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River network and hydro-geomorphology parametrization for global river routing modelling at 1/12° resolution

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Author response to reviewer #2

Reviewer comments are in italic and blue font.

This manuscript describes about the new river network data for river routing models. The new data is developed using the latest river topography dataset MERIT Hydro, and its accuracy is assessed using various river-related datasets as well as model simulations using CTRIP. I think the manuscript contains adequate description as a data paper, and the estimated accuracy is promising. Given that the river network map is a widely used fundamental information in many hydrology and earth system science studies, I think the manuscript is worth publishing on ESSD, after minor corrections on a few ambiguous parts.

We would like to thank the reviewer, Dr Dai Yamazaki, for his valuable comments on the manuscript. We also think that not only the river network map could be useful for hydrology and earth system science studies, but also all the associated hydro-geomorphological characteristics since they are consistent with the derived river network, which could hardly be the case if they are provided by different sources. Bellow are the responses to all the comments raised by the reviewer.

L68: "some recent studies provide new upscaled river network based on MERIT-Hydro (see, e.g., Eilander et al. , 2021), they do not necessarily follow a D8 convention, and they do not provide model parameters consistent with the new river network (such as sub-grid topography)."
Please carefully review the paper Eilander et al. , 2021. Their IHU method also generated D8 format river network, and it also provide some sub-grid topography info. Thus, some descriptions in this sentence is not correct.

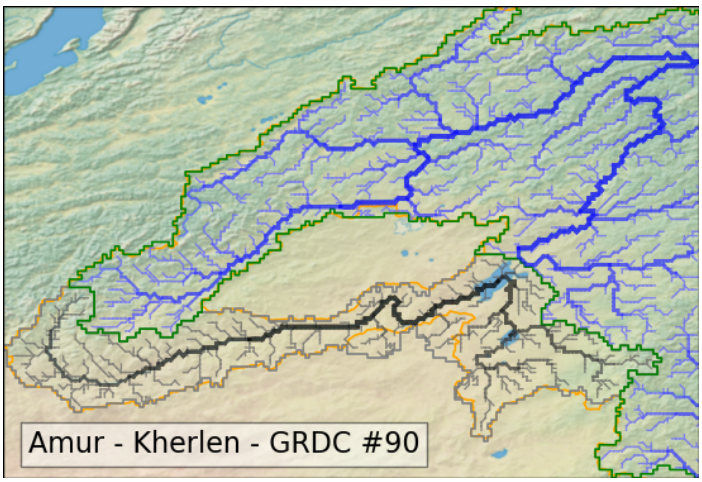
We thank the reviewer for this relevant comment. Indeed, Eilander et al. (2021) derived river network in the D8 format based on MERIT-Hydro using a somehow different upscaling method (IHU). They also provided river length and slope sub-grid parameters consistent with the upscaled river network since they are derived from MERIT-Hydro during the upscaling process. So we agree that our sentence is not correct. It has been rewritten as:
"Although some recent studies provide new upscaled river network based on MERIT-Hydro (see, e.g., Eilander et al., 2021), only a limited set of hydro-geomorphology parameters consistent with the new river network have been derived (such as sub-grid river length and slope)."

L191: "The automatic algorithm of MERIT-Hydro chose the outlet that flows into the Nelson River basin."
Development of MERIT Hydro was done with extensive quality assessment, and some input data such as water mask and elevations are modified to ensure realistic river network. Thus, it is not proper to say "Nelson river is chosen as mainstem by "automatic algorithm". Rather than that, the developer of MERIT Hydro decided that Nelson River to be the major outlet of the South Indian Lake, considering the existing diversion project.

We agree that this sentence is confusing. Indeed, in the case of the South Indian Lake, a significant part of the water volume is diverted from its original path, the Churchill River, to the Nelson River for water management purposes. Simplified river networks, such as those following the D8 format, are not able to represent such diversions, and it is to the developer to decide whether to conserve the natural flow path or not. Whatever this decision, the performance of river routing model will be limited on both basins if river diversion is significant. More complex models will have to be developed to handle this kind of situation. The sentence has been rephrased as suggested by the reviewer:
"The developer of MERIT-Hydro chose the Nelson River to be the major outlet of the South Indian Lake, considering the existing diversion project."

L203 Fig. 8
Probably it is better to explain that how to treat Lake Hulun is the source of the difference. Lake Hulun is usually an inland lake without outlet, but it is connected to the Amur in flooding year. Whether to include Lake Hulun in Amur basin or not highly depends on the developer's decision.

The reviewer is right, the main source of the difference between the river networks is the way Lake Hulun is treated. The following sentences have been added at the end of the previous paragraph, and the cause of the differences in Table S1 has been modified accordingly:
"Another noticeable difference can be shown in the upper Amur River basin (Asia) in which the Kherlen River appears disconnected to the Argun River, a tributary of the Amur River, while both are connected at Lake Hulun in the GRDC database. Lake Hulun is usually an inland lake without outlet, but in wet periods it may overflow and then join the Argun River (Brutsart and Sugita, 2008). As for the South Indian Lake, the developer of MERIT-Hydro preferred to keep them separated, which is reflected in the 12D river network."
Brutsaert, W., and Sugita, M. (2008). Is Mongolia's groundwater increasing or decreasing? The case of the Kherlen River basin. Hydrological sciences journal, 53(6), 1221-1229. doi:10.1623/hysj.53.6.1221



Amur-Argun-Kherlen River System. The Amur river network is drawn in blue, the Kherlen River in black, while their boundaries are in green and grey, respectively. The orange line represents the basin boundary of the Amur River basin from GRDC.

Besides, to illustrate the differences between GRDC and the 12D network over arid regions, the example of the Amur River basin has been replaced by the Tigris-Euphrates river system. The text and Fig. 8 with its caption are modified accordingly.

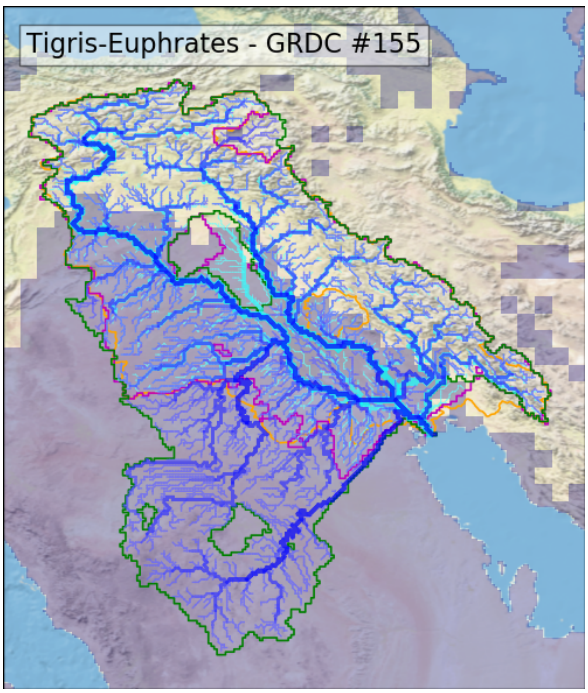


Figure 8. Tigris-Euphrates river system.

L204: "This major difference can be neglected since it is within the arid region of the Arabian Peninsula."
This sentence is confusing, I assume the authors are discussing about the Amur basin, but why "Arabian Peninsula" is mentioned?

Of course, there was a mistake here. Nevertheless, we now show the example of the Tigris-Euphrates river system, and the portion of the basin which differs between river networks is in the Arabian Peninsula.

L328: "we prefer here to focus on the routing part and capillary rise as well as floodplain evaporation deactivated."
It must be better to note that floodplain scheme affect river discharge and thus evaluation metrics is also affected. Therefore, there are some uncertainties in stating "increase in evaluation metrics meand river network quality is better". This point must be discussed.

We agree that evaluation metrics are affected by both the river and floodplain processes (as well as groundwater processes). Nevertheless, in this section, we aim at evaluating the whole set of new parameters, including those related to rivers and those related to aquifers and floodplains. To that purpose, we use the CTRIP model which accounts for all these processes (each of them has been validated separately in previous studies). With these considerations, we agree that improved performances are not necessarily due to a better representation of the river dynamics (river network and parameters) but to an overall better representation of rivers, floodplains and aquifers dynamics. That said, we think the pointed sentence could be confusing and has been rephrased as:
"Although the ISBA and CTRIP models are fully coupled in Decharme et al. (2019), we prefer here to run the CTRIP model in offline mode; then the configuration considered here includes the representation of floodplains and aquifers, but backward fluxes to ISBA (capillary rise and evaporation over floodplains) are neglected."

L406: “impacted by the new parametrization”
What the authors mean by “new parameterization”? Does this simply mean “new river network map” or does this mean “sub-grid topography parameters”? Please clarify.

As stated in the previous answer, the evaluation metrics are impacted by the new representation at 12D of river routing (river network and parameters), floodplains (roughness and sub-grid topography) and groundwater (aquifer parameters and sub-grid topography). This has been clarified in the revised version.

L419: “which impacts the generation of floodplains and aquifers sub-grid parametrization; 2. the use of observed-based river width for CTRIP-12D.”
I assume floodplain scheme is deactivated for these simulations, so it is not reasonable to discuss its potential impacts on simulation here. Also, did ground water scheme considered in this test simulations? Please provide informations.

We understand that there was a misunderstanding of the CTRIP configuration used for the simulations at HD and 12D. Floodplain and aquifer schemes are activated here, only the feedbacks to the ISBA model (capillary rise and evaporation over floodplains) are neglected. As stated previously, we tried to clarify this in the description of the modelling configuration (section 4.1).

We thank again the reviewer for his comments which, we think, helped us to improve the manuscript.