Response to Reviewers' Comments

We appreciate the efforts of the reviewers and we thank them for their insightful and constructive comments. We have provided information points and clarifications as to how we will modify the manuscript accordingly below. We provide detailed responses to each of the reviewers' comments. For convenience, we put the reviewer comments in black font, and author responses in blue.

SC1 - Short Comment by Yves Tramblay:

1- I found this study really informative about the issues related to the choice of "observed" rainfall for hydrological impact studies of climate change. However, the regionalization approach considered here is barely described in section 3.2, when the results for 795 stations out of 1145 rely on this regionalization procedure. I am not aware of other studies attempting to regionalize the model parameters of the GR4J or HMETS models at the scale of Africa, so the results of this regionalization procedure surely deserve more than one sentence (line 202). In fact, I really believe this type of regional analysis would requires a study on its own.

Point well taken. We will add additional information on the regionalization process. We agree that this issue is worth a separate study and we just very recently submitted a paper dedicated to the regionalization aspect of this work. We will summarize the results of the second paper in the revised version of this one to get a better sense of the regionalization method performance.

2- What is the efficiency the regionalization methods tested in a cross-validation framework? Beside the spatial proximity, how are the "physical similarity" and the "multiple-linear regression" methods implemented? what are the predictors, since the authors only mention watershed delineation in the manuscript?

This is a good point, which is in line with the previous comment regarding the necessity of having a separate paper to go into this level of detail. The main results will be summarized in the revised version of this paper. To answer the question more specifically, the multiple linear regression method did not work very well, but the physical similarity performed similarly to (and in some cases better than) the spatial proximity method. These 2 "catchment-descriptor-based" methods used land cover properties (% grassland, % forest, etc.), mean annual rainfall, aridity index, mean slope and other such properties to identify the relationships between parameters and descriptors (or to find the most similar donors).

3- Another aspect is the presence of dams and reservoirs. Many African rivers are regulated and no mention is given in the data section 2.2.3 if the selected rivers are regulated or not. We recently released a large dataset or river discharge in Africa (https://doi.org/10.23708/LXGXQ9) and from the metadata it can be seen that about one third of the basins are regulated. It could explain the bad modelling results for some basins, since the hydrological models are not validated against independent data in the present study (line

182). It is likely that the modelling results with different satellite products can be impacted by river regulation in some basins.

This is a good point and one that we have chosen not to investigate in the paper. We have KGE values exceeding 0.6 for 75% of the catchments for the best-performing hydrological model which we took as proof of the absence of any major regulation. Most of the catchments with a lower KGE performance are in arid and semi-arid regions, where hydrological modeling is more challenging, and especially so for simple models like the ones used in this study. But clearly, it is certainly possible that the lower performance over some of the catchments is due to regulation. We could have done some homogeneity testing to try to detect changes that could be related to flow regulation, but attributing inhomogeneity to a specific cause is not always simple. Considering the optic of the paper, we don't think we need to start investigating this issue in details, but the potential issue of flow regulation should definitely be mentioned in the discussion. We will add a paragraph or two on this issue. Thanks for providing the references below, which we will also to support the problem of data scarcity over Africa.

Tramblay, Y., Rouché, N., Paturel, J. E., Mahé, G., Boyer, J. F., Amoussou, E., ... & Lachassagne, P. (2020). The African Database of Hydrometric Indices (ADHI). Earth System Science Data Discussions, 1-21.

Tramblay, Yves; Rouché, Nathalie, 2020, "ADHI: African Database of Hydrometric Indices", https://doi.org/10.23708/LXGXQ9, DataSuds, V2

4- Finally, I am a bit surprised by the figures 5, 6 and 8, you have river runoff over the Sahara Desert?

This is a good point that should have been mentioned. This will be done in the revised version. There is indeed little to no runoff on most parts of the Sahara desert, a consequence of little to no precipitation over most regions. But it does rain (and even snows in some very rare cases). Predicted runoff was highly intermittent but consistent with precipitation datasets. We checked satellite imagery for many catchments and all images showed some drainage patterns (unconnected at the regional scale) consistent with very sporadic rainfall. Figures 5 and 8 show the relative contribution to variance of each uncertainty source. The absolute variance is however extremely small over this region, so these figure should be interpreted with care over the Sahara.