REVIEWER #3

Request: *I have major concern related to the scientific novelty of this study. In L107, the authors motivate their study by the fact that the two-way coupled WRF/WRF-Hydro has not been tested for the River Rhine. I find this motivation too weak. Neither from methodological point of view, nor from the case study perspective I found significant advances in model development and application. The profound review presented by the authors clearly demonstrates that many other hydrological models have been previously setup and applied in the Rhine basin. Also, WRF-Hydro has been setup, calibrated and applied in many different catchments, though seemingly not in the Rhine basin. The calibration methodology seems to be based on a two-stage parameter adjustment across their plausible ranges. This sounds like a very standard procedure applied in many modelling study.*

Response:

Dear Reviewer,

We appreciate your comments on our manuscript and will answer them to provide a more in-depth view of our project.

It is apparent from your comment that the objectives and novel aspects of our study were not clearly formulated in the manuscript. We are focusing not only on testing the model in the Rhine basin but specifically to do so for drought conditions. As stated in the manuscript, the most common implementation of WRF-Hydro has been performed for flood events. Additionally, we include several novel aspects, like the use of spatially distributed parameters methodology using land cover (Rummler et al. 2017) for the infiltration scaling (REFKDT) and percolation factor (SLOPE). Additionally, we propose the use of the slope of the terrain from the DEM to establish different values of surface retention depth (RETDEPRTFAC) rather than uniform values throughout the basin. With this approach, we document that the methodology works for the Rhine basin and specifically for drought situations.

We suggest enhancing the current manuscript by highlighting in more detail the objectives and the novel aspects of the methodology that we are proposing, like the new approach for the evaluation of the parameter RETDEPRTFAC in a complex basin. Based on our knowledge, no publications have a similar approach to our project. In case the reviewer is aware of some studies with similar approaches, we would like you to point is to them, so that we can include them in the reasoning of the paper.

Request: *The fact that the lake scheme did not work properly and needs to be switched off is not deeply investigated and critically discussed. Why does it lead to poorer results? How can it be potentially improved? It is not sufficient to point out to previous studies that identified the same flaw.*

Response: Thank you for your comment. Finding an improvement model's lake scheme is not the objective of our project.. The model WRF-Hydro version 5.2, used in this study, has a scheme for lakes representing weir overflow. The formula in L284 gives the methodology to estimate the lake contribution to the channel grid. The equation considers a weir parameter, the length of the weir (set with the ArcGIS pre-processing tool), and water elevation at the time step. The less desired results result are the result of the increase in volume from upstream and its accumulation downstream. We have added a more in-depth description of the Lake Scheme in the comments of the other reviewers. Our suggestion for improving the scheme is the interactive lake retention approach.

We propose improving the description of the Lake Scheme from WRF-Hydro and including our suggestion for improving the scheme in the conclusions, which could be used as a starting point for another publication.

Request: *Overall, I am not convinced that this study presents a significant model advancement. Neither, it is clear what we can learn from the presented application. I regret to suggest the rejection of the manuscript. Maybe the authors could develop a more appealing test case for the Rhine basin and consider a journal focusing on regional studies, e.g. Journal of Hydrology: Regional Studies. Alternatively, a methodological improvement focusing on developing a more profound lake and reservoir scheme seems promising.*

Response: The purpose of selecting GMD as a journal and specifically modeling evaluation is because the Aims & Scope of the journal states that the type of manuscripts that they allow for peer review include "full evaluations of previously published models" which is the case for WRF-Hydro and what the content of our manuscript is. Numerous previous publications regarding WRF-Hydro have focused on flood events; we provided an approach adequate to model extreme drought in the Rhine Basin. Furthermore, we evaluated the methodology of using spatially distributed hydrological infiltration parameters using land cover (Rummler et al.

2017), and we propose the use of terrain slope to determine spatially distributed values of that water retention depth parameter, which has a direct influence on the channel routing scheme. Providing model advancements for WRF-Hydro, i.e., improvement of the lake scheme, can be a suggestion for another publication.

References

Rummler, T., Arnault, J., Gochis, D., and Kunstmann, H.: Role of Lateral Terrestrial Water Flow on the Regional Water Cycle in a Complex Terrain Region: Investigation With a Fully Coupled Model System, J. Geophys. Res.-Atmos., 124, 507–529. https://doi.org/10.1029/2018JD029004, 2019