Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
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Comment on hess-2021-413

Anonymous Referee #2

Referee comment on "On constraining a lumped hydrological model with both piezometry and streamflow: results of a large sample evaluation" by Antoine Pelletier and Vazken Andréassian, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-413-RC2, 2021

General comments

The aim of this paper is to explore the added value of piezometer data besides using streamflow data for calibrating a lumped conceptual rainfall-runoff model, the GR6J model which is supplemented with a groundwater level simulation module in the manuscript. The authors investigate whether the additional piezometry information improves streamflow and groundwater level simulations in 107 French catchments. It is found that the additional piezometer data do not improve streamflow simulations, but the model is able to simulate groundwater levels satisfyingly well. Furthermore, the model parametrisation stability between calibration and validation periods also improved.

This is an interesting paper, the manuscript is well written, the results are presented in a clear way. The new module added to the original model and the use of additional information, not only streamflow data to calibrate the model which is extensively tested on 107 French catchments, furthermore, the presented recommendations in the Synthesis could be useful for the watershed modelling community.

A few comments addressing methodological and organizational issues, as well as minor technical corrections are listed below.

Specific comments

I understand the original version of the GR6J model does not simulate groundwater levels, i.e. a state which might be comparable with observed groundwater levels? In order to make use of groundwater level information, the authors added a new module to the existing model, i.e. two more parameters to represent the relationship between one of the model stores and the normalized groundwater level time series. I am not sure why this form in equation (2) was chosen? What is the physical meaning behind? Of course, the authors performed a correlation analysis between groundwater levels and the states of the different stores/reservoirs, and the state of the exponential store correlated the best with measured groundwater levels – still I very much miss the physical reasoning behind this choice and generally, the methodology and model itself.

On a very similar note, I was also wondering whether a generally good correlation between observed groundwater levels and the storages might have been caused by the choice/selection of catchments, i.e. those catchments were chosen where geology plays a dominant role in streamflow dynamics/runoff generation? – it might be good to see how well streamflow and the states of different stores are correlated with other fluxes and states, for instance precipitation, soil moisture, etc.

Generally, it would be good to add more physical reasoning to the manuscript, both in the methods and results and discussion sections. At the end of the results and discussion section, the catchments are categorised into 6 groups based on geological context, but the differences presented e.g. on Figure 17 are not explained in detail. Why can be streamflow/groundwater levels better simulated on one group than an other? What happens in reality in the catchments?

It is not mentioned whether the chosen piezometers are located on hillslopes or valley bottoms of the selected catchments – the groundwater level dynamics may be very different.

I am not sure if strong conclusions such as general recommendations for model calibration processes could be drawn based on the findings of this study? The choice of the model structure, and also the catchments (e.g. eliminating snow melt dominated, etc. catchments) may very much influence the results.

Considering Lines 170-181, the large variety of hydrological and hydrogeological configurations – I am not sure why the same model structure is used for each catchment or why it is expected that using additional data but the same model structure, streamflow simulations may improve?

The description of the methods could be probably slightly improved, in a way that the results could be reproduced, e.g. adding more details on selection of catchments, filtering low quality piezometer data, assessing groundwater level dynamics, calculation of potential evapotranspiration (please see detailed comments below).

Line 228: the authors argue that catchments with snow melt processes were eliminated from the study, therefore, no solid precipitation was simulated by the model. However, for certain catchments the maximum altitude is above 1000 m. How were these catchments handled? How was snow melt handled in these cases?

Figure 4: It might be good to explain the model structure or at least the names of the variables in the main text if these variables are presented on a figure in the main text instead of the appendix. For a reader it might be confusing jumping between the main text and appendix in order to understand the methods.

In case the authors decide to combine the Results and Discussion sections – it would be good to add further references to this combined section – how does this study fit into existing literature?

Technical corrections

-Generally: it might be good to use either present or past tense when presenting the methods, results, etc. – but not to mix the two.

-Line 8: Abstract: it might be good to add a few numbers, what does "satisfying performance" mean?

-Introduction (and also later in the manuscript): generally, it might be better to split very long sentences into more, shorter ones, this might make it easier for the reader to understand and follow the paper.

-Line 12: Subtitle – "low flow modelling" – the paper evaluates modelling of entire streamflow time series, including peaks, not only low flows – why are only low flows introduced here?

-Lines 15: "complex water cycle underground processes" – this expression could be maybe revised?

-Line 45: "consists of splitting streamflow…" (instead of consists in)?

-Line 85: computation costs might not be an issue in certain cases considering advances in computer sciences?

-Line 98: do the authors mean surface runoff/rainfall-runoff modelling studies, i.e. not most studies?

-Line 121: I am not sure what is meant by "but a visual evaluation of calibration is necessary"?

-Line 129: the meaning of this sentence is not clear: 1) it might be good to split it into shorter sentences; 2) what is meant by "in a catchment which few streamflow measurements" – do the authors mean "with few streamflow measurements"?

-Line 154: I am not sure, perhaps using piezometric information, streamflow simulations usually deteriorated?

-Figure 1: "N" in North arrow is barely visible; Bresse graben and Bievre moraine seems to have the same/very similar colour; it might be good to add longitude/latitude to the map; perhaps indicate in figure caption that 107 catchments are explored but this is a selection of 2 out of the 107 – maybe add why these two.

-Section 2.2 and generally: it might be good to write out all abbreviations/explain them (e.g. SAFRAN, INRAE).

-Line 200: RNESP is heritage national network for groundwater monitoring? If yes, it might be good to remove "-" twice or replace the second with a comma.

-Line 203: please explain on which basis these catchments were selected?

-Line 203: what is meant by "relevant"? Please explain.

-Figure 2: Hydrological maps? These seem to be geological maps or hydrogeological? Seno-Turonian chalk and Late Cretaceous multi-layer limestone seem to have very similar colour – is it possible to change this? It might be good to add a small map of France to this figure and indicate the locations of the sample catchments within France also on this figure.

-Line 211: please explain what "too low quality" means? Is there any objective/automatic way which was used to perform this step – a way readers can use to reproduce the results?

-Line 206: 10% of precipitation falls

-Line 208: how was the relative importance of hydrogeological formations assessed? Importance in/for what? Please explain in the manuscript.

-Line 220: how exactly were these dynamics compared? Please explain in manuscript.

-Table 1: does surface mean surface catchment area?

-Table 2: PET stands for potential evapotranspiration?

-Table 2: please add to the methodology section how potential evapotranspiration was calculated.

-Line 225: please replace "some" with "geographical and hydrological".

-Figure 3: black catchment boundaries are not visible on the map (due to symbols covering them).

-Line 246: this sentence seems to be incomplete.

-Line 248: available in R/available in R programming environment.

-Line 250: I understand solid precipitation was not simulated in the manuscript – if this is the case, this sentence might be confusing in the Methodology section.

-section 3.1.2: in the Methodology section please describe only that objective function/s which was/were used in this manuscript.

-Line 261: but which one was used in this manuscript? Please only describe/mention that one which was used.

-Line 264: an approach

-Line 267: Please add here which are these three, perhaps describe a bit these reservoirs (e.g. how they work, physical meaning, etc.).

-Equation 1: the term anomaly might be confusing – according to equation 1 – groundwater level time series were simply normalized?

-Equation 2: why/how was this form selected? Please add some explanation here (especially on the physical reasoning behind).

-Line 316: effect on what? Please explain.

-Section 3.5: please add exactly which years (how many years) were involved in P1 and P2?

-Lines 333-337: please split this sentence into more, shorter ones.

-Figure 6: top panel: are there values (below 0) which were cut off? If yes, maybe it is better to indicate e.g. in figure caption.

-Starting with line 350: this belongs to the Methods section.

-Line 350: please explain here what the authors mean by "differences between evaluation criteria distributions"?

-Figure 8: please add abbreviation shown on y axis title to figure caption as well.

-Figure 14 and 15: please add dimensions after each parameter, if one is dimensionless the authors may use "(-)".

-Line 383: "figure 15 does so" – please rephrase.

-Line 393: please explain what is meant by transferability?

-Line 401: please explain what is meant by "direct spatial pattern"?

-Line 403: "High scores" – please rephrase.

-Lines 406-408: please add why?

-Lines 409-416: please add more physical reasoning; and explanations why these results were found.

-Figure 16 caption: "square root"

-Page 23: this text belongs to the Methods section.

-Section 4.6: please add that these findings are for the specific case of using this model.

-Lines 461-474: this belongs to the Discussion section.

-Line 444-446: Please rephrase this sentence, it is very hard to understand.

-Line 448: what does probably mean? Did the authors reduce it or not?

-Line 455: "groundwater resource management anticipation" – I am not sure what this means, is it possible to rephrase?

-Line 475: what does particular conditions mean? Please add some information on this.

-Line 482: what does neutralised mean? Please explain.

-Line 484: does this mean that actual evapotranspiration is not calculated in the model?

-Section A1: it would be good to see dimensions in this description as well, so that the reader does not need to jump pages to check it in Table C1.

-Table B1: please explain here, e.g. in caption, what is search range, transformation and reciprocal transformation.

-Table C1: please add subsections, e.g. what is related to model, to optimization, etc.