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
```

1.4 YOU MAY INCLUDE TEX FILES (EQUATIONS, TABLES), FIGURES

```
!> @addtogroup Photosynthesis
!> @{
!>
!> 2.4.2 Assimilation for C4 plants (Collatz et al., 1991)\n
!! \latexonly
!! \input{diffuco_trans_co2_2.4.2.tex}
!! \endlatexonly
!> @}
!
DO ji = 1, kjpindex
  assimi(ji) = zero
ENDDO
!
IF (nic .GT. 0) THEN
   DO inic=1,nic
    !> @codeinc
    x_1 = - ( vc2(index_calc(inic)) + 0.092 * 2.3* swdown(index_calc(inic)) * &
          ext_coef(jv) * light(jv,jl) )
    x_2 = vc2(index_calc(inic)) * 0.092 * 2.3 * swdown(index_calc(inic)) * &
          ext_coef(jv) * light(jv,jl)
    x_3 = ( -x_1 - sqrt( x_1*x_1 - 4.0 * xc4_1 * x_2 ) ) / (2.0*xc4_1)
    x_4 = - ( x_3 + kt(index_calc(inic)) * leaf_ci(index_calc(inic),jv,jl) * &
          1.0e-6 )
    x_5 = x_3 * kt(index_calc(inic)) * leaf_ci(index_calc(inic),jv,jl) * 1.0e-6
    assimi(index_calc(inic)) = ( -x_4 - sqrt( x_4*x_4 - 4. * xc4_2 * x_5 ) ) / (2.*xc4_2)
    assimi(index_calc(inic)) = assimi(index_calc(inic)) - &
                                         rt(index_calc(inic))
    !> @endcodeinc
```

2.4.2 Assimilation for C4 plants (Collatz et al., 1991)

The photosynthesis is defined by a pair of nested quadratic equations:

M flux determined by the Rubisco and light limited capacities

Φ fixed equal to 0.83

β fixed equal to 0.93

M smaller root of

$$\Phi \cdot M^2 - M \cdot (V_c(l) + \alpha \cdot Q) + V_c(l) \cdot \alpha \cdot Q = 0 \tag{3.15}$$

Ci(l) (leaf_ci) global variable declared in diffuco module

W smaller root of

$$\beta \cdot W^2 - W \cdot (M + k_T \cdot C_i(l) \cdot 10^{-6}) + M \cdot k_T \cdot C_i(l) \cdot 10^{-6} = 0 \tag{3.16}$$

α quantum efficiency

$$\alpha \cdot Q = 0.092 \cdot 2.3 \cdot SWdown \cdot k \cdot e^{-k \cdot LAI(l)} \tag{3.17}$$

$$M = \frac{V_c(l) + \alpha \cdot Q - \sqrt{(V_c(l) + \alpha \cdot Q)^2 - 4 \cdot \Phi \cdot V_c(l) \cdot \alpha \cdot Q}}{2 \cdot \Phi} \tag{3.18}$$

$$W = \frac{M + k_T \cdot C_i(l).10^{-6} - \sqrt{(M + k_T \cdot C_i(l).10^{-6})^2 - 4 \cdot \beta \cdot M \cdot k_T \cdot C_i(l).10^{-6}}}{2 \cdot \beta} \tag{3.19}$$

$$A = W - R_T \tag{3.20}$$

```
  x_1 = - ( vc2(index_calc(inic)) + 0.092 * 2.3* swdown(index_calc(inic)) *
 &
        ext_coef(jv) * light(jv,jl) )
  x_2 = vc2(index_calc(inic)) * 0.092 * 2.3 * swdown(index_calc(inic)) * &
        ext_coef(jv) * light(jv,jl)
  x_3 = ( -x_1 - sqrt( x_1*x_1 - 4.0 * xc4_1 * x_2 ) ) / (2.0*xc4_1)
  x_4 = - ( x_3 + kt(index_calc(inic)) * leaf_ci(index_calc(inic),jv,jl) *
&
        1.0e-6 )
  x_5 = x_3 * kt(index_calc(inic)) * leaf_ci(index_calc(inic),jv,jl) * 1.0e
-6
  assimi(index_calc(inic)) = ( -x_4 - sqrt( x_4*x_4 - 4. * xc4_2 * x_5 ) )
/ (2.*xc4_2)
  assimi(index_calc(inic)) = assimi(index_calc(inic)) - &
                                                   rt(index_calc(inic))
```