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Hydrology and Earth System Sciences
Discussions



# *Interactive comment on* "Evaluation of the JULES land surface model in simulating catchment hydrology in Southern Africa" *by* N. C. MacKellar et al.

**Anonymous Referee #2**

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GENERAL COMMENTS:

This manuscript analyses the effect of varying the values of seven parameters of the JULES model on the validity of simulated runoff and river discharge in three southern African catchments.

The manuscript is generally well-written. The results are discussed in an appropriate and balanced way and the figures are of a good quality. I especially enjoyed reading the discussion section which was interesting. However, the description of PDM and TOPMODEL were difficult to understand (I will explain this later). There are also a



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number of other important issues that require improvement in my view (also explained below). For example; insufficient explanation is given on the method of selection of the 7 parameters that were evaluated in this manuscript.

The paper fits within the scope of HESS because the JULES model (which is applied in the paper) is an integrated model (modelling much more than just hydrological processes) designed for global application. However, the audience for this paper is very limited: The paper is probably only useful for JULES modellers specifically interested in the hydrological components of JULES.

I do not have very detailed knowledge of JULES, TOPMODEL and JULES' routing model, so I was perhaps not always fully able to judge the validity of statements in the manuscript.

SPECIFIC COMMENTS:

Line 12-13, page 11095 "To simulate streamflow in river catchments, runoff routing schemes are also now widely used": It is not clear why it is desirable to have runoff routing in an LSM as streams and rivers probably only account for a very small proportion of the energy, water and trace gas exchanges between land and atmosphere (i.e. it would seem to make sense to represent streams and rivers in a simpler way).

Lines 6-7, page 11096, "relationships to measured physical properties": Could these not also have the same equifinality problem as mentioned previously (Presumably not because they are probably not very complex, but this is not clear from the text)?

Line 2, page 11097, "at monthly timescales": JULES should probably work well for 6-hour time steps because it was designed to be coupled with a GCM which probably has 6-hour time steps. Therefore it surprises me that a monthly time step was used for this paper. Could the authors explain why this was done?

Lines 8-9, page 11097, "evaluate whether one offers a consistent advantage over the other": I think that the number of test catchments should be larger than 3 for such an



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evaluation. Could the authors comment on this?

Line 11-13, page 11098, "A higher value of b results in fewer high capacity (“deep”) stores relative to low capacity (“shallow”) stores and so will result in a more rapid production of surface runoff": This is incorrect, because a higher value of b in Eq. 1 results in a lower value of fsat, and thus less runoff production.

Line 16, page 11098, "per unit contour length": This is a bit confusing in the context of a grid-based approach. Do the authors not mean "per unit of grid cell area"?

Line 16-18, page 11098, "the representation of soil stores in PDM, which is not related to any physical characteristics of the catchment": This might be a little overstated because a modeller may choose to base values of PDM parameters on empirical relations with physical catchment characteristics that are commonly mapped (e.g. soil type or elevation).

Line 19, page 11098, "Sub-grid variation in lambda is modelled using a gamma distribution": Presumably the authors have switched here from describing TOPMODEL to describing the specific way in which TOPMODEL is implemented in JULES. If so, then please make this clearer in the text. Also, it is difficult for me (and other readers of this paper) to judge the quality of this modelled sub-grid variation because section 2.2 ("Data sets and catchments") does not mention the observations that were used to fit this gamma distribution.

Lines 23-24, page 11098, "an additional storage layer beneath the standard 4-layer, 3m deep soil column" For those that do not already know JULES and TOPMODEL, it is not clear whether this ’standard 4-layer, 3m deep soil column’ is standard to JULES, or standard to TOPMODEL (presumably the former).

Line 17, page 11098, Equation 2: This equation does not convey any information that was not already conveyed by the preceding sentence, so it seems redundant to me. In addition, this equation is only about the fifth layer whereas subsurface runoff is



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generated from any layer below or containing the top of the water table. Thus Equation 2 seems to govern only a small part of the generation of subsurface runoff. Why is subsurface-runoff generation from other layers not explained in the paper?

Line 3, page 11101, "Of particular interest for the selected catchments is the contrasting geological environments represented.": Please also indicate why the geological environments of the Okavango and the Zambezi catchment are contrasting (it is not mentioned anywhere in the paper).

Line 21-22, page 11101, "The grid resolution is 0.5": This is much finer than the resolution of GCM's (to which JULES was designed to be coupled). Is it reasonable to assume that all JULES parameters are still valid at this finer resolution? I think it is necessary to touch upon this scaling issue somewhere in the paper.

Line 26-28, page 11101, "Initial experiments identified that river discharge simulated by the PDM scheme is highly sensitive to the b shape parameter and that TOPMODEL is most sensitive to the f exponent (see Sect. 2.1).": Please mention the other parameters and configurations that were tested, and how this was done.

Lines 6-7, page 11102, "mean and standard deviation of the topographical index (TI)": Presumably, this is the data that was used to fit the gamma distribution mentioned in section 2.1. If so; then this dataset should be mentioned in section 2.2. It is difficult for me (and probably for other readers of this paper) to judge the quality of this modelled sub-grid variation without having an indication of the density and type of observations underlying this "spatially-varying ancillary field".

Line 5, page 11102: "within the range of previous regional implementations of 5 the respective schemes" Please clarify whether this means implementations of these schemes within JULES, or all implementations of these schemes.

Line 9-14, page 11102, "There ... (TOP1.0cr).": Please explain how those 5 routing model parameters were selected.



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Line 20-21, page 11102, "Three performance metrics are used to assess the efficacy of the model simulated monthly mean river discharge.": Can parameter criver be expected to have any sensitivity at a monthly time step given the river flow velocities and catchment areas of these three catchments?

TECHNICAL CORRECTIONS:

Line 16-17, page 11096, "intra-annual variability in mean annual runoff": This is a word combination contradicting itself.

Line 18, page 11097: "in" should be changed to "as".

Lines 20-21, page 11098, "which is calculated from moisture conditions in the soil profile": I would leave this out or modify because it seems rather obvious that the saturated grid-box fraction must be a function of (assumed?/calculated?) soil moisture conditions. Presumably, these "moisture conditions" are a modelled grid-cell average condition. If so, then please state this explicitly.

Lines 1-2, page 11099: "an exponent" should be replaced with "a parameter".

Lines 4-5, page 11099, "When the water table intersects with the land surface, saturation excess overland flow is produced.": This sentence seems redundant because lines 21-22 on page 11098 give the same information.

Line 1, page 11101, "discharge": I would either use the word "discharge" or "flow" (not both).

Line 18, page 11104, "TOP0.1": This should be changed to 'PDM0.1'.

Lines 20-21, page 11104, "This dry-season flow is absent in the PDM simulations.": This sentence might confuse some readers. Presumably, this sentence means that the simulated dry-season flow has negligible values. However, one might think that it means that the PDM model does not include dry-season flow.

Line 1, page 11106, "along with a": These words should be removed.



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Line13, page 11108: "produces" –> "produce"

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