

We thank both reviewers for their thoughtful and detailed comments. Your help has really made this a better paper!

Comments are addressed point-by-point below, with our responses highlighted for easier reading.

KL, AB, SF, KD

JL: MINOR COMMENTS

1) Sometimes you write landfast and sometimes land-fast. Please make these consistent.

We have corrected this to be 'landfast' throughout the paper.

2) Fig.6-8: I understand that the stars and squares identify the level of confidence of grounded ridges. How don't understand why, for example, a grounded ridge would have stars of different colors. If it the confidence is high then I would just show the star for the high confidence.

We have updated figures 5-8 consistent with both reviewers' recommendations: the ridge identifiers (Δ) only show the highest-confidence classification for a ridge, and the bathymetry type designator is now in a row at the bottom of the figure.

3) Fig. 6: The bathymetry is different between the two tracks (like from 2.5 km to 3.5 km). Is it because there is no perfect overlap between the tracks? It would be nice to clarify this for Fig. 6.

The two tracks are close to co-located, but there is a small amount of distance between them.

(We have spent a lot of time verifying that these differences in bathymetry are the result of slight differences in the ground tracks between the two passes). We have added mention of this to the text in line 279.

4) lines 306-307 and lines 309: I have the impression you repeat the same information.

We rephrased those lines to reduce repetition (now starting in line 314).

5) line 356: add a space after 6.17 km.

Thanks for catching this (line 361).

6) Fig. 9: why are some dots not connected with the lines?

There are some bins in the histogram that have no observations: dots not connected by lines indicate gaps in the observed distribution.

7) Fig. 9: These are PDF. They don't show directly the probability but the probability density. I would write PDF for the y-labels and write 'probability density function (PDF)' in the caption.

Thank you for catching this error: it has been corrected in Figure 9 and the caption.

8) Fig. 10: the y-labels 'Surface Height' should be replaced by 'Sail Height'.

This has been corrected in Figure 10 and the caption.

9) lines 416-417: rephrase.

This has been rephrased to "A similar seasonal trend is present in Beaufort sail heights, increasing from 1.5 m in December to 2.2 m in April." on line 420/421

10) line 421: replace 'ridge height' by 'sail height'.

This has been corrected in line 426

11) Fig. 10 and text associated with it: I think this figure is very interesting but requires some clarifications. This is only for grounded ridges, right? This is what the caption says but the titles above the columns are confusing. On line 410, it is written 'seasonal trend in ridge height, depth,...'. I would write 'seasonal trend in grounded ridge...'.

We have retitled Figure 10's columns "Grounded Ridges" and "Grounded Ridge Furthest From Shoreline" to clarify which data is plotted. We have rephrased line 410 to read as "Next, we show that seasonal trends in grounded ridge sail height, depth, distance from shore, and width can be delineated from the data with infrequent repeat measurements over the same geographic area." This is now line 415.

12) lines 412-413 (related to Fig. 10): it is not clear to me that depth (and maybe distance) tend to increase during the season. Please modify text if needed. The text on lines 419-420 contradicts this.

Thank you for pointing this out, we have added some additional text to clarify our results. We write "The mean distance from shore and width calculated based on all grounded ridges is variable throughout the season, but there are more evident trends when considering only the grounded feature furthest from shore along each track." We hope that this will shed light on the fact that the increasing trend is more present when accounting only for ridges furthest from shore. This is in line 424/425 now.

13) line 421: replace 'ridge height' by 'sail height' and add 'grounded' before 'ridge furthest seaward'...

This has been corrected in the text.

14) line 434: add 'during' after 'point'.

This has been corrected in the text.

15) the reference Beatty and Holland (2010) should be König Beatty and Holland (2010).

Thank you, this has been corrected in the text.

16) Fig. 11: the y-label 'Height' should be replaced by 'Sail Height'.

This has been updated on Figure 11.

AM comments:

Major Comments

1. Confusing grounded ridge legend (Figures 5-8)

I really like the addition of the colored regions to indicate keel depths derived from different sail

height ratios on Figures 5-8, but I find the symbology used to assign confidence and bathymetry data type to each grounded ridge somewhat confusing. First, it took me a little while to understand the meaning of the purple and yellow squares in Figure 5, when neither of these symbols is included in the legend. Reading between the lines, I assume the color of the symbol designates the confidence level, while the shape indicates the nature of the bathymetry data. If so, this should be spelled out clearly. However, as an alternative that might require less

explanation, I recommend using separate symbols above and below each ridge to provide this information. For example, you could use a single color-coded symbol above each ridge to indicate confidence and perhaps a letter character below the keel for bathymetry data type. Please also see my associated comment 2 below.

My second source of confusion is the presence of multiple symbols for each ridge. In Figure 5, this appears to indicate both ridges are identified with both low and medium confidence, but the caption states "These ridge features are characterized as medium confidence grounded ridges". I'm not sure why ridges would be assigned more than one confidence level, but unless there's an aspect to this that I'm missing, I would recommend the authors identify only the highest level.

Lastly, the locations of grounded ridges in the SAR imagery in Figures 6-8 is only marked with purple dots, potentially creating the impression that they are all high confidence features. Instead, you could use the same symbols as those used above each ridge (per my suggestion above) to indicate ridge locations.

We have updated figures 5-8 consistent with your suggestions: the ridge identifiers (Δ) only show the highest-confidence classification for a ridge, and the bathymetry designator is now in a row at the bottom of the figure. Rather than using letters (the font size necessary to avoid overlap was very small), we used symbols of | for a direct measurement, – for an indirect measurement, and ? for an unknown measurement.

2. GEBCO Type Identifier (TID) grid data

I appreciate the authors including an illustration of the GEBCO 2024 TID grid in their response, which

shows more shallow water single-beam data than I had known about. Nonetheless, there are still some areas of the coastline within this paper's study region that have few direct observations of bathymetry. In particular, the figure below highlights three areas with very few single beam data and primary reliance on interpolation. I realize this is something of a moot point now that the authors are using a deeper shallow-water cutoff for their analysis, but the figure below also illustrates that there is a greater diversity of data sources in the grounding regions than the 3 types that the authors discuss in their response and in the manuscript. Given this diversity, I recommend adopting GEBCO's categorization scheme and simply distinguishing between grid cells with "direct", "indirect", and "unknown" bathymetry measurements. Per comment 1 above, these could be designated with "d", "i", or "u".

We had grouped together the interpolated categories, but since the vast majority of direct observations in the region were single-beam, we missed that there were a few places with other direct measurements. We have fixed the figures and discussion to call them direct measurements rather than single-beam measurements per your suggestion. Rather than using letters (the font size necessary to avoid overlap was very small), we used symbols of | for a direct measurement, – for an indirect measurement, and ? for an unknown measurement.

3. Missing details on SAR data products and radiometric processing

This is a somewhat minor point, but since Figures 6-8 provide a color scale bar in dB (see minor comment below), I recommend adding some brief details about the acquisition mode and polarization of the data as well as the processing options applied (e.g., gamma-nought or sigma-nought for backscatter coefficient). The text should also state the source of the Sentinel-1 SAR data (i.e., ESA or ASF, or elsewhere) with appropriate link or DOI.

We added a brief description of the acquisition mode to the paragraph describing the SAR imagery starting at line 129. We have cited the Sentinel-1 SAR data consistent with the ASF's recommended citation (this was in the file previously, but didn't play nice with the LaTeX template. It's fixed now – reference to ESA 2022) and have added a note in the text that we accessed the data through ASF.

We also removed the numerical label on the dB color scale in figures 6-8: see further note following the minor comment below.

Minor comments

Figure 1: I like this new figure, but I have two minor comments. First, I feel the reader might benefit from some additional annotations to indicate which ice is mobile and which ice is stationary in each of the sub-diagrams A-D. This could help clarify that the ridge is part of the drifting pack ice in panel B, but is forming at the boundary between the landfast ice and pack ice in panel C. Second, the label for "Shorefast / landfast ice" should extend all the way from the shoreline to the SLIE. In other words, bottom fast ice, grounded ridges, and the shorefast ice extension are all different parts of the shorefast ice.

We have color-coded the ice in this diagram (Figure 1) to be light gray for stationary and white for drifting, in order to make it clear throughout the diagram

what is drifting versus shorefast ice. We have also fixed the shorefast/landfast ice label.

Figures 6-8: The color scale bar for the SAR imagery indicates a range of 12-22 dB, which I believe is in error. I expect the range should -22 to -12 dB.

We removed the numeric labels on the SAR images: the use here is to use pattern matching to monitor the persistence of features in the shorefast ice throughout the season in order to see when features form and break up. The imagery shown is 12-22 dB above background noise levels. Rather than get distracted by the processing details when they weren't particularly relevant to the paper, we omitted the numerical scale bar.

Lines 508-510: This statement about differences in the size and number density of ridges in the Chukchi and Beaufort Sea is very interesting, but I feel it requires some additional citation or other support. Is this something the authors found from their own data, or are they describing findings made by others?

This was found both in our data and is consistent with Strub-Klein and Sudom 2012. We added a note in that paragraph (which is referring to the data shown in figure 9) to that effect, on line 409.

Lines 589-591: I agree with your revised description of the impact of sea level variations on sail height and therefore grounded ridge detection. However, I feel the key sentence could use some clarification regarding the direction of sea level change. Here is a suggestion for rewording (strikethrough indicates deleted text and bold indicates new text):

"Assuming the level ice can float independently, positive variations **in sea level** would **lift** the level ice **around the grounded ridge, thereby reducing the relative** height **of the** ridge sail (H_s), and **leading to an** underestimate **of** keel depth (H_k)."

We have corrected this in the text at line 480