tc-2021-381

Review of tc-2021-381: Antarctic sea ice types from active and passive microwave remote sensing, by C. Melsheimer and co-authors

The authors present in this manuscript a method based on a combination of scatterometer and passive microwave radiometry data to map the distribution of the Antarctic sea ice types. With a product archive covering years 2013-2019, this is the first time a multiyear record of Antarctic ice type is presented and made publicly available. The Arctic sea ice type (or age) has been monitored for a long time and has shown a clear decreasing trend of the older ice. Similar monitoring of the different ice types for the Antarctic ice has been lacking and therefore the presented work is filling an important gap and the topic is very relevant for TC.

Below I present some of my major comments which should be considered before publishing. This is followed by other comments to consider as well.

Major comments:

Writing style

The manuscript would benefit from (and strongly needs) a thorough tightening up of the writing style of the whole manuscript, including but not limited to:
- Use a clear structure with separated sections for the data and the methodology. At present, the input data and input products are presented "here and there" within the method section.
- Avoid repetitions. Several repetitions occur and sometimes a simple re-ordering of the sentences would make the reading flow better.
- Make sure that information given across the manuscript is in synergy with itself. For instance, it is very unclear whether the new product covers 2013-2019, 2013-2020, or 2013-present.
- Make use of general spell checking.

The presentation of this work should be clearly separated from possible improvements or potential future works. Future works or possible upgrades should rather be listed and discussed in a discussion section or the Conclusion.

My general comments below is not a full overview of typos, grammatical errors, or repetitions, etc that I found.

Algorithm presentation vs presentation of long-term time series

The manuscript seems to have two main goals. On the one hand, it presents a methodology for mapping the Antarctic sea ice type from remote sensing data. And on the other hand, it presents, for the first time, a longer time series of Antarctic sea ice types. Both these topics

are very relevant, however, at the present stage, the manuscript covers these in an inadequate manner.

In order to be a manuscript presenting a new method, the methodology is only superficially described. Below are some specific points to be considered:

- I suggest naming the full algorithm which is implemented at the University of Bremen. When reading the manuscript, it is unclear if "the new method" is ECICE, modified ECICE, or ECICE + post-processing. Examples of this:
  - L64: "Recently, a method has been developed …". Which method is this? Add a reference.
  - L66-69: "The method is based on ECICE … and a later modification …" Unclear if the ECICE has been modified, or if post-processing includes modifications of the outcome…
  - L72-74: "In this study, we have adapted this method to the Antarctic conditions …". Again unclear what "this method" is.
  - L85-86: "Our estimation of MYI concentration actually is a two-step procedure that first uses ECICE and then applies two correction schemes …" Assuming that "our estimation" is coming from "the new method", here for the first time it seems clear that the method is in fact the ECICE retrieval pluss some post-processing (correction schemes).
  - L193: "The final result of the two-step retrival scheme …".
  - etc.
- L114-116: it is mentioned that "the median is used as a measure of confidence of the result for each surface type". However, this confidence field is never presented and it is not clear if this information is provided together with the ice type product.
- Section 2.1 is describing the core/backbone of the classification algorithm. I would have liked to see a few equations or illustrations (e.g. flow diagram) of the ECICE methodology. Especially, the paragraph relevant for the Antarctic adaption (L105-117) is hard to read as it is and would benefit from supplementing equations/illustrations.
- L166: "For all input parameters, we use daily gridded data". How did you arrive at these gridded data? Especially, for scatteromter data, a sentence on how the angle-dependent swath data are gridded would be relevant.
- L175: "Later in the season, sea ice that has formed … away from MYI is FYI". How do you account for the changing position of MYI during the season and thereby collect only FYI data?
- L196-197: "… retrieved the ice type concentrations for the months of Feb to Nov …". I did not find any comment on why summer months are omitted, or why exactly this period has been chosen for the Antarctic product.
- The final output is "corrected MYI" (L193), however the "uncorrected FYI, MYI, and YI" are also provided.
  - It is not clear if the uncorrected fields are "pure ECICE" outcome?
  - uncorrected MYI (or Ex-MYI) is never presented, and maybe they should be shown?
  - Could you include a comment whether MYIcorrected+FYI+YI or MYI+FYI+YI add opp to 100%? And if not, please comment on this as well.
- It is not clear if a threshold is used for the ice edge? Or are all surfaces with >0% ice concentration classified?

- Several places it is announced that this computation can be extended to present time. What will the latency be for such a retrieval?

In order to be a manuscript presentating a longer time series, it is surprising to see that there is a complete lack of presenting or showing any long-term (seasonal, interannual, regional) behaviour or variability. Only a few hand-picked days are shown and the year 2018 MYI total area time series. Since this is the first time a longer time-series of ice type is presented for the Antarctic, then it would be appropriate to show a full record plot and potentially discuss any trends and variabilities, (or missing trends).

Several places it is mentioned the possibility of a record covering the period 2002 to present. However, the present record covers the period 2013-2019. Can you make this more clear - what defines the period you present and why is this period selected? And hereafter (best fitted in a discussion or conclusion section) mention possibilities for extending the time series and what this would require and what is the timeline for implementing this.

Other comments:
General comment for the figures: Could you consider to label the sub-figures and thereby avoid " top-right", etc

Figure 1: Why not simply add the sensor type in the title of each subfigure instead of the "Dist. set: Aq2" which is a title that does not give any sense.

Figure 1: Some of the shown density distributions clearly shows a double-peak. Can you comment on this and could this in fact indicate that more types are represented by the distribution?

Figure 2: I find it difficult to locate this region. Either you could add an overview map or with words explain better where this is. E.g. " the inner part of ..."

Figure 3: the sub-titles should be upgraded, preferably with one sub-title for each subplot. Also the sub-title of the lower-right should be updated/corrected.

Figure 6-9: Here is used four figures for illustrating Young Ice. Potentially, these could be merge into fewer figures. The PSSM maps - the gray color should be defined in the caption. Even better, if the coast/land could be added for better orientation of the sub section.

Figure 10/L286: What is shown in this figure? Is it the extent of all ice pixels that contain some concentration of MYI? Or is the MYI concentration or the full ice concentration taken into account?

General comment for the tables: The layout of the table caption differs between the tables - some times it appears above and sometimes below.

General comments:
L25: you could add a reference to the YI definition (e.g. WMO Sea-Ice Nomenclature 2017)

L33: explain or add a reference to why all MYI is SYI.

L38-39: "Antarctic sea ice has strong region-dependent …" This sentence stands a bit alone. Could you say a few more words on this?

L43: Move "in the Antarctic" to the beginning: "Sea ice cover in the Antarctic…"

L51: repeats that MYI typically is in Weddell Sea (L31)

L62: "Total and partial sea ice concentration …" when first time reading this, it was not clear that "partial sea ice concentration" was referring to the ice types. I suggest re-wording this whole paragraph.

L72: "Ye et al., 2019" is not accepted for publication. Can you find another reference?

L74: replace "regularly" with "operationally"

L77: "brief account of ECICE and its adaption to Antarctic …" Would it be more correct with "brief account of ECICE, implemented correction schemes, and the adaption to Antarctic …"

L78: remove "first"?

L78-79: since the entire record is never presented, I would suggest deleting the period. Simply "In sec 3, the outcome of the Antarctic sea ice type concentration mapping is compared with …"

L91: Any reason why SSM/I can be included but not SSMIS (and other passive microwave radiometers)? Why mention SSM/I if it is not included in the present method/production?

L100: "Most methods" please include references.

L132: "If MYI .. drops at any location during a warm spell …". Are there not any restrictions on this drop to occur in the vicinity of where the warm anomaly appears?

L140: "After that, MYI can only drift …" What exactly do you mean by this? If you mean that no more MYI will be created (per theoretical definition) after this point, then say this more clearly. In the same sentence is used the word "melting" which is not a part of "drifting"... Please re-phrase this sentence.

L144: "... boundary of MYI cover …" Please define the boundary of MYI cover. Is this where MYI conc = 0%?

L153: "... sudden reductions …", sudden reductions in time, I assume?

L156: "The values of the parameters …". Please indicate from where these values are taken, e.g. include reference or discussion on how they have been chosen.

L160: Why is AMSR-E presented here when the ice type record covers 2013-2019?

L167-168: Is the Melsheimer reference the right reference to add just after NSIDC?

L168-169: Could you please elaborate a bit more on this, e.g. by simply presenting the approximate spatial resolution of the used input data?

L174: As "ASI" is used only once, I suggest to just fully write the full name here, for easier readabilty.

L174-175: It is a bit unclear from what seasons the training data is collected. Is MYI data collected from only beginning of the freezing period. Please give a bit more details.

L188: Are there any reasons for using ERA Interim instead of the newer ERA5?

L190: When mentioning the potential NSIDC ice drift data, please include a comment on why OSI SAF ice drift data are chosen to be used, and whether NSIDC data have been tested out in the ice type retrieval. Also, please note that an ice drift climate data record from OSI SAF is in the pipeline for this spring 2022 (regarding L202-203).

L191-192: this is a repetion

L218: Are these threshold procentages randomely chosen, or can you comment on why 50% is used for YI and 70% for the others.

L225: To my knowledge, NIS do not produce Stage of Development maps. Plese check this out.

L225: To my knowledge, no SoD maps are available on the webpage in 2014. Please chech this out.

L231-233: Is this information relevant (and is it true in practice?)?

L235-236: when you write "an overall correspondence" - is this referring to results shown here, or did you check all available charts against the product. Please give more information on what is in overall correspondence and how this has been concluded.

L279-280: The contribution from Ex-MYI is not shown or taken into account here. Please include this contribution to the discussion of FYI and YI.

L310: Please add affiliation or title for Ted.

L312-314: This paragraph is unclear. Please re-phrase.

L315-316: I suggest that you include some mapping examples from September/October to better visualize for the reader why you see an increase in the MYI area.

L332: "spatial resolution" or grid resolution?

L334: "(so far the only source of ice type information in the Antarctic)". This should be reworded. I assume that in situ data exists to some extent. Also, OSISAF ice type product exists and is processed on an operational basis.

L341-342: "The data become unstable toward the end of the freezing season in September/October, with MYI being underestimated" I think this has not been shown clearly in the result section. And how do you conclude that MYI is being underestimated?

L344: I would remove the sentence "outweighs the shortcomings". This only put your product in a bad light I would say.

L346-350: Give better and more correct references to upcoming satellites/sensors. And please add a comment on why 1.4 - 36.5 GHz is assumed to make scatterometer less important.