -9999. has to be specified then), but no sensible and latent heat fluxes are computed now; the resulting momentum flux is a neutral approximation.

2. Description

FLXSE1 uses the empirical surface layer profiles for wind, potential temperature and humidity. The stability corrections are specified in external routines (FPSIH and FPSIM) and can be modified by the user. The functions specified in this library are the same as in FLXLN1.

The profiles for wind, temperature and humidity are an interpolation between observed values and those at the sea surface. For the latter a roughness length has to be assumed. For wind, Z0 is taken in accordance with the Charnock-relation (Z0=UST**2/(70.*9.8); cf. [2]); the same roughness length scale is used for temperature and humidity by default. By means of SETSRF an option can be set to choose the empirical values as found by Large and Pond[10]. As surface value for the specific humidity, the saturation value is taken at the specified sea surface temperature.

When humidity measurements are not available, the Priestley-Taylor formulation for saturated surfaces is applied with ALFA=1.28 (cf. [2]).

3. Specifications

```
SUBROUTINE FLXSE1 (U2, ZU2, TS, T2, ZT2, TD2, ZTD2,
                   Z0, UST, TST, QST, TAU, H, LE, L)

REAL U2, ZU2, TS, T2, ZT2, TD2, ZTD2
REAL Z0, UST, TST, QST, TAU, H, LE, L
```

4. Parameters

U2 - real (input)
wind speed at ZU2 (at 10 m height in most cases) (m/s)

ZU2 - real (input)
measuring height for U2 (10. for most applications) (m)

TS - real (input)
sea water temperature (C)

T2 - real (input)
temperature at ZT2 (C)

ZT2 - real (input)
measuring height for T2 (m)

TD2 - real (input)
dew point at observation height ZTD2 (C)

ZTD2 - real (input)
measuring height for TD2 (m)

Z0 - real (output)
aerodynamic roughness length of the sea surface (m)

UST - real (output)
friction velocity (m/s)

TST - real (output)
temperature scale (K)

QST - real (output)
humidity scale (g/kg)

H - real (output)
sensible heat flux (W/m2)

LE - real (output)
latent heat flux (W/m2)

L - real (output)
Obukhov length (m)

General: The code -9999. is used for missing values. It can be specified for all observations. This error code is also returned for the fluxes if not sufficient information is available or when the iteration does not converge.

if U2 is missing	--->	no results at all.
if TS or T2 is missing	--->	neutral estimate for UST and TAU; no results for sensible and latent heat flux.
if TD2 is missing	--->	latent heat flux from Priestley-Taylor formulation.

6. Auxiliary routines

This routine calls the functions FPSIM, FPSIH, OBUK, ES, DES, SPCHUM and uses the common blocks FYSCOM and SRFCOM.

FPSIM - FLUXLIB F77 library routine (KNMI)

1. Purpose

   FPSIM returns the stability correction in the logarithmic wind profile.

2. Description

   The functions FPSIM and FPSIH are the Dyer and Hicks formulations for unstable situations [5] and the ones proposed by Holtslag and De Bruin [8] for stable situations. The latter have the usual behaviour for small stability corrections, but also perform reasonably well for more stable situations. In [7] and [8] it is shown that the empirical functions even apply in the outer part of the nocturnal boundary layer.

3. Specifications

```
REAL FUNCTION FPSIM(ETA)
REAL ETA
```

4. Parameters

   ETA - real (input)
   height devided by M-O length (z/L)

   FPSIM - real (output)
   stability correction in wind profile

FPSIH - FLUXLIB F77 library routine (KNMI)

1. Purpose
   FPSIH returns the stability correction in the logarithmic temperature (or humidity) profile.

2. Description
   See FPSIM

3. Specifications

```
REAL FUNCTION FPSIH(ETA)
REAL ETA
```

4. Parameters

   ETA - real (input)
   height devided by M-O length (z/L)

   FPSIH - real (output)
   stability correction in temperature (or humidity) profile

OBUK - FLUXLIB F77 library routine (KNMI)

1. Purpose

OBUK is an auxiliary function that expresses L into UST and TST. If moisture correction is required, OBUK should be called with the virtual temperature scale (cf. [3]).

2. Specifications

```
REAL FUNCTION OBUK(UST, TST)
REAL UST, TST
```

3. Parameters

UST - real (input)
friction velocity (m/s)

TST - real (input)
temperature scale (or virtual temp. scale) (K)

OBUK -real (output)
Obukhov length (m)

SUNHGH - FLUXLIB F77 library routine (KNMI)

1. Purpose

SUNHGH computes the sine of the solar elevation at a specified location for any time (in UTC).

2. Specifications

```
SUBROUTINE SUNHGH(SINPHI, LON, LAT, MNTH, DAY, HR, MIN)
REAL SINPHI, LON, LAT
INTEGER MNTH, DAY, HR, MIN
```

3. Parameters

SINPHI - real (output)
sine of the solar elevation

LON - real (input)
longitude (east is positive) (deg.)

LAT - real (input)
latitude (north is positive) (deg.)

MNTH - integer (input)
month (1-12)

DAY - integer (input)
day (1-31)

HR - integer (input)
hour (0-24) (UTC)

MIN - integer (input)
minutes after the hour (0-59)

RADIAT - FLUXLIB F77 library routine (KNMI)

1. Purpose

RADIAT computes the isothermal net radiation (cf. [8,12] for details).

2. Specifications

```
SUBROUTINE RADIAT(SINPHI, NN, KIN, QSTI)
REAL SINPHI, NN, KIN, QSTI
```

3. Parameters

SINPHI - real (input)
sine of the solar elevation

NN - real (input)
cloud cover fraction ranging from 0. to 1.
(N/8, where N from the SYNOP code)

KIN - real (input)
incoming short wave radiation (W/m2)
(if not available the code -9999. should be specified here)

QSTI - real (output) (W/m2)
isothermal net radiation (see [12] for the definition)

5. Auxiliary routines

This routine uses the common block FYSCOM.

TST2 - FLUXLIB F77 library routine (KNMI)

1. Purpose

   TST2 specifies the functional relationship between temperature scale and friction velocity as described in [12].

2. Specifications

```
REAL FUNCTION TST2(QST1, UST, T, QSTI)
REAL QST1, UST, T, QSTI
```

3. Parameters

   TST2 - real (output)
   temperature scale (K)

   QST1 - real (output)
   humidity scale (g/kg)

   UST - real (input)
   friction velocity (m/s)

   T - real (input)
   temperature (usually at screen height) (C)

   QSTI - real (input)
   isothermal net radiation (W/m2)

5. Auxiliary routines

   This routine uses the common blocks FYSCOM and SRFCOM.

TST3 - FLUXLIB F77 library routine (KNMI)

1. Purpose

TST3 specifies the functional relationship between temperature scale and friction velocity as described in [12], assuming that the net radiation is known.

2. Specifications

```
REAL FUNCTION TST3(QST1, UST, T, QNET)
REAL QST1, UST, T, QSTI
```

3. Parameters

TST3 - real (output)
temperature scale (K)

QST1 - real (output)
humidity scale (g/kg)

UST - real (input)
friction velocity (m/s)

T - real (input)
temperature (usually from screen) (C)

QNET - real (input)
net radiation (W/m2)

5. Auxiliary routines

This routine uses the common blocks FYSCOM and SRFCOM.

ES - FLUXLIB F77 library routine (KNMI)

1. Purpose

   ES calculates saturation water vapor pressure at temperature T (cf. [1]).

2. Specifications

```
REAL FUNCTION ES(T)
REAL T
```

3. Parameters

   ES - real (output)
   saturation water vapor pressure (mbar)
   T - real (input)
   temperature (C)

DES - FLUXLIB F77 library routine (KNMI)

1. Purpose

   DES calculates the slope of the saturation water vapor pressure curve at temperature T (compatible with ES).

2. Specifications

```
REAL FUNCTION DES(T)
REAL T
```

3. Parameters

   DES - real (output)
   derivative of saturation water vapor pressure curve (mbar/C)

   T - real (input)
   temperature (C)

5. Auxiliary routines

   This routine calls function ES.

BOWEN - FLUXLIB F77 library routine (KNMI)

1. Purpose

BOWEN returns Bowen-ratio for measured dry and wet bulb temperature differences (cf. [2]).

2. Specifications

```
REAL FUNCTION BOWEN(TWET, DD, WW)
REAL TWET, DD, WW
```

3. Parameters

BOWEN - real (output)
Bowen ratio

TWET - real (input)
wet bulb temperature at average measuring height (C)

DD - real (input)
dry bulb temperature difference (upper minus lower level) (K)

WW - real (input)
wet bulb temperature difference (K)

4. References

see ES(T)

5. Auxiliary routines

This routine calls function DES and uses the common block FYSCOM.

DEWPNT - FLUXLIB F77 library routine (KNMI)

1. Purpose

   DEWPNT returns dew point temperature for given water vapor pressure.

2. Specifications

```
REAL FUNCTION DEWPNT (E)
REAL E
```

3. Parameters

   DEWPNT - real (output)
   dewpoint temperature (C)

   E - real (input)
   water vapor pressure (mbar)

SPCHUM - FLUXLIB F77 library routine (KNMI)

1. Purpose

SPCHUM returns specific humidity for given water vapor pressure [1].

2. Specifications

```
REAL FUNCTION SPCHUM (E)
REAL E
```

3. Parameters

SPCHUM -real (output)
specific humidity (g/kg)

E - real (input)
water vapor pressure (mbar)

5. Auxiliary routines

This routine uses the common block FYSCOM.

SETFYS - FLUXLIB F77 library routine (KNMI)

1. Purpose

SETFYS sets the parameters in common block FYSCOM. The parameters in this common block depend weakly on temperature and/or pressure. Most routines that use parameters from this block, check whether it has been initialized. If the common block has no values yet, SETFYS is called with default values for temperature and pressure (10 C and 1005 mbar). This means that users do not have to call SETFYS; this is done automatically. Users are recommended to call SETFYS if the temperature and/or pressure are significantly different from their default values (more than 15 C or 30 mbar difference) [11].

2. Specifications

```
SUBROUTINE SETFYS(T, P)
REAL T, P
```

3. Parameters

T - real (input)
temperature for which the parameters are set
(only a rough indication is needed here) (C)

P - real (input)
pressure for which the parameters are set
(only a rough estimate is needed) (mbar)

4. Description

The common block contains the following parameters:

```
INTEGER PRSET
REAL TR, PR, RO, CP, LAMBDA, GAMMA
COMMON /FYSCOM/ PRSET, TR, PR, RO, CP, LAMBDA, GAMMA
```

PRSET :	index to indicate that parameters have been been initialized (PRSET has value 1 then)	
TR :	absolute reference temperature	(K)
PR :	reference pressure	(mbar)
RO :	air density	(kg/m3)
CP :	specific heat at constant pressure	(J/kg C)
LAMBDA:	vaporization heat	(J/ g)
GAMMA :	psychrometer constant	(mbar/K)

SETSRF - FLUXLIB F77 library routine (KNMI)

1. Purpose

SETSRF sets the parameters in common block SRFCOM. The parameters are related to the characteristics of the surface and the vegetation. The routines that use parameters from this block, check whether it has been initialized. If the common block has no values yet, SETSRF is called with default values which apply to the Cabauw site in the Netherlands (grassland with sufficient water supply on clay soil). This means that users do not have to call SETFYS if default values are appropriate; this is done automatically. Users can call SETSRF if they wish to specify another type of land surface (see [6] for a discussion on the the parameter values), or change the roughness length for temperature over sea (see [10]).

2. Specifications

```
SUBROUTINE SETSRF(XR, XD1, XALFA, XAG, XSZ0T)
REAL XR, XD1, XALFA, XAG, XSZ0T
```

3. Parameters

```
XR    - real (input for R)
XD1   - real (input for D1)
XALFA - real (input for ALFA)
XAG   - real (input for AG)
XSZ0T - real (input for SZ0T)
```

If the code -9999. is specified for one of the input parameters, the corresponding parameter in the common block remains unaltered.

4. Description

The common block contains the following parameters:

```
INTEGER PSSET
REAL R, D1, ALFA, AG, SZ0T
COMMON /SRFCOM/ PSSET, R, D1, ALFA, AG, SZ0T
```

PSSET : index to indicate that parameters have been been initialized (PSSET has value 1 then)

		default
R	: real (input) albedo, typically 0.23 for vegetated surfaces	0.23

```
D1     : real (input)                                        15.
         (0.5/0.4) LN (50/Z0H), where Z0H is the roughness
         length in the water vapor profile above land. Typical
         value for grass is 0.0001 m (Z0/100). This parameter is
         only used in the night time part of FLXLN2 and FLXLN3
         (see [12]).

ALFA   : real (input)                                         1.
         Modified Priestley-Taylor parameter over land, which
         is typically 1. for vegetation without water stress
         (0.5 for the Prairie grass experiment, see [6]).

AG     : real (input)                                         5.
         Bulk heat transfer coefficient in the soil.     W/(m2 K)
         Typically 5 W/(m2 K)  for clay.

SZ0T   : real (input)                                         0.
         Switch with value 0. or 1., used in FLXSE1
         to decide which roughness length to use in
         temperature and humidity profile.
         0. : The aerodynamic roughness length is taken over.
         1. : The values by Large and Pond are used
              (stable   : Z0T=2.2E-9 m, Z0Q=9.5E-5 m)
              (unstable : Z0T=4.9E-5 m, Z0Q=4.9E-5 m)
```

ZEROAB - FLUXLIB F77 library routine (KNMI)

1. Purpose

ZEROAB can be used to determine the zero of an externally specified function in the interval A to B. The function values for A and B should have opposite sign, otherwise an error condition occurs.

2. Specifications

```
SUBROUTINE ZEROAB(X, B, FX, ICALL, AE, RE, C)
REAL X, B, FX, AE, RE, C(6)
INTEGER ICALL
```

3. Parameters

```
X - real (input, output)
   first entry : lower bound of the interval (A)
   next entries: best estimate of zero from previous call
   on exit     : best estimate of X for which FX=0

FX - real (input)
   function value corresponding to actual value of X

B - real (input)
   upper bound of interval

ICALL - integer (input, output)
   iteration counter and error indicator
   first entry : ICALL should be 0
   next entries: ICALL should not be changed
   on exit     : number of iterations
   last exit   : -N, where N is the number of iterations
                 -2, error because FA*FB > 0
                 -1, requested accuracy can not be attained
     Important:
          User should test the sign of ICALL after every call
          and stop iterating if ICALL is negative.

AE, RE - real (input)
   Parameters to specify absolute and relative accuracy of X
   for which FX(X) = 0.

C - real (-)
   Working space. The contents of this array
   should not be altered between successive calls.
```

4. Example

The following example program computes the zero of function FX=x**2-4. The upper and lower bound of the interval over which the solution is searched, are 0 and 4 respectively.

```
      ICALL=0
      X=0.
      B=4.
 10   FX=X**2-4
      CALL ZEROAB(X, B, FX, ICALL, 0., 1E-6, C)
      IF (ICALL .GE. 0) GOTO 10
      IF (ICALL .LE. -3) THEN
         WRITE(6,*) ' FX=0 for X= ', X
      ELSE
         WRITE(6,*) ' ERROR ; ICALL= ', ICALL
      ENDIF
      END
```

References

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