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The Cryosphere Discussions

Interactive comment on "Vertical profiles of the specific surface area of the snow at Dome C, Antarctica" *by* J.-C. Gallet et al.

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This is an important and interesting paper aimed at the snow vertical profiling (snow specific area, grain size). The comments given below can be used by authors to improve the final version of the manuscript.

Comments

p.1650. I diasagree that the complex shapes of snow crystals can adequately be represented by spheres for radiative transfer modelling. There is an extensive evidence that this is not the case (see, e.g., Mishchenko et al., JQSRT, 1999; Kokhanovsky and Zege, Appl. Optics, 2004; Xie et al., JQSRT, 2006). The works cited by you address the question if the results of modelling (say, specral albedo) can be adequately repre-

sented using spherical grains. Yes, it is possibble to find such models. However, they do not provide accurate estimations of the size and the specific area of the snow. The results derived on the use of spherical models are highly biased. I advice that you study this question in detail using, e.g., hexagonal crystals as input in DISORT (see, e.g., Xie et al., 2006).

p.1650. Eq. (1) is valid not only for spheres (see Domine et al., 2008).

p.1650. What is the penetration depth (PD) at 1300nm? What vertical depth you need to make useful measurements of SSA? I guess, the PD must be larger than several grain diameters. Is there water vapour absorption at 1300nm? How do you correct for corresponding effects (including absorption by liquid phase)?

p.1652. The accuracy of reading of the is 2mm. This is not a small number. The extinction coefficient is snow is about 1 inverse cm. So the error in optical thickness is about 2, which is not a small number as far as snow optics is concerned.

p.1653. How stable is your calibration curve? You need to prove that your calibration curve can be used for any snow sample.

p.1661. You may mention that it follows from Eqs. (2), (4) that the optical thickness tau is just SAI/2. Therefore, you may use measurements of tau to estimate SAI. In Eq. (2) you need to wtite 'ro$_snow, i'$.

p.1661. You write that the spectral albedo depends on density. Please, prove it refering to measurements or references. In case of a semi-infinite snow, there are two parameters, which influence the reflectance : the single scattering albedo and the phase function (Mishchenko etal., JQSRT, 1999). Both do not depend on the snow density. However, both are influenced by the shape of grains. Please, estimate the influence of crystal shapes on your results (the determination of SSA and the average grain size).

p.1662. You write that clouds enhance the diffuse radiation. This is not always the case. Actually it could be quite dark under clouds (alnmost no radiation penetrates).

p.1663. I am not sure that it is useful to introduce Eq. (6). The radiatiev transfer theory enables the calculation of albedo for any atmospheric state numerically not using aapproximations like Eq.(6). Why yo do not make direct numerical simulations instead?

p.1671. You state that the thin high-SSA laye was never observed. This is too strong sentence.

Table 2. Please, include the geometrical thickness of layer here and also average grain size (related to SSA).

Table 3. Could you give grain size here.

Fig.17. The DISORT results depend on the grain size and shape. How did you select these important parameters for Fig.17?

Interactive comment on The Cryosphere Discuss., 4, 1647, 2010.