Review for Parameterization of lakes water dynamics in the ISBA-CTRIP land surface system by Guinaldo et al.

Paper summary:
The paper describes new lake mass balance model component called Mlake and how the new module is integrated into the river routing model (CTRIP) coupled to ISBA land surface model. The paper also evaluated the developed model at 4 river basins across the globes and shows improvement of downstream discharges and lake level simulations compared to the observations.

Overall comments:

The descriptions of lake water balance model implementation into a river model for ESM fits very well in the GMD, model description paper. The lake water balance computation used in this paper seems to be more precise(account for lake-ground water interaction, separate treatment for surface runoff inflow and baseflow inflow) than other lake models even used for global hydrologic models. So, particularly for the ESM, I think it is substantial advancement of model process representations. Simulated impacts of lake parameter (i.e., outlet structure parameter) on the lake level and downstream discharge seems to be reasonable and discussed well. Figures showing results are also clear overall. My main concern is a lack of conciseness: the paper can be shortened by textural editing as well as by cutting some materials. More importantly, I feel the authors need to polish the descriptions throughout the paper. I put a few science related comments following numerous minor editorial comments I found as I read.

The authors would like to thank the referee for the time allocated to the detailed revision of this paper and her/his positive comments about our work that help us to come up what we believe is an improved version of the manuscript. Our point by point responses to the reviewer comments are below in blue.

Specific comments:

•P29-L920: This might be typo, but KGE expression seems to be incorrect. Standard KGE (Gupta et al., 2009) is a distance based on correlation(r), ratio of standard deviation (alpha) and mean ratio (beta). Modified KGE (from Kling et al. 2012) uses ratio of coefficient of variation (gamma) instead of ratio of standard deviation(alpha).In my opinion, KGE is convenient for model calibration since KGE aggregates three metrics into one, which allow modelers to use a single objective (target metric) to optimize the model, rather than multi-objectives, but for just model evaluation, KGE (aggregated metric) itself does not mean much(what aspects of time series the model simulate better or worse). Since table 6 compare Qs/Qo and sigma_s/sigma_o, I would suggest adding correlation and removing KGE.

Thank you for raising this point. We agree with you about the KGE expression and we have changed it accordingly. The modified KGE expression was used in the evaluation thus, the description is now corrected.
We also understand your concern about using KGE. This score have been replaced by the correlation in Table 6.

•Section 2.3.2 and 2.3.3 seems be a crux of the paper (descriptions of lake implementation strategy), and therefore need to be clear so reader can understand how exactly the lake are implemented in the network. Unfortunately, I am having hard time following section

2.3.2 after I read through several times. So,I feel I need to request the author revise this section drastically. Section 2.3.3 is described well.

The section has been modified as well as Fig. 3 and Fig. 4. The latest versions of the figures are now more readable and show the step described in the paragraph 2.3.2

•P22, L717: I found this (sub-grid variability of lake levels for a large lake) is interesting discussion and may be important. Impact of such lake sub-grid variability on downstream discharge is described in L725, but not clear and would be nice to see a little more elaboration on this. For even larger lakes (e.g., Great Lakes), the lakes should be represented by a number of grid boxes, and make individual grided lake interact each other?

We agree on the need to modify the clarify of this section. As proposed by Referee#1, we have separated a sub-section with the title "lake internal dynamics". Regarding the discussion point on the sub-grid variability, the following paragraph has been added:

P.22, L695:
" One of the easiest approaches could be to also take into account simple bathymetry in order to characterise a distributed water layer. Modelling could also benefit from observations datasets. As was done for lake Geneva, these gaps could be overcome by gathering data from several measurement sites along the lake shore, but this depends on the data availability. Over the long-term, comparison between modeled and observed water levels could be improved by valuable satellite data as proposed in the Surface Water and Ocean Topography (SWOT, Biancamaria et al, 2016)."

Editorial comments:

•Throughout the paper: The authors use "resolution",instead of "solution", which I would suggest using (e.g., numerical solution, not numerical resolution). Using "resolution" to mean "solve an equation or something" be confusing since "resolution" is also used for grid box sizes and vertical resolution of soil layer, snow layers

Thank you for raising this point. We agree that a mismatch has been made between the two definitions. We corrected the manuscript to include the appropriate wording (see L.150, L.205, L232, L236, L385, L388).

.•Throughout the paper: I know this may not be critical issue...but I feel the paper uses "scale" carelessly. "scale" is the characteristic length (space and time) of processes, modeling and observations (see Blöschl et al., 1995: https://onlinelibrary.wiley.com/doi/abs/10.1002/hyp.3360090305). For example, "global scale model" used throughout the paper means globe is the characteristic length of modeling, but it really means global domain model and scale used for model should be smaller.

The comment is justified since scale usually should correspond to some specific time (diurnal, decad, month…) or distance (mesoscale, beta, micro, kilometric etc…).
the authors went throughthe manuscript and made sure each time that the word "scale" was mentioned, some distance or time dimension/unit was attached to it.

Also we added this text (below) at the beginning of the manuscript in order to better describe what are we referring to when referring to scale:

L.185.
"In this study, we refer to CTRIP as a global scale model meaning that it is a 1/12° degree resolution model applied to areas ranging from large basins to a domain covering the entire globe."

•Title: SURFEX v8.1 is the name of land surface model platform, but here, should lake model component name and version be in title. Here, is MLake name?

The names of the model version and the land surface model platform were added in order to respect the GMD specifications since Mlake is intended to be included in the latest SURFEX version. At the moment, there is no mention of a version for the lake model. However, the name of the lake model should be added to the title, thus we propose:

Proposed title: "Parametrization of a lakes water dynamics model MLake in the ISBA-CTRIP land surface system (SURFEX v8.1)"

•P2, L44-46: I feel this sentence is really opening sentence. Descriptions priors to this sentence seem to be little related to the topic in this paper.

Referee#1 raised the same issue. Thus, we deleted the first paragraph and changed the opening sentence with:

P.2, L28
« Only 2.5 % of the total water mass of the planet is defined as fresh water, and only a very small fraction is directly accessible for human consumption (Oki and Kanae, 2006). Lakes are of fundamental importance to ensure freshwater supply to the 800 million people which have insufficient safe drinking water, according to the World Health Organization (WHO, 2010; Marsily et al., 2018).»

•P3, L65: Suggest adding references .Climate change impact on Lake Chad has beenreportedin publication (https://www.nature.com/articles/s41598-020-62417-w)

Reference added: "Pham-Duc, B., Sylvestre, F., Papa, F., Frappart, F., Bouchez, C., and Crétaux, J.-F.: The Lake Chad hydrology under current climate change, Scientific reports, 10, 1–10, 2020."

•P3, L70: Suggest changing runoff -> discharge. e.g., lowering inter-annual and seasonal variability of downstream discharge?

The sentence has been changed.

•P3, L95: "General Hydrological Model" -> Global Hydrological Model?? If not, what does General Hydrologic model mean?

It is a mismatch between General Circulation Model and Global Hydrological Model. We changed the sentence to say 'Global Hydrological Model'.

•P5, L136: Awkward description. Suggest removing this.

We agree this paragraph is not essential and therefore we have removed it.

•P7, L214: main driver -> main motivation?

This has been corrected

•P8, L258: what does "component" mean here? I believe it is lake, but please be specific.

This has been corrected
P8. L244
"However, integrating a lake which can cover more than one grid cell in the CTRIP river networks is not straightforward"

•P8, L272: "dynamic close to a lake". Not clear to me.

This has been corrected as:
P8. L259:
"In some regions, the river stretch can be large and thus the streamflow time response remains slow which can be close to the response time of a lake"

•P8, L273: "lake hydrological dynamic". Sounds awkward to me.
This has been corrected as:
P9.260
"Consequently, finding a compromise between the lake spatial extension at different resolutions and
the actual lake water dynamic is important"

•section2.2: this section provides brief description of Flake model, which simulates energy balance in lake (my understanding), and lake evaporation is a part of the energy balance. I feel header should be "Flake model: lake energy balance model". This way, consistent with the following section (Mlake)

The sub-section title has been added.

•Section2.3.4: I am not sure about importance of this section. Figure 7 could follow more conventionofflowchart(https://en.wikipedia.org/wiki/Flowchart). I wonder if this section (after shortened) could be moved to very beginning of section 2.

In accordance with your comment, this section has been shortened and moved to the appendix section as it is useful to understand how the program works which we understand is within in the scope of GMD publications.

•P22, L719: "uni-dimensional" -> one-dimensional.

This has been corrected

•P22, L724: "fast time variations of the river discharge". Not clear phrase. Please consider describing different way.
Proposed sentence:

P.22, L.690

"Observed height differences over lakes can reach several meters from one shore to another depending on the wind stress and the distance of the fetch among other factors, and consequently this can influence the relatively high frequency variability of river discharge"

•P25, L798: "a unique composite energy budget for soil and vegetation". Does this mean control volume for energy budget computation is combined of soil and vegetation (not separate)?

The idea is correct. The default version ISBA/SURFEX used for this study uses a composite soil-vegetation layer for the non-snow covered surface energy budget, while an explicit snow scheme is used for the snow surface energy budget. This version has been the standard version in recent years for both hydrological studies and for our fully coupled CMIP6 global climate simulations. A more recent version has been developed which separates the soil from the vegetation but it was not finalized (fully evaluated) at the time this work was performed. But as mentioned in the conclusions, this version will be used in the future with the lake module and is expected to have an impact essentially in high latitude forest-dominated basins. But this will not impact the formulation of the lake model presented herein nor the conclusions of this work.

•P26, L834-836: this paragraph sounds out of place in this section (simulation sensitivity to lake outlet width)

A sub-section has been added in order to keep this discussion part consistent with the rest of the section.

•P27, L842: "has been conducted" -> use past tense?
This has been corrected

•P27, L842: "four river networks" -> four river basins?
This has been corrected

•P27, L865: "monitoring" -> monitor.
This has been corrected

•P27, L867-869: I would suggest moving this sentence to the end of the paragraph (replace the last sentence with this). Eventually we would like to see the effect of lake bathymetries on lake levels, downstream discharge across the globes.

Last sentence of the paragraph has been replaced by the following sentence:
P27.L852
"All this advocates for results to be extended to the global scale in order to characterise the systemic improvement for an ensemble of climate and physiographic conditions."

•P28, L878-L879: I would suggest adding references. Some groups have done some work on reservoir operation schemes, e.g., Hanasaki et al., 2006 JH, Shin et al., 2020 WRR.

The references have been added and the sentence has been modified as:

"Numerous studies have been focused on such developments (Hanasaki et al., 2006; Zhou et al., 2016; Busker et al., 2019; Shin et al., 2019) and on-going research is focusing

on creating a global reservoir system that will be added to MLake to improve the representation of dam operating rules."

•P28: Appendix header is missing?
This has been corrected.

•Figure 11. Add y-axis labels

The y-axis labels have been added to the figures.