SCIENTIFIC DOCUMENTATION

Objectives:

1. Improve readability of the source code by developing scientific comments

and at the same time

2. Generate automatically an up-to-date and dynamic scientific documentation

1.1 EVERY SUBROUTINE/MODULE HAS A HEADER

```
!! ==============================================================================\n
!! SUBROUTINE   : diffuco_trans_co2
!! AUTHOR       :
!! CREATION DATE:
!!
!> BRIEF        : This subroutine computes carbon assimilation and stomatal
!! conductance, following respectively Farqhuar et al. (1980) and Ball et al. (1987).\n
!!
!! DESCRIPTION (functional, design, flags):\n
!! The equations are different depending on the photosynthesis mode (C3 versus C4).\n
!! Assimilation and conductance are computed over 20 levels of LAI and then
!! integrated at the canopy level.\n
!! This routine also computes partial beta coefficient: transpiration for each
!! type of vegetation.\n
!! There is a main loop on the PFTs, then inner loops on the points where
!! assimilation has to be calculated.\n
!! This subroutine is called by diffuco_main only if photosynthesis is activated
!! for sechiba (flag STOMATE_OK_CO2=TRUE), otherwise diffuco_trans is called.\n
!!
!! REFERENCES   :
!! - Ball, J., T. Woodrow, and J. Berry (1987), A model predicting stomatal
!! conductance and its contribution to the control of photosynthesis under
!! different environmental conditions, Prog. Photosynthesis, 4, 221- 224.
!! - Collatz, G., M. Ribas-Carbo, and J. Berry (1992), Coupled photosynthesis
!! stomatal conductance model for leaves of C4 plants, Aust. J. Plant Physiol.,
!! 19, 519-538.
!! - Farquhar, G., S. von Caemmener, and J. Berry (1980), A biochemical model of
!! photosynthesis CO2 fixation in leaves of C3 species, Planta, 149, 78-90.
!!
!! FLOWCHART    :
!!
!! REVISIONS    : N. de Noblet     2006/06
!!                - addition of q2m and t2m as input parameters for the
!!                calculation of Rveget
!!                - introduction of vbeta23\n
!! ==============================================================================
```

4.1.1.2 subroutine diffuco_trans_co2 ()

BRIEF : This subroutine computes carbon assimilation and stomatal conductance, following respectively Farqhuar et al. (1980) and Ball et al. (1987).

. DESCRIPTION (functional, design, flags):

The equations are different depending on the photosynthesis mode (C3 versus C4).

Assimilation and conductance are computed over 20 levels of LAI and then integrated at the canopy level.

This routine also computes partial beta coefficient: transpiration for each type of vegetation.

There is a main loop on the PFTs, then inner loops on the points where assimilation has to be calculated.

This subroutine is called by diffuco_main only if photosynthesis is activated for sechiba (flag STOMATE_-OK_CO2=TRUE), otherwise diffuco_trans is called.

REFERENCES :

- Ball, J., T. Woodrow, and J. Berry (1987), A model predicting stomatal conductance and its contribution to the control of photosynthesis under different environmental conditions, Prog. Photosynthesis, 4, 221– 224.
- Collatz, G., M. Ribas-Carbo, and J. Berry (1992), Coupled photosynthesis stomatal conductance model for leaves of C4 plants, Aust. J. Plant Physiol., 19, 519–538.
- Farquhar, G., S. von Caemmener, and J. Berry (1980), A biochemical model of photosynthesis CO2 fixation in leaves of C3 species, Planta, 149, 78–90.

FLOWCHART :

REVISIONS : N. de Noblet 2006/06

- addition of q2m and t2m as input parameters for the calculation of Rveget
- introduction of vbeta23

1.2 EVERY VARIABLE HAS A LONG NAME AND UNIT

```
!! INTERFACE DESCRIPTION

!! INPUT SCALAR
… :: kjpindex              !! Domain size [-]
… :: dtradia               !! Time step [s]
!! INPUT FIELDS
… :: swdown                !! Downwelling short wave flux [W/m2]
… :: temp_air              !! Air temperature [K]
… :: pb                    !! Lowest level pressure [Pa]
… :: qair                  !! Lowest level specific humidity [kg/kg]
… :: q2m                   !! 2m specific humidity [kg/kg]
… :: t2m                   !! 2m air temperature [K]
… :: rau                   !! air density [kg/m3]
… :: u                     !! Lowest level wind speed [m/s]
… :: q_cdrag               !! Surface drag [m/s]
… :: assim_param           !! min+max+opt temps, vcmax, vjmax for photosynthesis [K, umol/m2/s]
… :: ccanopy               !! CO2 concentration inside the canopy [ppm]
… :: humrel                !! Soil moisture stress [-]
… :: veget                 !! Type of vegetation fraction [fraction]
… :: veget_max             !! Max. vegetation fraction (LAI -> infty) [fraction]
… :: lai                   !! Leaf area index [m2/m2]
… :: qsintveg              !! Water on vegetation due to interception [kg/m2]
… :: vbeta23               !! Beta for fraction of wetted foliage that will transpire [mm/d]

!! OUTPUT FIELDS
… :: vbeta3                !! Beta for Transpiration [mm/d]
… :: rveget                !! Surface resistance of vegetation [s/m]
… :: rstruct               !! structural resistance [s/m]
… :: cimean                !! mean intercellular CO2 concentration [umole/m2/s]
… :: vbetaco2              !! beta for CO2 [mm/d]

!! LOCAL VARIABLES
… :: vcmax                 !! maximum rate of carboxylation [umol/m2/s]
… :: vjmax                 !! maximum rate of Rubisco regeneration [umol/m2/s]
```

dtradia [in] Time step (s)

swdown [in] Downwelling short wave flux (W/m^2)

temp_air [in] Air temperature (K)

pb [in] Lowest level pressure (Pa)

qair [in] Lowest level specific humidity (kg/kg)

q2m [in] 2m specific humidity (kg/kg)

t2m [in] 2m air temperature (K)

rau [in] air density (kg/m3)

u [in] Lowest level wind speed (m/s)

v [in] Lowest level wind speed (m/s)

q_cdrag [in] Surface drag (m/s)

humrel [in] Soil moisture stress (-)

assim_param [in] min+max+opt temps, vcmax, vjmax for photosynthesis (K, umol/m^2/s)

ccanopy [in] CO2 concentration inside the canopy (ppm)

veget [in] Type of vegetation fraction (fraction)

veget_max [in] Max. vegetation fraction (LAI -> infty) (fraction)

lai [in] Leaf area index (m^2/m^2)

qsintveg [in] Water on vegetation due to interception (kg/m^2)

qsintmax [in] Maximum water on vegetation (kg/m^2)

vbeta3 [out] Beta for Transpiration (mm/d)

rveget [out] Surface resistance of vegetation (s/m)

rstruct [out] structural resistance (s/m)

cimean [out] mean intercellular CO2 concentration (umole/m^2/s)

vbetaco2 [out] beta for CO2 (mm/d)

vbeta23 [in] Beta for fraction of wetted foliage that will transpire (mm/d)

1.3 MAIN POINTS ARE NUMBERED TO OUTLINE THE STRUCTURE

```
!! 1. Preliminary calculations
!! 1.1 Calculate LAI steps
!! 1.2 Calculate light fraction for each LAI step
!! 1.3 Estimate relative humidity of air

!! 2. Loop over vegetation types

!! 2.1 Initializations
!! 2.2 Calculate temperature dependent parameters for C4 plants
!! 2.3 Calculate temperature dependent parameters for C3 plants

!! 2.4 Loop over LAI steps to estimate assimilation and conductance
!! 2.4.1 Vmax is scaled into the canopy due to reduction of nitrogen
!! 2.4.2 Assimilation for C4 plants (Collatz et al., 1991)
!! 2.4.3 Assimilation for C3 plants (Farqhuar et al., 1980)
!! 2.4.4 Estimate conductance (Ball et al., 1987)
!! 2.4.5 Integration at the canopy level

!! 2.5 Calculate resistances
```