**Responses to reported discrepancies in CABLE’s transpiration, soil evaporation and runoff rates – preliminary discussion**

1) Transpiration rate is generally lower than expected:

N.B. The supporting calculations are done in newFevc.xlsx which would be referred to as ‘the spreadsheet’ in the following discussion.

a) In the existing code, no matter which fwsoil switch is used, the demand for water at the top 2 to 3 soil layers are usually much greater than the available supply from these thin soil layers. In the spreadsheet, change the initial demand from 50 mm to 10 mm to 1 mm (grid B1) to see the effect on the situations (shrubs, grass and trees) using standard fwsoil calculation. The calculated total water extraction is passed from canopy module onto the soilsnow module for redistributing so that the top layers would be preferentially depleted before the lower layers.

The exceedingly high demand in the first 3 soil layers is a result of using

demand in layer j = total demand **x** fraction of roots in layer j

A proposed change is to have the demand redistributed to layers with more water available

demand in layer j = total demand **x** fraction of roots in layer j **x** available water in layer j

Example for code changes in SUBROUTINE fwsoil\_calc\_std:

Old code:

rwater = MAX(1.0e-9, &

SUM(veg%froot \* MAX(1.0e-9,MIN(1.0\_r\_2,ssnow%wb - &

SPREAD(soil%swilt, 2, ms))),2) /(soil%sfc-soil%swilt))

fwsoil = MAX(1.0e-9,MIN(1.0, veg%vbeta \* rwater))

New code:

rwater(:) = 0.0

do ns=1,ms

fextroot(:,ns) = veg%froot(:,ns) \* (ssnow%wb(:,ns) - soil%swilt(:)) &

/(soil%sfc(:)-soil%swilt(:))

fextroot(:,ns) = MAX(1.0e-9,MIN(1.0\_r\_2,fextroot(:,ns)))

rwater(:) = rwater(:) + fextroot(:,ns)

enddo

fwsoil(:) = MAX(1.0e-9,MIN(1.0, veg%vbeta(:) \* rwater(:)))

do ns=1,ms

fextroot(:,ns) = fextroot(:,ns)/rwater(:)

enddo

Note that it is the same equation used in calculating rwater, but it is now recorded for each soil layer and normalized as the distribution factor. The effect of this new strategy is illustrated in the spreadsheet as the ‘new std case’ (just study the green area in the case).

As this change will affect all options of cable\_user%FWSOIL\_SWITCH, similar additions to the Lai & Ktaul method is introduced. In the spreadsheet, the final columns illustrate the results of the new distribution factor for the Lai & Ktaul switch. The main parameter for this method is rootgamma (grid R1) which is ranging from 0.0001 to 0.001 normally.

Finally, the non-linear method may need some looking into, but for now it can just default back to using root fraction as the distribution factor.

b) There is a fudging factor (= 1.1) in the canopy module calculation to limit supply. Eva has put that in to guarantee that arid and semi-arid area won’t be producing an erroneous water flux when the soil is bone dry. This should be tested in online global runs to provide data for discussion. Preferably, this factor can be removed.

In the spreadsheet, the fudging factor (at grid V1) can be changed back to 1.0 and one can easily see how much transpiration has been reduced (~12%, 65% and 7% lowered).

c) The existing code in the trunk has a bug in SUBROUTINE fwsoil\_calc\_Lai\_Ktaul which has missed a few lines.

d) The existing code in the trunk cannot run with the second option for the cable\_user%FWSOIL\_SWITCH because the character length of 20 set in the cable\_common.F90 file is too short. It should be at least 24 or more to accommodate the 'non-linear extrapolation' switch.

2) Soil evaporation is very high and runoff is very low to extinct:

This has been worked on by Eva earlier this year independent from the transpiration problem mentioned above. Her modifications are saved in

<https://trac.nci.org.au/trac/cable/browser/branches/Users/ewk599/CABLE-2.1.2_N/>

and mainly playing with the parameter values in the sinfil calculation. The effect is bringing down soil evaporation to reasonable values and some runoff is recorded in the EucFACE experiments. Eva has since run many online simulations using this setup and find it satisfactory.

However, in view of the changes to be made in improving the transpiration rate, it will then limit the amount available for soil evaporation and runoff. We need to We need to recalibrate these parameter values after the above changes are made.