Dear Reviewer 2,

Thank you very much for taking the time to review our manuscript. All your comments received were very helpful to improve the paper. We have responded to all the comments below. We believe that all your concerns have been now addressed.

Best regards,
Naota Hanasaki (on behalf of authors)

Hyper-resolution global water resource modeling is important for provide locally relevant information (e.g., water stress) for the public and policy makers. However, the lack of precise data (e.g., forcing, flow directions with the consideration of facilities, local scale water consumption, local scale dam operation rules and etc.). Hanasaki et al., provide a successful example of high resolution water resource modeling by using the global water resource model. The paper is generally well written, but I still have some major comments before its publication in HESS journal.

Thank you for your positive evaluation to this paper.

Major Comments:

The added value of high resolution meteorological forcing, high resolution hydrological and geographic data (e.g., flow direction, agricultural area, domestic water withdraw) and model improvements (e.g., improved crop classification, new aqueducts scheme) are not clear currently. Although the author discussed this issue in the results and discussion, for example "We speculate that the difference in performance between the two simulations is due to the quality of precipitation data" in L367. I suggest to separate the contributions from these three different factors to make it more clear to the reader that which is the most important for the improvement in high resolution modeling. Sensitive experiments such as "only use high resolution meteorological forcing", "use both high resolution forcing and hydrological data" can be conducted to address the above issue.

Thank you for your suggestion. We agree with you that the improvements in simulation performance should be attributed to individual factors. Taking the advice by Dr. Luka Brocca (Community Comment), we conducted and analyzed a sensitivity simulation as shown in newly added Appendix C. The results clearly support our claim in the line 367 of the original manuscript. Please see our response to Dr. Luka Brocca for further details.

The inter-grid-cell connection for groundwater. The author give a comprehensive discussion on the challenges of high-resolution modeling and have noticed the importance of inter-grid-cell connection (e.g., the aqueducts and water supply). However, the subsurface or groundwater lateral flow which is important at high resolution is not discussed (Ji et al., 2017). I am wondering whether the H08 model has considered the lateral transport of groundwater from the adjacent grids to the gird which experiences extensive groundwater plumping? If not, whether this process, that is important in hydrology science, lead to uncertainties to the water resource assessment?

Ji, P., Yuan, X., & Liang, X.-Z. (2017). Do Lateral Flows Matter for the Hyperresolution Land Surface Modeling? Journal of Geophysical Research: Atmospheres, 122(22), 12,077-012,092. doi:10.1002/2017jd027366

Thank you for your suggestions. We totally agree with you that lateral groundwater flow is not negligible in hydrological simulations at 1-2 km spatial resolution. From the viewpoint of water resources, it influences the availability of groundwater. Unfortunately, the process is not included in the current H08. To our knowledge, none of the global water resources models (i.e. the global hydrological models including human activities in rich) are able to deal with this flow. Exceptionally, some models offer an option to combine with independent groundwater flow models (e.g. PCR-GLOBWB and MODFLOW; Sutanudjaja et al. 2018, CWatM and MODFLOW; Burek et al. 2020). We have renamed "4.3.4 Other factors" to "4.3.4 Natural hydrological processes" and intensively discuss the uncertainty due to natural hydrological processes. The section now reads as follows.

While this study has mainly focused on the processes of water use and management, natural hydrological processes also need to be further improved. Snow falls only in limited mountainous areas of Kyushu Island and, therefore, the performance of snow process estimation was not evaluated in this study. Groundwater is expressed in highly conceptual way in H08 (treated as a hypothetical tank) which hampers the validation of groundwater simulation. As for the lateral flows of subsurface water, Ji *et al. (2017) reported that they matter to the distribution of soil moisture and evapotranspiration at the spatial resolution of 1000m and finer. The inclusion of the process is crucial particularly in the regions where groundwater is the major water source. As such, the dominant hydrological processes differ region by region. Further application and investigation of the model under various environment is indispensable to fully realize globally applicable hyper-resolution modeling.*

The author review the Wada's work which found "water stress is unrealistically concentrated in grid cells containing the downtown areas of the largest cities (e.g., Paris, New York) and therefore recommended assessment across larger spatial domains, such as sub-basins and counties." While current work wants to assess the water stress at 2 km resolution or even higher resolution in the future. How do you consider or address this unrealistic phenomenon shown by Wada et al., (2016)? Moreover, the author pointed out that "Thus, water scarcity may be underestimated in major cities in this simulation..." this seems to be contrary to Wada's work. Detailed discussions are needed.

Thanks for these important questions. As for the first question, we have resolved the problem by introducing the concept of inter-basin water transfer. The key problem of the approach of Wada et al. (2016) is that the water withdrawal and water use occurred in the single grid cell. Now this study introduced the implicit and explicit aqueducts which allow water withdrawal from surrounding grid cells where water resources are abundant. To make our point clearer, we have added the following text at the beginning of "4.3.3 Municipal water systems".

In this study, we have introduced the implicit and explicit aqueducts which allow water withdrawal from surrounding grid cells where water resources are abundant. This is particularly important for urban areas where municipal and industrial water is highly concentrated. Although improved compared to earlier approaches (e.g. Wada et al. 2016), which assumed water withdrawal and use occurred in a single grid cell, there is still room for progress.

Our direct answer to the second question is that we should eventually include anthropogenic water network (i.e. water treatment plants, water pipe and sewer pipe network, and wastewater treatment plants) into the model. Since our intension was unclear in the original text, we have added the following sentence at the very last part of "4.3.3 Municipal water system".

This problem will be largely solved by including waterwork facilities (i.e. water treatment plants, water and sewer pipe network, and wastewater treatment plants) into the model. This will make the simulation more realistic in terms of representation of the urban water scarcity problem.

On the difference of using global and local water resource model. The author said that data localization and model localization are important for global high resolution hydrological modeling. As I am not expert at water resource modeling, I am confused that what the difference between high resolution global modeling and high resolution regional modeling? If the difference is due to the input data (e.g., forcing, reservoir operation, water use data), then what the difference between the following pathways: 1. use global water resource model, 2. use regional models (e.g., SWAT) and apply them at all global catchment.?

Thank you for this interesting question. We speculate that eventually the results of a high-resolution global model and those of a regional applied to all basins in the world will become indistinguishable. We also suppose, however, the difference in procedure and concept between two models could remain long. The global models (including H08) are designed to apply globally even if input data were insufficient or details of processes were unknown. Hence the simulations tend to be model-oriented, relying on universal physical or empirical (statistical) relationship to estimate various fields uniformly. On the contrary the regional models (e.g. SWAT) are designed to apply the basins where fundamental input/validation/ boundary condition data are available. Hence the simulations tend to be data-oriented, utilizing parameter estimation techniques.