

## ***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

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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 ...

P4L19: You use both BioSNICAR and Bio-SNICAR (with and without hyphen). Please standardize.

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  $r_{\text{eff}}$ . You could add a second equation here, defining  $r_{\text{eff}}$  as

$$r_{\text{eff}} = 3 / (\rho_{\text{ice}} * \text{SSA})$$

P10L11: Ambiguous. Please reformulate: "... unless dust can be accounted for accurately. Otherwise, there is a high risk of biomarker false positive"

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P10L12: 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))

P13L14: straightforward

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.

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2017-73>, 2017.