The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2019-41-RC2, 2019
© Author(s) 2019. This work is distributed under
the Creative Commons Attribution 4.0 License.

The Cryosphere Discussions
Open Access
EGU

Interactive comment on "Motion of dust particles in dry snow under temperature gradient metamorphism" *by* Pascal Hagenmuller et al.

Teruo Aoki (Referee)

teaoki@okayama-u.ac.jp

Received and published: 22 April 2019

This paper describes the result of laboratory experiment using X-ray tomography on movement of dust particles in dry snowpack under temperature gradient metamorphism and isothermal metamorphism conditions. The paper clearly shows the dust particles move downward in case of temperature gradient metamorphism, in which three types of motion mechanisms are confirmed. They also present the quantitative vertical speed of the movement depending on relative position of dust particles to the ice matrix and estimated the total possible displacement of the dust distribution over dry snow period in the arctic. The authors discuss the influence of motion of light absorbing particles (LAPs) under strong temperature gradient in the arctic snow and the potential impact of dust vertical distribution near the snow surface on the radiative

Printer-friendly version

Discussion paper

CC BY

properties.

The manuscript is well-written with the effective presentations including movies. This study gives new findings on the time evolution of vertical distribution of LAIs in snowpack which is valuable information to communities of snow microphysics and climate studies. I recommend this paper for publication in The Cryosphere after revising the following points:

Specific comments: p.2, L9-11: “Typically, the albedo decreases more when the mass of LAPs is concentrated in the first centimeter compared to the case when the mass is distributed over several centimeters (Dumont et al., 2014).” The effect of the vertical inhomogeneity of snow impurities was already investigated by Aoki et al. (2000), in which the same situation is represented.

p.9, L12-13: “In addition, the dust velocity varies with particles size: smaller particles are slightly faster than the larger ones (Fig. A3).” Please describe the (possible) cause. This is because the smaller dust particles as well as BC are more important for the albedo reduction. We should understand this mechanism.

p.11, L1ff and Figure 6: (1) Figure 6 suggests possible albedo increase due to the downward displacement of dust particles near the snow surface. Water vapor sometimes sublimates to the atmosphere from snow surface, which enhances the concentration of LAPs at the topmost layer (Aoki et al., 2014). This is opposite effect for the albedo change discussed here. Please describe that motion of dust particles near the surface could be affected by the other factor such as sublimation from snow surface.

(2) Albedo reduction due to dust contamination in snow depends on size distribution of dust particles. If the authors assume it based on the dust particles used in this experiment (i.e., Mongolian sand), it would be larger than the common atmospheric dust (e. g., A mode radius of dust model “Mineral-transported” compiled by Hess et al. (1998) is 0.5 μm.) and thus the estimated albedo reduction could be smaller than usual. Please indicate the size distribution parameters or single scattering parameters

CC BY

of dust particles employed here.

(3) When upper part of snowpack is heated by solar radiation in daytime, the temperature gradient would be inverse near the surface (Pinzer and Schneebeli, 2009). In that case the vertical movement speed of dust particles due to temperature gradient metamorphism may differ from the result presented in this paper (e. g., the speed slows down?). Please mention on this situation briefly.

Figures 5-6 and A2-3: Some label values of both X and Y-axes are unreadable characters.

References: Aoki, T., T. Aoki, M. Fukabori, A. Hachikubo, Y. Tachibana, and F. Nishio (2000), Effects of snow physical parameters on spectral albedo and bidirectional reflectance of snow surface, J. Geophys. Res., 105(D8), 10,219–10,236, doi:10.1029/1999JD901122.

Aoki, T., Matoba, S., Yamaguchi, S., Tanikawa, T., Niwano, M., Kuchiki, K., Adachi, K., Uetake, J., Motoyama, H., and Hori, M., (2014), Light-absorbing snow impurity concentrations measured on Northwest Greenland ice sheet in 2011 and 2012, Bull. Glaciol. Res., 32, 21–31, doi:10.5331/bgr.32.21.

Hess, M., P. Koepke, and I. Schult, (1998), Optical properties of aerosols and clouds: The software package OPAC, Bull. Am. Meteorol. Soc., 79, 831-844, doi:10.1175/1520-0477(1998)079<0831:OPOAAC>2.0.CO;2.

Pinzer, B. R., and M. Schneebeli (2009), Snow metamorphism under alternating temperature gradients: Morphology and recrystallization in surface snow, Geophys. Res. Lett., 36, L23503, doi:10.1029/2009GL039618.

Interactive comment on The Cryosphere Discuss., https://doi.org/10.5194/tc-2019-41, 2019.

CC BY