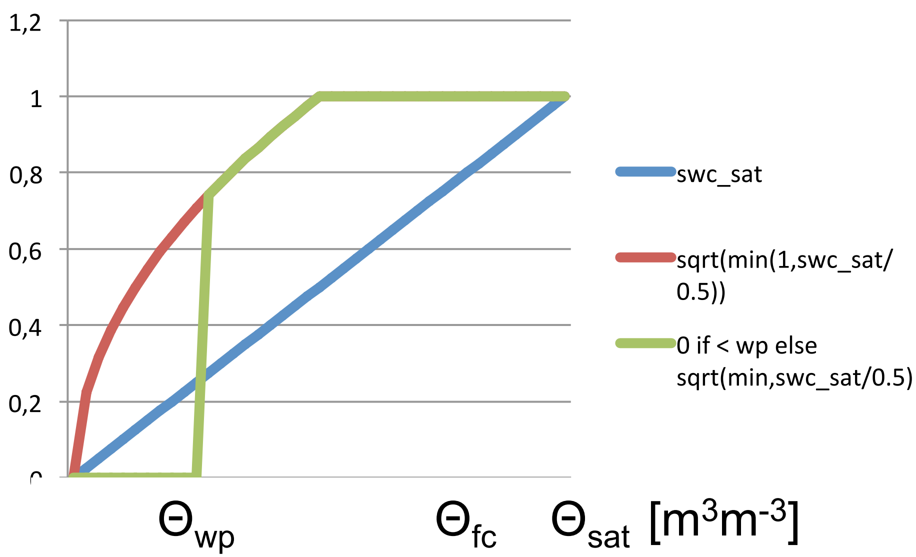
Impact of the soil humidity on transpiration

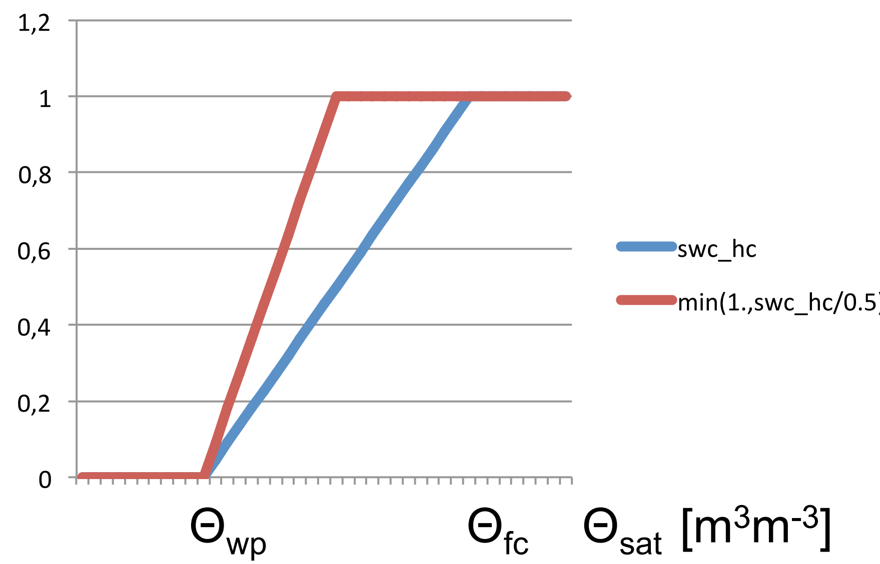
- **Computation 1**

F^n of the swc rel. to $[\Theta_{res}; \Theta_{sat}]$: swc_sat



- **Computation 2**

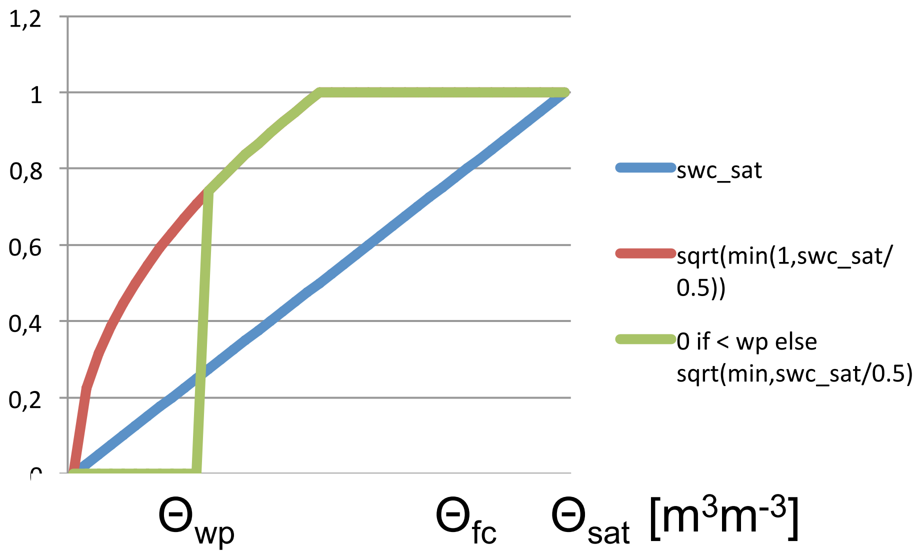
F^n of the swc rel. to $[\Theta_{wp}; \Theta_{fc}]$: swv_hc



Impact of the soil humidity on transpiration

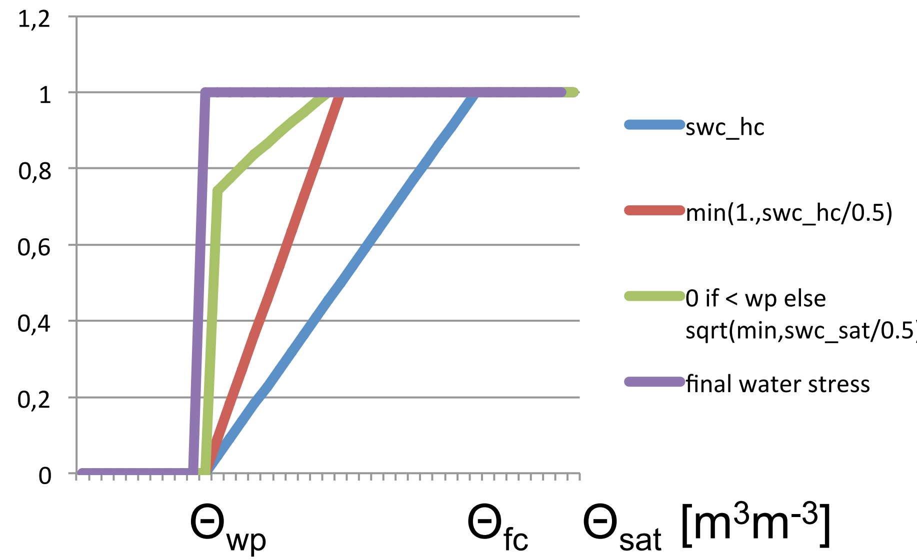
• Computation 1

F^n of the swc rel. to $[\Theta_{res}; \Theta_{sat}]$: swc_sat



• Computation 2

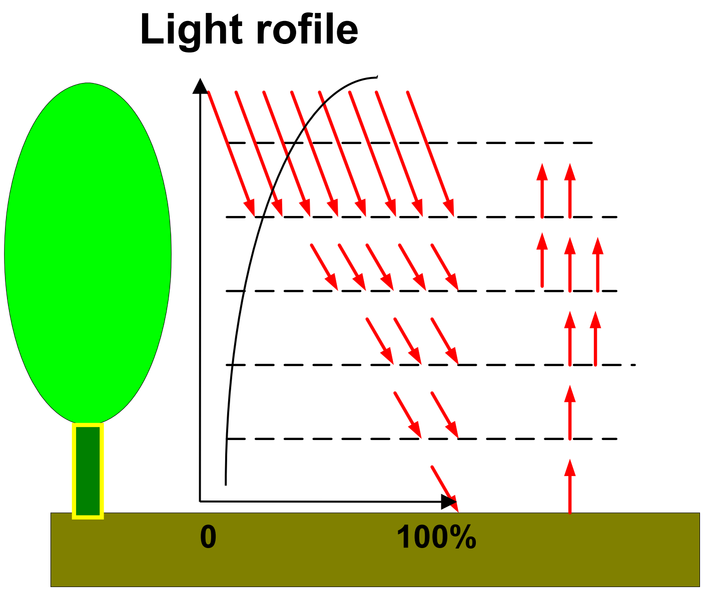
F^n of the swc rel. to $[\Theta_{wp}; \Theta_{fc}]$: swv_hc



Bare soil fraction & albedo

- Fraction of incident radiation at the soil surface = transmitted fraction below the canopy

$$f_{soil} = \exp\left(-kLAI\right)$$



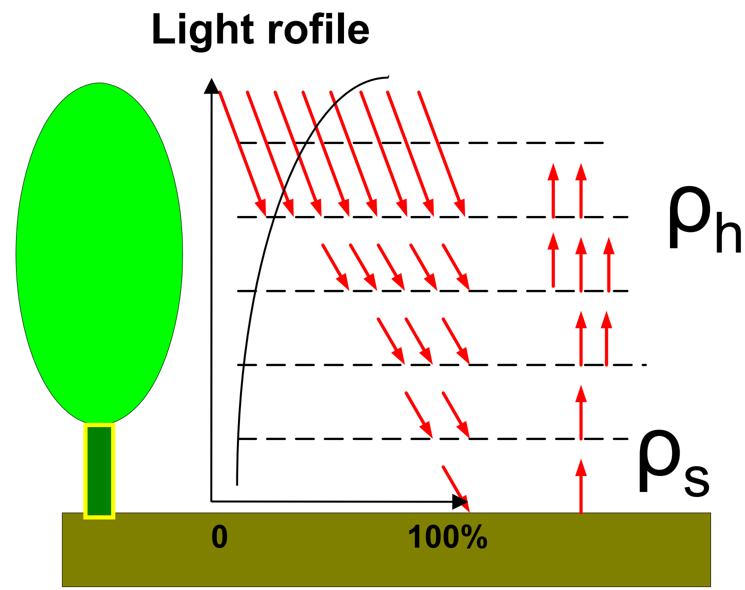
Hyptohesis :

- black leaves
- Spherical leaf angle distribution

Bare soil fraction & albedo

- Could be defined on a absorbed radiation basis (Net radiation)

P_{eff} effective reflection coefficient of soil-canopy system



$$\rho_{eff} = \frac{(\rho_s \rho_h - 1)\exp(K.LAI) + (1 - \rho_s/\rho_h)\exp(-K.LAI)}{\left(\rho_s - \frac{1}{\rho_h}\right)\exp(K.LAI) + (\rho_h - \rho_s)\exp(-K.LAI)}$$

From Goudriaan, 1977

Hyptohesis :

- Horizontal leaves

Bare soil fraction & albedo

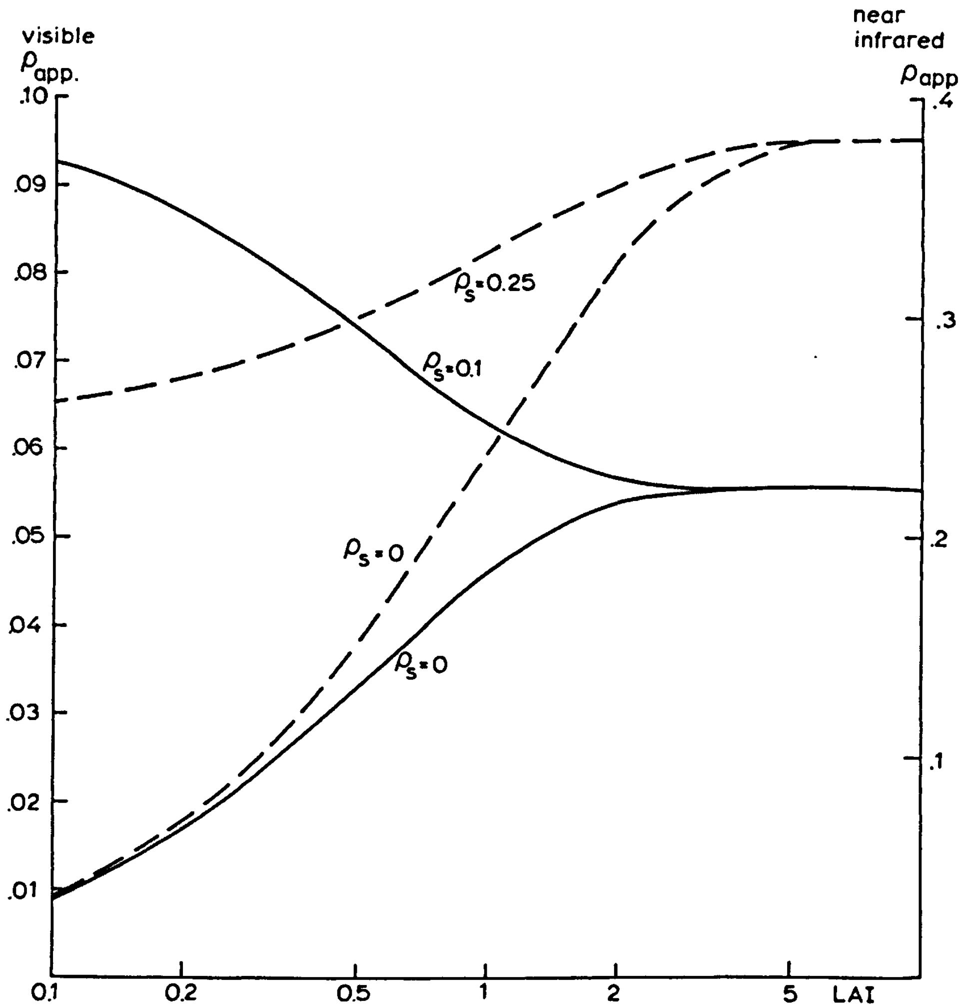
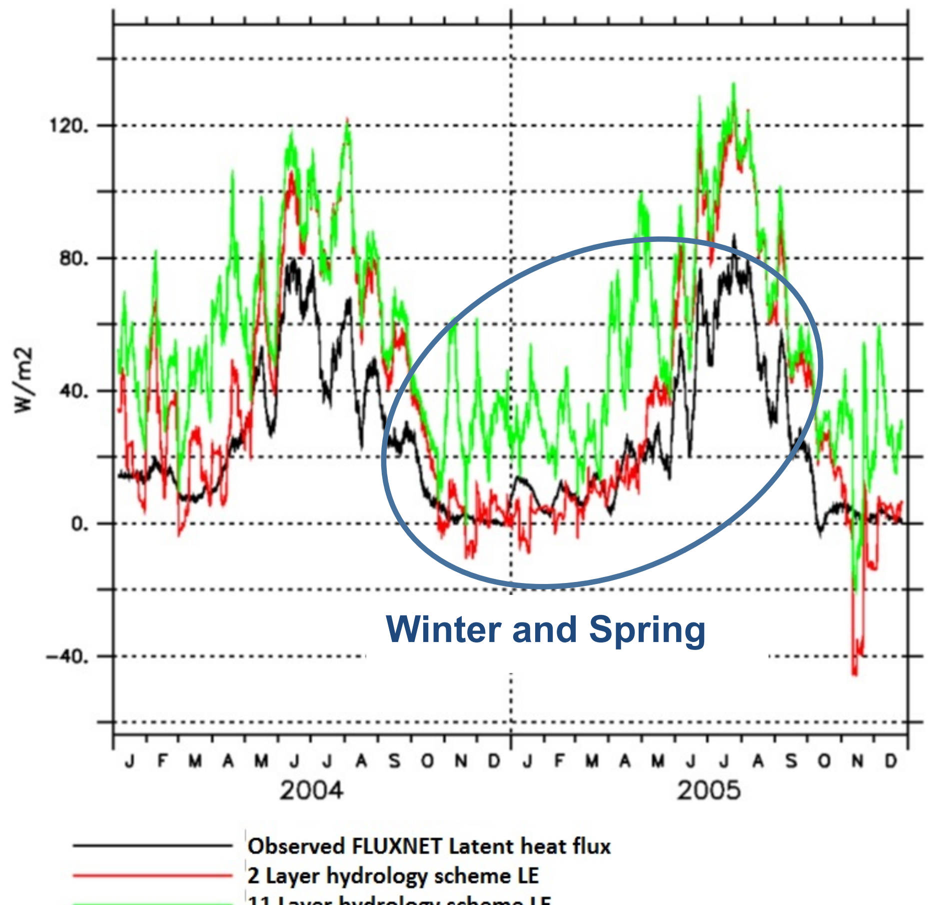


Fig. 3 | Apparent reflection coefficient of the canopy-soil system as function of the leaf area index for two values of the soil reflectance ρ_s. For the visible region (solid lines) the values are indicated on the left ordinate and for the near-infrared region (broken lines) on the right ordinate.

From Goudriaan, 1977

Bias on evaporation

- Shifting from the 2-layer hydrological scheme to the 11-layer one increases latent heat flux for some PFT's
  - That is due to the evaporative component
  - It acts at winter time for deciduous trees when no canopy coverage



US-Bar - Temperate deciduous forest
Servettaz, 2014 (L3 report)

2-layer : soil resistance to BSE

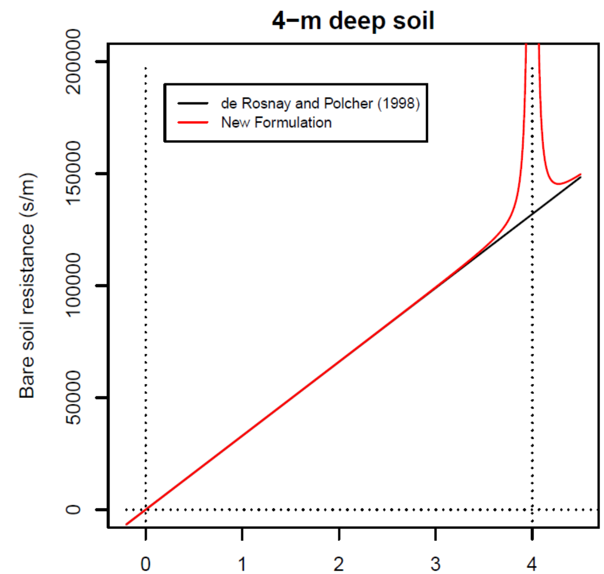
- r_{sol} is the main control of water stress onto bare soil evaporation

$$E_{sol} = \rho U_s \frac{q_{sat}(T_s) - q_{air}}{r_a + r_{sol}}$$

- r_{sol} depends on the dry soil height of PFT 1

$$r_{\text{soil}} = r_{\text{soil}}^{\text{m}} \left(h_{\text{dry}} + \frac{1}{100(h_{\text{tot}} - h_{\text{dry}})^2} \right)$$

1 cm of dry soil exerts r_{soil} = 330 s/m

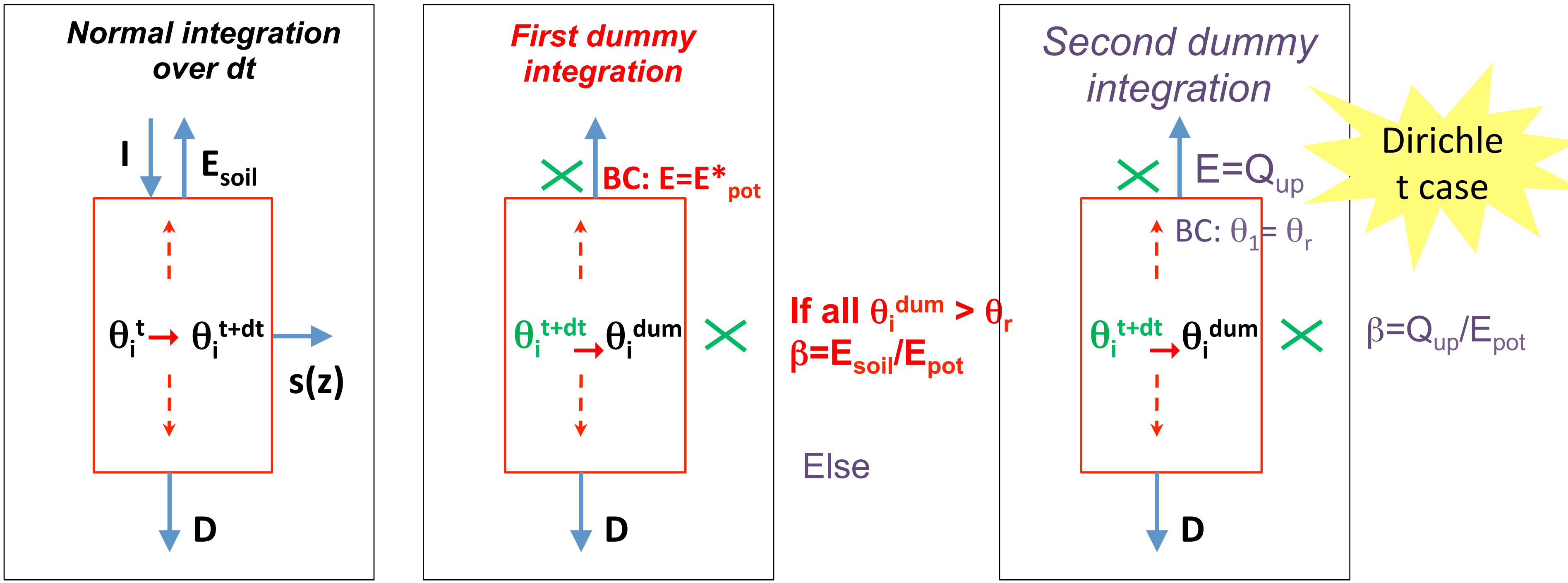


11-layer: demand/supply approach

- The principle is that soil evaporation follows a supply/demand approach

$$E_{soil} = \min(E^{*}_{pot}, Q_{up})$$

- In practice, this relies on dummy integrations of the water diffusion scheme



Work on E_{pot} via the $r_{aerodynamic}$

$$E_{pot} = \rho \frac{q_{sat}(T_s) - q_{air}}{r_a}$$

$$r_a = \frac{1}{\kappa^2 u_a}\left[\ln\left(\frac{z-d_0}{z_{0m}}\right)\ln\left(\frac{z-d_0}{z_{0v}}\right)\right]$$

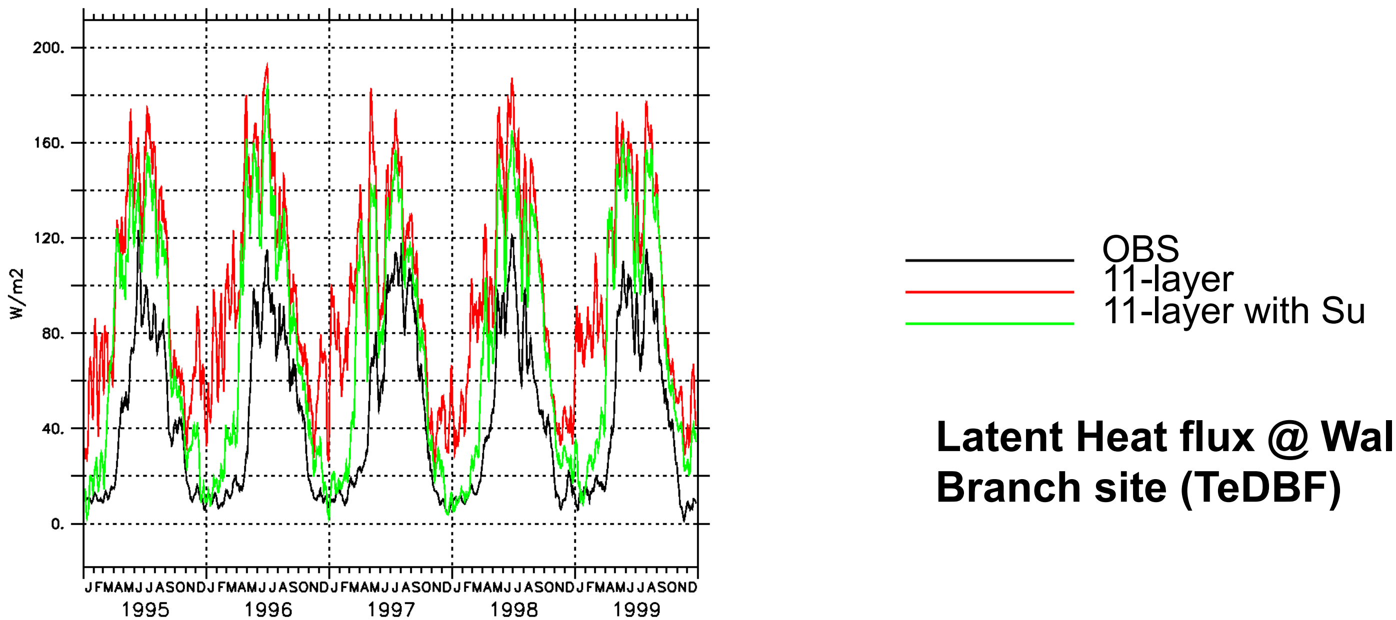
where

- z is measurement height (m)
- u_a is wind speed (ms^{-1})
- k von Karman's constant
- d_0 is displacement height
- z_{0m} and z_{0v} the roughness heights for momentum and water vapor transfer

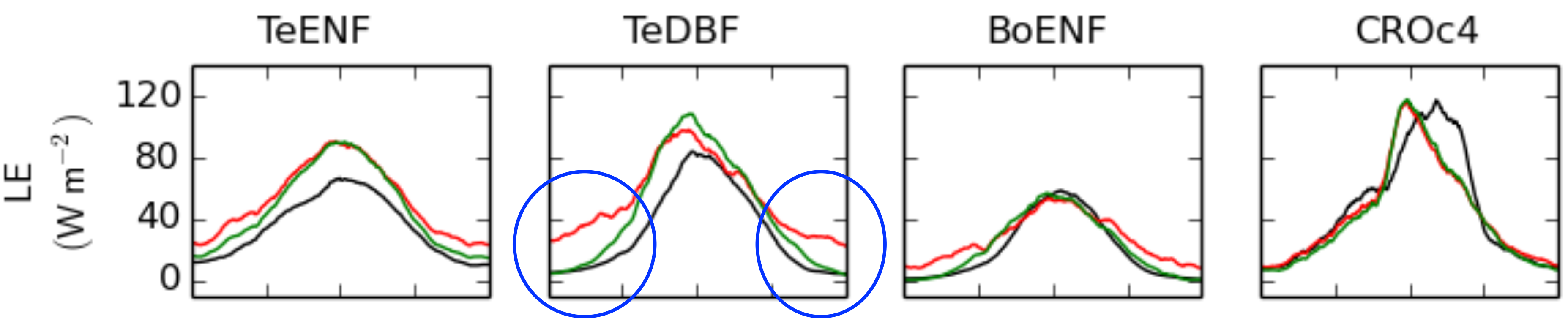
⇒*One assumes that the trunk and the branches impact as a full canopy coverage on z_0*

- Search for literature supporting that z_0 varies with LAI : Ershadi et al. (2015) uses the formulation of Su et al. (2001)

Evaluation at site level



Latent Heat flux @ Walker Branch site (TeDBF)



Offline simulation over the Mississippi basin (1999-2008)

Su's parametrization in ORCHIDEE (1999-2008):

- ET decreases during winter and early spring => better agreement with the global ET products
- Mean annual river discharge at Vicksburg increases by 11%.
  - 8 % of bias reduction

Evapotranspiration (mm/yr)