

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-272

Ruzica Dadic (Referee)

Referee comment on "SNICAR-ADv4: a physically based radiative transfer model to represent the spectral albedo of glacier ice" by Chloe A. Whicker et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-272-RC2>, 2021

This paper uses extends the current multi-layer two-stream delta-Eddington radiative transfer model to be applicable in a wide range of snow and ice environments. The work is relevant because of the role that cryospheric albedo plays in Earth's climate in the context of climate change. Especially the inclusion of LACs is of relevance and I appreciate that the authors include different types of impurities, so the model really is applicable in a wide range of regions.

The paper is well written with and th emethods are well explained. I only have a few minor comments, that I summarize below.

1) There are inconsistencies on the definition of "snow" and "ice" in the model. In the abstract, the cutoff is 650 kg/m^3 . In Figure 2, density of 600 is defined as ice. And later you say that snow is below 500 and ice is above 600? How is the firn modeled, as firn or as ice? This just needs to be made consistent. I think it's just adjustments in the text, the results appear to be ok.

2) Usually the term SSL (surface scattering layer) is used just for sea ice and shows a particular structure because of the anisotropic structure of brine channels in sea ice. To avoid confusion, you might considering calling it a different name, because the "crusty layer" on glacier ice is not associated with brine channels and is more sotropic that the same layer on sea ice.

3) You say that snow layers are represented as "ice crystals", but it's rather "spheres". I would correct this throughout the manuscript, unless you are really representing the crystal shape instead of a collection of independent spheres.

4) L 153: what is the "merged" ice refractive index?

5) Figures 8-11 are hard to read, because the x-axis is so stretched. Maybe redo them with a better readable x-y-ratio. Also it may be worth plotting the difference (in %) between model and measurements at different wavelengths, rather than actual values. Or add the differences as a righthand y-axis. It may be worth to give the %-ages of albedo variations in the manuscript, rather than absolute values (e.g. L24, L288, L291)