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The Cryosphere Discussions

Interactive comment on "Vapor flux and recrystallization during dry snow metamorphism under a steady temperature gradient as observed by time-lapse micro-tomography" *by* B. R. Pinzer et al.

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General comments:

The writing needs help, but the experimental work and results appear sound to me. The figures, particularly their captions, also need revision. The use of particle tracking to estimate vapor flux is simple and innovative. The most salient conclusion – that the ice lattice is constantly renewed – is well emphasized and supported throughout the manuscript. I am not qualified to provide in-depth analysis on the mass flux calcula-

tions, so I won't comment on those. I especially enjoyed the video supplement, which is the single most compelling piece of evidence for hand-to-hand vapor transport that I have seen.

In regards to the writing, the use of stacked adjectives and adverbs (i.e. "non-destructive direct view" or "initially almost fully rounded") and too many words in general dilutes the messages conveyed. There is tremendous overuse of the article "the." There are dozens of places where the can be deleted. For instance, (p. 1685 l. 6-7) "Because the ice structures gain mass at the (colder) bottom and lose mass at the (warmer) top, the vapor transport results in an apparent displacement of the structures" can more succinctly be written as, "Because ice structures gain mass at the (colder) bottom and lose mass at the (warmer) top, vapor transport results in an apparent displacement."

There are numerous style mistakes such as: repeated misuse of verb tense, errors in citation format, and incorrect pronoun usage. Idioms such as "on the one hand" are overused and add excessive verbiage.

I have made corrections and suggestions to improve the manuscript. With these revisions, this manuscript has potential to be a valuable contribution to the field of snow metamorphism.

Specifics:

The use of "steady temperature gradient metamorphism (STGM)" is too verbose. I suggest referring to it as temperature gradient metamorphism, without an acronym.

p. 1673

The affiliations are excessive. I suggest using only each author's current institution, removing both cases of "now at:" and the line "these authors contributed equally to this work", which is already discussed after the acknowledgments, for those who are especially interested.

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p. 1674

7: delete “steady” and (STGM)

9-10: delete “and in”, insert “to” after “addition”

10-11: delete “From the four-dimensional data set,” and capitalize “We”

12: delete “,” after sublimated

14: “snowpack” not “snow pack”, change all other instances to “snowpack”

18-19: replace “STGM” with “temperature gradient metamorphism”, delete “that is” and delete “by directly observing the microstructure of snow in situ”

24: delete “,” after i.e.

26: insert space between the temperature and °C, e.g. “-27 °C”.

p. 1675

28: delete “On the operational side, e.g.”, capitalize “For”

p. 1676

7: delete “all”

7-9: delete “Despite...mass transfer thorough snow,”, capitalize “Some”

21: delete “in situ”

22: change “an” to “a” and delete “instrumented”

24: delete “undergoing STGM”. Replace “non-destructive direct” with “this”.

26: replace “could” with “can”

28: same as l. 26

p. 1677

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12-13: delete “relative to its surroundings"

13-14: delete “relative to the surrounding grains”

20: define “tortuosity”

23: replace “Their” with “His”

26: change “(. . .)” to “. . .” and put in block quotes

p. 1678

1: change “they referred” to “Yosida is referring”

6: change “they” to “Yosida”

8-9: delete “, with an excellent. . .experiment,”

12: change “the author” to “Satyawali”

16: “conclude”

22: I’m using brackets here to avoid confusion. Change {[. . .]”.} to {. . .”}

24: change {[. . .]} to {. . .}

25-26: Should be: “He supports this work with earlier theoretical studies (Colbeck, 1983; Gubler, 1985; Sommerfeld, 1983), which predicted enhanced vapor flux.”

27: “indicates”

p. 1679

1: delete “(1993)” and “in general”

5: change “already pointed out” to “has shown”

6: delete “very”

13: delete “a”

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14: change “did” to “conducted”

16: delete (1994). Since there is only one Christon et. al study, the year of the study need only be cited in its first use.

19: Change ”Christon et al. (1994)” to “They”

22: delete “-“ after “2-D”

24: delete (1994)

p. 1680

7: delete “(Sturm and Benson, 1997)” and place period inside quotation marks, change “[. . .]” to “. . .”

9: “implies”

11: change “implies” to “suggests”

14-15: point (2) needs to be shortened. I suggest: “(2) How large is the contribution of latent heat to the total heat flux?”

19: change “allow for addressing” to “could address”, delete “and”

24: delete “in an instrumented sample holder”

25: delete “by” and “in situ”

27: change “could be” to “was”

p. 1682

9: What is a “representative elementary volume? Reword or define this term.

25: “In the following” what? In the following section?

p. 1683

17: You cannot claim that the snow did not densify without reporting density measurements. See comment on lines p. 1684 l. 11-12.

18-21: That's good evidence that settlement alone could not account for the perceived downward movement of the grains.

25: change "is therefore" to "was therefore"

p. 1684

6: Figures should be cited with parentheses, not directly. Delete the sentence "An illustration of the. . .Fig. 1." and insert "(Fig. 1)" after the first sentence in the paragraph.

11-12: You need to show the densities and explain how they were measured. Perhaps you could show densities in Table 1.

15: "snowpack"

18: I believe this should read ". . .diffusion equation (Eq. 1),. . ."

20: "was replaced"

p. 1685

5: I suggest, "Vapor mass flux obtained by particle image velocimetry"

25: ". . .was found to be.." sounds weak and passive. Change to "the optimal window size we chose was 32 voxels, ensuring. . ."

26: I suggest "The choice of temporal separation Δt takes into account the changing shapes of ice structures and is a trade-off between signal size and spatial correlation."

p. 1686

10: replace "and we will now show that " with ",yet "

15: change, ", as illustrated in Fig. 2." to "nearest neighbors (Fig. 2)."

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16: replace “one” with “side”.

Eq. 4: I don’t understand why an approximation is needed. Is it because the particles are not actually spherical? Explain why you are using an approximation.

p. 1687

2: change the end of the sentence to “...is the vertical displacement of the structures.”

9-11: This sentence is not clear. Change it to something like “. . .(Fig. 3), increases the projected area, but does not affect the flux”

18: replace “,” with “and”

p. 1688

9-10: should be “Kelvin effects”. You can also cite (Flanner and Zender, 2006) here.

15: should be “structures (. . .) are changed. . .”

24: delete “away”

25: Break up the sentence “. . .air. In that case,. . .“

p. 1689

14: change to “lead”

26: change to “compared”

p. 1690

15: change to “z-direction” or “vertical direction”

p. 1691

6: As I previously mentioned (p.1684 l. 11-12), you need to report densities.

11: use a parenthetical, not a direct, citation for Fig. 5

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15: same as line 11

23: replace “around past” with “after”, delete “initially almost fully”

24: replace “is” with “occurs”. The time itself is not the interesting feature.

p. 1692

12: use a parenthetical citation

19: should be “distributions”

20: use parenthetical citations for figures

21: delete “in the course of the experiment”

22: delete “during STGM”

26: change to something like “Writing about growing grains. . .” Literature is written, not spoken.

p. 1693

13: use parenthetical citations for figures

15: replace “: the” with “. The”, insert “:” before “121, 130. . .” 23-24: change sentence beginning with “Figure 9 shows. . .” to “Plotting the turnover rate versus number of ice structures shows a correlation (Fig. 9).”

p. 1694

2: delete “from the measured data”

3-4: use parenthetical citations for figures

14: use parenthetical citations for figures

17: “error” not “errors”

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19: change “2” to “two”, delete “, this bearing in mind”

24: use parenthetical citations for figures, replace “. . .features : first,. . .” with “. . .features. First,. . .”

26: should be “Second”, delete “during the time of the experiment”

p. 1695

1: insert comma after “that” and after “snow”

10: change “was discussed controversially in the literature” to “is controversial”

13: insert comma after “study”

23: I agree, but this contradicts your statement in the beginning of the manuscript (p. 1675 l. 8-9)

p. 1696

1-2: change “STGM” to something like “a steady temperature gradient”

5: “under a typical temperature gradient for the development of depth hoar”, again the contradicts with the p. 1695 l. 23

10: change “helped to understand” to “helps to show”

12 and 15: “lifetime” is one word

13: change “were already appearing” to “appear”

17: insert comma after “changes.” Again, you are not speaking: you are writing. Change “speak of” to “write about”

27: delete “on the one hand” and “on the other hand”

p. 1697

1: insert comma before “for” and after “experiments”

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3-4: Those densities do not include new snow. You should qualify that statement by saying something like “seasonal snow that is at least a few days old”

5: This what? Lack of dependence on ice structure? Change “this” to something definite.

6: change to “provide”, data is plural.

14: change “First results show” to “Our previous work shows”

16: change “a very important tool” to “important tools”. Delete “better”

p. 1698-1702 I have not checked the references

p. 1703

Table 1. remove (-) after “solid volume fraction.” Remove the last sentence in the table caption. A caption should not describe trends in the data.

p. 1704

Fig 1. Label the color bar in the figure on the right. What is RT(t)? Explain RT in the caption.

Show the direction of the temperature gradient and the coordinate system.

p. 1705

Fig 2. Change to “arrows”. This figure would be better in 3-d. As it is, Aproj looks like a diameter. Again, show the direction of the temperature gradient and the coordinate system.

p. 1706

Fig 3. What does the mid-gray represent? Include this in the caption. Include a scale in mm. Show the direction of the temperature gradient.

p. 1707

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Fig 4. Why is there no temperature gradient across the grains? Delete the last sentence in the caption. Show the coordinate system.

p. 1708

Fig 5. I especially enjoyed the video supplement for this experiment and I think it is worth pointing the reader towards in several places, as you have done. Delete the sentence "For the first time. . ." As with the other figures, I'd like to see the direction of the temperature gradient indicated and the coordinate system.

p. 1709

Fig 6. Include the direction of the gradient and the coordinate system.

p. 1710

Fig 7. Explain what the three curves, versus the markers, are in the caption. I had to go back to the text to look this up. Are the three vertical colored lines mean values? Explain these vertical lines in the caption. Delete the sentence "The mean. . ." Move the sentence "After the experiment. . ." to the conclusion of the manuscript.

p. 1711

Fig 8. What are the trend lines, linear regressions? Explain what the trend lines are (not whether they show an increase or decrease) in the caption. Delete the sentence "Series 1 and 2. . ." Move the sentence "These numbers show. . ." to the p. 1693 l. 17.

p. 1712

Fig 9. Define structure-number in the caption. Also, why is there a dash? I think it should be "structure number." Delete the sentence "Series 1 and 2. . ."

p. 1713

Fig 10. Delete the sentence "Series 3 shows no clear. . ." and delete the blue trend line. Explain the trend lines.

p. 1714

Fig 11. Use dashed lines for jPIV to differentiate from j. Delete sentences “The vapor flux. . .” and “The large scatter. . .”

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