

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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We thank the reviewer for the questions raised, and answer them in the following.

1) surface kinetics (p. 17)

As we wrote, $\alpha < 1$ over facets, which means a less effective vapor transport over facets. We did not observe any decrease in vapor flux in the PIV-calculations (TCD-Fig. 11), although large facets developed over time. In principle, we could calculate the difference between the massflux calculated by the numerical simulation and

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the massflux calculated from PIV at the location of faceted crystals. However, the calculation by PIV needs currently quite a large volume, and is not sufficiently precise to calculate a difference in fluxes for a single crystal. In this sense, we are not able to provide more precise numbers of α in this paper. However, with improved spatial resolution and improved stability in positioning the sample this should be no principal problem.

Regarding literature values, it has to be emphasized that the coefficient for surface kinetics, α , is extremely difficult to measure experimentally. A review and critical discussion of past experiments performed on isolated droplets or by growing ice on a substrate is given by Libbrecht (The physics of snow crystals, Rep. Prog. Phys. 68, 2005). The conclusion is that practically all results published to date are distorted by systematic errors to some degree, and that modern experiments are just beginning to address this problem. Therefore, no literature value of α for faceted crystals can be given.

For our main conclusion, namely that there is no significant macroscopic diffusion enhancement in snow, a violation of the assumption $\alpha=1$ is irrelevant. In our simulation, we assumed a diffusion limited transport process of water molecules. If we introduce a process limited by surface kinetics, then the vapor transport through snow would decrease. By assuming $\alpha=1$, we get an upper limit for the vapor flux, and this upper limit is not supporting the strong diffusion enhancement discussed in the literature.

2) behavior of Series 3 (p. 21) Series 3 has a higher density than the other two samples. We suspect that we are closer to the snow type which is usually described as "hard depth hoar" (see e.g. Perla and Ommanney, Cold Regions Science and Technology, 11, 23–35, 1985). It was observed that in this case, the crystals can not grow freely and are hindered in the growth by their neighbors. Microscopically, we suspect that the higher density in combination with the higher temperature (closer to melting point) leads to rapid local fluctuations in the temperature field, and therefore there is no general

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coarsening of the structure. This causes that the mass turnover rate remains almost constant over time (Fig. 8), as well as the structural number (TCD-Fig. 9), and that there is no trend in turnover rate (TCD-Fig. 10). We will include this discussion in the revised manuscript.

3) — table of previous work about diffusion enhancement — We answer this question, including references, in the supplement.

Please also note the supplement to this comment:

<http://www.the-cryosphere-discuss.net/6/C1132/2012/tcd-6-C1132-2012-supplement.zip>

Interactive comment on The Cryosphere Discuss., 6, 1673, 2012.