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Interactive comment on "A Robust calibration/validation protocol of a hydrological model using hidden Markov states" *by* Etienne Guilpart et al.

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We would like to thank you for carefully reading our manuscript and providing us with valuable comments. We please to invite you to read the first paragraph underlining the context in which the paper has been achieved. Then, you will find our point-by-point response to your comments.

Paper context: The work was supported by a project from the Food and Agriculture Organization of the United Nations (FAO) entitled SAGA "Sécurité Alimentaire: une Agriculture adaptée". In this project; we focused on the Senegal River basin. A complete modeling chain has been set involving climate projections, hydrological projec-

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tions, and hydro-economic modeling. The goal was to assess the relevance of existing and planned infrastructures (such as dams and irrigated areas) in the light of climate changes. Consequently, we developed this calibration/validation protocol for the hydrological model in order to produce hydrological projections. That is why the studied area was limited to the Senegal River basin.

Responses to your comments: (i) River discharges could be seen as integrative signals of all hydrological processes in the basin, and applying Pettitt's test or HMM classification on it leads to detect either climate segments or land uses switching. We completely agree that a comparison between Pettitt's test/HMM classification on river discharge and a climate variable (such as precipitation) would be relevant to distinguish climate sequences from land-use changes. In that sense, some "hydrological anomalies" (as mentioned in Savenije 2009) could be highlighted by a more formal process. However, this interesting point is not a part of the calibration/validation protocol stricto sensu, and we could consider adding a new section in the supplementary material to tackle it depending on the reviewer's comments.

(ii a) It is true that additional basins in another part of the world would permit better generalize the results of this study. As mentioned in the "Paper context" paragraph, here we limited our study to the Senegal River basin because this paper is a part of the large project SAGA. Also, even if we agree adding other illustration cases would bring more clearness to this paper, it is not strictly speaking our scientific mandate. (ii b) The section only focuses on the 1940-1998 period, which displays clear trends for each sub-basin. To underline the relevance of HMM classification in a not-clear trend situation, we added in Supplementary Materials two sections focusing on shorter periods (26 years long periods, 1945-1971 and 1972-1998). These results allow us to discuss the length of the period.

(iii) Please accept our apologies if, after careful reading, the main focus of this article has passed out of scope. The goal is to improve the robustness of the calibration/validation of a hydrological model by evaluating its performance under a large

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panel of climate conditions. Strictly speaking, that does not necessarily imply obtaining a better fit, but reaching NSE or KGE values for dry/wet or dry/normal/wet sub-periods, and thus getting an idea of the performance of the model under these conditions. So, we thank you for underlining this point, and we will clarify it according to the reviewer's comments.

(iv) Indeed, a full analysis of the minimum length for a period is not carried out. However, you could find in Supplementary Materials two sections dealing with shorter periods (as mentioned above). Please, let us know if these two sections could be considered as a minimal analysis to support the statement in conclusion, or a deeper analysis would be required.

(v) We particularly appreciate your careful reading, and we will proofread all the paper to check for the mentioned mistakes and for any mistakes.

Reference : Savenije, H. H. G.: HESS Opinions "The art of hydrology"*, Hydrol. Earth Syst. Sci., 13, 157–161, https://doi.org/10.5194/hess-13-157-2009, 2009.

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