

## ***Interactive comment on “A lead-width distribution for Antarctic sea ice: a case study for the Weddell Sea with high resolution Sentinel-2 images” by Marek Muchow et al.***

### **Anonymous Referee #2**

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Comments on the manuscript “A lead-width distribution for Antarctic sea ice: a case study for the Weddell Sea with high resolution Sentinel-2 images”, open for discussions in the Cryosphere Discussions.

The manuscript uses Sentinel-2 data from a visible channel (665 nm) to detect leads in the Weddell Sea during the daylight season between November 2016 and February 2018. The authors use an approach published in a previous study to identify the surface cover of the lead using thresholds of reflectance pertaining to each surface type, open water, nilas, grey ice, grey-white ice and first-year ice with snow cover. They also use another published approach to measure the apparent width of the lead as the

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orientation can be different than the along-track direction of the satellite.

While the study provides interesting statistics about leads in the Weddell Sea, it does not offer details about the uncertainties implied in the data or the methodology (i.e. setting the thresholds). The subject is certainly timely and will have immediate implications, given the impacts of climate change on the polar regions, but I think with such a short manuscript it suits more a letter-style paper. I am not sure if TC allows this.

The manuscript is fairly well written though I found some sentence structure can be improved, e.g. “we noticed that on products with wide leads ...” or “The goal of the classification is to get thresholds ...”. A better word would be “to identify thresholds”. The “amount of lead” should be “the number of leads”, and so on. I am not including more details but the authors and the site editor(s) can adjust the style.

#### MAJOR ISSUES:

The title suggests that results of lead distribution apply to the Antarctic ice cover. I don't think this would be true. The authors concentrate on the Weddell Sea as a case study. There are two features in this region that make it unique, the dominant old ice and the gyre (Weddell Sea gyre). That should make the leads in this area unique. Perhaps a better title should specify Weddell Sea only.

The authors admit that in presence of snow, the reflectance measurement will not be an indicator of the underlying ice cover. I don't see how they addressed this problem. Please clarify.

While leads are mostly covered with open water or thin ice, they also serve as a path for broken thick ice. The authors set thresholds on reflectance to identify the surface of the lead, OW, nilas, grey ice, etc. If I understand it correctly, the authors calculate the lead statistics for each type separately (Fig. 5 shows OW and nilas), but a lead may have all types of ice plus OW. What if the lead in your data is composed of the five ice types you referred to? Would that be included in the lead statistics? The answer is still

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not clear to me after reading the entire manuscript.

The authors use Reflectance to set thresholds to identify surface types. However, Reflectance is angular-dependent measurement, therefore it is not a property of the surface. Albedo is a property of the surface because it is the integration of the angular reflectance. The comparison between albedo and reflectance on page 6 lines 24-26 cannot be used to confirm the reflectance thresholds. To proceed with the reflectance in this study, all leads must be viewed with the same angle from the different satellite orbits.

#### MINOR ISSUES:

**INTRODUCTION:** There are many more references that can be used to review the work on lead width geometry and width distributions. The authors should check and quote more than the 2 references used here. Moreover, the Introduction jumps too much between different themes. I would recommend the authors to re-write while grouping themes in separate paragraphs.

P 1 L18: leads may not always form in linear shape. P2 L1: what is “coupled climate models”? P2 L15: “Reiser et al. (2020) introduced a retrieval algorithm for lead fraction in the Antarctic, but these studies indicate that knowing about lead-width distributions is beneficial when estimating heat transfer”. It is not clear how this can be a conclusion from a lead identification study. For one thing, it can only be a conclusion from a heat flux study but more importantly is a logical conclusion. It does not need a study. P2 L28: “To narrow down the effect of the fitting methods, we applied ...”. Please change the sentence as the purpose of applying the two methods is not clear. P3 L4: “The determined thresholds for leads covered with open water ..” Threshold on what? Reflectance? P3 L5: the sentence “Two threshold are applied to identify ..” is not understood. Please rephrase. Figure 1: I find some of marked frames of the satellite images odd (with 3 or 5 sides instead of 4). Why is that? Also, in the caption, instead of “with shelf ice” it is better to use “including shelf ice border measured with ...” then

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specify the satellite radar sensor

DATA: P2 L10: attach the spatial resolution to the band. P2 L11: please include the spectral band for channel 4 (665 nm). Also, in Line 12, provide a reference to support your statement - that it is best for thin detection. I am not sure about the reason. Please specify. P2 L13: which Landsat? When I read this statement, I expect to see use of the coincident SPOT and LANDSAT data to support your finding. But they are mentioned here only to refer to their future use. Using these data will add value to the manuscript.

Table A1: why A1? It is not in an appendix? I would recommend inserting in the main text at the end of Section 2.

METHODS: The use of  $n=2$  and  $n=3$  in Equation 1 for light-grey ice and dark-grey ice is not clear to me. I see clearly the use of  $n=1$  for the other types in Figure 2. I don't think there is something wrong here. It is just my failure to understand. Please re-phrase.

Also, according to my information, what you call dark-grey and light-grey ice, should be grey ice (10-15 cm thick) and grey-white ice (15-30 cm thick). These are nomenclature set by WMO and used in operational ice centers. You can refer to the document that defines ice types, published by the Canadian Ice service: MANICE (2005), "Manual of Standard Procedures for Observing and Reporting Ice Conditions", Canadian Ice Service – Environment Canada, ISBN 0-660-62858-9, Catalogue No. EN56-175/2005.

Figure 3: in the caption "The upper border of every image is 50 km wide". This is not the swath. Please clarify what you mean by upper border. This figure shows the OW in the lead. What about other ice cover, nilas, grey ice, etc.?

RESULTS P6 L21: the sentence "the TOA reflectance is only measured passively in the absence of clouds ..." is not clear. Please rephrase. P7 L5: Nilas threshold cover also open water? Why? There is overlap between nilas and OW, but the threshold does not cover both. P7 L6-21: it would be better to expand on the difference between lead statistics in the Arctic and Antarctic in a separate sub-section. Most of the lead studies

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in the Arctic are conducted in the Beaufort Sea area. Some organized presentation should show the differences in the results, with related reasons if possible, and then comparison with findings from the Weddell Sea area.

**CONCLUSION** Before you mention about the method, you should mention the data used in the study.

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