

Reply to comment on tc-2021-366 (Lamare et al.)

Legend

Reviewer

Author

I want to thank the authors for carefully revising the manuscript, I think it reads much more clearly now. The study is an important contribution for the remote sensing community, and the revisions helped to present the results more clearly. A more stringent use of the terminology of the reflectance quantities presented here makes the results immediately more applicable. This is important, as currently investigations of the directional reflectance of bare sea ice are underrepresented in the literature. Please find my remaining comments below.

Thank you and thank you for taking the time to improve the manuscript.

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Title: I suggest removing the wavelength range in brackets in order to get a less bulky title. It is sufficient to mention the wavelength range in the abstract and throughout the text. Similarly, removing the abbreviations CCRF and BRDF from the title would foster reading comprehension and I think the paper will benefit from a clearer title.

Done.

Introduction: The introduction reads better than in the last version. However, I still have some comments:

(1) To focus the motivation of the study on the surface albedo and thus energy budget (for monitoring from satellite to inform models) is of course a very valid and relevant point. However, I am missing the connection of the CCRF/BRDF to other remote sensing retrievals (e.g. aerosol/cloud properties). These also have potentially large effects on the energy budget and a better representation of the directional reflectance can increase their accuracy, especially in the polar regions with large solar zenith angles.

The following text and reference has been added to this short paragraph – “The change in angular distribution of radiance at the top of the atmosphere, relative to the surface is significant, but the changes in the top of the atmosphere angular distribution of radiance owing to changes in atmospheric conditions are small(e.g. Hudson et al., 2010).”.

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(2) The introduction ‘jumps’ a lot between thickness, roughness, wavelength considerations as well as between observations and modelling. Reordering of some of the points will help to foster reading comprehension.

The text was changed, especially regarding roughness and is now clearer.

(3) The introduction needs some paragraphs to break up the text, e.g. after the general motivation, after the definition of the CCRF/BRDF, and then potentially observations/modelling.

Paragraphs added.

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Methods: I recommend breaking up the Methods a bit more, e.g. dedicating a separate subsection to the definition of the roughness parameter (new 2.3, and 2.3 becomes 2.4). It is great that it is included here now already, however I think it is easier to find and refer to if it is a separate subsection.

Done.

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P2L33: large number of terms

Fixed.

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## P2I35: sea ice

Fixed.

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P2L36: please mention some more recent observational studies as well, e.g. Goyens et al. (2018), Becker et al. (2022). These are highly relevant to the paper.

Fixed – references added.

P2L42: please specify the type of parameters used

Fixed – “However, the study was limited to 2 spectral bands at 580–680 nm and 725–1000 nm and a single type of multi-year sea ice with parameters (salinity profile and air volume) obtained from Weeks and Ackley (1994).”

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P2L56: please correct me if I am wrong, but wasn't the study by Marks et al. (2015) focused on Antarctic snow rather than sea ice? Do you mean Marks and King (2013) instead?

## P4L100: close brackets

## P4L113: affecting

P4L125-129: This should go into the introduction to introduce typical roughness of sea ice. And in the Methods, only explain the choice of roughness parameters and reference the Tucker et al. (2013) study.

P5L134: please consistently name it PlanarRad

Figure A3: the axis annotation font size needs to be larger, it is very hard to read at the moment

P6L163: is defined

### P6L167: overly cautious/ conservative

Fixed – “conservative” used.

Caption Fig. A4: owing to changes *\*in\** roughness are hard to discern...

Fixed.

Legend Fig. A4: please add the used roughness parameter to each line entry in the legend, not just for some of them.

Fixed.

P6L180: Please specify in the text whether the % changes given here are based on the peaks in the spectrum or are integrated quantities.

## P7L190: CCRF instead of BRF

Fixed.

## P8L234: CCRF instead of BRF

Fixed.

P11L324: explain acronym HDRF in the text here, as it is mentioned for the first time

P11L354: effect on...also remove double 'other'

Fixed both.

Acknowledgements: please change to the full link to the dataset  
<https://doi.org/10.5281/zenodo.5733402> as the current display of the doi is not working directly.

Fixed.

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References

Goyens, C., Marty, S., Leymarie, E., Antoine, D., Babin, M., & Bélanger, S. (2018). High angular resolution measurements of the anisotropy of reflectance of sea ice and snow. *Earth and Space Science*, 5, 30–47. <https://doi.org/10.1002/2017EA000332>

Becker, S., Ehrlich, A., Jäkel, E., Carlsen, T., Schäfer, M., and Wendisch, M.: Airborne measurements of directional reflectivity over the Arctic marginal sea ice zone, *Atmos. Meas. Tech.*, 15, 2939–2953, <https://doi.org/10.5194/amt-15-2939-2022>, 2022.