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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Snow physics as relevant to snow photochemistry" *by* F. Domine et al.

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General comment The paper is a welcome attempt to summarize the current knowledge of snow physics. The different sections of the authors are very heterogeneous in style, and repetitions as well as different conventions (on units, on presentation of material) are numerous. The length and difficult to understand structure of the paper make it hard to follow. The title restricts to photochemistry, however the question of wet snow is partially discussed (although incomplete - this topic should be completely dropped. The section on remote sensing is confusing. With no doubt remote sensing could have an important impact to the global simulation of snow chemical processes, but has nothing to do with snow physics. This topic could be treated in another paper without any loss. The section on the QLL is overly long and could be shortened. Again, the goal can not be to treat all problems of snow chemistry with respect to the QLL. Finally, the self-citation rate of papers from the group of authors of this paper is done to a degree which is alienating. In addition, the citations are not specific enough to be guide to a reader, as it could be expected from a review paper.

The paper needs a major revision in content and structure. A much better consideration of the literature outside of the authors direct fields is necessary to represent the state of the science in this field.

Specific comments

p 5943 l 1 ff Snow has a very small surface area compared to soils. Typical values of the SSA of soils are 5- 150 mˆ2/g, and the corresponding soil area index is under the assumption of a permeable thickness of a few millimeters in the same order as for snow. See eg. Petersen, L. W. 1; Moldrup, P. 2; Jacobsen, O. H. 1; Rolston, D. E. 3 RELATIONS BETWEEN SPECIFIC SURFACE AREA AND SOIL PHYSICAL AND CHEMICAL PROPERTIES. Soil Science. 161(1):9-21, 1996.

p 5945 l 1 with descrease: should read "will decrease"

p 5945 l 7 the notation in equations 1.1-2 and 1.1-3 is not consistent with later equations

p 5946 l 28 one reference (Judson and Doesken) is sufficient - this is trivial.

p 5947 l 5 What is the concentration of aerosols in snow?

p 5947 l 24 This section should contain a section about liquid water content of snow.

p 5948 l 2 No quotation marks needed for the terms "snow metamorphism" etc

p 5948 l 19 ff: References are missing from the work of Colbeck and Brun onwet snow metamorphism, and transport of solutes in wet snow (e.g. Bales, Waldner, Williams)

p 5949 section 1.4: This can be read in any good book on soil physics: eg. Jury and Horton, Soil Physics, 6th ed, 2004

p 5950 l 17 The citations here are again very unspecific and one of the most important recent contributor to the topic is missing (Libbrecht, K. G., The physics of snow crystals. Reports on Progress in Physics 2005, 68, (4), 855-895).

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p 5950: l 22: the size of all crystals which are not of almost equal size in their principal axes is not unique to new snow. This is the case for all snow types (new snow, rounded forms, faceted forms, depth hoar, wet snow clusters), as long as not at least a fcc or bcc configuration is reached (density larger than 350 kg m-3).

p 5951 l 4: SSA could be measured since long with very good accuracy (Narita, 1971; Davis 1987) using stereological methods.

p 5951 l 10 ff The listing of the snow types follows neither a genetic nor morphological sequence. The enumeration is a repetition of the International Classification, and can be shortened to a reference.

p 5952 l 7: This proposition is not at all new, see Warren 1980 (and references therein), Grenfell and Warren, 1999 etc)

p 5952 l 17: the formation of depth hoar is not limited to moderate density, it continues to very high density, also at higher density no cup formation is possible.

p 5960 l 20ff The authors seem not to be aware of the highly layered nature of most natural snowpacks. While for certain applications integrated values can be sufficient, this is definitively not the case when snow metamorphism, thermal conductivity, light adsorption and air permeability are involved. The complexity of the "layers" is shown eg. in M Sturm, J Johnson,J Holmgren Variations in the mechanical properties of arctic and subarctic snow at local (1-m) to regional (100-km) scales http://snow.usace.army.mil/snow_mechanics/pdfs/SturmISSM2004.pdf_copy.pdf To understand the complexity of these gradual and abrupt changes, a high-resolution method as x-ray tomography is required.

p 5966 l 16 Here "S" is used to denote the Kubelka-Munk scattering coefficient, and later (p p 5967 l 1) "S" is used for surface

p 5967 eq 2.4-8 is a repetion of p 5951 l 7) p 5972 l 7 Kaempfer et al showed that thermal properties can be predicted from the microstructure: Kaempfer, T. U., M. Schnee-

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beli, and S. A. Sokratov (2005), A microstructural approach to model heat transfer in snow, Geophys. Res. Lett., 32, L21503, doi:10.1029/2005GL023873

p 5973 section 2.6 Sommerfeld and Rocchio (1993) were the among the first who measured and correlated SSA to snow permeability (Sommerfeld, R. A., and J. E. Rocchio (1993), Permeability measurements on new and equitemperature snow, Water Resour. Res., 29(8), 2485-2490)

p 5997 A recent key article which gives a thermodynamically consistent description of the QLL is: Henson, BF; Voss, LF; Wilson, KR; Robinson, JM Thermodynamic model of quasiliquid formation on H_2O ice: Comparison with experiment JOURNAL OF CHEMICAL PHYSICS, 123 (14): Art. No. 144707 DOI:10.1063/1.2056541

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 5941, 2007.