

Specific comments:

Introduction

L58 – L59: Why is the limitation of daylight not mentioned for visible satellites?

L81: “we aim to present...” I suggest removing the verb “aim” as you successfully present two new lead products in this paper.

Section 2: “Lead fractions from different retrieval methods”

Section 2.1:

Generally, I like the idea of starting this section with highlighting the different ways how leads can be detected (Section 2.1). It makes a great summary of methods and a good introduction. Nevertheless, there is some disconnect between 2.1 and the satellite products in 2.2 and 2.3. Some subsections contain repetition of information stated (slightly differently) within the physical properties (e.g., L242 – L246 correspond to L118 and following lines). One solution could be mentioning the satellite product using this physical property there and then pointing towards the subchapter or not repeating physical properties and pointing back to the explanation of the physical properties within 2.2 and 2.3?

Why is the concept of LKFs not introduced within (2) Elongated feature?

Figure 1 and Section 2.1 Physical properties of a lead detected by remote sensing are not well connected. Some, but not all titles of the physical properties relate to the Figure. I propose either changing them to make them match or include the numbers from the physical properties into Figure 1.

Other minor comments on Figure 1: The thin ice cover (?) marked with the light blue and crosses is not explained anywhere. On a printed version of the manuscript the yellow and grey writing are hard to read – consider changing colors or making the font bold.

L142: Citation format is not correct.

Section 2.2:

L146: Should the title not be plural “Novel lead products based on ...”?

L147: I suggest replacing “These” with “Both” for clarity.

L163: Does “area” refer to the radius around the *R/V Polarstern*? If yes, I suggest replacing it.

L171: Does “deformation data” refer to the calculated divergence? Is the directional filter applied to all div data or only div > 0? I assume to all div data (see statement in L181) but maybe that could be made clearer with the naming of the data set.

L181: Why is lead fraction plural in “average lead fractions per grid cell”? Is the result not one lead fraction for the whole grid cell?

L182: I suggest including “rafting” within the results of convergent motion in “indicate closing and ridging”.

L190: I personally found it hard to figure out how each step relates to Figure 2. If Figure 2 is here used to illustrate the creation of that data set, maybe include references within the steps of the procedure. If it includes the result, then I would suggest mentioning it after the explanation.

L194: What does “b1” (also in L197) refer to?

L231-234: What exactly is the second quantity? I assume that this paragraph is supposed to give the second quantity as it starts with “Secondly”.

L226 – 236: I suggest making it into one paragraph, as “We are computing two different quantities” highlight that both quantities are mentioned within one paragraph. And L235-236 is a solid summary of what the product includes.

Section 2.3

L242-246: Repetition of information given in the physical properties of leads (2.1)

Section 3 Evaluation of lead fraction based on divergence during MOSAiC

Section 3.1.1:

L365: Why are the manually measured widths not included into the Figure 3?

Section 3.1.2:

L381-382: According to Figure 4b) the lifetime always follows an exponential fit (with all lifetimes and with 3-11 days lifetime)? Why does the text only mention the latter? Also, why observing the lifetime after 3 days only if 33% of the leads are present for two days? (L383)? I am not sure if displaying both fits in the Figure 4b) is necessary and if it is necessary, this information is lost on me.

L385: How many leads are 2% of the leads? All mentioned numbers are given in relative numbers or percentages, and I suggest mentioning somewhere how many leads occur in your analysis.

L393-394: Why is the exponent of the linear fit not mentioned? The exponent is not mentioned here, nor is it discussed in comparison to other exponents derived for the Arctic sea ice based on remote sensing (e.g., Wernecke and Kaleschke (2015), Marcq and Weiss (2012)) later in the article.

L400-401: I disagree with the correlation between the lead width variability and the number of lead pixels as a Pearson R value from 0.26 is a low R value. The correlation might be strong in October and November, but there is no effect between April and May, which is a time of strong variability. Additionally, periods of similar variability as October and November do not show an increase in number of lead pixels (e.g., December).

Section 3.1.3:

L414: Are “time instances” the same as “time steps” (used in L390)? From here on onwards I only recognized the usage of “time instance” and was sometimes confused what the difference between a “time instance” and a “time step” would be.

L418: Does “no geolocation errors” mean that there are no errors due to advection?

L421: I assume that the “tracking uncertainty” is the before mentioned “tracking error”?

L422: It was hard for me to identify the unit of the lead fraction uncertainty. Maybe it would be clearer if the unit would be written directly after the value as a unit and not in words. Similar to L423 where it would be easier with $56-122 \text{ m day}^{-1}$.

L431: What is the “threshold for lead-ice thickness set by the research question”?

After the end of this section, it is still hard for me to understand the uncertainty of your products, e.g., what does this mean for people using this product and how this uncertainty compares to other available products.

Section 3.1.4:

Figure 6: Panel a): It took me a significant amount of time to identify the “no accumulation” and “10x accumulation” line and understand that this panel highlights how the accumulation effects the lead activity. Maybe these lines need color, or the gray lines (1x-9x) in-between are not needed.

Section 3.1.5:

Figure 6: Panel b) I assume the goal of this panel is to show how the area influences the lead fraction. For consistency I would remove the gray 0-10x accumulated lines, because all other lines display 5x accumulated. Additionally, the dark purple and black line are basically not distinguishable (neither in print-out nor on screen), which is unfortunate as this is the line especially mentioned in the text.

L474-475: I suggest including a reference for localized and intermittent nature of deformation. Additionally, I was wondering if the mentioned effect within the smallest radius results from the R/V *Polarstern* influencing the local ice.

Section 4: Comparison of different lead products

Section title of 4.2 “Temporal variability of different lead products”

This section has several inconsistencies within its organization:

- The title of the section (L529) is not properly represented in the topic sentence (L530-531) of the section with “(1) the temporal variability and (2) the temporal resolution and coverage”.
- The name of (1) within the topic sentence (L530) is inconsistent with the later used title for part (1) (L533)
- The name of (2) within the topic sentence (L530) is also inconsistent with the later used title for part (2) (L575)

This makes it hard for the reader to figure out what exactly is discussed in this section and where it is discussed. I also wonder why here the numeration of (1) and (2) is used, while other sections have a second-level subsection (e.g., 3.1 with) subsections ranging from 3.1.1 to 3.15.

Figure 7: I suggest calculating the ice concentration from 0 to 1 instead of the display with “1-ice concentration” as this feels unintuitive. Additionally, the text only mentions the ice concentration and quick readers might miss the small gray label.

L544-545: For me it is not obvious why the last sentence of this paragraph (“In fact,”) explains the difference between the classified SAR and the divergence products highlighted in blue in Figure 7. The LF_{PMW} also features a blue area – how does that fit into the picture?

Figure 7: Does it make sense to connect the dots with a dashed line for $LF_{\text{Heli_TIR}}$? Why are a few C2 absolute dots not connected?

Section 4.3

L587 and L614: Why do these headings not result in their own subsection 4.3.1 and 4.3.2 respectively?

Figure 8: Is there a way to highlight the four lead pixel within the MODIS subplot (f)? On print-out they are not visible at all and on-screen only with zooming in a lot. Otherwise, a comment in the Figure description could help as well.

Figure 9: The comparison between e) and f), for example, is difficult visually as red is a more vibrant color compared to the muted green for the MODIS subplot. I suggest making the colors for leads the same or at least perceptually similar. The same comment applies to g) and h). Why does the colormap change?

L587-590: Where do the measurements from the leads come from? What is their uncertainty?

L643-645: I do not understand why missing leads is a reason for a comparably high lead fraction of LF_{CS2} ?

L646-648: A paragraph needs at least two sentences. Additionally, there is no summary of the performance from both case studies.

Section 5: Discussion

L652-653: The sentence introducing the advantages should go into the section where you address these advantages. Otherwise, the impression could arise that these four advantages could relate to the four bold titles throughout this section.

L656, L686 L715, L735: Why are these no subsections but rather bold titles?

L659-660: I assume this sentence is about the large-scale ice strength as we miss detailed information of the ice on centimeter to meter scale, which are scales mainly associated with mechanical properties of sea ice. Maybe phrasing it more precise would be helpful.

L687: One sentence is not a full paragraph. Additionally, “on the other hand” generally needs first a mention of “on the one hand”.

L688: I suggest adding an “other” in front of “products” as I assume that the usage of a shape criterion is compared to LF_{div} .

L692-694: It would be nice if there would also be a comment on the uncertainty. After the uncertainty section and this paragraph in the discussion it is still unclear to me how you rate your uncertainty and how strong it is (compared to other products).

L697: I assume “suffocated” is the wrong word here.

L730: This result of the exponent is not mentioned in the results section.

According to the bold title in L715 this section should include a discussion of the lead width. This discussion does not happen apart from stating that it follows an exponential fit. As there are several studies about lead-width distribution cited in this paper I suggest that you discuss your result of the lead-width distribution quickly with other research. Otherwise, there seems to be no assessment of the general lead width detected by your methods.

Section 6: Conclusion

L757 and L760: The end of the paragraph is odd as “the first product” (L757) and “the second product” (L760) should be in one paragraph. One suggestion would be to make the paragraph break after “Sentinel-1 mission” and combine all following lines until the enumeration (L764) into one paragraph.

L758 and L768: What is the difference between a “time step” and “time instance”? I know I asked that above as well, but especially in the conclusions it needs to be clear if this is the same or something different as readers might only read the conclusions.

Technical comments:

The use of compound adjectives varies within the paper and leads to inconsistent use:

- a) Inconsistencies within the same word group; examples:
 - sea ice cover (e.g., L19), sea ice dynamics (e.g., L24) and similar are mainly written without turning “sea ice” into a compound adjective (“sea-ice”), but sometimes “sea-ice” is used as a compound adjective (e.g., L82 sea-ice divergence)
 - “Lead-fraction retrievals” (L66, L91) versus “lead fraction dataset” (L73)
 - “EM ice-thickness measurements” (L515) versus “airborne ice thickness measurements” (L514-515)
- b) Inconsistencies across the article
Compound adjectives are for example used for ice-covered leads (e.g., L28)

I know that some people assume compound adjectives to be a matter of personal style.

Some numbers written in the text do not follow the TC style guide (<https://www.the-cryosphere.net/submission.html#math>). One example is “6 existing lead products” (L498).

Not all (e.g., ...) references in the manuscript include the necessary comma after “e.g.” (e.g., L43, L45 and L143)

L142: Citation format is not correct.

L226: LKLF is not formatted in the right way.

L336: Citation format is not correct.

L371: There is a space missing between the word “studies” and the start of the citation.

L393-394: There is a comma between the number and the unit in three cases.

L419: L should be replaced with ΔL .

Figure 4 and Figure 5: The caption should probably be “mean (\pm standard deviation)

L483: LF_{div} should be LF_{div}.

L489: I assume “as” is supposed to be “has”.

L512: 0.05 misses the “%” symbol.

Table 1 – first row: Coefficient of variation has only one number after the decimal, should have two for consistency with other rows.

L607: I suggest exchanging the verb “leads” to another verb as this is slightly confusing for the reader.

L634: There is the word “Figure” missing in the brackets.

L668: “on” should be replaced with “in”.