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Earth Surface Dynamics Discussions

Interactive comment on "Identification and ordering of drainage divides in digital elevation models" *by* Dirk Scherler and Wolfgang Schwanghart

Anonymous Referee #2

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The authors present an algorithm to automatically extract the drainage divide networks from digital elevation models as well as ordering schemes to classify the different divides with respect to each other. The application of the algorithm to a field example (San Gabriel Mountains) and different numerical landscapes is shown, exploring the relationship between different geometric and topographic metrics attributed to divides with respect to their mobility.

I believe that the tool presented in this manuscript (and already implanted in Topotoolbox) is valuable to explore landscapes more systematically, offering the potential of developing new approaches to characterize landscape stability and to retrieve informa-

tion about the history and drivers of landscape evolution.

I also believe that Esurf is the perfect outlet for this contribution, but before I can recommend the manuscript for publication, I would like to point out some comments/concerns for the authors to consider in order to clarify certain parts of the manuscript, as well as to highlight the main points of this contribution.

1 General Comment

The authors have carried out an extensive analysis of divide drainage networks from a field case (Big Tujunga catchment) and several numerically simulated landscapes (including their temporal evolution) by exploring different (topologic, geometric and topographic) metrics. The manuscript contains 21 figures (with 120+ panels! – some of them quite complex). I think the number of figures is excessive, particularly because the presence of many of them (and their description) are not that insightful/necessary to make the main points on the paper, which are currently diluted. I would strongly suggest that the authors transfer to the Supplementary Material most of the panels, keeping only the ones that are key to the message, and expanding in their description and insight gained from this analysis. I believe the manuscript will substantially benefit from an effort in this direction, improving its readability and impact.

2 Comments:

- Line 76: It is stated that *divide networks even contain cycles*. Do cycles correspond to enclosed (internally drained) basins? In the rest of the manuscript, it is said that these networks are represented as tree-like networks, i.e. no cycles, (e.g. line 116) and that enclosed basins are not considered in the analysis. Is

the algorithm and ordering scheme applicable for the cases the network contains cycles?

- A new ordering scheme is introduced (Topo) and it is mostly adopted for the analysis reported in the manuscript. However, I missed a more detailed comparison between the different schemes in terms of characterizing the divide network.

- There are some metrics used or introduced in the manuscript, which although might seem intuitive, are not properly defined, and they can lead to misunderstandings. I would encourage the authors to properly define each of the metrics, particularly those that are central to the manuscript. As an example, I have struggled in imagining what is the definition of divide distance (which is used in almost every figure on the paper). The first time that it is mentioned in the manuscript is in line 129-131, where it is stated: *"We thus propose to order the nodes and edges of the divide network, by their maximum down-divide distance from divide endpoints, measured either in map units or in the number of divide segments. From now on, we call the distance measured 130 in map units along the divide network the divide distance (dd)."* What does *down-divide distance* mean? Only paths where elevation is strictly decreasing are considered? Please provide a clear definition of the different metrics utilized (consider including an illustration if needed – e.g. Fig 4 is quite helpful)

- Section 3, particularly section 3.1 and Appendix 7.1, are the central contribution in the paper. However, I find the description of the algorithm not very clear, particularly the second step (lines 140-143) and Figure 3, which I am unable to follow. There are terms that are not defined, e.g. how do you define (the number of) segment termini?

- Line 181 – Since the metrics are computed for each divide edge, isn't $\sum X$ just twice the value of $\bar{X}$? In that case, I guess there is no need to keep both.

- Equation 7. Not clear. Should d and d_d function of x within the integral?

- Line 240-241:*"In contrast, the ordering rules of the Strahler and Shreve scheme (see Eq. 1 and Eq. 2) may yield unequal orders during the sorting, so that the divide orders of the last divide segments may be different by more than one."* I can see how this can happen for the Shreve scheme but under what circumstances would that occur using the Strahler scheme?

- Line 254 – Why the analysis is limited to $\omega < 55$. Is it because for $\omega > 55$ Λ is not defined?

- Lines 262-263 / Fig 13: I don't think that using the cumulative divide length is the most effective way to determine what are the orders changing the most (why not to use length(ω)) since by construction the curve shown in Fig 3 will be robust to changes for values corresponding to small ω in comparison with large ω. I would be also interesting to see a similar curve when the analysis is done using the Strahler scheme, which I believe is more robust in terms of assigned orders (particularly to high order segments), to verify that indeed high order segments are the most affected. (Also lines 364-365)

- Lines285-290: There are some statements about dependencies between variables. Are those just inferred from visual inspection?

- Line 314-315: resembling instead of mimicking?

- Lines 332-333: *"Furthermore, the junction connectivity along the eastern edge is relatively low, despite being high up in the divide network (Figure 20a)."* Very qualitative statement and not that obvious from visual inspection, could you further quantify this point?

- Line 355: topology instead of geometry?

- Figure 4. The green and red tones are not that easy to distinguish (at least in a printed copy).
- Figure 18: I wonder whether the higher variability observed for the first 5 km is partially due to the higher density of points in that range. Does the same observation hold when distance percentiles are used on the x-axis (instead of the linear axis)?
- Fig 20: The layout/background used in panel a makes it difficult to delineate the actual catchment and compare with Fig 19a for example. enditemize

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