Review of the manuscript

"Comparison of different methods to retrieve effective snow grain size in central Antarctica"

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General comments

The problem discussed in the manuscript is very topical and important for a few modern challenges, including the remote sensing of polar regions, the climate change problem, etc. Joint consideration of the satellite, airborne and field techniques to explore snow microstructure in Central Antarctica is presented in this manuscript. This task required the joint efforts of scientists from several European research centers and has brought valuable results. The ground-based experimental procedures included measurements of the SSA (specific surface area) of snow (technique of Gallet at al, The Cryosphere, 3, 2009) and of the snow spectral albedo at wavelengths 1280nm and 1100nm. The 2-wavelength technique for retrieving effective snow grain size with this data has been refined. As a result the admissible accuracy of the used retrieval procedure has been secured.
For validation of the currently employed retrieval techniques the results from MODIS and airborne SMART system (AWI) taken simultaneously to the field measurements were explored as remote sensing data. The results of the validation of the various retrieval techniques presented in this study look very promising. For instance, very satisfactory correlation between field data (SSA) and results of the SGSP retrieval from the spaceborne MODIS data (linear correlation coefficient: 0.86) has been found.
The article is written clearly, well-structured, presents new useful results, and demonstrates authors' good knowledge of the state of the art of the problem.
The problems considered in this manuscript are completely within the scope of TC
Below a list of specific comments is presented.

This paper is recommended to be published in "The Cryosphere" after minor revision.

Specific comments

Below the pieces of text from the reviewed manuscript will be given in italic in difference on the reviewer comments.

Page 8, Lines 3-6:

The large uncertainty of the SGSP retrieval for high solar zenith angles is related to the conversion of the measured reflectance from one viewing direction by the satellite sensor into measured albedo. For this, the bidirectional reflectance distribution function (BRDF) of the snow surface has to be assumed."

This statement is incorrect. *"The conversion of the measured reflectance from one viewing direction by the satellite sensor into measured albedo* " **is not used in the SGSP algorithm.** Actually in the SGSP algorithm, the angular dependency in the registered signals is excluded using registration of

the signal for additional wavelength, and no assumptions about BRDF is used. It is one of the main advantages of this technique.

P.8, Lines 6- 7

Due to the strong forward scattering characteristic for snow grains, ***small errors in the assumed BRDF greatly distort the albedo****, especially at low sun elevations*

Correspondingly, this sentence should be corrected, because there is no use of "assumed BRDF "in SGSP procedure.

P.10, Fig 5

Fig. 5 presents important data. For more fast understanding and analysis it would be very useful to give the corresponding Sun polar angles as the second scale at X- axis.

P.10, Lines 7-8

As no snowfall occurred on that day, the diurnal cycle is likely to be an artifact originating from the change in solar zenith angle and the assumed escape function $K_0(\theta_0)$.

It might be a very interesting and useful observation. In all cases it makes a reader think about necessity to use more accurate approximation of the $K_0(\theta_0)$ function for interpretation data at low Sun positions. The recommended formula

$$K_{emp}(\theta_0) = \frac{3}{7}(1.5 + 1.1\cos\theta_0) = \frac{2}{7}(1 + 0.73\cos\theta_0) \quad (10)$$

should be rather taken as empirical approximation for considered case. This result requires a more detail consideration in future studies.

P.10, Lines 8-10

The escape function might be incorrect if the snow BRDF is more complex due to the non-spherical snow grain shape.

This statement is incorrect. More accurate would be "The used approximation (3) for escape function might be incorrect for snow at very oblique incidence because of its very elongated phase function".

P.11, Lines 24-25

Therefore, each instrument retrieves the effective grain size from a different depth within the snowpack.

Moreover, even the same instrument takes measurements from layers with different depth dependent on wavelength. All retrievals considered in this paper (and in many others) were performed neglecting snow layer stratification.

P.13, Line 4

*which can be related to snowfall of about **1mm** at Kohnen*

Do authors really mean "1mm"?

Minor correction

Abstract

P.1

The effective size of snow grains affects the reflectivity of snow surfaces and thus the local surface energy budget in particular in polar regions. Therefore, the specific surface area (SSA) was monitored.

There is some breach of logic: " *The effective size of snow grains affects… Therefore, the specific surface area (SSA) was monitored."* Still it is not stated how these quantities are related.

P.2, Line 5

*For example, Munneke et al. (2008) found variations of **the broadband albedo** of snow at five different locations in Dronning Maud Land in a range between 0.77 and 0.88.*

I recommend small change:

" For example, Munneke et al. (2008) found variations of the broadband albedo of snow in a range between 0.77 and 0.88 at five different locations in Dronning Maud Land."

P.2, Line 3-7

*However, the snow surface albedo varies both on a temporal and spatial scale. For example, Munneke et al. (2008) found variations of **the broadband albedo** of snow at five different locations in Dronning Maud Land in a range between 0.77 and 0.88.*

*This variability is caused by different parameters such as snow grain size (and shape), surface roughness (e.g., Warren et al., 1998), soot content (e.g., Bond et al., 2013), and cloudiness; **it depends on wavelength…**and solar position.*

Because the first sentence is only about the broadband albedo, the second sentence is required to be corrected.