Responses to interactive comments on "Comparison of algorithms and parameterisations for infiltration into organic-covered permafrost soils" by Y. Zhang et al.

Y. Zhang, S. K. Carey, W. L. Quinton, J. R. Janowicz, J. W. Pomeroy and G. N. Flerchinger

The authors are highly appreciative of the constructive comments and suggestions made by the two anonymous reviewers. We fully agree with the issues and corrections raised by the reviewers. Implementation of the suggestions in the revised manuscript will greatly improve its overall quality. Following are revision details and responses to the reviewers. Reviewer comments are presented in underlined text, followed immediately by responses from the authors.

1. Revision made by the consensus of all the current co-authors.

One co-author suggested that J. W. Pomeroy be recognized as a co-author due to his important contribution of original research data. Consent has been reached among all co-authors that J. W. Pomeroy should be listed as a coauthor between J. R. Janowicz and G. N. Flerchinger.

2. Responses to anonymous referee #1.

2.1 The text mentions calibration and validation several times, but there is no explicit section describing how this was done. I'd like to see a short section or sub-section explain the cal-val process. I would make sense to include it in Section 3.3.

Descriptions of calibration and validation procedure were separated into two parts in the original manuscript, i.e. Page 5719 Line 9-15 in Section 3.3 and Page 5723 Line 15-22 in Section 4.5. In order to make the procedure more comprehensible to the readers, we combine these two parts into one integrated paragraph with more specific information than the original manuscript. In the revised version, the following quoted paragraph will replace the last paragraph of section 3.3. Corresponding changes will also be made to Section 4.5 to avoid repetition.

"The modified SHAW model is fed with daily surface forcing variables including T_s, R, M_{sn} and ET. Much smaller and dynamic time step (half-hourly or smaller) is used internally to ensure convergence of the numerical scheme. A 16-layer soil vertical resolution is used at all three sites. The layer depths are 0.05 m for top two layers, 0.1 m for 0.1-0.8 m depth and progressively increasing for deeper layers until the simulated soil bottom at 5 m. Site specific parameters (e.g. coefficients to quantify T_s and ET from known meteorological variables) and unknown initial conditions (e.g. initial soil temperatures and moisture profiles below the observation depth) were achieved by fitting the simulated diagnostic variables to their observed values during calibration years (1998 and 2004). The principal diagnostic variables are thawing depth, cumulative infiltration/runoff and soil liquid water content corresponding to the measurement depths. Since multiple unknowns and multiple diagnostic variables are involved, an iterative procedure is performed until all the diagnostic variables achieve their best fitting results.

Similar procedure has been performed in evaluating the thawing/freezing simulations in Zhang et al. (2008). The calibrated parameters and conditions at the end of calibration periods are then used to quantify the required inputs and initiation conditions during the model validations years (1999 and 2005). A common set of inputs and initial conditions are used for all the model validation runs with different infiltration algorithms to ensure valid comparison of the algorithms".

2.2 The results sections contains of lot of discussion. This is OK, but I suggest renaming the section to Results and Discussion, and then Conclusions.

Suggestion taken and manuscript revised.

2 3 The depth of thaw is a critical calculation. However, I don't see any explanation about how the various algorithms are accomplishing this. I think the heat transfer components of the various infiltration models are just as important as the water transfer components. However, heat transfer receives just casual mentions. The methods section should explain how temperature and thawing fronts are calculated in as much detail as how infiltration is explained.

The authors agree with this reviewer about the critical role of thaw depth calculation in infiltration simulation. Please see our conclusion point #1 (Page 5726 Line 10-15) to confirm. We have published a similar paper as current one to solely discuss the thawing/freezing simulation algorithms and parameterisation methods (see Zhang et al. 2008 in the reference list of original manuscript). In this study, the thawing/freezing scheme is from original SHAW model and kept the same for different infiltration algorithms. To clarify this, we will insert the following statement after " …a finite difference scheme." in Line 22 of Page 5718:

"The thawing/freezing process is simulated by an apparent heat capacity parameterization, which has been proved effective in permafrost regions by Zhang et al. (2008)".

2.4 Responses to specific comments from reviewer#1:

(page, line) 5711, 9-17: These sentences could be deleted. It is not worth listing the parameters that are already in tables. The paragraph could start with "Practically all of the parameters in Eqs. 1-6: : :"

Done

5715, 7: Add the word "scenarios" after "infiltration" so that the sentence doesn't sound like a general statement about infiltration.

Done

5715, 18: This approach to estimate snowmelt assumes that sublimation and evaporation

from the melting snow are negligible. While this may be true, I think it is worth stating.

Point taken. The following statement will be inserted after "(SWE)." in Line 19 of Page 5715:
"This approach assumes that sublimation and evaporation from the melting snow are negligible."

5718, 2-5: Begin the list components with the verbs with used, designed, and required.

Text revised.

5718, 22: Finite difference is a numerical method. In the previous review the authors stated that numerical methods are rarely used because they are computationally intensive. They therefore did not review numerical methods. Perhaps some clarification is needed.

The numerical method excluded from this study refers to the numerical method for infiltration simulation. The finite difference scheme here is for solving the soil temperature and soil moisture redistribution among the soil layers. Hopefully, the insertion of following statement after " …a finite difference scheme." in Line 22 of Page 5718 and before the insertion stated in revision #2.4 will clarify the confusion.

"The numerical scheme quantifies the depth of soil thawing/freezing and the soil moisture redistribution among soil layers by non-infiltration processes."

5719, 24: I suggest placing the figure reference at the end of the sentence such as shown below. There are several examples throughout the text like this.
All three commonly used methods in Table 5 are able to fit observed soil water retention curves in moderate soil moisture ranges for several organic soils (Fig. 1).

Good suggestion. We will make changes to all the occurrences.

5722, 15: In line with the previous comment, the phrase "Results show that: : :" is unnecessary. This is the Results section, so you don't have to say it again. There are many examples of this writing habit throughout the text.

Changes have been made throughout the text to address this.

5723, 22-23: This sentence can be deleted, and then include (Table 7) at the end of the next sentence.

Done.

5723, 27: This sentence is unnecessary. It simply states what is in the figure. This can be accomplished in the figure caption.

It will be deleted from text and explained in the figure captions.

5726, 10: Delete the phrase “This study demonstrates that: : :”. Just say it.

Done

3. Responses to anonymous referee #2.

3.1 Specific comments: Because of the large amount of information (equation and parameter lists, and figures), I found it rather cumbersome moving back and forth between the text and the figures or tables. Hopefully, the final editing and placement of figures and tables will help in this matter.

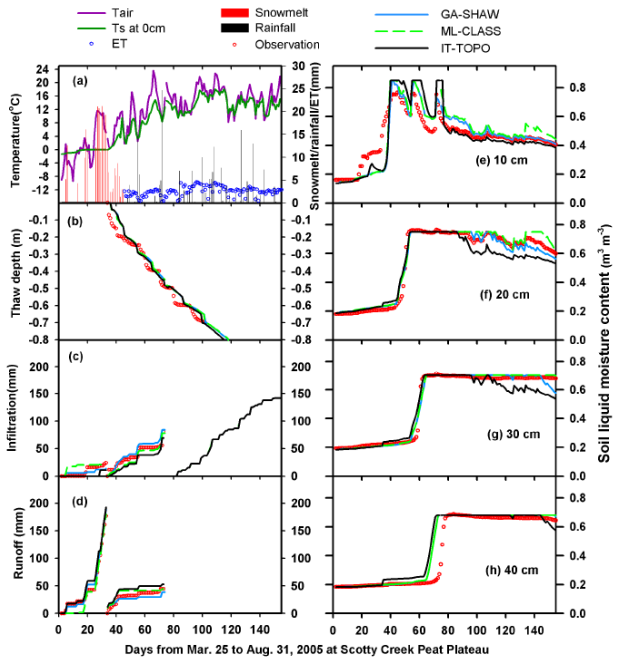
We hope in the final published format, the figures and tables will be put back to text where they are firstly referenced. As for the equations and parameter lists, we believe that put them into integrated tables could help comparison and look-up.

3.2 Section 5 is called Discussion and conclusions; however, essentially all of the discussion has been provided in section 4. The section titles could be modified to reflect this.

We will change as suggested. Also see comment #2.2 of reviewer #1.

3.3 Adding colour in figures can be quite useful. However, one should pay close attention to the selection of colours to be used; dark bleu and black may be difficult to differentiate; the same may be true for certain shades of red. The difficulty to differentiate colours will be greater when the figures are reduced. The authors may want to review Figures 5 - 7 with a view to ensure clarity.

We tried our best to improve the color schemes of Figures 5-7 in the revised manuscript. Following is an example for Fig. 5.



3.4 Technical corrections:
P. 5707, line 5. the reference "Gusev, 2003" does not appear in the references list; should this be "Gusev and Nasonova, 2003"?

Corrected

p. 5707, line 21. the word "macrospore" should read "macropore".

Corrected

p. 5708, line 8. the reference "Kuchment et al., 2000" does not appear in the references list.

Reference added.

Kuchment, L. S., Gelfan, A. N. and Demidov, V.N.: A distributed model of runoff generation in the permafrost regions. J. Hydrol., 240, 1-22, 2000.

p. 5712, line 1. the reference "Quinton, 2008" should read "Quinton et al., 2008"?

Corrected

p. 5724, line 29. Should read: "... as it does not allow water to infiltrate..."

Changed

p. 5742, Table 4. In order for the table to stand alone, the use of abbreviations should be avoided, or they should be explained. The full names should be used rather than the designations "SC-P", "WC_F" and "WC_A" in the column headers.

Good suggestion. We will follow.

p. 5744, Table 6. See comments for Table 4. The column to the right (header "Thawed") appears not to be associated with any of the three sites. Is this simply a mis-placed column?

Thanks for pointing out. The abbreviations will be avoided. There was a formatting error in Table 6. Column groups should be “Frozen, Thawing and Thawed”. Spacing that separated the groups should be between column “thawed” and column “frozen”. The site name should in the middle of the three columns.

p. 5745, Table 7. In the table title, the word "accumulative" should be replaced with "cumulative".

Corrected

p. 5746, Fig. 1. The boxes (a) and (b) refer to Granger Creek. This site has not been mentioned in the text. The location and/or description of this site should be provided in the figure caption as well as in section 3.2.6.

The following statement will be inserted before “The mineral soil…” in Line 21 of Page 5714.

“Some organic soil parameters that are not available from WC_A and WC_F are estimated from measurements taken at Granger Creek site, located on a north-facing slope above treeline in a subcatchment of Wolf Creek.”

Caption of figure 1 will be changed to

“Figure 1. Measured soil water content–pressure head relationships and best fitting curves with three parameterisation methods for several organic soils at a peat plateau of Scotty Creek and at a north-facing slope of Grange Creek.”