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Interactive comment

Interactive comment on "Dynamic hydrological discharge modelling for coupled climate model simulations of the last glacial cycle" by Thomas Riddick et al.

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<General Comment> The manuscript describes a method to calculate river flow directions dynamically. This must be of interest to hydrologist and paleo-climate researchers, given that the preparation of the paleo river network is difficult. The paper can be potentially acceptable, but there are some major issues to be addressed. 1. Provide a literature review on the method for generating paleo river direction map. There is no citation to the previous method in the manuscript. If there is no previous study, please state so. 2. The method section is difficult to understand. The authors stated that the method is applied for every 10-100 years, but the method description





suggested some manual processing is needed. It is not clear how the authors could update the river direction dynamically during the paleo climate simulation. 3. Related to above, only one river direction for the paleo climate was shown, though the method must have been applied multiple times during the simulation. As long as the authors stated that the method is for "dynamic river direction", the time series of gradual river direction change should be shown as a figure.

iijIJSpecific Comments> P2. L26: Negative values of are set to a constant. Please clarify which value was used. I guess, zero slope is also problematic, this the authors actually used "minimum threshold". Please clarify.

P3. L4: The challenge for a paleoclimate simulation is to develop a method for periodically updating the river directions and flow parameters used with sufficient accuracy. Please provide reference to previous papers. How LGM river map was prepared in past studies. Is there any previous method which can treat "dynamic" river map generation?

P3. L20: False sinks also appear at higher resolutions due to various imperfections in the measurement of orography satellite: Recommended citation to the errors in DEM is: Yamazaki D., D. Ikeshima, R. Tawatari, T. Yamaguchi, F. O'Loughlin, J.C. Neal, C.C. Sampson, S. Kanae & P.D. Bates A high accuracy map of global terrain elevations Geophysical Research Letters, vol.44, pp.5844-5853, 2017 doi: 10.1002/2017GL072874

P4:L8 A brief outline is given here From this section, it seems all steps are automated. While in Section 2.3 the authors mentioned the "by-hand" method which must be not automated. Please clarify this discrepancy. The "by-hand" correction was applied only once at the first step? Then, the description in Section 2.1 should be revised to avoid confusion.

P4. L19: any intervening cells It is not clear that what "intervening cell" means.

P4. L24: 2.2 Changing the present day base orography This section is very difficult to understand. What is the difference between the present-day-base-orography amd

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present-day-reference-orography? Do they have different characteristics? Which data is used as "present-day-base-orography"? Do the two DEMs have the spatial resolution? Please clarify.

P5. L15: effective hydrological heights It is not clear what is the "effective hydrological height". Please write a brief explanation when it first appears.

P6. L2: below a given threshold What threshold was used? Please clarify.

P6. L23: as the height of the highest point in the most likely river pathway It is not clear why "highest point" was used. Please explain.

P6: L25: lowest highest point This expression is confusing. Please revise.

P7. L1: "flooding each coarse cell" It is not clear what "flooding" means here. Please explain in detail.

P7. L13: If the detailed description here is not needed to explain the main work (regenerating river maps during the climate simulation) proposed in the manuscript, I recommend to move this section to Appendix.

P10. L8: For this paper we upscale the unconditioned 30-second orography SRTM30 PLUS (Becker et al., 2009) to a 10-minute grid Is this used as "present day base orography" in Eq(3)? It is not clear how this data is used.

P13. L19: as all true sinks will be removed for actual paleoclimate simulation Is this a reasonable assumption? Please discuss.

P14. L14: in all cases they are either due to minor errors in the manually corrected JSBACH river directions The error could be "minor" for the purpose of climate simulation, but the same error could be critical for different purpose. The authors have to acknowledge the method is suitable for climate simulations, but the accuracy could be not adequate for different use (such as water resource assessment or flood risk modelling).

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P14. L31: Application to a LGM simulation P14.L32: Figure 7 I guess, many readers want to check how the algorithm calculates gradual change in river directions following the change in orography. Given that the authors stated in Section 2.1 that "River directions are regenerated approximately every 10-100 years", there must me multiple river maps for glacier period simulations. However, the authors showed only 1 river map for the paleo climate simulation. I think this is not adequate to proof the usefulness of the proposed method. I here suggest to show the time series of river map development, by focusing on some locations where the authors can observe the gradual change of river directions during the paleo simulation. Otherwise, it is difficult to state that the proposed method is "dynamics" river direction mapping.

Figure 7: Please use different color for the "new land" or "new ocean" in Figure 7 to show the change in land sea mask.

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