Improving river flow generation over Great Britain in a land surface model required for coupled land-atmosphere interactions

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This study focuses on improving river flow generation in the land surface model JULES for 13 GB catchments. The authors perform a range of sensitivity analyses of alternative runoff production schemes and parameters to identify the best combination for representing daily flow and compare their results to a commonly used rainfall-runoff model. The study concludes that a mean catchment slope parameterisation produces the best result.

In general, the results are presented well and the work is a potentially useful contribution to improving river flow generation in land surface models. However, the paper suffers from two major limitations in its current form, (1) the tests are carried out at a small number of locations across GB, and (2) the wider applicability and novelty of the methods and results presented are poorly stated.

General Comments

Firstly, the title promises 'Improving river flow generation over Great Britain', however, this is tested at very few locations (13 catchments) across Great Britain. The model needs to be tested against a larger number of catchments to offer a robust test of the model, the scheme and parameters tested and ultimately, support the conclusions of the paper. It is difficult to see the wider applicability of the results (and how well they might perform across GB!) having such a small sample of catchments. Given the availability of a comprehensive flow dataset provided by the NRFA of over 1000 GB catchments, I found it surprising that the model was tested against so few catchments.

The selection of catchments also does not represent a wide diversity of catchments in the UK as the authors state. There are no drier catchments from the East of England, only one catchment with a high BFI (which gets excluded from some of the subsequent analysis as the model does not perform well in this catchment) and no catchments with a low BFI less than 0.3. There is a mix of both natural and human influenced catchments but then no discussion of what impacts this might have on the robustness of the results.

Secondly, I struggle to see the wider applicability and novelty of the methods and results presented. This is not well formulated in either the discussion or conclusions and so it is difficult to understand the relevance of your results to the wider research community. All of the discussion focuses on the improvements to be made to the JULES model. It is important that model improvement papers not only focus on the model in question but also what we can learn for improving similar models.

Specific Comments

1. The introduction and methods section need to have a clearer rationale for the choice of tests and sensitivity analyses undertaken in the paper.

2. There needs to be a better description of your choice of parameter ranges and number of parameters throughout the manuscript. For example, why choose 25 variations of the b shape parameter?

3. Why did you just use a naturalised flow record for Thames at Kingston? The River Severn at both the Bewdley and Haw Bridge gauges and the River Ock at Abingdon are both heavily influenced by human activities and will certainly affect your performance metrics and results. Does the model

include anthropogenic processes such as reservoirs and abstractions? If not, then why not limit your analyses to natural catchments?

4. It is really difficult to discern any differences between the observed and simulated flow in Figure 7. It would be better to plot a shorter time period so you can at least see how the model performs relative to the observed.

5. Table 1 – The authors list the catchment area of the Ock at Abingdon as 639km^2, whereas on the NRFA website it is listed as 234km^2 (see http://nrfa.ceh.ac.uk/data/station/info/39081). What is the reason for this discrepancy?

Page 9 L15 The authors also state that the spatial resolution (1km^2) may be too coarse to represent small catchments like the Ock. The majority of NRFA catchments are smaller than this 'small' catchment in the UK, so in this context I don't think it is such a small catchment. Can the authors comment on the applicability of the model to represent runoff in the majority of catchments in the UK?

Finally, I imagine that the reason for the discrepancy is probably more to do with the significant human influences (groundwater abstraction and recharge) affecting flows at this site rather than the coarseness of the model.

6. It would be useful to add the average annual rainfall totals to Table 1.

7. P11 L 23 'all flavours of JULES' does not make sense to me.

8. The spectral analysis felt a little redundant given all the other tests and is barely mentioned in the discussion or conclusions. I recommend removing this from the paper or better incorporating these results into the conclusions.