

## ***Interactive comment on “Use of a thermal imager for snow pit temperatures” by C. Shea et al.***

**C. Shea et al.**

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Previous comments are *in italics*, responses are in normal text.

*General comments:*

*The authors present a new method for investigating small, micro-scale 2-dimensional temperatures and temperature gradients in a natural snowpack that could represent an important improvement over standard point temperature measurements. I only have a few, mostly technical, corrections, listed below.*

Thank you very much for your attention to detail in our phrasings, and also for your enthusiasm in applying this to micro tomography work.

*Specific comments:*

*I do think that the manuscript, and future work on the micro-scale temperature investi-*

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*gation, could benefit greatly from an examination of snow micro geometry which does not involve disaggregating the snow crystals, such as micro tomography or stereology so that the pore specs geometry is left intact. The pore size is not necessarily the same size as the snow crystal, as has been assumed here. The macro photography presented here, while useful for proving the existence of faceted snow grains indicative of kinetic metamorphism and 2D extent does not give a good measure of the 3D geometry. I'm skeptical of the volumes estimated for faceted grains assuming a 1:50 width to height ratio. Perhaps some wording to the effect that this is just a gross estimate is in order.*

Agreed. The wording has been added, new line 423.

In the open review of our previous thermal paper (in The Cryosphere), use within micro CT specifically was also suggested. And, as one can see from the Previous Work section, the only existing body of work which attempts to model thermal differences at these small scales also often uses tomography. Thermal imaging of seasonal snow seems to have many future avenues, and it is heartening to see such additional applications being proposed. With this paper specifically, we chose focus on field use only. However, we agree that thermal imaging also has application to understand snow metamorphism from a more theoretical perspective. The tracking of structure and pore space in Schneebeli and Sokratov (Hydrological Processes, 2004) do show that our gross size estimation and a one-time field measurement are quite limited in expanding our theoretical understanding of ice micro processes. Hence, micro CT would be an interesting addition, though it is somewhat beyond the scope of field-only work. If anyone wishes to pursue such a combination, please contact us, as we would share our thoughts and progress enthusiastically.

*Technical corrections:*

*Page 2524, line 11. There is a missing comma between "gradients" and "adjust"*

Thank you, this has been fixed. New line 9.

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Page 2525, lines 2-3, this sentence is mis-worded, it should say something like, "The transition between equilibrium and kinetic metamorphism is generally accepted by field practitioners to occur...". The way it reads now is incorrect.

The sentence has been re-phrased along these lines. New lines 25-27.

Page 2528, line 19, the phrasing here is awkward, and difficult to understand. I think that the sentence means, "the largest magnitude difference at a single pixel within a thermal image to any of the pixel's eight nearest neighbors". I would suggest rewriting this sentence to be somehow clearer.

The two descriptive sentences have been combined, with your suggested phrasing. New lines 114-118.

Page 2535, line 11, there is a bit of a non sequitur between the first sentence and the next two in this paragraph. It seems like this first sentence belongs in the next paragraph, and this paragraph should instead open with a sentence about the cause, or the importance to sampling size error, of the different sizes present in the natural snowpack.

This section has been re-written - to address another reviewer's comment - to make it clear that we are looking for secondary lens effects specific to snow only. The new organization should address this comment as well. New lines 287-292.

Page 2537, several instances (lines 4,7,8,9,12) numbers are written out without hyphenating, for example, thirty-five, twenty-four

Thank you, these have been fixed. New lines 339, 342, 343, 344, and 346.

Page 2540, line 21, maybe add some wording about whether the 1:50 ratio is valid for hoar formations

The reference to this being a gross estimation, as per above, has been added. The largest source of error, however, is probably the attachment rate, which has a possible

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span of more than 50 fold. New line 423.

Page 2541, line 19, this sentence either has some miswording or I don't understand what is being said. I don't know what the phrase "air the temperature" used twice, means.

This meant to imply 'air at the temperature of...'; however, from the comments of J. Dozier we now calculate from ice to ice rather than across the air alone. Hence, the entire sentence has been rephrased. New line 440.

Page 2542, line 3, maybe add wording about the assumption that the pore size is equal to the grain volume

The description is not for the grain volume, or for the pore volume, as it is a two-dimensional flux value in  $m^2$  per s. However, it is an important point that the crystal may not have any side entirely exposed to a pore. We now state this assumption link on new line 448.

Page 2544, line 1, macro scale is two words here, but one word previously in manuscript

The only use of macro in a combined word previously was "macroscopic", which is itself a word. When used as an adjective, such as "macro crystal" or "macro photograph", macro is consistently separate, so we left it as-is.

Page 2545, line 10, define MFcr

New line 524.

Page 2546, line 25, perhaps should be written "values of similar magnitudes have been documented"

This has been changed to read "the row gradient values have been observed at similar magnitudes using thermocouples", new lines 559-560.

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*Page 2547, line 2, the word "to" should be deleted*

Thanks, it has been removed, and in addition the sentence has been re-phrased and combined with the previous paragraph for clarity. New line 563-564.

*Figure 3: perhaps adding a legend with the colors and times photographs were taken would make the figure easier to read*

The image difference timing had some changeover on either end to make a key with precise times per colour impractical. However, the lines are coloured in order of the typical rainbow order, so the readers eyes can jump from one line to the next by colour as you suggest. The caption now points out this rainbow ordering.

*Figure 7: maybe add the length of the scale bar to the image as the ruler isn't that easy to read. This is a really interesting figure, it's a great result considering that it is a natural snowpack.*

Great suggestion, thanks. This is now part of Figure 7.

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Interactive comment on The Cryosphere Discuss., 5, 2523, 2011.