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| **Site characterization** |
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Lat Latitude

FR Fertility rating

SC(SoilClass) texture (1-sandy; 2-sandyloam; 3-clayloam; 4-clay;<0-default values; 0-no effect of ASW)

MaxASW Maximum available soil water

MinASW Minimum available soil water

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| **INICIALIZATION** |
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t0 initial age (years)

Wf(t0) leaf biomass at t0 (kg ha-1)

Ws(t0) stem, bark and branches biomass at t0 (kg ha-1) – may also be Wwy(t0)

Wr(t0) root biomass at t0 (kg ha-1)

Wa(t0) aboveground biomass at t0 (kg ha-1) = Wf(t0)+Ws(t0)

W(t0) total biomass at t0 (kg ha-1) = Wa(t0)+Wr(t0)

N(t0) Number of trees at t0

ASW(t0) Water available in the soil at t0 (mm)

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| **STAND VARIABLES** |
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**stand Density**

IF t=t0 THEN

N(t)=N(t0)

ELSE IF wg > 300 kg THEN

 N(t) according to the 3/2 power law

ELSE

 N(t)=N(t-1)

ENDIF

**LEAF, ROOTS, Woody, total biomass and litter**

IF t=t0 THEN

Wf(t)=Wf(t0)

Wr(t)=Wr(t0)

Ws(t)=Ws(t0)

Wlit(t)=0

ELSE

 

  (minus biomass of dead tress????)

 

 

ENDIF

W(t1)=Wl(t1)+W\_l(t1)+Wr(t1)

**Leaf area**



LAI(t)=0.1 Wf(t) sla(t)

**Litter**





onde:

γF(t) is the monthly leaf litter fall per unit of Wf (monthly leaf litter fall rate)

γF0 is monthly leaf litter fall rate at t=0

γFX is the maximum monthly leaf litter fall rate

tγF is the age at which the monthly leaf litter fall rate is equal to (γF0+γFX)/2



**Information for managers**













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| **MODIFIers** |
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**TEMPERATURE**



**VAPOUR PRESSURE DEFICIT**



**SOIL WATER**



where:



The parameters cθ e pθ dependo on soil texture

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Sandy | Sandyloam | Clayloam | Clay | Default | SC=0 |
| SC | 1 | 2 | 3 | 4 | <0 | 0 |
| cθ | 0.7 | 0.6 | 0.5 | 0.4 |  |  |
| pθ | 9 | 7 | 5 | 3 |  |  |

**NUTRITION**



fN0 is the value of Fnutr when FR=0 (=1 in 3PG of Sands and Landsberg)

This expression is diferente in the program:



where fNn is a parameter (=0 in 3PG of Sands and Landsberg)

**FROST**



where:

kF is number of days of production lost due to a one day of frost

Nfrost is number of frost days in the month

**AGE**



where:

MaxAge is the maximum age that the stand may achieve

rAge is the relative age (t/MaxAge) at which fAge=0.5

nAge is a parameter that controls the variation rate of the function

**MODIFIER**



where:



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| **NET PRIMARY PRODUCTION** |
|  |

**RADIATION**



φs is total radiation in the month (wave length between 375-2500 nn)

**CanCover**

IF fullCanAge<0 OR t<fullCanAge THEN

 

ELSE

 CanCover=1

ENDIF

**PHOTOSYNTHETIC ACTIVE RADIATION**



φp is photosynthetic active radiation

**INTERCEPTED RADIATION (ABSORBED)**



φpa is the intercepted photosynthetic active radiation (absorbed)

k is the extinction coefficient

**GROSS PRIMARY PRODUCTION**







α is canopy quantum efficiency (alpha)

gDM\_mol is dry matter molecular weight (conversion factor)

molPAR\_MJ\*2 is the conversion of MJ m-2 month-1 in mol of quanta m-2 month-1

(note: in the EXCEL file this factor includes the transformation of φp in φpa

**NET PRIMARY PRODUCTIVITY**



(note: respiration is assumed to represent 50% of GPP)

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| **ALLOCATION** |
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If the total carbohydrate production rate per month is dW / dt, then the production rates of leaves, woody materials and roots at the same time (allocation) will be given by:



where γf, γs e γr are the litterfall, tree mortality and root turnover rates for the month and ηf, ηs e ηr are the allocation coefficients.

**ROOTS**

Landsberg & Waring (1997):

$$η\_{r}=\frac{0.8}{1+2.5 m \left({ϕ\_{pau}}/{ϕ\_{pa}}\right)}$$

where m has a maximum value of 1, on a highly fertile site, reducing towards zero as site fertility decreases.

Sands & Landsberg (2002):

$$η\_{r}\left(t1\right)=\frac{η\_{Rx} η\_{Rn}}{η\_{Rn}+m ϕ \left(η\_{Rx}-η\_{Rn}\right)} m=m\_{0}+\left(1-m\_{0}\right) FR$$

With ηRx and ηRn being the maximum and minimum partitioning ratios to roots and m0 being the m for sites of poor fertility (FR=0). Using the Landsberg & Waring (1997) equation, ηRx=0.8 and ηRn=0.25 (??? To me it must be 0.228571429, see the EXCEL file 3PG\_Functions&Modifiers)

**LEAVES AND WOODY MATERIALS**

Landsberg e Waring (1977)

From the equations that express growth rates in leaves and woody materials it can be concluded that the allocation coefficients for leaves and woody materials can be given approximately by:



The allocation in the first version of the model is based on the existence of allometric (tree level) relationships between the biomass of a component and the total biomass, as well as the allometric relationships between the total biomass and the diameter:



If we use these expressions in the equations for the allocation coefficients will come:





The ratio between allocations for leaves and woody materials can then be obtained (pFS):



Note that in these "deductions" there are several simplifications, as well as some "confusion" between tree and settlement equations.

Sands & Landsberg (2002):

Noting that after canopy closure, leaf biomass remains approximately stable (with some initial decrease), which was not verified in the initial version, the ap and np parameters were obtained indirectly from the pFS values ​​for a d=2 (p2) and for a d=20 (p20). It comes then that:



The partition for woody materials and leaves is then obtained in either version:



Finally, variations in the various components can be calculated:



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| **TRANSPIRATION** |
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Transpiration is estimated with the Penman-Monteith method.

Some constants used in the transpiration calculus (PM formula in Landsberg & Gower, 1997):

e20 = 2.2 (rate of alteration of the saturated VP at T=20 C)

rhoair = 1.2 (air density, kg m-3)

lambda = 2460000 (latent heat of water vaporization, J kg-1)

VPDconv = 0.000622 (conversion of VPD for the saturation deficit =18/29/1000)













where:

netRad is net radiation

Qa is the intercept in the relationship between netRad and solar radiation

Qb is the slope in the relationship between netRad and solar radiation

Q is solar radiation

h is the duration of the day (computed with the function getDayLength)

VPD is vapor pressure deficit

gBL is the conductance of the canopy boundary layer (BLCond)

coeffCond is a parameter that defines the stomata response to VPD

gC is canopy conductance (canCond)

MaxCond is the maximum canopy conductance

LAIgcx is the LAI at which the canopy conductance is maximum

Etransp is evapotranspiration (flux density)

Transp\_d is daily transpiration

Transp is monthly transpiration

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| --- |
| **SOIL WATER BALANCE** |
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RAIN INTERCEPTION

IF LAImaxIntcptn <= 0 then

 RainIntcptn = Rain MaxIntcptn

ELSE

 RainIntcptn = Rain MaxIntcptn min(1, LAI/LAImaxIntcptn)

ENDIF

EVAPOTRANSPIRATION

EvapTransp = Transp + RainIntcptn

SOIL WATER

ASW = ASW + Rain – EvapTransp + Irrig

IF ASW > MaxASW THEN

 ASW = MaxASW

ENDIF

WATER USE EFFICIENCY

