

# Improved CABLE simulation of diurnal CO<sub>2</sub> and water fluxes by integration of leaf water constraint

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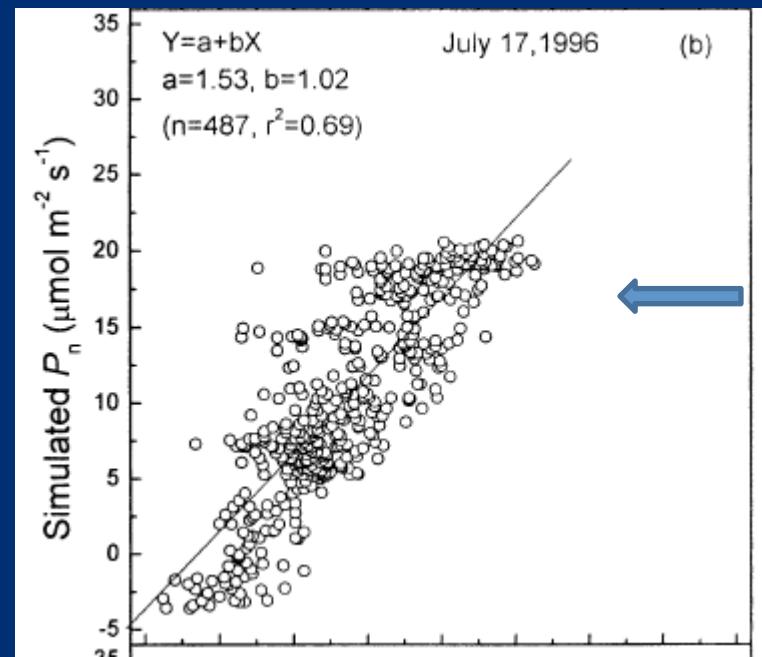
- Deficiencies of flux modelling around noon
- Measurement of diurnal variation of C & H<sub>2</sub>O fluxes
- Integration of leaf water limitation into CABLE
- Model sensitivity analysis

# Deficiencies of flux modelling around noon

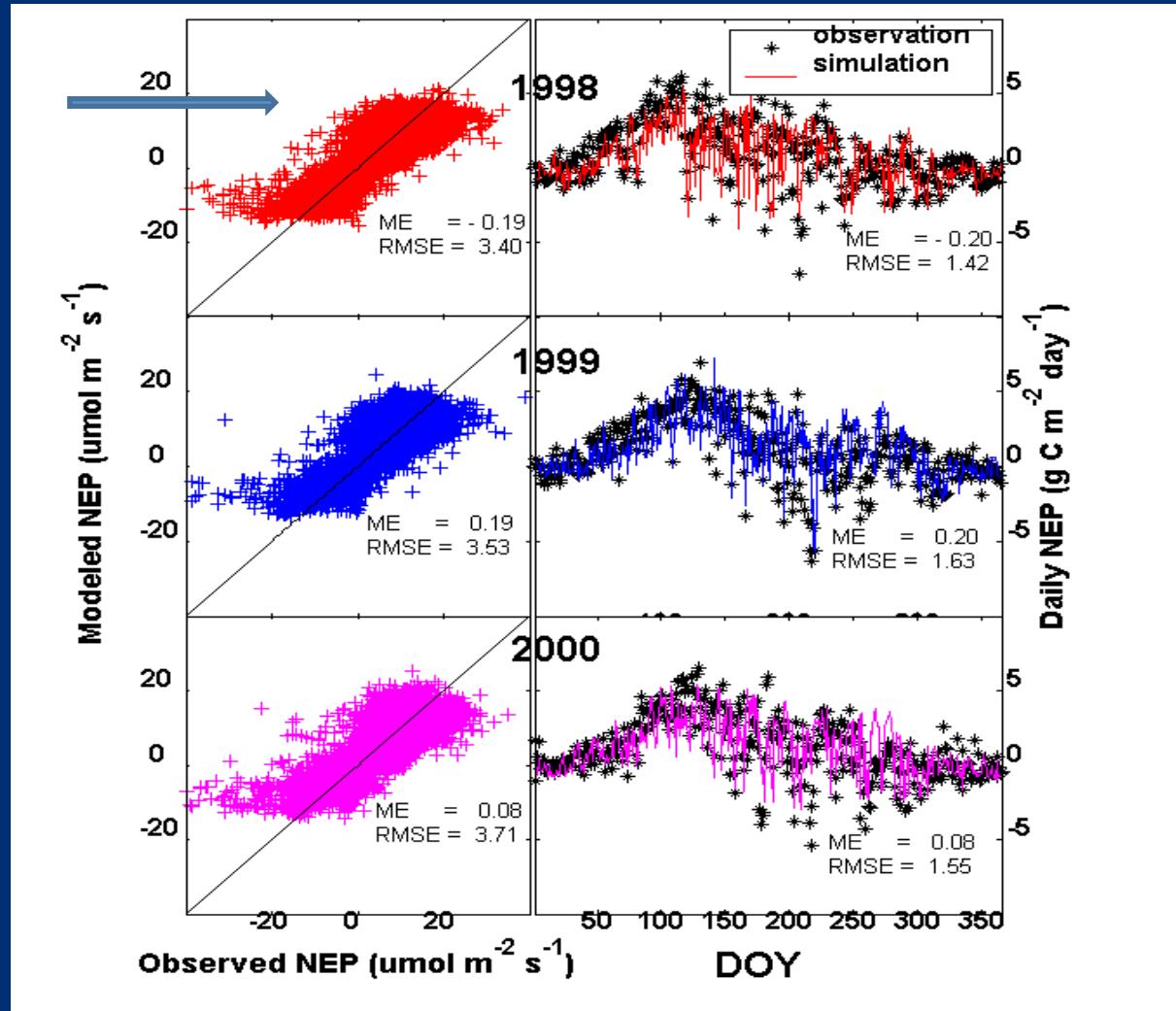
## (1) Leaf photosynthesis modelling

Simulation in midday ranges from 15-20, while measurement is around 10-25.

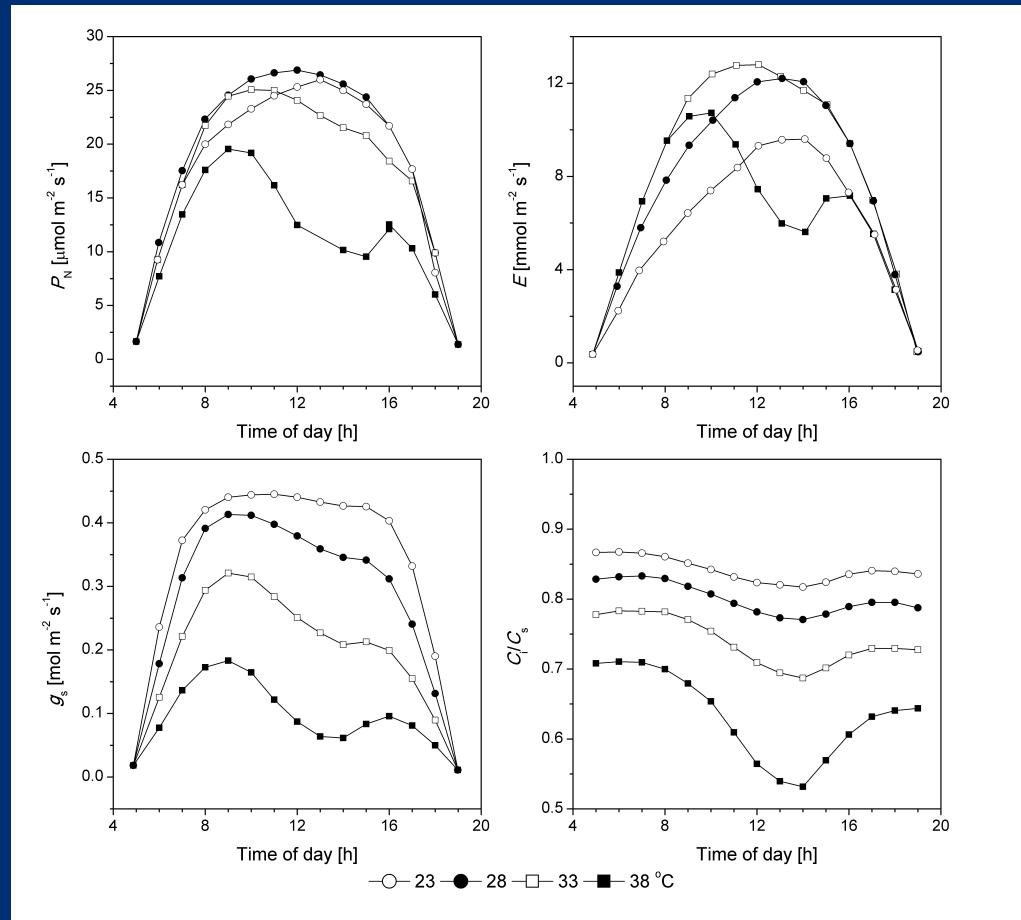
Near midday, model fails to capture reduction of photosynthesis



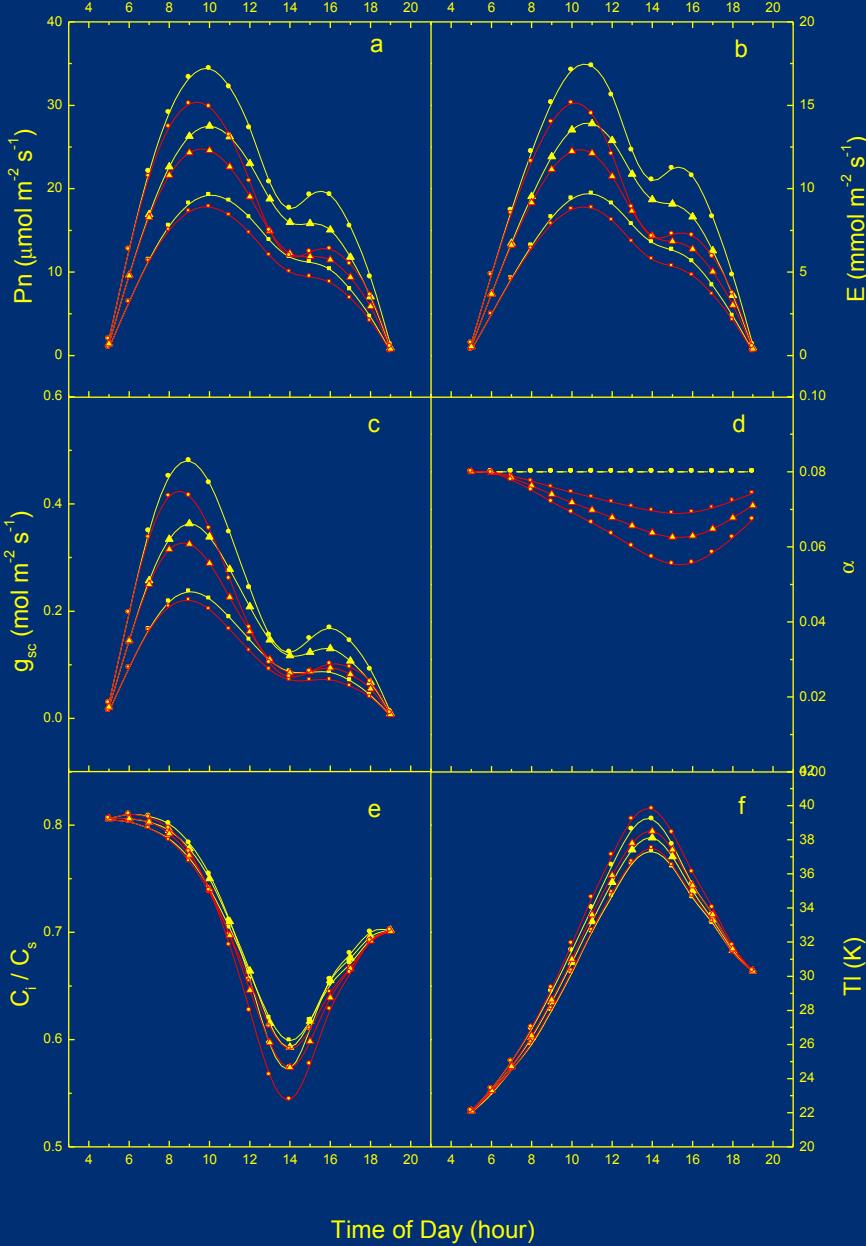
## (2) Land surface modelling using CALSS (Canadian Land Surface Model)



# Sensitivity analysis of diurnal variations of photosynthesis and transpiration



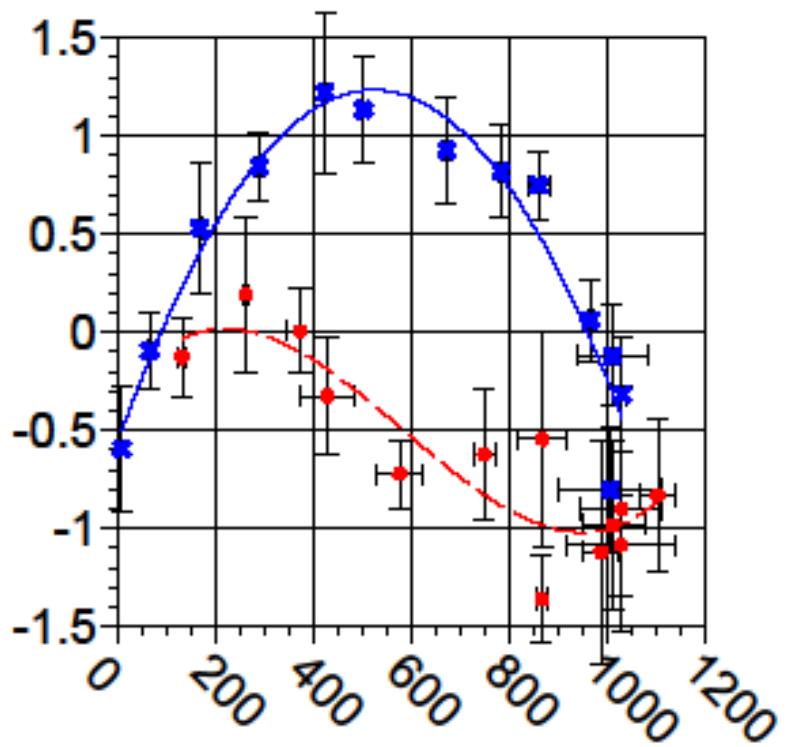
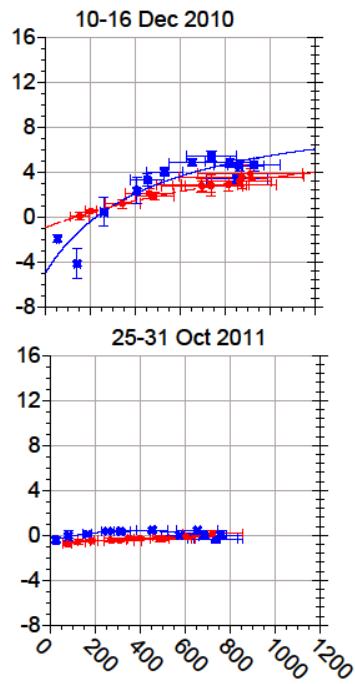
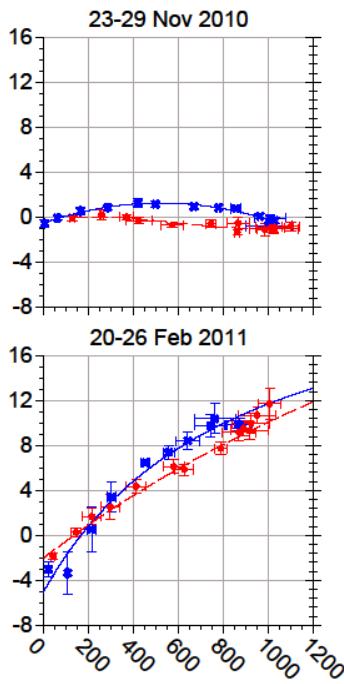
Simulation of diurnal variation of photosynthesis, transpiration, and stomatal conductance (red: photoinhibited)



# Flux measurement in Alice Springs

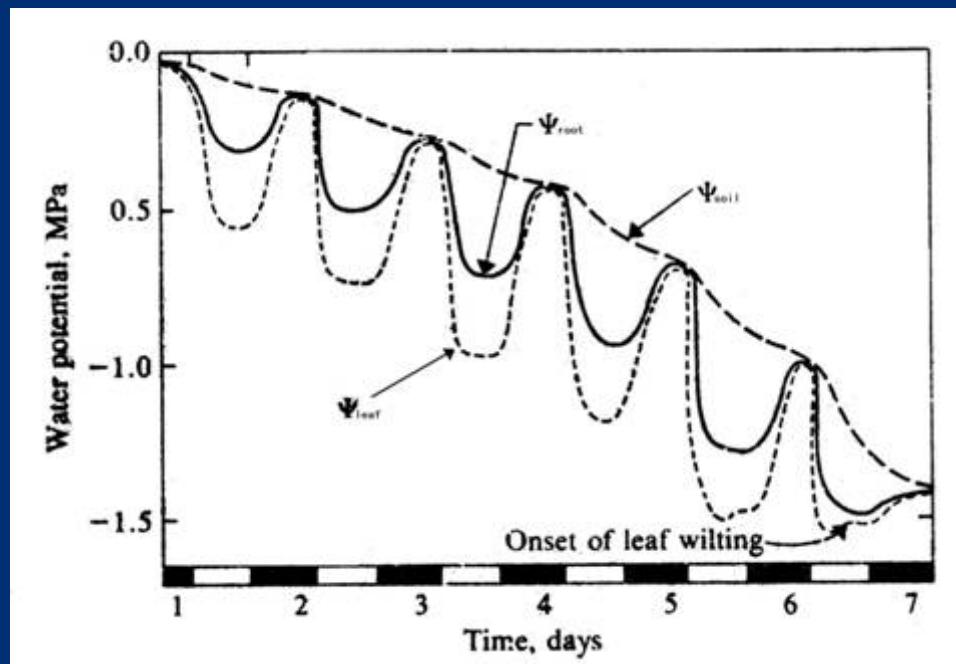


# Light response of carbon flux in Alice Springs



# Consideration of the model – a dynamic leaf water

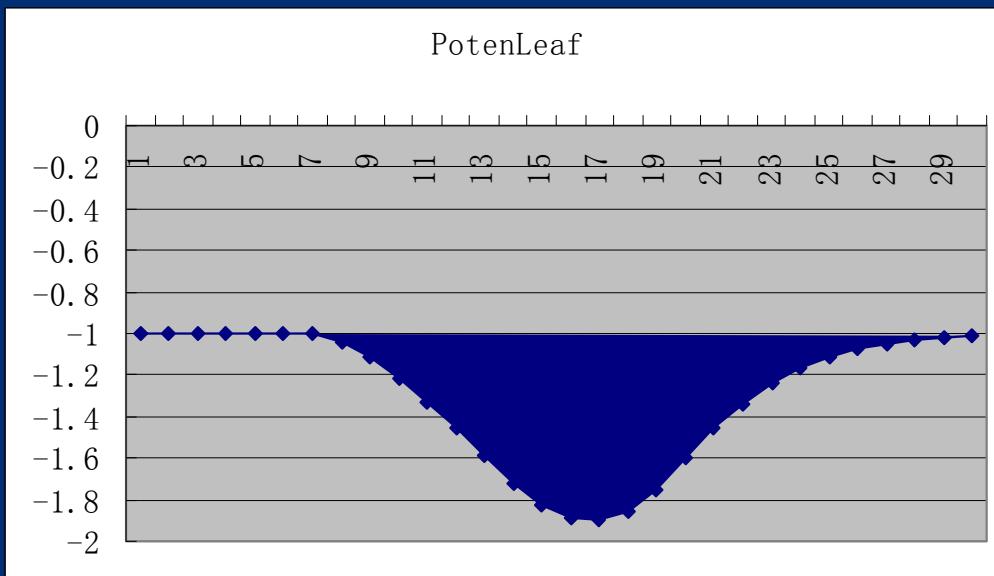
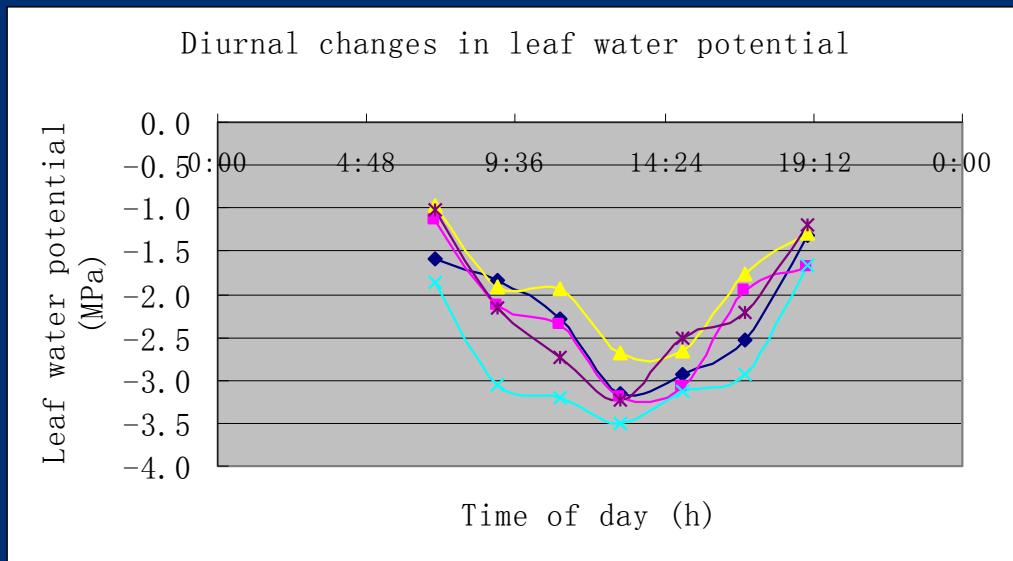
- Leaf water potential may play an important role in midday depression of photosynthesis
- Leaf water potential controls photosynthesis and transpiration through stomatal regulation



# Dynamic leaf water potential equation

$$-\frac{d\psi_l}{Cdt} = T_r - \frac{\psi_s - \psi_l}{R_{sl0} \text{EXP}[k(\psi_s - \psi_l)]}$$

- ❑  $C$  water capacitance;
- ❑  $\Psi_s$  root water potential;
- ❑  $\Psi_l$  leaf water potential;
- ❑  $R_{sl0}$  maximum resistance to water from soil to root



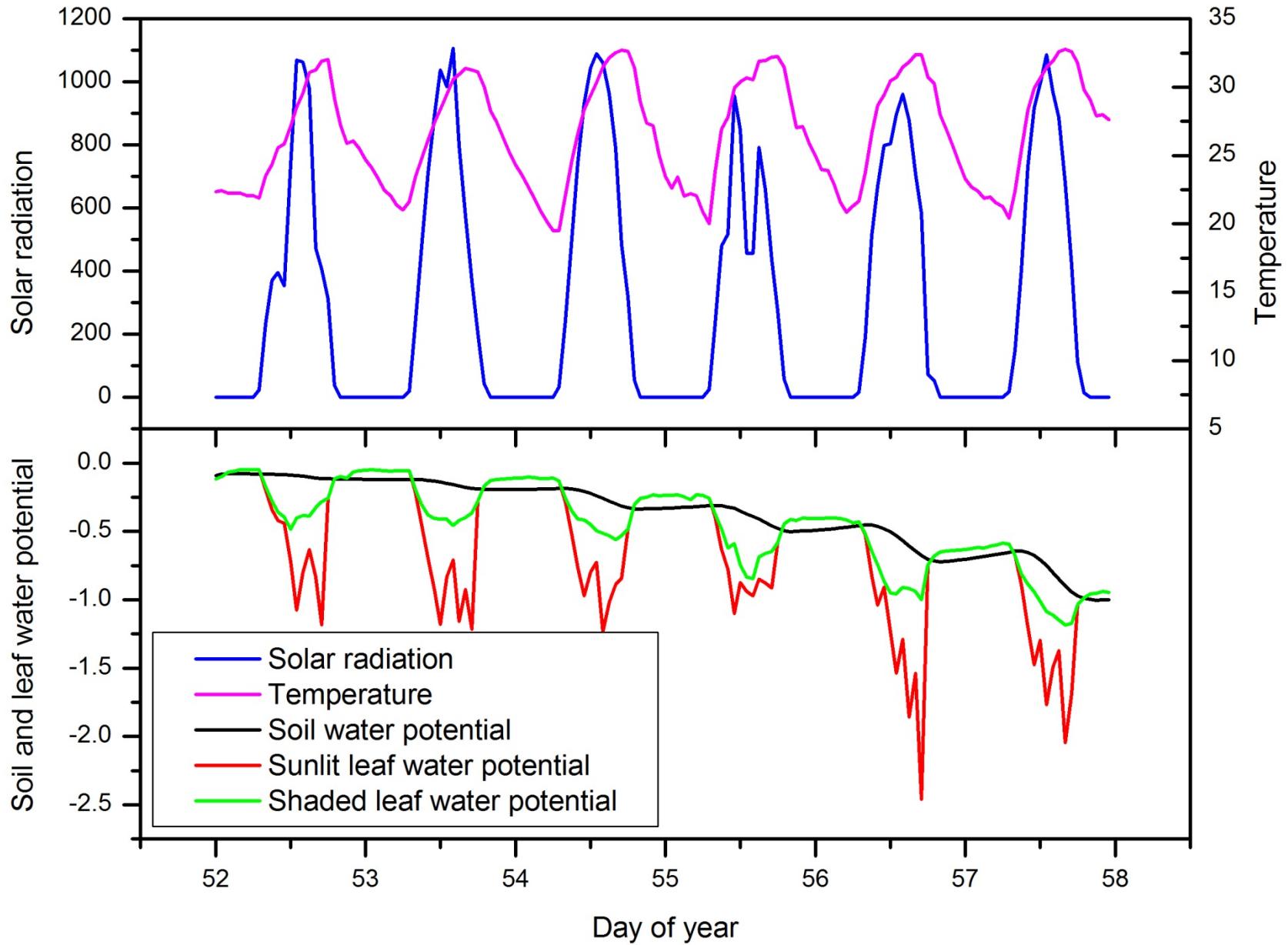
## Change soil water limitation in CABLE to leaf water

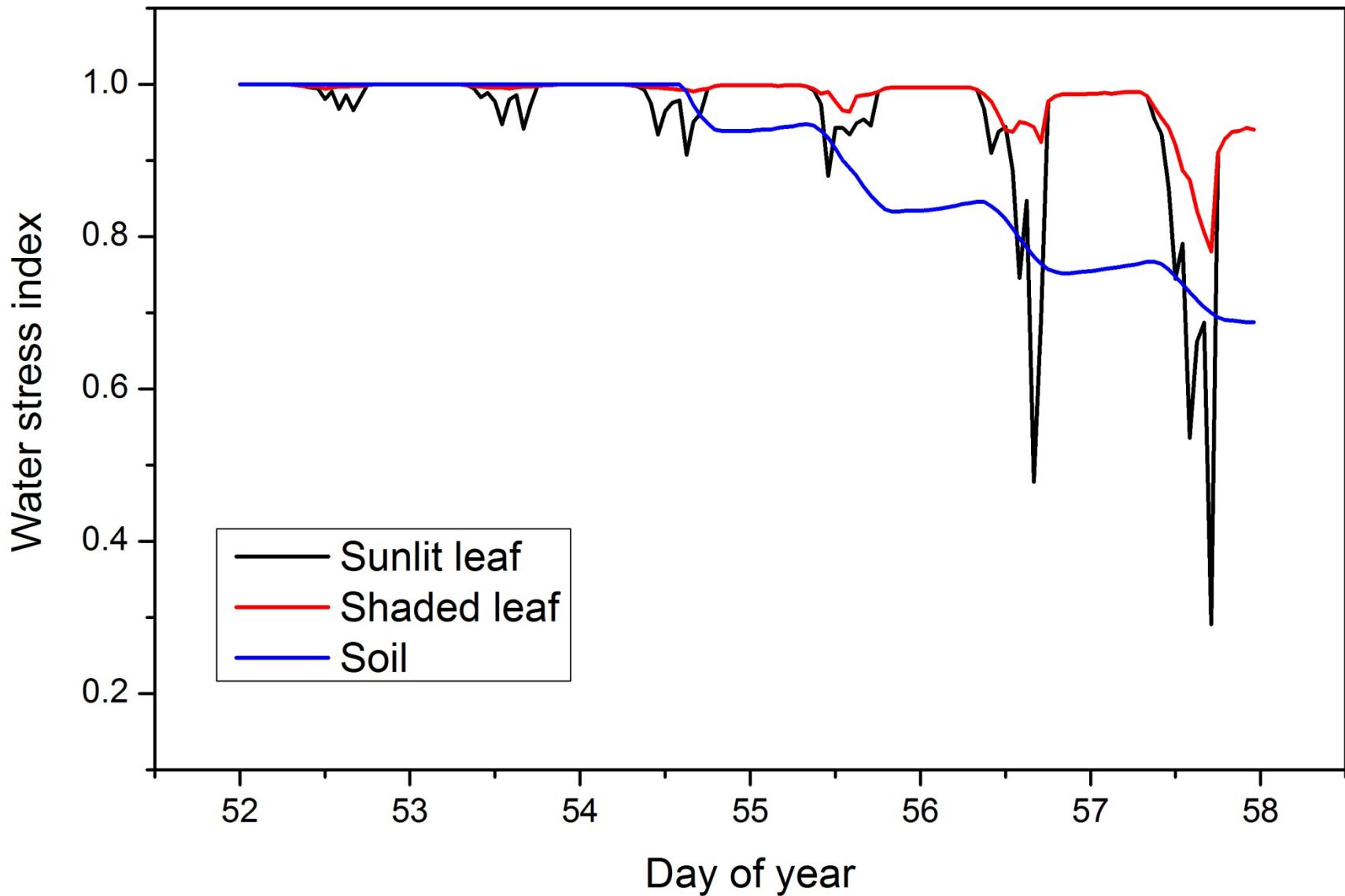
(replace soil water potential with leaf water potential  
in the water limitation function)

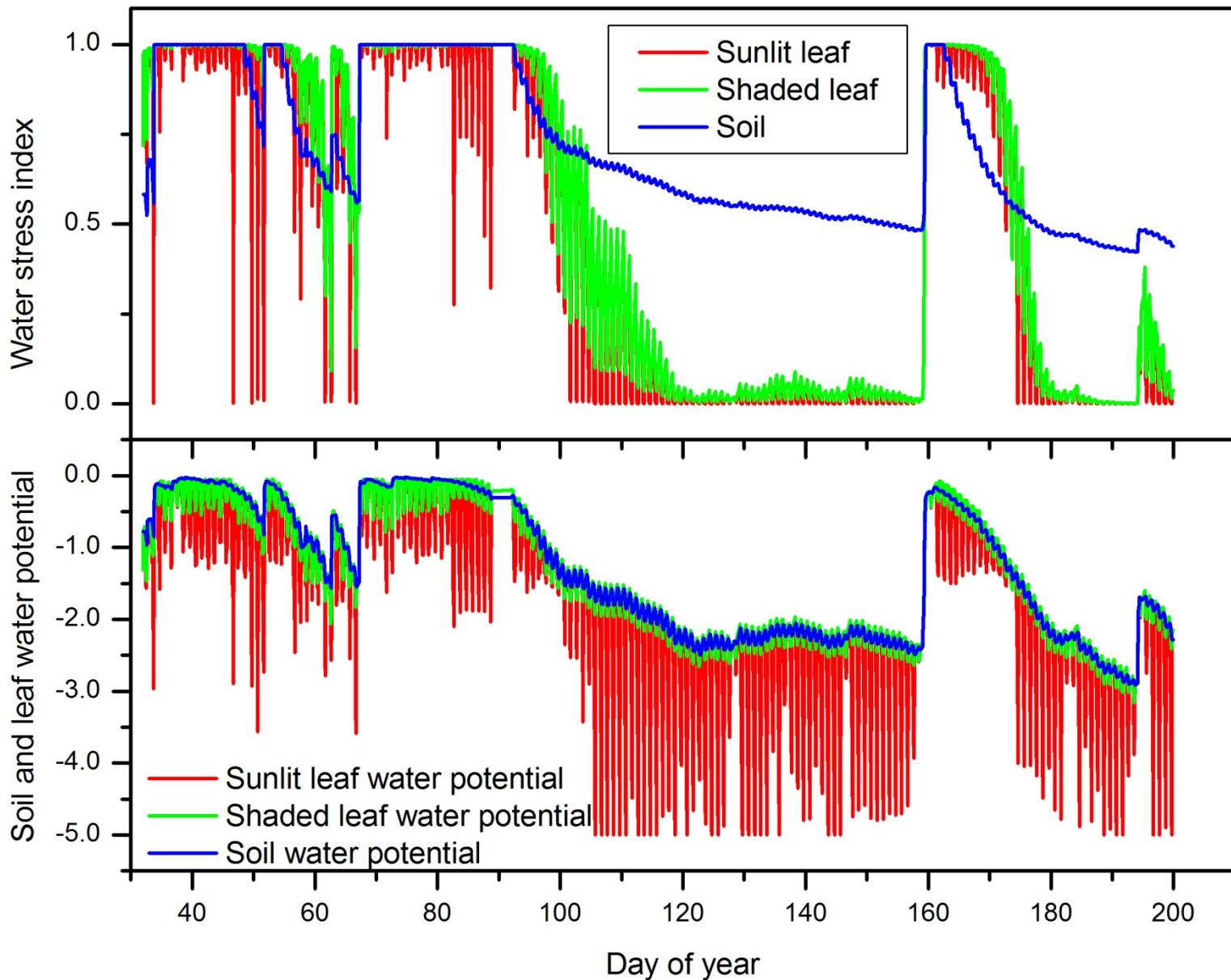
Stomatal resistance in Tuzet *et al.*, (2003)

$$g_s = m \frac{P_n}{C_s - \Gamma} f(\psi_l) + g_0$$

$$f(\psi_l) = \frac{1 + \exp(s_l \psi_f)}{1 + \exp[s_l (\psi_f - \psi_l)]}$$







## Next steps

- To validate modified CABLE model against Alice Springs data
- To evaluate CABLE model performance under dry and wet conditions

## In summary,

- Land surface models are limited in capturing midday carbon and water fluxes based of soil water constraints
- Inclusion of leaf water stress may improve prediction of fluxes and understanding of interaction between solar radiation, water, and temperature

# Acknowledgement

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