

Interactive
Comment

Interactive comment on “Snow spectral albedo at Summit, Greenland: comparison between in situ measurements and numerical simulations using measured physical and chemical properties of the snowpack” by C. M. Carmagnola et al.

Anonymous Referee #1

Received and published: 4 January 2013

Overview:

This paper presents comparisons of spectral albedos of snow surface measured at Summit in Greenland and at the Col de Porte in the French Alps with those theoretically calculated based on in situ measured snow physical and chemical parameters using a radiative transfer model. The effect of vertical profiles of specific surface area and the effect of snow impurities on the spectral albedo are quantitatively discussed. At the wavelengths shorter than 1400 nm the calculated albedos agree well with the measurements. However, the discrepancies remain at 1430 nm and around 1800 nm.

C2718

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



The authors concluded that the discrepancies are independent of the snow properties and the instrument used, and they may be due to the uncertainties on the ice refractive index at these wavelengths.

The field works for snow SSA measurements and snow impurity analyses are well designed and the spectral measurements look fair except some procedures. Many spectral albedo data synchronized with snow pit data are valuable for the improvements of snow albedo modeling and satellite remote sensing as mentioned by the authors. However, error evaluations coming from set-up of spectral albedo measurements and theoretical discussion on volume to surface ratio equivalent sphere radius are not sufficient. There are following points to be checked before reaching the conclusion on the issues of ice refractive index.

(1) The deviation factor for RCR from the perfect cosine response was not finally corrected in this study. The reason is mentioned as “The resulting albedo values were slightly higher than 1.” (p.5219, L5) when the deviation factor on another RCR detector is applied. It sounds that inconvenient correction was not applied. If the deviation factor for the RCR used in this study is different from that another RCR, the actual deviation factor of RCR used in this study should be corrected. In that case, bidirectional reflectance is much anisotropic at the NIR wavelengths, that is extremely high in forward scattered direction, and thus assumption of isotropic reflectance could cause the correction error.

(2) My understanding for the cosine response of ASD’s RCR is not so good although the RCR used in this study may differ from it. Lubin and Vogelmann (2011) reported that the RCR’s deviation from perfect cosine angular response in the spectral interval 400–1000 nm increases linearly from zero at overhead illumination to approximately +10% at 60° illumination angle, then decreases to zero for larger illumination angles up to 76°, and at 1600 nm, RCR angular performance is better, with cosine error < +2% for illumination angles 0–60°, with degraded performance to an error of –10% by illumination angle 76°. In these cases the correction for RCR cannot be ignored.

There are also reported the deviation of cosine response of ASD's RCR by Meywerk and Ramanathan (1999) and Malthus and MacLellan (2010) in which cosine responses at some wavelengths are shown. Please indicate the figure of cosine response of RCR in the present study as well.

(3) Spectral albedo is calculated using spherical model for snow grains in this study. Basically I agree this approach. However, the spherical assumption is not completely verified for all nonspherical snow particles. Especially for very complicated crystal such as stellar dendrites, rime, and surface hoar shown in Fig. 5 there is still room for discussion as possible cause for discrepancies in spectral albedo between calculation and measurement.

Specific comments:

p. 5122, L22: "visible region ($\lambda = 0.35\text{-}0.75 \mu\text{m}$)" Spectral domain $0.35\text{-}0.40 \mu\text{m}$ is in general the ultraviolet region. It should be revised throughout the manuscript.

p. 5123, L1: "is absorbed within the top few millimeters of snow" Please indicate the reference.

p. 5128, L16: "Four repeated measurements were made at each location." I recommend to plot the standard deviation calculated from those four measurements at each wavelength in Figs. 3, 8, 10, and 13.

p. 5129, L7: "to account for the shadow of the observer and the aluminium arm of the instrument" According to Fig. 2, the aluminium arm does not affect the radiation measurements.

p. 5129, L12: "where $F_{\text{upward,dif}}$ is the measured upwelling diffuse radiation, assumed isotropic," The forward bidirectional reflectance at NIR wavelengths is very strong (anisotropic). How much is the estimated error of correction factor for upward radiation due to this effect by assuming isotropic?

p. 5129, L19: "and practically negligible elsewhere" Under clear sky condition

$F_{\text{downward,dif}}$ would be very small at NIR wavelengths and only the correction factor for upward radiation (1.31%) affects the corrected albedo, that is not negligible.

p. 5129, L24: “an integrating sphere, which eliminates the need of the RCR.” Even using integrating sphere the cosine response is not perfect. If the optical fiber is horizontally connected to the side of the integrating sphere, azimuthal dependence of cosine response would occur. Please indicate the deviation factor for the integrating sphere from the perfect cosine response.

p. 5135, L21: “The dust refractive indices were taken from the GEISA database.” There are many refractive indices for dust in the GEISA database. Please indicate which data base is used in this study.

p. 5135, L29: “the fist one” Typo of “first”?

p. 5138, L7: “At Summit, the surface snow layer can display a significant horizontal variability.” This could cause of the difference in spectral albedo between calculation and observation. Please discuss it.

p. 5139, L6: “On 15 May” The date indicated in Fig. 8 is 19 May.

p. 5140, L23: “whole fist cm” Typo of “first”?

p. 5140, L25: “for larger wavelengths” It is better to use “longer wavelengths”.

p. 5144, L23: “the optical constants of BC France et al. (2012) and dust Balkanski et al. (2007) are uncertain.” The left parentheses of the years are misplaced.

p. 5147, L6: “including trace elements and black carbon (BC).” What is the trace elements, dust?

References:

Lubin D. and A. M. Vogelmann: The influence of mixed-phase clouds on surface shortwave irradiance during the Arctic spring, *J. Geophys. Res.*, 116, D00T05,

doi:10.1029/2011JD015761, 2011.

Malthus, T. J. and C. J. MacLellan: High performance fore optics accessories and tools for reflectance and radiometric measurements with the ASD FR3 spectroradiometer, Proc. Hyperspectral 2010 Workshop, Frascati, Italy, 17-19 March 2010 (ESA SP-683, May 2010), 2010.

Meywerk, J., and V. Ramanathan: Observations of the spectral clear-sky forcing over the tropical Indian Ocean, J. Geophys. Res., 104, 24,359-24,370, doi:10.1029/1999JD900502, 1999.

Interactive comment on The Cryosphere Discuss., 6, 5119, 2012.

TCD

6, C2718–C2722, 2013

Interactive
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

C2722

