**Response letter to Anonymous Referee #1**

This study combines sea ice thickness retrievals from CryoSat-2 with different ice drift products to estimate the volume of ice export through the Fram Strait over the winters of 2010-2017. The authors find that ice drift variability dominates the variability of ice volume export over annual and inter-annual timescales, but the seasonal cycle is also impacted by the thickness of exported ice. The export of sea ice through the Fram Strait accounts for 54% of the variability of multiyear ice (MYI) volume over a given winter season.
The manuscript is clearly written and the figures are well-constructed and informative. Unfortunately, I still struggled with this review as I'm left wondering what the key pur- pose of the paper is. The manuscript includes a wealth of information but doesn't read like a complete method or scientific study. This is highlighted by the concluding bullets ranging from comparison of drift products to importance of ice export, presented as a list rather than a logical connected paragraph.
For a methods-based paper I would expect a more thorough description of the product development. This includes expansion on the error analysis explaining why the specific approach was chosen, how sea ice drift uncertainty is estimated using empirical error functions (brief summary of Sumata (2015) method), which high resolution SAR data is used a reference, and why such a reference is needed. The usefulness of the paper in a scientific sense is currently limited over such a short time frame, and it lacks novelty considering the number of existing sea ice export studies for the Fram Strait. The obvious way to develop the paper scientifically would be to investigate long-term trends in ice volume export, but as the authors state this would require a consistent methodology to compute ice volume flux through Fram Strait from multiple products.
I encourage the authors to think about their intended purpose for the paper then either a.) sufficiently describe the development of their new Arctic sea ice volume export product or b.) expand their scientific analysis utilizing the product. Despite these reservations I would like to repeat that this was a well-written paper and the content will be of interest to the sea ice community, so I have included some detailed and technical comments below.

We thank the reviewer for these thoughtful comments which helped to improve the paper. The novelty of the paper is to use the CryoSat-2 monthly ice thickness estimates for the computation of ice volume export. This hasn't been done before. Monthly retrievals allow a much more detailed analysis of the seasonal cycle and how the variabilities in sea-ice thickness, drift and concentration affect the volume export. These investigation were not (or very limited) possible with ICESat ice thickness retrievals that are available only twice per season (October-November and February-March), leaving gaps in December/January.
The Arctic research community is putting a lot of effort into quantifying contributions to exchanges between the Arctic and the North Atlantic (see ASOF for example, http://asof.awi.de ). One key question is: What are the fluxes of mass, heat, liquid freshwater and ice from the Arctic Ocean into the subpolar North Atlantic (ASOF II Objectives)? Our study addresses some of these issues.
We have emphasized the scientific importance of this study in the revision. Nevertheless, we also included a more detailed description of the error estimates.

We have revised the paper substantially to address the comments from both reviews. The main changes are listed in the following:

- We have carefully revised the computation of the ice volume flux and checked the results.

- We have updated the NSIDC ice drift data set, since it is now available until February 2017, which allowed us to update the NSIDC ice volume export time series until the 2015/2016 season. 2016/2017 has not been computed, since March and April are still missing in the NSIDC data.

- The Methods section has been revised for a more detailed description of the ice volume export calculations, especially of the uncertainty estimates.

- We have added a figure showing the ice concentration along the Fram Strait Gate, corresponding to Figures 2 and 3 for sea ice thickness and sea ice drift.

- We have revised section 4.4, discussing the impact of openings in the MYI zone, which might lead to a positive bias in MYI growth rates due to erroneously classified MYI.

In the following, please find our responses separately for each of the detailed comments:

Detailed comments

P1L18-P2L7: The reasoning is not clear here with regards to concentrating on MYI and winter. For example, the authors should explicitly state that winter does not play such an important role for FYI mass balance, and why. They also mention summer ice concentration when the focus of the manuscript is on the winter period. If the authors want to justify their concentration on a given ice type and season then I suggest they first discuss winter ice mass balance variations (MYI and FYI) and then summer (MYI and FYI), then reach a logical conclusion.

In this paragraph, it is our intention to point on the importance of MYI for the Arctic ice mass balance and for the state of Arctic sea ice. Winter does indeed play an important role for FYI mass balance. However, in this study, we focus on the MYI export and its effect on MYI mass balance. We have revised this paragraph for clarification.

P2L16: State ICESat periods

We added the ICESat periods (October/November and February/March)

P2L20: "...we use the CS-2 ice thickness dataset..." -> "...we use *our* CS-2 ice thickness dataset. . ." There are numerous datasets, so the authors should be specific about which is used.

Agreed. We have added „AWI" here.

P2L21: Be more explicit about which part of the study is novel (i.e. the "first" estimates of what). It is not the sea ice export estimates themselves, but the timeframe for which they're provided.

The novel part is the time frame, but also, and even more, using CS-2 ice thickness data for the first time to estimate volume export rates. The CS-2 data allow for a much more detailed analysis of seasonal variability of ice volume export as it provides monthly estimates, in contrast to ICESat, which provided only two estimates per year. We have edited the introduction to emphasis the goals and the novelty of this paper.

P2L21: Define "winter"

We have added „(October-April)" for clarification.

P4L21-23: Explain how unconstrained polynomials are dealt with at lower latitudes

Here, we consider the Warren climatology (W99) only in the Arctic Basin, e.g. where the polynomials are constraint by in situ measurements. For example, W99 shouldn't be applied over Baffin Bay, or at least with caution.

P4L26: And also snow depth, correct?

Thank you, this is indeed missing here. Added.

P5L11-12: NSIDC products are also provided monthly

Added in the text.

P6 Figure 1: The FYI and MYI masks are quite hard to distinguish with the current color separation. I'd like to be able to see them clearly for each year.

We have enlarged the figures and slightly enhanced the contrast between the blue tones, so it should be easier to distinguish now.

P9 Figure 4: It is not clear why the frequency scale ranges from 0-25 for the right hand box. It's also hard to see the variation in the lines over one another. Sub-plots could work better here. It may be for thickness and drift the time-series isn't necessary, as the relevant data is already displayed in Figures 2 and 3.

We have changed this figure. Ice thickness, concentration and drift are now divided by their means for better comparison of their variability. The frequency refers to the number of samples that are within a given bin size of 0.2.

P9L7: "2012/2013" is repeated. I believe second date should be 2014/2015.

Thank you for pointing on this. The second date should have been 2013/2014. Corrected.

P12L5-6: I suggest moving the statement that the choice of drift product has no major impact on the variability analysis to the start of the start of the section, as until then I wasn't sure of the point of the section.

The point is that this statement is a result of the comparison between the different products. Therefore, we think that this statement should be somehow at the end of this section. However, we agree that the purpose of this comparison should be mentioned in the beginning. This has been added.

P14L1: Should this read "Similarly" rather than "On the other hand" as it's previously explained that uncertainty of ice drift also increases at lower latitudes.

This is true and we have exchanged "On the other hand" with „In addition".

P14L3: What is the "compromise" here? Uncertainty reduction vs. discarding higher ice velocities? It's not clear.

There is actually no compromise, therefore we changed this sentence to avoid confusion. In the western part, towards the coast of Greenland, the shelf area is more narrow than further south. Therefore, ice velocities are quite high also close to the coast, which might be associated with uncertainties in the low resolution drift product. On the other hand, further south, e.g. 80°N, the open ocean in the eastern part of the gate is associated with uncertainties in ice concentration and velocity as well. In any case, velocities at 82°N are more reliable than further south, as shown in Sumata et al. (2014).

P15L33: ". . .**seasonal** or **winter** MYI area loss can be explained almost entirely by ice export."

„winter" added.

Technical comments

P1 L1: "*Sea* ice volume export. . ."

Fixed.

P2L18: "sea-ice" -> "sea ice" for consistency

We have corrected this and avoided hyphenating throughout the paper.

P2L22: "access" -> "assess"

Fixed.

P3L11: "...(Continuous MCC)..." -> "...(Continuous Maximum cross-correlation (MCC)). . ."

FIxed.

P3L9: “Table 1” -> “Table 3”

Fixed.