

# Final comments to review: Welling and the RNO-G Collaboration; Precision measurement of the index of refraction of deep glacial ice at radio frequencies at Summit Station, Greenland

Manuscript #: egosphere-2023-745

Thank you to Christoph Welling and co-authors for responding point-by-point to my initial review to your manuscript.

I am posting a response with final comments ahead of the release of a revised version of the manuscript, as I am shortly heading to Antarctica on fieldwork with limited to no internet access. I am happy for the manuscript to be published once the authors address these final points (all minor) below. In the mean time, in the spirit of progress I am assuming that the revised manuscript accurately reflects the changes mentioned in your 13 August response.

TJ Young (University of St Andrews)  
23 October 2023

## General comments

Separated into the same sections as the initial review, I have some last comments as well as several requests as you prepare your manuscript towards publication:

### (a) Further clarity on radio wave properties

Thank you for clarifying that your antenna setup is the same as Aguilar et al. (2022c). Please make this clear and explicit in your manuscript, perhaps in the Methods section. I would also recommend that you include a statement somewhere in the manuscript that frequency will affect the strength of the observed conductivity-induced englacial reflections (Fujita & Mae 1994), which is a caveat that dictates the optimum range of frequencies that could be used to conduct a similar experiment in the future.

### (b) Explicit statement needed that this method assumes additional invariance in several parameters

I am glad that you have added a brief paragraph discussing the assumption of invariance in density, permittivity, temperature, and crystal orientation fabric. I hope this paragraph also addresses that reflections detected by the radio wave are assumed to arise from abrupt contrasts from conductivity and not from permittivity (Fujita & Mae 1994).

### (c) Consideration of the “echo-free zone”

I agree that given the data you present, the method could potentially be applied to data to 1700 m. It was not clear until L182 that you had limited your measurements to the upper ~850 m in ice column. This perhaps should be stated much earlier in the manuscript, such as in the beginning of the results section or in the Methods section.

### (d) Suggestions to consider employing ice-penetrating data to strengthen the argument

I'm glad that you found the radio-echo sounding transects from Jacobel & Hodge (1995) helpful.

## Specific comments (by line L)

86-92        Thanks for clarifying that your antennas were the same and positioned closer than the

setup at the GISP2 hole. I would recommend stating this in the manuscript even though they were not used for the refraction measurements, as you still show the data to lower depths and use these results to suggest that the method can hold over deeper domains.

176 Thanks for clarifying the two measurements of  $n$ —I'd recommend making this explicit in the manuscript at or around this line.

## References

- Fujita, S., & Mae, S. (1994). Causes and nature of ice-sheet radio-echo internal reflections estimated from the dielectric properties of ice. *Annals of Glaciology*, *20*, 80-86.
- Jacobel, R. W., & Hodge, S. M. (1995). Radar internal layers from the Greenland summit. *Geophysical Research Letters*, *22*(5), 587-590.