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Interactive comment

Interactive comment on "Evaluating a land surface model at a water-limited site: implications for land surface contributions to droughts and heatwaves" *by* Mengyuan Mu et al.

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Review of Mu et al. "Evaluating a land surface model at a water-limited site: implications for land surface contributions to droughts and heat waves"

In this study the authors validate the CABLE land surface model against measurements representing multiple relevant state variables and fluxes from a site in Australia. Using different model configurations they test the relevance of a range of processes known to affect modelling performance and find that most of them are also important at the considered site. They conclude that land surface modelling and model development should focus on several variables and correspondingly multiple processes at the same

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Discussion paper

time to ensure meaningful model performance is obtained, and for the right reasons.

Recommendation: I think the paper requires moderate revisions.

The topic of this study is timely, and relevant for the community and even beyond in the context of climate change projections. While there are many studies investigating particular known challenges in land surface modelling, I find it very insightful to see a joint consideration of these challenges, and of their interactions. But I also see some shortcomings in this paper which should be addressed before the paper is suitable for publication in HESS:

(1) The order of the changes applied to the model configuration is not motivated. I think it should at least be discussed why and how this order was chosen, as I believe that the different changes applied to the model interact with each other, thereby leading to over- or underestimation of the effect of individual changes.

(2) The observations with which the model simulations are compared are themselves subject to uncertainty. While I acknowledge that the authors are aware of this, and mention this here and there in section 4, I would like to see a more extensive discussion of this, particularly in the results section where model performance differences are assessed without discussing the significance of these changes in the light of observation uncertainties.

(3) It would be nice to have some discussion on the representativeness of the obtained conclusions across spatial and temporal scales (actually I could not even find the temporal scale at which the model simulations were done). Are these model improvements expected to hold at larger spatial scales relevant for climate (change) modelling? And more generally, to which extent can we possibly learn from such small scale analyses to improve large scale modelling?

(4) Similarly, I was missing some discussion on the potential applicability of the derived

conclusions to other models and regions. How can modellers using different models and focusing on other sites/regions benefit from the results obtained in this study?

I do not wish to remain anonymous - René Orth.

Specific comments:

lines 23-24: not clear at this point what 'median level of water stress' is

line 25: 'Alternative' could be replaced by 'The range of tested' for improved clarity

lines 42-43: you could cite here Orth and Destouni 2018

line 79: 'soil moisture extending root zone', please improve phrasing

line 95: what is meant with 'Sm' here?

line 105: You talk about gap filling here. How many gaps were filled this way?

lines 120-123: Could you give some details on how the neutron probe measurement works and is done at 12 different depths?

line 286: why 31 layers?

line 309: 'Due to muted variability', can you please give more details here?

line 339: Why not stating the applied exponent 0.425 here?

line 354: Why would accounting for defoliation by decreased LAI be insufficient?

line 379: it is not mentioned in the repsective section 2.4.3 that the aquifer is 'initialised' drier

lines 407-411: Figure 6 should be mentioned earlier in this paragraph

line 439: 98% is relative to the maximum I guess?

line 467-469: Shouldn't this be the other way round?

line 598: typo in 'transpiration'

line 615: you could cite here Orth et al. 2017

Figures 2-7: Please point the reader to the different time axes used in this plot, and/or use a regular time step spacing in plots c,d,e while showing data gaps e.g. in gray. This can improve readability and comparability across plots I think.

Figure 10: The different timing of the peaks which you repeatedly refer to in the text could be illustrated by vertical thin lines with respecitve colors highlighting these peaks.

References:

Orth, R. and G. Destouni, Drought reduces blue-water fluxes more strongly than green-water fluxes in Europe. Nature Communications 9, 3602, 2018.

Orth, R., E. Dutra, I.F. Trigo and G. Balsamo, Advancing land surface model development with satellite-based Earth observations, Hydrol. Earth Syst. Sci. 21, 2483–2495, 2017.

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