Equations

Canopy Radiation

$$\delta = -23.5 \cdot \cos\left(\frac{360(D_j + 10)}{365}\right) \tag{1}$$

$$\cos(\theta) = \sin(\Omega)\sin(\delta) + \cos(\Omega)\cos(\delta)\cos(15 \cdot (t - t_{sn})) \tag{2}$$

$$I_{dir} = I_s \alpha^{\frac{(P/P_o)}{\cos(\theta)}} \tag{3}$$

$$I_{diff} = 0.5 \cdot I_s \cdot (1 - \alpha^{(P/P_o)/\cos(\theta)}) \cos(\theta) \tag{4}$$

$$\frac{1}{2}\cos((15 \cdot t_{len}) = -\tan(\lambda)\tan(\delta) \tag{5}$$

$$\tag{6}$$

Weather Downscaling

$$\text{Mean} = T_1 + T_2 \cdot \sin\left(2\pi \frac{D_j - D_{\text{start}}}{365}\right) \tag{7}$$

$$\text{Range} = T_3 + (T_4 - T_3) \cdot \sin\left(2\pi \frac{D_j - D_{\text{start}}}{365}\right) \tag{8}$$

$$\text{Excursion} = \sin\left(2\pi \frac{h_r - 10}{24}\right) \tag{9}$$

$$T_{air} = \text{Mean} + \text{Range} \cdot \text{Excursion} \tag{10}$$

$$\tag{11}$$

Not sure what these are

$$q = \frac{n_r}{n} \tag{12}$$

$$N_{eff} = \frac{\frac{(1-q)}{q}}{C_{ov}^2} \tag{13}$$

$$r^{\sim} = \frac{m_r}{n} \tag{14}$$

$$h = \frac{r^{\sim}}{q} \tag{15}$$

$$\tag{16}$$

C4 Photosynthesis

$$V_{\max} = V_{\max,o} \cdot Kt(E_{vc\,max}) \tag{17}$$

$$R_d = R_o \cdot Kt(E_{Rd}) \tag{18}$$

$$M = \min \frac{(V_{\max} + \alpha_{\text{slope}} I_{\text{abs}}) \pm \sqrt{(V_{\max} + \alpha_{\text{slope}} I_{\text{abs}})^2 - 4(V_{\max} \alpha_{\text{slope}} I_{\text{abs}}) \theta_{\text{curve}}}}{2\theta_{\text{curve}}} \tag{19}$$

$$A_{\text{gross}} = \min \frac{\left(M + k_t \cdot \frac{c_i}{P}\right) \pm \sqrt{\left(M + k_t \cdot \frac{c_i}{P}\right)^2 - \left(4 \cdot M \cdot k_t \cdot \frac{c_i}{P} \cdot \beta\right)}}{2 \cdot \beta} \tag{20}$$

$$\tag{21}$$

C3 Photosynthesis

From Appendix 2 in Bernacchi et al 2003 Plant, Cell and Environment 26, 14191430 doi: 10.1046/j.0016-8025.2003.01050.x

$$
\begin{align}
A &= (1 - \Gamma^*/C_i) \tag{22}\\
W_c &= \frac{V_{c\max} c_i}{c_i + K_c(1 + O/K_0)} \tag{23}\\
W_j &= \frac{J c_i}{4.5 c_i + 10.5\Gamma^*} \tag{24}\\
\Gamma^* &= exp(19.02 - 37.83/(R(T_1 + 273.15))) \tag{25}\\
K_c &= exp(38.05 - 36.38/R(T_1 + 273.15)) \tag{26}\\
K_0 &= exp(20.30 - 36.38/R(T_1 + 273.15)) \tag{27}\\
V_{c,\max} &= V_{c,\max,25^\circ C} exp(26.35 - 65.33/R(T_1 + 273.15)) \tag{28}\\
J &= \frac{Q_2 + J_{\max,T} - \sqrt{(Q_2 + J_{\max,T})^2 - 4\Theta_{PSII} Q_2 J_{\max,T}}}{2\Theta_{\mathrm{PSII}}} \tag{29}\\
J_{\max,T} &= J_{\max,25^\circ} exp(17.57 - 43.54/(R(T_1 + 273.15))) \tag{30}\\
& \tag{31}
\end{align}
$$

From Appendix 1, Equations 7-9 in Long 1991 Plant, Cell and Environment 14, 729-739. doi:10.1111/j.1365-3040.1991.tb01439.x

$$
c_i = 0.7 c_a \left(\frac{1.6740 - 6.1294 \cdot 10^{-2} T + 1.1688 \cdot 10^{-3} T^2 - 8.8741 \cdot 10^{-6} + T^3}{0.73547} \right) \tag{32}
$$

$$
c_i = 0.7 c_a \text{ at } 25^\circ C \tag{33}
$$

$$
O_i = 210 \left(\frac{4.7000 \cdot 10^{-2} - 1.3087 \cdot 10^{-3} T + 2.5603 \cdot 10^{-5} T^2 - 2.1441 \cdot 10^{-7} T^3}{2.6934 \cdot 10^{-2}} \right) \tag{34}
$$

$$
O_i = O_a \text{ at } 25^\circ C \tag{35}
$$

$$
\phi = \frac{A_{\mathrm{I}=50} - A_{\mathrm{I}=25}}{25 f} \tag{36}
$$

Leaf Water Potential

$$h_s = \frac{e_l - VPD}{e_l} \cdot 100 \tag{37}$$

$$g_s = g_0 + g_1 \cdot A_{\text{gross}} \cdot \frac{h_s}{C_a} \tag{38}$$

$$g_{w,\text{mod}} = \left(\frac{\Psi_l - \Psi_t}{1000} \right) \cdot g_{ws} \tag{39}$$

$$g_1 = g_1 \cdot (1 - g_{w,\text{mod}}) \tag{40}$$

$$A_{n,\text{water stress}} = A_n \cdot h_s \tag{41}$$

$$\tag{42}$$

????

$$J_a = 2 \cdot I_{\mathrm{abs}} \cdot \left(\frac{1 - r - \tau}{1 - \tau} \right) \cdot \ell \tag{43}$$

$$L_b = (2.126 \cdot 10^{-5} + 1.48 \cdot 10^{-7} \cdot T_{\mathrm{air}})/0.004 \cdot \sqrt{L_w/u_{\mathrm{layer}}} \tag{44}$$

$$u_a = \frac{u \cdot 0.41}{log((u - d)/z_o)} \tag{45}$$

$$g_a = \frac{(u_a^2/u_{\mathrm{layer}}) \cdot L_b}{(u_a^2/u_{\mathrm{layer}}) + L_b} \tag{46}$$

$$\rho_v' = 610.78 \cdot e^{\left(17.269 \cdot \frac{T_a}{T_a + 237.3}\right)} \tag{47}$$

$$\Delta\rho_{va} = \rho_v' \cdot \left(1 - \frac{h_s}{100}\right) \tag{48}$$

$$\gamma = \frac{\rho \cdot c_p}{\lambda} \tag{49}$$

$$s = 18 \cdot (2501 - 2.373 \cdot T_a) \cdot \left(\frac{\rho_v'}{8.314 \cdot (T_a + 273)^2} \right) \tag{50}$$

$$R_{lc} = 4 \cdot 5.67 \cdot 10^{-8} \cdot (273 + T_{\mathrm{air}})^3 \cdot \Delta T \tag{51}$$

$$\Phi_N = J_a - R_{lc} \tag{52}$$

$$\Delta T = T_{\mathrm{leaf}} - T_{\mathrm{air}} = \frac{\Phi_n \left(\frac{1}{g_a} + \frac{1}{g_c}\right)}{\lambda \left[s + \gamma \left(1 + \frac{g_a}{g_c}\right) \right]} - \frac{\lambda \Delta\rho_{va}}{\lambda \left[s + \gamma \left(1 + \frac{g_a}{g_c}\right) \right]} \tag{53}$$

$$E = \frac{s \cdot \Phi_N + \lambda \cdot g_a \cdot \Delta\rho_{va}}{\lambda \cdot [s + \lambda \cdot (1 + g_a/g_c)]} \tag{54}$$

$$\mathbf{E_c} = \sum_{\mathrm{layer}N}^{\mathrm{layer1}} (\mathbf{E}_{\mathrm{sun}} \cdot l_{\mathrm{sun}}) + (\mathbf{E}_{\mathrm{shade}} \cdot l_{\mathrm{shade}}) \tag{55}$$

$$\mathbf{E}_{\mathrm{tot}} = \int_{\mathrm{D=365}}^{D_j=1} \int_{\mathrm{hr=24}}^{hr=0} \mathbf{E_c} \tag{56}$$

$$\tag{57}$$

Sun / Shade Canopy

$$
\begin{align}
k &= \frac{\sqrt{\chi^2 + \tan^2(\theta)} \cdot \cos(\theta)}{\chi + 1.744 \cdot [\chi + 1.183]^{-0.733}} \tag{58} \\
F_{\text{sun}} &= \frac{1 - e^{(-k \cdot F_{\text{canopy}} / \cos(\theta))} \cdot \cos(\theta)}{k} \tag{59} \\
F_{\text{shade}} &= F_{\text{canopy}} - F_{\text{sun}} \tag{60} \\
F_{\text{canopy}} &= F_{\text{sun}} + F_{\text{shade}} \tag{61} \\
I_{\text{sun}} &= I_{dir} \cdot k / \cos(\theta) + I_{\text{shade}} \tag{62} \\
I_{\text{shade}} &= I_{\text{diff}} \cdot e^{(-0.5 \cdot F_{\text{canopy}}^{0.7})} + I_{\text{scat}} \tag{63} \\
I_{\text{scat}} &= 0.07 \cdot I_{\text{dir}} \cdot (1.1 - 0.1 \cdot f) \cdot e^{-\cos(\theta)} \tag{64} \\
I_{\text{total}} &= I_{\text{dir}} + I_{\text{dif}} \tag{65} \\
& \tag{66}
\end{align}
$$

Total Canopy Assimilation

$$A_c = (A_{c,\text{sun}} \cdot F_{\text{sun}}) + (A_{c,\text{shade}} \cdot F_{\text{shade}}) \tag{67}$$

$$F_{\text{sun}} = \sum_{\text{layer}N}^{\text{layer1}} l_{\text{sun}};\; l_{\text{sun}} = \frac{1 - e^{(-k \cdot F_{\text{sun}})}}{k} \tag{68}$$

$$F_{\text{shade}} = \sum_{\text{layer}N}^{\text{layer1}} \ell_{\text{shade}};\; \ell_{\text{shade}} = F_{\text{sun}} - \ell_{\text{sun}} \tag{69}$$

$$F_{\text{canopy}} = F_{\text{sun}} + F_{\text{shade}} \tag{70}$$

$$I_d = I_{\text{diff}} \cdot e^{(-k \cdot F_{sun})} \tag{71}$$

$$I_{\ell,d} = k \cdot I_d \tag{72}$$

$$I_{\ell,s} = k \cdot I_{\text{dir}} + I_{\ell,d} \tag{73}$$

$$A_c = \sum_{\text{layer}N}^{layer1} (A_{c,\text{sun}} \cdot F_{\text{sun}}) + (A_{c,\text{shade}} \cdot F_{\text{shade}}) \tag{74}$$

$$A_{c,\text{tot}} = \int_{D_j=365}^{D_j=1} \int_{\text{hr}=24}^{\text{hr}=0} A_c \tag{75}$$

$$g_c = \sum_{\text{layer}N}^{\text{layer1}} (g_{s,\text{sun}} \cdot l_{\text{sun}}) + (g_{s,\text{shade}} \cdot l_{\text{shade}}) \tag{76}$$

$$g_{c,\text{tot}} = \int_{D_j=365}^{D_j=1} \int_{\text{hr}=24}^{\text{hr}=0} g_c \tag{77}$$

$$\tag{78}$$

Allocation

$$
\begin{aligned}
A_{\text{stroot}} &= abs(\omega_{\text{stroot}} \cdot k_{\text{stroot}})\ ;\ k_{\text{stroot}} < 0 && (79)\\
A_{\text{total}} &= A_c + A_{\text{seed}} + A_{\text{stroot}} && (80)\\
\omega_{\text{leaf}} &= \omega_{\text{leaf}} + (A_{\text{total}} \cdot k_{\text{leaf}}) && (81)\\
\omega_{\text{stem}} &= \omega_{\text{stem}} + (A_{\text{total}} \cdot k_{\text{stem}}) && (82)\\
\omega_{\text{sroot}} &= \omega_{\text{sroot}} + (A_{\text{total}} \cdot k_{\text{sroot}}) && (83)\\
\omega_{\text{froot}} &= \omega_{\text{froot}} + (A_{\text{total}} \cdot k_{\text{froot}}) && (84)\\
\Psi_{\text{adl}} &< \Psi_{\text{pt}};\\
k_{\text{leaf}} &= k_{\text{leaf}} \cdot k_{\text{mod}};\\
k_{\text{stem}} &= k_{\text{stem}} \cdot k_{\text{mod}};\\
k_{\text{stroot}} &= k_{\text{stroot}} \cdot k_{\text{mod}};\\
k_{\text{mod}} &= (\Psi_{\text{adl}} - \Psi_{\text{pt}}) \cdot \Psi_g; 0 \le k_{\text{mod}} \le 1 && (85)\\
\Delta F_{\text{canopy}} &= \frac{\omega_{\text{leaf}}}{Sp_{\text{leaf}}} && (86)\\
\Delta L_{\text{stem}} &= \frac{\omega_{\text{stem}}}{Sp_{\text{stem}}} && (87)\\
\Delta L_{\text{sroot}} &= \frac{\omega_{\text{root}}}{Sp_{\text{sroot}}} && (88)\\
& && (89)
\end{aligned}
$$

Soil Evaporation

$$E_{\text{soil}} = \sum \frac{(\Psi_{\text{si}} - g \cdot z_i - \Psi_x)}{R_{\text{si}} + R_{\text{ri}}} \tag{90}$$

$$R_{\text{ri}} = R_r \cdot \frac{\sum L_i}{L_i} \tag{91}$$

$$\Psi_x = \sum \frac{(\Psi_{\text{si}} - q_w \cdot z_i)}{R_{\text{si}} + R_{\text{ri}}} / \sum \frac{1}{R_{\text{si}} + R_{\text{ri}}} \tag{92}$$

$$\Psi_L = \Psi_x - E \cdot R_L \tag{93}$$

$$E_d = \begin{cases} E_p, & \theta^* \geq \theta_1 \\ E_p\left(\frac{\theta - \theta_2}{\theta_1 - \theta_2}\right), & \theta_2 < \theta^* < \theta_1 \\ 0, & \theta^* \leq \theta_2 \end{cases} \tag{94}$$

$$\theta_{i+1} = \theta_i - \frac{E_i \cdot \theta_i}{\rho_w \cdot d_s} \tag{95}$$

$$g_{a,\text{soil}} = \frac{(2.126 \cdot 10^{-5}) + (1.48 \cdot 10^{-7}) \cdot T_{\text{soil}}}{\left(0.004 \cdot \sqrt{\frac{S_{size}}{u_{\text{soil}}}}\right)} \tag{96}$$

$$R_{lc,\text{soil}} = ((4 \cdot 5.67 \cdot 10^{-8}) \cdot (273 + T_{\text{soil}})^3 \cdot \Delta T) \tag{97}$$

$$J_{a,\text{soil}} = 2 \cdot I_{\text{soil}} \cdot \left(\frac{1 - S_r - S_\tau}{1 - S_\tau}\right) \tag{98}$$

$$\Phi_{N,soil} = J_{a,soil} - R_{lc,soil} \tag{99}$$

$$E = \frac{s \cdot \Phi_{N,soil} + \lambda \cdot g_{a,soil} \cdot \Delta\rho_{va}}{\lambda \cdot [s + \gamma]} \tag{100}$$

$$\tag{101}$$

Respiration

$$R_{\text{total}} = (a \cdot A_n) + (b_{\text{stem}} \cdot \omega_{\text{stem}}) + (b_{\text{root}} \cdot \omega_{\text{root}}) \tag{102}$$

$$\tag{103}$$

Energy Balance

$$HS_{\text{soil}} = HO_{\text{soil}} \cdot exp\left[\frac{h_{\text{soil}}}{46.97 \cdot (T_s + 273.16)}\right] \tag{104}$$

$$HO_{\text{soil}} = 1.323 \cdot exp\left[\frac{17.27 \cdot T_s}{273.3 + T_s}\right] \bigg/ T_s + 273.16 \tag{105}$$

$$G_{\text{soil}} = -\lambda_{\text{soil}} \frac{\delta T}{\delta x} \tag{106}$$

$$G_{\text{soil}} = -\lambda_{\text{soil}} \cdot \left[\frac{T_2 - T_s}{\Delta z}\right] + (T_s - T_l) \cdot C \cdot \frac{\Delta z}{(2 \cdot \Delta t)} \tag{107}$$

Definition of Terms

Term	Units	Definition	Value
A_{gross}	$\mu mol\, mol^{-1}$	Gross rate of CO_2 uptake per unit leaf area	-
A_{net}	$\mu mol\, mol^{-1}$	Net rate of CO_2 uptake per unit leaf area	-
A_c	$\mu mol\, mol^{-1}$	Net canopy rate of CO_2 uptake per unit ground area	-
$A_{c,\text{tot}}$	$g\, m^{-2}\, yr^{-1}$	A_c integrated over the course of a year	-
$A_{c,\text{sun}}$	$mol\, mol^{-1}$	Net rate of CO_2 uptake per unit area sunlit leaves	-
$A_{c,\text{shade}}$	$mol\, m^{-2}\, s^{-1}$	Net rate of CO_2 uptake per unit area shaded leaves	-
A	$\mu mol\, mol^{-1}$	Predicted rate of CO_2 uptake	-
C_a	$\mu mol\, mol^{-1}$	Atmospheric CO_2 concentration	378
a	Dimensionless	Coefficient for growth respiration	0.2
c_i	$\mu mol\, mol^{-1}$	Intercellular concentration of CO_2 in air corrected for solubility relative to 25°C	Calculated based on A, c_a and h_s
b_{leaf}	Dimensionless	Coefficient for maintenance respiration for leaf	0.03
b_{stem}	Dimensionless	Coefficient for maintenance respiration for stem	0.015
b_{root}	Dimensionless	Coefficient for maintenance respiration for root	0.01
c_p	$J\, kg^{-1}\, K{-1}$	Specific heat capacity of dry air	1010
C_{ov}	Dimensionless	Coefficient of Variation for probability of rain in each month	-
D_j	d	day of year	-
D_{start}	d	Day of year on which the sinusoidal temperature function is assumed to start	45
d	dimensionless	Zero plane displacement	0.77
E	$J\, mol^{-1}$	Activation energy	R_d = 66405 $V_{\max}$ = 6800
E_l	$mmol\, m^{-2}\, s^{-1}$	Evapo/transpiration rate at sunlit/shaded leaves in a canopy layer	-
E_c	$mmol\, m^{-2}\, s^{-1}$	Instantaneous canopy evapo/transpiration rate	-
E_{tot}	$mmol\, m^{-2}\, yr^{-1}$	E_c integrated over the course of a year	-
e_l	kPa	Saturated water VPD in the leaf	-
F_{canopy}	$m^2\, m^{-2}$	Canopy leaf area index	9
F_{shade}	$m^2\, m^{-2}$	Canopy shaded leaf area index	-
F_{sun}	$m^2\, m^{-2}$	Canopy sunlit leaf area index	-
F_{sum}	$m^2\, m^{-2}$	Summed leaf area index from top of canopy to layer considered in calculation	-
g_a	$mmol\, m^{-2}\, s^{-1}$	Leaf boundary layer conductance	-
g_s	$mmol\, m^{-2}\, s^{-1}$	Leaf stomatal conductance	-
g_c	$mmol\, m^{-2}\, s^{-1}$	Canopy conductance of CO_2	-
g_0	dimensionless	Stomatal slope factor	3
g_1	dimensionless	Stomatal intercept factor	0.08
$g_{s,\text{sun}}$	$mmol\, m^{-2}\, s^{-1}$	The sum of stomatal conductance of sunlit leaves	-
$g_{s,\text{shade}}$	$mmol\, m^{-2}\, s^{-1}$	The sum of stomatal conductance of shaded leaves	-
h_r	h	Hour of day	-
h_s	%	Relative humidity	-
h_{canopy}	m	Height of canopy	5
h_{ms}	m	Wind speed measurement height	2
h_{layer}	m	Height of canopy layer above ground	-
I	$\mu mol\, m^{-2}\, s^{-1}$	Photon flux	-
h	$mmday^{-1}$	The amount of water received on a given rainy day	-
I_{abs}	$\mu mol\, m^{-2}\, s^{-1}$	Photon flux absorbed by either sunlit or shaded leaves within a canopy layer	-

Table 1 – continued from previous page

Term	Units	Definition	Value
I_{dir}	$\mu mol\, m^{-2}\, s^{-1}$	Photon flux in direct solar beam	-
I_{diff}	$\mu mol\, m^{-2}\, s^{-1}$	Photon flux in diffuse radiation	-
I_{total}	$\mu mol\, m^{-2}\, s^{-1}$	Total photon flux incident on canopy	-
I_s	$\mu mol\, m^{-2}\, s^{-1}$	Solar constant, photon flux in a plane perpedicular to the solar beam above the atmosphere	2600
I_{short}	$\mu mol\, m^{-2}\, s^{-1}$	Short wave radiation component of incident light	-
I_{soil}	$\mu mol\, m^{-2}\, s^{-1}$	Solar radiation incident upon soil surface	-
I_{sun}	$\mu mol\, m^{-2}\, s^{-1}$	Mean I for leaves which receive direct solar radiation, i.e. are sunlit	-
I_{shade}	$\mu mol\, m^{-2}\, s^{-1}$	Mean I for leaves shaded from direct solar radiation	-
I_{scat}	$\mu mol\, m^{-2} s^{-1}$	Direct beam radiation scattered by surfaces within the canopy	-
J_a	$\mu mol\, m^{-2}\, s^{-1}$	Total solar radiation absorbed by either sunlit or shaded leaves within a canopy layer	-
k	dimensionless	Foliar absorption coefficient	-
K_c	$\mu mol\, mol^{-1}$	Michaelis constant for CO_2	460
$K_{\mathrm{CO_2}}$	$mol\, m^{-2}\, s^{-1}$	Initial slope of photosynthetic CO_2 response	0.7
K_o	$mmol\, mol^{-1}$	Michaelis constant for O_2	330
k_{slope}	Dimensionless	Initial slope of photosynthetic light response	0.04
LN	$g\, m^{-2}$	Leaf nitrogen concentration	-
k_{leaf}	Dimensionless	Partitioning coefficient for leaf	-
k_{stem}	Dimensionless	Partitioning coefficient for stem	-
k_{sroot}	Dimensionless	Partitioning coefficient for storage root	-
k_{froot}	Dimensionless	Partitioning coefficient for fine root	-
k_{stroot}	Dimensionless	Partitioning coefficient for structural root	-
ω_{leaf}	gram	Leaf biomass	-
ω_{stem}	gram	Stem biomass	-
ω_{sroot}	gram	Biomass of storage root	-
ω_{froot}	gram	Biomass of fine root	-
ω_{stroot}	gram	Biomass of structural root	-
Sp_{leaf}	gram m^{-2}	Specific leaf area	50
Sp_{stem}	gram m^{-1}	Specific stem elongation factor	60
Sp_{froot}	gram m^{-1}	Specific fine root elongation factor	10
Sp_{stroot}	gram m^{-1}	Specific structural root elongation factor	60
L_w	m	Leaf width in the direction of the wind	0.04
O_a	$mmol\, mol^{-1}$	Atmospheric O_2 concentration	210
q	Dimensionless	The probability that there is no rainfall	-
n	Day	The number of days in a month	29, 30, or 31
nr	Day	The number of rainy days in a month	-
O_i	$mmol\, m^{-2}\, s^{-1}$	Intercellular concentration of O_2 in air corrected for solubility relative to 25°C	-
P	kPa	Atmospheric pressure at Lake Naivasha	80
P_o	kPa	Standard atmospheric pressure at sea level	101.324
P_s	kPa	Leaf surface partial pressure of CO_2	-
v		Saturated water vapour concentration	-
Q_{10}	dimensionless	Is the proportional rise in a parameter for a 10°C increase in temperature	2
r	dimensionless	Leaf reflection coefficient for total solar radiation	0.2
R	$J\, k^{-1}\, mol^{-1}$	Real gas constant	8.314
R_o	$mol\, m^{-2}\, s^{-1}$	Dark respiration rate at $25°C$	3
R_d	$mol\, m^{-2}\, s^{-1}$	Dark respiration at a given temperature	-
R_{lc}	$mol\, m^{-2}\, s^{-1}$	Longwave radiation	-
s	kPa K^{-1}	Slope of saturated water vapor pressure change with respect to temperature (look up table)	-

Table 1 – continued from previous page

Term	Units	Definition	Value
s_p	dimensionless	Spectral imbalance	-
S_{size}	m	Average size of soil particles	0.04
S_r	Dimensionless	Soil reflectance	0.2
S_t	Dimensionless	Soil transmission	0.01
τ	Dimensionless	Leaf transmittance coefficient	
t	h	Time of day	-
t_{sn}	h	Time of solar noon	12
T_{leaf}	°C	Leaf temperature	-
T_{air}	°C	Ambient air temperature	-
T_{soil}	°C	Soil surface temperature	-
T_1	°C	Annual mean air temperature	18
T_2	°C	Annual range in air temperature	2
T_3	°C	Average daily range in air temperature	7
T_4	°C	Maximum daily range in air temperature	7
u	m s^{-1}	Measured wind speed at known height (2m)	2
u_{layer}	m s^{-1}	Wind speed in a given canopy layer	-
u_{soil}	m s^{-1}	Wind speed at soil surface	-
$V_{\max}$	$mol\, m^{-2}\, s^{-1}$	Maximum rubP saturated rate of carboxylation at a given temperature	-
$V_{c,\max_o}$	$mol\, m^{-2}\, s^{-1}$	Maximum rubP saturated rate of carboxylation at 25°C	39
VPD	kPa	Leaf-air water vapour pressure deficit	-
z_o	m	Roughness length	0.234
χ	dimensionless	The ratio of horizontal:vertical projected area of leaves in the canopy segment	1
α	dimensionless	Atmospheric transmittance	0.85
slope	$mol\, m^{-1}$	Initial slope of photosynthetic CO_2 response	0.7
Θ_{curve}	dimensionless	Curvature parameter	-
δ	degrees	Solar declination	-
Ω	degrees	Latitude	-
Θ	degrees	Solar zenith angle	-
curve	dimensionless	Curvature parameter	0.83
λ	MJ/Kg	Latent heat of vapourisation	-
γ	Pa K^{-1}	psychrometer constant	-
α_{slope}	mol mol^{-1}	The quantum yield of CO_2 uptake determined by the initial slope of the response of A versus I_{abs}	0.04
β		C_4 curvature parameter	0.93
Kt		C_4 slope factor	-
Ψ_l	MPa	Leaf water potential	-
Ψ_t	MPa	Threshold leaf water potential for decreasing gs	-
Φ_N	W m^{-2}	Net radiation	-
Ψ_{adl}	MPa	Average daily plant water potential	-
Ψ_{pt}	MPa	Threshold water potential	-
Z	m	Thickness of a soil layer	-
Ψ_x	MPa	xylem water potential	-
Ψ_{si}	MPa	Soil water potential of the ith layer	-
q_w	Kg s^{-1}	Flux of water	-
R_{si}	$m^3 kg^{-1} s^{-1}$	Soil resistance of the ith zone	-
R_{ri}	$M^3 kg^{-1} s^{-1}$	root resistance of the ith zone	-
L_i	$cm\, cm^{-3}$	Root density of ith zone	-
g	$m\, s^{-2}$	Gravitional constant	9.8
R_L	$m^3\, kg^{-1}\, s^{-1}$	Leaf resistance	-
E_d	$g\, m^{-2}\, s^{-1}$	Potential soil evaporation	-
E_p	$g\, m^{-2}\, s^{-1}$	Actual soil evaporation	-
Θ^*	Kgm^{-3}	Actual volumetric water content	-
Θ_1	$Kg\, m^{-3}$	The volumetric water content for maximizing Evaporation	

Table 1 – continued from previous page

Term	Units	Definition	Value
Θ_2	$Kg\,m^{-3}$	The volumetric water content for wilting point	-
d_s	m	Soil depth	-
ρ_w	$Kg\,m^{-3}$	Density of water	1000
$R_{lc,\text{soil}}$	$mol\,m^{-2}\,s^{-1}$	Soil longwave radiation	-
I_{soil}	$W\,m^{-2}$	Solar radiation on soil	-
Θ_i	$Kg\,m^{-3}$	The volumetric water content of the ith day	-
$\Delta\rho_{\text{va}}$	KPa	Vapor pressure deficit	-
HO_{soil}	$Kg\,m^{-3}$	Saturated humidity of the air at the soil surface	-
HS_{soil}	$Kg\,m^{-3}$	Humidity of the air at the soil surface	-
h_{soil}	m	Water pressure head	-
λ	$W/(m^{\circ}C)$	Thermal conductivity for the soil surface	-
G_{soil}	$W\,m^{-2}$	Soil heat flux	-