egusphere-2024-2904 Response to Arttu Jutila

Landy et al.

July 18, 2025

In this document, we outline our responses to comments, including modifications that we intend to make to the manuscript where necessary. Reviewer comments are shown in black and our responses in blue with intended changes to the revised version of the manuscript given in italics.

Dear Jack and co-authors,

Kudos to you on your important and timely work on this topic! With this community comment, I would like to raise some points regarding the reference observations (L175ff).

Thank you Arttu for identifying these technicalities and for your comments on the application of pySnowRadar to OIB data. We hadn't considered some of the points you raise, which have prompted us to re-evaluate the OIB snow radar data.

First off, the minor technicalities:

Could you please update the reference Jutila et al. (2021) from the preprint in The Cryosphere Discussions to the published article that has been available now for nearly three years? I mention this here because I have encountered recent papers where this has not always been caught even after professional copy-editing.
Jutila, A., Hendricks, S., Ricker, R., von Albedyll, L., Krumpen, T., and Haas, C.: Retrieval and parameterisation of sea-ice bulk density from airborne multi-sensor measurements, The Cryosphere, 16, 259–275, `https://doi.org/10.5194/tc-16-259-2022`, 2022.
While the geophysical measurement data have not changed, I would appreciate if you would refer to the most recent version (v2) of the AWI IceBird dataset as: Jutila, A., Hendricks, S., Ricker, R., von Albedyll, L., and Haas, C.: Airborne sea ice parameters during the IceBird Winter 2019 campaign in the Arctic Ocean, Version 2 [dataset publication series], PANGAEA, `https://doi.org/10.1594/PANGAEA.966057`, 2024.

Will be corrected.

Then to the more interesting bit, which is applying pySnowRadar and the peakiness method to the April 2019 OIB data.

1. Which flights have you processed exactly?
The snow radar parameter spreadsheet (`snow_param_2019_Greenland_P3.xls` available at `https://gitlab.com/openpolarradar/opr_params`) lists a total of six, not five, flights over sea ice (sheet `\cmd", column \mission_names", \Sea Ice:*"`). Also NSIDC has six files with those dates in

2019 data (`https://doi.org/10.5067/GRIXZ91DE0L9`).

We did not use the flight on April 8th because the flight report included a comment for the snow radar "digital malfunction" and it wasn't used in the OIB-quicklook processing. See `https://daacdata.apps.nsidc.org/pub/DATASETS/ICEBRIDGE/Evaluation_Products/IceBridge_Sea_Ice_Freeboard_SnowDepth_and_Thickness_QuickLook/Documentation/icebridge_ql_products_2019.pdf`. We will clarify this in the manuscript.

2. On L185, you mention using "the same pySnowRadar parameters as the IceBird data", but I guess you mean the peakiness method parameters? pySnowRadar contains also other retrieval algorithm modules like the wavelet method (Newman et al., 2014) with very different parameters for very different purposes.

Yes exactly, will be corrected.

3. From the snow radar parameter spreadsheet notes, it is also obvious that some OIB flights were carried out with a reduced bandwidth (2-8 GHz instead of the full 2-18 GHz) and/or at an unusually high altitude of 3500 ft (nominally ∼1500 ft). The peakiness method was not developed and has not been tested for such missions, and I am curious how the snow depth retrieval results looked like. Did you compare them against the official OIB product at NSIDC (`https://doi.org/10.5067/GRIXZ91DE0L9`)?

We initially used the OIB quicklook product available from NSIDC for all our analyses, but then, based on the issues with the QL method identified in [Kwok et al., 2017], we decided to reprocess the CReSIS data ourselves with the same "peakiness" method applied to the IceBird data, to ensure consistency across the reference data. The reprocessed OIB peakiness data were then used for the snow depth validation and retracker analysis.

There is one case where the flight tracks from OIB on 6th April and from IceBird on 5th April 2019 crossed, with data available from both flights at three of our 25 km grid cells. Both flights were performed with the snow radar covering a 2-18 Ghz bandwidth and at ∼500 m flight altitude. The mean airborne snow depth estimate for each grid cell is shown in Figure 1, including the IceBird peakiness estimate, and OIB quicklook, peakiness and wavelet method estimates. It is evident from these three grid cells, at least, that the peakiness snow depths are very consistent between flights, but the QL and especially wavelet results show thicker snow depths.

To avoid confusing the message, we will not include this analysis in the revised manuscript, but will clarify our method applied to the OIB snow radar data.

4. While its impact is rather minor, which snow density value did you use in the processing? Later, on L193, you mention assuming snow density of 350 kg m-3. Or was it perhaps varying according to Mallett (2024)? In AWI IceBird, it was fixed at 300 kg m-3.

We used a fixed snow density of 300 kg m-3 in our OIB processing for consistency with the IceBird processing, which will now be clarified in the manuscript.

GRID CELL	LAT	LON	ICEBIRD	QL	PEAKINESS	WAVELET
1	83.7330	-59.7430	0.3231	0.4350	0.3319	0.4959
2	84.1190	-57.5280	0.3539	0.4175	0.3630	0.5227
3	84.4940	-55.0080	0.3531	0.3953	0.3625	0.5251

Figure 1: Statistics of the snow depths derived from three different processing methods applied to the OIB snow radar data on 6th April 2019, for three 25-km grid cells crossing an IceBird flight on April 5th 2019.

References

[Kwok et al., 2017] Kwok, R., Kurtz, N., Brucker, L., Ivanoff, A., Newman, T., Farrell, S., King, J., Howell, S., Webster, M., Paden, J., Leuschen, C., MacGregor, J., Richter-Menge, J., Harbeck, J., and Tschudi, M. (2017). Intercomparison of snow depth retrievals over Arctic sea ice from radar data acquired by Operation IceBridge. *The Cryosphere*, 11:2571–2593,. Type: b.