

Simple Plant Hydraulics

model development and implementation

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February 9, 2018

Recipe

1. Solve for maximum stomatal conductance based on the Medlyn model (involves iterating for intercellular CO_2).
2. Solve for the vegetation water potential (and associated stomatal conductance) that matches plant water supply with Penman-Monteith demand.
3. Calculate the photosynthesis based on the stomatal conductance solution (involves iterating for intercellular CO_2).

Plant Water Supply Equations

$$q = \int_{\psi_{soil}}^{\psi_{leaf}} \frac{K(\psi)}{z} d\psi \quad (1)$$

$$K(\psi) = \frac{\psi - p_2}{p_1 - p_2} \cdot K_{max} \quad (2)$$

$$q = \frac{K_{max}}{z} \cdot f(\psi) \cdot (\psi_{soil} - \psi_{leaf} - \rho g z) \quad (3)$$

$$f(\psi) = \frac{\frac{1}{2}(\psi_{soil} + \psi_{leaf}) - p_2}{p_1 - p_2} \quad (4)$$

Plant Water Demand Equations

$$g_{c,max} = g_0 + \left(1 + \frac{g_1}{\sqrt{D}}\right) \frac{A}{C_a} \quad (5)$$

$$C_i = C_a - \frac{A}{g_c} \quad (6)$$

$$A = \frac{j/4(C_i - \Gamma)}{C_i + 2\Gamma} \quad (7)$$

$$g_c = g_{c,max} \cdot h(\psi_{leaf}) \quad (8)$$

$$h(\psi_{leaf}) = \frac{1}{1 + \left(\frac{\psi_{leaf}}{p50}\right)^a} \quad (9)$$

$$g_w = 1.6g_c \quad (10)$$

$$E = \frac{\frac{\Delta}{\gamma} (R_{net} - G) + \rho L_v g_a dq}{L_v \left(1 + \frac{\Delta}{\gamma} + \frac{g_a}{g_w}\right)} \quad (11)$$