Inferring the seasonality of sea ice floes in theWeddell Sea using ICESat-2

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General comments

The authors have conducted a study which is related to a quantitative analysis of sea ice floe characteristics in the Weddell Sea using ICESat-2 high-resolution altimetry data. The study focused on two areas of the Weddell Sea: the western and southern areas, which exhibit different sea ice conditions (as shown in Figure 2). The authors used the MICIT (Multiyear Ice Concentration and Ice Type) dataset to estimate daily concentrations of multiyear ice (MYI), first-year ice(FYI), young ice (YI) and open water, and derieved floe chord distribution (FCD), ice thickness distribution (fITD), lead width distribution(LWD) and vertical floe roundness from ICESat-2 along-track ATL10 data. The main insights the study offered about the seasonal variations in these characteristics were as follows:

1. the seasonality of the FCD is consistent, coinciding with the asymmetric melt/freeze cycle of the pack, while the seasonality of the fITD suggests an anti-phase relationship between the two regions.
2. The LWD is almost identical for the two regions, characterized by a mostly monotonic decrease with size, while the mean lead spacing in the west is up to 2.5 times larger than that in the south.
3. The vertical floe roundness by Compositing floe profiles shows that smaller floes are more vertically round than larger floes, and that the mean roundness of floes increases during the melt season.

This work is justified, as the authors state, konwledge of floe-scale charactistics is important for understanding the sea ice dynamic. However, I think there are some room for improvements. It should be a good contribution to the TC and sea ice communities, after comments here or from the other reviews are adequately resolved.

specific comments

1. Introduction

Page 1, line 44: "Due to the sparseness of polar imagery, inter-regional comparisons of floe-scale properties are also limited..."

Although there are difficulties in collecting imagery, it would be better to mention the efforts they have made (Koo et al., 2023; Muchow et al., 2021). Studying sea ice in the Weddell using a combination of imagery and altimetry seems feasible.

2. Data products

Or Datasets and method?

Page 4, line 89: "We use the uncorrected version of the dataset, as the corrected version does not provide FYI and YI concentrations, though the timeseries of multiyear ice (MYI) area in theWeddell Sea compares well between the two products (not shown)."

Why don't you use the version with temperature and drift correction? Although the corrected version does not distinguish between the FYI and YI, but classifies them as non-MYI, it should provide a more reliable distribution of MYI and non-MYI, which is more important. Or it would be better to show the differences between the two versions in the appendix.

Page 4 108: "we define the ice located between two consecutive leads along a track as a single floe, and the extentof that ice segment as the floe chord length (Figure 1)."

How do you deal with the situation often found in ATL07/ATL10 where not all the segments on a lead could be classified as a lead (Figure 8 in Koo et al., 2023)? I think it would increase the number of small floe chords by your current method.

Page 5 line 120: "We test the sensitivity of our results to the following different lead definitions: (i) Specular + Dark (default)..."

In ATL07, there is actually a third lead definition, ssh_flag, which is the result of the radiometric decision tree and local height filter. Can you at this point add this lead sensitivity test if the “ssh_flag” also exists in ATL10?

3. Results

Page 6 line 135: “the south and west (blue and yellow boxes in Figure 2).”

The southern region should be in the red box. The same typo is also in the description of Figure 2.

Page 6 line 138: “The melt/freeze cycle is asymmetric, characterized by rapid melt between November and February, with approximately 15-30 % loss in freeboard thickness (except in 2020-2021).”

Is there any explanation for the anomalous increase in sea ice concentration in January? Or a data problem?

Page 6 line 147: “Melsheimer et al. (2023).”

Should be (Melsheimer et al., 2023).

Page 6 line 147: “Between July and December, the total sea ice concentration in the western region tends to drop, driven almost exclusively by a decline in the MYI concentration.”

Why the total sea ice concentration tends to decrease between July and December in both regions, while the freeboard thickness shows different trends in 2020 and 2021.

Page 8 line 174: “Very high freeboard values (> 1 m) are also observed over small floe lengths, which may be affected by the presence of icebergs, as discussed in Section 2.3.”

I think it might also be affected by misclassification of real sea ice as lead. For example, if there are several sea ice segments on a thick floe that are classified as lead, they will be calculated as some small floes with high freeboard.

Page 10 figure 4c: “$\alpha_{FCL}^{\prime}$”

Should be α'_{CLF}.

Page 11 line 212: "Lead width and spacing."

A little confused about the definition of the lead width and the lead spacing. I cannot find a clear answer. Are they the total length of consecutive leads and the distance between two leads, saparetely? The lead spacing looks like the floe chord. It would be better to clarify them here or in the section 2.3.

Page 13 figure 6: "while the black 'plus' and 'cross' symbols represent yearly-mean aggregates for the two regions, respectively."

There is no the black 'plus' symbol in the figure.

Koo, Y., Xie, H., Kurtz, N.T., Ackley, S.F., Wang, W., 2023. Sea ice surface type classification of ICESat-2 ATL07 data by using data-driven machine learning model: Ross Sea, Antarctic as an example. Remote Sensing of Environment 296, 113726. https://doi.org/10.1016/j.rse.2023.113726

Muchow, M., Schmitt, A.U., Kaleschke, L., 2021. A lead-width distribution for Antarctic sea ice: a case study for the Weddell Sea with high-resolution Sentinel-2 images. The Cryosphere 15, 4527–4537. https://doi.org/10.5194/tc-15-4527-2021