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Geoscientific Model Development Discussions

Interactive comment on "A module to convert spectral to narrowband snow albedo for use in climate models: SNOWBAL v1.0" *by* Christiaan T. van Dalum et al.

Anonymous Referee #1

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This paper presents a novel method for coupling the snow spectral albedo model TARTES to the regional climate model RACMO using a representative wavelength approach under both direct and diffuse illumination conditions, with the goal of improving the albedo scheme and hence energy budget simulation of the Greenland Ice Sheet. The method revolves around the generation of lookup tables which define the representative wavelength of each RACMO narrow-band as a function of illumination conditions. This makes it possible to run TARTES within RACMO, with two principal benefits: (1) significant improvements in the computation of the snow albedo within RACMO compared to the existing broadband approach, and (2) computational efficiency maintained by running TARTES only once for each RACMO narrow-band - using the representative

wavelength - as opposed to for the entire shortwave part of the spectrum. The study shows that very large differences can be found between the broadband and spectral approaches and hence concludes that treating snow albedo spectrally is critical to a good energy budget simulation.

I consider this study to be timely and important for two reasons. First, it clearly illustrates that existing broadband albedo calculation approaches introduce significant uncertainties in energy budget calculations because they are unable to explicitly account for spectrally dependent processes including clouds and snow metamorphism. Second, given the recent literature which seeks to understand the impact of cloud cover upon GrIS runoff during the coming century (e.g. van Tricht et al., 2016, Hofer et al., 2017), it is timely to consider whether the models used to investigate cloud cover are capable of adequately resolving their impact upon albedo and hence runoff. To my understanding, the methods chosen are appropriate to answer these kinds of questions. The study combines existing mature models together through its elegant computation of lookup tables for representative wavelengths.

The model code and a user manual are provided. I have not tried to run the code as there are a number of dependencies that I would need to install first. The code is reasonably well commented and clear and I would not anticipate experiencing problems with its use as a third-party user.

I consider the manuscript to be in excellent shape. The figures and tables are all of good quality. I have only a few, relatively minor comments:

* A more appropriate reference than Dumont et al.(2014) for P1, L21-23 should be sought. The Dumont paper was really about the potential impact of impurities on snow albedo and hence melt, and subsequent research suggests that its conclusions were not correct (Polashenski et al., 2015). * The study mentions that a spectral approach is important for examining the impact of impurities upon snow albedo in the abstract, but later on (page 14, L13-17), states that the effect of dust is not considered as TARTES

uses the delta-Eddington approach (P5, L7) as opposed to Mie scattering. This seems a fundamental issue and so I wonder if the study would benefit from an additional paragraph, perhaps in the introduction, which outlines the different optical approaches and what they permit in terms of albedo modelling. Reference to Cook et al. (2017) may be useful here. * The text can be tightened in places - many sentences are very wordy and could be simplified without loss of meaning.

References not in the text:

van Tricht et al. (2016), Nat. Commun., 7, 10266. Hofer et al. (2017), Sci. Adv., 3, e1700584. Polashenksi et al. (2015), Geophys. Res. Lett., 10.1002/2016GL065912. Cook et al. (2017), The Cryosphere, 11, 2611-2632.

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