The Cryosphere
Discussions

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Interactive comment on "Verification of the multi-layer SNOWPACK model with different water transport schemes" *by* N. Wever et al.

Anonymous Referee #1

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General comments

In this paper, SNOWPACK model was verified using observation data for multi year. This verification pointed out positive and negative change by replacing a bucket scheme with RE scheme. In addition to comparisons discussed in this manuscript, suggestions of studies to reduce discrepancies should be discussed for future reference. It will be informative to decide what observation and experiment is necessary to improve SNOWPACK model.

Many discussions are about the difference between RE model and bucket model. In terms of runoff, calculation scheme affects simulated results. However, in terms of wet snow area, residual water content seems to affect more rather than calculation scheme. According to author's previous paper (Wever et al., 2014), residual water content was

not constant and not larger than 0.02. I think values or temporal variation of residual water content of bucket scheme and RE scheme should be shown in this paper. If the difference of θr between two schemes is large, discussions about suitable value of θr is also necessary.

Specific comments

P8 In section 2.2, improvement of a calculation scheme for soil was discussed. It is one of the updated contents of the model in this paper. However, the effect of this improvement seems to be not shown in this paper. Is there large differences at the snow-soil boundary between before and after improvement of soil scheme? Probably it will be verified by comparison between simulated and observed soil water content profiles. It may be future works.

P16 L20 Table1 showed average values for more than 10 years. I think it varies from year to year. Therefore, information of fluctuation from year to year is also necessary in Table 1. For example, standard deviation of annual average is calculated and added in Table 1 as 'average ($\pm$SD)'

P19 L13 True, snowpack runoff is strongly coupled to the LWC distribution, but good agreement of runoff does not mean good agreement of water content in the snowpack. Do you have any water content profile data obtained in snow pit observation? Direct comparison of water content is important even if it is discontinuous and destructive.

P20 L8 NSE coefficient of snow-height driven simulation is better. I agree accurate percolation time is one of the reasons of it. In addition to this, does the difference of date of snow disappearance affect NSE? In many years, snow disappeared faster in precipitation driven simulation than that in snow-height driven simulation. In NSE estimation, did you consider the period after snow disappearance in precipitation driven simulation? Also, Table 1 had better include difference of date of snow disappearance.

P20 L16 In Fig6a, different Y-axes were used for different depth of sensor of soil tem-

perature. Before I aware the difference of y-axis, soil temperature seemed to be stable around 3 and 6 degree Celsius at 30cm and 50 cm in depth, respectively. To avoid misunderstand, caption is necessary at the right side, and scales of right side should show 0 at the zero-point.

P22L3 Is Figure 8a misdescription of Figure8? Also, It needs caption on right side and showing 0 at the zero-point as well as previous comment for Fig. 6.

P24 L1 Fig. 11 showed comparison of measured and simulated snow density separating upper, middle and lower part. I think it is suitable using relative height (1 at the top and 0 at the bottom) like relative date used in Fig. 2, and compare at the specific relative heights (e.g. 0.1, 0.5 and 0.9).

P25 L7 According to fig. 13a, simulated increase of average grain size during melt season seems to be smaller than that in observation. Also, according to fig. 13b, simulated SD was smaller than observed SD. Although display of average and SD express overall trend, it is not easy to find the reason of discrepancies. Can you add the example of direct comparison of grain size profile in supplement figures?

P21 L11 and P27 L26 Isothermal part of snow temperature relates the wet snow area. In terms of isothermal part of temperature, simulation result of RE scheme corresponded better with observations than bucket scheme. On the other hand, comparing with the upGPR measurement, bucket scheme corresponded better with observation. Can you explain the reason of this contradict results?

P29 L19 In conclusion, you wrote "updated soil module can provide a correct lower boundary for snowpack in the model". Is it written in the main text? I could not find the discussion of difference of reproducibility at the boundary with calculation schemes in section 4.3 and Figure 6b.

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