Thank you for your comprehensive and constructive feedback on our manuscript. We have carefully addressed each of your comments to improve the clarity, accuracy, and overall quality of our work. Below is a summary of the key revisions made in response to your suggestions:

1. **Clarification of Dataset Improvements**: We elaborated on how our Arctic Sea Ice Thickness (SIT) product advances upon previous datasets, highlighting its higher spatial resolution (5 km grid), extended temporal coverage (1995–2023), and innovative data processing methods, including improved lead detection and inter-mission bias correction.
2. **Figure Revisions**: We updated several figures to improve clarity, including reorganizing subfigures, adding color-coded borders, increasing font sizes, and adjusting axis labels. High-resolution versions of all figures were provided in the WORD file.
3. **Validation Section Placement**: We moved the validation section earlier in the manuscript to ensure a logical flow, allowing readers to understand the validation of our methods before delving into the analysis.
4. **Statistical Evaluation Enhancement**: We added Mean Error (ME) and Correlation Coefficient (R) to Table 5 to provide a more comprehensive assessment of our product's performance, demonstrating strong correlations with other datasets.

We sincerely appreciate your thoughtful and detailed feedback, which has significantly strengthened our manuscript. We hope these revisions address your concerns and enhance the clarity, rigor, and impact of our study. Thank you for your invaluable contributions to improving our work.

Next, we respond point by point to your comments.

General comments:

1. It is currently difficult to identify how this dataset improves upon previous SIT datasets. The authors need to articulate these improvements more clearly.

Response: Thanks for your suggestion. In this study, we have developed a new Arctic

SIT datasets by combining multiple radar altimetry data from ERS-2, Envisat, and CryoSat-2. The SIT is presented on a monthly 5 km grid, which is highest in satellite altimetry-based SIT products. The time series of our product spans from 1995 to 2023, making it the second-longest continuous record, surpassed only by the CTOH dataset.

Furthermore, we have introduced an innovative data processing methodology that encompasses lead detection, freeboard-to-thickness conversion, and inter-mission bias correction. Specifically, we enhanced the lead detection method by combining waveform parameter thresholds with the lowest elevation approach. This improved method effectively mitigates the impact of grease ice, nilas, and newly frozen leads. The freeboard was then converted to thickness using a quadratic model based on hydrostatic equilibrium and least squares adjustment. Additionally, we generated a monthly thickness correction grid using common period observations from Envisat and CryoSat-2 to address inter-mission biases. This correction reduced the thickness difference between Envisat and CryoSat-2 from 0.66 m to 0.35 m.

We have detailed these advancements in the conclusion section (Lines 768-781) to provide a clearer understanding of the improvements our dataset offers over previous SIT datasets.

2. The language and structure of the paper require refinement to enhance overall readability.

Response: We have engaged a professional scientific editor who is proficient in English to review the language of the paper. The editor has checked for grammar errors, improved sentence structures, and ensured the clarity of the writing. Additionally, we have re-organized the paper to enhance its logical flow.

3. The figures require better visual design to improve clarity and aesthetics.

Response: Thank you for your constructive feedback on the figures. We have carefully revised and polished the figures based on your specific comments to enhance their clarity and visual appeal. Additionally, we have provided high-resolution versions of the figures in the WORD file to ensure better readability

and detail. We hope these improvements meet your expectations and contribute to a more effective presentation of our data.

Specific comments:

4. Line 22: “Finally, the monthly SIT estimates for the Arctic Ocean from October 1995 to December 2023 are generated.” This statement is unclear. You only obtained SIT results from October to April of the following year. I understand that it is challenging to extract sea ice thickness during the summer, but this statement is misleading.

Response: Thank you for pointing this out. We have revised the statement in Lines 23-24 to clarify the temporal scope of our SIT estimates. The updated text now reads: "Finally, the monthly SIT estimates for the Arctic Ocean are derived for the freezing period spanning from October 1995 to December 2023."

5. Lines 85-100: What is the purpose of describing the progress in snow depth research?

Response: Thanks for your question. The discussion of snow depth research progress serves a critical purpose in our study. Snow depth is a key factor that significantly impacts the accuracy of SIT estimates, as uncertainties in snow depth can contribute up to 70% of the total uncertainty in SIT calculations. In previous studies, snow depth data from sources such as W99 or PMW sensors were commonly used. However, these datasets are known to have substantial uncertainties in snow depth estimation.

By highlighting these limitations, we aim to provide context for our methodological choice. Specifically, we introduced the Least Squares Adjustment (LSA) method to convert freeboard to thickness, which addresses the inherent uncertainties in traditional snow depth datasets. This approach allows us to improve the reliability and accuracy of our SIT estimates. We hope this clarification underscores the importance of our methodological innovation in the broader context of snow depth research.

6. Line 111: "They have limited temporal coverage", what is the temporal coverage?

Response: Thank you for your question. To provide clarity, we have added specific details about the temporal coverage of ICESat and ICESat-2 in Lines 112-113. The revised text now reads: "They have limited temporal coverage, with ICESat operating from 2003 to 2009 and ICESat-2 commencing operations in 2018."

7. The authors produced a SIT product with a temporal resolution of one month and a spatial resolution of 5 km. Lines 101-116: The authors should explain the issues with current products in terms of spatiotemporal resolution and coverage.

Response: Thanks for your valuable suggestion. The temporal coverage of SIT product is inherently linked to the operational periods of the satellites used. Most existing SIT products primarily provide data during the CryoSat-2 era, as earlier satellites like ERS-2 and Envisat are pulse-limited and have larger footprints. These larger footprints are more susceptible to specular returns, leading to increased mixing of different surface types. This susceptibility poses significant challenges for lead identification and freeboard retrieval, ultimately affecting the spatial resolution of SIT products.

In this study, we addressed these challenges by enhancing the lead detection method through the combined use of waveform parameter thresholds and the lowest elevation approach. This improved method effectively mitigates the impact of grease ice, nilas, and newly frozen leads, thereby improving the accuracy and reliability of our SIT product.

We have added detailed explanations regarding these issues in Lines 115-123 to provide a clearer understanding of the limitations of current products and the advancements made in our study. We hope this addition enhances the clarity and depth of our manuscript.

8. Line 138: A reference is required here.

Response: We have added the following reference in Lines 143:

Legresy, B., Papa, F., Remy, F., Vinay, G., Van Den Bosch, M., and Zanife, O. Z.: ENVISAT radar altimeter measurements over continental surfaces and ice caps using

the ICE-2 retracking algorithm, Remote Sens Environ, 95, 150–163, https://doi.org/10.1016/J.RSE.2004.11.018, 2005.

9. There is no textual reference to Table 1 in the manuscript. It should be moved to the appendix.

Response: Thanks for your suggestion, Table 1 has been moved to the appendix.

10. Table 2 should be moved to Line 164.

Response: Thank you for your suggestion. We have relocated Table 2 (now referred to as Table 1 in the revised manuscript) to the recommended position at Line 172.

11. Figure 2 is unclear: Figures (c)-(g) should be placed below (b) according to the sequence; The connections between the boxes in (a) and (b) and figures (c)-(g) are unclear. I suggest adding color-coded borders for each subfigure, corresponding to the colored boxes and arrows in (a) and (b); The font size of the coordinates in (a) and (b) is too small, and the y-axis label in (b) is reversed.

Response: Thank you for your detailed feedback on Figure 2 (now referred to as Figure 3 in the revised manuscript). We have made the following updates to address your concerns:

- Reorganization: Figures (c)-(g) have been repositioned below (b) to follow a more logical sequence.
- Clarification of Connections: We have added color-coded borders to each subfigure, corresponding to the colored boxes and arrows in (a) and (b), to make the connections clearer.
- Font Size and Axis Labels: The font size of the coordinates in (a) and (b) has been increased for better readability. Additionally, to prevent the y-axis labels from overlapping, the y-axis of (b) has been moved to the right-hand side.

We hope these improvements enhance the clarity and overall presentation of the figure.

12. Figure 4 appears to be a screenshot rather than an original figure. The titles for figures (a)-(c) seem incomplete.

Response: Thank you for pointing this out. We acknowledge that the resolution of Figure 4 in the PDF version was compromised, which may have given the impression of a screenshot. To address this, we have provided high-resolution versions of the figure in the WORD file to ensure clarity and detail.

Additionally, we have updated the caption for Figure 4 (now referred to as Figure 5 in the revised manuscript) to include more complete explanations for subfigures (a)-(c). The revised caption now reads: " Numbers of (a) ERS-2, (b) Envisat, and (c) CryoSat-2 observations falling within each 5 km grid cell.

13. I understand that the primary focus of this paper is to publish a new SIT product. However, I hope you can provide explanations for sea ice variation phenomena in the results section. For instance, in Line 530, why was the average SIT in 2012/2013 the historical minimum? This could be explained by citing relevant literature.

Response: Thank you for your insightful suggestion. We have incorporated additional explanations in Lines 659-664 to address the sea ice variation phenomena observed in our results. Specifically, we have added the following text:

Correspondingly, the Arctic sea ice cover reached a record minimum in 2012 for the satellite era. Cui et al. (2015) demonstrated that in 2007 and 2012, there was a higher surface air temperature and sea level pressure, which was accompanied by increased surface specific humidity and a higher sea surface temperature. As a result, the strengthened poleward wind was conducive to the melting of summer Arctic sea ice in various regions during those two years.

This addition provides a clearer understanding of the factors contributing to the historical minimum in average SIT during 2012/2013, supported by relevant literature. We hope this enhancement adds depth to our discussion and better contextualizes the observed phenomena.

14. Figures 11-15: All these figures are line plots of SIT. Why do some include grids while others do not? Additionally, the x-axis title is “Year” in all cases, but some display "22/23," while others use "2023." My suggestion is to either unify the format or explain the differences.

Response: Thank you for pointing this out. To address the inconsistencies in Figures 11-15 (now referred to as Figures 10, 16, 17, and 18 in the revised manuscript), we have made the following clarifications:

- Grids: Grids are included in Figure 18 (previously Figure 13) to enhance readability.
- X-axis Format: As defined in Lines 515-516, the annual average SIT refers to the average thickness during the frozen season, specifically from October to April of the following year. In Figures 10, 16, and 17 of the revision, we present the variations of annual average SIT, hence the x-axis is displayed as "22/23" to indicate the frozen season spanning two calendar years. In contrast, Figure 18 shows the monthly average thickness from 1995 to 2023, so the x-axis refers to specific years.

We hope this explanation clarifies the differences in the figures and ensures a more consistent and understandable presentation. Thank you for your valuable feedback, which has helped improve the clarity of our manuscript.

15. Logically, validation should precede sea ice thickness analysis.

Response: Thank you for your suggestion. We agree that validation should logically precede the analysis of sea ice thickness. Accordingly, we have moved the validation section forward in the revised manuscript. This adjustment ensures a more coherent and logical flow, allowing readers to first understand the validation of our methods and data before delving into the analysis of sea ice thickness.

16. Figure 14: The primary focus is the WHU dataset (red line), but it is currently unclear. I suggest: (1) Increasing the color contrast for the red line. (2) Using dashed lines for other datasets to make WHU stand out.

Response: Thank you for your valuable feedback. We have updated Figure 14 (now referred to as Figure 10 in the revised manuscript) to enhance the clarity and focus on the WHU dataset. The following changes have been made:

- Color Contrast: We have increased the color contrast for the red line representing the WHU dataset to make it more prominent.
- Line Style: We have used dashed lines for the other datasets to further distinguish the WHU dataset and ensure it stands out clearly.

We hope these adjustments improve the readability and visual impact of the figure, making it easier for readers to focus on the primary dataset of interest.

17. I cannot understand the statistical evaluation in Table 6: (1) MAE measures the average magnitude of absolute errors. (2) STD measures the variability or dispersion of the data, but what does it aim to express here? (3) ME (Mean Error) is crucial for assessing the direction of errors. (4) R (correlation coefficient) is also important for assessing the linear relationship. Therefore, both ME and R should be added to provide a more comprehensive assessment.

Response: Thank you for your detailed feedback on the statistical evaluation in Table 6 (now referred to as Table 5 in the revised manuscript). To provide a more comprehensive assessment, we have made the following updates:

- Mean Error (ME): We have added ME to assess the direction of errors, which is crucial for understanding any systematic bias in our product.
- Correlation Coefficient (R): We have also included R to evaluate the linear relationship between our product and other datasets.

The updated statistics in Table 5 (Line 535) now include MAE, STD, ME, and R. Our product demonstrates a strong correlation with other datasets, with the highest correlation of 0.977 with AWI-CS2 and the smallest correlation of 0.879 with GSFC-IS2. These additions provide a more robust and comprehensive evaluation of our product's performance.

We appreciate your suggestions, which have significantly enhanced the statistical analysis and overall clarity of our manuscript.

18. Line 601: Why is October 2010 used as the dividing line for comparing two periods? Please provide justification for this choice.

Response: Thank you for your question. The choice of October 2010 as the dividing line for comparing two periods is based on the transition in the type of altimetry data used for SIT calculations. Before October 2010, SIT was derived from pulse-limited altimetry data from ERS-2 and Envisat. These pulse-limited altimeters have larger footprints and lower accuracy compared to CryoSat-2, which began operations in October 2010.

In the revised manuscript, we have provided a more detailed justification for this choice. We first presented the statistics of the draft difference between Upward-Looking Sonar (ULS) observations and satellite-based products for the entire period from 2008 to 2022. Our analysis indicates that products incorporating Envisat data (CCI, CTOH, and WHU) prior to October 2010 exhibit relatively lower accuracy compared to CryoSat-2-based solutions. This distinction is quantitatively substantiated in Table 7, which presents post-October 2010 statistics showing marked accuracy improvements for these three products when transitioning to CryoSat-2 data. The comparative results clearly demonstrate the enhanced precision of CryoSat-2-derived thickness estimates over Envisat-based methodologies.

These discussions have been added in Lines 553-561 to provide a clearer rationale for the choice of October 2010 as the dividing line and to highlight the improvements in accuracy with the use of CryoSat-2 data. We hope this explanation addresses your concern and enhances the clarity of our manuscript.

19. Figure 15: The x-axis labels are unclear. It is unnecessary to label every tick; you can increase the spacing between tick marks. The most important consideration is to clearly convey the information.

Response: Thank you for your feedback. We have updated Figure 15 (now referred to as Figure 11 in the revised manuscript) to improve the clarity of the x-axis labels. We have increased the spacing between tick marks to reduce clutter and improve

readability.

20. I understand your intention with A-D in Table 7 and Table 8, but you need to explain this explicitly in the table caption to ensure clarity.

Response: Thank you for your suggestion. We have updated Table 7 and Table 8 (now referred to as Table 6 and Table 7 in the revised manuscript) to ensure clarity. The following changes have been made:

- Table Captions: We have explicitly explained the significance of labels A-D in the captions of both tables. This addition provides a clear understanding of the categories and their relevance to the data presented.
- Table Formatting: We have ensured that the tables are formatted consistently and clearly to enhance readability.