Appendix

Leakiness calculations at low light

The light limited C_4 photosynthesis model (von Caemmerer, 2000) was deployed to derive electron transport flux (J_t) as a function of photosynthetic rates (A) as described by Ubierna et al. (2013) as bellow,

$$J_{\mathrm{t}} = \frac{-II+\sqrt{II^2-4\cdot III\cdot I}}{2\cdot III} \quad \text{(S1)}$$

where

$$I = \left(1+\frac{R_{\mathrm{d}}}{A}\right)\cdot\left(R_{\mathrm{m}} - g_{\mathrm{bs}}\cdot c_{\mathrm{m}}\cdot\frac{7\cdot g_{\mathrm{bs}}\cdot\Gamma^*\cdot O_{\mathrm{m}}}{3}\right) + (R_{\mathrm{d}}+A)\cdot\left(1+\frac{7\cdot\alpha\cdot\Gamma^*}{3\cdot 0.047}\right) \quad \text{(S2)}$$

$$II = \frac{1-x}{3}\cdot\left[\frac{g_{\mathrm{bs}}}{A}\cdot\left(c_{\mathrm{m}} - \frac{R_{\mathrm{m}}}{g_{\mathrm{bs}}} - \Gamma^*\cdot O_{\mathrm{m}}\right) - 1 - \frac{\alpha\cdot\Gamma^*}{0.047}\right] - \frac{x}{2}\cdot\left(1+\frac{R_{\mathrm{d}}}{A}\right) \quad \text{(S3)}$$

$$III = \frac{x-x^2}{6\cdot A} \quad \text{(S4)}$$

Variable definitions and units are presented in Table 1. We used measured values for α and Γ^* for biochemical subtypes of C_4 photosynthesis (Table 2, (Sharwood et al., 2016).

We calculate C_s (CO_2 mole fraction in the bundle-sheath, V_p (PEP carboxylation rate), V_c (Rubisco carboxylation rate) and V_o (Rubisco oxygenation rate) at low light using C_4 model (von Caemmerer, 2000)

$$C_s = \frac{(\gamma^* \cdot O_s) \cdot \left(\frac{7}{3} \cdot (A + R_d) + \frac{(1-x) \cdot J_t}{3}\right)}{\frac{(1-x) \cdot J_t}{3} - (A + R_d)} \quad \text{(S5)}$$

$$V_p = \frac{x \cdot J_t}{2} \quad \text{(S6)}$$

$$V_c = \frac{(1-x) \cdot J_t}{3 \cdot \left(1 + \frac{7 \cdot \gamma^* \cdot O_s}{3 \cdot C_s}\right)} \quad \text{(S7)}$$

$$V_o = \frac{V_c - A - R_d}{0.5} \quad \text{(S8)}$$

The term $\overline{b_4}$ and $\overline{b_3}$ in Eqn 9 are defined as,

$$\overline{b_3} = b_3 - \frac{eR_d}{V_c} - \frac{0.5 \cdot f \cdot V_o}{V_c} \quad \text{(S9)}$$

$$\overline{b_4} = b_4 \left(1 - \frac{V_p}{V_h}\right) + (e_s + h) \cdot \frac{V_p}{V_h} - \frac{eR_m}{V_p} \quad \text{(S10)}$$

and we assumed that CA is saturating and V_p/V_h is approx. 0, hence:

$$\overline{b_4} = b_4 - \frac{eR_m}{V_p} \quad \text{(S11)}$$

Note that equations 7 and 8 are rearranged forms of equations S9 and S10 from (von Caemmerer et al., 2014).