JULES – surface exchange

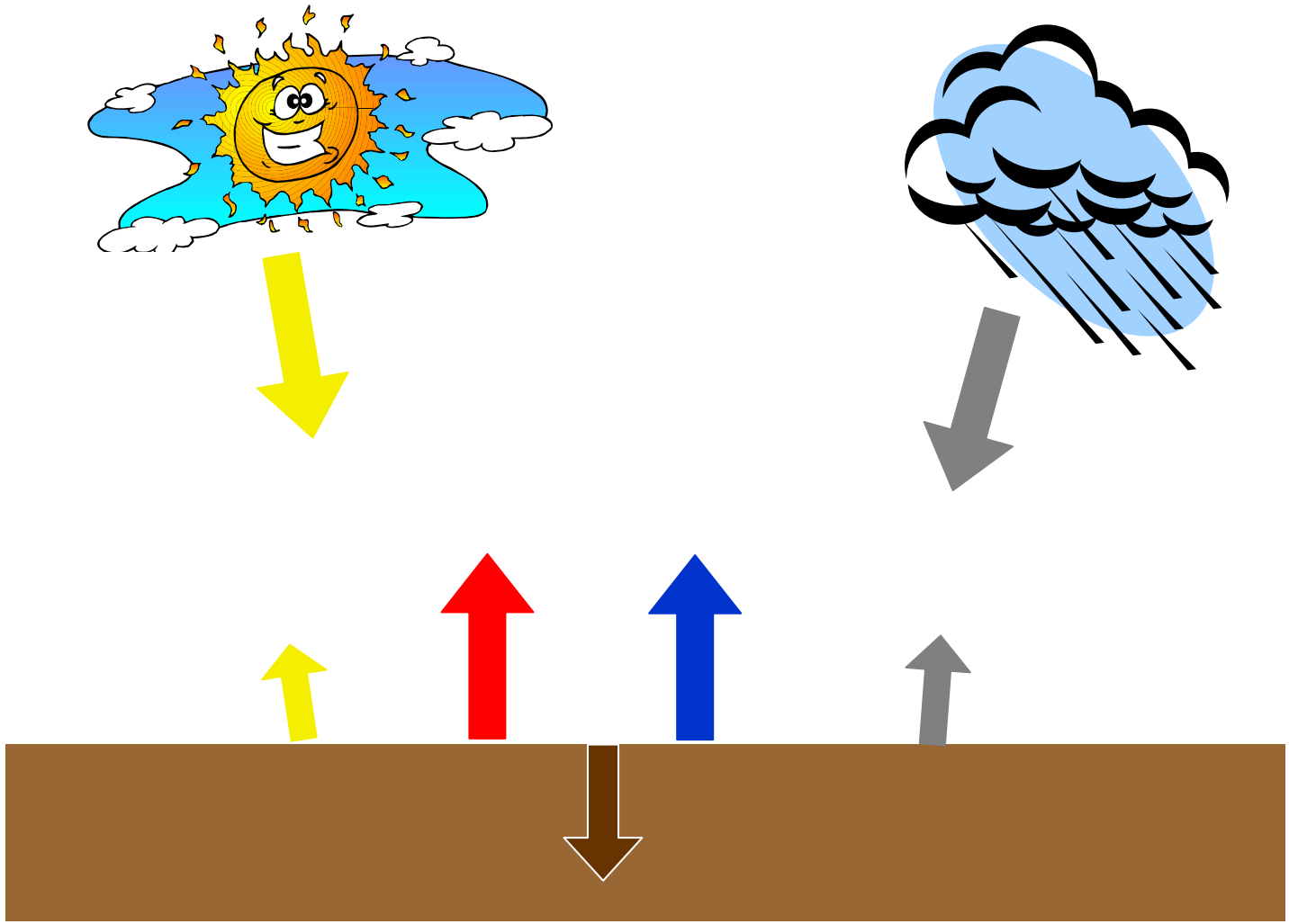
JULES 2nd science meeting

Martin Best, CEH Wallingford, 8th January 2008

Contents

- Penman Monteith
- Atmospheric turbulence
- Vegetation canopy
- Heterogeneity
- Future structure

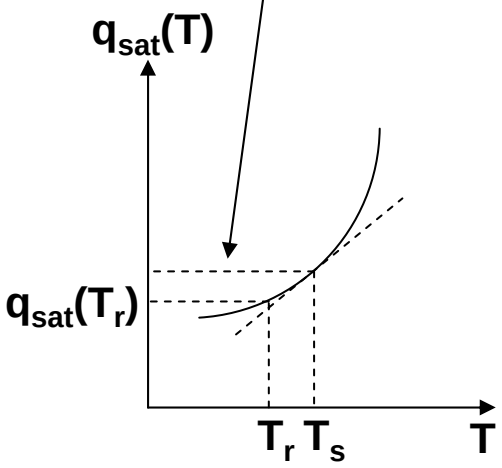
Surface Energy Balance



SEB Equations

$$\alpha = \left.\frac{dq_{sat}}{dT}\right|_{T_s}$$

$$\alpha\left(T_s - T_r\right) + q_{sat}\left(T_r\right)$$



$$H = \frac{\rho C_p}{r_a}\left(T_s - T_a\right)$$

$$\lambda E = \frac{\rho\lambda}{r_a + r_s}\left(q_{sat}\left(T_s\right) - q_a\right)$$

$$G = A_s\left(T_s - T_{s1}\right)$$

$$R_n = H + \lambda E + G$$

Monin-Obukhov similarity theory

$$\frac{dU}{dz} = \frac{1}{\kappa}\frac{u_*}{z}$$

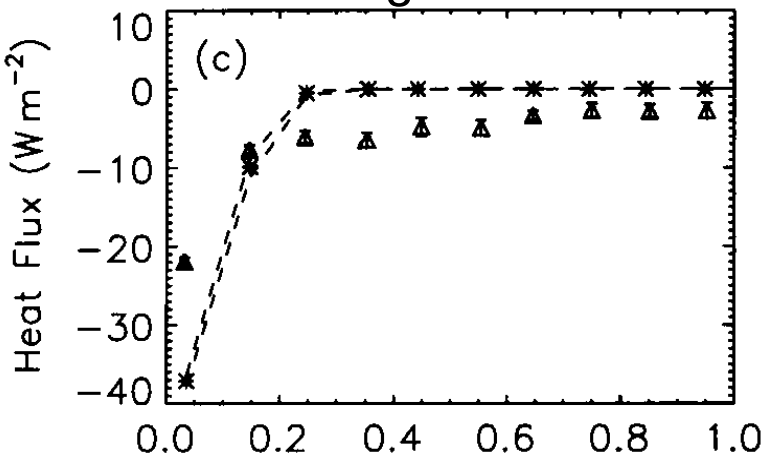
$$u_* = f_1\left(z/L\right)$$

$$H = f_2\left(z/L\right)$$

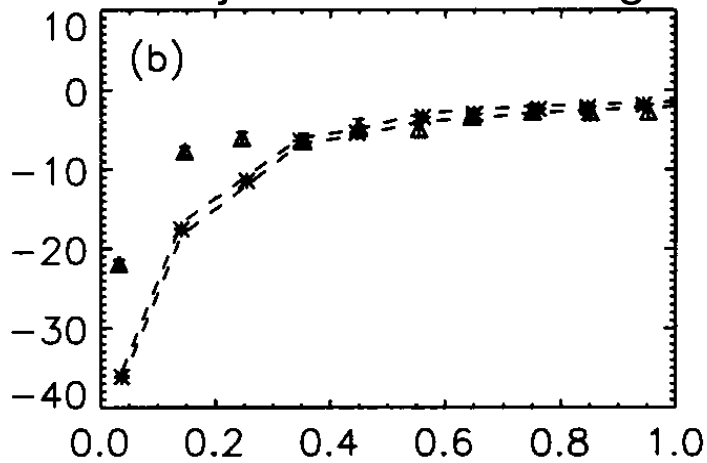
$$L = f_3\left(u_*, H\right)$$

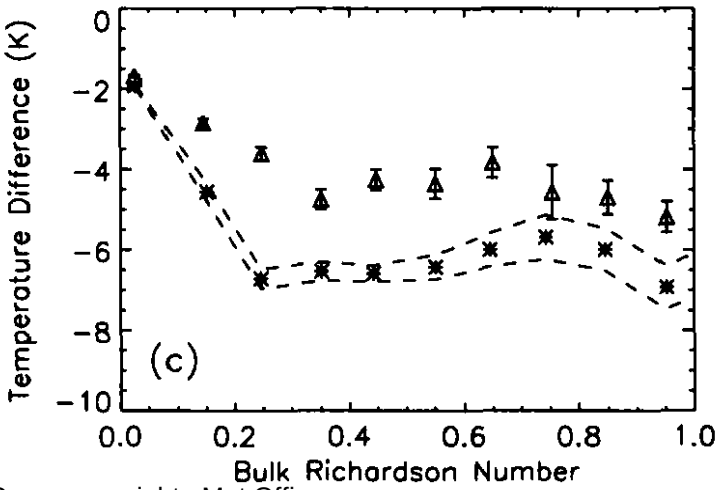
Impact of stable stability functions

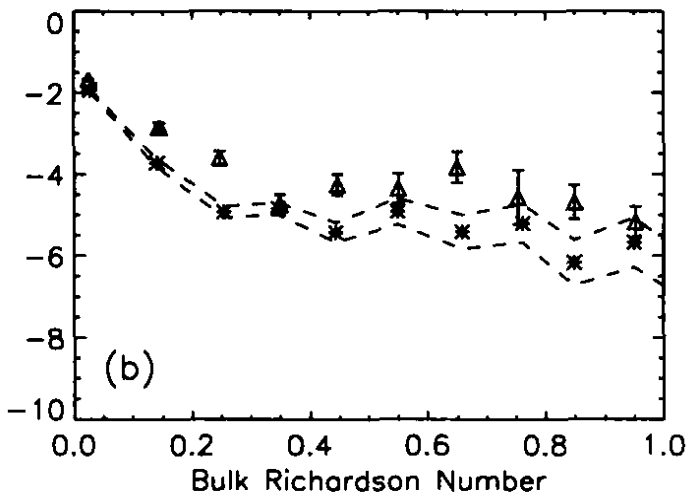
Log linear



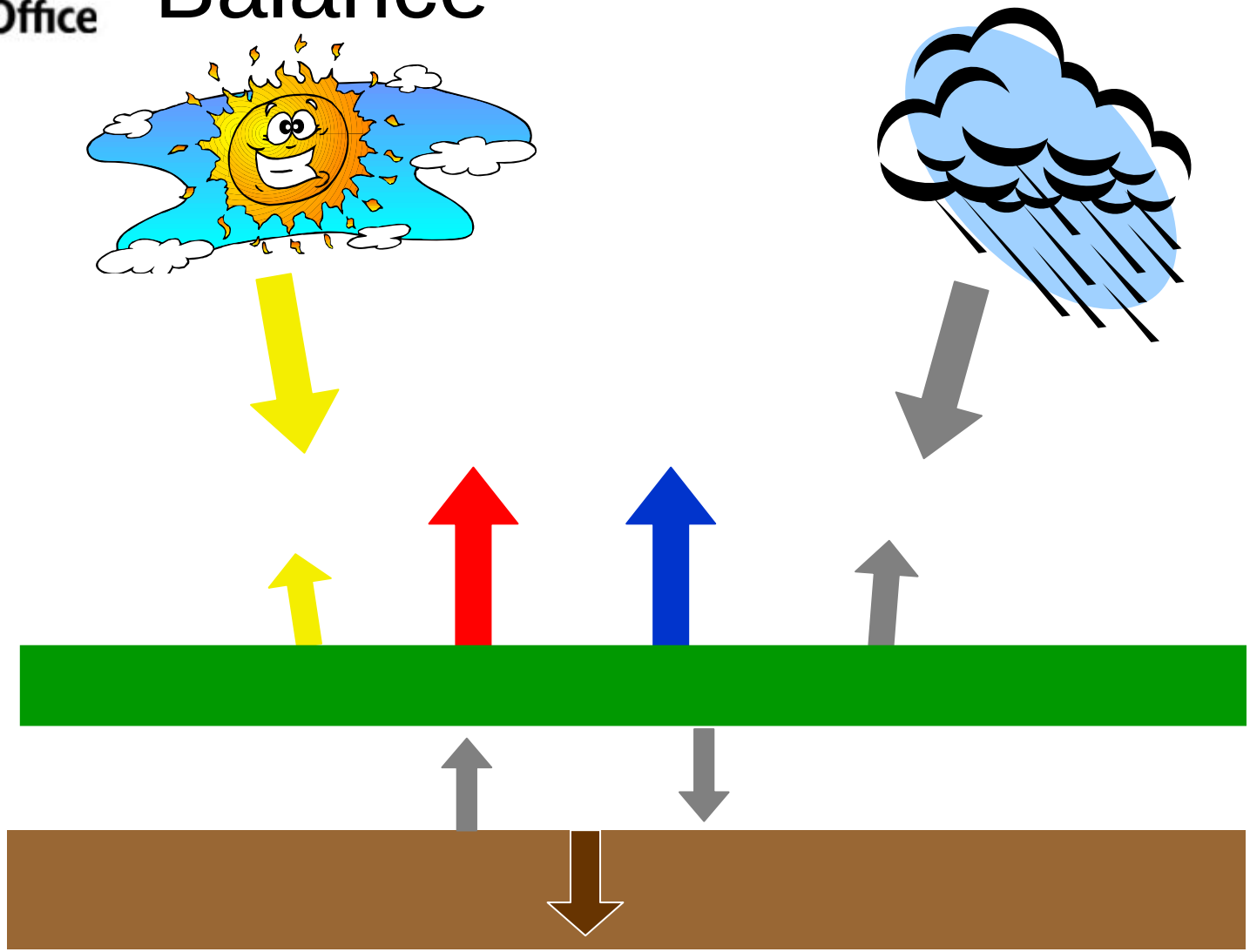
Beljaars and Holtslag







Canopy Surface Energy Balance



SEB Equations for Canopy

$$G = A_s\left(T_s - T_{s1}\right)$$
$$R_n = H + \lambda E + G$$

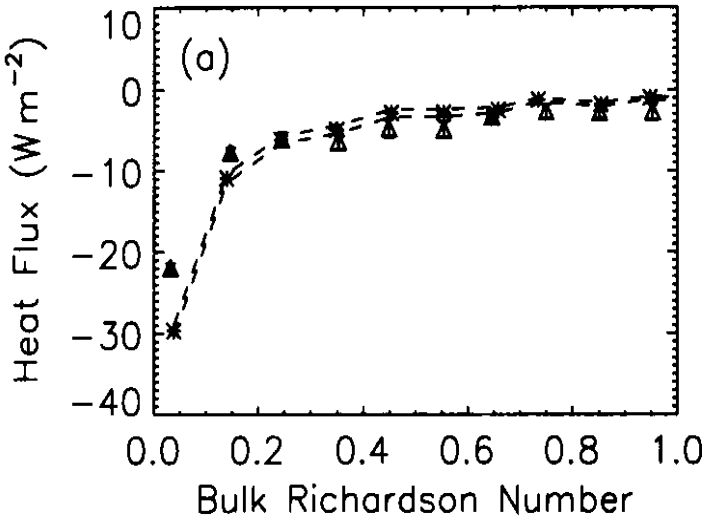
$$G = \nu\left(\sigma T_s^4 - \sigma T_{s1}^4\right) + \left(1-\nu\right)A_s\left(T_s - T_{s1}\right)$$

$$S_{w\downarrow} - \alpha S_{w\downarrow} + L_{w\downarrow} - \sigma T_s^4 = H + \lambda E + G + \frac{C}{\Delta t}\left(T_s - T_s\big|^n\right)$$

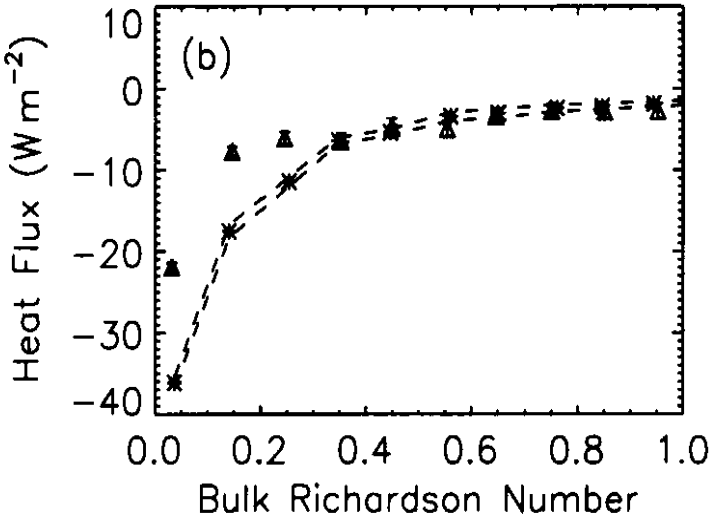
$$T_s^4 = T_{s1}^4\left(1 + \frac{T_s - T_{s1}}{T_{s1}}\right)^4$$

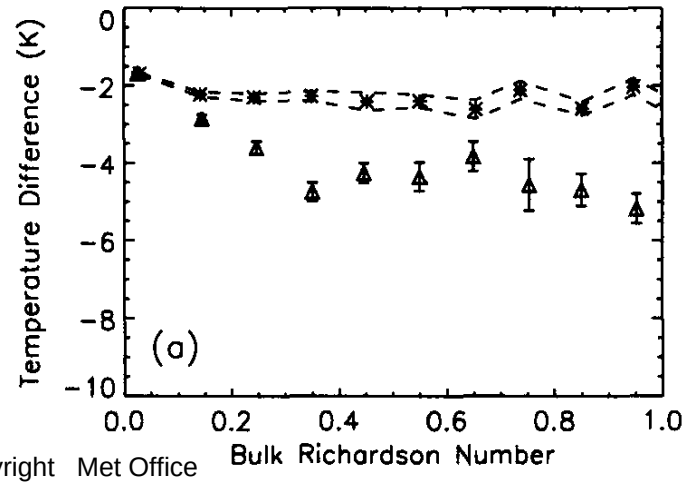
Impact of vegetation canopy

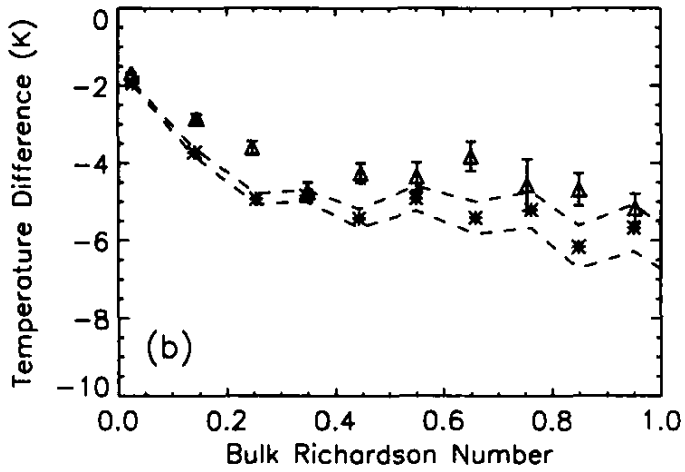
No canopy



Canopy

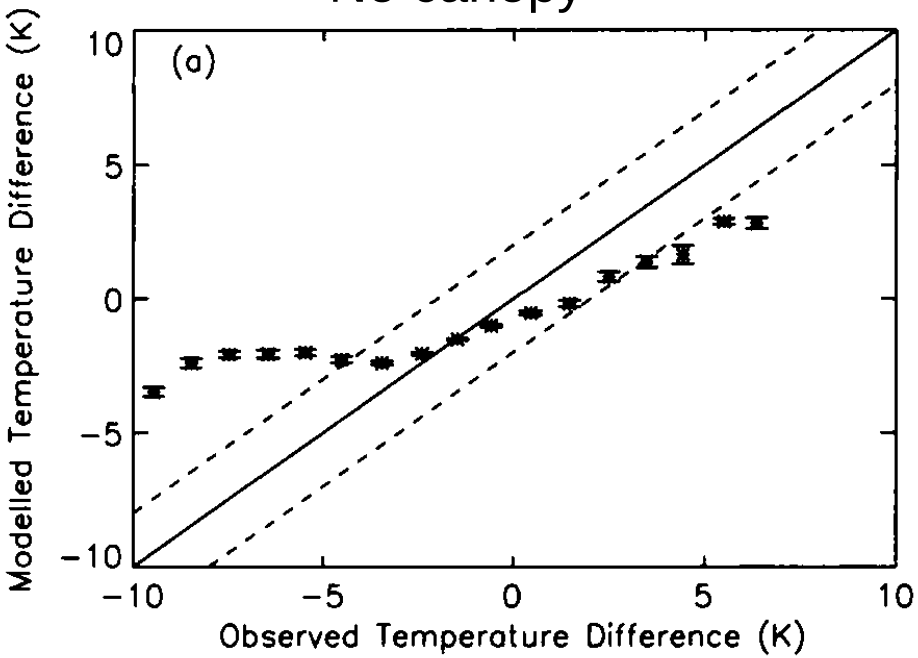




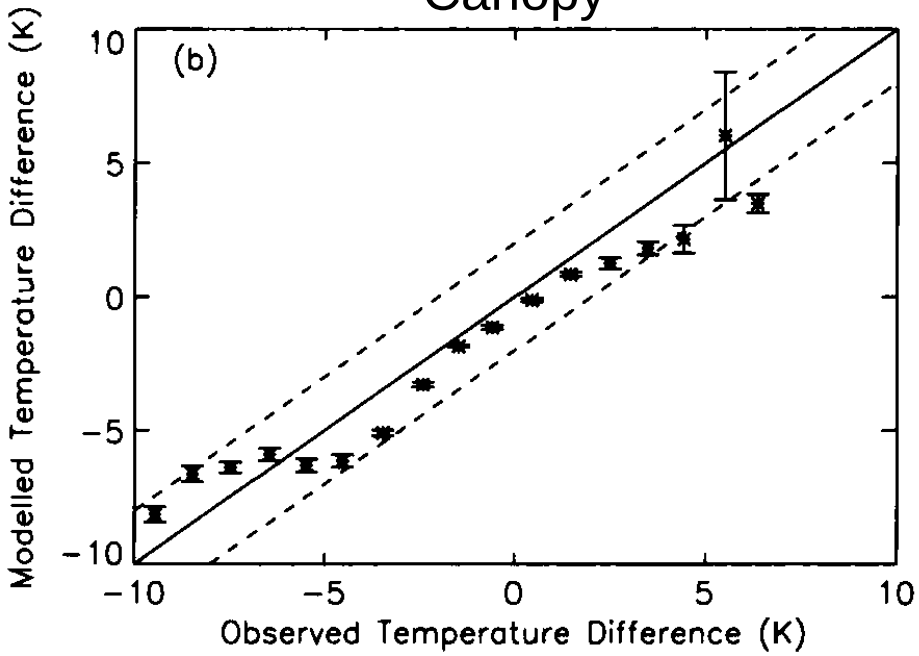


Impact of Vegetation Canopy

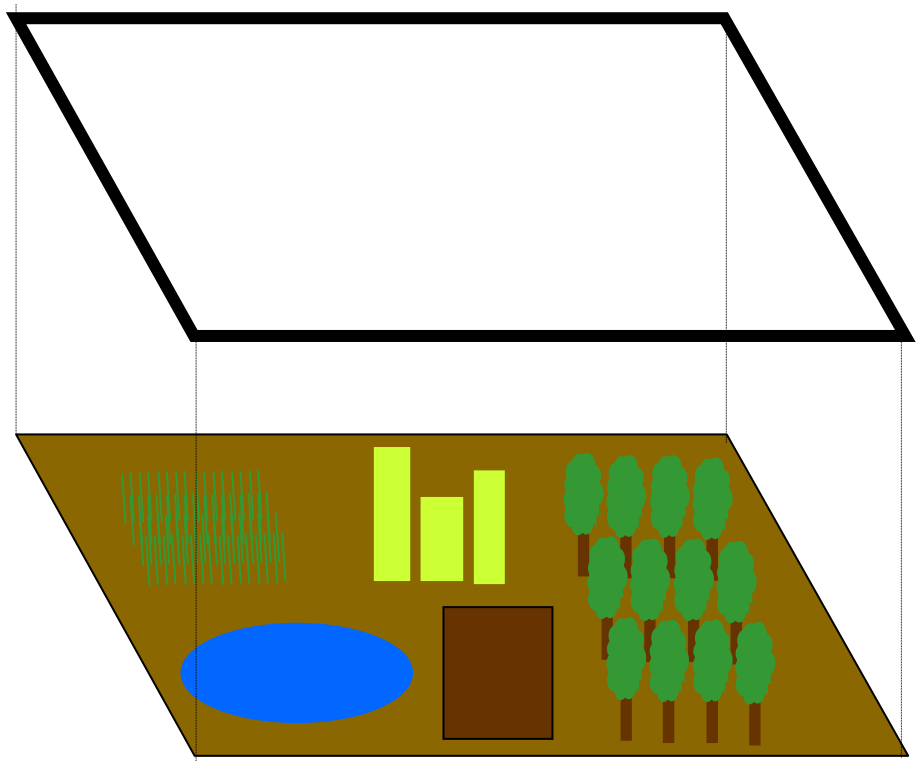
No canopy



Canopy



Heterogeneity



Future developments

- Multi-stage surface energy balance calculations
  i. Fully explicit calculation
  ii. Penman Monteith calculation
  iii. Implicit atmospheric calculation
- Multiple source tiles

Questions and answers