**Replies to Referee #2**

Dear Anonymous Referee #2,

Re: Manuscript #HESS-2019-301 entitled "Dynamics of hydrological model parameters: calibration and reliability".

We sincerely appreciate the referee is favor of the content of this research and the positive evaluation for its scientific significance. The Referee's constructive suggestions for *background*, *sub-period calibration schemes*, and *a tool for reliability evaluation* are helpful to improve this manuscript. Most importantly, we would make efforts to improve the text and structure of this manuscript. We are very grateful for your great patience on a new improved version of the manuscript.

We have carefully studied, considered and responded to all comments point-by-point as follows. For clarity, all comments are given in black and responses are given in the blue text. All the comments and suggestions have been replied below and will be addressed in the revision.

Yours sincerely,

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Professor in hydrology
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**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.

**Reply:** We greatly appreciate the positive evaluation for scientific significance of this study. With your constructive suggestions, the revised version will be greatly improved, especially in the presentation quality. Besides, the English will be corrected by a professional before submission of the revision.

**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.

**Reply:** We agree with the Referee's comment. Section 1 and section 2 will be merged in the revised manuscript. The relevant clustering method, the definition of the sub-period, and the main results in the study areas will be supplemented in the revised manuscript. Meanwhile, the parameter convergence evaluation (currently the second objective) will be regarded as a tool, and not as one of the main goals in this work. The detailed description in this topic will be moved to the supplementary materials.

*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 synthetized 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.

**Reply:** Thank you for the Referee's constructive advice. A synthesized and general description of the four sub-period calibration schemes will be added in the caption of Figure 2. We agree with Referee's comment that the subfigures 2b and 2c will be removed in the revised manuscript.

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

**Reply:** Thanks for the Referee's comment. For scheme 2, the parameters which are sensitive to dynamic catchment characteristics were usually chosen to calibrate the models. However, due to the complex correlations among the parameters, the individual parameter may not represent its defined physical characteristics. Hence, the most sensitive parameters were usually identified and optimized per sub-period, and the others are optimized for the entire simulation period (Merz et al., 2011; Me et al., 2015; Pfannerstill et al., 2015; Zhang et al., 2015; Deng et al., 2016; Guse et al., 2016; Ouyang et al., 2016; Deng et al., 2018; Xiong et al., 2019). Accordingly, the most sensitive parameter $K_q$ identified by the HYMOD application carried in the study areas was selected to sub-period calibration in this work. All related explanation will be clarified in the revised manuscript.

Moreover, considering the possible interference in calibration artifacts (Merz et al., 2011), all parameters in HYMOD will be exposed to sub-period calibration, respectively. The relevant discussion will be supplemented into the revised manuscript.

References:


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Zhang, D., Chen, X., Yao, H., and Lin, B.: Improved calibration scheme of SWAT by separating wet and dry seasons, Ecol Model, 301, 54-61, https://doi.org/10.1016/j.ecolmodel.2015.01.018, 2015.

*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.

**Reply:** We really appreciate your advice. The SCE-UA algorithm is a subset of global evolution algorithms (see Figure S1) (Duan et al., 1993; Hanne, 2000; Michalewicz and Schoenauer, 1996; Omran and Mahdavi, 2008; Storn and Price, 1997; Yiu-Wing and Yuping, 2001). The method to assess parameter convergence is designed generally for global evolution algorithms. The SCE-UA algorithm will be replaced by the basic concepts of generally global evolution algorithms, as shown in Figure S1. The more technical descriptions will be added to the revised manuscript. Moreover, the specific theories of SCE-UA algorithm will also be added in the supplementary materials.

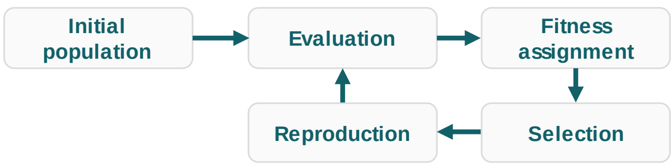


**Figure S1:** The basic cycle of global evolution algorithms.
***Note.*** Initial population: Create an initial population of random individuals; Evaluation: Compute the objective values of the solution candidates; Fitness assignment: Use the objective values to determine fitness values; Selection: Select the fittest individuals for reproduction; Reproduction: Create new individuals from the mating pool by crossover and mutation.

References:

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