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Discussions

Interactive comment on "Tomography-based observation of sublimation and snow metamorphism under temperature gradient and advective flow" *by* P. P. Ebner et al.

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By employing time-lapse micro-CT approach, the work by Ebner et al. (2015) provides a fresh look onto old and important questions of sublimation and ice reposition within snow, which are indeed crucial for our understanding of snow physics and snow chemistry. Overall, I find the manuscript to be in a good shape, but nevertheless would like to suggest multiple points to consider for improving the readability and clarity of the paper.

p. 4846

Line 14

Consider giving a broader perspective: ". . . relevant for atmospheric chemistry." -> ". . . relevant for atmospheric chemistry {and isotope contents in snow}."

p. 4847

Line 1

In this introduction, I suggest to remind this well familiar effect before giving its name, say: "due to the Kelvin-effect" -> "due to higher vapor pressure over curved surfaces (Kelvin-effect)"

Line 10

As non-native English speaker, I can not correct language. Nevertheless, I note that I never saw "whistler-like crystals" in conventional snow classifications and could not get what was meant by it.

Lines 10-11

Please, reread this sentence, seems to be the opposite? You say the opposite (in p. 4850, Lines 18-21).

"The flow rate dependence on the deposition rate of water vapor on the ice matrix was observed, reaching asymptotically a maximum rate of . . . (Ebner et al., 2015b)." ->

"The {deposition rate of water vapor on the ice matrix} dependence on the {flow} rate was observed, reaching asymptotically a maximum rate of . . . (Ebner et al., 2015b)."

Line 19

In regard to ice-core interpretation I also suggest to add a reference to experimental study on isotopic content of snow driven by sublimation.

Ekaykin, A. A., Hondoh, T., Lipenkov, V. Y. and A. Miyamoto (2009) Post-depositional changes in snow isotope content: preliminary results of laboratory experiments, Clim. Past Discuss., 5, 2239–2267.

Lines 22-23

About Albert (2002) and his 2D finite-element model ->

Please note, that much more recently Slaughter and Zabaras (2012) took into account such effects on microstructure through a 3D FEM micro-structural model, which considers vapor deposition and sublimation within the snow. The latter study is indeed very relevant reference here.

Slaughter AE and Zabaras N (2012) A phase-tracking snow microstructure model. In Proceedings of the International Snow Science Workshop, 16–21 September 2012, Anchorage, Alaska, 395–397 http://arc.lib.montana.edu/snow-science/item/1739

p. 4848

Line 8

the warm site of the snow -> the warm si{d}e of the snow?

Lines 10-11

If available, a range of estimated naturally occurring flow rates would be useful to mention here for indicating how significant the used values were.

Lines 15-16

"…and to evaluate the structural change in the earlier stage of metamorphism of new snow." -> I could not follow where in this paper this earlier stage had been discussed? Since it does not seem to be mentioned ever again in this particular manuscript, this phrase could be removed as irrelevant here.

Lines 19-20

Please, state the resolution of taken projection X-ray images and reconstructed 3-D scenes.

p.4849

Line 3

"is analyzed" -> "was analyzed" (for consistency with overall past tense) however, see also below where I suggest to remove this sentence.

Line 6

pictures -> images

Lines 7-8

"was determined by direct pore-level simulations (DPLS) to determine" -> to avoid repetition of the same word, in one place it could be "was estimated by …"

Line 9

a reference is made to Lowe et al. (2012), which does not appear in the references.

Lines 2-3 & 6-9

These two sentences could be easily merged to avoid redundant text and repeating references:

"As additional physical and structural parameter, the {effective} thermal conductivity{, k_e,} was estimated by direct pore-level simulations (DPLS) to determine the influence of changing microstructure (Kaempfer et al., 2005; Petrasch et al., 2008; Calonne et al., 2011; Löwe et al., 2012)."

Also, for someone who is not familiar with DPSL, an extra sentence introducing the main principle of this computational approach would be informative.

Line 19

"were observed for example, Fig…" "were observed{,} for example, Fig…"

Line 20

since a reference to test names is made for the first time, it could be smoothed by

adding: "for {tests} "ota3" and "ota4".

Here I also note that Tables 1 and 2 use test names which are different from those mentioned in the main text, Figs. 2 & 4 or a caption of Fig. 3 (e.g., "ta1" vs. "ota1").

Line 26

What was an uncertainty for estimated pore size? Similar to the one stated for evaluating reposition?

p.4850

Lines 1-2

Should be also mentioned that possible ice loss could not be detected due to limited accuracy (which is almost the same as provided values; p. 4849, Line 21)?

Line 13

What was the accuracy of estimated thermal conductivity (could be mentioned in DPSL part)?

Line 21

This phrase is slightly confusing: "In this study, changing flow direction lead . . .", given that in methods Fig. 1 showed this direction as constant. Was it flipped instead of flipping your heating system? If so, please, check if it is clear in methods. Or if it refers to previously published paper, re-written -> "In the {latter} study, . . ."

p. 4851

Line 5

the analyze volume -> the analyzed volume?

Line 7

due to the undersaturated airflow -> In methods, you indicated that the incoming ad-

vective flow was initially saturated. Here it is undersaturated. Due to warming during propagation? Perhaps, it could be mentioned here for a sake of clarity.

Line 11-12

Please, explain how mass transfer between diffusion and advection was measured? It remains not very clear from the context.

Lines 19-20

Please, clarify here what causes the increased interaction between air and ice. Residence time? Or air pressure increase due to Bernoulli's principle?

p. 4852

Line 14

I could not follow how Reynolds number was evaluated in the study, and in Table 1 in particular.

Line 22

As the air in the pore spaces are always -> As the air in the pore spaces {is} always

p. 4855

Line 14

Similarly to Abstract: ". . . impact on atmospheric chemistry. -> ". . . impact on atmospheric chemistry {and isotope contents in snow}.

Figure 3, caption:

108 h for (left panel) "ota3" and (right panel) "ota4". -> 108 h for "ota3" (left panel) and "ota4" (right panel).

Figure 4

- in the caption a reference to (b) is missing.

- also the label of y-axis for (d) uses different symbol from the one used in the main text. Should be consistent (k_e v.s. k_cond).

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