Review of tc-2023-103
Evaluation of satellite methods for estimating supraglacial lake depth in southwest Greenland

Summary

This paper offers methodological insight into the effectiveness of the radiative transfer equation (RTE) for calculating supraglacial lake depths. It does this by comparing the RTE using the red band and green band from Sentinel-2 against lake depths calculated from both ICESat-2 and ArcticDEM. Overall, I think this is an excellent paper, which is well written and contributes significantly to the field of remote sensing in glaciology. However, there are some major and minor comments that I would like to be addressed prior to publication.

Major Comments

The methods section for the RTE method is very difficult to follow. I think it would help to start by explaining that until now, there have been values for various parameters that have been used in the literature, and to state these first. You can then go on to justify why you look to create and use new values.

The above comment cascades into Figure 6 and the caption for Figure 6 being very hard to follow. Please think about how you can better explain and present the variables tried and tested. It may be that some information from Appendix Section 4 would be better placed in the main text. Following on from this, whilst in Figure 6 you vary each parameter in turn, what happens if you vary all parameters together, is this not something that needs testing?

More attention should have been paid to the selection of values of Ad in the RTE. Specifically, I would recommend the authors test a wider range of Ad values before this work is published. The author should read and refer to Dell et al. (2020), who use careful selection of Ad values to avoid the impact of slush.

Despite your comments r.e. averaging the red and the green band depths, I would like to see some evidence for this method not being suitable moving forward, particularly given its use in both Pope et al. (2016) and Williamson et al. (2018). I understand what you are saying with regards to the plateauing effect caused using the red band, but it would be more convincing if you could provide evidence for this. You also do not mention the fact that previous studies have averaged these depths until the discussion, I would advise mentioning this much earlier on.

Minor Comments

L74: Does this region only contain active lakes?

L134-136: For the section starting ‘we manually appraised’, please can you better clarify what was done here, I can’t make sense of it.

L160: Whilst I understand that it is more likely for lake bathymetry to change over 11 months for Lake 5, surely the lake bathymetry could feasibly change over any lake and time period?

L165: For the paragraph containing line 165 (which details the method used to calculate each lake's depth from the DEM) and the two following paragraphs, much more detail is needed. It is very unclear how you carried out your methodology.

L194: lake surface?

L269-L275: You only talk about the red depths in detail here, what about the green depths?

L325: I am not sure 'However' is the right word to use here.

L332-224: This section could do with some re-wording to improve its clarity.

L357: The authors should also consider referencing Moussavi et al. (2020) here.

Figures

Figure 1: Caption – where are the background images from? Sentinel-2?
North Arrow is hard to see in main map and subset maps.

Figure 3: For the Y-axis find a way to space out the text for 'ArcticDEM' and 'ICESat-2'

Figure 4: Please add North labels and scale bars to these plots! You also need to state that you show the ICESat-2 transects on the depth plots.

Appendices

Appendix A Section 1: The authors should consider moving comments on the quality of ICESat-2 into the main text.

Appendix A Section 2:
Table A1: What date was the imagery downloaded by you? – Apply this comment elsewhere too.

References in this review

Dell, R., Arnold, N., Willis, I., Banwell, A., Williamson, A., Pritchard, H., & Orr, A. (2020). Lateral meltwater transfer across an Antarctic ice shelf. *The Cryosphere*, *14*(7), 2313-2330.

Moussavi, M., Pope, A., Halberstadt, A. R. W., Trusel, L. D., Cioffi, L., & Abdalati, W. (2020). Antarctic supraglacial lake detection using Landsat 8 and Sentinel-2 imagery: Towards continental generation of lake volumes. *Remote Sensing*, *12*(1), 134.

Pope, A., Scambos, T. A., Moussavi, M., Tedesco, M., Willis, M., Shean, D., & Grigsby, S. (2016). Estimating supraglacial lake depth in West Greenland using Landsat 8 and comparison with other multispectral methods. *The Cryosphere*, *10*(1), 15-27.

Williamson, A. G., Banwell, A. F., Willis, I. C., & Arnold, N. S. (2018). Dual-satellite (Sentinel-2 and Landsat 8) remote sensing of supraglacial lakes in Greenland. *The Cryosphere*, *12*(9), 3045-3065.