The Bucket model of Land Hydrology
(Hartmann 5.6.1)

Simplest model for soil water budget:

Soil has a fixed capacity to store water available for evapotranspiration (E).

W_w : mass of water per unit area

$$\frac{\partial W_w}{\partial t} = \rho_w \frac{\partial h_w}{\partial t} = P_r - E + M_s - \Delta f$$

equivalent

h_w: depth of water in soil ($W_w = \rho_w h_w$)

P_r: rainfall rate

Δf: runoff

M_s: snow melt rate

If $h_w > h_c$ (≈ 15 cm), soil is saturated.

If $P_r + M_s > E$ when saturated, Δf occurs at rate to keep soil saturated ($h_w = h_c$).

Snowcover budget:

$$\frac{\partial W_s}{\partial t} = \rho_w \frac{\partial h_s}{\partial t} = P_s - E_{sub} - M_s$$

P_s: snowfall rate

E_{sub}: sublimation

E depends on soil moisture:

$$E = \beta_E \times PE$$

PE: potential (maximum) evap.

(<u>Bucket model</u>)

$$PE = \rho C_H V_1 (q^*(T_0) - q_1)$$

Veg. may transpire at PE even when soil is not saturated. When $h < h_r$, transpiration < PE. A simple approx.

$$\beta_E = \begin{cases} 1 & h_w \geq h_r \\ \frac{h_w}{h_r} & 0 < h_w < h_r \end{cases}$$

Can extend bucket model by <u>adding a deep layer</u> that exchanges water with the upper layer at a slow rate that depends on the relative saturation of the layers.