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Interactive comment on "An integrated multi-fingerprint sensitivity-nested approach for regional model parameter estimation and catchment similarity assessment" *by* Simon Höllering et al.

Anonymous Referee #4

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I have to admit that I struggled for a couple of days to understand the message of this paper, and I am disappointed to say I failed to do so. My understanding is this paper is an amalgam of sensitivity analysis, parameter estimation and catchment clustering, however it is not well described how these approaches are linked together. Each of these elements, if performed elaborately, can be a separate paper and mixing them only confuses readers. Neither the abstract nor the introduction sections support the goals of the study. Well to be fair, goals are not clear either! Also I should mention that manuscript is not fluent at times. In my comments, I only focus on major flaws of the manuscript and skip my minor comments:

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Discussion paper

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I noticed there are several unsupported claims in the manuscript, one of them is “parameter estimation”. I can’t find how the parameter estimation is performed. It is not close to sufficient to consider the 91 parameter combinations from the sensitivity analysis and use a selection criteria based on some fingerprints of the catchment to select parameters as behavioral from this limited set. This would lose many behavioral parameter combinations, and doesn’t provide any information about the posterior distribution.

I might be wrong, but my understanding is that the sensitivity analysis of model parameters depends on a residual based objective function. At least it is highly dependent on simulation of the system response at individual time steps! This is in contrast with the purpose of using fingerprints of catchments, which are originally defined to constrain model parameters to represent an aggregate behavior of the catchment.

It is not clear how the selection criteria is adopted to delineate the behavioral parameter distribution. There are times that authors discuss one fingerprint is used, whereas in other instances they used a couple of fingerprints jointly! In the original application of fingerprints that authors referred to (Vrugt and Sadegh, 2013), 4 fingerprints were uses that are necessary to meet the acceptance criteria jointly. It is not clear if authors have performed their analysis on single sites (headwaters), or they have modeled the entire system altogether.

Page 2, line 32: My experience shows that, at least for US catchments, parameters of certain models are more correlated with climatic variables rather than soil characteristics. It is worth mentioning here, although the sentence is correct in how it describes the findings.

In section 3.3.2, authors talk about the study area before introducing it!

Page 6, Line 3: I don’t understand the sentence: “relate physiographic and climatic characteristics to sensitivity-confined hydrodynamic response fingerprints”

Page 10, line 7: Water is withdrawn from the system, it is not lost!

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Section 5.3: authors talk about consistency of behavioral parameter sets. In what sense have you analyzed the consistency of parameter sets? For definition of hydrologic consistency refer to: Martinez, G. F., and H. V. Gupta (2011), Hydrologic consistency as a basis for assessing complexity of monthly water balance models for the continental united states, Water Resources Research, 47 (12).

Page 15, line 25: In the entire manuscript authors are talking about 6 model parameters, and all of a sudden they switch to 52 global mHM parameters! It confuses me which one is the correct number of model parameters.

Page 16, line 26: Authors suddenly talk about temporal sensitivity of parameters! This is completely different from what reader expect from a joint sensitivity-parameter estimation analysis. The latter works with the entire data set, whereas the former is concerned about individual time steps!

Page 19 lines 6-16: Categorizing catchments based on model parameter assumes that the model is sufficiently describing the system. This assumption is not well justified nor supported by the results.

Page 20, lines 21-22: This is again unjustified claim to say this paper does: “(1) investigate hydrologically relevant structural and functional attributes in terms of consistency and feasibility in classifying similar catchments, (2) assess the value of functional constraints for the parameter spaces of distributed hydrologic models”. I am not convinced that the results of this study support these claims.

Figure 3 is not well explained in the text.

Figure 10 & 11: How is it possible to differentiate between model simulations of the two gauges?

Figure 12: Why four of the parameters and not all 6?

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