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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.

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Dear Dr. Jenny Hutchings,

thank you for handling the editing process and for giving all this hands-on advice for improvement of the paper. Our responses to the referees are posted. If anything is missing and/or unclear, we are happy to provide more answers and information. We are thankful for the explicit examples for language improvement made by you and the reviewers and it was helpful to see where we can improve our writing. We also agree, that the paper will become longer after we edit it due to integration of more content in the method section and discussion of our results and that a short letter-styled paper

will not benefit this paper.

Thank you for your time and kind regards, Marek Muchow, Amelie Schmitt Lars Kaleschke

Specific Editor comments

The first paragraph of the paper demonstrates some of the language that could be tightened and "Leads are created by dynamic motions of the sea ice (Miles and Barry,1998) and thus follow a linear-like shape" Please rephrase, this is not correct. *Will be revised.*

"For parametrization of the lead width lead-width distributions are used." This could be clarified somewhat. *We will revise this sentence for clarity.*

"Shear and divergence rates, estimated from models and satellite observations, follow a power law for the Arctic sea ice (e.g. Girard et al., 2009; Marsan et al., 2004), which suggests that a power law can also be used for the statistical parametrization of the lead width." Perhaps this paragraph would read more clearly if the second part was before this sentence. *Will be revised.*

The mixing of observation types and models then makes the opening to the next paragraph confusing. There you want to clarify you are only talking about lead width observations, rather than "these studies". *Will be revised.*

Specify the wavelength of band 4. *The wavelength is 665 nm.*

"For the simplification of the problem only cloud-free Level-1C products were used". Can you even use your method for cloudy images. I think the statement "For the simplification" is not the correct phrase here. *Indeed, the method only works for cloud-free cases. We will rephrase this sentence for clarity.*

"The goal of the classification is to get thresholds for different surface types". I think "get" is not the correct word to use here. *Will be revised.*

What parameters are you identifying thresholds in? First state that the method is classi-

fication of surface types using x and y-data. Then point out that you look for thresholds in band 4 reflectance that distinguish different the surface types. *We will rephrase the description of the method for clarity.*

"Therefore, nine out of 20 later used Sentinel-2". Therefore is not the correct word to use here. There is no follow on from the previous sentence. *We will rephrase this sentence for clarity.*

I agree with the reviewers that the methods section would benefit from some additional figures to demonstrate the procedure and how thresholds are identified. *We will add schematics to clarify the methodology.*

Some particular comments:

Where do the values in Table 1 come from?
The values are derived from the intersection points of the Gaussian curves for different surface types, as described in Section 3.1. We will include a more detailed reference to Table 1 in the text.

Is your Gaussian fit appropriate?
We fitted the Gaussian curves to histogram data, which indicated a Gaussian distribution or a combination of Gaussian distributions with several maxima.

Are the thresholds consistent across images with different sun and look angles?
We estimated the thresholds with images from January to April of 2017. Thus, the data for fitting the Gaussian curves includes several sun and look angles. Before estimating the thresholds we compared the TOA reflectance values for the the surface types within the each products and found no significant difference, but nevertheless used 9 products for the classification for a larger data base.

I also agree that you can clarify the methods description. For example you could describe what the apparent width is succinctly, and how this differs from the true width.
As suggested by the reviewers, we will add a more detailed description.

Figures 4 and 5 lead me to wonder if the apparent lead width can be accurately measured down to 10m. There is an arc is the data points, with the gradient becoming less steep towards smaller lead widths, which could be indicative of white noise.
We have actually measured leads with a with of 10 m, but as stated, the amount of leads with a width of 10 m is less then might be expected (see Figures 4 and 5). A possible reason is the resolution itself, since capturing a 10 m lead is more difficult than a 30 m lead with a resolution of 10 m. To accurately capture a 10 m lead the lead needs to be directly in the same place as the "image pixel". This problem is also explained by Wernecke and Kaleschke (2015) "Compared to the power law, the found number of apparent lead width of 300 m is smaller than expected. This is a typical feature of the lower bound of the resolution as leads of this size are not always covered by a single measurement but partially by more, not necessarily leading to a detection". We will add a short discussion in the paper.

I echo the reviewers interest in a more detailed discussion of the errors introduced in the method.
We will include an extended error discussion were a lack of discussion was identified through the review process.

Can you describe the reasons for the differences in LF and MF fit based on their weighting of the data?
The linear fit (LF) method applies a least-square approach, which means that every data point has the same distance to the best fit. The MF method by Clauset et al. (2009) is based on a maximum likelihood approach.

It might be more interesting to consider if the fit is statistically significant. For both fits, we calculated the standard error of the slope/fitted parameter, which we called standard deviation in the paper. While revisiting, we realized that the term "standard deviation" alone might be not explanatory enough.
We will discuss the significance in more detail.

"Based on our current knowledge, previous studies (Table 2) focused on different regions in the Arctic and not on Antarctic regions." Here "Based on our current knowledge" is not needed in the sentence. *Will be revised.*

When comparing to other studies in the Arctic it should be clarified that you are not comparing like method for like. In particular the different sensors have different spatial resolution, which will constrain the range over which the power law fit is made.
Yes, as suggested by the reviewers, we will clarify the differences of the sensors and methods used in the literature.

If you consider how there appears to be a decrease in exponent at smaller scales in your data, would this explain any of the differences to previous studies with lower resolution sensors?
We will add a discussion about a possible scale dependency of the power law fit.

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