

Interactive comment on “Two-Dimensional Liquid Water Flow through Snow at the Plot Scale in Continental Snowpacks: Simulations and Field Data Comparisons” by Ryan W. Webb et al.

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Thank you for the review of our manuscript and I apologize for not responding to this review sooner.

The major comment is that quantitative comparison of the model results to field data are not done. While we agree that this would greatly improve the manuscript, there are some difficulties that arise. For example, our model has a 20 m long domain with no flow upper boundary conditions whereas field data have no such limitations. However, we can likely make some comparisons based on the previously published observations and are happy to spend more time making these comparisons.

C1

Minor comments:

P3 L75-82 Please clear what scheme did the author use for the water transport in the SNOWPACK (bucket, Richards equation or dual domain approach).

Response: We will clarify the scheme in revisions.

P4 L91-92 The resolution of elements differs 50 times between parallel and perpendicular to the slope. Does it lead any problem for correct simulation due to this large resolution difference?

Response: The variability in properties occurs in the vertical direction which is what justifies the difference in resolution. This should not have an impact on the simulation results at the scale of interest.

P4 106-116 This paragraph describes that authors performed the snow pit observation of tracer experiment, measuring water content distribution. These data should be used for quantitative validation especially the distance of the water movement for longitudinal direction. Comparison with these observations enhances the value of simulation result.

Response: We can certainly add some comparisons to these data as suggested.

P5 L131-135 Snow profile data should be shown in Fig. 3 especially grain size and snow density. These parameters relate the formation of capillary or hydraulic barriers which lead to longitudinal flow.

Response: We will add these data in revisions.

P5 148-155 The number of longitudinal flows were used for the validation of this model. Although, accuracy of longitudinal flow path means that capillary or hydraulic barrier was reproduced correctly, it did not mean the slope flow characteristics was reproduced well. Also, authors should show figures of result of field experiments, not only reference.

Response: We will add more comparisons with field data as previously mentioned.

C2

P6 173-175, P7 L193-195 In my opinion, neglecting heterogeneity affects the ratio of water flow direction (parallel or perpendicular to slope) rather than the number of longitudinal flows. Heterogeneity sometimes leads the movement to a difficult direction, which leads to decreased the ratio of water flow direction. So the ratio (250:1) has the possibility to be overestimated of the ratio due to neglecting heterogeneity. Furthermore, it was not endorsed by field observation.

Response: This is one of the reasons that we discuss heterogeneity being a necessary question for future research (Line 181). As for the ratio of 250:1, this occurred many hours after surface melt stopped and many layers naturally drained. field data show liquid water remained in layers of hydraulic barriers, thus this ratio occurs when most vertical flow has stopped and almost only longitudinal flow along the layers remains. This will be clarified in revisions.

P7 L197-199, 205-206 Authors have several field data. But they were only used for mention for consistency of the trend. Can the author make quantitative comparison between field data and simulation?

Response: More comparisons, including quantitative where possible, will occur in revisions.

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