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Interactive comment on "Seasonal evolution of snow permeability under equi-temperature and temperature-gradient conditions" *by* F. Domine et al.

Anonymous Referee #1

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General Comments

This is an interesting study of snow permeability seasonal evolution in two different regimes of snowpack metamorphism. The results regarding the influence of depth hoar microstructure on permeability/air flow are particularly interesting and I believe an important contribution to the body of work regarding these kinds of investigations. There are some instances where the manuscript could be clarified to help make certain points more readable, as noted below, and a very few typos. I also think there are a few instances where the methodology and parameters being used need to be described, which I've noted below in chronological order.

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Specific Comments

My one main concern with respect to the scientific merit is the ET measurements, which seem to e very unrealistic. I think a stronger case for why these measurements are relevant or important is needed. I do think that it is an interesting comparison between the evolution and the deviations from the model results of the two metamorphic regimes, but this should be discussed in the introduction.

Technical Corrections

Abstract, line 34, This sentence is confusing on first reading, and I think because the idea of the depth hoar not being spherical is introduced rather abruptly. I would suggest rewriting to "Simulated permeabilities are up to a factor of two greater than measurements for depth hoar layers, which we attribute to snow microstructure and the aerodynamic properties of the snow crystals." If the sentence is left as is, an added description of the model using SSA to calculate permeability might help to make this easier to understand.

Line 38. I suggest making this into two sentences as it is a bit of a run-on, i.e. . . ."Finally, the large difference in permeabilities between ET and TG metamorphic regimes will impact atmosphere-snow energy and mass exchanges. These effects deserve consideration. . ."

Line 45. This sentence is slightly awkward, borderline not grammatically correct. I would suggest rewriting as, "One noteworthy consequence of these processes is the deposition of atmospheric particles such as sulphate and sea salt to snow, affecting the snow chemical composition."

Line 63 and throughout, The format of the citations that are directly referred to as part of sentences is strange, and should be checked that it conforms with the journal guidelines, i.e. normally the citations would be formatted as Domine et al. (2008).

Line 65. Should be written as "to be able to properly calculate. . ."

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Line 68. This sentence is unclear, and should be written, “Equations have been proposed that relate permeability to other snow physical parameters. Shimizu (1970) relates permeability to snow grain size, r, and snow density. . . .and is probably the most widely used:” And I suggest citing some references after the first sentence, as there are several (i.e. Freitag et al., 2002; Horhold et al., 2009 among the more recent). I also would suggest adding a phrase describing r as being determined from hand lens measurements, to differentiate this r from the r determined from SSA in Eq. 4.

Line 73. “offer” should be “offers” or change “work” to “works” and leave offer singular

Line 86. “during” should be “due to”

Line 91. In order to clarify that the measurements were made by Taillandier, this sentence could be written as “against in-situ collocated measurements of K, SSA and rho which are presented in Taillandier et al. (2007) and Taillandier et al. (2006). . .”

Line 101. This sentence is confusing, and I would suggest writing as “The site was in a clearing with a low wind setting which resulted in a laterally homogeneous snowpack. . .”

Line 101. What is the typical wind speed of the area?

Line 104. Because only one temperature is mentioned in the previous sentence (-40), I suggest writing the next sentence as “The low air temperature, combined with. . .” The word “to” should be changed to “with” to make the sentence grammatically correct.

Line 116. What is the range of the temperature gradients? I think it would be helpful to state that here.

Line 125. This sentence is awkward. . .I suggest rewriting as, “Even though the wind was never strong enough to cause saltation at the ground level. . .”

Line 137. The acronym CRREL should be defined.

Line 143. What is the range of pressure differences measured?

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Line 145. Even more importantly, what is the range of flow rates measured?

Line 157. This sentence is awkward, and I suggest, “The main improvement over the previous-stand along version of Crocus (ref.) is that the snowpack. . .”

Line 162. By “ground surface,” do the authors intend “snow surface” ? It should also be “below the ground (or snow) surface”

Line 163. Should be “imposed on” not “imposed to” This section is confusing in that the description of the model set-up is jumping between the ground and table model inputs.

Line 175. What does the word “diagnosed” refer to? Is it the modeled or computed properties?

Line 177. There is either a missing closing parenthesis at the end of the citation, or if citation formats are changed, there is an extra parenthesis.

Line 183. “increase” should be “increases”

Line 183. This phrase is awkward, I suggest “to phenomenologically represent the impact of snow metamorphism” or something along those lines.

Line 185. What do the variables Tfus and T represent? And what is the definition of alpha sub eta? Or is it just an empirical fit?

Line 187. “To overcome unrealistic hampering of snow compaction. . .” is awkward, and a little unclear. I would suggest something like, “In order to prevent the model from unrealistically computing low snow compaction due to sustained extremely low temperature conditions. . .”

Line 199. ERA-Interim should be defined and briefly described.

Line 200. SUFEX/ISBA-Crocus should be defined and briefly described.

Line 203. The acronym LARS should be definedâĂŤmaybe in line 199 when the study site is introduced as being at LARS.

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Line 210. The impact of the altitude difference should be specified (maybe even just the percent differences) so that the reader can determine if it is insignificant.

Line 211. “twice higher than” should be “twice as high as the in-situ data”

Line 229. “stratigraphies” isn’t commonly used, but instead “stratigraphic layers” is more commonly used. It is also a little confusing what the stratigraphy is from, the samples or the pits?

Line 234. As above, “stratigraphies” in not in common usage

Line 240-244. This section is slightly confusing because it is not always clear that the table snow is being referred to in the plots, i.e. it might be helpful to specify that “The results for the table snow in Figure 3 show. . ..” and then, the rest of the sentence is hard to follow, only because “towards the top” is vague, so perhaps finishing the sentence with something along the lines of, “. . .a decreasing trend in the top 20-30 cm of the density profile.” Also, the density trend should be increasing, or at least it appears to be increasing at the top in the figure. Or is this referring to the decrease in density at the bottom 10-20cm of the profiles? In any case, this is confusing and should be sorted out.

Line 256. The phrase “on the contrary” is awkward and should be deleted.

Line 258. This first sentence is confusing and/or grammatically incorrect. I suggest, “The present data can be combined with SSA, density and permeability measurements to test the relationship. . ..”

Line 262. “nor” should be “not”

Line 296. The sentence should be written, “The model illustrates the contrasted thermal field within the snow between the ground and table simulation well.”

Line 319 and elsewhere. The reported permeability values are missing the “x” term before the exponential term, i.e. 200 x 10ˆ-10 is written as 200 10ˆ-10

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Line 320. Awkward as written. Maybe, “On the contrary, values from the snow on the ground keep increasing up to about. . .” ?

Line 322. “follows” should be “follow”

Line 347. “within” should be “with”

Line 348. Actually, field measurements of the same type and same sample of snow are generally within 10-20% (depending on the instrument, and possibly instrument user), so this bais is high.

Line 350. What are the sources of error in the simulated data?

Line 368. “that” should be “than”

Line 376. “are” should be “is” or you should change “difference” in line 375 to “differences” to make verb and subject agree

Line 384. There is either a missing parenthesis or an extra parenthesis depending on how the references are formatted.

Line 389. “equations (3)” should be “equation (3)”

Line 391. “coupled to” should be “coupled with” and “result” should be “results”

Line 395. I think the rest of this paragraph is speculation. As there are no measurements or model results to support it, I think the discussion of anisotropy and horizontal permeability should be deleted. (the last sentence is fine comparing TG and ET snow, and that is interesting)

Line 400. Similarly, I think the last paragraph brings up some very interesting points, but does not belong in this section of the paper, since it again is speculative and not supported by measurements. It maybe could go in the intro/background as motivation to do this sort of work, or this section of the paper could be introduced as “some possible implications of the effect of temperature gradient metamorphism on snow properties

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are. . .” or this paragraph should be deleted.

Line 421. This sentence is slightly awkward, I suggest deleting the “Then” in front of the sentence.

Line 423. The simulated results are reasonable for the ET snow, as shown in table 2, but they are not as reasonable for the ground snow. You should specify this in the conclusion.

Table 2. I think “n” should be defined as the number of samples measured

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Interactive comment on The Cryosphere Discuss., 7, 2725, 2013.