The Cryosphere Discuss.,
doi:10.5194/tc-2016-185-RC1, 2016

The Cryosphere Discussions
Open Access
EGU

Interactive comment on "Simulating ice layer formation under the presence of preferential flow in layered snowpacks" *by* Nander Wever et al.

Anonymous Referee #1

Received and published: 8 September 2016

Implementation of the preferential flow process into one-dimensional numerical snowpack model is valuable effort. Reproduction of ice layers in numerical snowpack model is also valuable. Furthermore, the dual domain approach is interesting idea. I appreciate the development of the new schemes to consider the preferential flow effect. On the other hand, considering the heterogeneous process in one dimensional model needs the various assumption, and it leads to the discrepancy between simulations and field observations. In the present state, this model still have the limitation of accuracy. In my opinion, achievement in this paper is new development of the concept to implement the preferential flow process in one-dimensional model with the purpose of reproduction of ice layers. The accuracy of this model is expected to be enhanced by cooperation with multi-dimensional model and laboratory experiment. In that context, the suggestion in the discussion section, laboratory experiment with small water input rates and heat

Printer-friendly version

Discussion paper

process simulation with multi-dimensional models, are important messages from this study. In my opinion, this paper is acceptable in the Cryosphere. I made lists following minor comments to make better contents of the paper.

minor comments

Introduction: Attempt to consider the effect of preferential flow in the numerical snowpack model is also tried by Katsushima et al. (2009). The preferential flow process in their model is not physical base, but it is the start point of their experiment in Katsushima et al. (2013). I recommend to include following reference.

Katsushima, T., Kumakura, T., Takeuchi, Y., 2009. A multiple snow layer model including a parameterization of vertical water channel process in snowpack. Cold Regions Science Technology 59(2-3), 143-151.

P3 l22: In the present state, Equation (1) seems reasonable method to estimate the ratio of preferential flow area. However, this equation is too simplified and needs the improvement in the future. For example, considering only grain size is not sufficient. If author has any ideas of the experiment to improve this equation, I recommend to add the suggestion in this manuscript. It will be informative message for other researcher.

P3 l25 Usually, preferential flow path area get wider with time. Therefore, decrease in preferential flow area due to grain growth seems distant from actual process. However, in the dual domain simulation, if the decrease in preferential flow area due to grain growth leads the movement of water to matrix flow area, it can be considered as indirect expression for expansion of preferential flow area.

P8 L26 Fig.5 Can you add the detailed figures of snow temperature, density and water content focusing the beginning of March during the formation of ice layers? It helps the understanding why ice layer formed only the simulation with preferential flow.

p9L7 When the density data was counted, was the layer thickness considered? Also, Fig.6 show two figures, left one seems for all layers and right one seems data in specific

Printer-friendly version

Discussion paper

condition. However, in PFP simulation, the data near 900 kg/m3 existed in right figure despite it did not exist in left figure. It seems strange.

P9 L20 Figure 7 does not include the result of REQ. Ice layer may form even if the preferential flow is not considered depending on temperature and liquid water condition. Result of REQ had better be included in Fig. 7 to show the advantage of the consideration of preferential flow.

P10 6-7 No consist difference of r2 values considering preferential flow indicates that the matrix flow is predominant in this period. Thus, I guess most of snow was wet in this period. When enhancement in accuracy of runoff by considering preferential flow is discussed, information of snow stratigraphy should be included to show the ratio of dry snow, existence of ice layer and difference of grain size at layer boundary. Results of runoff simulation is discussed mainly in Würzer et al. So if their paper shows the snow stratigraphy as well as runoff simulation, it is not necessarily required in this paper.

P10-11 In the discussion section, descriptions '(1)P10L27-31, the absence of studies at low input rates makes the general validity of condition 1 we implemented uncertain (2)P10L6-9 Muti-dimensional snowpack models may help here to develop better understanding of the heat exchange processes between preferential flow paths and surrounding snow matrix, as a function of the number density of active preferential flow paths' are important messages. These suggestions provide the idea for valuable laboratory experiment and analysis using other model. If authors have other idea (e.g. the experiment to parameterize the process of transition from preferential flow to matrix flow.) and added in the manuscript, it will be welcomed as valuable information for reader studying wet snow.

Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-185, 2016.