

Review of paper HESS-2019-301

Title: Dynamics of hydrological model parameters: calibration and reliability

This paper presents a methodology for the estimation of parameter sets of hydrological models that vary in time. The main argument is that by considering the model parameters dynamic throughout different simulation periods, hydrological models can better represent the dynamic behavior observed in real catchments. The paper also presents a methodology to assess the reliability and performance of the optimization.

The authors apply the proposed method to three basins located in China, for which different sub-periods with different hydrological characteristics were previously defined (research done by the same authors).

In the following, I provide general remarks on this paper, and afterwards a list of more specific comments.

General comments

I find the work presented in this paper of relevance and major interest for the scientific community. Although the benefit of considering time-varying parameters in hydrological modeling has been highlighted in many publications, considering dynamic parameter sets during model calibration has not yet been given great attention. The topic discussed within this work fits the scope of HESS. However, the authors need to do a thorough proofread of the paper. Unfortunately, the grammatical errors, confusing sentences, redundant vocabulary and an erratic writing style, hinder the message that the authors want to convey, and in some cases render some statements ambiguous or even mistaken.

I conclude that this work cannot be considered for publication as it is. I recommend the authors to further work with the text and structure of the manuscript, and encourage to undergo a resubmission process. I would be more than willing to continue the review process once a new improved version of the manuscript is available.

Specific comments

For Section 2. Background

- The description of the previous research is poorly presented. I suggest merging *section 1* of the supplement with *Section 2 Background*, and include relevant information concerning the clustering method and the main results that led to the definition of the sub-periods in the three sub-basins.

In agreement with referee 1, I consider that the second objective defined by the authors shadows the first one. The suggested approach to assess the convergence performance of the optimization should be considered as a tool chosen by the authors, and not as one of the main objectives of the work. Still, the advantages of such an assessment tool over others should be emphasized.

For Section 3.1.1 Sub-period calibration schemes.

- Explanation of the sub-period calibration schemes is confusing, vague wording.
- I suggest adding at the beginning of the subsection a synthesized and general description of figure 2, guiding the reader through such a complex figure. I got the impression that the three arrows in figure 2b are related to the objective function, parameters, and state variables or fluxes

compartments of subfigure 2a. If that is the case, the alignment between figure 2a and b should be fixed. Ultimately, not sure whether subfigures 2b and 2c are really necessary.

- For scheme 2, how do the authors define which parameter is to be dynamic and which parameters are fixed throughout the calibration?

For Section 3.2.2 A tool for reliability evaluation.

- If the method to assess parameter convergence is designed specifically for SCE, I suggest to elaborate in the description of the theory behind SCE, otherwise is hard to understand how does the assessment tool really functions.
- Following the previous comment, I consider subfigure Figure 3c not necessary if SCE is not really explained in the text.