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The Cryosphere Discussions

Interactive comment on "Application of asymptotic radiative transfer theory for the retrievals of snow parameters using reflection and transmission observations" *by* H. S. Negi et al.

Anonymous Referee #1

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Overview:

This paper uses an asymptotic analytical radiative transfer (AART) theory to calculate optical parameters of snow cover treated in AART formulation (extinction coefficient, asymptotic flux extinction coefficient (AFEC), snow optical thickness, probability of photon absorption (PPA), and e-folding depth) from spectral reflectance and transmittance data observed by Perovich (2007) for different types of temperate snow cover. The AFEC calculated by AART theory are compared with those obtained by Perovich (2007) using a two-stream radiative transfer model. From those optical parameters calculated, the optically equivalent snow grain size and snow density are retrieved and

compared with in-situ measurements by Perovich (2007).

My impression of this paper is a case study for limited setting of parameters in the model. Many optical parameters were calculated from measured reflectance and transmittance data. However, many of them are only variables used in AART and did not compared with the measurements. The important parameter is snow grain size, whereas the measured grain sizes to be compared were not accurate optically equivalent sizes. Furthermore, although some single scattering parameters (g, beta_infinity, and M) are fixed in this study, they might depend on snow grain size, shape, and snow impurities in some cases. When the authors try to compare the retrieved snow grain size with the measurements, variable ranges of snow grain size calculated for the possible ranges of the single scattering parameters of snow particles should be discussed.

Specific comments:

(1) p.1241, line 27: The calculated result of "diffuse exponent," is not shown anywhere in the manuscript.

(2) p.1243, equation (6): Is this equation correct? It is not consistent with equation (16) and the description "where N is constant (=0.72) by considering the value of g as 0.76." on line 10 in p.1245.

(3) p.1245, line 11: Please add "a_ef" after "effective grain size".

(4) p.1248, line 11: The terms "15.5 cm new snow" lead misunderstanding. It should be "1.5 cm new snow on the top of 14 cm old snow".

(5) p.1248, lines 15-16: "Here we feel AART theory does not work correctly for melt freeze crust with large grains." Is it related with the fixed single scattering parameters for the inhomogeneous snow layer?

(6) p.1248, line 21 ff: "The difference for the high values of AFEC can also be attributed to contamination, as impurities in snow can significantly increase the AFEC in visible region (Choudhury et al., 1981). . .." Although AART theory in this study does not ex-

plicitly treat snow impurity, equation (18) looks to affect the retrieved snow grain size. Please explain the possible error of retrieved snow grain size due to snow impurities.

(7) p.1249, lines 4-5: “The retrieved SOT shows a linear relation with snow geometric thickness (Fig. 4).” Which data in Table 1 are used to plot Fig. 4? Please indicate the date? Is the linear line is regression line?

(8) p.1249, lines 16-17: “The e-folding depths retrieved using AART theory were found in the range between 5 and 25 cm in the visible region for different types of snow.” The results should be listed in Table 1.

(9) p.1249, lines 17-19: “These values depend on the absorption within the ice, scattering by the snow grains, and reflection at the boundaries of snow layers.” Snow impurities also affect the e-folding depths.

(10) p.1250, line 18: “due to measurement error in the field observation of snow grain size” The measured data being inconvenient for the authors are treated as “error”. It is just different definition of dimensions in the field observation of snow grain size.

(11) p.1257, Table 1: What is “S. No”?

(12) p.1257, Table 1: The derived K_ext value for S. No (1) is shown as “0.92 mm-1”. If the value is determined from a linear line in Fig. 4, the K_ext value should be 1.0 mm-1. The value of 0.92 mm-1 would be determined from the one plotted value at the snow thickness of 10 cm. The authors should use the value determined from a regression line.

(13) p.1258-1260, Figs 1-3: It is better to unify the line colors, types or (symbol) at least for AART and Perovich.

(14) p.1262, Figs 5: It is better to unify the vertical axes (scale) of two figures.

Interactive comment on The Cryosphere Discuss., 5, 1239, 2011.