Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC1
https://doi.org/10.5194/gmd-2022-92-RC1, 2022

Comment on gmd-2022-92

Anonymous Referee #1

Referee comment on "An Improved Algorithm for Simulating Surface Flow Dynamics based on the Flow-Path Network Model" by Qianjiao Wu et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-92-RC1, 2022

GENERAL COMMENTS

This manuscript describes a new algorithm for surface flow dynamics simulation, which is an improvement to the existing TIN-based method by Chen et al. (2014). Both of them divide a raster DEM into TIN, generate flow path network (FPN) over the TIN, and track the flow along the FPN. The main difference to the TIN-based method, if I understand the text correctly, is that the algorithm proposed in this study adopts an improved Manning equation to calculate the flow velocity, as well as the parallel computing to improve the efficiency. The new Manning equation takes into account slope length factor, topographic wetness index and flow path curvature, while a new method is introduced for topographic wetness index calculation with the TFN network. Although it is odd to introduce new parameters into the Manning equation, the results show the behavior to be effective.

Overall, I find this may be a useful paper, and it may propose an effective improvement to the classical Manning equation.

However, I think this manuscript is not reader-friendly especially for people who know less about this field. Firstly, the section Methodology lacks some important figures for

illustration. For example, are the triangular facets of FPN (e.g., L136) and TFN (e.g., 169) the same? Secondly, some abbreviations and letters appear in multiple equations and have different definition. For example, S denotes slope in Eq. 1&6, and denotes specific catchment area in Eq. 4. Thirdly, the flow path is simulated over triangular facets (Section 2.1), and the parameters are calculated for DEM grids (Section 2.2), so how to combine the triangular facets and grids when simulating the surface flow dynamics?

I have major issue with the improved Manning equation. The authors explain that the slope length factor, topographic wetness index and flow path curvature should be normalized for Eq. 6, but I find no information about the method for normalization. Does this step rely on any parameter in the DEM? If so, a point may be assigned with different flow velocities when different basins or sub-basins containing this point are adopted. In addition, the results show that the improved Manning equation combining four parameters outperforms the classical Manning equation only considering the slope. More assessments may be valuable to show whether all the four parameters are acting, or a better result may happen when only two or three important parameters are adopted.

Finally, the authors may add more descriptions about their methods and assessments such as whether they consider the baseflow like Chen et al. (2014) when assessing the algorithms. More discussions are need to explain why they ignored some conditions, such as the infiltration and water depth (Nilsson et al., 2022).

SPECIFIC COMMENTS

P2 L41&54 The statements here are contradictory that "regular-grid DEMs can better describe continuous terrain surfaces" in L41 and TIN is "better expression of complex and changeable surface" in L54.

P3 L67-78 The authors described that the method of Shen et al. (1995) can "simulate runoff and surface flow discharge at any position and time" in L67-68. However, they

stated that the introduced methods including Shen et al. (1995) "can only simulate the surface flow dynamics of a limited number of points" (L75-76), and it is difficult to simulate "at any location" (L78). The statements above are contradictory.

P5 L118-137 The authors may want to add a figure to Section 2.1 to show the processes of FPN generation clearly.

P6 L147 The definitions of letters in Eq. (1) were not introduced.

P7 L173 The reference of TFN by Zhou et al. (2011) seems to be missed. The authors may explain why they accepted the method of Zhou et al. (2011) for the flow accumulation but used a new method rather than the one of Zhou et al. (2011) for aspect. Can it improve the accuracy?

P7 L183 "n denotes the nth triangular facet"? The "n" may be the number of the triangular facets treating the cell as the vertex. In addition, it is different for the readers to understand the triangular facet mode of TFN because there is no figure and the triangular facets decided by FPN in Figure 2 may mistake them.

P7 L186-188 For Eq. (4), A should denote the number of flow lines passing the cell over the TFN (Zhou et al., 2011).

P8 L194 tanβ denotes the slope (m/m).

P8 L204 How did the authors normalize the slope length factor, topographic wetness index, and flow path curvature?

P8 L214 The analytic hierarchy process (AHP) may be effective according to the results. But authors may explain more about why they decided the relative importance between the parameters like Matrix 1. A reference is required because the method of AHP is existing.

P11 L262 The resolution of original DEM was 5 m. Why only the resolutions ranging from 10 m to 30 m were adopted for subsequent analysis?

P12 L276-283 This paragraph should be improved because multiple thresholds with different uses are confusing. Is the filter threshold used to avoid narrow facets as described in L127-128? Are the same values of drainage network threshold (2000 m2) and the filter threshold (8 m) adopted by the DEMs with coarser resolutions (i.e., 10-30 m) used below? If so, the distance between two points over a10-m resolution DEM is always longer than 8 m, is this threshold necessary?

P12 L282 A table can be added to list the numbers of critical points and facets over DEMs with different resolutions.

P12 L285-288 There are six resolutions but five flow line numbers. So is the resolution of 5 m ignored?

P13 L293 Which step requires the threshold to cut the flow line?

P14 L298 Table 3 contains land use data, climate data, and soil data, but the caption only mentions the land use data, while only the land use data was used in this study.

P17 L322 Why was only the resolution of 30 m adopted for comparison between SWAT and the improved algorithm?

P19 L348 The terms "scale" and "resolution" seem to be mixed up in this manuscript.

TECHNICAL CORRECTIONS

P2 L50 The full name of the abbreviation "BGIS" should be "Basin Geomorphic Information System" rather than "Geomorphic Information System". And the reference "Tachikawa (1994)" may be false because this reviewer found the article published in 1992 and another journal according to the DOI.

P3 L68-69 The full name of the abbreviation "SCS" and "HRU" were missed.

P21 L374 There are two lines labeled as scale = 5 m.

References

Chen, Y., Zhou, Q., Li, S., Meng, F., Bi, X., Wilson, J. P., Xing, Z., Qi, J., Li, Q. and Zhang, C.: The simulation of surface flow dynamics using a flow-path network model, Int. J. Geogr. Inf. Sci., 28(11), 2242-2260, https://doi.org/10.1080/13658816.2014.917312, 2014.

Nilsson, H., Pilesjö, P., Hasan, A., & Persson, A. (2021). Dynamic spatio-temporal

flow modeling with raster DEMs. Transactions in GIS, 26, 1572-1588. https://doi.org/10.1111/tgis.1287

Shen, X., Wang, L. and Xie, S.: A dynamic precipitation-runoff model for a watershed based on grid data, Acta Geographica Sinica, 50(3), 264-271, https://doi.org/10.11821/xb199503009, 1995.

Tachikawa, Y., Shiiba, M. and Takasao, T.: Development of a basin geomorphic information system using a TIN-DEM data structure, Water Resour. Bull. Am. Water Resour. Assoc., 30(1), 9-17, https://doi.org/10.2208/prohe.36.677, 1994.

Zhou, Q., P. Pilesjö, and Y. Chen (2011), Estimating surface flow paths on a digital elevation model using a triangular facet network, Water Resour. Res., 47, W07522, doi:10.1029/2010WR009961.