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The Cryosphere Discussions

Interactive comment on "Evaluation of a new snow albedo scheme for the Greenland ice sheet in the regional climate model RACMO2" *by* Christiaan T. van Dalum et al.

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This study incorporates the TARTES and SNOWBAL radiative transfer schemes into RACMO2, and evaluates the performance of the new model against remote sensing and in-situ measurements, and also against the old RACMO2 scheme. The evaluation shows general improvement in comparison with the original scheme, and is also more justifiable on physical grounds, including more realistic treatment of spectral characteristics and vertical penetration of radiation. The use of soot as a tuning parameter to achieve targeted albedo is not a desirable long-term solution, but okay in the context presented. Overall, the paper is well-written, well-presented, and scientifically sound.

Several minor issues outlined below should be clarified, however, before publication in TC.

General issues:

The MODIS albedo product used for model evaluation is Version 6 of MCD43A3. The version evaluated by Stroeve et al (2013), however, was version 5. Hence the RMSE and biases reported for MCD43A3, and used to tune the model albedo, may not be applicable. I am unsure of changes in the retrieval algorithm between versions 5 and 6, but they may be non-negligible (see, e.g., Polashenski et al., 2015, doi:10.1002/2015GL065912). Some exploration and assessment of this issue should be included.

Section 2.1.1 - Are the multilayer firn updates new features that need to be introduced here, or are/can they be described in another study? I ask because this sub-section seems somewhat tangential to the study, which otherwise focuses on snow albedo.

Minor issues:

Lines 47-52: Some models do conduct coarsely-resolved spectral calculations. For example, The CESM and E3SM models include SNICAR, which currently calculates snow albedo in 5 spectral bands when embedded in these GCMs. Insolation from the atmosphere is partitioned into only 2 bands (visible and near-IR), however. SNICAR also represents sub-surface absorption of solar energy. Details can be found in the CLM technical note: http://www.cesm.ucar.edu/models/cesm2/land/CLM50_Tech_Note.pdf

line 101-102: Why was the initialized ice density changed from 910 to 917 kg/m3, given the next sentence which states that bare ice density is usually lower than 917 kg/m3? Also, does the ice density change with time in the model? Finally, "mimicking" might be better replaced with "indicating", in this context.

line 118-129: Description of SNOWBAL: It would be helpful to mention or briefly describe how much of an impact on broadband albedo/absorption this clever selection of

sub-band wavelength causes relative to use of the sub-band center wavelength, which is the technique likely employed by most others.

line 125-129, and Figure 1: Is the MCD43 "clear-sky diffuse" albedo field equivalent to their "white-sky" albedo? If so, I suggest applying consistent terminology throughout the paper. Also, is the only difference between your clear-sky and cloudy diffuse albedo fields associated with cloud-induced spectral shifts? I assume the clear-sky diffuse albedo only minimally impacts the clear-sky albedo, except at very short wavelengths where Rayleigh scattering is appreciable.

line 140: "Firstly, we assume that clean bubble-free ice has an albedo of approximately 0.6" - Pure, bubble-free ice technically has a much lower albedo than this, as described by the Fresnel equations. I assume this higher (measured?) albedo is caused by surface scattering and roughness. If so, this should be mentioned.

line 154: What type of impurity is indicated with these concentrations? (Presumably soot).

line 169: "RACMO2 only allows for a fixed soot concentration." - But to be clear, the prescribed soot concentration varies over bare ice, and is only fixed over snow, correct? This distinction could use some clarification.

line 184-185: "But note that the MCD43A3 WSA product remains a slightly different albedo product than the clear-sky RACMO2 albedo it evaluates, which includes both direct and diffuse radiation." - As described earlier, however, both direct and diffuse clear-sky albedos are calculated by the model. Why not use the diffuse clear-sky albedo for comparison with MCD43 white-sky albedo. Wouldn't this be an apples-for-apples comparison?

line 199: Again, I believe Stroeve et al (2013) use version of 5 of this product.

line 357: "... high SZA... The spectral albedo of IR radiation is low, hence the broad-band albedo drops" - But the SZA grazing effect outweighs the spectral shift, producing

higher albedo at higher SZA, doesn't it? Your language on p.2 suggests so: "... this increase of spectral albedo at large SZA is largely mitigated by the red shift..." (i.e., largely, but not entirely, mitigated).

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