

# Arctic spring-time snow UV-B albedo measurements in Sodankylä, Finland

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## Background

Albedo of snow depends on the physical properties of snow, and varies according to wavelength. Albedo is often measured as broadband albedo excluding the UV range. However, UV albedo for a surface with snow is high and effects the downwelling radiation due to multiple reflections. New polar Arctic measurements on UV-B albedo of snow were planned and carried out in 2007 in Sodankylä, 67°N, Finland.

## Continuous measurements until snow melt in May 2007

For albedo measurements, two sensors of the UV-Biometer Model 501 from Solar Light Co. (SL501) with similar spectral and cosine responses (Figures 1, 2 and 3) were used, one placed upwards and the other downwards. SL501 spectral response resembles the action spectrum for erythema. Wavelengths in the UV-B (280-310 nm) are most weighted. The data were logged from 25th Feb till May 2007 at 1-minute-intervals into the data base. This period includes aspects of: i) accumulation of snow, ii) new snow, and iii) melting snow.

## Ancillary data

In addition to albedo data, information of snow grain size is used (Figure 4). In Sodankylä, the state of atmosphere at 2 m height is measured once a minute by an Automatic weather station (AWS). From these, the information on the beginning of rain, snow depth, and cloud cover, e.g., can be gained.

## Calibration of the measurements

The calibration of the raw signal requires calibration matrix with SZA and ozone (Webb et al. 2006, WMO SAG UV. COST-726, ISBN 92-898-0032-1):

$$ECIE = U - U_{offset} * C * f_n(SZA, TO_3) * \epsilon(T) * C_{oscor} \quad (1)$$

where ECIE is erythemal effective irradiance, U is the measured electrical signal from the radiometer,  $U_{offset}$  is the electrical offset for dark conditions, C is the calibration coefficient (a constant value determined for specific conditions like SZA=40° and O<sub>3</sub>=300 DU),  $f_n$  is a function that can be expressed as a calibration matrix normalized at a SZA=40° and O<sub>3</sub>=300 DU,  $\epsilon(T)$  is the temperature correction function, and  $C_{oscor}$  is the cosine correction function.

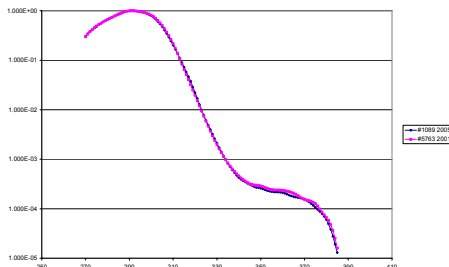


Fig1. The spectral responses of the sensors.

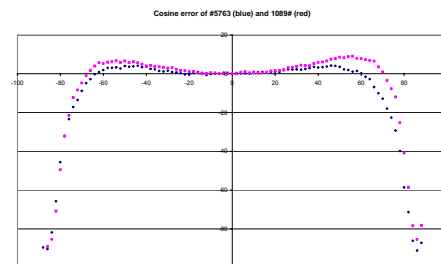


Fig2. The cosine responses of the sensors.



Fig3. The holder designed for the two SL501.

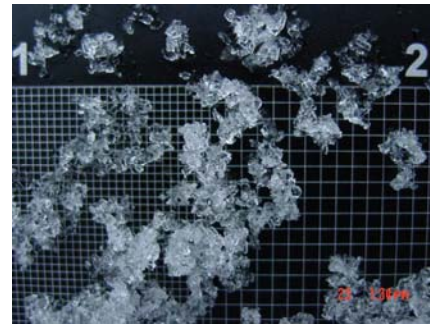


Fig4. Snow grain size measurements,

## Empirical calibration due to SZA > 60

Here, the calibration factors (C) had been determined as an average for conditions with SZA < 55 deg. Keeping in mind that i) the spectral responses of the sensors were similar, and ii) differences in cosine responses relatively small, and iii) we are only interested on the relative signal of these two sensors, the calibration coefficients C1 and C2 might be sufficient for conditions SZA < 55 degrees. Due to low Sun (SZA > 60 deg), the use of laboratory calibration as such was found non-satisfactory. Several solutions exist: 1) New empirical calibration coefficients were produced the 27th March by turning both of the sensors upwards and calibrated against each other, and also both of them against to SL-501 placed to the roof of the observatory. This was remade on the 2nd May. 2) Data of the original calibration as a function of SZA were available. 3) It would be possible to use a radiative transfer model to calculate the calibration as in Eq.(1).

## Results

The preliminary results of the very first cases indicate:  
**> 86 % albedo for day 12th March 2007, and a much lower albedo (60 %) for snow melt season (day 2nd May 2007). The snow grain size varied between 0.5 and 2.6 mm.**



Fig5. SL501 snow UV albedo measurements in 2007.

## Acknowledgements

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