Review on "Mapping of sea ice concentration using the NASA NIMBUS 5 ESMR microwave radiometer data 1972-1977" by Kolbe et al. (2023)

Submitted to Earth System Science Data (ESSD)

13 November 2023

The submitted paper presents a newly developed sea ice concentration algorithm, that makes use of historic Nimbus-5 ESMR satellite data – a single (low) frequency passive microwave sensor that operated between 1972 and 1977. The new re-processed data set is intended to extend previous CDR of passive microwave sea ice observations back in time. Not only due to an often quite low data quality, with prolonged data gaps especially towards the end of the covered time period, a range of modern processing techniques, various filters steps and additional post-processing are applied to ensure a sufficient output data quality with added uncertainty quantifications. While differences to sea ice extent (SIE) estimations from other comparable OSISAF CDR seem to be rather low, i.e., showing similar magnitudes in the 70ies and 80ies, the authors note apparent differences (positive offset) when comparing this new data set to the older NASA ESMR SIC processing by Parkinson et al. (2004). While land mask differences seem to play a role in that context, the overall SIE differences cannot be explained to full extent at this stage, but seem to be more related to algorithm and processing issues.

The paper is nicely written and, in most parts, well-structured and easy to follow. Below, I list several parts that could benefit from some rephrasing/clarification under general and specific comments. Figures and Tables are generally good and informative, but could here and there be improved by some small tweaks, additions and potentially merging (see technical comments below).

Overall, I consider the study well worked out, so that some rather minor changes could well be sufficient to grant publication.

General comments

- I noted several suggestions to make the figures a bit more concise below under "technical comments". While often a stylistic choice, I would consider this to be an area where the paper could easily be improved a bit – also with regard to some descriptions/discussions in sections 4 & 5.
- Please pay attention with your equations - sometimes they miss proper explanations (see specific comments below) and are quite briefly "rushed" over.
- In your "Sea Ice Concentration Product User Guide for ESMR", I noticed a processing flow-chart that didn't make the jump to this paper here. I would consider this to be a nice addition here as well.
- It would have been nice to read a bit more about the core differences between your new approach and the study by Parkinson et al. (2004). For instance, right in the introduction where it is currently just one short sentence. It doesn't need to be overly long, but it might help to get a sense on where algorithm-related differences might originate from, without having to read the full Parkinson et al. study first.
- As already mentioned in RC1, I also got the impression that sub-sections 3.1 to 3.3 do not necessarily relate to a section entitled "The radiative transfer model". Hence, I agree to think about an alternative way of naming / subdividing section 3.

Specific comments/questions

Introduction (Sect.1)

L.26: I'm sure the references are picked on purpose here, but it seems like a rather long list for this single statement? Is it worth to point out the key differences among those studies here?

Instrument & Data (Sect.2)

L.56-68: Reference(s) missing for all these platform / sensor specific information.

L.77: "…and appended to a NetCDF file, …" – it is the same file as the satellite parameters, this could be phrased a bit clearer.

L.107 (Eq.2): "n" not explained in the following

L.110 (Eq.3): Was the threshold for Tb outliers (150 K) also experimentally estimated or was it chosen arbitrarily?

L.111 / Eq.4: There are some explanations for this equation missing (size of the search window & effect of varying it; meaning of $\neq 0$)

Radiative transfer model (Sect.3)

L.145 (Eq.7): Careful with the second use of "p". Although different from earlier uses as "p_i" as single pixel indicators, it might be confusing for the reader and should, for instance, be augmented by an additional explanation of "p" and "q" in Eq.7.

L.182: Please provide more details on the ERA5 OSTIA SIC, as they are quite crucial for the selection of tie points (affecting SIC thresholds and presumably also distance to the ice edge). Further, how is the distance to the ice edge defined, and where/how is this criterion depicted in Table 2?

Fig.3: Add data source to caption.

L.200: Add data source for T2m data.

Results (Sect.4)

L.267: "This is a consequence of the one channel SIC algorithm." – Can you comment more on this effect? Is there any way / idea to correct for this?

L.267/268: Uncertainties are also high along the coastal margins, especially at lower latitudes. Might be worth to mention and explain.

L.270-272: As noted under technical comments below - hard to locate for readers that are unfamiliar with the geographical setting of one or the other hemisphere. Simple lat/lon indications could help (when present on the maps), or alternatively, a regional close-up figure (daily level? Could then even feature other parameters from the data set, such as uncorrected/corrected brightness temperatures).

L288: "For the Northern Hemisphere the SIE seems to have been slightly lower during the operational period of NIMBUS 5 ESMR 1972 to 1977 than during the operational period of NIMBUS 7 SMMR from 1978 to 1987." – To me & purely based on Fig.14, max. values in winter seem to be more or less similar, while the two available min. values in summer are seemingly even slightly higher than in the 80ies. Am I wrong?

Discussions (Sect.5)

L.300: Is it possible to illustrate this with an example? I.e., where do the land masks differ the most?

L.325: You mention a planned reprocessing of some sort to increase the number of rescued data points. Do you already have concrete ideas on how you intend to do that?

L.330: Can you name some examples for "related snow and ice processes" that are causing the noise over sea ice? How about atmospheric effects over sea ice that also trouble other widely used SIC algorithms?

Technical comments

L.82: Brackets around reference missing (NASA CR, 1974)

L.100: "a value of 10" – unit missing

Figures 2, 3, 4 & 5: Similar to other line plots, the addition of grid lines could help to make out differences more easily.

Figure 4 & 5: Smaller points could help to reduce the large red "cluster-patches". Further, the captions read more like notes, this could be improved by using proper phrases. Lastly, Fig.4 & 5 could be combined into one Figure 4 (a & b), just to spare two almost identical captions next to each other.

Figure 6 & 7: As before - could be combined into one Figure (a & b) to spare two almost identical captions next to each other.

L.219-225: Steps 1) and 2) could be formatted as bullet points, thereby reducing potential confusions with the numbers just before point (2).

L.254-255: Double use of "also".

Figures 8-13: Multiple comments/suggestions

- Size of individual panels could be increased
- Geographic references are missing in all panels – e.g., thin lat/lon lines could be added
- Is the wide spatial extent of the maps chosen on purpose or would it make sense to zoom in a bit, sparing some lower latitude regions?
- Monthly mean SIC & uncertainties could be combined in merged Figures (a & b)

L.280 & 283: "threshold of 30%" – better write s.th. like "$c_{ice} \geq 30\%$"

Figure 14 & 15: As before - could be combined into one Figure (a & b) to spare two almost identical captions next to each other. Plus: be more specific with the thresholds: "… a 30% sea ice concentration (SIC) threshold…" and further "…, where the 30% SIC-threshold has been applied".

L.348 / Section 6: reads more like a Summary and is quite short. One could think about merging this part with section 5 as a "Discussions & summary" chapter, but this is certainly personal taste.

Table A1 (Appendix A): Under "ERA5 variables", I think there is an error with u10m / v10m and their latitude / longitude reference.

Dataset entry on CEDA archive: The document "Algorithm Theoretical Basis Document (ATBD) - ESMR Sea Ice Concentration" is currently not accessible from the ESA website. Has it been moved?