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Hydrology and Earth System Sciences
Discussions

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.

Anonymous Referee #2

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Mu et al., evaluate the performance of the Community Atmosphere-Biosphere Land Exchange (CABLE) land surface model for a water-limited measurement site in south-eastern Australia. The stand-alone model performance is assessed by comparing the simulation results to soil moisture and evapotranspiration measurements. By changing specific model configurations, the general model bias is tried to be reduced. In this context, one focus of the study is on heatwaves and droughts. Results show that a meaningful improvement of the model performance can only be achieved if both quantities, soil moisture and evapotranspiration, are considered for model validation.

Recommendation: The study is within the scope of HESS and addresses a relevant

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and interesting topic for the modelling community. The manuscript is well structured and comprehensibly written. Nevertheless, there are some issues which should be addressed before publication.

Comments: 1) The study highlights the large uncertainties related to the simulation of evapotranspiration and soil moisture. Thus, averaged land use specific parameters used in LSMs can deviate considerably from the actual hydrological characteristics at measurement sites. Large differences between simulation results and observations are the consequence. In order to improve the model performance, therefore, model configurations have to be adapted. This issue is clearly and comprehensibly demonstrated in the manuscript. But due to such site-specific changes the adapted model can only be applied at the location for which it is tuned and the model results are not transferable to other situations (or would the authors say that the results are transferable? If yes, please discuss it). Therefore, it is difficult to state lessons learned from this study beyond its specific application on southeastern Australia. At a few places in the discussion section the authors try to derive general conclusions, which could be beneficial also for modelling groups in other regions and with other models (e.g. implications for incorporated groundwater schemes, suitability of satellite-derived soil moisture estimates for model calibration), but this discussion should be more detailed. For instance, are there any processes to which special attention should be paid in LSM developments, or can you derive minimum requirements (e.g. spatial resolution) for external model data (e.g. soil texture), etc., or are such statements not possible for the chosen model setup? I recommend to address this in a separate sub-section in the discussion.

2) please discuss the uncertainties in the observations in more detail. I suppose that especially for the “indirect” or “derived” observations of Etr und Es, uncertainties are quite large and thus affect the assessment of the model performance.

3) the control run exhibits an overestimated Es in conjunction with a soil moisture wet bias. Because of that, I was quite surprised about the first step to improve the model

performance by increasing the resistance for soil evaporation Sres. Of course, such an increase in Sres results in a reduced Es, but must, at the same time, inevitably cause an intensified wet bias. Therefore, it would have been more intuitive to first increase the vertical drainage (as it is later done in the Watr experiment) to reduce the available water amount for evaporation in the upper soil. Is there any reason for the chosen sequence of experiments? I suppose that especially for the chosen "layering" approach, the order of the experiments is essential.

4) In this study, the influence of non-hydrological factors on evapotranspiration (e.g. temperature, aerodynamic characteristics of the surface) is neglected. For instance, how good are the surface temperatures (soil and vegetation surface) simulated in CABLE? Are there any surface or soil temperature measurements which can be used for validation? Maybe surface temperature is overestimated and in consequence also evapotranspiration? In this case, an adjustment of the aerodynamic parameters in CABLE might help to improve the model performance. For instance, an increase in surface roughness facilitates sensible heat transport into the atmosphere. A cooling of the surface and lower evapotranspiration rates are the consequence (e.g. Breil et al., 2020). From my point of view, the impact of non-hydrological factors on evapotranspiration should at least be discussed.

References: Breil, M., Davin, E., and Rechid, D. (2020). What determines the sign of the evapotranspiration response to afforestation in the European summer? Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-275.

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