Hydrol. Earth Syst. Sci. Discuss., 6, C2319–C2323, 2009
www.hydrol-earth-syst-sci-discuss.net/6/C2319/2009/

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.

D. Yamazaki et al.

yamadai@rainbow.iis.u-tokyo.ac.jp

Received and published: 9 October 2009

We are very glad that Dr. Orlandini acknowledged our new method is technically sound and original. We are most grateful for his constructive comments on our HESSD manuscript. We revised our manuscript according to his suggestions. The followings are replies to his detailed comments.

RC : Reviewer's comment

AC : Authors' comment

<Replies to Specific Comments>

RC1: 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."

AC1: The title is changed to "Deriving a global river network map and its sub-grid topographic characteristics from a fine-resolution flow direction map". We think this title is suitable for the contents of the manuscript.

RC2: 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."

AC2: They are added to references for the "steepest slope method".

RC3: Section 1, third paragraph, fifth last line. The original work by O'Donnell et al. (1999) needs to be cited when introducing macro-scale river network methods.

AC3: It is already referred in page 5022, line 14.

RC4: 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).

AC4: We also referred those works in the revised manuscript.

RC5: 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.

AC5: Truly, flow directions can be derived from digital elevation models if they are sufficiently precise. However, such precise digital elevation models with adequate special resolution are limited in global-scale. Furthermore, actual river channel networks are artificially modified. In such a case, realistic flow directions cannot be derived only from digital elevation models. Thus, following sentences are added to the manuscript:

"In fact, flow directions can be determined if a sufficiently precise surface elevation map is provided (Orlandini and Moretti, 2009). However, such precise elevation maps for the global scale are still limited. Furthermore, if river channels are artificially modified from the natural condition, it is quite difficult to derive actual flow directions only from DEMs. Therefore, a flow direction map is also listed as a requirement for the FLOW method."

RC6: 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.

AC6: We replaced the term "catchment" with "drainage area" in the revised manuscript. According to this change, the tem "upstream drainage area" in the manuscript is replaced with "upstream area" in order to avoid confusion.

RC7: 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.

AC7: We added following sentences to the revised manuscript: "An accurate reproduction of the upstream area is a necessary-but-not-sufficient condition for the validation of river networks, because upstream area does not represent shapes of basins and subbasins (Orlandini and Moretti, 2009). However, comparison of original and upscaled upstream areas is considered to be adequate for validating the accuracy of upscaling."

RC8: 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).

AC8: Certainly, out method is still not the ultimate way for the description of global river network maps. We added a paragraph to discuss about this point into the end of section 5 as follows:

"A Drainage-area-based approach requires disaggregation of forcing data (e.g. runoff, precipitation, and evaporation) in order to dissolve the mismatch between rectangular gridded forcing and irregular drainage area elements (Koster et al., 2000). This disaggregation technique is somewhat computational, but it brings realistic representation of flux exchanges into hydrological modeling. When this technique is adopted, coarse-resolution grids are no more essential elements upon which river network maps are based. Since drainage area elements can be defined independently of the coarse-resolution grids as done in smaller-scale hydrological models (e.g. Moore and Grayson, 1991; Goleti et al, 2008; Moretti and Orlandini, 2008), the grid-based river network map, which underlies the FLOW method, is not the absolute way for the description of global river network maps. Therefore, upscaling method for macro-scale river network maps may have a potential to be father improved. "

<Reply to Technical Corrections>

AC : We really appreciate Dr. Orlandini for suggesting various problems on technical matters, even including English usage. We accepted all of his suggestions and revised our manuscript according to them.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 5019, 2009.