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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Liquid water infiltration into a layered snowpack: evaluation of a 3D water transport model with laboratory experiments" *by* Hiroyuki Hirashima et al.

Anonymous Referee #2

Received and published: 12 July 2017

This paper presents model simulations performed with a recently developed 3D model for water movement through snow (published by the authors in 2014), to simulate recently published detailed experiments by Avanzi et al., 2016. These simulations show good agreement with the experimental results, for water content, timing, preferential flow, and ponding of water at capillary barriers. The results demonstrate that the recently developed model represents the complex physics of unsaturated flow in snow quite well, as long as the snow material properties (grain size, density, etc) are known.

There are a few additional steps that the authors could likely easily take, which would greatly improve this manuscript. I would highly recommend these improvements before

publication:

1) The authors compare their simulations to simulations using the operational SNOWPACK model, and argue that their representation of preferential flow allows more accurate estimates of water flow timing and liquid water content. However, they use the SNOWPACK model without the recent improvements in this area (e.g. Wever et al, 2016; Wurzer et al, 2017), although these papers are cited. To complete this study, they should compare their small scale 3-D model with the most recent SNOWPACK model, which includes these improvements.

2) A sensitivity analysis would be very helpful. The authors use the measured grain sizes (from seiving) used in the experiment, and report these values to 0.001 mm. In nature, grain sizes are typically measured to 0.1mm, and models of grain growth are unlikely to be accurate to better than 0.5mm. It would be very helpful to see how sensitive their model results are to variations in grain size on the order of 0.1mm.

3) A recent similar paper using a different model, by a different group, also used the Avanzi et al, 2016 experiments and attempted to reproduce their results with a 2-D snow heat and mass flow model: Nicolas R. Leroux , John W. Pomeroy , Modelling capillary hysteresis effects on preferential ßow through melting and cold layered snowpacks, Advances in Water Resources (2017), doi:10.1016/j.advwatres.2017.06.024.

While the Leroux and Pomeroy paper was not published at the time this paper was submitted, now that it is accepted and online, it would be useful for the authors to cite and discuss the differences between their model and this one.

4) A more thorough discussion of model resolution would be appropriate. At the resolution of this model, it is unlikely modeling could be performed at the basin scale. How do the authors envision this new understanding of liquid water movement in snow, to impact large scale snow models? How could this understanding be implemented (emperically?) in operational modeling contexts?

Overall, this paper is well-written, presents a new result, and is suitable for publication in HESS.

Detailed line-by-line edits/suggestions are in the attached PDF.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2017-200/hess-2017-200-RC2-supplement.pdf

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