Author comment to Anonymous Referee #3

We thank Reviewer #3 for his/her review of our work. Please find below our responses to the specific points raised.

The manuscript presents an interesting set of results regarding a variety of physical parameters undergoing temperature gradient metamorphism. The description of the anisotropy of various parameters over the course of time during the temperature gradient experiment is of particular interest, as is the role of microstructure vs. the macro property of density. The manuscript would improve with a few modifications, mainly technical, to improve the presentation and the grammar. Most of these are slight. I have made some specific suggestions, mostly technical, below, but a careful reading is in order. I think improving the technical issues will improve the readability of the manuscript. It is presenting good experimental and modeling work, and deserves to be well-presented.

Specific comments:

References: This work slightly reminds me of a PhD thesis I read once (Courville, 2007), which also compared a range of measured natural snow physical properties and naturally induced metamorphic regimes from a megadunes region in Antarctica. I am wondering if you are familiar with the work, and if it should perhaps be cited?
Thank you for the suggestion. We added the reference to Courville et al, 2010.

Technical comments:
We thank Reviewer #3 for his/her comments to improve the presentation and grammar of the manuscript. All the comments below have been taken into account in the revised version of the manuscript. Please find below our responses to the specific points raised.

Abstract: Line 3, delete "a" in front of "temperature gradient metamorphism" Line 4, suggest using the word "for" instead of "during" Line 9, delete "a" in front of "specific attention"

Page 1409 Line 3, I'm not sure what is meant by "their close environment" Line 3, The sentence that starts with, "The morphology of the snow structure..." could be rewritten to be clearer. I.e. "in a typical way which is called Temperature Gradient metamorphism..." is awkward. Line 8, and throughout, while "facetted" is acceptable, typically, it is spelled "faceted" Line 12, delete "the" in front of "TG metamorphism" Line 26, This is a minor point, but Sturm, 1997 does state that the density-thermal conductivity relationship that they have developed does not pertain to depth hoar/temperature gradient snow structures.

Page 1410 Line 5, "require" should be "requires" Line 6, should be written, "We propose addressing these issues.." Line 10, "into" should be "from" Line 18, delete "a" in front of "specific attention" Line 24, I would suggest the word "possibilities" instead of "outlooks"

Page 1411 Line 1, "to monitor" should be "monitoring of" Line 9, This is made more clear from the figure, but perhaps it would be good to specify which is the length, width and height. Line 14, "firstly" should be "first"

Page 1412 Line 10, delete "the" in front of "further" and "process" should be "processes" Line 20, "allowing to maintain" should be "which maintains a regulated..." Line 25, delete "a" in front of "water circulation" and delete "of" in front of "360" Line 28, delete "the" in front of DIgiXCT

Line 1413 Line 3, Are the machined samples larger than the region scanned in the CTscanner?)
We scanned the entire diameter of the machined samples. The final 3D images correspond to cubes extracted from the middle of the scanned cylinders.
What is the reason for the different sample sizes?
We had two types of snow cores:

- The snow cores scanned to obtain the images 0A to 4A have a diameter of 0.9 cm and a height of around 1.3 cm.
- The snow cores scanned to obtain the images 5G and 7G have a diameter of 1.6 cm and a height of around 2 cm.

We machined bigger snow volumes to finally obtain bigger images for the 5G and 7G samples. The reason is that we wanted to ensure to have a representative elementary volume for the snow with larger ice structures, i.e. the evolved snow.

Line 9, delete "such as" should just be "as" Line 13, "were" should be "was" or "specific surface area" should be "specific surface areas" Line 14, delete "such as" Line 18, add the word "and" in front of "L is the total length.."

Page 1414 Line 3, "a" should be italicized since it is a variable Line 4, "l^a" is not defined Line 19, What is 7G? A specific sample? This should be described in the text, along with why it is being referenced here.
7G is a specific sample of the more evolved snow of our experiment, that we use to illustrate the two-point probability function. We clarified this part in the revised paper.

Page 1416 Line 1, "limiting thus" should be "thus limiting"

Page 1419 Line 19, here, and throughout, I find the use of referring to the respective case in parentheses distracting throughout the manuscript. Maybe it would be better to discuss one case, and then state that in another case, the opposite would be true, or however it should be presented.
Whenever possible, we modified the concerned sentences according to the comment.

Page 1420 Line 14, "By this way" should be "This way" and "at a density" should be "for a density" or somehow reworded, because it reads a little awkwardly Line 17, "allowing" should be "which allows us" Line 18, delete "their"

Page 1421 Line 17, "which allow to capture" is not grammatically correct. It should be rewritten as something along the lines of, "which allows the matrix (phase 2) and the dispersed particles (phase 1) to be connected and disconnected, respectively." Again, I

don’t like the continued use of "respectively" throughout the manuscript, and wonder if there is another way to present it. (this is just a suggestion)

Page 1422 Line 5, what does chi stand for? I think it should be defined. Line 13, delete "and we have"

Page 1423 Line 6, What case is, "In that case," referring to? This should be explained.

Page 1424 Line 6, should the classical expression of permeability be cited as the Kozeny-Carmen expression (with reference?)
We added the citation.

Line 19, delete second phrase "and bigger" i.e. it’s repeated

Page 1429 Line 13, "submitted to" should be "undergo" Line 26, "become" should be "becomes"

Page 1430 Line 20, "conduces" should be "conducts"

Page 1432 Line 7, "bonds between grains..." should be "i.e. bonds between grains" Line 8, "allow to capture" is not grammatically correct. It should be something like "our results show that the models capture the overall evolution.." Line 23, add an "a" before "cold room"

Page 1433 Line 3, delete the word "the" in front of "temperature gradient"

Page 1441 figure caption: delete "here" in front of "removed" and delete the word "the" in front of "visualization purposes"

Page 1442 "zoomed" isn’t quite right, maybe "magnified" is better

Page 1444 the fonts in the figure are too small to read
Page 1445 a great figure, but again, the fonts are too small to read
Concerning the figures, upon acceptance of our article for final publication, we will adapt the font sizes to ensure readability in the final layout of *The Cryosphere* (different from *The Cryosphere Discussions*).