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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 #1

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Referee report on "Identification and ordering of drainage divides in digital elevation models" by Scherler & Schwanghart

The manuscript submitted by Scherler & Schwanghart proposes a new way to calculate and characterize drainage basin boundaries and shows how the new metrics can be used to identify sections of the divide, which are vulnerable to topographic changes.

The paper presents a valuable contribution to geomorphology especially as the tools are made freely available in a easily usable framework (topotoolbox), which is accessible also for IT-skilled geomorphologists.

While the technical part of the manuscript is well presented and the algorithms clearly

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Discussion paper

described, the analysis section lacks a central theme. Instead of getting to a point which shows how landscape perturbations affect the geometry or better topology of drainage divides the authors rush in a rather descriptive way through a series figures (Fig 11-21) most with multiple sub-pannels.

Given that the title focuses on "algorithm and metrics" with the analysis only being an "application showcase", I do not see this as a critical part for the paper. However the authors may consider shortening this part and focusing on only one perturbation scheme (maybe the rotating one which shows the most striking responses) which exemplifies their metrics without trying to make a geomorphological claim.

A more thorough analysis of different perturbations and their impact on drainage divide networks may be presented in a separate paper.

Below a few minor comments and questions/suggestions:

For the efficient calculation of watersheds, as well as their susceptibility to perturbations by topographic changes, I would like to draw the author's attention to a series of papers which may not be on the general "radar" of the geomorphology / hydrology audience:

Fehr, E., et al. "New efficient methods for calculating watersheds." Journal of Statistical Mechanics: Theory and Experiment 2009.09 (2009): P09007.

Impact of Perturbations on Watersheds E. Fehr, D. Kadau, J. S. Andrade, Jr., and H. J. Herrmann Phys. Rev. Lett. 106, 048501

Scaling relations for watersheds E. Fehr, D. Kadau, N. A. M. Araujo, J. S. Andrade, Jr., and H. J. Herrmann Phys. Rev. E 84, 036116

Usually, when making a topographic analysis stream networks are defined by a flow accumulation threshold. The authors define a parameter which describes the distance from the divide to the closest stream. Such a parameter would, however, depend on the specific choice of the flow accumulation threshold and could vary between 0 and the system size. The authors should add a formal definition of their stream networks and clarify how they addressed this point.

The following comments/questions are using Figures as reference, but should also be addressed in the corresponding parts of the main manuscript.

Figure 1: Wouldn't it make sense to put (a) and (b) into a single (bigger) figure such that the reader directly can associate the divide network with the corresponding stream network?

Figure 3: Would it be possible to reduce the complexity of the figure without scarifying the main message. If I read the figure correctly, the right hand half contains already all necessary information.

Fig 7: The 3d figures are small hard to understand.

a. Initialize: I would suggest the authors to put an arrow "time" from the initial to the final (steady state condition). (this may also be presented simply in plain top view) c. Labeling the (rotating) circle and 12h initial position and showing how this marker moves through time (3 snapshots) may be easier to understand than the small 3d visualization d. and e. I had first difficulties to understand these graphics as they show the LEM surface and the "lithology" underneath, which changes the erodibility as the landscape erodes through this heterogeneous bottom. Here the authors may improve they description explicitly mentioning (depth) and the fact that the topography erodes through these formation creating a variable erodibility over time.

another option would be to combine c. d. e. as small panels in Fig. 11 and showing there 2 time snapshots in the evolution of the topography.

Fig 13: While the "Initialize" plot shows a significant change over the course of 10Myr, the changes in the plots of the perturbed systems seems almost insignificant, especially when compared to the changes of the "Reference" topography offer the course 10Myr-20Myr. Note, if I am correct, the "Reference" solution should have reached steady state and therefore should show no changes at all. In order to present how the disturbance changes affect the divides it would make more sense to compare the disturbed system to the reference system at the same time, thus t=15Myr and 20Myr and show the difference between the two. Alternatively one could also evaluate the time evolution of the different perturbed cases relative to the evolution of the "Reference" solution.

Fig 17: Fig 17b consists of a main (invariant) cluster (black dashed line) corresponding to the general topographic shape of the landscape. It would be interested to see where (in the landscape) the deviations from this behavior are located.

Fig 21: The scatter plots in this figure are difficult to interpret, especially because color is an additional variable. e.g. do yellow points mask blue markers underneath? It may be favorable to divide the color scale in 3 or 4 categories and bin the results in x,y for each category. Additionally the authors should quantify between the different measured quantities using e.g. a simple linear regression model.

I hope that the above comments & suggestions help the author to improve the manuscript and strengthen their arguments.

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