# Simple Plant Hydraulics

model development and implementation

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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

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

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

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

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

Plant Water Demand Equations

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

$$C_i = C_a - \frac{A}{g_c} \tag{6}$$

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

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

$$h\left(\psi_{leaf}\right) = \begin{cases} 1 & \psi_{leaf} < p_c \\ 1 - \left(p_c - \psi_{leaf}\right)^n & p_c - 1 < \psi_{leaf} < p_c \\ 0 & \psi_{leaf} \leq p_c - 1 \end{cases} \tag{9}$$

$$g_w = 1.6 g_c \tag{10}$$

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