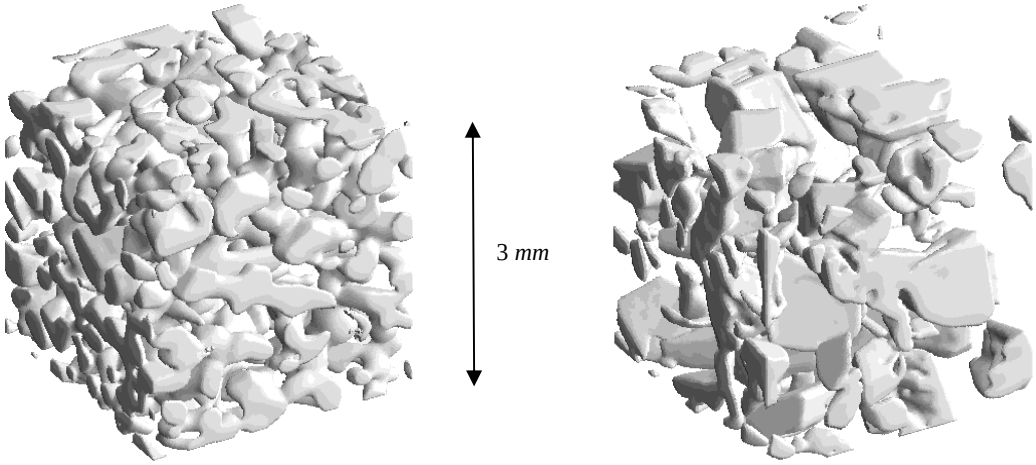
A tentative model for the temperature gradient snow metamorphism and its validation on X-ray microtomographic data

Frédéric Flin[1], Jean-Bruno Brzoska[2], Romeu André Pieritz[2], Bernard Lesaffre[2], Cécile Coléou[2], Yoshinori Furukawa[1]

[1]*Institute of Low Temperature Science, Hokkaido University, Japan*
[2]*Snow Research Center, Météo-France, Grenoble, France*

A simple physical model describing the temperature gradient metamorphism of snow is presented in this work. This model, based on Kelvin and Langmuir-Knudsen equations, is close to a previously developed model of isothermal metamorphism (see [1]), but takes into account the variation of the saturating vapor pressure with temperature. It can determine locally whether the ice is condensing or sublimating, just depending on both temperatures in the snow matrix and local mean curvatures of the ice/air interface. This model can also explain the formation of facets that occurs during the metamorphism (see figure).
Thanks to X-ray microtomographic images of snow samples obtained under different temperature gradient conditions, the validity of this model has been verified. This offers interesting outcomes for the numerical simulation of the temperature gradient metamorphism.

Snow samples after 3 weeks of temperature gradient metamorphism (Météo-France/CEN - Grenoble, France).
Experimental images obtained by absorption X-ray microtomography (ESRF/ID19 - Grenoble, France).
E=18 keV, image size: 300^3 voxels.



Temperature gradient: ~3 K/m

Temperature gradient: ~16 K/m

Reference:

[1]. F. Flin, J. B. Brzoska, B. Lesaffre, C. Coléou and R. A. Pieritz, “Full three-dimensional modelling of curvature-dependent snow metamorphism: first results and comparison with experimental tomographic data”, Journal of Physics D: Applied Physics, vol. 36, pp. A49-A54, 2003.