The Cryosphere Discuss., 3, S53–S56, 2009
www.the-cryosphere-discuss.net/3/S53/2009/

The Cryosphere
Discussions

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3, S53–S56, 2009

Interactive
Comment

Interactive comment on "Rapid and accurate measurement of the specific surface area of snow using infrared reflectance at 1310 and 1550 nm" *by* J.-C. Gallet et al.

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Received and published: 16 March 2009

GENERAL COMMENTS The paper describes a new and useful additional method to determine optical grain size. The comparison to DISORT and the identification of instrumental artifacts is detailed and useful for future instrument improvement. This kind of instrument is a very useful an timely addition to near-infrared photography, and will help to calibrate simulation models.

The method described here is very similar to the method developed by Painter et al (), using surface spectroscopy. I think the title is somewhat misleading, as it is still necessary to take samples. Compared to NIR photography, the method is comparatively slow (number of samples / second). I would like to propose a title like: Dual-wavelength reflectance spectroscopy of snow to measure the optical diameter and surface area

The accuracy of 10 and 12%, respectively, is similar to other methods. In this respect, a quasi-volume (NIR-photography) or full volume (adsorption, tomography) are much better concerning the representative sampling volume. Unfortunately, the representative sampling volume in a natural snow cover is poorly known. However, high-resolution stratigraphy indicates that for alpine snowpacks the variability in SSA is very high (see vertical sections in Matzl and Schneebeli (2006), and underestimated by point sampling methods and by traditional stratigraphic profiles.

In my opinion, the existing data of direct measurements of SSA in snow shows that the uncertainty is dominated by the intrinsic variability of the snowpack. As two completely independent methods, adsorption and tomography, are on a 1:1 line, this is now a well justified statement. Therefore, the main problem is the selection of a representative sampling volume, and a sufficiently dense sampling interval (according to high-resolution penetration measurments and NIR-photography, SSA can easily vary by more than 20% even in a layer of homogenous traditional stratigraphy.

It may also be useful to the reader to point out shortly the equivalence of SSA (and in this case better expressed as 1/m, ie inverse length) and optical diameter. A relevant reference in this context is also Maetzler, C. 2002. Relation between grain-size and correlation length of snow. J. Glaciol., 48(162), 461–466.

SPECIFIC COMMENTS p34 l26: One of the important properties of snow in this respect is the specific surface area. : there are many other important properties, e.g. the high emissivity, the high porosity giving cause to a relatively low thermal conductivity, etc)

p36 l 9 : This is correct sensu-strictu. But consider the hundreds if not thousands of traditional snow profiles were traditional grain size and density is recorded: it is for almost all snow types to get a reasonable estimate of SSA, especially if the grain size

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is measured on a reproducible way. This should be mentioned here.

p36 l 19 one value take -> takes

p36 l 29 By increasing the resolution of x-ray tomography, see eg. Kaempfer and Schneebeli, the range of SSA measured is easily extended to very fresh snow types. The same is valid for stereological methods.

p37 l17 I think the discussion about SSA and optical diameter should be moved to the very first paragraph of the discussion. This is the essential well confirmed assumption that snow, also a sintered material, can be very well be considered (what concerns EM-properties) as a dispersed material consisting of spheres!

p37 l31 I agree that the study by Painter does not compare a direct measurment of SSA. However, the study by Matzl precisely states the accuracy which can be obtained in comparison to SSA!

p38 l5 The larger e-folding depth is rather an advantage than a drawback. Tomographic and stereological studies show that a volume of at least around 5 mmˆ3 is necessary to receive a representative volume. In fact, with a larger e-folding depth, artifacts resulting from the preparation of the snow pit or the snow sample are much less important. Small particles at the surface of the sample, caused by preparation, could significantly influence the reflection, an by this the SSA. The argument of interference can be refuted by the combined measurements of stereological surface area and NIR-reflectivity of Matzl, where vertical surface sections of highly layered samples were measured.

p40 l13 Picard et al (2008) simulated the effect of certain very idealized geometrical shapes, but not real snow crystals. This is a big difference to real snow!

p47 l 4 Bänninger et al Sensors 2008, 8, 3482-3496; DOI: 10.3390/s8053482 treated the problem of real snow structures - this could be the way to improve and realistically model the path of rays.

p47 l 25 a more recent reference to facet formation during isothermal metamorphism is

Kaempfer, T. U., and M. Schneebeli (2007), Observation of isothermal metamorphism of new snow and interpretation as a sintering process, J. Geophys. Res., 112, D24101, doi:10.1029/2007JD009047

p47 l 17 : Here a system which samples directly at the wall (direct spectroscopy or NIR-photography) has advantages, because boundary effects are smaller. An improvement could also be that the sample is simply compressed before measurement, because density is not important. (see also discussion, p 49 15 ff)

p48 l 25 The scraping of the snow surface will create small particles, increasing the SSA. Are these particles removed after preparation?

P54 L 20 ff : SAI is probable only useful by weighting with light penetration - which is SSA and density dependent. I think that SAI should be left in this article. However, the authors could discuss the method in the context of quantitative stratigraphy, see also the paper by Satyawali et al. http://dx.doi.org/10.1016/j.coldregions.2008.09.003 and the general lack in quantitative methods in the analysis and validation of snowpack simulation models.

p51 l 9: change: "not to an effect" -> "not an effect"

Interactive comment on The Cryosphere Discuss., 3, 33, 2009.