Impact of water vapour feedback on canopy gas exchange under climate change

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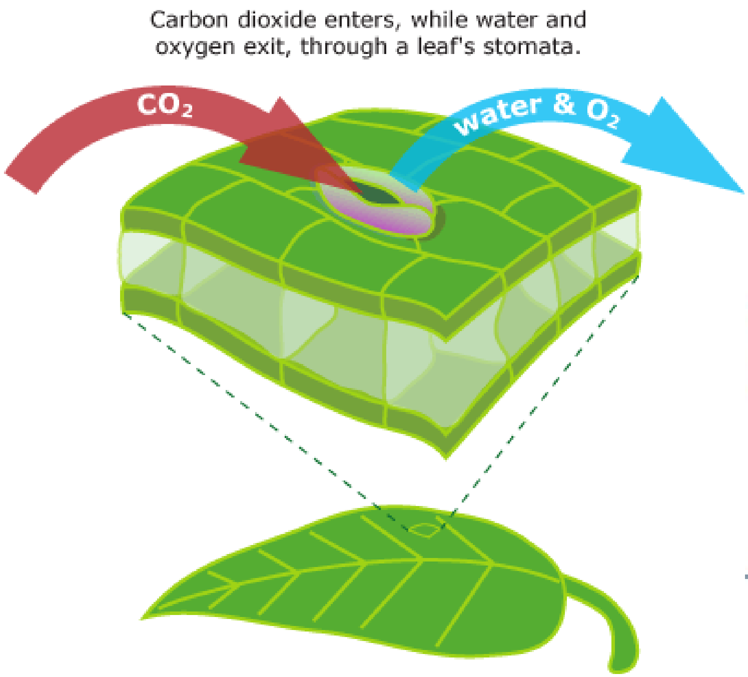
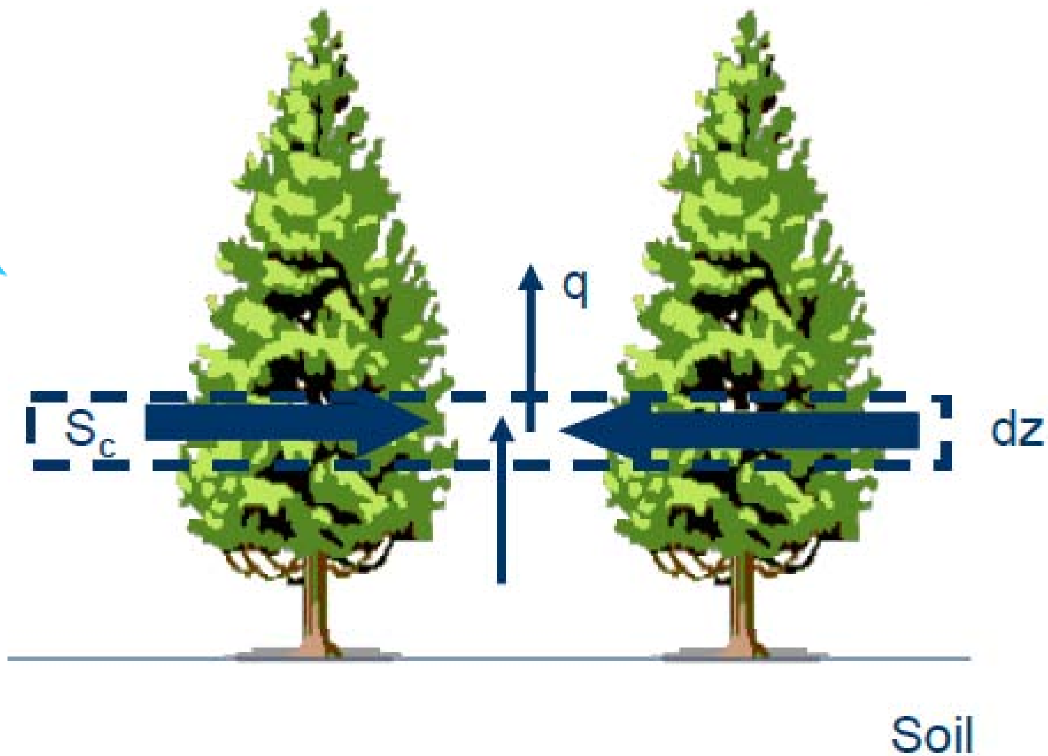
Stomata: exchange of CO_2 and water vapor, then mixing in the canopy

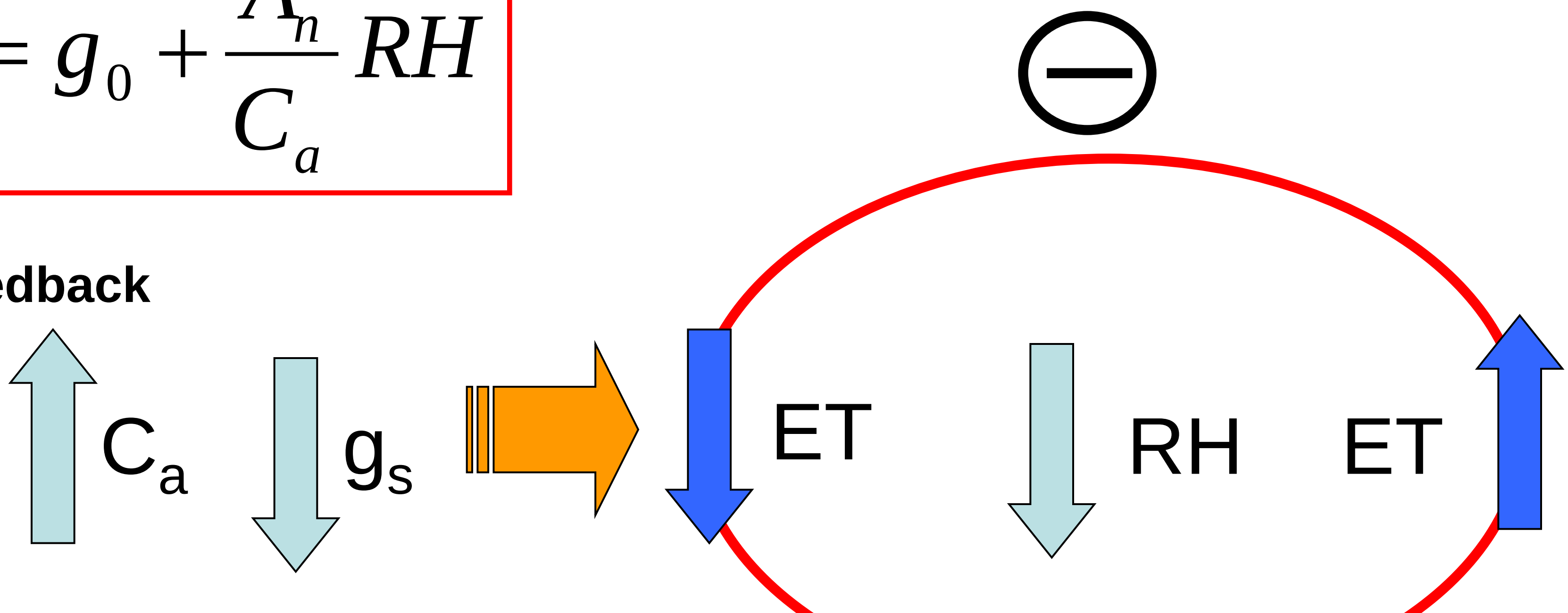




Feedbacks with CO2 and temperature

$$g_s = g_0 + \frac{A_n}{C_a} RH$$

CO2 feedback



Temperature feedback

Implement humidity balance and couple with CO_2 balance equation in canopy model

$$\frac{\partial}{\partial z}\left(-K_t \frac{\partial c}{\partial z}\right) = a(z)\, g_s \left(c_i - c_{sat}\right)$$

$$\frac{\partial}{\partial z}\left(-K_t \frac{\partial c}{\partial z}\right) = a(z)\, g_s \left(c_i - c_{sat}\right)$$

$$\frac{\partial}{\partial z}\left(-K_t \frac{\partial q}{\partial z}\right) = a(z)\, g_s \left(q_i - q_{sat}\right)$$

ORIGINAL MODEL

CO_2=CO_2(z;t)
RH=RH(t)
T=T(t)

FEEDBACK MODEL

CO2=CO2(z;t)
RH=RH(z;t)
T=T(t)

Numerical experiments:

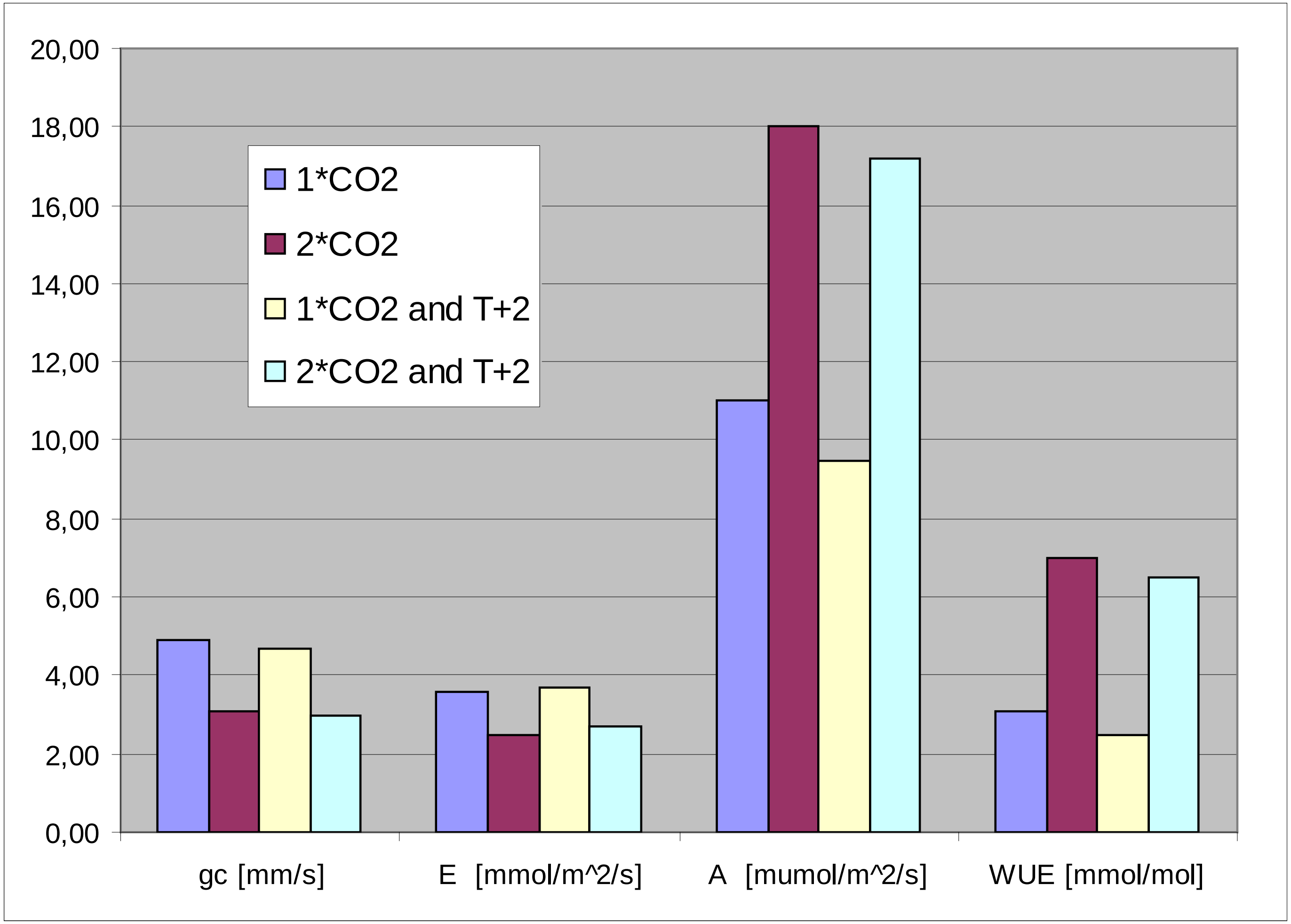
Reference exp: present day temperature and CO_2

Exp1: $2*CO_2$

Exp2: +2 C

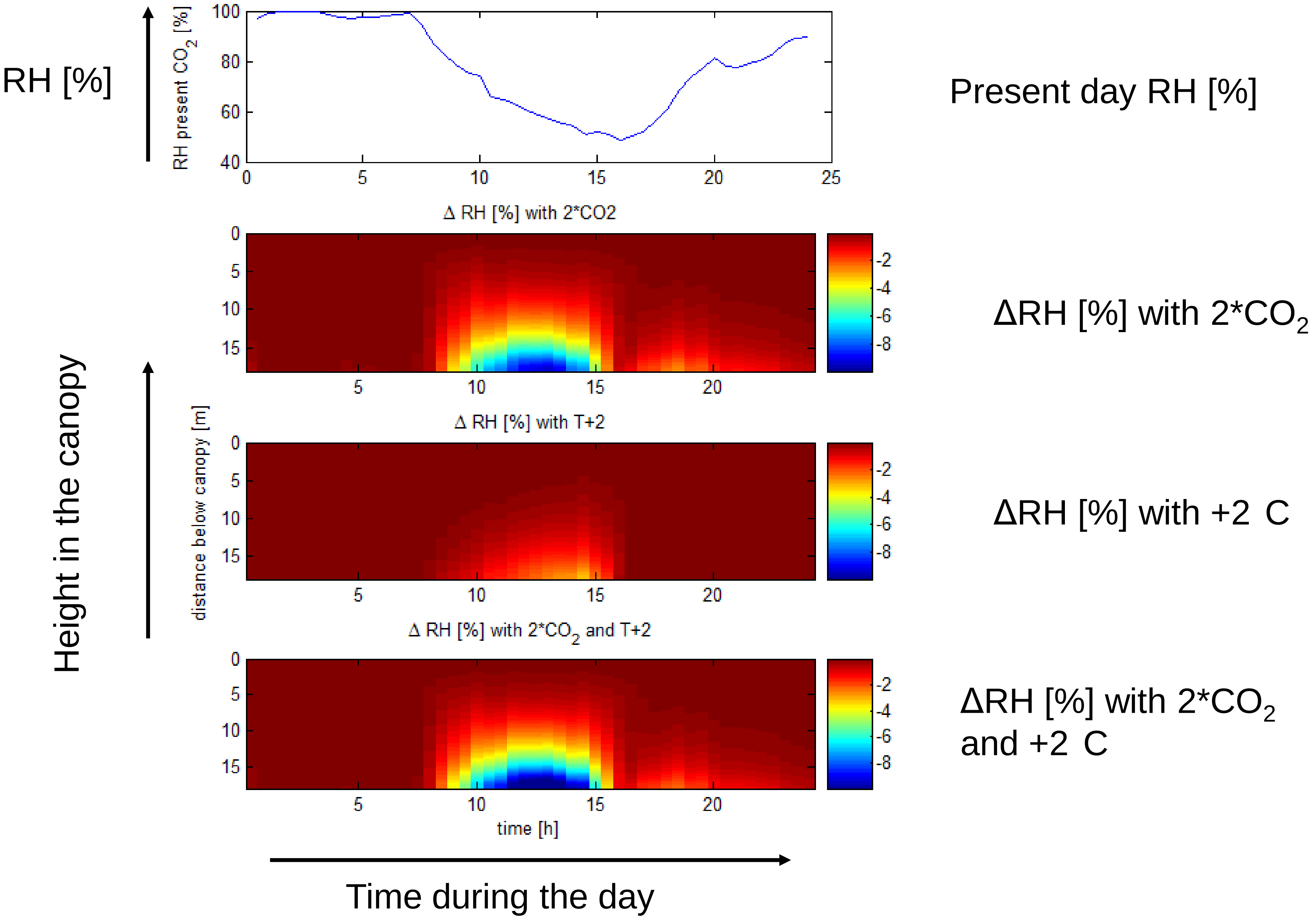
Exp3: $2*CO_2$ and +2 C

Results: changes due to CO_2 and temperature increase



Conductance Transpiration Assimilation Water-use efficiency

Results: changes in relative humidity in the canopy

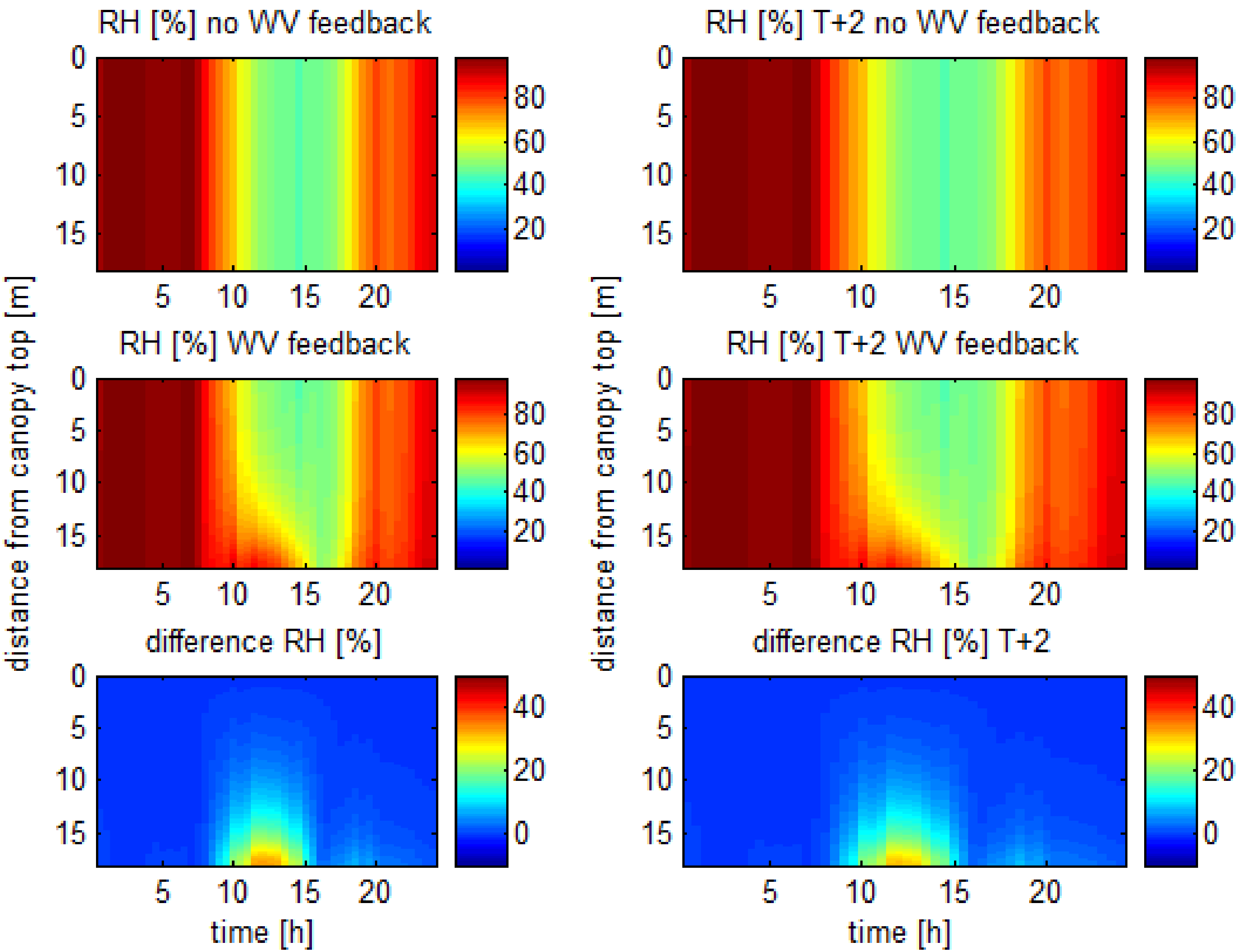


Conclusions

- Increment on CO_2 leads to a major decrease of stomatal conductance, increase of assimilation and decrease transpiration
- This results in higher WUE
- The model is less sensitive to temperature increment

Further study…

- Implementation of heat balance
- Different vegetation


RH [%] no WV feedback
RH [%] T+2 no WV feedback
RH [%] WV feedback
RH [%] T+2 WV feedback
difference RH [%]
difference RH [%] T+2
distance from canopy top [m]
time [h]
0
5
10
15
20
80
60
40
20
0