Point-by-point response to editor and reviewer concerns by
corresponding author: H. Jakob Belter
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tc-2019-307:
Satellite-based sea ice thickness changes in the Laptev Sea from 2002 to 2017: Comparison to mooring observations
https://doi.org/10.5194/tc-2019-307:
Belter, H. Jakob, Thomas Krumpen, Stefan Hendricks, Jens A. Hoelemann, Markus A. Janout, Robert Ricker, Christian Haas

Dear anonymous Reviewer #1,

on behalf of all authors, I would like to thank you for your detailed and constructive comments. In the following you can find a point-by-point response to your comments. We really have the feeling that your insights helped improve the manuscript and we hope that all your concerns have been answered to your satisfaction. We would also like to refer you to the responses to the other reviewers for more improvements and changes to the manuscript

General comments:

- *(1) The authors should discuss whether their main results are also applied to other Arctic areas dominated by FYI, like Kara Sea, and point out clearly whether the current CCI-2 CDR can be used to investigate SIT trends over FYI dominated oceans, in Figure 2 only SIT anomaly trend from the CS2 period was statistically significant.*
  -Response:
  This is a really good question that unfortunately can not be answered given the data limitations we are facing in the Russian Shelf Seas. We do not see why the presented results should not be confirmed for similar FYI-dominated shelf seas, however, since we only happen to have moorings in the Laptev Sea we can not provide any proof. Therefore, this study is focused on the region where data is available to us - the Laptev Sea. Our conclusion clearly states that these results only concern the Laptev Sea, however, as we are also providing suggestions and 'to-dos' for further algorithm development we reckon that agreement between satellite and VAL data will be improved across the Arctic. However, without actual in situ observations to validate the satellite products in other regions of the Arctic this remains speculation. In fact, having this newly acquired sonar-based validation data set for the Laptev Sea is already a big step towards analysing regional differences in the performance of the available satellite products. We are certainly hoping for more data sets from other regions but also long-term measurements of similar quality as the unique ULS sea ice draft time series in Fram Strait (NPI and Hansen et al.,2013) for future validation purposes. As for your second comment, longer time series are also the aim for the CCI-2 SIT CDRs, as they will help strengthen the statistical significance of possible satellite-based SIT anomaly trends (Fig. 2).
  -Changes:
  No changes.

- *(2) In Introduction Section you could review what is current understanding on the accuracy/quality of the CCI-2 SIT CDR: it seems this has been investigated at least by Kern et al. 2018. Are there any other studies, especially in peer-reviewed journals? You could also review similar other studies: comparisons between RA SIT records and sonar draft data. What is the typical relationship(s) between sonar and RA drafts over MYI?*
  Response:
  In order to avoid a lengthy introduction we decide to combine this request for an additional review of already existing validation results with your later comment in the 'Conclusion'. Rather than introducing validation results over MYI here we move them to the 'Conclusion'.

Changes:
No changes in the 'Introduction' but a short additional review of previous results and a comparison between MY and FYI results in the 'Conclusion'.

- *(3) A short section describing typical sea ice conditions and typical progress of sea ice season in the Laptev Sea would be good addition to the paper. How much there can be MYI in the Laptev Sea? Can there be large areas of grounded landfast ice for which the used freeboard to SIT conversion is not valid, and thus, could have an effect on your results?*
  -Response:
  Sea ice in the Laptev Sea is mostly FYI, however, fast ice is also present in the coastal regions. As for the influence of fast ice on the satellite SIT thickness: We consider the lack of leads and thus the lack of constraints for the instantaneous sea-surface height the primary issue for SIT retrieval in coastal fast ice regions. Therefore any valid freeboard point in the CCI SIT dataset is discarded if it is further away than 100 km from the next sea-surface height tie points. For the freeboard to thickness conversion we assume that the main sea ice mass is in isostatic compensation with the exception of the grounded anchor points. However, for the satellite SIT data we are comparing to the mooring data this shouldn't be a concern since the mooring locations are far enough away from the fast ice edge. Lena, Anabar and Khatanga stations are the farthest south but rather influenced by the polynyas than the fast ice.
  -Changes:
  We added a short paragraph to introduce the general conditions of the Laptev Sea sea ice cover to the 'Introduction' (**LINES 52-57**).

- *(4) Sections 2-4 should have short introductions about their content and focus.*
  -Response:
  In order to keep this paper as short as possible we tried to clearly distinguish between the different sections. We also made sure to specify our objectives in the 'Introduction' and used multiple subsections in the individual sections so that it is clear what we are presenting and when. We think that with your suggestions for new subsection titles this is even clearer now. We also know that separate introductions into the sections are a personal preference and we hope that you can condone that we prefer to leave these additional introductions out to not interrupt the flow of the text.
  -Changes:
  Title changes in the subsections of the 'Results' section (**LINES 215, 216, 253, 260**).

- *(5) The processing of ADCP data to the sea ice draft is based on reference*

(Belter et al., 2019b), but this is paper under review; so it is possible that it may not ever get published, or at least at time of possible publication of this paper this reference is not available. Is it possible to include this ADCP processing method (summary) as Appendix here? Are there any conference papers, web-pages, etc., you could also have as references?
-Response:
You are quite right, unfortunately, the corresponding method paper is still under review. We hope that the below mentioned changes and additions are sufficient for now and keep our fingers crossed that the method paper will be accepted soon.
-Changes:
For now we published the ADCP-derived sea ice draft time series for all the stations that have been used in this manuscript. We also added a short summary of the processing steps for the derivation of sea ice draft from upward-looking ADCPs in the Laptev Sea to these data sets (Belter et al.,2020a, **LINE 116**) and refer to it in the 'Data and methods' section of this manuscript. In response to Reviewer #3 we extended the subsection on this new method in the manuscript as well **LINES 112-116**.

- *(6) In Section 2 you could have a sub-Section which describes how different datasets are processed to match each other. Now this information is scattered in sub-Sections describing the datasets. Also include a Table which summarizes datasets: spatial and temporal resolutions, accuracies, etc.*
-Response:
Thank you for this helpful comment. We summarized how the different data sets are processed to be comparable to the VAL data in a subsection below the introduction of all the satellite data sets ('Data and methods' section). As for the suggested table, we do not think that a table is the right way to go here, although we could certainly summarize the temporal and spatial resolutions, accuracies and uncertainties are a little less clear because they vary on temporal but also spatial scales. Every CCI-2 grid point has its own uncertainty value. Orbit data for example is only available when the trajectory of the satellite coincides with the 25 km area around the mooring, this is something that can happen six or seven times in one month and only 3 times in others. Although we agree that a table supports comparability of the individual products some of them would not fit in or would have unclear values for the selected parameters (spatial, temporal resolution, accuracies, etc.). We would therefore leave the description of the data sets the way they are, clearly mentioned in the individual paragraphs of the different products. We hope you agree.
-Changes:

Summary paragraph for satellite data processing following the introduction of the satellite data sets **LINES 161-171**).

- *(7) How many pixels there are in the gridded datasets over the Laptev Sea? This is relevant to Figure 2. The gridded (25 km) SIT data were selected from and an area of 25 km radius around a sonar mooring, thus at maximum four pixels were selected? You should give these kind details on the dataset matching Section.*
  -Response:
  We are not quite sure whether adding this information is really necessary. As you rightly mentioned in your comment when selecting gridded data (25 km grid) from within a radius of 25 km around the mooring the maximum number of values is four. This is the case for the gridded CCI-2 data sets ENVISAT and CS2 but also the CS2SMOS one. For the orbit data this number is significantly higher. We therefore would have to mention this detail about the number of data points for each of the presented satellite data sets separately, which is contradicting your previous comment ((6)) about combining the information about the processing into on paragraph rather than scattering it over the individual data set paragraphs. We agree with your previous comment that one summary is the better choice and with the clear information of what the data sets look like in terms of resolution the reader can see how many data points combine for the satellite-derived mean draft value. The same holds for the Fig. 2 data, we added the respective area from which the data was selected to Fig. 1 which helps understand the number of data points that go into the results presented in Fig. 2 the grid resolution was also added to the caption of Fig. 2. We hope you agree with this assessment and the changes that we made.
  -Changes:
  Addition to Fig. 2 caption.

- *(8) The uncertainty of the sea ice draft calculated from the CCI-2 CDR SIT data is estimated with (1)*
  $dunc = d/SIT \cdot SITunc$
  But d = SIT - freeboard, so dunc could be sqrt($SITunc^2$ + $fbunc^2$)? Well SIT and fb are correlated. How about if you estimate dunc with typical uncertainties of all parameters in the equation $d = SIT - fb$ e.g. snow thickness, would you end up a same figure as with (1)?
  -Response:
  You are right that the CCI-2 draft uncertainty should be calculated differently, however, Reviewer#3 rightly mentioned that we are not really using draft uncertainty anywhere in the paper except Fig. 7. We therefore removed that entire part about draft uncertainty and the uncertainty bars that were

visible in Fig. 7 before. Since uncertainty is an important part of an analysis such as this one we provide typical SIT uncertainty information for each of the discussed satellite products in the respective 'Data and methods' satellite data subsections.
-Changes:
Uncertainty equation and uncertainty bars in Fig. 7 have been removed. Information about uncertainties have been added to the respective 'Data and methods' satellite data subsections.

- *(9) Section 3.3.2 Merged CS2SMOS sea ice draft contains also a summary of all results; this should be in its own sub-Section.*
-Response:
We added a free line after the Section 3.3.2. to show that the summary below is the summary for the entire 'Results' chapter rather than the 3.3.2. Section.
-Changes:
Addition of extra line after **LINE 272**.

- *(10) Section 4.4, Taymyr 2013/2014 case, is under 'Discussion', but it includes data processing and analyses, these could be under 'Results', also the data processing methods would fit better to Section 2. Why this very important case study which reveals that the CDR SIT correspond modal sea ice draft, and not the mean draft, was not repeated with any ADCP dataset? This would be very important so that we would see consistency of this conclusion. This case study could be also described with more details in Introduction, now only one sentence.*
-Response:
Thank you for commenting on this case study, we discussed the question whether this should be part of the 'Results' or 'Discussion' section among the authors as well and found that this case study is not so much a new result at this point but an example that highlights and explains the results we already presented. Rather than leaving the reader with the comment: 'overestimation by the satellites for thicknesses below 0.7 m and underestimation for thicknesses above 1.5 m', we discuss how these results can be explained and what satellite draft values really show. This case study and more specifically the comparison between modal VAL and mean satellite drafts are the means to further explain and interpret the results shown in Section 3. The analysis of ICETrack data is done to determine possible reasons why satellite and VAL draft do not agree well, especially when VAL data suggests large daily mean draft values, like between Jan and Mar 2014 at the Taymyr mooring. We therefore would like to keep the case study subsection at the end of the 'Discussion' as it is right now. As for the repetition of this case study with ADCP data: Due to the low temporal resolution of the ADCP measurements

(mostly hourly and half-hourly values) the number of values per day is not large enough to compute the ADCP ice draft modes reliably. We therefore focused on the four draft time series that are based on high resolution ULS data (2013-2015) and provide reliable modal sea ice draft values. The Taymyr 2013/2014 results showing the better agreement with modal VAL data are confirmed by the other three time series that were analysed.
-Changes:
We added a respective sentence on why the comparison to modal values was only done with ULS data to the text (**LINE 364-366**), however, it is also mentioned in the caption of Tab. 4.

- *(11) Tables 1-3 show averages of statistical parameters from different mooring locations. I am not sure this is meaningful, what an average correlation coefficient really tells us here? I think better would be here to combine all datasets together and then calculate RMSD, mean difference and r.*
-Response:
We agree with you, that averages of the correlation coefficients do not tell us anything about how good the agreement is between individual VAL and satellite data, however, we are providing the values of RMSD, mean difference and correlation coefficient for each of the stations individually and add those averages over all stations only for additional information and comparison between the different satellite data sets. With the correlation coefficients available for the individual stations as well we feel that it is clearly displayed what these averages are and it is legitimate to show them here. In case of the mean difference and RMSD these average values actually tells us how different VAL data is from the respective satellite data, on average. While average correlation coefficient might only provide a measure to compare the different satellite eras, combining all data sets to calculate an overall correlation coefficient might not be meaningful either. There are a couple of time series that were recorded simultaneously which means that in order to provide an all data correlation coefficient we either need to leave out time series when more than one is available in some years or we need to combine data that was recorded at the same time which involves more averaging and altering of the data. However, calculating all-data-versions of the statistical parameters would certainly be the right way in cases where the entire time series was recorded at the same position.
-Changes:
We hope you agree that we clearly state that the averages of the correlation coefficients are nothing more than averages over all stations and do not provide information about how good the general agreement between VAL and the respective satellite data is. No additional changes have been made here.

Specific comments:

- *(1) line 21: 'While knowledge about SIC is widely available it provides limited insight into overall sea ice changes.'*
  You could include reference(s) to SIC records, like OSI SAF ones.
  26: 'Satellite remote sensing of SIC started in the 1970s with passive microwave sensors (Parkinson et al., 1999) and was further developed, updated and improved by multiple follow-on missions (Comiso and Nishio, 2008; Cavalieri and l. Parkinson, 2012) until today.'
  Some newer references would be nice, like:
  Lavergne et al., Version 2 of the EUMETSAT OSI SAF and ESA CCI sea-ice concentration climate data records, The Cryosphere, 13, 49-78, 2019
  -Response:
  Thank you for this suggestion. We added the recommended reference to provide some more recent publications.
  -Changes:
  Citation added (**LINE 28**).

- *(2) 36: 'the impact of snow radar backscatter'*
  the impact of snow on radar backscatter?
  -Response:
  Changed.
  -Changes:
  LINE 37

- *(3) Explain that both gridded and orbit track SIT CDRs are used in your study.*
  -Response:
  We added a sentence to the objectives paragraph of the 'Introduction' to indicate that we will also compare VAL data to higher temporal resolution satellite products. We do not mention these higher resolution products here since they are properly explained in the 'Data and methods' section right below.
  -Changes:
  LINES 76-77

- *(4) 64: 'Taymyr mooring', at this point a reader does not know what this Taymyr mooring is*
  -Response:
  We added a link to Fig. 1 (the map) so that the reader can find the mooring location here.
  -Changes:
  Reference to Fig. 1 (**LINE 78**).

- *(5) Can you explain why ADCPs where not moored at some locations in different years?*
  -Response:
  There are a number of reasons why some locations weren't visited more often. For one, most of these mooring locations are within the Russian EEZ, which requires a permission for the deployment and recovery of moorings from the Russian government. Secondly, were the expeditions based on multiple different research proposals and therefore varying research questions. While one location might have been interesting for one project it was not for one of the following projects. In the end, none of the available ADCPs were specifically deployed for the purpose of measuring sea ice draft therefore it was not a priority to generate a long-term time series at a specific location.
  -Changes:
  No changes required.

- *(6) Figure 1: you could mask land out; add color scale for the water depth; show boundaries of the Laptev Sea.*
  -Response:
  We kept the land, but added a proper color scale for bathymetry of land and ocean.
  -Changes:
  Colour scale added to Fig. 1.

- *(7) It would be interesting to see what is the typical variation of the sonar draft during a day, week and month. A figure about a time series of sea ice draft from some ADCP location would be nice.*
  -Response:
  We agree that the variation of sea ice draft is very interesting especially since it is not visible from either the daily mean VAL values nor the satellite data, however, since this study is focused on validating the ESA CCI-2 SIT CDR and other satellite SIT products we feel that this extra figure would be outside the scope of this study and simply to much information. An example of the variation on a monthly scale is given in Fig. 7 (the Taymyr case study) and we are happy to provide the high frequency (1 Hz) sea ice draft time series (also for the Taymyr case) below (Fig. 1).
  -Changes:
  No changes to the manuscript.

- *(8) How sonar draft data was processed to a monthly scale, just averaging all datapoints?*
  -Response:
  You are right, sonar draft was simply averaged over the respective month,

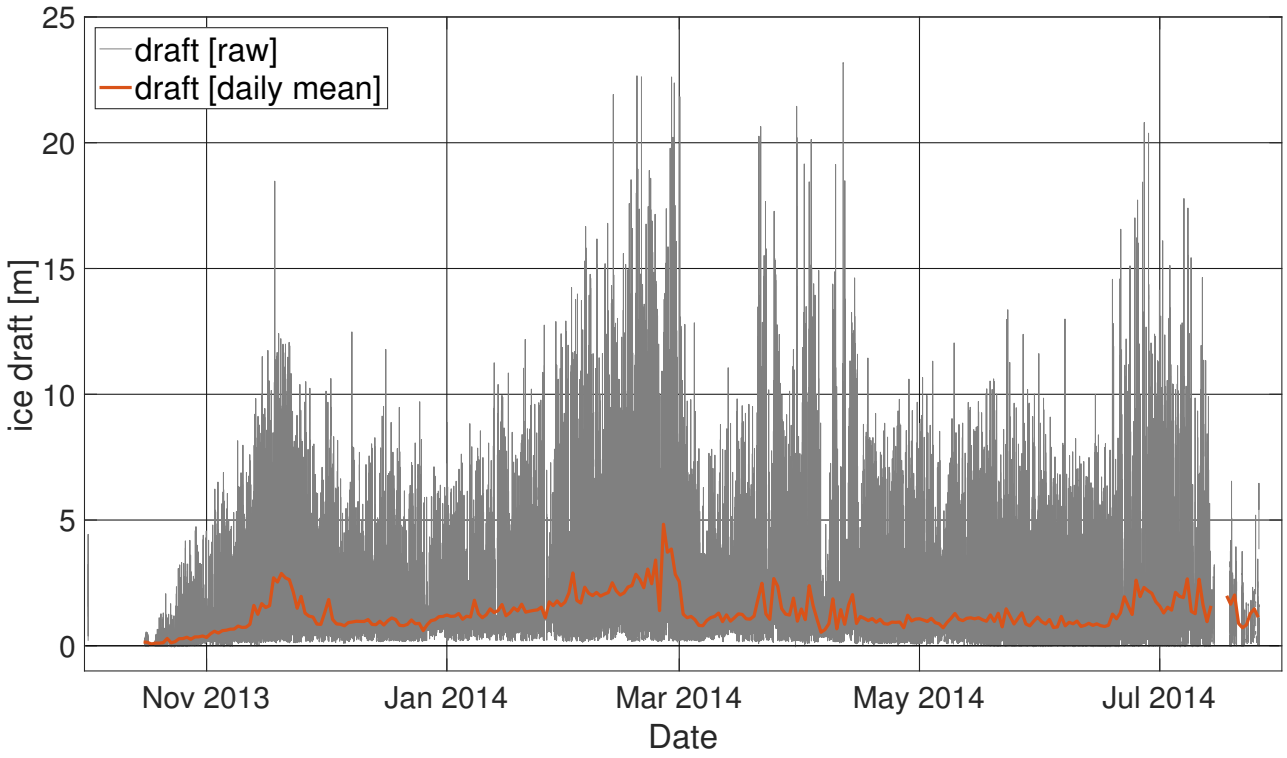

Figure 1: ULS sea ice draft at the Taymyr mooring (2013-2014). Grey line shows raw (1 Hz sampling frequency), orange line shows daily mean sea ice draft data.

however, we only saved a monthly mean value when data was available for at least 50% ('number of data points'-wise) of the month.
-Changes:
An additional paragraph was added to the 'Data and methods' section (**LINES 121-124**, also in response to Reviewer #3)

- *(9) Are there any peer-reviewed journal papers that could be put as reference to CCI-2 SIT CDR in Section 2.2.1? A figure about monthly gridded SIT over the Laptev Sea would be interesting see also what it typical SIT spatial variation over the Laptev Sea in this monthly product? How many pixels there are over the Laptev Sea?*
  -Response:
  Unfortunately, there are no peer-reviewed publications for the CCI-2 SIT CDRs. Only publications about radar altimetry freeboard are available and have been cited here (Paul et al., 2018). The citation for the data sets themselves are in the Section 2.2.1 text as well.
  Arctic-wide sea ice thickness data is available (at least for the CS2 period) on the seaiceportal (https://data.meereisportal.de/gallery/).
  -Changes:
  No changes to the text required.

- *(10) 118: 'Although Paul et al. (2018) minimized the inter-mission sea ice freeboard biases for the basin average, ENVISAT freeboards in multi-year ice*

(MYI) regions are still thinner than CS2 freeboards, while ENVISAT provides thicker freeboards than CS2 in regions that are dominated by FYI.' Give some figures; how much thinner and thicker.
-Response:
We added a reference to the respective figure from the Paul et al., 2018 paper so that the reader can find the minimized differences between ENVISAT and CS2 freeboard. We also mention the average difference in the 'Data limitations' subsection (see Line 197) that has been moved from the 'Discussion' to the 'Data and methods' section.
-Changes:
Added reference to the figure in Paul et al., 2018 (**LINES 140**).

- *(11) 127: 'a weighted mean sea ice draft value.' What is this weighting?*
-Response:
Since multiple satellite data points fall into the 25 km radius around the moorings we did not just calculate an average over all of these values for the comparison to the VAL data but also considered the distances between the individual satellite data points to the mooring location. Closest satellite data points account for a larger fraction of the mean than data points that are further away. The fraction with which each data point is adding to the mean is dependent on its distance to the mooring.
-Changes:
Reviewer#3 had a very similar comment and we clarified the weighted mean in the text (**LINES 161-171**).

- *(12) Section 2.2.2: Give typical uncertainty in a single SIT orbit value. How many SIT points are typically averaged within 25 km radius and in a daily scale? What is the uncertainty of this average?*
-Response:
As mentioned before, due to the variability in overflights between the months and dependent on the exact path relative to and overlap with the 25 km area around the moorings the number of data points that are averaged for the comparison to VAL data is very different. With the two different approaches (satellite versus mooring-based point measurements) we have to accept the fact that we are not going to be able to measure the exact same thing. Satellite data uncertainties are high for the measurements as well as for the parameters that go into the processing. The selected approach to utilize all available data within the vicinity and calculate a weighted mean is a measure to achieve best possible comparability under the given circumstances. We looked at the numbers of values that go into the weighted mean of one orbit trajectory (over the 25 km area around the mooring) and found numbers between 30 and 60 data points. But as mentioned before these numbers

can be very different from case to case and we made sure to account for these differences by weighting whatever values go into the average depending on how far away they are from the exact mooring location. The same holds for the uncertainty of the averaged values, they depend on the uncertainty of the individual orbit data points and the number and the variance of the values that go into the average themselves. They are very different for each individual data point but due to the noise and variance likely higher than the typical uncertainties of the single SIT orbit values.
-Changes:
We added the typical uncertainty of one SIT orbit value for ENVISATorbit and CS2orbit to the corresponding section in 'Data and methods' (ENVISATorbit: approx. 1.5 m, CS2orbit: approx. 1.1 m, **LINE 146**).

- *(13) Comment correlations shown in Figure 2 in Section 3.1.*
  -Response:
  We are not sure what correlations you are referring to here. We are not showing any correlations in Fig. 2 and therefore do not mention any in the text.
  -Changes:
  No changes.

- *(14) Did you investigate SIT anomalies in different part of the Laptev Sea? I think AARI uses Eastern and Western Laptev Sea regions. Is it possible to compare the SIT anomaly trends to any other study/data source? E.g. based on AARI ice charts? Are the trends related to polynya activity (extent, ice production) in the Laptev Sea?*
  -Response:
  We decided to investigate SIT anomalies for the entire Laptev Sea (as defined in Fig.1) and not divide this into Eastern and Western Laptev Sea mainly due to the fact that our available sonar data originates from moorings that are scattered all over the Laptev Sea. It is certainly possible to compare the SIT anomaly trends to other data sources, however, the focus of this study was on the comparison to high resolution sonar measurements, also for the investigation into stability of the CCI-2 sea ice data. We presented the Laptev Sea SIT anomaly as the basis for our investigation and provide a conclusion on whether the changes are based on satellite performance and how we interpret satellite SIT data in this region. However, as we mention in the 'Conclusion' the presented satellite SIT anomaly needs to be further investigate to understand the observed trends and the reasons behind them. This is beyond the scope of this study and will be tackled in future studies.
  -Changes:
  No changes.

- *(15) Figure 3(b) is not commented/discussed in the text; e.g. symmetry/normality of the pdf?*
  -Response:
  Figure 3b is now described in the text.
  -Changes:
  Short description of Fig. 3b in **LINE 220**.

- *(16) Section 3.2 title could be 'Gridded monthly sea ice draft'.*
  Section 3.3 title 'Higher temporal resolution satellite products' is not good, what is this 'higher'?
  'Daily and weekly sea ice draft products'?
  -Response:
  Apparently, you are not the only one who thought that these titles should be different. Thank you for commenting on this, we followed suggestions from Reviewer #3 to slightly change the structure of this section and accordingly update the titles. We used your suggestion 'Gridded monthly sea ice draft' in the process. We hope you agree with the changes that we made.
  -Changes:
  Changes were made to the structuring of the 'Results' section, including new titles.

- *(17) In Figure 4 it is difficult to see grey crosses. Maybe these single data points can be removed and instead describe in the text how many RA draft data points were typically in each VAL draft interval.*
  -Response:
  Thank you for bringing this up. We think that it is really important to not just show the binned averages but also the data points that combine for those values. However, since the number of data points per bin is very variable it does not really make sense to mention these numbers in the text, we feel that this is better covered by showing the raw data in the figure. In order for the reader to really see those crosses we changed the color to black. We hope this improves readability of the figure.
  -Changes:
  Figure 4 colouring of the raw data (crosses) was changed from grey to black.

- *(18) 214: 'It also confirms the intermission biases between ENVISAT and CS2 that were published by Paul et al. (2018).' Please give out these biases here.*
  -Response:
  Following a comment from Reviewer #2 we moved the 'Data limitations' section from the 'Discussion' to 'Data and methods', there we specifiy the intermission bias for the Laptev Sea. We also added the reference to the respective figure in Paul et al., 2018 to the 'ESA CCI-2 monthly mean gridded

product' section ('Data and methods', your specific comment #10). Therefore, intermission biases have been mentioned and specified leading up to this comment and we think it is not necessary to mention them again here. We hope you agree.
-Changes:
Changes to the general structure were made to account for this comment. No changes were made to this specific sentence though.

- *(19) 227: 'Consequently the underestimation of sea ice draft with increasing thickness is largest for CS2SMOS because of the larger uncertainties of SMOS over thicker sea ice.' But for thicker ice CS2MOS SIT comes only from CS2 data? If so then SMOS uncertainty should have no effect here.*
-Response:
First of all, you are right the uncertainty of SMOS should not be the reason for the larger underestimation of VAL sea ice draft from CS2SMOS. CS2SMOS is based on an optimal interpolation, that means that both data products 'contribute' to the final value. This contribution is dependent on the uncertainty of the individual data points over the area in question. The underestimation observed for the CS2SMOS product is likely a result of local thin ice patches in the region that lead to a larger contribution of SMOS data to the final interpolated merged CS2SMOS SIT value.
-Changes:
We cut 'uncertainty' from the sentence in question and clarified that the underestimation of the CS2SMOS product is based on the influence of SMOS data on the final interpolated SIT product and not its uncertainty (**LINE 271-272**).

- *(20) Figure 6(b) is not discussed in the text.*
-Response:
We discuss Fig. 6 as a whole in the text and feel that this is enough here.
-Changes:
However, we changed the histogram plot in Fig. 6(b). Rather than showing the same PDF as in Fig. 3 we now distinguish between the distributions of the selected thickness ranges (same as in panel (a) of Fig. 6). We accordingly updated the figure caption here.

- *(21) What data is ICETrack using? SAR imagery? Describe in the text.*
-Response:
A short summary of the motion products that are used by ICETrack has been added to the Taymyr case study section.
-Changes:
LINES 341-346

- *(22) 346: 'That means that, for investigations into the sea ice cover in the Laptev Sea it is important to be aware that sea ice can persist some time after the presented satellites stop providing SIT data.'*
  How about before the winter in late summer? Phrasing here: satellites do not provide SIT data, but your data processing methods do, i.e. SIT estimation is not possible (at least currently) for summer/melting season.
  -Response:
  The sentence you are referring to has been changed accordingly.
  -Changes:
  LINES 370-372

- *(23) 350: 'The ESAs CCI-2 gridded SIT CDR covers a period from 2002 to 2017 and has been validated for multiple regions around the Polar regions of the Earth.'*
  A short summary about the results of these validation activities would be good here. Later in Conclusions you could summarize what new insight in the accuracy of the CCI-2 SIT CDR your study resulted.
  -Response:
  Although this study is mainly focused on the validation of satellite SIT data in the Laptev Sea we agree that a short comparison and summary is beneficial to the 'Conclusion' section of this study.
  -Changes:
  Additional sentences on previous efforts (**LINES 374-376**) and the comparison to our results (**LINES 391-392**) were added to the text.

- *(24) 378: 'Therefore, improvements in the processing of radar altimetry data are required for the estimation of surface roughness but also for the parametrizations of snow depth and densities of snow and ice.'*
  How surface roughness would be utilized in the freeboard tracking? How about different freeboard trackers for different ice types, like FYI and MYI?
  -Response:
  Surface roughness widens the leading edge of the radar waveform and this information is used in the Envisat retracker to define the retracking point (Paul et al., 2018). A similar algorithm for CryoSat-2 synthetic aperture waveforms is currently under development and that is what our statement of needed improvements referred to. As for the question about different retracker algorithms for different ice types, this information has to be known on a per-waveform basis. This is currently not the case.
  -Changes:
  No changes.

- *(25) 383: 'Furthermore would continuous long-term SIT measurements in the Laptev Sea provide much needed information on deformation processes.'*

Is this supposed to be an interrogative clause? Or 'Furthermore, continuous long-term SIT measurements in the Laptev Sea would provide.'?
-Response:
-Changes:
Sentence has been revised (**LINE 410-411**).

Additional changes from the authors

- *(1) Due to changes in the review process of the ADCP sea ice draft derivation method paper (previously Belter et al., 2019b, now Belter et al., 2020b, in review at the Journal of Atmospheric and Oceanic Technology) the estimated uncertainty values provided for the daily mean sea ice draft time series have been changed. See changes in* ***LINE 116-117 and LINE 179-181****.*
- *(2) Daily mean sea ice draft time series from the Laptev Sea ADCPs have been published and a reference was added to the 'Data availability' section (****LINE 415****).*

Finally, we would like to thank you again for your efforts to help us improve our manuscript.
Kind regards,
H. Jakob Belter