

We would like to first express our appreciation to Dr. Nander Wever for reviewing our manuscript. We especially appreciate the constructive criticism of our work and the suggestions for improving the manuscript. We believe that some excellent points are made to improve the final product. Below are our initial responses to the comments with the original comment quoted followed by our response in blue. We are happy to further discuss anything that is not clear.

Comment: “Even though the concept of the study is very robust, the manuscript itself falls short at several aspects, and many issues are not, or only weakly discussed.”

Response: We appreciate this broad feedback on our manuscript. I think that we revised an earlier version of the manuscript to focus on brevity and ended up over-editing. Many of the points that you identify are true and more information would likely make the study clearer and offer further discussion and insights into processes. We address these concerns in the other, more specific comments below.

Comment: “The main drawback of the way the study is presented is the lack of validation with the available field data (as for example published by the authors as Webb et al, 2020)”

Response: Looking back over the manuscript, I definitely see your point here. Per my last response, I think we ended up over-editing for brevity and relying a bit too much on the previously published field observations. In the future revision we will certainly include more of the validation. As suggested in your comment, SNOWPACK comparisons do compare well to observed wetting of the snow profile from a bulk perspective (total LWC in entire profile) and we will also check wetness of layers.

Comment: “Also, it is reported that: “Initial conditions were provided through manual snow pit observations” (L92), while at the same time, it is reported that: “Within this domain, the iTOUGH2 numerical model simulated the flow of liquid water with time-varying snow layer properties provided by the SNOWPACK model.” (L59). That seems contradictory.”

Response: Many of your comments and thoughts on this are true. We apologize for not being clearer in the writing. We can certainly expand on this methods section in revisions. But to clarify in this interactive discussion, we initiated a SNOWPACK simulation with snow pit observations. The hourly output from SNOWPACK are used to define the material properties and introduction/subtraction of any liquid water through melting/freezing in iTOUGH2. Any liquid water that remains and is not re-frozen is transported following Richards’ equation in the iTOUGH2 simulation.

The microstructure of the snow does not change much at the time scale of our study, with the exception of the melting/accumulating layers near the snow surface. iTOUGH2 has not previously been capable of temporally varying properties or the removal of layers, so these upper layers in the snow allowed this new capability to be tested along with pretty minor changes deeper in the snowpack.

Comment: “Furthermore, I struggle to relate earlier reported dye tracer levels to the ones shown here”

Response: These are excellent points and I will make sure to double check that our presented results match with observations previously published. However, it is important to note that there were multiple dye tracer experiment observations at some of the sites reported in previous publications. This will be made more clear in revisions through using the same name of sites and specifying which set of observations are used. We will also double-check that observations are correctly input into figures.

Comment: “In Webb et al. (2020), it is reported that the SNOWPACK simulations were run using the Richards’ equation water transport scheme. However, the liquid water content distributions shown in Fig. 2 in Webb et al. (2020) and Fig. 2a in this manuscript, are remarkably homogeneous, even though I found in multiple studies that using Richards’ equation in SNOWPACK leads to inhomogeneous water distributions. To me, it looks like results from the bucket water transport scheme”

Response: Thank you for pointing this out. Upon further review of our input files, we did use the bucket scheme for seasonal simulations to have an idea of the temporal evolution of liquid water (i.e. timing of melt, etc.). We then use Richards’ scheme for the shorter time domain of the study periods. We will add more detailed descriptions to explain this and figures that show the results of the Richards’ scheme as implemented in the study. We apologize for this mistake and thank you for noticing this.

Comment: “At several instances, it is important to repeat information from earlier published work. For example, the setup and driving data of SNOWPACK simulations should be explained in more detail.”

Response: I agree. I think this is one example where we over-edited for brevity. We will repeat information from previous citations to make the current manuscript stand-alone.

Minor Comments: multiple

Response: Thank you for these comments. The requests for more information pertaining to specific calculations and methods will be included in revisions and directly addressed in the final response to reviews.

If you would like further clarification on specific methods or have further thoughts on how we may improve the presentation of results, we welcome your feedback.

Thank you again for the thorough review.