General comments

This paper addresses the important issue of land surface model behaviour during lack of rainfall. Its plots are clear and the statistics appear sound, albeit somewhat basic. However, I felt somewhat empty-handed at the end. Very little, process understanding was gained. Why are the key equations not provided? There are various points in the paper where I get the impression the authors have used the model like a black-box without truly understanding the equations within the model. This is also evident from their description of the model physics, soil physics in particular. This is a missed opportunity and leaves the reader somewhat frustrated. I guess most of the Conclusions could have been drawn without having gone through this considerable modelling exercise. More in-depth explanation of the findings is required using equations presented and explored explicitly, not tentatively (using words such as 'likely', 'multiple explanations are possible', etc.

Specific comments

Page 10792:

I think the statements in lines 3-8 are somewhat naïve.

"We use *QE* because it is the variable that links the land surface energy, water and carbon budgets. It is also one of the variables supplied by the land surface to the atmosphere and is therefore important to a climate model. We do not use soil moisture as evaluating soil moisture from LSMs directly is problematic (Koster et al., 2009) due to different soil structures assumptions, storage capacity and timescales inherent in how LSMs represent this variable" .

Soil moisture, and the models underlying hydraulic properties and soil water transfer and root water uptake equations, ultimately determines the latent heat flux; via transpiration and direct soil evaporation. If a model gets QE right, but soil moisture content (considerably) wrong, this is a sign of poor process presentation particularly with regards to soil hydrology and plant water stress parameterisations.

Also, what exactly is meant by 'soil structure assumptions'. This is unclear terminology.

Line 25: soil texture is generally not a model parameter. It is used to derive other parameters from, such as hydraulic conductivity or the water retention curve. On the next page line 13 you use the term soil properties, which would be more appropriate.

Page 10792:

Line 15-17 You say "Where the LSM cannot capture the observations, despite variations in LAI and soil parameters, points to systematic errors in the model's representation of physical processes"

I guess we could consider this roughly to be the case, but this ignores errors in driving variables and energy balance closure errors, or the fact that your parameter range was possibly unsuitable.

Also, it is not sure that the error in QE was related to soil hydrological parameterisations. It could just as well have to do with soil thermal and land surface radiative parameterisations, affecting sensible and soil heat flux.

Page 10795:

Lines 8-9: “The soil module simulates the transfer of heat and water within the soil and snowpack following the Richards equation”.

This is incorrect: soil heat transfer cannot be determined with the Richards equation. It is generally determined with the Fourier’s law.

Page 10796:

Line 4-5: “It does not distinguish between saturated and un-saturated top soil fractions or simulate groundwater dynamics”

This sentence needs elaborating. Distinguish in what way? In the context of surface run-off? At the moment it reads as if model soil moisture plays no role in any soil hydrological process.

Page 10796:

Line 24: ..... Table S2.

Table S2 in Supplementary material contains soil physically incorrect terminology. It should be “Soil dry bulk density” not simply “Soil density”.

Also, “suction at saturation” is per definition equal to zero. What you mean is “suction at air entry point”. Furthermore, suctions always have positive values. If you use negative values, as in Table S2, it should be referred to as “matric potential” or rather “matric head” as you are working in length units.

Finally what is meant exactly by soil heat capacity? At air-dry or saturated moisture content? Why are these values the same for all soil texture types?

Page 10798:

Lines 1-4: “The default hydrological scheme uses these three soil parameter sets directly, whereas the new scheme employs an empirical approach to calculate the parameters governing water holding and thermal capacities from sand, silt and clay fractions”

I am not sure what is meant here? The default scheme also has values for wilting point moisture content etc. They must also have been derived from texture?

In both cases using so called ‘pedotransfer funcions’? Use this word instead of “ empirical approach”. Which ones were used? By the looks of it Cosby et

al., seeing you are using the Clapp and Hornberger B parameter? You need to state this explicitly.

Also, these soil hydraulic parameters govern more than just water holding capacity. They govern soil water transfer via Darcy's law and Richard's equation (with Ks embedded in them).

Finally: you are using heat capacity, but is thermal conductivity not required in Fourier's law?

Line 6-7:" Leaf area index (LAI) plays an important role in the surface energy balance in CA- BLE (Kala et al., 2014)".

Can this sentence be elaborated upon by 1-2 follow-on sentences? In what way? By upscaling from leaf to canopy scale conductance? In light interception?

Page 10799:

Line 1-3: "..... the dry periods were defined based on precipitation as this allowed the use of available observations, but we note the simulated fluxes will also depend on other processes such as soil moisture availability".

The simulated fluxes will also very much depend on the driving variables that determine evaporative demand. That has been overlooked in this definition of 'dry periods'.

Line 8-10. "The dry-down period generally coincides with the maximum and the following minimum observed latent heat flux during the one-year period but has been adjusted for some sites to best capture typical model behaviour (Fig. S6)".

What is meant by this exactly?

I feel what is missing from the paper is a basic description of plant water stress, e.g. along the lines of the beta function in the Jules model (see Egea et al. 2011). I understand CABLE uses the same approach?

Page 10800

Lines 23-24: "This is likely due to overly rapid drying of top soil layers, which strongly control *QE* in CABLE (De Kauwe et al., 2015c)"

But which process is being affected (mostly) here? Transpiration or evaporation?

In both cases soil moisture content is a key variable, yet we do not get any insight into how well this variable is predicted by the model.

Lines 23-24: "This is particularly evident during warmer summer months when fluxes are more strongly moisture-limited"

One may assume that this is indeed the case, but with no information on soil moisture content, nor how SMC affects evapotranspiration, this remains speculative.

Lines 27-28: "While encouraging, this is likely due to compensating errors, such that early season overestimations in *QE* are counteracted by underestimations during the dry-down periods. "

Remove the word likely. It either is or it isn't. You have the data in front of you.

Page 10801

Line 8: "The model dries down too quickly". The model itself is not drying...

Line 12-14: "These characteristics of CABLE are not dependent on the choice of LAI, *g*s, or soil parameters; the range in *QE* fails to overlap the observations irre- spective of how these properties are varied."

I have not been able to find anywhere in the paper between what values these variables have been ranged. Nor am I sure what is meant by soil variables. Are these the soil hydraulic variables? Or texture percentages?

Page 10802

Line 19-23: "Both hydrological schemes are sensitive to soil parameters during the dry- down period but show smaller variations due to soil during other parts of the year (see Amplero, Blodgett, Howard Springs and Palang in Figs. 6 and 7). This transition from low to high sensitivity occurs as soil moisture stores begin to deplete and *QE* becomes increasingly limited by moisture supply".

This last sentence seems a very obvious statement. Does it need stating? How meaningful is it anyway, if we are not told (at least approximately) how CABLE deals with plant water stress?

Line 23-25: "The new hydrological scheme uses a narrower range of parameter values for water holding capacity and conductivity (Table S2) and thus results in a smaller range of uncertainty due to soil parameters."

As far as I can see Table S2 does not give a range per soil parameter. It gives one value only for each soil texture type. Also, what is meant by water holding capacity? Water holding capacity is defined as the total amount of water a soil can hold at field capacity. Did you mean 'water retention curve'. Furthermore, 'conductivity' needs to read 'hydraulic conductivity'

Page 10803

"The slope parameter affects the rate of subsurface drainage and represents a key difference between the new and default schemes"

If this is the case, then why the emphasis on water retention? These parameters are generally related to plant water availability.

Why is the slope parameter not in Table S2?

What meaning does this parameter have anyway at the site scale?

Page 10804

Seems this section makes a lot of rather obvious statements that could have been made without the work conducted in this paper.

Page 10805

Lines 5-7: “The reason for the overestimation of peak fluxes is not clear but is not resolved by the new hydrological scheme despite this parameterising many of the relevant processes differently”.

This sentences underlines the frustrating nature of this paper: CABLE is used like a black-box without the authors truly having investigated the inner workings of the model. I doubt this is acceptable to the journal and its readers.

Why/how would changes in a slope parameter affect soil evaporation?

Line 9: “..multiple potential causes to this excessive QE??” There are only a limited number of casuses and they are all embedded in the equations that determine soil evaporation.

Page 10806

Line 9-11 “Other model processes, particularly vegetation response to drought, have been identified as critical for capturing drought processes and shown to improve CABLE performance during droughts but were not explored here.”

I do not understand this? Wilting point and field capacity are two key parameters in the CABLE model plant water stress factor (empirical scalar beta, see De Kauwe et al. 2015).

So implicitly you have explored vegetation response to drought?!