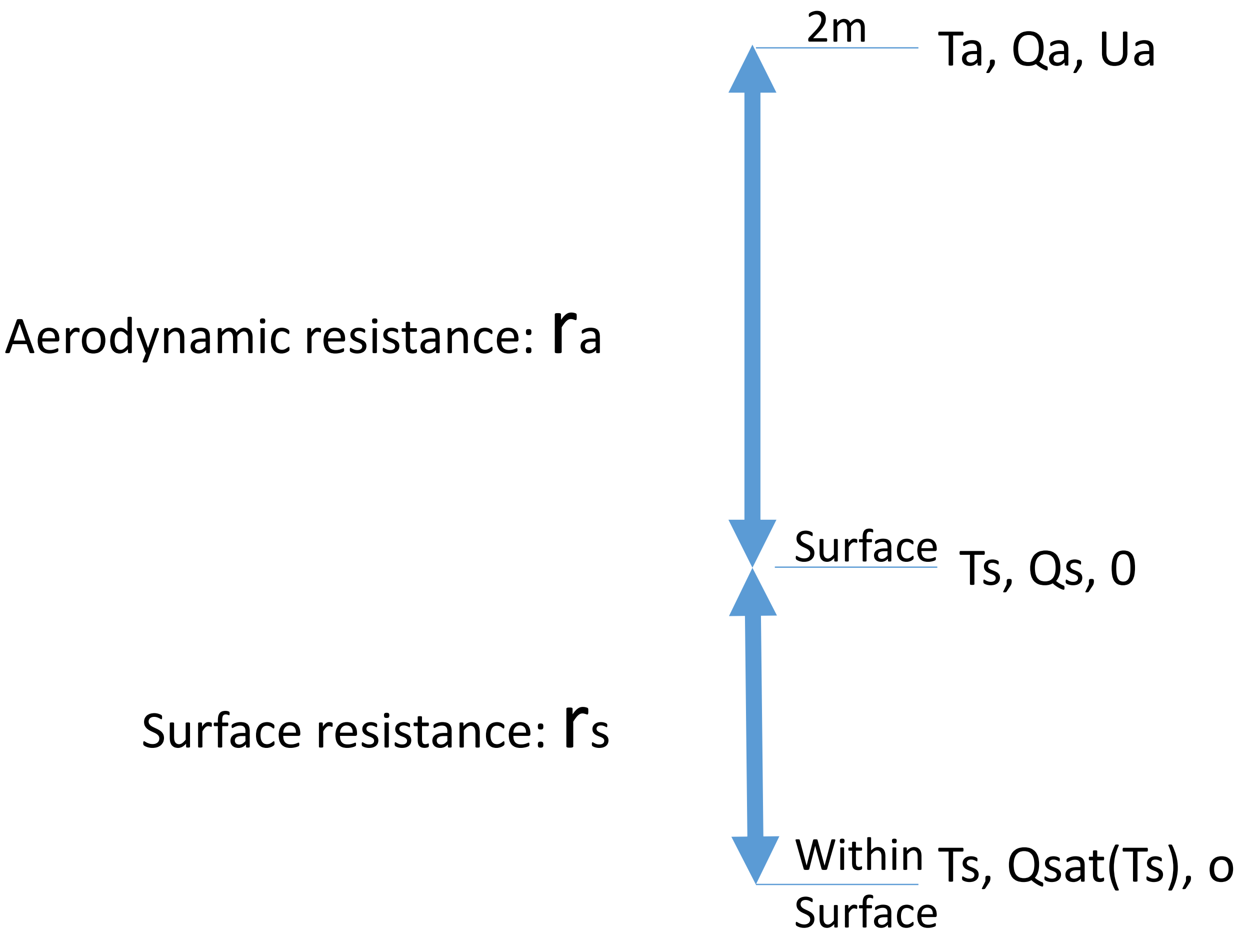
Vertical Structure of the land cover and its importance in energy exchanges with the atmosphere

Eleanor Blyth, CEH

Current structure of JULES

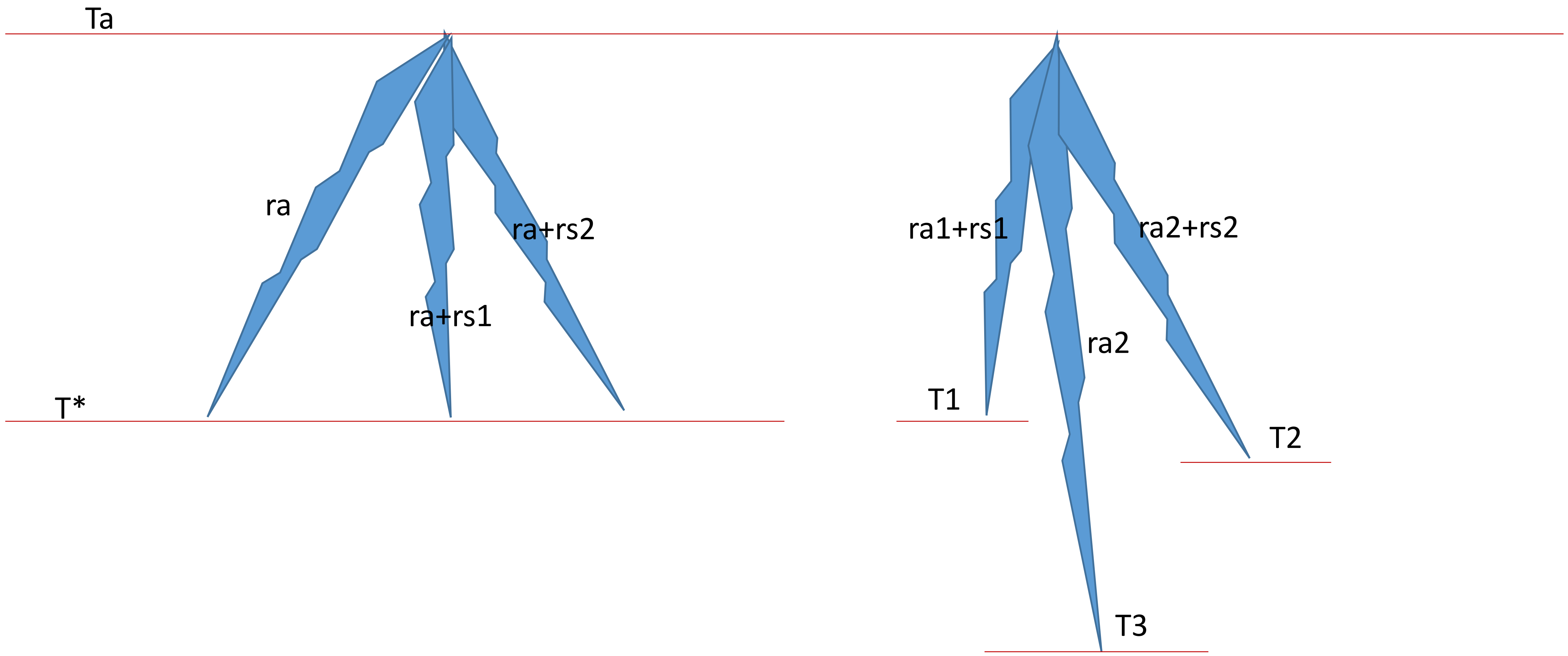


JULES is set up to solve the energy budgets using just one value of r_a and one value of r_s

This means that there is one value of T_s to calculate the emission of long wave radiation

In practise there are several surfaces within a PFT, each with a different r_a and r_s

Leading to a non-linear combination of T_s.



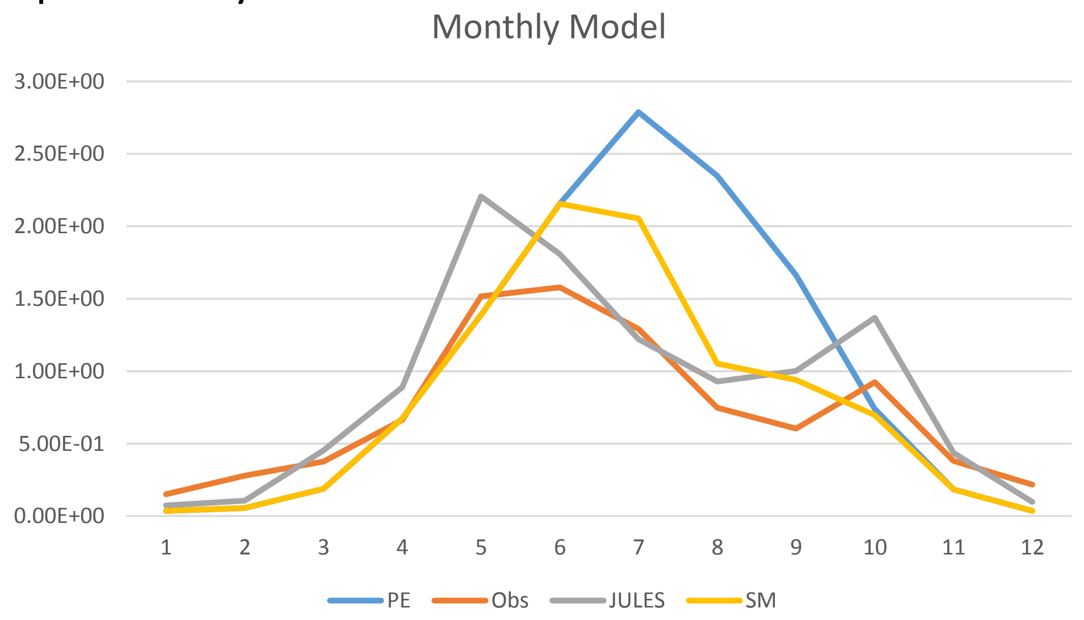
Note – not always needed:

Different time scales require different levels of accuracy in a model.
One of the Benchmark datasets for JULES is Fort Peck, a grassland site in the USA which has strong seasonal rainfall.

Here a simple monthly water balance model is used which only knows the PE, the rainfall total and number of rain-days for each month.

It is assumed that the soil moisture controls the evaporation in a linear way such that after each rainfall event, the evaporation reduces exponentially.

The model is surprisingly successful.

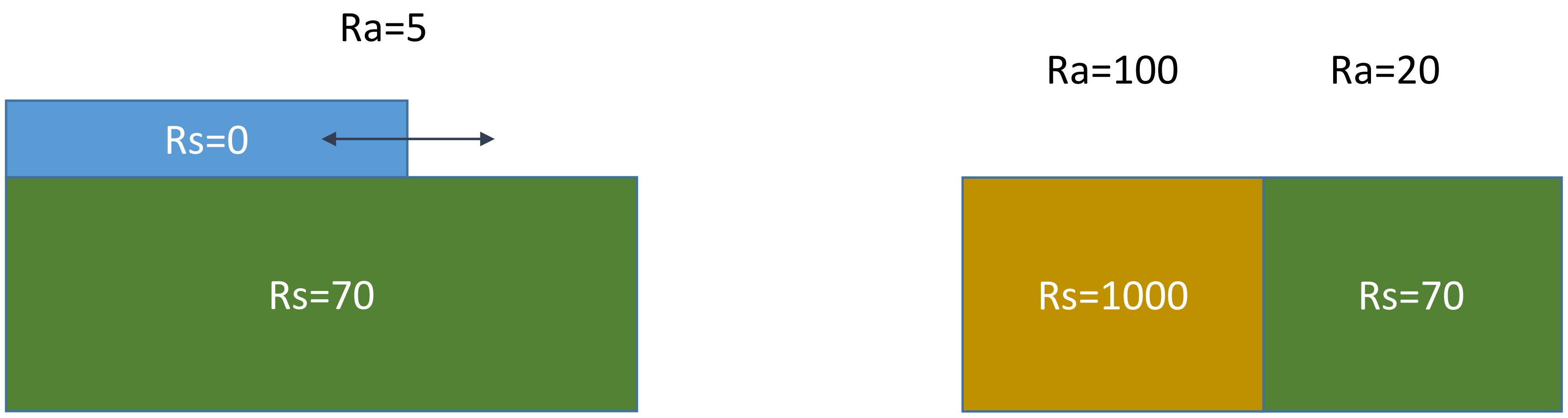


However, weather-forecast model need to have heat and moisture fluxes at an hourly timescale.

Two case studies explored using the data from a single day at Fort Peck.

1. Interception: what is the impact of using a single surface temperature on the rate of drying?

2. Sparse canopy: what is the impact of having a single aerodynamic resistance on the land surface temperature?



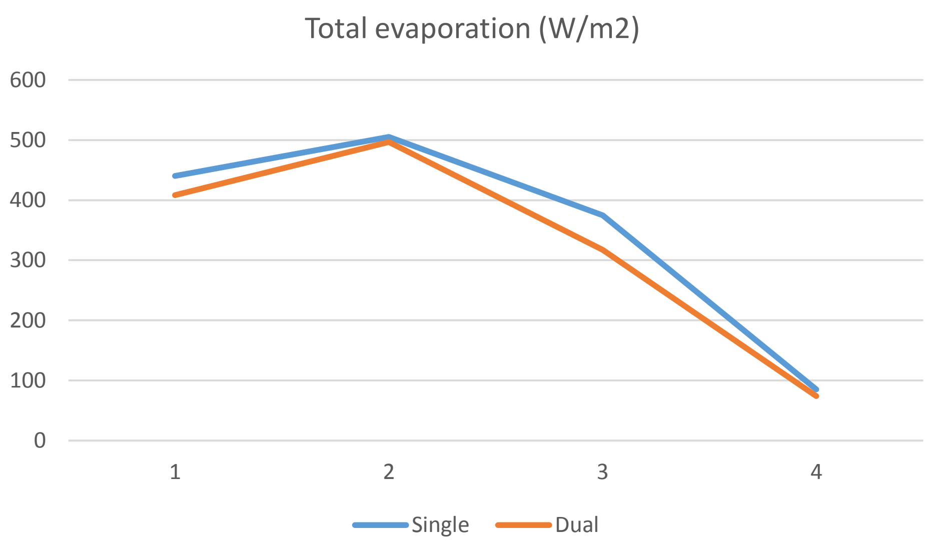
Case 1. Intercepted water covering a fraction of the grid

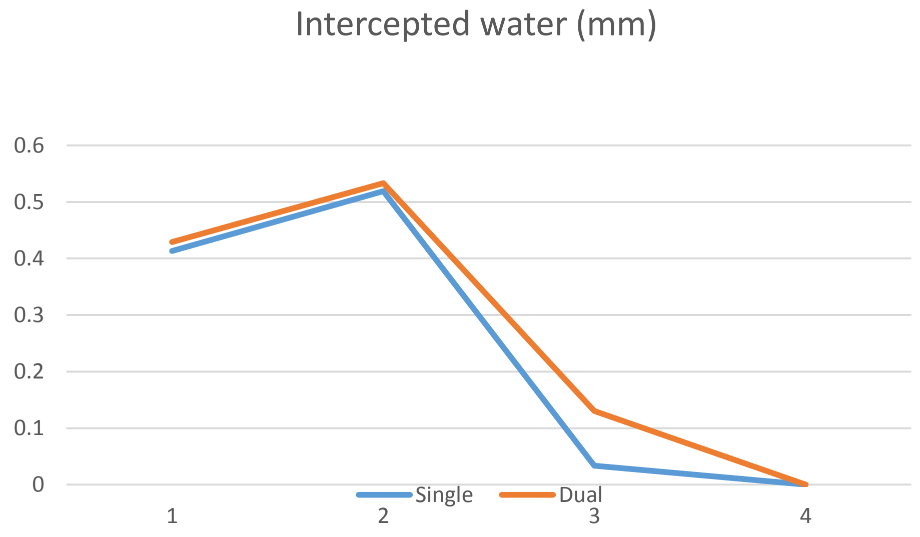
Dual: Calculating the energy budget of the intercepted water separately

Single: Assuming a single surface temperature and thereby using a model of parallel resistances:

rs1=1/(1/(rs+ra)*(1-fwet)+1/(ra)*fwet)-ra

Single energy budget overestimates the evaporation by 13% over 4 hours and dries out one hour earlier

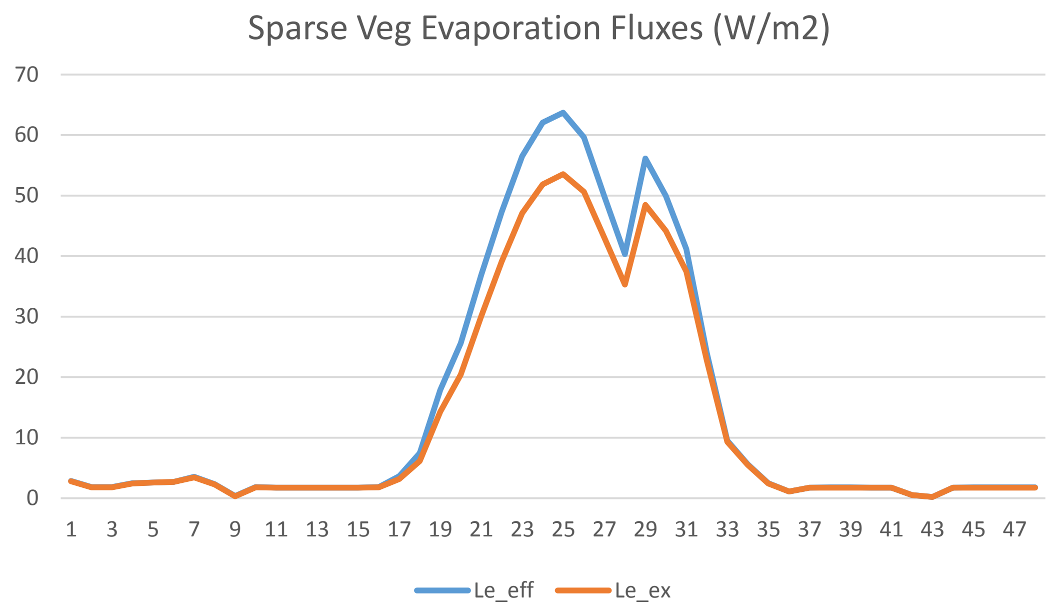


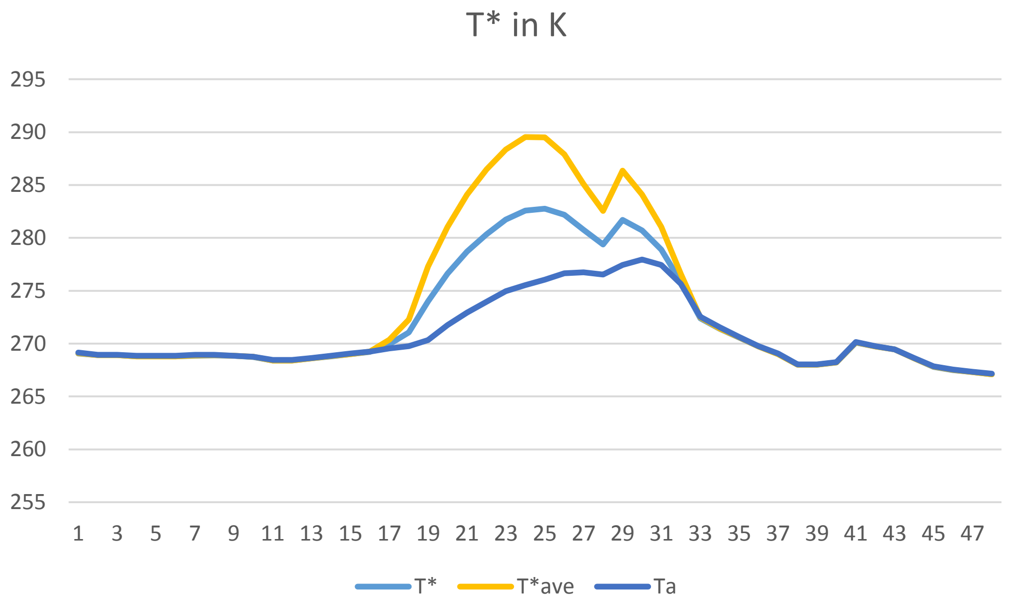


CASE 2: Calculating the energy budgets of a soil and vegetation separately

17% increase in evaporation if calculated as a single source.

7 ˚ difference in the average surface temperature

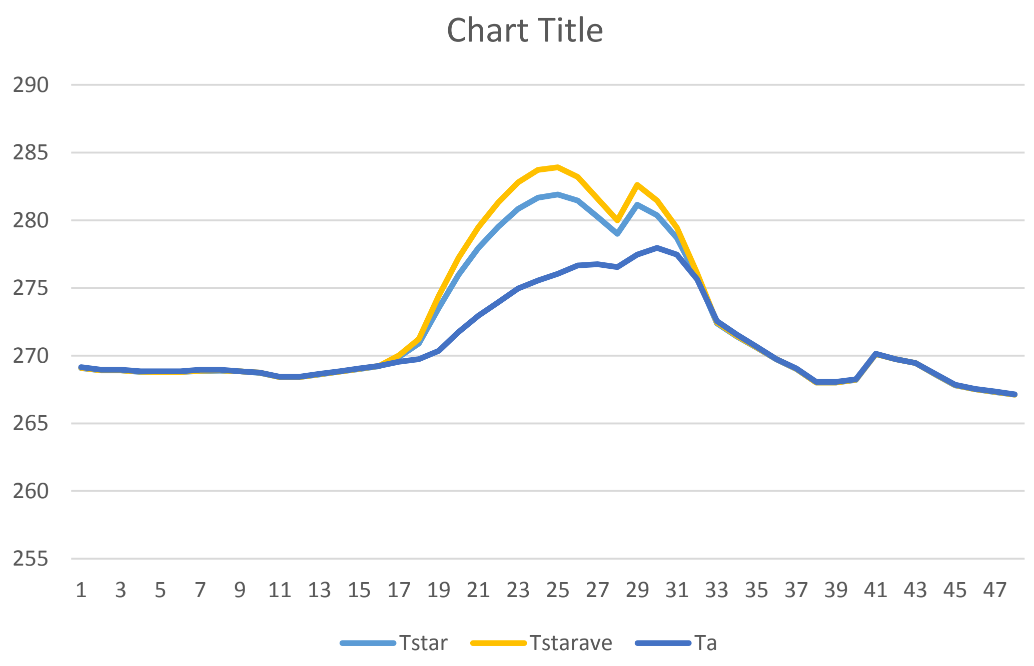




This will make a big difference when using LST satellite products to evaluate or data-assimilate into the model.

Big uncertainty in aerodynamic resistance gives big uncertainty in surface T

Change the value of the understorey aerodynamic and you get this: only a 3˚ difference



Multiple Source Energy Balance Model Working Group

In addition to these simple examples, there are issues about radiation.

The radiation is assumed to reduce through the canopy but this is only picked up by the photosynthesis routine.

Long wave and short wave radiation interactions between the canopy and the soil surface can be key. Only some of this is captured in the JULES code currently.

I propose we have a working group on this issue, starting with a meeting in the autumn.

Issues to be discussed:

- what data is available to inform the model?
- Do we include multiple surfaces (>2) or just 2?
- How would we get parameters fro global model?