Reply to RC2

The paper presents a graphical representation of global water models that aims to simplify model communication, both for a non-technical audience as well as for technical model users. The paper focuses on ISIMIP 2b models, creating a "reference" model that is a superset of all the ISIMIP 2b models. The authors briefly describe the process that they followed to arrive to this graphical representation, they describe and explain how to use it. They also mention an open-source tool to create versions of this image.

The paper presents an interesting "tool" to communicate the main characteristics of global water models. A graphical representation may simplify the process of comparing different models, so making it easier to grasp where differences may appear and what experiments may be required to fully understand modeling choices. It may also be interesting to a broader audience, that may find a hint of which effects may be at play when interpreting the results of one of these models. In this regard, the paper is very interesting. I believe that it may deserve publication in GMD.

However, I have some comments that I would like to see answered -or implemented when possible- before publication.

Answer: Thank you for your time to review the manuscript and for providing your comments and suggestions. We will reply to the referee comment, indicated by **RC2** (in black)**,** by our answer indicated by **Answer** (in green), and corresponding actions, indicated by **Action** (in blue) and textual changes in *italic font*:

RC2: 1) I wonder how general the framework is and if it could not be applied to "almost" any water or hydrological model. I understand that ISIMIP 2b models were the reference, but the authors mention that adaptations may be required for ISIMIP 3 models, and also, many hydrological models could fit into the framework. A more clear discussion on this topic would be appreciated, since I believe the framework may be more general, but I may be missing some limitations.

The framework being fully general may be an argument for having the paper published in GMD. If its generality is more limited, it may require a more clear statement of the limitations. In a sense, what I may be missing is a clear characterization of the framework, testing it with models outside of the ISIMIP 2b experiment: what else would be necessary to capture other models?

Answer: Thank you for elaboration on the general usage of the framework. We believe that the process and experiences that led to the framework and its corresponding graphical representation could be of value to other hydrological modellers, and even other modelling communities outside of hydrology, e.g. crops modelling. However, we do not claim that the graphical representations (e.g. the background image and the considered components of the water cycle) are so general that it can be directly used for any water / hydrological model. For example, our framework will not work with black-box models. We followed specific ISIMIP nomenclature and foci of ISIMIP, e.g. the representation of specific direct human impacts, e.g. water use sectors as defined in the modelling protocol, which means some processes (like river meandering, avalanches, and protection afforded by levees) are missing - some models not operating within ISIMIP include such processes (e.g. LISFLOOD-

FP). We acknowledge that the underlying image behind the JSON-file would need updating to include such processes. The JSON tool provides a very useful starting point, however, and it would mean that a new modeling team in other sectors (e.g., crops) would not have to start from scratch if they wanted to create a visual representation of their model.

We agree that testing the JSON-tool with models outside of ISIMIP2b would be an interesting exercise. However, this would require an extensive communication process with other modelling communities/modelling groups, which would be an entirely new (and interesting) paper. Having had the experience of a long and intense interaction/discussion within the ISIMIP global water community to get to this stage, we do not intend to test the applicability of the JSON-tool to other models quite yet. This is beyond the scope of the current paper, but it would make an extremely interesting follow-on paper down the line, which we will keep in consideration. Nevertheless, the JSON-tool can be used and adapted freely, and we would like to see other modeling groups test the applicability of the tool for their own model.

Actions: As mentioned in response to comment #1 of RC1 we will provide much more details about the process that led to the graphical representation. Furthermore, we will discuss more broadly the experiences gained during this process and provide some recommendations for repeating the process.

RC2: 2) Related to the previous point, I would have appreciated a more detailed methods section. This paper's may have been a "naive" approximation to solving the problem, since the authors mentioned that other professionals should have been included in the effort earlier in the process. However, I believe the methods section does not present a structured procedure to follow. I am thinking about other communities of modelers that may be interested in doing something similar. They would not be able to learn much from the current description of the methodology in the paper.

Here, I believe that the best approach would be to describe the methodology estimated to be the best after the fact, and then clearly indicate where the actual methodology differed from the suggested one. Such a description may also serve for scientists in other fields (not necessarily technical) to suggest improvements or modifications that may expand the methodology further.

Answer: Thank you for the comment and for the opportunity to enhance the paper so that it can be of greater value to other modellers who might like to replicate what we have done here. Indeed, the whole process, or the study-design from beginning to the finalization of the diagrams, was not specifically pre-designed. Instead it was an organic and iterative community-based effort that was adapted many times as the project evolved. It was initiated and maintained by (a group of) key modelling persons (who also changed over time). We understand that the approach appears "naive" without such a specific pre-design, e.g. we did not recruit a social scientist to document the process formally or to design the discussion sessions. On the other hand, this has been an incredible and very valuable learning experience for the many modellers that make up this community and we are proud of what we have achieved with the diagrams. We agree that the submitted manuscript lacks details on the process, partly as this was not the primary focus of our endeavors, rather the focus was on creating the diagrams. But your comment, and also comments of Referee #1 have

encouraged us to describe the whole process in much more detail to provide recommendations for similar efforts by other researchers.

Action (identical to RC1 major comment #1): We describe the whole process in much more detail. This includes a generation of a visual time-line with milestones (e.g. conferences/workshops), meetings, interactions of the steering group with the graphics designer, stakeholder interactions, review rounds of diagram drafts and brief summaries of the results of each interaction round, but also of the manuscript. It also includes information, which software has been used for the different parts of the discussion. We also would like to provide at least some of the diagram drafts in the Supplementary material to document the development. Furthermore, we further elaborate about some of the difficulties that arise when so many modeling groups and persons/opinions arise. That also includes some metrics as numbers of groups per model involved, and in particular difficulties when responsible persons change positions over time or leave academia. We believe that this information and shared experience will be helpful for other communities that intend a similar activity.

RC2: 3) I was surprised that the code that the authors made available to generate this graphical representations receives such little attention in the manuscript. Obviously, if the framework is less general than what I think, it may make sense to just present the results for the models of ISIMIP 2b, but if it is more general that that, explaining how to use it would be a nice inclusion on the paper or at least in the GitHub repo. As it stands now, the repo is not very user-friendly.

Answer: Thank you for this comment and encouragement to improve the usability of the tool. The development of the tool itself was not intended from the beginning. However, it became necessary at a later stage of the process for a very practical reason - when the funding for the graphics designer ran out, we still had to make several refinements and edits to the diagrams and we had to do this ourselves (as modellers and not graphics designers). Thus we developed the JSON-tool to enable us to make the edits to the diagrams. However, based on your comment and the corresponding comment #3 of RC1, we believe that such a tool can be helpful in a model component visualization process, in particular to focus the dialogue with the graphics designer and the overall design but keep the discussion of the details (e.g. which component is greyed out for a specific model) to the users of the tool. Indeed the tool is a bit cluttered and e.g. position arguments are hard-coded which is a bit unhandy and the repo is not too user-friendly. The main intention was to enable reproducibility of the figures, but we fully agree that the tool can be better integrated.

Action: We better document the JSON Tool (within the code and in the readme file) and improve readability. Furthermore, we add the intent of the tool generation into the process description. Finally, we reflect in the recommendations how such a tool can be reused for similar exercises.

RC2: 4) I am not sure that including all the images as an appendix makes sense. As supplementary information it may. I believe that presenting the framework and a couple of examples should be more that enough for the paper.

Answer: Thank you for the suggestion. We do not intend to highlight one or the other model and thus put all individual models (from Figure A1 onwards) into the Supplementary material.

RC2: Some minor comments follow:

RC2: 1 The first sentence of the introduction is a bit complicated (I am not a native English speaker). I would say that rephrasing it would help the readers get into the paper.

Answer: Thanks.

Action: We rephrase this text from "Graphical visualizations (simply referred to as diagrams hereafter) of the water cycle are essential for communicating the system, for researchers, in education, for water management, policy-related processes, and in general for science communication (Linton, 2008; Abbott et al., 2019; Cardak, 2009; Fandel et al., 2018). For example, Linton (2014) showed that the development of such diagrams is associated with an increasing awareness of the social dimensions of water. Some of the water cycle diagrams received much attention in the scientific context, for example the visualization of the terrestrial water balance including model-based quantifications of global fluxes and storages from Oki and Kanae (2006)."

to:

"*Graphical visualizations, or more simply put, diagrams, are essential communication tools in science. They are helpful for researchers, in education, for management, and policy-related processes (Linton, 2008; Abbott et al., 2019; Cardak, 2009; Fandel et al., 2018). Here, we focus on diagrams of the water cycle, as it is represented in a set of global-scale water models. Linton (2014) showed that the development of water cycle diagrams is associated with an increasing awareness of the social dimensions of water. Some water cycle diagrams have received much attention in a scientific context, for example the visualization of the terrestrial water balance including model-based quantifications of global fluxes and storages by Oki and Kanae (2006).*"

RC2: 2. Line 124: I would write greying out together, before the parenthesis. As it currently stands, it is difficult to know why the out outside fo the parenthesis is there.

Answer/Action: Thanks, we will modify as suggested

RC2: 3. Line 208: The reference to "Telteu et al. (2021)" should be better included in the text or included in parenthesis.

Answer/Action: Thanks, we will modify as suggested

RC2: 4. Line 253: Same comment as before.

Answer/Action: Thanks, we will modify as suggested