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The Cryosphere Discussions

Interactive comment on "Simulation of the specific surface area of snow using a one-dimensional physical snowpack model: implementation and evaluation for subarctic snow in Alaska" *by* H. W. Jacobi et al.

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General comments

The paper deals with the snowpack modelling in the Alaska environment. In a first step, the authors use the snow model Crocus and show some limitations that are due to the fact that Crocus has initially been developed for alpine seasonal snowpack. In Alaska environment, some physical processes like vapour transfer in the snow or soil dehydration play a significant role, which explain some model limits. Thus, the authors

test the sensitivity of the model to some parametrizations (like ground heat flux, heat conductivity or turbulent fluxes) to better understand what should be investigated in the model in order to improve the results. Nevertheless, general results appear to be realistic enough in order to introduce the simulation of a new variable. In a second step, the authors implement the Specific Surface Area (SSA) of the snow in Crocus. They use two different parametrizations, assessing the SSA from snowpack characteristics (following Dominé et al., 2007) or directly from temporal evolution (following Taillandier et al., 2007). This work appears me to be well structured and innovator. Indeed the SSA is a parameter which is now more and more frequently measured in the field with a sufficient accuracy and numerous methods are available to get large data sets. Moreover, it presents a real interest for snow models as a quantifiable variable which plays a major role in different physical and chemical snow processes. The paper is a first step to introduce the SSA in a sophisticated snow model. The methodology is clearly explained and a particular attention is paid to the model results analysis (advantages and limirts). The references appear to be pertinent and the figures are convincing. The work presented in the paper is very valuable and offer three main outlooks : 1) the Crocus results analysis points out the physical processes which are dominant in a sub-artic snowpack and that should be improved in the model for this kind of snowpack, 2) the SSA simulations are very encouraging and the method needs to be extended to other snowpack types, based on SSA data bases which are actually or should be soon built. 3) The next step will be to use the SSA in a complete loop to modify snowpack characteristics (e. g. albedo), i. e. to simulate a complete feed-back between SSA and the other snow physical variables. Given the very good quality of this paper and its innovator results, I strongly support its publication in The Cryosphere.

Specific comments

Page 70, line 6 and figure 5 : how is estimated the SSA for melting period? Is there a specific parametrization when the snow contains liquid water? This point should be précised in the paragraph 2.4.

Page 702, line 24 and following : this disadvantage seems a bit artificial, because it is due to the choice of a correspondence criteria between the snow type and the simulated snow grain characteristics (paragraph 2.4). If this correspondence was "smoother" from one grain type to another, the SSA discontinuities would disappear, which would be physically consistent.

Page 706, line 7-8 : authors accord a better value to the prognostic equations because of a better agreement of the results. Since these equations have partly been established in the snow field on the Fairbanks site, it is probably a part of the explanation of their good results. Could the equations easily be transposed to other snowpack types? This point should be discussed in the paper.

Figure 5 (and other coloured figures) : the colour scale is ambiguous : for instance dark blue corresponds to values between 0 and 100 cm2 g-1 ? Moreover all the colours do not appear in the scale, which is a bit tricky. This should be improved.

Figure 6: the uncertainty for SSA observations and simulations is lacking. For the model for instance, it could be estimated from the different sensitivity runs and from the uncertainty of the equations (4) to (10). For the observations, the uncertainty is probably discussed by the papers which provide them (Taillandier and Dominé). This would help the reader to interpret the differences between observations and the two ways of simulating SSA.

Figure 9 : are there enough observed SSA data in each snow pit to accurately evaluate the snow area index? Indeed, when one considers observed data on figure 6, one has the feeling that the vertical sampling is relatively weak, especially close to the surface (where SSA values are the highest). Did the authors take into account this uncertainty source in the error bars calculation presented on figure 9?

Interactive comment on The Cryosphere Discuss., 3, 681, 2009.