Reply to RC1
Raf Antwerpen et al.

Author comment on "Assessing Bare Ice Albedo Simulated by MAR over the Greenland Ice Sheet (2000–2021) and Implications for Meltwater Production Estimates" by Raf Antwerpen et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-37-AC1, 2022

Dear reviewer,

We thank you for your thorough and constructive comments on our paper. All authors have discussed your comments and we have addressed all of them below. Where it is appropriate, we adjusted the text and figures in our manuscript accordingly. We believe these changes have improved the quality and clarity of our manuscript.

Sincerely,

Raf Antwerpen

General comments

The paper presents results from a comparison of the bare ice extent and albedo simulated by the regional climate model MAR and derived from MODIS satellite imagery. Additionally, an energy balance model is used to estimate melt water production. Authors limit their investigations to the GrIS below 70°N in the time period 2000-2021.

Overall, the differences between model results and observations are quite substantial. The albedo parameterization scheme in MAR is identified as a major source of these differences. It is underlined that the impact of light-absorbing constituents in ice and accumulated surface melt water on the GrIS is not properly accounted for in the albedo parameterization scheme.

As discussed in the paper, already earlier evaluations of MAR results pointed to these deficiencies. Hence, what can we really learn from the paper presented here? What is the benefit for the modelling community?

We believe that multiple papers with different methods for understanding the limitations and improvements of climate models are necessary. The results here contribute actively to
the relatively small literature focusing on improving albedo schemes in climate models that estimate mass loss from Greenland. This manuscript uses a combination of tools that is not present in other studies. In particular, the study of Alexander et al. (2014) evaluated simulation of Greenland ice sheet albedo in the MAR RCM and identified a negative albedo bias in the ablation area. This was attributed to the lack of impurities over bare ice in MAR, but that study did not specifically address bare ice albedo because a method for separating bare ice from snow using satellite data had not yet been developed. As it is now possible to separate bare ice from snow using the method of Shimada et al. (2016), this study can specifically evaluate bare ice extent and bare ice albedo simulated by MAR, and will contribute to an improved understanding of processes that could be responsible for the mismatch between modeled and observational results. This manuscript therefore improves our understanding of the spatio-temporal evolution of light-absorbing constituents on the Greenland ice sheet, and provides a basis for future improvement to model simulations.

I miss sensitivity studies with respect to the albedo parameterization scheme and it would have been very helpful to implement and test at least simple schemes that account for LAC and melt water signatures on the ice sheet. To know the impact of different parameterization schemes on bare ice extent and melt water production and a comparison to observations would be really interesting and very helpful.

Implementing albedo parameterization schemes and sensitivity studies are next steps for our research group, the focus of this work is evaluation. Experiments with the model are outside the scope of the current study. The current study is focused on evaluating the existing schemes within MAR, and it is not trivial to add such new schemes in MAR, particularly with regard to representing LACs and water ponding, as the sub-grid scale ponding of water and even the nature of the LAC constituents are not well-known. This is a subject of ongoing research within the community.

The subject is appropriate for EGUsphere.

The title reflects the content of the paper, the abstract provides a complete summary and the paper is generally well structured.

The review of existing published work is good, the number of references is appropriate.

Overall, figures and tables are clear and their captions self-explanatory.

The use of the English language is very good.

We thank you for your valued comments on our manuscript.