

Review of “Relevance of warm air intrusions for Arctic satellite sea ice climatologies” by Rostosky and Spreen. <https://doi.org/10.5194/tc-2023-69>

The authors introduce a method to detect and categorize Warm Air Intrusion from atmosphere reanalysis temperature data. They apply the method over four decades and document a (slight) increase in the occurrence and severity of WAIs. They also document that four widely used sea-ice concentration datasets derived from passive microwave data respond differently to WAIs. All datasets are affected by the most severe WAIs ( $T_{2m} > -2C$ ), but three out of four are already significantly affected by less severe WAIs ( $-10C < T_{2m} < -5C$ ). The study is of interest for users of sea-ice data records, and can be interesting for developers of sea-ice concentration retrieval algorithms. It can be published after some revisions.

#### GENERAL COMMENTS:

Kern et al. (2019) concluded that the NSIDC CDR (v3) was high-biased at 100% SIC, while the OSISAF CDR (v2) was low-biased at 100% SIC. This is very well in line with your results. For a SIC CDR to appear un-affected by WAIs, a strategy is to overestimate the SICs (by selecting tiepoints that return  $> 100\%$  SICs) and apply the 100% SIC threshold. You see this with your Figure A.6. At present, algorithm calibration is mentioned in passing with only 2 sentences (257-261) in your manuscript, although it is possibly a key element of what you observe. By referring to Kern et al. (2019), using your knowledge of how SIC algorithms work and especially the impact of tie-point selection, and moving your Figure A.6 to the main body of the manuscript, I invite you to significantly expand on these aspects in the Discussions.

From your text, it looks like you are using the OSI SAF SIC CDR v2 (OSI-450 and OSI-430-b). If this is the case, I strongly encourage you to update your study to use the SIC CDR v3 (OSI-450-a and OSI-430-a). The v2 CDR is deprecated, the v3 CDR was released in October 2022. Part of the update from v2 to v3 was exactly to reduce the low bias observed in v2 at high SICs. Using the v3 SIC CDR should not be too cumbersome, as it has the same file format and map projection as v2. This would ensure that your manuscript stays relevant for the latest version of the SIC CDRs. If you are already using the v3 CDR, all is good, but you should make it clear in the text (see specific comments below).

If SIC algorithm developers want to improve their SIC CDRs, they will need to study in details how the Tbs change with WAIs on many WAI cases, across satellite missions, etc... Even if imperfect, your WAI detection method could be a key asset to get these studies started. I thus invite you to: 1) publish the maps of your WAI detection (e.g. daily maps with integer values recording if there was a WAI, and what category it was) and 2) publish the software for the WAI detection on a software repository. This will ensure not only transparency and reproducibility of your research, but also help future developments of SIC algorithms to improve on the situations you report.

#### SPECIFIC COMMENTS:

Title : Your study is only about Sea Ice Concentration (not Drift, Type, etc...). Also, “Climatologies” often refers to the average (or median, etc...) over long time periods (WMO definition). The data you are studying are often referred to as “Climate Data Records”, or “timeseries”. Please modify the title to reflect the above.

#### Abstract :

- “during warm air intrusions”. This does not convey that the SIC is impacted after as well (when when Temps are back to nominal).
- The last sentence could be made shorter and more impactful.

L23 : You could have cited the recent Kern et al (2019, 2020, 2022) papers. Especially Ker et all 2020 look specifically at summer conditions.

L25-26 : Here would be a good place to remind the readers that WAIs have different phases, and that the effects on the microwave emissions might perdure several days after the WAI is finished (in terms of higher temperature).

L29 : surface ice glazing was the main hypothesis of Rückert et al. (2023) but formulate your sentence as a certainty. You could revise. Also it might be interesting to note that the two case studies in Rückert et al. (2023) were along the MOSAiC drift.

L33-34 : please specify which versions of the CDRs you are using. Also you should spell out these acronyms.

L38 : “the following” → “as follows”. Possibly rework these sentences. For example you state here that chapter two will briefly discuss the physics of microwave emissions, but the title of the section is about SIC algorithms, which is not exactly the same thing. Also, I think these are called “Sections” and not “Chapter”.

L45 “quantities” → “surfaces”

L53 You could rework the transition from your first to second paragraph. For example open the 2<sup>nd</sup> with “However, the emissivity of the snow/ice system depends on many parameters”. And maybe introduce the WAIs later in the 2<sup>nd</sup> paragraph, when the other parameters have been discussed.

L73, L81, L85, L93, L97, etc... check the numbering of your headings. Should it be “2.1”, “2.2”, etc...

L74 From the URL it seems you are using NSIDC SIC CDR v4. Please check and write it in the text.

L81 OSI SAF is preferred to OSI-SAF (throughout the text and figures).

L82 From the URL it seems you are using OSI SAF SIC CDR (OSI-450) and ICDR (OSI-430-b) v2. Check and write it in the text.

L82 The OSI SAF processing chain also uses ERA5 NWP fields and corrects the Tbs for the atmospheric effects. This could be noted as one could have assumed that this would help in the early phases of the WAI.

L87 I thought ASI was the name of an algorithm. Could you write “ASI SICs from AMSR-E and AMSR2”, e.g. ?

L97 Since your only auxiliary data is ERA5, you can rename your section.

L98 I think ERA5 (not ERA-5) is the accepted acronyms.

L100 For the ERA5 bias, please add some more citations rather than the etc, e.g. Wang et al. 2019, Batrak and Müller (2019).

L119 the definition of the three categories is not entirely clear. L118 you define T threshold with  $> -10C$ ,  $> -5C$ , and  $> -2C$ . Thus, a category 2 ( $> 5C$ ) is automatically also a category 1 (since  $>10C$ ). But later (L133) you use the thresholds as brackets ( $-10C < T < -5C$ ). Please clarify in the text and review your figure captions and headings of Table 2.

Fig 1 and Fig 2 : Please use the same y-range for the top row graphs. Currently Fig 1 uses (84-100) while Fig. 2 uses (86-100)

Table 2: In Fig 1, Fig 2, and Table 2 you introduce the concept of “All Categories” but this is not explained in the text. Is it the collection of all Cat1, Cat2, and Cat3 events? But it is then not obvious why the number of “All categories” events in Table 2 is not the sum of the three other Categories.

Table 2: specify the units of the area and area loss.

L180: Rather than performance of the algorithm, you could refer to the impact of the WAIs on the algorithms.

Fig 4 : Fix NSIDC (not NSICD) and OSI SAF (not OSI-SAF).

Fig3 and Fig 5 : re-use the same colors as Fig 1 and Fig 2 (for the data sources)

Fig 4: use the same colors as Fig 1 and Fig 2 (Categories)

Fig 4: add text for the time periods covered in the panels.

L206: From what I understand, you have two observations: 1) the number / area / category of WAIs detected by your method increases throughout the 40 years, and 2) their impact on the SIC products increases. You might want to reformulate this paragraph to make this distinction.

L218 : The sentence starting with “Through...” seems broken. Please rework.

L237 : The sentence would work equally well without “sophisticated”.