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Hydrology and Earth System Sciences Discussions

Interactive comment on "Deriving a global river network map at flexible resolutions from a fine-resolution flow direction map with explicit representation of topographical characteristics in sub-grid scale" *by* D. Yamazaki et al.

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General Comments

The authors present an interesting paper on the representation of global-scale river networks. The proposed method is technically sound and original. With respect to existing methods, river networks are described by connecting grid cells that are not necessarily neighboring. This new strategy opens the route to the definition of a new

class of methods. The proposed method does not represent an ultimate procedure for describing global river networks, but rather a transitional step towards the description of global flow nets based on fine-resolution gridded elevation data analysis. There is, however, sufficient merit in the presented paper, as such, to deserve publication. I feel that this paper makes a significant, new contribution in the area of water resources and meteorology, and I recommend therefore that it is accepted for publication in Hydrology and Earth System Sciences.

The paper is well written and organized. While the methods are fully described, the paper is concise and goes to the important points. Figures are informative and essential. It can especially be appreciated the authors' ability to make the manuscript quickly understandable by expert readers just from figures and related captions, while also allowing a larger audience to be introduced in the field by reading the full text. The manuscript may require editing/rewriting to improve the grammar and English usage. The help of an English speaking person in the preparation of the final version of the paper would certainly be beneficial. Following there are some comments and suggestions that this reviewer hopes will help the authors to improve the paper.

Specific Comments

Title. The term "flexible resolutions" is used in the title. The text reveals, however, that the introduced flexibility is rather on the location of draining cells. The author may want to revise the paper title by omitting this term: "Deriving a global river network map from a fine-resolution flow direction map with explicit representation of topographical characteristics in sub-grid scale."

Section 1, third paragraph, third line. The original works by O'Callaghan and Mark (1984) and Marks et al. (1984) need to be cited when introducing the "steepest slope method."

Section 1, third paragraph, fifth last line. The original work by O'Donnell et al. (1999) need to be cited when introducing macro-scale river network methods.

Section 1, fourth paragraph, third line. The authors may want to replace the term “alteration on them” with “improvement of it” and cite state-of-the-art methods such as those described by Costa-Cabral and Burges (1994), Tarboton (1997) and Orlandini et al. (2003).

Section 2.1, first paragraph. The flow direction map is listed as an essential requirement for the method. Reliable methods for the determination of flow directions from fine-resolution gridded elevation data are, however, available in the literature (Orlandini and Moretti, 2009). The authors may want to acknowledge that fine-resolution digital elevation models are the only essential requirement for the implementation of their method and flow directions can either be computed using reliable terrain analysis methods or imported from available data sets.

Section 2.1, Step 3.3. The terms “catchment” and “basin” have well-defined geomorphological meanings and they cannot be redefined in the paper. The authors may want to use the term “drainage area” instead of “catchment” to describe the drainage area within cells.

Section 3.2, first paragraph. As pointed out in Orlandini and Moretti (2009), an accurate reproduction of the drainage area is a necessary-but-not-sufficient condition for the validation of surface flow paths. While the validation reported in the manuscript can be considered adequate to the scope of the paper, the authors may want to acknowledge this point in their discussion.

Section 4, last paragraph. The authors propose to relax the constraint that any cell is drained by a neighboring cell, making it possible that a given cell is drained by a non-neighboring cell according to the surface flow paths identified from the analysis of fine-resolution elevation data. The relevant physiographic features of the river network are also determined on the basis of the fine-resolution data analysis and attributed to coarse cells in order to describe sub-grid variability. This strategy is possible and technically sound, but it probably needs to be further developed in order to provide a

new, comprehensive method for the description of global river networks. In fact, one can observe that coarse grid cells are no more an essential elements upon which the global river network is based. As also noted by the authors, the proposed method actually uses elements derived from surface flow paths and sub-catchment divides as identified from the analysis of fine-resolution elevation data. Since these elements can be defined independently of the coarse grid, the full development of the strategy proposed by the authors seems to be the construction of a flow net with large elements that are suitable to global hydrologic and climatic analysis from fine-resolution elevation data. This idea really makes sense in the opinion of this reviewer and has the potential to provide a new, clean method for the description of global river networks. The authors may want to expand a bit their discussion to better define the potential of the proposed strategy while also acknowledging the limitations of flow nets described by Moore and Grayson (1991) and Moretti and Orlandini (2008).

Technical Corrections

I noted several possible corrections of the English grammar and usage. Some of them are reported below in this comment. I am not, however, an English speaking person and my suggestions certainly need to be verified. - Abstract. Replace “map for the use in global” with “map for use in global.” - Abstract. Replace “can be flexibly located” with “can flexibly be located.” - Section 1, fourth paragraph. Replace “is stand for” with “stands for.” - Section 1, fifth paragraph. Replace “target cell toward downstream” with “target cell downstream.” - Section 2.1. Step 2.2, first line. Replace “reaches to a river” with “reaches a river.” - Section 3.1, first paragraph. The authors may want to revise the last two sentences as follows: “Some intersections of river channels can be found in the upscaled river network map as highlighted in Figure 7a. These intersections appears, however, only if an illustration method connecting the centers of drained and draining cells is used. As shown in Figure 7b, no intersections are displayed if a more appropriate representation of connections is used.“ - Section 3.1, third paragraph. Replace “necessary to be selected” with “necessarily selected.” - Caption of

Figure 1. Replace “Figure 1a and 1b” with “Figures 1a and 1b.” - Caption of Figure 3. Replace “Procedures to identify” with “Procedure for identifying.” The authors may want to replace “(pixels with small squares in Figure 3c)” with “(rejected and replacing outlet pixels indicated by crosses and small squares, respectively, in Figure 3c).” - Caption of Figure 4. Replace “Procedures to deciding the downstream of each cell to construct a river network” with “Procedure for deciding the downstream cell of each cell and constructing a river network.” Replace “include” with “includes.” - Caption of Figure 5. Replace “Procedures of determining a catchment for each cell” with “Procedures for determining the upstream drainage area for each cell.” Replace “The area of catchment for each cell” with “The drainage area for each cell.” Replace “catchment area map” with “drainage area map.” - Caption of Figure 7. This caption may be rewritten as follows: “As shown in Figure 7a, if river channels are drawn as to connect centers of upstream and downstream cells, a river channel intersection may occur. However, as shown in Figure 7b, such channel intersections are only apparent errors that are not observed if a more appropriate representation of cell connections is used.” - Caption of Figure 8. Replace “Correspondence of upstream drainage areas between an upscaled river network map and an original flow direction map” with “Comparison between upstream drainage areas obtained from an upscaled river network map and from an original flow direction map.” - Caption of Figure 9. Replace “Illustration of a part (the Mississippi River basin) of an upscaled river network map at” with “Illustration of an upscaled river network map describing part of the Mississippi River basin at.” - Note of Table 1. Replace “river channel slope is calculated” with “ river channel is calculated.”

Section 1, third paragraph, first line, and throughout the manuscript. Insert a space between the measure of a quantity and the related unit (e.g., “10 km” instead of “10km”).

Section 1, fourth and fifth paragraphs. Some important sentences are reported on brackets. The authors may want to remove the brackets and report these sentences as regular text.

Section 1, sixth paragraph. Should “alternation” be replaced with “alteration” (twice)?

Section 2.1, Step 2. Should “B4” be replaced with “B5” (twice)?

Figure 1. The outlet pixels are not gray as reported in the caption.

References

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