Response to Reviewer 2

We thank the reviewer for these helpful comments and suggestions to improve the clarity and flow of the paper. We have addressed and implemented the proposed changes in the paper.

This paper documents the development of a new data production algorithm that considers the drift of sea ice when gridding satellite altimeter measurements of sea ice thickness. This new processing method is a valuable addition to sea ice thickness observations and a timely and important development.
The manuscript is detailed and covers the many intricacies and details involved in its development well, although some of these details can be tricky to follow in the current from. The figures are particularly well presented and well communicate the processing method and impact of incorporating sea ice drift into sea ice thickness gridding. I recommend the article for publication with only minor textual corrections to aid understanding and to make some technical aspects clearer on a first reading – with a single question on the results.
The one result that I am interested to see that was not included in the current draft, is how the linear model used to deal with the variation in thickness over a lag period relates to the mean thickness presented elsewhere. As equation 1 is a function of n, where n=0 is the centre day of a lag window, does this mean p0 will represent the modelled thickness at this centre day whilst considering thermodynamics? How does this p0 relate to the mean of DA measurement stack or the daily data fields? Which of these variables are recommended and what are the best use cases for each? While the final conclusions well cover the context and improvements of the new algorithm, it be will good to also see some recommendations of when best to use the data created here.
I hope the following minor corrections are helpful and aid in the improvement of the manuscript. Harry Heorton

With regard to the linear growth model: For a given 25 km grid cell, we normally only find a handful of parcels from different days, and they are often not symmetrically distributed around the target day (n=0), e.g., we could find SIT estimates from +14 days, +10 days, and -2 days. Averaging this set of SIT values likely results in an overestimation of the mean SIT without growth correction.
Yes, p0 will represent the modeled thickness on the target day (n=0). For those grid cells, where the growth estimation is performed, p0 indeed represents the mean SIT of the growth-corrected SIT estimates. However, we also apply the growth correction to parcels in the vicinity (see interpolation, Fig. 4b), where we cannot derive growth, because we do not have enough spatially and temporally coinciding parcels. We have rephrased the relevant paragraph for clarity.

L 1. This sentence needs to reference 'satellite derived thickness' or similar otherwise the 'along track' part doesn't work.
We rewrote this sentence.

L 9 – 'trackiness' this makes sense for those in the sea ice remote sensing field, but may need expanding for a wider audience
We have rewritten the sentence to avoid "trackiness" in the abstract. We refer to "trackiness" later in the manuscript.

L 16 – summer sea ice extent declined
We clarified this in the text.

L 25. This intro needs the reasons for ice drift to be described – winds and currents.
We added that ice motion is "primarily driven by winds and, to a lesser extent, ocean currents".

L 30 -32. This sentence is out of place for this paragraph and will be better later (L51 and beyond)
We have moved the sentence to the "objectives" paragraph.

L 34 The beginning of the sentence can be removed. Start with "Within the Transpolar drift . . . "

Thanks for the suggestion, we removed the beginning.

L 35 remove 'processes like', they have all been listed!
Fixed.

L 40. Some quantification of these anomalies is needed - I'm not sure which anomaly is being referred to here.
This sentence points to the high along track resolution and small footprint, which enables to even register individual sea ice pressure ridges. We have rewritten this sentence and changed references to clarify.

L 42 – this sentence repeats the previous paragraph and is not needed unless there something specific about the anomalies that is different to thickness measurements.
This sentence shall emphasize the use for sensor merging. We agree that the application is very similar, but we think it is worth to mention the potential use for data merging methods. We rephrased the sentence.

L 44 observer – observe
Fixed.

L45 this whole paragraph needs to be reordered. The details about Cryo2Ice can come first as this will make the rest more clear.
We restructured and rephrased this paragraph.

2.1.1 first paragraph – this general information is not necessarily needed and it may be better just incorporated into the next paragraph. While IceSat2 is mentioned in the intro, the rationale for only using ESA radar altimeters needs to be included. Some info for wider readers on what is meant by level-2 will help here. The crucial aspect for context in wider studies is the choice of SIT over freeboard is needed. This will need a description of the snow data used in the ESA CCI product as this is relevant to the drift of sea ice (for example in the SM-LG product that also considers it – Liston et al (2020).)
We primarily use CS2 and Envisat because this study has been performed within the framework of an ESA-funded project (CCI Sea Ice). However, we also mention at the end of this section, that the method is also applicable to ICESat-2 and other altimeters. We have added a rationale for using ESA altimeters. We also rephrased this section to clarify the meaning of "level-2". We demonstrate the drift-awareness with SIT as this is an end-product that most users are interested in. We clarified this in the text. We also added another reference for further details on the along-track SIT processing of the data used in this study.

L 128 Last sentence needs rewriting – do you mean that some had drifted further than 200km?
We rephrased this sentence.

L 155 this sentence is awkward in the flow of the whole paper. A more coherent sentence or possibly the whole paragraph is that – the collection of drift corrected thickness measurements will represent the same ice during changes to thickness. Thus we use a linear model. The logic at the moments is the other way round – in order to represent the thickness change we must use drift and intersections – this is against the flow from the previous section.
We agree that the explanation lacks clarity. We rephrased and res-structured this paragraph.

L 160. While it is fine to use this resolution this argument neglects important sub-kilometer or floe to floe thickness distributions. Perhaps just state that the method is representative of average ice thickness at this scale length.
We added a sentence for clarification.

Equation 1 While p1 is well discussed, does p0 represent anything physically? Is it related to the mid- or n=0 day thickness? Does this correspond well to the later arithmetic mean?
p0 represents the thickness at the target day (dt=0).We added a sentence explaining this.

L 169 to calculate the covariance matrix (p0,p1) does the data uncertainty need to be given to the least squares fitting algorithm?
No, it does not at the moment. We will consider other fitting methods that also include the data uncertainties for the next iteration of the algorithm.

L170 while it is very helpful to have this illustrated information within this section, the detailed description of the uncertainty may be more helpful in the results section.
There is no results section as this is more like a method paper. Our aim is to describe the method and the different steps in detail; therefore, we believe the illustration is best placed where it currently appears.

L 204 In any case.. this sentence can be removed and the next be reduced to state the incompleteness windows.
Agreed. We deleted the sentence as suggested.

L 206 Is this missing value issue/method for stacks also true for cells near an advancing/retreating ice edge? How does this all relate to equation 5? Figure 4 shows some peak values near the ice edge in the Chukchi sea, is this related to missing values in the stack and a minimal thickness measurement from CryoSat2? (due to the sensors vertical resolution)
The issue with the incomplete stacks is that we are missing entire satellite passes in certain regions as the altimeter sub-cycle is typically one month. We will also have partly skewed coverage due to a changing ice edge, this is correct. This effect is small compared to the incomplete sub-cycle and also present in conventional monthly gridded products.

Equation 5 – the nanmean approach makes sense for missing values – but does this result in a time bias at the beginning and end of a record – and possibly for advancing retreating ice edge? How does this relate to the earlier comment on equation 1 and p0?
Yes, during the ramping phase in the beginning and at the end, there will be a time bias, because the target day is not in the center of the stack. This is one reason, why we apply the growth correction, which is an attempt to correct for the thickness change of the respective ice parcel between the target day and the time of the actual satellite measurement.

L 218 Is the sigma for each along track taken from the CS2 L2 track files? What variable name is this?
Here we refer to the CCI sea ice thickness product. The L2 files (along-track SIT) contain a variable called "sea_ice_thickness_uncertainty". We added this information in the text.

L 255 is it just the larger uncertainty in drift or just due to the drift being faster? The next sentence is just a repetition – or is there are more detailed reason why the uncertainty is higher near coastlines?
Along the coast lines, higher uncertainties in the passive-microwave drift products are a result of land-contamination and the low resolution. Similarly, in the marginal ice zone, low ice concentration complicates the feature tracking in the ice drift processing.

L 256 - often results.... Is this comment about the paper methods? I'm assuming it is but it will be good to make this certain.
yes, this relates to the methods used in the paper. We tried to clarify this in the sentence.

L 258 – this paragraph all has good information on the drift data. Is there a citation that contains more detailed explanations on the uncertainty? There may not be, these aspects are not always well documented.
Information on uncertainties in the satellite-derived drift product are provided in Lavergne and Down (2023) and Sumata et al. (2014). We added these references in the respective sentence.

L 259 – this sentence needs to be added to the previous paragraph. A figure needs to be cited here. A similar pattern of uncertainty can be seen in figure 2 of Heorton et al (2025).
Agreed, we integrated the sentence into the previous paragraph. Moreover, we added a description on the along-track and total uncertainty, to have a complete description of this figure. We also added the recent

Heorton et al. (2025) study as a references for ice mass balance studies using altimetry.

L 263 this paragraph will benefit from an opening sentence on what metric the buoy data produce to validate the data - a measure of the accumulated uncertainty in parcel location over the lag window. Is this correct?
Yes, we use the buoy trajectories as a reference for the DA-SIT trajectories. We re-wrote the sentence.

L 267 'which require' the integration of sea ice thickness measurements over at least....
Agreed and changed.

L 287 about - approximately
We assume L 297 is meant here. Agreed.

L 300 – it will be worth repeating here the differences between the AEM total thickness and the thickness of the DA data – I assume this is due to the AEM coming from the snow air interface and representing the thickness of the combined snow and ice thickness?
We added a half-sentence clarifying that total thickness is the combination of sea ice thickness and snow depth.

L 329 is this 'conventional gridding' performed by the authors for this study, or data from a prior study? A citation or reference back to the data section is needed here.
The 'conventional gridding' was performed by us to make sure that, except of the drift-correction, everything is consistent. We added a reference to Section 2.3.

L 382 – similar to an earlier point, has C-SIT been created for this study?
Yes, see above.

Figure 11 – caption needs to say that the SD here is the SD in differences as described in the text.
Thanks for pointing this out. We fixed it.

References

Heorton, H., Tsamados, M., Landy, J., and Holland, P. R.: Observationally constrained estimates of the annual Arctic sea-ice volume budget 2010–2022, Annals of Glaciology, 66, e9, https://doi.org/10.1017/aog.2025.3, 2025.

Lavergne, T. and Down, E.: A climate data record of year-round global sea-ice drift from the EUMETSAT Ocean and Sea Ice Satellite Application Facility (OSI SAF), Earth System Science Data, 15, 5807–5834, https://doi.org/10.5194/essd-15-5807-2023, 2023.

Sumata, H., Lavergne, T., Girard-Ardhuin, F., Kimura, N., Tschudi, M. A., Kauker, F., Karcher, M., and Gerdes, R.: An intercomparison of Arctic ice drift products to deduce uncertainty estimates, Journal of Geophysical Research: Oceans, 119, 4887–4921, https://doi.org/https://doi.org/10.1002/2013JC009724, 2014.