# Equations

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

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

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

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

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

$$\text{Mean} = T_1 + T_2 \cdot \sin\left(2\pi \frac{D_j - D_{\text{start}}}{365}\right) \tag{6}$$

$$\text{Range} = T_3 + (T_4 - T_3) \cdot \sin\left(2\pi \frac{D_j - D_{\text{start}}}{365}\right) \tag{7}$$

$$\text{Excursion} = \sin\left(2\pi \frac{h_r - 10}{24}\right) \tag{8}$$

$$T_{air} = \text{Mean} + \text{Range} \cdot \text{Excursion} \tag{9}$$

$$q = \frac{n_r}{n} \tag{10}$$

$$N_{eff} = \frac{\frac{(1-q)}{q}}{C_{ov}^2} \tag{11}$$

$$r^{\sim} = \frac{m_r}{n} \tag{12}$$

$$h = \frac{r^{\sim}}{q} \tag{13}$$

$$V_{c\max} = V_{c\ \max\ o} \cdot Kt(E_{vc\,max}) \tag{14}$$

$$R_d = R_o \cdot Kt(E_{Rd}) \tag{15}$$

$$M = \min \frac{(V_{c,\max} + \alpha_{\text{slope}} I_{\text{abs}}) \pm \sqrt{(V_{c,\max} + \alpha_{\text{slope}} I_{\text{abs}})^2 - 4(V_{c,\max}\alpha_{\text{slope}} I_{\text{abs}})\theta_{\text{curve}}}}{2\theta_{\text{curve}}} \tag{16}$$

$$A_{\text{gross}} = \min \frac{\left(M + k_t \cdot \frac{c_i}{P}\right) \pm \sqrt{\left(M + k_t \cdot \frac{c_i}{P}\right)^2 - \left(4 \cdot M \cdot k_t \cdot \frac{c_i}{P} \cdot \beta\right)}}{2 \cdot \beta} \tag{17}$$

$$A_n = A_{\text{gross}} - R_d \tag{18}$$

$$h_s = \frac{e_l - VPD}{e_l} \cdot 100 \tag{19}$$

$$g_s = g_0 + g_1 \cdot A_{\text{gross}} \cdot \frac{h_s}{C_a} \tag{20}$$

$$g_{w,\text{mod}} = \left(\frac{\Psi_l - \Psi_t}{1000}\right) \cdot g_{ws} \tag{21}$$

$$g_1 = g_1 \cdot (1 - g_{w,\text{mod}}) \tag{22}$$

$$J_a = 2 \cdot I_{\text{abs}} \cdot \left(\frac{1 - r - \tau}{1 - \tau}\right) \cdot \ell \tag{23}$$

$$L_b = (2.126 \cdot 10^{-5} + 1.48 \cdot 10^{-7} \cdot T_{\text{air}})/0.004 \cdot \sqrt{L_w / u_{\text{layer}}} \tag{24}$$

$$u_a = \frac{u \cdot 0.41}{log((u - d)/z_o)} \tag{25}$$

$$g_a = \frac{(u_a^2/u_{\text{layer}}) \cdot L_b}{(u_a^2/u_{\text{layer}}) + L_b} \tag{26}$$

$$\rho'_v = 610.78 \cdot e^{\left(17.269 \cdot \frac{T_a}{T_a + 237.3}\right)} \tag{27}$$

$$\Delta\rho_{va} = \rho'_v \cdot \left(1 - \frac{h_s}{100}\right) \tag{28}$$

$$\gamma = \frac{\rho \cdot c_p}{\lambda} \tag{29}$$

$$s = 18 \cdot (2501 - 2.373 \cdot T_a) \cdot \left(\frac{\rho'_v}{8.314 \cdot (T_a + 273)^2}\right) \tag{30}$$

$$R_{lc} = 4 \cdot 5.67 \cdot 10^{-8} \cdot (273 + T_{\text{air}})^3 \cdot \Delta T \tag{31}$$

$$\Phi_N = J_a - R_{lc} \tag{32}$$

$$\Delta T = T_{\text{leaf}} - T_{\text{air}} = \frac{\Phi_n \left(\frac{1}{g_a} + \frac{1}{g_c}\right)}{\lambda \left[s + \gamma \left(1 + \frac{g_a}{g_c}\right)\right]} - \frac{\lambda \Delta\rho_{va}}{\lambda \left[s + \gamma \left(1 + \frac{g_a}{g_c}\right)\right]} \tag{33}$$

$$E = \frac{s \cdot \Phi_N + \lambda \cdot g_a \cdot \Delta\rho_{va}}{\lambda \cdot [s + \lambda \cdot (1 + g_a/g_c)]} \tag{34}$$

$$\mathbf{E_c} = \sum_{\text{layer}N}^{\text{layer1}} (\mathbf{E}_{\text{sun}} \cdot l_{\text{sun}}) + (\mathbf{E}_{\text{shade}} \cdot l_{\text{shade}}) \tag{35}$$

$$\mathbf{E}_{\text{tot}} = \int_{\text{D=365}}^{D_j=1} \int_{\text{hr=24}}^{hr=0} \mathbf{E_c} \tag{36}$$

$$k = \frac{\sqrt{\chi^2 + \tan^2(\theta)} \cdot \cos(\theta)}{\chi + 1.744 \cdot [\chi + 1.183]^{-0.733}} \tag{37}$$

$$F_{\text{sun}} = \frac{1 - e^{(-k \cdot F_{\text{canopy}} / \cos(\theta))} \cdot \cos(\theta)}{k} \tag{38}$$

$$F_{\text{shade}} = F_{\text{canopy}} - F_{\text{sun}} \tag{39}$$

$$F_{\text{canopy}} = F_{\text{sun}} + F_{\text{shade}} \tag{40}$$

$$I_{\text{sun}} = I_{dir} \cdot k / \cos(\theta) + I_{\text{shade}} \tag{41}$$

$$I_{\text{shade}} = I_{\text{diff}} \cdot e^{(-0.5 \cdot F_{\text{canopy}}^{0.7})} + I_{\text{scat}} \tag{42}$$

$$I_{\text{scat}} = 0.07 \cdot I_{\text{dir}} \cdot (1.1 - 0.1 \cdot f) \cdot e^{-\cos(\theta)} \tag{43}$$

$$I_{\text{total}} = I_{\text{dir}} + I_{\text{dif}} \tag{44}$$

$$A_c = (A_{c,\text{sun}} \cdot F_{\text{sun}}) + (A_{c,\text{shade}} \cdot F_{\text{shade}}) \tag{45}$$

$$F_{\text{sun}} = \sum_{\text{layer}N}^{\text{layer1}} l_{\text{sun}};\ l_{\text{sun}} = \frac{1 - e^{(-k \cdot F_{\text{sun}})}}{k} \tag{46}$$

$$F_{\text{shade}} = \sum_{\text{layer}N}^{\text{layer1}} \ell_{\text{shade}};\ \ell_{\text{shade}} = F_{\text{sun}} - \ell_{\text{sun}} \tag{47}$$

$$F_{\text{canopy}} = F_{\text{sun}} + F_{\text{shade}} \tag{48}$$

$$I_d = I_{\text{diff}} \cdot e^{(-k \cdot F_{sun})} \tag{49}$$

$$I_{\ell,d} = k \cdot I_d \tag{50}$$

$$I_{\ell,s} = k \cdot I_{\text{dir}} + I_{\ell,d} \tag{51}$$

$$A_c = \sum_{\text{layer}N}^{layer1} (A_{c,\text{sun}} \cdot F_{\text{sun}}) + (A_{c,\text{shade}} \cdot F_{\text{shade}}) \tag{52}$$

$$A_{c,\text{tot}} = \int_{D_j=365}^{D_j=1} \int_{\text{hr=24}}^{\text{hr=0}} A_c \tag{53}$$

$$g_c = \sum_{\text{layer}N}^{\text{layer1}} (g_{s,\text{sun}} \cdot l_{\text{sun}}) + (g_{s,\text{shade}} \cdot l_{\text{shade}}) \tag{54}$$

$$g_{c,\mathrm{tot}} = \int_{D_j=365}^{D_j=1} \int_{\mathrm{hr}=24}^{\mathrm{hr}=0} g_c \tag{55}$$

$$A_{\mathrm{stroot}} = abs(\omega_{\mathrm{stroot}} \cdot k_{\mathrm{stroot}}) \; ; \; k_{\mathrm{stroot}} < 0 \tag{56}$$

$$A_{\mathrm{total}} = A_c + A_{\mathrm{seed}} + A_{\mathrm{stroot}} \tag{57}$$

$$\omega_{\mathrm{leaf}} = \omega_{\mathrm{leaf}} + (A_{\mathrm{total}} \cdot k_{\mathrm{leaf}}) \tag{58}$$

$$\omega_{\mathrm{stem}} = \omega_{\mathrm{stem}} + (A_{\mathrm{total}} \cdot k_{\mathrm{stem}}) \tag{59}$$

$$\omega_{\mathrm{sroot}} = \omega_{\mathrm{sroot}} + (A_{\mathrm{total}} \cdot k_{\mathrm{sroot}}) \tag{60}$$

$$\omega_{\mathrm{froot}} = \omega_{\mathrm{froot}} + (A_{\mathrm{total}} \cdot k_{\mathrm{froot}}) \tag{61}$$

$\Psi_{\mathrm{adl}} < \Psi_{\mathrm{pt}}$;

$k_{\mathrm{leaf}} = k_{\mathrm{leaf}} \cdot k_{\mathrm{mod}}$;

$k_{\mathrm{stem}} = k_{\mathrm{stem}} \cdot k_{\mathrm{mod}}$;

$k_{\mathrm{stroot}} = k_{\mathrm{stroot}} \cdot k_{\mathrm{mod}}$;

$$k_{\mathrm{mod}} = (\Psi_{\mathrm{adl}} - \Psi_{\mathrm{pt}}) \cdot \Psi_g; 0 \leq k_{\mathrm{mod}} \leq 1 \tag{62}$$

$$\Delta F_{\mathrm{canopy}} = \frac{\omega_{\mathrm{leaf}}}{Sp_{\mathrm{leaf}}} \tag{63}$$

$$\Delta L_{\mathrm{stem}} = \frac{\omega_{\mathrm{stem}}}{Sp_{\mathrm{stem}}} \tag{64}$$

$$\Delta L_{\mathrm{sroot}} = \frac{\omega_{\mathrm{root}}}{Sp_{\mathrm{sroot}}} \tag{65}$$

$$R_{\mathrm{total}} = (a \cdot A_{\mathrm{gross}}) + (b_{\mathrm{leaf}} \cdot \omega_{\mathrm{leaf}}) + (b_{\mathrm{stem}} \cdot \omega_{\mathrm{stem}}) + (b_{\mathrm{root}} \cdot \omega_{\mathrm{root}}) \tag{66}$$

$$E_{\mathrm{soil}} = \sum \frac{(\Psi_{\mathrm{si}} - g \cdot z_i - \Psi_x)}{R_{\mathrm{si}} + R_{\mathrm{ri}}} \tag{67}$$

$$R_{\mathrm{ri}} = R_r \cdot \frac{\sum L_i}{L_i} \tag{68}$$

$$\Psi_x = \sum \frac{(\Psi_{\mathrm{si}} - q_w \cdot z_i)}{R_{\mathrm{si}} + R_{\mathrm{ri}}} / \sum \frac{1}{R_{\mathrm{si}} + R_{\mathrm{ri}}} \tag{69}$$

$$\Psi_L = \Psi_x - E \cdot R_L \tag{70}$$

$$E_d = \begin{cases} E_p, & \theta^* \geq \theta_1 \\ E_p\left(\frac{\theta-\theta_2}{\theta_1-\theta_2}\right), & \theta_2 < \theta^* < \theta_1 \\ 0, & \theta^* \leq \theta_2 \end{cases} \tag{71}$$

$$\theta_{i+1} = \theta_i - \frac{E_i \cdot \theta_i}{\rho_w \cdot d_s} \tag{72}$$

$$g_{a,\text{soil}} = \frac{(2.126 \cdot 10^{-5}) + (1.48 \cdot 10^{-7}) \cdot T_{\text{soil}}}{\left(0.004 \cdot \sqrt{\frac{S_{size}}{u_{\text{soil}}}}\right)} \tag{73}$$

$$R_{lc,\text{soil}} = ((4 \cdot 5.67 \cdot 10^{-8}) \cdot (273 + T_{\text{soil}})^3 \cdot \Delta T) \tag{74}$$

$$J_{a,\text{soil}} = 2 \cdot I_{\text{soil}} \cdot \left(\frac{1 - S_r - S_\tau}{1 - S_\tau}\right) \tag{75}$$

$$\Phi_{N,soil} = J_{a,soil} - R_{lc,soil} \tag{76}$$

$$E = \frac{s \cdot \Phi_{N,soil} + \lambda \cdot g_{a,soil} \cdot \Delta\rho_{va}}{\lambda \cdot [s + \gamma]} \tag{77}$$

$$HS_{\text{soil}} = HO_{\text{soil}} \cdot exp\left[\frac{h_{\text{soil}}}{46.97 \cdot (T_s + 273.16)}\right] \tag{78}$$

$$HO_{\text{soil}} = 1.323 \cdot exp\left[\frac{17.27 \cdot T_s}{273.3 + T_s}\right] \Big/ T_s + 273.16 \tag{79}$$

$$G_{\text{soil}} = -\lambda_{\text{soil}} \frac{\delta T}{\delta x} \tag{80}$$

$$G_{\text{soil}} = -\lambda_{\text{soil}} \cdot \left[\frac{T_2 - T_s}{\Delta z}\right] + (T_s - T_l) \cdot C \cdot \frac{\Delta z}{(2 \cdot \Delta t)} \tag{81}$$

# Definition of Terms

| Term | Units | Definition | Value |
|---|---|---|---|
| $A_{\text{gross}}$ | $\mu mol\, mol^{-1}$ | Gross rate of $CO_2$ uptake per unit leaf area | - |
| $A_{\text{net}}$ | $\mu mol\, mol^{-1}$ | 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 $h_s$ |
| $b_{\text{leaf}}$ | Dimensionless | Coefficient for maintenance respiration for leaf | 0.03 |
| $b_{\text{stem}}$ | Dimensionless | Coefficient for maintenance respiration for stem | 0.015 |
| $b_{\text{root}}$ | 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 | - |
| $D_{\text{start}}$ | 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 $Vc\,max$ = 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 | - |
| $E_{\text{tot}}$ | $mmol\, m^{-2}\, yr^{-1}$ | $E_c$ integrated over the course of a year | - |
| $e_l$ | kPa | Saturated water VPD in the leaf | - |
| $F_{\text{canopy}}$ | $m^2\, m^{-2}$ | Canopy leaf area index | 9 |
| $F_{\text{shade}}$ | $m^2\, m^{-2}$ | Canopy shaded leaf area index | - |
| $F_{\text{sun}}$ | $m^2\, m^{-2}$ | Canopy sunlit leaf area index | - |
| $F_{\text{sum}}$ | $m^2\, m^{-2}$ | 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 | - |
| $h_{\text{canopy}}$ | m | Height of canopy | 5 |
| $h_{ms}$ | m | Wind speed measurement height | 2 |
| $h_{\text{layer}}$ | 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 | - |
| $I_{\text{abs}}$ | $\mu mol\, m^{-2}\, s^{-1}$ | Photon flux absorbed by either sunlit or shaded leaves within a canopy layer | - |

**Table 1 – continued from previous page**

| Term | Units | Definition | Value |
|---|---|---|---|
| $I_{\text{dir}}$ | $\mu mol\, m^{-2}\, s^{-1}$ | Photon flux in direct solar beam | - |
| $I_{\text{diff}}$ | $\mu mol\, m^{-2}\, s^{-1}$ | Photon flux in diffuse radiation | - |
| $I_{\text{total}}$ | $\mu mol\, m^{-2}\, s^{-1}$ | 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 |
| $I_{\text{short}}$ | $\mu mol\, m^{-2}\, s^{-1}$ | Short wave radiation component of incident light | - |
| $I_{\text{soil}}$ | $\mu mol\, m^{-2}\, s^{-1}$ | Solar radiation incident upon soil surface | - |
| $I_{\text{sun}}$ | $\mu mol\, m^{-2}\, s^{-1}$ | Mean I for leaves which receive direct solar radiation, i.e. are sunlit | - |
| $I_{\text{shade}}$ | $\mu mol\, m^{-2}\, s^{-1}$ | Mean I for leaves shaded from direct solar radiation | - |
| $I_{\text{scat}}$ | $\mu mol\, m^{-2} s^{-1}$ | 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 |
| $K_{\text{CO}_2}$ | $mol\, m^{-2}\, s^{-1}$ | Initial slope of photosynthetic $CO_2$ response | 0.7 |
| $K_o$ | $mmol\, mol^{-1}$ | Michaelis constant for $O_2$ | 330 |
| $k_{\text{slope}}$ | Dimensionless | Initial slope of photosynthetic light response | 0.04 |
| LN | $g\, m^{-2}$ | Leaf nitrogen concentration | - |
| $k_{\text{leaf}}$ | Dimensionless | Partitioning coefficient for leaf | - |
| $k_{\text{stem}}$ | Dimensionless | Partitioning coefficient for stem | - |
| $k_{\text{sroot}}$ | Dimensionless | Partitioning coefficient for storage root | - |
| $k_{\text{froot}}$ | Dimensionless | Partitioning coefficient for fine root | - |
| $k_{\text{stroot}}$ | Dimensionless | Partitioning coefficient for structural root | - |
| $\omega_{\text{leaf}}$ | gram | Leaf biomass | - |
| $\omega_{\text{stem}}$ | gram | Stem biomass | - |
| $\omega_{\text{sroot}}$ | gram | Biomass of storage root | - |
| $\omega_{\text{froot}}$ | gram | Biomass of fine root | - |
| $\omega_{\text{stroot}}$ | gram | Biomass of structural root | - |
| $Sp_{\text{leaf}}$ | gram $m^{-2}$ | Specific leaf area | 50 |
| $Sp_{\text{stem}}$ | gram $m^{-1}$ | Specific stem elongation factor | 60 |
| $Sp_{\text{froot}}$ | gram $m^{-1}$ | Specific fine root elongation factor | 10 |
| $Sp_{\text{stroot}}$ | 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 | - |
| $R_{\text{lc}}$ | $mol\, m^{-2}\, s^{-1}$ | 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 | - |
| $S_{\text{size}}$ | m | Average size of soil particles | 0.04 |
| $S_r$ | Dimensionless | Soil reflectance | 0.2 |
| $S_t$ | Dimensionless | Soil transmission | 0.01 |
| $\tau$ | Dimensionless | Leaf transmittance coefficient | |
| $t$ | h | Time of day | - |
| $t_{\text{sn}}$ | h | Time of solar noon | 12 |
| $T_{\text{leaf}}$ | °C | Leaf temperature | - |
| $T_{\text{air}}$ | °C | Ambient air temperature | - |
| $T_{\text{soil}}$ | °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 |
| $u_{\text{layer}}$ | m $s^{-1}$ | Wind speed in a given canopy layer | - |
| $u_{\text{soil}}$ | m $s^{-1}$ | Wind speed at soil surface | - |
| $V_{c,\max}$ | $mol\, m^{-2}\, s^{-1}$ | 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 |
| $\chi$ | dimensionless | The ratio of horizontal:vertical projected area of leaves in the canopy segment | 1 |
| $\alpha$ | dimensionless | Atmospheric transmittance | 0.85 |
| slope | $mol\, m^{-1}$ | Initial slope of photosynthetic $CO_2$ response | 0.7 |
| $\Theta_{\text{curve}}$ | dimensionless | Curvature parameter | - |
| $\delta$ | degrees | Solar declination | - |
| $\Omega$ | degrees | Latitude | - |
| $\Theta$ | degrees | Solar zenith angle | - |
| curve | dimensionless | Curvature parameter | 0.83 |
| $\lambda$ | MJ/Kg | Latent heat of vapourisation | - |
| $\gamma$ | Pa $K^{-1}$ | psychrometer constant | - |
| $\alpha_{\text{slope}}$ | 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 |
| $\beta$ | | $C_4$ curvature parameter | 0.93 |
| $Kt$ | | $C_4$ slope factor | - |
| $\Psi_l$ | MPa | Leaf water potential | - |
| $\Psi_t$ | MPa | Threshold leaf water potential for decreasing gs | - |
| $\Phi_N$ | W $m^{-2}$ | Net radiation | - |
| $\Psi_{\text{adl}}$ | MPa | Average daily plant water potential | - |
| $\Psi_{\text{pt}}$ | MPa | Threshold water potential | - |
| $Z$ | m | Thickness of a soil layer | - |
| $\Psi_x$ | MPa | xylem water potential | - |
| $\Psi_{\text{si}}$ | MPa | Soil water potential of the ith layer | - |
| $q_w$ | Kg $s^{-1}$ | Flux of water | - |
| $R_{\text{si}}$ | $m^3 kg^{-1} s^{-1}$ | Soil resistance of the ith zone | - |
| $R_{\text{ri}}$ | $M^3 kg^{-1} s^{-1}$ | 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 | - |
| $\Theta^*$ | $Kgm^{-3}$ | Actual volumetric water content | - |
| $\Theta_1$ | $Kg\, m^{-3}$ | The volumetric water content for maximizing Evaporation | |

**Table 1 – continued from previous page**

| Term | Units | Definition | Value |
|---|---|---|---|
| $\Theta_2$ | $Kg\,m^{-3}$ | The volumetric water content for wilting point | - |
| $d_s$ | m | Soil depth | - |
| $\rho_w$ | $Kg\,m^{-3}$ | Density of water | 1000 |
| $R_{lc,\text{soil}}$ | $mol\,m^{-2}\,s^{-1}$ | Soil longwave radiation | - |
| $I_{\text{soil}}$ | $W\,m^{-2}$ | Solar radiation on soil | - |
| $\Theta_i$ | $Kg\,m^{-3}$ | The volumetric water content of the ith day | - |
| $\Delta\rho_{\text{va}}$ | KPa | Vapor pressure deficit | - |
| $HO_{\text{soil}}$ | $Kg\,m^{-3}$ | Saturated humidity of the air at the soil surface | - |
| $HS_{\text{soil}}$ | $Kg\,m^{-3}$ | Humidity of the air at the soil surface | - |
| $h_{\text{soil}}$ | m | Water pressure head | - |
| $\lambda$ | $W/(m^{\circ}C)$ | Thermal conductivity for the soil surface | - |
| $G_{\text{soil}}$ | $W\,m^{-2}$ | Soil heat flux | - |