RC1: 'Comment on egusphere-2025-2657', John Yackel, 14 Jul 2025

Dear Authors and Handling Editor,

Iceberg influence on snow distribution and slush formation on Antarctic landfast sea ice from airborne multi-sensor observations by Steven Franke and co-authors presents a highly novel multi-sensor remote sensing assessment of of iceberg infiltrated snow-covered landfast seasonal sea ice in Atka Bay, Antarctica focused on early December 2022 during the ANTSI campaign. The datasets consist of quad-polarized, ultra-wideband microwave (UWBM) radar from CReSiS U Kansas, airborne laser scanner (ALS), the Modular Airborne Camera System (MACS), four Global Navigation Satellite System (GNSS) antennas, TanDEM-X band SAR imagery, along with coincident ground-based measurements including electromagnetic (EM) induction sounding (GEM2) and in-situ snow depth and sea ice drilling conducted reasonably close in time to the remote sensing data.

The research approach and its datasets are, in my opinion, highly novel and unique. The manuscript is extremely well written and organized and includes some of the most exquisitely constructed illustrations I have seen in a long time. Figure 3 is one such example. This manuscript makes a strong contribution towards improved understanding of snow processes on Antarctic sea ice including the interpretation and use of FMCW and X-band SAR and their polarization capability for snow depth estimation. I recommend publication subject to minor revisions and addressing my questions below.

> **We gratefully thank John Yackel for the time and effort reviewing our manuscript as well as for the positive and helpful feedback and comments. We outline below how we intend to address the comments and how we will modify our manuscript accordingly.**

General Comment:

1) I found the Introduction written oddly in the sense that results/conclusions are alluded to on several occasions (L44-47; L67-72) without having read an objectives statement. I strongly recommend that the Introduction include explicitly written and tractable objectives statements and also remove the suggestive language as to what the results and conclusions of the analysis will show.

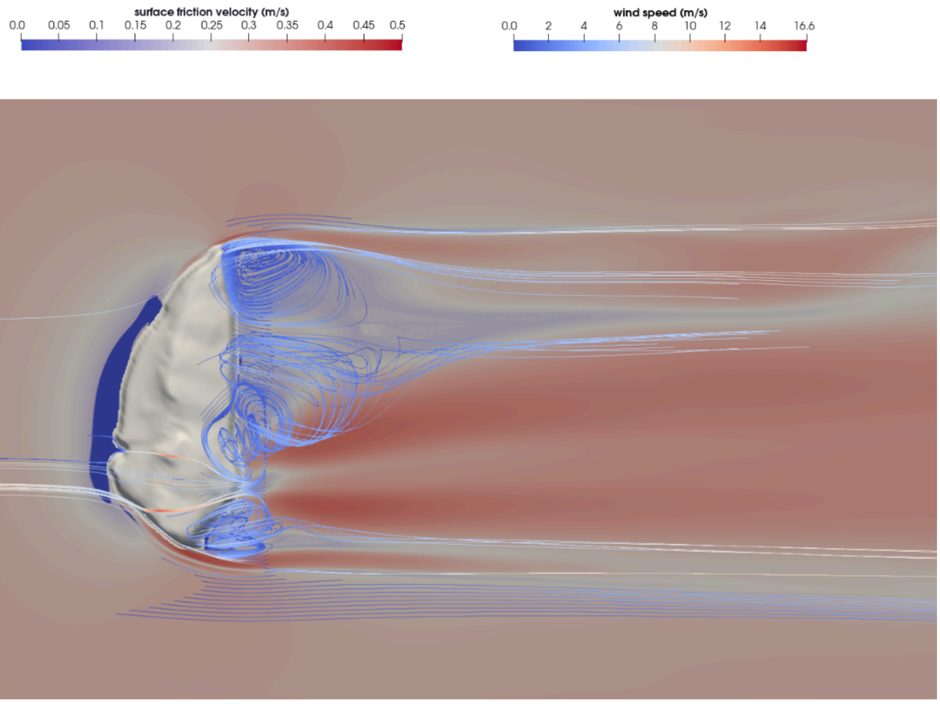
> **We agree and will rewrite the introduction section focusing on removing suggestive statements with respect to the results or conclusions of our manuscript. Additionally, we will add the objectives of this study in the introduction.**

2) The Venturi effect or similar fluid dynamic principles appear to be operating here. I suggest the authors research and possibly mention this principal and relate the effect

RC1: 'Comment on egusphere-2025-2657', John Yackel, 14 Jul 2025

to blowing snow around obstacles such as icebergs and discuss whether or not they expect the wind speed to increase leeward of the icebergs further enhancing wind scouring to keep the snow cover thin.

The reviewer raises a valuable point. In our case, the Venturi effect is not exactly what we believe is acting here, because this refers to the speed-up and pressure drop that occurs through a narrow passage with solid boundaries. However, we do agree with the reviewer that there is a speed-up when the flow gets deviated by the iceberg, which also leads to pressure drops (Bernouilli's principle). The figure below displays the simulation results showing surface friction velocity and flow streamlines around the iceberg, with streamline color representing wind speed.



At this point we'd like to point out that one of the authors of this manuscript worked on extensive simulations on snow transport and deposition in the iceberg-carrying AtkaBay setting. The results of this work are, however, content of a standalone manuscript, which is under review. Therefore, we aim to address the reviewer's comment by adding a detailed suggestive statement that a speedup on the iceberg lee side—arising from both flow reattachment and turbulent momentum mixing, with their relative importance depending on atmospheric stability—is expected, leading to a very thin snow cover. However, we cannot go into too much detail about the simulation results in order not to reveal too much ahead of the other study.

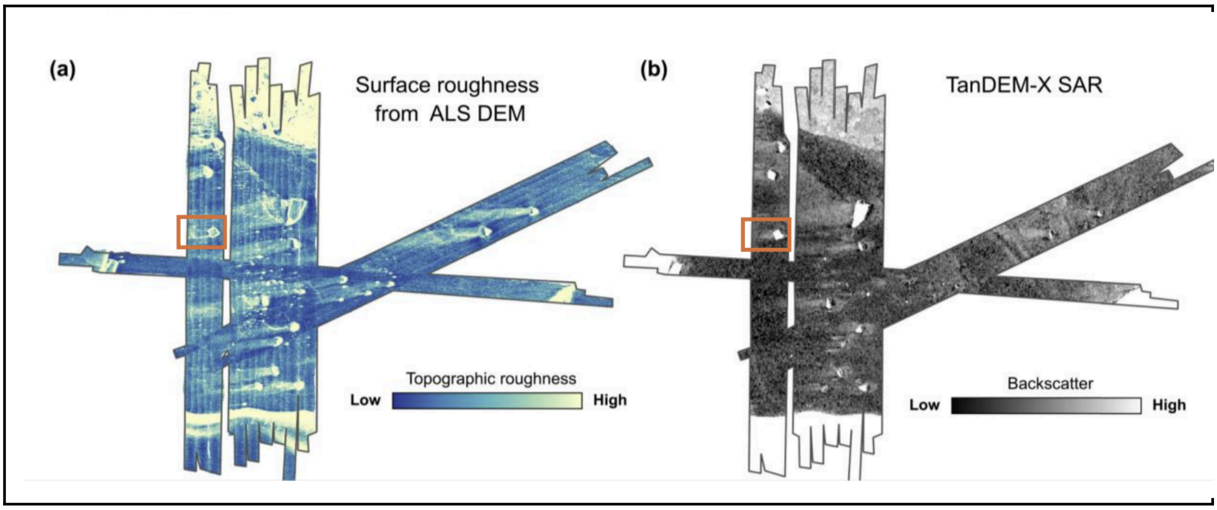
RC1: 'Comment on egusphere-2025-2657', John Yackel, 14 Jul 2025

3) The easterly wind direction is mentioned several times as the predominant wind direction. Can a wind rose be provided from the nearest weather station to support the Klöwer et al., 2013 study? Undoubtedly there are winds from other directions which can often produce secondary drifting patterns on the snowscape.

> **This is a great suggestion, which we will gladly implement. We have access to wind speed and direction data from the meteorological observatory from Neumayer III Station, which is located ~ 6.5 km from the western fast ice edge of Atka Bay. A wind rose will be added to Figures 1c, 2, and 4 to better compare with the patterns on the ice berg lee sides. The wind rose values in these Figures will be from November 5th to December 5th, hence covering one month. To further explore the wind patterns, we intend to add an additional appendix figure showing wind direction and speed patterns on a weekly basis between October 5th and December 5th.**

Minor Comments:

L256-258; L383-384; L420-422. While I generally agree with the statement that high backscatter snow covered sea ice corresponds to larger topographic roughness, one has to be careful in entirely associating this high backscatter with surface roughness (even though your surface roughness metric from the ALS DEM data suggest as much). For example, in the attached supplement I have uploaded, there is a small iceberg (highlighted in red box) which has high backscatter in the lee of the iceberg but does not show the high roughness in the center region of the lee (other than the lateral side edges as described by the authors). So, it apparently does not occur in all cases. In my opinion, it is equally likely that this thin snow region can permit the warmer air temperatures to produce higher basal snow layer temperature and brine volume, altering dielectrics and increase volume scattering (as you allude to in L279; L341-350 and elsewhere). In other words, it could be MORE than just surface roughness, especially for your Type 2 reflections. This process is nicely described in https://ieeexplore.ieee.org/abstract/document/9000883



RC1: 'Comment on egusphere-2025-2657', John Yackel, 14 Jul 2025

Figure from the reviewer's supplement highlighting high SAR backscatter on the lee of an iceberg, which is unrelated to topographic roughness of the surface (red rectangles).

We will gladly implement the reviewer's suggestion and agree that not in all cases (however in the vast majority of cases) the topographic roughness of the surface is most likely responsible for high backscatter in SAR images. The suggested alternative mechanism (warmer air temperatures leading to warmer snow, higher brine volume and therefore altering the dielectric properties) as well as the suggested reference are a valuable addition to this topic in the manuscript. However, they do not seem to apply on most cases of the thick snow drifts that generally have lower backscatter.

Table 1 - is it possible to provide AFIN drill site labels for Figure 1 circles?

Agreed. The drill site labels will be added in Figure 1c.

L335 ... typo 'single'

Will be corrected.

L358 .. while snow-ice formation horizon is a likely candidate, a brine-wetted snow snow layer and its effect on dielectric properties and scattering, owing to the warm air and snow temperatures, is equally likely.

We agree and will modify the text accordingly.

L369 .. typo ... space needed

Will be corrected.