Dear Dr. Petra Heil,

Many thanks for the review of our manuscript. We have considered each comment from the reviewers carefully and provided an itemized response to the comments as follows. We also polished the language. Attached is a revised version of our manuscript, in which we marked all the changes in blue. Also, the revised version of supplement file is attached.

Looking forward to hearing from you soon.

Best Regards,
Xiaoping Pang and other contributors.

Response to comments from Vishnu Nandan

Dear Chen et al. Thanks for answering my questions on your manuscript and incorporating my suggestions in your revised manuscript. Its much improved. However, I found your description of Figure 5 (lines 275 to 283 in your revised manuscript) to be vague and sort of 'washed off' the main points.

a) Why is the TB difference greater for thin snow covers compared to thick?

Reply:

Thanks for your question. We have added the statistic results of TB differences with different snow depths, shown in the supplement file (Table S3). Results show that the TB differences are larger for thin snow covers compared to thick snow covers. Additionally, the statistic results of SIC differences with different snow depths were shown in Table S2 of the supplement file.

Page 12-13, Line 278-282, we wrote:

When the snow depth is lower than 10 cm, the SIC differences are the largest with a mean MAD of 7% between the MWRI-ASI and SSMI-ASI and of 9% between the MWRI-ASI and AMSR-ASI, which are about three times of those (2% and 3%) when the snow depth is higher than 40 cm (Table S2 of the supplement file). One of the reasons is that the TB differences are also largest when the snow depth is lower than 10 cm, about twice as much as when the snow depth is higher than 10 cm (Table S3 of the supplement file).

Supplement file, Page 8, we wrote:

Table S2: MADs between the MWRI-ASI SIC and other two SICs with the snow depth of 0-10 cm, 10-40 cm, and 40-60 cm in the Arctic and Antarctic from 2010 to 2019.

	Arctic (%)			Antarctic (%)		
	0-10 cm	10-40 cm	40-60 cm	0-10 cm	10-40 cm	40-60 cm
SSMI-ASI	7	2	2	6	3	2
AMSR-ASI	9	4	3	8	5	3

Table S3: MADs in the polarization difference at 89 GHz between the MWRI sensor and other two PM series sensors with the snow depth of 0-10 cm, 10-40 cm, and 40-60 cm in the Arctic and Antarctic from 2010 to 2019.

	Arctic (K)			Antarctic (K)		
	0-10 cm	10-40 cm	40-60 cm	0-10 cm	10-40 cm	40-60 cm
SSMI	2.7	1.3	1.2	2.6	1.5	1.3
AMSR	2.4	1.1	1.0	2.3	1.3	1.0

b) Also, you make a speculative statement about Tb differences being high for thin snow covers in summer. What is the reason for that? Is it geophysical? This chimes back to my comments from my first round where especially in the Antarctic, there is stronger effect of snow (due to loading, flooding, melt/refreeze cycles and its deterrent effects such as slush/snow-ice/ice layers etc etc). But I dont think the authors have addressed any of them or even taken into consideration. Yes, this is a paper focusing on the product. But at the same time, there should be at least a discussion on geophysical uncertainties especially with snow being the dominant parameter affecting your SIC. I still feel that needs to be accounted for in your revised manuscript.

Reply:

Thanks for your questions and comments. We have reconsidered the influence of snow on SIC. We suggested this phenomenon can be explained by metamorphoses in the properties of snow during summer, which is supported by some references. Also, we have presented the explanation in the text.

Page 13, Line 285-296, we wrote:

This could be explained by metamorphoses in the properties of snow over sea ice during summer, such as increased wetness (even saturated with meltwater), increased snow density, increased snow grain size, the occurrence of diurnal melt–refreeze cycles on surface, and slush on surface, etc., which have an impact on TB (Ivanova et al., 2015; Kern et al., 2016, 2019). The increase of snow wetness usually leads to an increase in TB of about 10 - 60 K, while the increase of snow grain size, which would cause the geophysical properties of snow cover to be very close to the surface scattering layer of sea ice, typically leads to a decrease in TB of about 15 - 35 K, resulting in large uncertainty of SIC (Kern et al., 2016). With the increase in snow depth, e.g., > 40 cm, the corresponding increased snow load may lead to a negative ice freeboard, especially for the thin ice in the Antarctic, resulting in the slush layer appearing between the snow cover and the ice layer (Li et al., 2023). However, such slush layer is often thin, and the surface covered with thick snow would generally keep dry. This mechanism can be used to explain why the deviation of SIC is always the smallest for thick snow cover in both winter or summer. Thus, the snow over sea ice could play a significant role on the SIC uncertainties, which is greater at lower snow depth, especially in summer.

I think the paper would be more impactful if you could answer my a) and b). The paper is good to be published subject to this revision (which wont take much of your time, if you can find some literature discussing my above mentioned issues). Think about it :)

Response to comments from referee

This paper describes a new sea ice concentration (SIC) data product produced using a modified version of the ASI algorithm and a new intercalibrated brightness temperature data set from the FengYun-3 series of satellite Microwave Radiation Imager. The paper provides a thorough intercomparison of the new SIC product with similar passive microwave SIC products from AMSRE/AMSR2 and SSMI/SSMIS as well as a comparison of the derived sea ice extents to other existing sea ice extent products. In general, the new dataset compares similarly to the other products and the authors do a nice job of framing their new data set as an independent measure of SIC while new sensors for the other SIC products come online in the future. The paper also describes the common limitations of their data that affect all passive microwave sea ice concentration products. The dataset is publicly available at the PANGAEA repository, and I was able to download and read a sample of the data without any problems.

I think this work provides a good contribution and is appropriate for publication in ESSD pending a few minor revisions as described in my comments below.

Minor Comment

I have one minor comment regarding the intercomparison of the gridded SIC product with ship-based observations discussed in Section 3.3. Specifically, I disagree that larger disagreement between the satellite SIC and ship observations in the low SIC categories automatically means that the satellite SIC is less accurate. There is a more complex relationship here related to the distribution of sea ice within the gridded cell versus an observation at a single point or along a transect. I suggest the authors add a bit more discussion about how the differences in the scale of these two observation types are not a one-to-one comparison. The remainder of my comments listed below are very minor technical suggestions.

Reply:

Thanks for your comment and suggestion. We have added the discussion about the differences in the scales between the gridded SIC products and ship-based observations in discussion Section 4.3.

Page 23, Line 466-474, we wrote:

This study and the results given by Spreen et al., (2008) both presented that the SIC differences between PM-based and ship-based observations are larger in the low-SIC region than those in the high-SIC region. The large SIC differences can be explained by the different spatial and temporal scales between PM SICs and ship-based SICs (Beitsch et al., 2015; Kern et al., 2019). Ship-based SICs are obtained on an elliptically shaped area of 1 km on each side of the ship, while the footprint sizes of PM frequencies were considerably larger than 1 km, which are several kilometers to tens of kilometers. In contrast to ship-based SIC gained by observers at a specific time, the PM SICs are the daily averages combined with swath SICs from different time in one calendar day. The ship-based SIC may not be fully representative of the entire grid of PM SIC and the observation results may also be affected by visibility and light around the ship.

Technical Comments

L64: Change "easily ignored by the PM observations" to "unresolved by the PM observations"

Reply:

Thanks for your suggestion. We have changed it.

Page 2, Line 63-65, we wrote:

Results indicated that the three SIC products were slightly lower than the ship-based SIC in winter but higher in summer by 10% to 12%, because the small-scale morphological features such as leads and sparse small floes are unresolved by the PM

observations.

L73: Grammar - change "which is only use" to "which only uses"

Reply:

Thanks for your suggestion. We have corrected it.

Page 3, Line 73-75, we wrote:

Due to low frequencies applied in the NT2 algorithm, the original resolutions of the NT2 SIC products are lower than those of the ASI SIC products, which only uses the highest frequency with high spatial resolution (Spreen et al., 2008).

L131: Change "It is notes" to "It is noted"

Reply:

Thanks for your suggestion. We have changed it.

Page 5, Line 132, we wrote:

It is noted that this data is averaged by a five-day running window and only includes the depth of dry snow.

L132: I recommend deleting "Besides" from this sentence.

Reply:

Thanks for your suggestion. We have deleted it.

Page 5, Line 133, we wrote:

This data provides snow depth for the entire South Ocean in the Antarctic, but only for the first-year ice in the Arctic.

Figure 7: The color scale below the figure does not seem to map to the data in any regularly spaced bins, other than dark blue = 0, white or grey = 3, and dark red = 55. This makes some lower percentage proportions (e.g., 5 – 15 range) appear to be more significant (pink and red) than they may be. I suggest binning the data into a regularly spaced color scale and not using a diverging color map.

Reply:

Thanks for your suggestion. We have changed color scale of Figure 7.

Page 17, Line 368, we wrote:

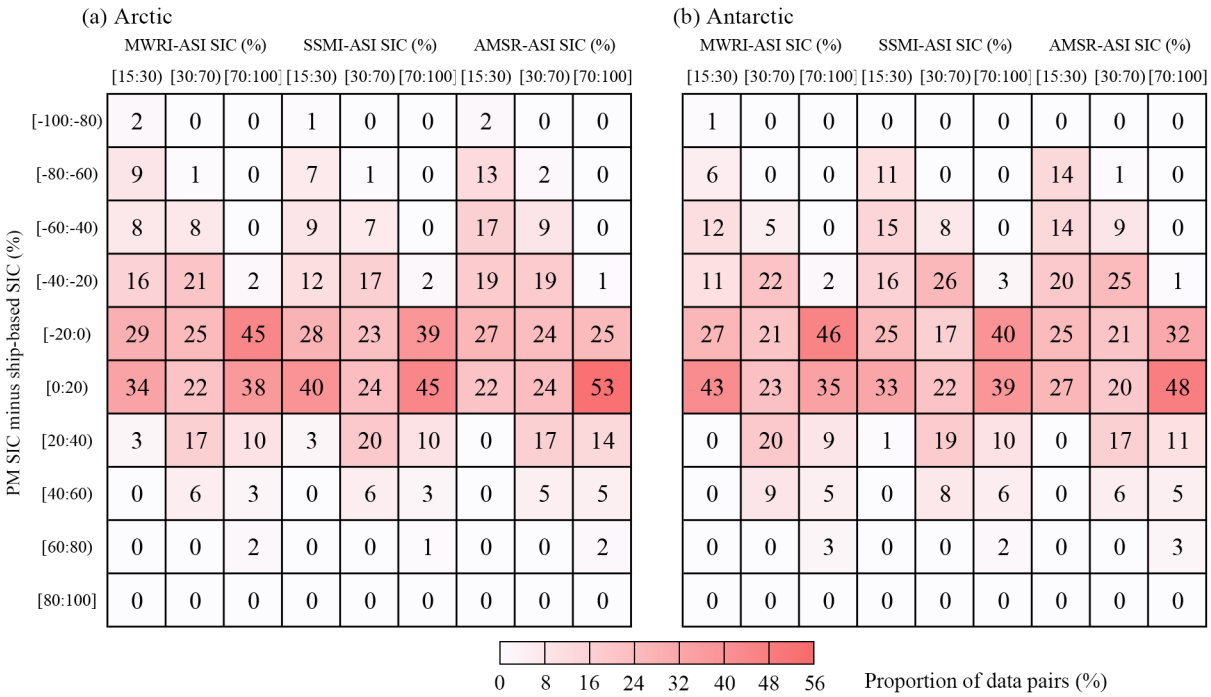

Figure 7: Proportion of data pairs (number in the grid) of the PM SIC products vs SIC differences between the PM SIC products and ship-based SIC. The PM SIC products are divided to 15–30%, 30–70%, and 70–100% (horizontal axis). The SIC differences are grouped with an interval of 20% from -100% to 100% (vertical axis).

L345: An observer on a ship is reporting the concentration of sea ice immediately surrounding the ship, not the concentration of ice distributed around the full area of a grid cell. Wouldn't the bigger differences between MWRI-ASI SIC and the ship observations in the lower sea ice concentration groups be related to differences in the distribution of sea ice within the gridded observations versus a point observation from a ship? I think the conclusion at line 345 that MWRIASI SIC is more accurate in high concentration regions is more complex than stated.

Reply:

Thanks for your question and advice. We have deleted the sentences at original line 345 and added the discussion in Section 4.3.

Page 23, Line 466-474, we wrote:

This study and the results given by Spreen et al., (2008) both presented that the SIC differences between PM-based and ship-based observations are larger in the low-SIC region than those in the high-SIC region. The large SIC differences can be explained by the different spatial and temporal scales between PM SICs and ship-based SICs (Beitsch et al., 2015; Kern et al., 2019). Ship-based SICs are obtained on an elliptically shaped area of 1 km on each side of the ship, while the footprint sizes of PM frequencies were considerably larger than 1 km, which are several kilometers to tens of kilometers. In contrast to ship-based SIC gained by observers at a specific time, the PM SICs are the daily averages combined with swath SICs from different time in one calendar day. The ship-based SIC may not be fully representative of the entire grid of PM SIC and the observation results may also be affected by visibility and light around the ship.

L375 and 376: Typo? Should "lightly" be "slightly"?

Reply:

Thanks for your advice. We have corrected it.

Page 19, Line 394-396, we wrote:
Overall, the polarization difference at 89 GHz of the MWRI sensor is slightly higher than that of the SSMI sensor with a mean positive bias of 0.9 K and slightly lower than that of the AMSR sensor with a mean negative bias of -1.1 K.

L416 – 422: Do not introduce a new dataset and results in the discussion section. I suggest moving this up to the results section.

Reply:

Thanks for your suggestion. At original line 416 to 422 (now line 433 to 439), we aimed to discuss the influence of temporal filter on land spillover. In the result Section 3.1, we found that our MWRI-ASI SIC is limited in terms of the land spillover. For a better discussion of land spillover, the second paragraph of the discussion Section 4.2 illustrated this limitation in more details. We added the Single-day SSMI-ASI SIC product only to analyze the land spillover. The Single-day SSMI-ASI SIC product are not added into the analysis of the result Section. Therefore, we think these sentences are better placed in the discussion Section.

L428-430: Is this future work? "in the next step" suggests that you will address it in the next section of the paper. I recommend changing the wording here to say this will be future work.

Reply:

Thanks for your suggestion. We have corrected it.

Page 21, Line 447-449, we wrote:
Thus, in the future work, we will attempt to identify and remove the spurious ice caused by land spillover and weather effects, by combining the optical or synthetic aperture radar images with higher resolutions, to further improve our MWRI-ASI SIC product.

L455: I recommend changing "Besides" to "Additionally" to make it clearer that these biases are also provided with the SIC data set.

Reply:

Thanks for your suggestion. We have changed it.

Page 23, Line 482-483, we wrote:
Additionally, the biases between this SIC dataset and other two ASI SIC products, i.e., SSMI-ASI and AMSR-ASI, are provided.