essd-2021-434

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

Simon Munier and Bertrand Decharme

Author response to reviewer #3

Reviewer comments are in italic and blue font.

General comment

In this work, Munier and Decharme reported a new global global-scale river network 1/12°, which was derived from the widely used MERIT-Hydro dataset. High spatial resolution river networks are increasingly important for current/future studies on water resources management, climate impact on hydrological processes (e.g., floods), etc. The updated river network represents a great advance in delineating global stream networks, although it is derived from previous datasets and models. In addition, the authors also derived a set of hydro-geomorphological parameters, which would facilitate future studies on network-based hydrological and geomorphological, or even biogeochemical studies (like greenhouse gas emissions from streams and rivers). This updated river network map with higher spatial resolution is thus quite important and will greatly contribute to the scientific community. The manuscript was well organized, but some details were missing/lost, which should be addressed (see specific comments below).

We would like to thank the anonymous reviewer for his/her valuable comments on the manuscript. Bellow are the responses to all the comments raised by the reviewer.

My another concern is related to validation and data quality. The authors have tried to compare the new river network with previous network datasets or models. To help readers to follow, it may be clearer to present the comparison results (e.g., % in differences) in a table so that readers can easily find out the improvements or performance of this new river network product. This also applies to the derived hydro-geomorphological parameters, in particular for the groundwater and floodplain components, which warrant further data quality assessments.

As specified in Section 2.3 “Quality assessment”, the newly derived river network has been assessed qualitatively and quantitatively over the 69 largest basins of the world. The quantitative assessment is done by comparing the basin area from different sources and the relative difference with the new river network, and by computing the IoU index (Eq. (1), L183) of the basin masks. As written in L186, details of the statistics are gathered in Table S1 in supplementary material. Moreover, in this table, possible causes of main differences are identified.
Concerning the derived hydro-geomorphological parameters describing the groundwater and floodplain components, a direct quantitative assessment is not possible since there is, to our knowledge, no equivalent existing dataset at the same spatial resolution. This is why we proposed an indirect assessment using the CTRIP model, which has been extensively validated in previous work (see Decharme et al., 2019, and references therein), especially in its groundwater and floodplain components. This has been clarified in the revised version of the manuscript.

Specific comments (with line number):

L117: what's the difference between pixel and cell?

As written in L117-118, a pixel is a unit element at high resolution (1/1200°) while a cell is a unit element at the 12D resolution (1/12°).

L137: if I understand correctly, 1000 pixels, if near the equator, is ~8.1 km2. It might be reasonable to assume a headwater stream develops within this area size in temperate regions. But for tropical regions, I'm afraid this threshold is too large (i.e., more than 1 headwater stream has developed in 8.1 km2) while for arid regions, the threshold is too small (i.e., a headwater stream may have not necessarily developed within 8.1 km2).

Yes, the reviewer is right, a threshold of 1000 pixels corresponds to different areas depending on the latitude. Also, the real size of headwater streams may depend on the region.
Yet, the type of river network required by most of river routing models (especially those working with the D8 convention) has to provide a flow direction for each cell of the model. This ensures the closure of the global scale water budget. The type of soil (nature, river, lake, cities etc.) and other characteristics (such as climate zone) are then not considered to set up the global scale river network.
Consequently, the threshold of 1000 pixels is only used to ensure that the considered river drains at least 10 % of the cell. In that sense, the river network should be considered as a drainage network. This has been clarified in the revised version.

L150: what's a D∞, please explain.

As stated in L52, Dinf is a drainage network convention for which the water in a unit catchment may flow into any other unit catchement (not necessarily a neighouring one). In this sentence, Dinf has been changed to D∞.

Fig 3: the figure caption is repetitious. It is not necessary to repeat the text already shown in the text.

The figure caption has been changed to:
Figure 3. Example of river diversions within the Loire River basin (France). As in Fig. 2, rivers are treated in descending order of their drainage area: 1. the Loire river (dark blue), 2. the Vienne river (light blue), 3. the Cher river (green), 4. the Creuse river (orange) and 5. the Indre river (red). Solid lines and dashed lines represent rivers at HR and 12D, respectivelly. Green squares represent gauge stations.

L160: have you assessed the error resulting from such diversion processing?

No, the error resulting from the diversion processing has not been assessed rigorously. The main error caused by the diversion processing relies in the attribution of runoff generated by a Land Surface Model (LSM) to wrong cells of the river network. Yet, the current spatial resolution of most LSMs is generally greater than 1/12° (usually 0.25° or larger at global scale), which suggests that runoff fields would not show high spatial variability at 12D, then minimizing the diversion error.

On the other hand, without the diversion processing, some rivers may merge at wrong locations, causing potential large errors in the river network structure, as show in the following figure. This figure will be integrated as a part of Fig. 3.

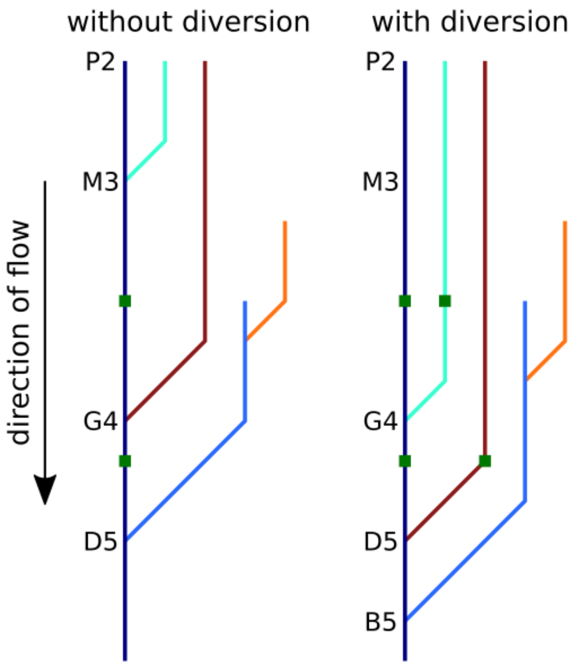

Figure: Schematic representation of the structure of the part of the Loire river network shown in Fig. 3.

Fig 5: This global river network map is nice. But the delineated network results in some regions may be problematic, including Greenland, the Sahara desert, and perhaps the middle east (Saudi Arabia). The high river density in these regions is inconsistent with the real world. Also, in fig 6, why are there rivers in the Great Lakes in the USA/Canada?

As stated in a previous answer, here the river network should be seen as a drainage network, and in that sense, it has to provide a flow direction for every continental cell, no matter the type of soil or any climatological characteristic. This is required to ensure the closure of the global scale water budget in Earth System Models.
The mean runoff used in section 2.3 to determine arid regions could be used to mask out the river network in such regions, but we preferred here to show the entire drainage network. Also, for the same reason, lakes are not considered in the drainage network. Instead, lakes can be integrated into the river network for models able to simulate the water budget within lakes (see e.g., Guinaldo et al., 2021).

L174: change 'consists in' to 'consists of', also in L353

Done, thanks.

L228: could river channel slope be estimated for each cell? With only one elevation for a cell, how could the slope be calculated? Please clarify.

For a given cell, we consider the corresponding HR river stretch to compute the river slope as the difference between the elevations of the first and last pixels of the HR river stretch divided by the its length. This has been added in the revised version.

L235: change 'contrarily' to 'contrary'

Done.

L275: refs?? Also, add 'a' before 'number of….'.

"refs" has been removed, and 'a' has been added.

L320-322: references are missing.

The following references has been added: Alkama et al. (2010), Decharme et al. (2012, 2019), Vergnes et al. (2012, 2014).

L329: 'nearest'

Done.