Interactive comment on “Quantifying bioalbedo: A new physically-based model and critique of empirical methods for characterizing biological influence on ice and snow albedo” by Joseph M Cook et al.

Anonymous Referee #1

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This crystal clear, relevant, and very complete paper provides a physically-based framework for quantifying the effect of biological activity on the albedo of snow and ice. For a radiative transfer expert, this paper dwells quite long on RT theory and observational techniques. But I guess that the authors have a much broader audience in mind for this paper (but this is nowhere stated explicitly!), including biologists that have not worked much with RT before. In that sense, this manuscript is a great one-stop reference for everyone working on bioalbedo. I have only one major request: For figures 2, 3, and 4, could an additional panel be added showing the dependence of the broadband albedo on the variable of interest? Otherwise, I only have some minor suggestions for improvement.

Note to the editor: my background is in radiative transfer modelling, so separate advice on the biological aspect of this paper should be sought by another reviewer.

P1L28-31: I would cast some of the 10 challenges differently, such that it is clear what the challenge exactly is. E.g. "Ambiguity in terminology:" -> "Reconciling ambiguous terminology"; "Surface anisotropy" -> "Accounting for surface anisotropy"; "Measurement and instrument configurations" -> "Standardizing measurement and instrument configurations" or similar.

P1L37: ... on THE ice surface ...


P4L21: Please turn this list into a table, with an additional column showing the mathematical symbol used in this paper. Instead of the somewhat cumbersome lines 42-45.

P4L21: I guess that these library files are wavelength-dependent? At least, the items 2,3 and 4 in the list? Could you indicate which information is wavelength-dependent?

P5L39: This is a good example of a section that I would recommend to shorten significantly, if the audience of this paper were strictly limited to RT specialists. No new insights are presented here, and a paper like Schaepman-Strub et al. covers this entire section.

P7L15: strictly speaking, the rightmost part of the equation is a definition of r_eff. You could add a second equation here, defining r_eff as

\[
 r_{\text{eff}} = \frac{3}{(\rho_{\text{ice}} \times \text{SSA})}
\]

P10L11: Ambiguous. Please reformulate: "... unless dust can be accounted for accurately. Otherwise, there is a high risk of biomarker false positive"
on the other hand, rough surfaces create photon cavities that increase scattering and absorption, and lower albedo (e.g., Cathles et al., 2011, Ann. Glac. 52(59))

Figure 2: It would be very illustrative to add a panel here that shows broadband albedo as a function of pigmentation level. I understand that this requires an additional setting, namely the prescription of an atmospheric vertical profile determining the spectral composition of the radiation arriving at the surface. Nonetheless, I believe that this would be very instructive. How much does the presence of biomass really mean for broadband albedo? And what aspects of the biomass matter most for albedo?

Figure 3: idem, but with a panel showing broadband albedo as a function of biomass concentration, for 3 cell radii.

Figure 4: idem, but with a panel showing broadband albedo as a function of layer thickness, for different mass concentrations.