Geoscientific Model Development Discussions

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# Reply on RC2

Qianjiao Wu

Community 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-CC2, 2022

**Dear Researcher,**

Thanks for all of the comments and suggestions for our submission GMD-2022-92. We have carefully examined the comment in the interactive discussion of its preprint and revised the manuscript accordingly. Detailed correction is listed below point by point.

**General comments:**

*The manuscript authored by Wu et al. presents an improved algorithm to simulate the surface flows. To increase the simulation accuracy and calculation efficiency, a flow-path network model by constructing the drainage-constrained TIN and refining the Manning formula using three terrain parameters. The improved algorithm was conducted and evaluated in the case study area, the Black Brook Watershed in north-western New Brunswick, Canada. Overall, the paper is presented in a clear logic.*
Response: Thanks for the comments.

*However, several aspects of issues regarding the algorithm design and accuracy evaluation prevent the recommendation to be accepted in its present form.*
*(1) In the study, modifying Manning's equation by combining the FPN and three terrain parameters (slope length factor, topographic wetness index (TWI), and flow path curvature) is the key step of the improved algorithm and one of the main contributions of this method. However, why the three terrain parameters were chosen and the roles of the different parameters on improving the simulation were not elucidated explicitly and evidenced powerfully. How about only using one or two parameters or add other terrain parameters???*
*Actually, the slope used in the classic Manning's equation represents the situation in pixel scale, while the parameters, e.g., the slope length factor and TWI, are calculated in hilly slope (regional) scale. How to handle the merging of parameters in different spatial scales? In addition, the three parameters have strong self-correlation.*

**Response:** Thanks for the comments. 1) There are several terrain parameters (such as slope length factor, topographic wetness index, flow path curvature, upslope slope, and upslope area) have an influence on the flow velocity. In this paper, we tried to choose the slope length factor, topographic wetness index and flow path curvature to improve the

simulation and found that this behavior has some effectiveness and we are exploring the use of only one or two parameters or other terrain parameters whether a better result may happen. 2) The slope used in the classic Manning's equation represents the situation in pixel scale. The constrained-drainage TIN is constructed in a regional scale. And the parameters, e.g., the slope length factor and TWI, are also calculated in pixel scale. The flow path is simulated over triangular facets over the constrained-drainage TIN (Section 2.1), and the parameters are calculated for DEM grids (Section 2.2). When simulating the surface flow dynamics, we assigned the value of parameters at their corresponding position to the flow source points to combine the triangular facets and grids. 3) The three parameters have strong self-correlation and we will try to improve the proposed algorithm in further to get a better result by reducing the self-correlation.

*(2) A critical step to modify Manning's equation is integration of three added terrain parameters. In this study, the three parameters are weighted by the analytic hierarchy process (AHP) method. However, as presented in Table 1 and Section 2.2.2, the determination of the importance of one factor to another factor and the weights is subjective. The weighting scheme needs to be validated more.*

**Response:** Thanks for the comments. The subjectivity of the determination of the importance of one factor to another factor and the weights is a shortage and we will validate the weighting scheme for a better result furtherly.

*(3) The good performance of the improved algorithm was validated by comparing with the results derived from the SWAT model. Why was it compared with that derived from the conventional Manning's equation? Besides, the performance of SWAT model simulation largely depends on the parameter calibration upon the sufficient in-situ data. However, the information on the SWAT modeling is not given in detail.*

**Response:** Thanks for the comments. 1) The good performance of the improved algorithm was not only validated by comparing with the results derived from the SWAT model, but also compared with that derived from the conventional Manning's equation. In addition, the improved algorithm consists of parallelization for enhancing the computational effectiveness. And we also compare the results before and after the parallelization. 2) The experiment uses the daily runoff discharge of BBW in 2001 to simulate the daily surface flow discharge. The daily runoff discharge is simulated by the SWAT model according to the daily rainfall, and the data have a high accuracy (Chen et al., 2014). Daily observed daily flow discharge at the outlet of the BBW in 2001 is measured data provided by the BBW Watershed Monitoring Station. The observed daily flow discharge is a combined surface runoff discharge with the baseflow discharge. The improved algorithm also only simulated the surface runoff discharge which is added to the baseflow discharge for getting the daily flow discharge. The baseflow discharge is calculated using the method proposed by Zhang et al. (2012). For the comparison, the same procedure was used for the SWAT to simulate the daily flow discharge. We have supplemented these in the revised manuscript (P13, Line285-292).

**SPECIFIC COMMENTS:**

*(1) Line 92: A punctuation is missing after the bracket?*

**Response:** Thanks for the comments. We have added the punctuation in the revised manuscript (P3, L93).

*(2) Line 138: The section title is too wordy. The content within the bracket is suggested to be deleted.*

**Response:** Thanks for the comments. We have deleted the content within the bracket (P6, L138).

*(3) Line 143: The same to the advice above.*
**Response:** Thanks for the comments. We have deleted the content within the bracket (P6, L143).

*(4) Line 147: What do the variable symbols mean? Please specify the descriptions for these variables of the formula, albeit the Manning's equation is well known already.*
**Response:** Thanks for the comments. We have added the definitions of letters in Eq. (1) in the revised manuscript (P6, L148-149).

*(5) Line 159: Here the abbreviation TWI is not presented first.*
**Response:** Thanks for the comments. We have corrected it and the abbreviation TWI is presented in P4 Line 11 first.

*(6) Line 160: The punctuation is missing in the paragraph end.*
**Response:** Thanks for the comments. We have supplemented the punctuation in the revised manuscript (P7, L163).

*(7) Line 163: The citation is not formatted correctly.*
**Response:** Thanks for the comments. We have modified "(Wu et al., 2020)" as "Wu et al. (2020)" in the revised manuscript (P7, L165).

*(8) Line 179: What is the new point? Is it reliable?*
**Response:** Thanks for the comments. Considering the constant slopes and aspects of the triangular facets, we tried to obtain the slope and aspect from the TFN constructed from the no-depression DEM by the TFN algorithm (Zhou et al., 2011). The accuracy of the surface flow dynamics demonstrates that the behavior is not bad. We hope to get the required parameter from the vector TFN or FPN for further integration. In addition, we added a figure to understand the triangular facet mode of TFN in the revised manuscript (P8, L179-180).

*(9) Line 270: The geographic coordinates should be added in the insert map of Figure 3. The legend for the insert map is suggested. What is the mean of grey line (state boundary)? What does refer to?*
**Response:** Thanks for the comments. We have added the geographic coordinates in the main and insert map. The legend for the insert map has been added to the revised manuscript. The mean of grey line is the province or territory boundary of Canada. The red rectangle in the main map was used for some illustration of the sub-region in the next two Figures and we have added some states in the caption of the Figure (P13, Line284).

*(10) Line 325: The line thickness and format of Figure 8 may be modified to enhance the clarity, especially for the highlight of the "improved algorithm" line.*
**Response:** Thanks for the comments. We have modified the color of the "improved algorithm" line in the Figure to green (P18, L339).

*(11) Line 375: Similarly, the line thickness and format of Figure 11 should be adjusted.*
**Response:** Thanks for the comments. The line thickness and format of Figure 11 have been corrected in the revised manuscript (P21, L369).

*(12) Line 459: The TWI was calculated by a new algorithm? As presented in Section 2.2.1, the TWI is estimated by the definition reported by Beven and Kirkby (1979).*
**Response:** Thanks for the comments. The TWI is estimated by the definition reported by Beven and Kirkby (1979), but the slope and SCA in their definition are calculated by the new algorithm. It has been described in Section 2.2.1.