Review of « SNICAR-AD V3: A community Tool for Modeling Spectral Snow Albedo»
by Flanner et al. (gmd-2021-182)

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Summary and recommendations

This paper presents a new release of the snow spectral albedo model, SNICAR-AD v3 including the most recent developments in terms of radiative transfer solver, ice refractive index and light absorbing particles. It was a great pleasure to review this paper. This is a very important and useful study and release considering the wide range of users of SNICAR and the relevance of the model. I think the model is extremely beneficial for the climate and the cryosphere community and beyond (extra-terrestrial studies). I only have a few general and minor comments that I am detailing below.

General comments.

1 – In the model evaluation (section 5) and the conclusions, the need for a very thin layer of snow with high SSA is underlined to better reconcile the measurements and the simulations in the NIR. The agreement in the NIR wavelengths can also be improved by using alternative values of the ice refractive index in these spectral ranges (e.g. Carmagnola et al., 2013 fig. 13 et 14 – with spheres, Dumont et al., 2021 with the theoretical of Malinka, 2014; fig. 10). I was wondering if this has been tested as an alternative to the very thin layer in SNICAR-AD.

2 – Still in the model evaluation (section 5), most of the comparison between the model and the measurements are visual and qualitative. I was wondering if some more quantitative information (e.g. broadband albedo bias, RMSE …. maybe just at least order of magnitude ?) can be added to ease the comparison with other models and other studies ?

3 – Many different acronyms are used in the literature for light absorbing particles (constituents, impurities, …), LAP, LAC, LAI. In this paper, LAC and light absorbing particles are used. Is there a reason for using both ?

Minor comments.

P2 line 21 - “the morphology and size of the ice grains” . The use of the term “ice grains” is a bit ambiguous since snow can be seen a porous media, and it’s not always easy to segment “grains”. Grains might also refer to crystallographic orientation (e.g. Montagnat et al., 2020). “ice grains” is however useful for defining re. I tend to refer to the morphology of the snow microstructure instead.

P2 line 40 – TARTES uses the Kokhanovsky and Zege formalism only for the single scattering properties.

P4 line 93 – Maybe the definition the extinction optical thickness could be helpful

P4 line 94 – Is it “single-scatter” or “single-scattering” albedo ?

P4 line 96 – Maybe details about the meaning of g =0, g=1 could be also helpful

Section 2.2 (p5). Why was the resolution of 10 nm chosen ? I guess it's a compromise between the numerical efficiency and the accuracy ? Is the ice refractive index averaged over a 10 nm spectral bands ? Or is the value of the central wavelengths used ?

Section 2.3 Maybe it could be useful to shortly describe here the underlying hypothesis in terms of optics (independent scatterers ..) that allows the writing of Eq. 4-6.

P6 Eq 7. What is the spectral resolution used to compute F(lambda) ?

P7 Table 1 – What are the values of ozone used ?

P7 line 177 – I agree that the spectral irradiance and the broadband albedo are sensitive to the RT model, and TOA irradiance. They also greatly depends on the atmospheric profiles and cloud properties ...

P7 line 183 – What are the types of aerosols used ?

P 9 Eq 9 (and at several places in the paper) – What is the reason for the choice of a log normal distribution ?

P10 line 232 – Maybe a very short sentence to justify the selection of the 4 shapes could be helpful (maybe it's already somewhere and I missed it).

P12 line 294 – "MAC", I guess it's "ka". Maybe the acronym should be added line 289.

Figure 3 c,e, just out of personal curiosity from what are the little bump around 400 nm for fine dust coming ?

Figure 7 – I think "(FGBC)" is missing in the caption.

Section 5 – For the clear sky measurements, where the direct/diffuse irradiance ratio used in the model compared to the one measured in the field (if any) ? This could also impact the comparison.

P4 line 793 - "less exposure of sub-surface LAC", the reason is then the same of the increase effect of LAC for "large grains" (p 31 lines 729-731) ?

Code availability

The code, the web app and the library are well structured, documented and easily accessible. I was wondering if it is possible to add a *readme* file for the LAC properties. The .nc are self-documented but maybe it could help the reader to know which properties are required to implemented a new type of LAP ?

The code is in matlab. Is there any plan to have an 'open language' version ?

For the web-app is it possible to use "ground" albedo that would be not constant with wavelength ?

References used in the review.

- Carmagnola, C. M., Domine, F., Dumont, M., Wright, P., Strellis, B., Bergin, M., Dibb, J., Picard, G., Libois, Q., Arnaud, L., and Morin, S.: Snow spectral albedo at Summit, Greenland: measurements and numerical simulations based on physical and chemical properties of the snowpack, The Cryosphere, 7, 1139–1160, https://doi.org/10.5194/tc-7-1139-2013, 2013.

- Dumont, M., Flin, F., Malinka, A., Brissaud, O., Hagenmuller, P., Lapalus, P., Lesaffre, B., Dufour, A., Calonne, N., Rolland du Roscoat, S., and Ando, E.: Experimental and model-based investigation of the links between snow bidirectional reflectance and snow microstructure, The Cryosphere, 15, 3921–3948, https://doi.org/10.5194/tc-15-3921-2021, 2021.

- Malinka, A. V. (2014). Light scattering in porous materials: Geometrical optics and stereological approach. Journal of Quantitative Spectroscopy and Radiative Transfer, 141, 14-23.

- Montagnat M, Löwe H, Calonne N, Schneebeli M, Matzl M and Jaggi M (2020) On the Birth of Structural and Crystallographic Fabric Signals in Polar Snow: A Case Study From the EastGRIP Snowpack. Front. Earth Sci. 8:365. doi: 10.3389/feart.2020.00365