

Author comment to Anonymous Referee #1

We thank Reviewer #1 for his/her positive appreciation of our work. Please find below our responses to the specific points raised.

This is a very well-designed study. Three topics are addressed in this manuscript: (1) variations in physical parameters of snow (density, specific surface area, correlation length, mean and Gaussian curvature distribution, air and ice tortuosities, effective thermal conductivity, and intrinsic permeability) based on 3-D image measurement using an X-ray system, (2) development of physical parameter anisotropy under TG conditions, and (3) comparison of measured data with two analytical models based on snow density, and size and anisotropy. The study demonstrates the importance of anisotropy of the snow physical parameters in modeling snow under TG conditions. The three topics are well organized and their conclusion is reasonable. The manuscript is very well written, and I do not see any problems with the analysis or presentation. Moreover, the data are definitely useful in evaluation of snow metamorphism models. I believe the manuscript requires only minor editing before publication in *The Cryosphere*. I have provided specific editorial comments below, and my suggestions for improvement of the arguments are in the manuscript.

Specific comments:

2.5. Re-adjustment in density

The authors readjusted the values of effective thermal conductivity and permeability to eliminate the influence of spatial inhomogeneities of density, but they did not readjust the values of other physical parameters (e.g., correlation length, air and ice tortuosities, and specific surface area). As pointed out by the authors in 4.2 Link with the physical properties, effective thermal conductivity and permeability depend on these physical parameters. Thus, if effective thermal conductivity and permeability need to be readjusted against inhomogeneities of density, other physical parameters should also need readjustment. I believe the effect of readjustment is not strongly evident in their results: however, if there are specific reasons for not readjusting other physical parameters, they should be explained in the text.

We agree that the effective thermal conductivity and the permeability tensors of the snow, which are both transverse isotropic, depend not only of the density but of other microstructural properties (correlation lengths or/and specific surface area) as it is shown in the present paper. However, many previous studies (see for example Yen et al. 1981, Shimizu et al. 1970, Calonne et al. 2011, Löwe et al. 2013, Calonne et al. 2013) showed that these properties strongly depend on the density in first order of approximation. Indeed, in our experiment, we can see some similarities in the time evolutions of conductivity, permeability, air and ice tortuosities and density. Based on these previous studies and observations, the re-adjustment in density has been performed on the effective thermal conductivity and the permeability only, in order to focus on the evolution of snow properties driven by the temperature gradient and not influenced by the initial spatial density heterogeneity in the snow slab.

It was not possible to do a similar re-adjustment for the tortuosities since no fit of the tortuosity versus density is available in our knowledge.

P1418L2 & P1430L26

Although the room temperature during the experiments was -4 degree Celsius (269 K), the authors used the value of k_i and k_a with 271 K. I believe the difference between the values with 269 K and those with 271 K is small; however, if there are specific reasons for using the values with 271 K, please explain them in the text.

We performed our computations at 271K in order to be consistent with previous studies (Calonne et al, 2011). We added this remark in the manuscript.

Suggestions for improvements:

P1415 L11. The equation (7) may have typing error: K should be G.
The equation (7) has been modified accordingly.

The legends in Fig. 5 are difficult to read because of the small size. Please make these legends bigger.

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*).