Response to editor

ilo and hsk

March 2025

Thank you for your responses to the reviewers and community comments. After reviewing your responses, we believe the paper is on the right track but will require major revisions to fully address the comments. Below, we outline areas where additional work is needed:

Thank you very much for your editorial comment, this is highly appreciated. We agree with your assessment and appreciate the concrete suggestions for solving some of the issues addressed by the reviewers. We will implement the suggested changes and submit a revised manuscript. Please, find below the concrete comments related to the points highlighted.

1 Response to Reviewer 1 (Alek Petty):

Reviewer 1 queries the use of the term 'reference'. While you propose a revised title, we recommend removing 'reference' from the title. Similarly, it would be helpful to take care with the terms 'reference measurements' or 'reference observations' to ensure that users of the dataset clearly understand the limitations.

We acknowledge that the term "reference measurements/observations" should be clearly defined. However, we would prefer to keep the term and define its meaning at the very beginning of the paper. The term "reference measurements" serves as an alternative to "validation measurements" (which would be incorrect due to data limitations) and "in-situ measurements" (which typically do not include remote measurements such as airborne campaigns). The Copernicus service itself refers to all "reference" observations as in-situ, stating: "Within Copernicus, in-situ data refers to local, on-site or in-position observation data collected from ground, sea, or air-borne sensors as well as geospatial reference data, imagery gathered by drones (Unmanned Aerial Vehicles or UAVs) and information collected by crowds of volunteer contributors." (`https://insitu.copernicus.eu/about/what-is-in-situ-data`). However, we believe this definition does not align with the general understanding of "in situ," which typically refers to on-ground measurements. For readability, we prefer to use a common term that refers to the collection of non-satellite measurements. We therefore propose to continue using the term reference observations/measurements (depending on whether they are actual observations or measurements) in the paper, including in the title. However, we will state clearly

in the beginning of the paper what we define as reference measurements e.g. a collection of non-satellite measurements (in-situ and airborne), which can be used as a comparison to satellite remote sensing measurements. If you have an alternative term, which we can use, we would appreciate suggestions.

We appreciate the paragraph from your response highlighting this as a "first approach" and emphasising the broader community usage of the methodology. We recommend this is clearly articulated in both the introduction and discussion sections. This will help contextualise the work and address Reviewer 1's broader concerns. Consider reorganising the introduction to highlight the broader goals of the study before delving into technical challenges.
Thank you for the suggestion. We will make sure to highlight that this is a "first approach" and further emphasize the broader community usage of the methodology first in the introduction and during the discussion section.

Reviewer 1 highlights the importance of addressing uncertainties. While redoing uncertainty analyses for each dataset is out of scope, it is essential to ensure that users of the dataset are aware of the validation processes relating to the underlying datasets. In each case, we suggest:

- explicitly stating the community standards or validation processes that the input datasets have undergone including a critical discussion of the limitations of these datasets and their potential impact on the results
- In particular, the discussion on airborne data (Operation IceBridge) requires more explicit acknowledgement of algorithmic differences and their impact on uncertainties, as suggested by the reviewer.

We will make sure to revise relevant sections ensuring that they include an overview of validation procedures used in the production of the input datasets. For OIB in particular we will make sure to highlight algorithmic differences, along with uncertainties related to these, including adding relevant references to existing literature.

Reviewer 1 expressed concerns about the inclusion of data that may not be reliable for satellite validation due to issues like spatial and temporal mismatches or other uncertainties. While you propose flagging data for representativeness issues, this must be implemented clearly in the dataset and supported with clear definitions and examples of how to use the flags to ensure that users can make informed decisions.

We will ensure that the flagging process is supported with clear definitions of the flagging methodology. All flags will be consolidated into a single table with adequate descriptions. Additionally, we will include examples illustrating the application of these flags, such as demonstrating the effects of removing data with representativeness issues and discussing the impact of this approach.

Reviewer 1's comment on L598 about collocation and representation errors is significant. While you acknowledge this issue, it is not sufficient to defer it to future work. The reviewer suggests that this method introduces uncertainties related to temporal and spatial representation errors, which should at least be

estimated or discussed in the study. To address the reviewer's concerns, we recommend

- Including a preliminary analysis or educated estimates of the introduced uncertainties
- Discussing how these uncertainties could affect the results.

We will look further into this matter to decide how we can best address this point. As an initial step we propose to do a sensitivity study, where we examine the impact on the matchup statistics if we use other temporal matchup windows, such as one week. We will ensure that we discuss how uncertainty linked to representation errors could affect the results.

You posed a number of questions to Reviewer 1 in your response. As he has not responded on the Copernicus interactive discussion interface, we recommend that you contact him directly to clarify these points.

We will contact him directly regarding remaining questions.

2 Response to Reviewer 2 (Anonymous Referee):

Reviewer 2 raises valid concerns about the pre-processing and uncertainty flags. While you have proposed clarifications, the manuscript should include a clear table or section explicitly defining the flagging system and examples of how users should interpret these flags.

We will include a table with clear definitions of the flags, and provide examples of how the users should inpret these flags.

The reviewer also questions the inclusion of certain datasets with significant pre-processing (e.g., AEM-AWI timestamps, IMB-CRREL data). Your response defends these choices but does not fully address the broader implications for data reliability. Please elaborate further in the manuscript to justify its importance explicitly and discuss its limitations.

We will clarify this in the manuscript.

The issue of inconsistent time series lengths (e.g., Fram Strait data ending in 2018, IMB data until 2015) should be addressed more explicitly. If newer data is unavailable, this should be clearly stated in the manuscript. Where possible, it would be useful to indicate when updates might be made.

We will ensure that the extent of the available datasets is clearly stated, along with how/when/if they are expected to be updated and extended.

Your response to the specific reviewer comment on L47-48 does not directly address the reviewer's point. You could explicitly state that while snow depth is not uniquely challenging compared to other parameters, it is highlighted due to its critical role in sea ice thickness estimation.

Thank you for the suggestion. We will update the text accordingly.

3 Community Comment (Robbie Mallett):

The comment about the variability in penetration depth estimates from snow radar algorithms is critical. While you acknowledge this limitation in your response, the manuscript should explicitly discuss the limitations of OIB data and their influence on uncertainties. Ensure that the discussion of penetration depth variability is improved and supported by relevant citations.
We will include a paragraph to elaborate on the uncertainties linked to the use of OIB data, both regarding the algorithm uncertainties and the uncertainties linked to penetration depth variability. We will support this with relevant citations.

4 Comments common to both reviewers:

Both reviewers emphasized the need for a more consistent and transparent approach to uncertainty quantification. Reviewer 1 and 2 both highlight the need to address representation errors more thoroughly. Your proposal to flag data for representativeness issues is a good start, but it should be supported with quantitative examples or case studies in the manuscript.

We will ensure to both flag data with known representativeness issues and to include examples of how to use them. We propose conducting case studies to assess the statistical impact of including and excluding data with known representation errors when comparing with satellite altimetry data.

Both reviewers note the absence of key datasets (e.g., IceBird, MOSAiC, Nansen Legacy). While you propose including these in future updates, the manuscript should include a clear roadmap for how the dataset will be expanded and improved over time. We also encourage the inclusion of available, long-term consistent timeseries, as you mention in the last paragraph of Section 1 in your response to Reviewer 1.

We have extended the data record to include the latest available data of all data sources and we have included IceBird data. We will include some of the MOSAiC data and the Nansen Legacy data, which is similar in methods to already existing data e.g., drifting buoys and helicopter/airborne EM. We will provide a concrete plan for how and when we expect to update the database.

We encourage you to proceed with the revisions and submit a revised manuscript for further consideration.

Thank you, this is highly appreciated.