“Seasonal and interannual variability of landfast sea ice in Atka Bay, Weddell Sea, Antarctica” by Stefanie Arndt et al.

Response to Anonymous Referee #1

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#preface: the terminology in several figures (legends, axes labels) will need to be updated at a later stage in the review process, since the main author is currently still in the field and file transfers are limited. We already updated several (but not all) figures with regard to the reviewers’ other comments, but we decided to not send back and forth all the figures at this point to not stretch the line to the ship. We hope that this is acceptable.

General Comments:
This manuscript presents the results of a semi-continuous 9-year study of sea ice, platelet ice, freeboard and snow conditions in Atka Bay, an embayment in front of the Ekström Ice Shelf located on the coast of Dronning Maud Land in the eastern Weddell Sea, Antarctica. This is a novel data set that is analyzed in the manuscript to elucidate seasonal and interannual variability and determine whether there are any noticeable trends. The results of the analysis indicate that the seasonal character of the fast-ice regime in Atka Bay predominates and no noticeable trends were observed.

The manuscript provides a very valuable dataset for evaluating the fast-ice conditions in Atka Bay in the context of local and regional atmospheric and oceanic conditions, including the effect of the adjacent Ekström Ice Shelf on the formation of platelet ice. It thus represents an important contribution to the current understanding of how Antarctic fast-ice regimes adjacent to ice shelves are affected by sub-ice-shelf processes, such as the formation of frazil laden Ice Shelf Water plumes. I think the manuscript represents substantial progress beyond current scientific understanding and merits publication once the comments I have made in the following sections have been addressed.

#Dear reviewer, we are very grateful for the effort you have put into this thorough review. We are incredibly happy that you seem to appreciate the work that we have done, and we will do our best to implement your valuable comments into the manuscript to improve it and get it ready for publishing.

My principal comments are that the authors have not cited in the manuscript a number of studies that have investigated the fast-ice regime in McMurdo Sound, which, similar to Atka Bay, is an area of fast ice growth adjacent to an ice shelf. The inclusion of these studies will, I believe, add greatly to contextualizing and interpreting the data presented in the manuscript.

#We appreciate the comment and we are aware of the wealth of great studies performed in the McMurdo Sound area. We will try to follow the advice and add some of the suggested references where suitable. Having said that, we do think that we should still limit the number of McMurdo references since these studies have been compiled pretty thoroughly before, most notably in the Langhorne et al., 2015 paper (which has now been cited a number of times).

I also would like the authors to review how they use the concept of freeboard in the manuscript, as their definition of freeboard in the text does not align with their Equation 1 and Figure 5.

#The concept of freeboard has been reviewed and adjusted based on the reviewer’s comments. See also the individual answers below.

Specific Comments:

Line 52, I recommend the authors also cite Leonard et al. (2006) as another example of Antarctic landfast sea ice that reached a thickness greater than 2 m and was not perennial.
#Included as suggested

Line 69. I didn't have Foldvik (1977) in front of me when reviewing the manuscript, but I still feel comfortable enough to question the statement that supercooled ISW favors the formation of floating ice crystals "deep" in the water column. Can the authors define what they mean by "deep" – buoyant ISW needs to rise some distance through the water column to become sufficiently supercooled to initiate frazil crystal formation.
#We agree with this comment. We just wanted to express that the crystals form in the water column rather than at the surface, where sea ice usually gorws. Since a more detailed discussing is beyond the scope of this paper, we decided to change the statement to read "… favors the formation of floating ice crystals within the water column (Foldvik, 1977), as opposed to the regular process of sea-ice formation by heat transport from the ocean towards the colder atmosphere."

Line 70. The authors have not mentioned other studies that have reported on field observations of frazil laden ice shelf water plumes advecting out from an ice shelf cavity that then rise to the surface, e.g. Mahoney et al. (2011) and Hughes et al. (2014).
#The suggested references have been included.

Line 71. I suggest the authors include the work of Price et al. (2014) and Brett et al. (2020) as they also report on the accumulation of sub-ice platelet layers under the sea ice.
#The suggested references have been included.

In Figure 2, what is the uncertainty with the annual fast ice extent estimates? It would be useful to report what the average and standard deviation of the extent was over the study period.

#We provided a table containing the time series and the corresponding estimated digitization uncertainty as a supplement to this response. We also added the following sentence to the caption: "The average fast-ice extent over the entire time series is 319.2 ± 167.8 km^2, with a mean uncertainty of 86.6 km^2."

Please note that, due to the strong annual cycle, the standard deviation is of limited use.
The uncertainty estimation methodology is fully detailed in a forthcoming Fraser et al., Earth System Science Datasets paper.

Did the authors consider showing fast ice extent anomalies instead of fast ice extents? This would negate the need to repeat the average extent for each year of the study.
#We did consider to show the anomalies. We decided against it because the strong seasonal cycle would not be as apparent. I hope the reviewer understands that we prefer to keep the current format.

Section 2, Line 173. I did not understand what was meant by "An additional metal bar…". Does that mean the measuring tape had two metal bars at its base? I don't understand how this would work. The authors mention that this is a "modified" thickness tape, but don't describe the characteristics of an "unmodified" thickness tape and hence it is not clear to the reader how the "modified" thickness tape is meant to perform better.
#Sorry for the confusion. What was meant is that the regular metal plates usually used on the thickness tapes were replaced by a heavy metal bar of about 1-2 kg (and a small rope on one end) in order to penetrate the semi-consolidated platelet layer. This part was changed to read: "Sea-ice and platelet-layer thickness as well as freeboard are measured with a

(modified) thickness tape. In order to enable the penetration of the usually semi-consolidated platelet layer, the regular metal plates at the bottom of the thickness tape were replaced by a metal bar of ~2kg. . The underside of the platelet layer is determined by gently pulling up the tape and attempting to feel the first resistance to the pulling. Sea-ice thickness was measured either by pulling this modified tape through the entire platelet layer until the solid sea-ice bottom is reached (with a high risk of it getting stuck), or using a regular ice thickness tape. The modified tape is retrieved by pulling a small rope attached to one side of the metal bar."

Section 2, Lines 178 – 182. It would be useful for the reader for the authors to explain here why they are both measuring and calculating the freeboard.
#The freeboard is calculated in order to determine the factors that contribute to flooded/non-flooded regions. In doing so, we neglect within the calculations the thickness of snow or the platelet ice, respectively. To make that clearer to the reader, we changed that part to "In order to determine the major contributors to the measured freeboard (F), we also calculated this parameter … ".

I believe "Archimedes law" should be "Archimedes principle".
#The reviewer is correct and this has been changed as suggested.

Equation 1 is not consistent with the manuscript's statement that a "snow/ice interface above sea-water level is referred to as positive" with respect to freeboard. For example, if there were no snow or platelet ice, Equation 1 would produce a negative freeboard.
The reviewer is right. The missing minus sign has been added in front of Equation 1.

I assume that the densities of ice and water have been interchanged in line 182 as the density of sea ice cannot be greater than the density of seawater!
#The reviewer is right, this has been changed.

Authors need to state the "indices" in Equation 1 are thicknesses
#We added that the letters I, S and P refer to thicknesses (the indices still refer to the respective medium).

and should show how the density of the platelet ice is calculated from the ice volume fraction.
#The density of platelet ice is calculated as the product from sea-ice density and ice volume fraction of platelet ice. This has been included in the corresponding paragraph accordingly.

On a related note, the authors state that the lines in Figure 5 are "freeboards". They are not "freeboards" (i.e. vertical separation between the water surface and a point of interest, in this case the snow / ice interface). Rather they are measurements and estimates for where the water surface is relative to the snow/ice interface, with different assumptions (coloured lines). The caption attempts to describe what these lines are, but still incorrectly and confusedly refers to them as freeboards.
#Thank you for this comment. You are absolutely right. We measured in the field and described in the text of the manuscript what is commonly referred to as "freeboard". Usually a positive freeboard means the water level is below the snow/ice interface and therefore "reverse" to the measurement of snow depth/ice thickness. However, in this figure we thought it is clearer to plot the line with the inverse sign (to display the location of the water level relative to the snow/ice interface). We are not sure whether the reviewer has an issue with this way of display. In any case, we now renamed what was wrongly called "freeboard" due to the opposite sign to "water level". Thus, a (positive) water level equals a negative freeboard. The figure legend and caption have been modified to make this more clear, and we hope that this is acceptable for the reviewer.

The authors generally present what are assumed to be mean values and standard deviations when reporting their observations, but do not explicitly state that this is the case. The authors

should confirm what they are presenting, and also, provide an estimate of the uncertainties associated with their measurements.
#We added a sentence in section 2.3: “Throughout this manuscript, we mainly present the mean values from those up to five single measurements per sampling site.”

The authors make a number of references to “thermodynamically grown ice” in the manuscript, but do not provide a definition of what they mean by this, and also do not provide any direct evidence of the mechanism behind sea ice growth, as they have not presented fabric crystal structures as per Hoppmann et al. (2015). At the very least, reference should be made to the Hoppmann et al. study as those measurements were made within the time frame of this study (2010 - 2018) in Atka Bay.
#We agree that this term has been used inconsistently. We have clarified all instances where “thermodynamically grown ice” is mentioned.

I suggest that the authors re-consider the naming convention they have used for what they term “platelet ice” to help distinguish columnar sea ice from sea ice that has formed by “consolidating” platelet ice. For example, see Hughes et al, 2014, where the term “sub-ice platelet layer” is used to describe the loose platelet crystals under the sea ice, and “consolidated platelet ice” is used to describe that part of the sea ice that formed by congelation ice growing down into the sub-ice platelet layer and consolidating the platelet ice. This approach might also clarify whether the authors are using the term “thermodynamically grown ice” to refer to just columnar ice, or columnar ice and consolidated platelet ice.
#Thank you for this comment on the terminology. We modified a large number of instances based on your advice that are too many to include here. Please refer to the track changes document.

I feel this manuscript could benefit greatly from more contextualizing of the results presented here with other studies. For example, in the discussion, there is no mention at all of the body of work on sub-ice platelet layers under fast ice in McMurdo Sound, including both observational and modelling studies. Sub-ice platelet thickness gradients have also been observed (and modelled) in the McMurdo Sound studies. See for example Hughes et al. (2014), Dempsey et al. (2010), Robinson et al. (2014) and Cheng et al. (2019).
#Thank you for this comment. Most of the suggested studies (and some more references) were added to the manuscript.

I would also suggest the authors consider producing spatially interpolated plots of the measured variables, similar to what is presented in Price et al. (2014) so that they could better present spatial trends in their data. This would help to strengthen the discussion where they consider mechanisms driving changes in the measured variables, e.g. the “washing-out” mechanism invoked to explain the thinning of platelet ice. Reference is made in the discussion to oceanographic drivers influencing the platelet ice in Atka Bay, but no oceanographic data is presented or referenced. In particular, reference is made to “underwater topographic features of the ice shelf” potentially leading to “blocking of oceanic circulation patterns”, but these features are not shown or cited in other works. Their hypothesis could be strengthened by including supporting oceanographic observations / modelling output.
#We appreciate the comment on the oceanographic data as a driver of fast-ice evolution and variability. We agree that this is a critical aspect, but we decided to focus on other elements in this particular paper. A separate study focusing on oceanographic observations in this area is currently in preparation. We hope for the reviewer’s understanding.

In Lines 439 – 445 of the Discussion, arguments are put forth for dynamical growth and compaction of the platelet ice layer dominating over thermodynamic growth. Although I agree with the authors that this is probably the case, without fabric crystal structure information, this cannot be said definitively. I also would like the authors to discuss the compaction of platelet

ice (referred to as consolidation in other studies) in more detail, as this process has a strong thermodynamic element (refer to Wongpan et al. (2015).
#this paragraph has been modified extensively. We would love to show ice core crystal structure and associated data from each sampling site each year. And actually this was planned to be a standard component in the monitoring. However, it turned out that this was far too much effort for the wintering teams, which do not have a dedicated sea ice person. All the ice activities are done as a "side job". Same is true for the oceanographic observations, which will from now hopefully be performed despite these issues. The only ice core data we have is from 2011/12, and partly shown in the Hoppmann papers. Since we do not have a consistent fabric crystal structure record, we decided to omit this aspect from this manuscript. Again, we hope for the reviewer's understanding.

Technical Corrections:

Below is a list of technical corrections / suggestions for the authors to address and consider:

Note: Line numbers over 99 are assumed as the leading digit was cut off in the preprint.
#Sorry or that, not sure wat went wrong…

Section 1: Line 12, change "of fast ice of Atka Bay…" to "of fast ice in Atka Bay…".
#changed as suggested

Line 15, change ", sea-ice-…" to "and sea-ice".

#changed as suggested

Line 17, insert a comma after "Neumayer Station" and a second comma after "satellite images". Also insert "us" after "allows".
#changed as suggested

Line 19, change "meters snow" to "meter thick snow cover".
#changed as suggested

Line 20, insert "interannual" before "trend".
#changed as suggested

Line 23, replace "event" with "of landfast sea-ice".
#changed to "of landfast sea ice"

Line 28, replace "on" with "of".
#changed as suggested

Line 36, replace "extent" with "seaward edge".
#changed as suggested

Line 54, replace "but also to" with "and".
#changed as suggested

Line 57, replace "the" with "an".
#changed as suggested

Line 58, re-arrange "for the Arctic recently" to "recently for the Arctic".
#changed as suggested

Line 62, replace "particular" with "particularly".

#changed as suggested

Line 78, replace “in” with “over” and “parts” to “portions”.
#changed as suggested
Line 88, replace “for” with “in”.
#changed as suggested

Line 96, replace “in McMurdo Sound at Scott Base” with “working out of Scott Base in McMurdo Sound”
#changed as suggested

and put “e.g.” in front of “Smith et al., 2001) – Smith et al. (2001) is one of the earlier manuscripts but there are many more, such as Smith et al. (2015).
#changed to (Langhorne et al., 2015, and references therein) since this seems to give the best comprehensive overview.

Line 97, replace “Fimbul ice shelf” with “the Fimbul Ice Shelf”.
#changed as suggested

Line 99, replace “the knowledge gap” with “a knowledge gap”.
#changed as suggested

Section 2: Line 112, add “depth” after “275 m”.
#changed as suggested

Line 115, add “the” in front of “sea ice”.
#changed to “between the sea ice and the ice-shelf surface”

Line 117, remove the two semi-colons.

#changed as suggested

Figure 1a, replace “Grounded ice sheet” with a more accurate description in the caption as this looks to me to be the “land” feature in the Antarctic Digital Database. If it is, add a citation to the Antarctic Digital Database. Add a north arrow.
#Reference was added

Figure 1b, add a bounding rectangle to show the extent of Figure 1c.
Figure 1b and 1c show the exactly same extent, so a bounding rectangle should not be necessary.

Line 123 -Figure 1 citation – re-word “in same distance” to improve clarity.
#We removed that part of the sentence since it was made clear in the text that the numbers indicate the distance to the western ice-shelf edge.

Line 126, replace “the sampling sites” with “adjacent sampling sites”
#changed as suggested

and reword “all sampled additionally” to improve clarity.
#This has been changed to read “The southern, eastern and western transects were sampled during a field campaign between November and December 2018”

Add “is” before “a Sentinel”
#Has been changed to “In the background is a Sentinel-1 image taken on December 01, 2018.”

and provide the required citation for the Sentinel imagery as per https://sentinels.copernicus.eu/documents/247904/690755.
#This link seems outdated. The following has been added according to https://asf.alaska.edu/data-sets/sar-data-sets/sentinel-1/sentinel-1-how-to-cite/: “Background: Copernicus Sentinel data 01 December 2018, processed by ESA. “

Line 127, delete the “s” from “images”
#changed as suggested

Line 129, replace “… sea ice, attached” with “… sea ice that is attached”
#changed as suggested

Line 133, replace the comma with a semi-colon and the add “and” after it.
#changed as suggested

Line 140, insert “of” before “Atka”.
#changed as suggested

Line 141, replace “currents, winds” with “currents and winds,”.
#changed as suggested

Line 145, replace “causing” with “resulting in”.
#changed as suggested

Line 147, insert “for” in front of “a second time”.
#changed as suggested

Line 149, replace “summer afterwards” with “the following summer”.
#changed as suggested

Line 160, be consistent with spelling of “kilometer” etc. Here it is “kilometer”, but the rest of the manuscript uses “…meter”.
#All instances have been changed to “…meter”

Line 163, replace “one” with “four more” and replace “5 meter” with “5 meters”.
#changed as suggested

Line 164/165, replace “measurement frequencies” with “the number of observations”
#changed as suggested

Line 166, re-word the sentence from “however,” onwards to improve clarity.

#changed to “In years of prevailing second-year ice in the bay (2012/2013, 2014/2015), the number of observations per sampling site may be reduced to one (the center measurement) due to exceptionally thick snow and ice.”

Line 169, replace “Figure 1” with “Figure 1c”.
#changed as suggested

Line 184, replace “we use” with “was used”.
#changed as suggested

Line 192, replace “today” with something like “and beyond the end of the study period”.
#changed to “At the meteorological observatory of the nearby wintering station Neumayer III, atmospheric conditions have been recorded since 1981 (König-Langlo and Loose, 2007), in

particular covering the sea-ice study period from 2010/2011 onwards, and continuing beyond the end of the study period (Schmithüsen et al., 2019)"

Line 193, add "sea" in front of "ice".
#changed as suggested

Line 196, mention that the meteorological data used in this study included 2m air temperatures and 10 m wind velocities.
#changed to read "Therefore, we utilize in this paper the 2m air temperature and the 10m wind velocity data of the meteorological observatory…"

Line 200, re-word from "The second mode in in the wind…" to improve clarity.
Changed to read "The second strongest mode in the wind direction distribution at 270° (westward) is associated to super geostrophic flows …"

Line 204 or thereabouts, provide some more information on the MET data such as sampling frequency, averaging (if there is any), uncertainties, etc.
#The following paragraph has been added: "The Neumayer data is recorded as minutely averages of typically 10 values per averaging interval. The instrumentation is checked on a daily basis, any erroneous values, e.g. caused by riming or instrument failure, are removed from the record. Therefore, the data quality is high, even though there might be gaps in the records due to the validation routines. Nevertheless, data availability is 99.4% for wind direction, 99.0% for wind speed and 99.7% for temperature data. Uncertainties are essentially those classified by the manufacturers. Instrument details are given in the metadata of the datasets since February 2017 in Schmithüsen et al. (2019), earlier data is documented in König-Langlo and Loose (2007)."

Figure 3, x axis title, these are wind speeds, not wind velocities.
@The figure has been changed accordingly.

Line 207 in Figure 3 caption, again these are wind speeds not wind velocities that are related to the wind directions.
#changed as suggested

Section 3: Line 219, add "the" in front of "highest snow.."
#changed as suggested

Confirm that accumulations are per year.
#changed to "the highest annual snow accumulation"

Line 223/224. This sentence is confusing. The mean thickness of all of the sea ice in the bay is not varying between 1.74 m, and 2.58 m. These are the means at particular sampling locations. I take it that the mean ice thickness over the entire bay was estimated as being 1.99 m based on the measurements.
#Has been clarified to read "The mean thermodynamically grown seasonal fast-ice thickness based on the measurements during the observation period…"

Line 229, clarify what is meant by the statement "an average of additional …." Additional as referenced to what?
Changed to read "In 2013 and 2015, the fast ice in Atka Bay became second-year ice due to blocking icebergs in front of the bay. Within the respective second year, snow depth increased further by an additional 0.88 +- 0.43 in 2013 and 0.74 +- 0.27 m in 2015."

Line 230, clarify what is meant by "…increased by another …"

#has been clarified to read “In 2013, the average fast-ice thickness across the bay increased by an additional 1.21 +- 0.42 m, while it even increased by an additional 2.79 m #- 1.48 m in 2015.”

Line 231, How do the authors know that there is “second-year” platelet ice at these sites? The platelet ice /sub-ice platelet layer is not attached to the overlying sea ice, so could have a different history to the sea ice directly above it. The authors again refer to “additional” accumulation, how was this determined?
#has been reformulated to read “In the years of prevalent second year ice in the bay, the thickness of the platelet layer underlying the fast ice increased on average by 5.13 m +- 1.43 m in 2013 (compared to the end of 2012), and 4.11 m +- 1.86 m in 2015 (compared to the end of 2014). During these periods, ATKA11 experienced the highest annual platelet-layer thickness increase of 6.82 m and 6.44 m, respectively.”

Line 232, add “the” before “highest”
#changed as suggested

Figure 4, refer to the comment in the Specific Comments section regarding the naming convention for platelet ice.
#The figures can only properly be redone after the first author returned from the MOSAiC experiment, which is currently delayed due to the corona crisis. The terminology will be changed after the next review round or during final editing. We hope this is acceptable.

Figure 4 caption, Line 239, remove “has” before “strongly”.
#changed as suggested

Line 249, correct equation reference to read “Equation 1”.
#changed as suggested

Figure 5, refer to the comments in the Specific Comments section regarding the use of the term freeboard. Correct misspelling “freedboard” in legend.
#Typo corrected as suggested

Line 263, why have the authors referred to “loose platelet ice thickness” here where elsewhere the have used the term “platelet ice”?
#has been corrected to read “platelet-layer thickness”

Line 277, insert “the” before “highest”.
#changed as suggested

Line 287, how do the authors define “typical thermodynamic sea-ice growth”? 1 m per month sounds very high to me for ice that has only grown “thermodynamically”, i.e. by heat being removed from the ocean though the ice to the atmosphere. Are the authors including the growth of consolidated platelet ice as “thermodynamic growth”? If so, this will include ice that has formed within the supercooled ISW.
Reference to “typical thermodynamic sea-ice growth” has been removed and the text has been modified to read: “The highest average monthly fast-ice growth rates of up to approx. 1 m per month (80th percentile) are measured in autumn, and decrease in the following month until spring. These exceptionally high growth rates result from rapid growth of the solid fast ice into the (unconsolidated) sub-ice platelet layer, i.e. from the subsequent freezing of the interstitial water between the platelets in the top part of the platelet layer. In other words, some of the heat within the newly growing ice was already extracted earlier by the ocean during the process of platelet crystal formation in the supercooled Ice Shelf Water plume. “

Line 289, remove “even” in front of “sea-ice melt”.
#changed as suggested

Lines 288 and 289. Line 288 uses “sea-ice thickness rates” and Line 289 uses “melt rate”. Suggest authors stick to “thickness rate” and use positive values for growth and negative values for melt. I.e. in Line 289, change “melt rate” to “thickness rate” and change value to a negative.
#changed as suggested

Figure 6 y axis label. Please change to growth / accumulation rates in m month-1.
changed as suggested

Line 303, please clarify what is meant by the statement “the fast-ice thickness over the bay in the south-north and west-east direction is rather constant with …” I assume for the preceding statement that this pertains to the “additional” transect measurements, but this should be made more clear.
#has been clarified to read “Considering the thermodynamically grown ice only, the complementary transect data show that …”

Line 304, replace “higher” with “greater”.
#changed as suggested

Line 305, replace “decrease” with “decreases”.
#changed as suggested

Line 306, Figure 7 strictly shows changes in platelet ice layer thickness, not accumulation. This change in thickness can be due to in-situ growth of the platelet ice crystals or the accumulation of new ice crystals flushing out from underneath the ice shelf.
#Good point. The terminology has been changed throughout to read “platelet-layer thickness increase” instead of “accumulation”.

Line 307, add “the” before “lowest”.
#changed as suggested

Line 310, add “the” before “south-to-north”.
#changed as suggested

Figure 7, these plots do not show freeboard, instead they show the height of the water surface relative to the snow/ice interface.
#You are correct. ”Freeboard” has been changed to “water level” in this figure.

Figure 7 caption, line 315, replace “Overview on” with “Overview of”.
#changed as suggested

Line 319 and 320, remove space between “Figure 1” and “c”.
#changed as suggested

Line 329, replace “that” with “the”.
#changed as suggested

Line 333. Re-word “snow cover completely isolates heat fluxes”. The heat fluxes are not isolated, rather the snow cover acts as an insulator that reduces the heat fluxes.
#changed to “…until the thickening snow cover more and more reduces the heat flux…”

Line 336. There are other key studies that should be referenced regarding the consolidation of platelet ice, such as Dempsey et al. (2010).
#This part has been modified to read: ”The continuous sea-ice growth (i.e. ocean-atmosphere heat flux) proceeds with decreasing growth rate through fall and winter until the

thickening snow cover more and more reduces the heat flux between the upper ocean and the atmosphere, preventing further thermodynamic growth. However, the fast-ice thickness still (albeit very slowly) increases in spring and even during austral summer months. This could potentially be explained by the measurement uncertainty with respect to the large spatial variability of sea-ice thickness even on very small (centimeter) scales, but the consistency in the data suggests that it could also be caused by consolidation processes within the platelet layer below, i.e. in-situ sea-ice growth by heat transport into a supercooled plume residing right beneath the solid fast ice similar to observations in McMurdo Sound (Smith et al., 2012; Leonard et al., 2011; Dempsey et al., 2010; Robinson et al., 2014). So far, in Atka Bay there is only evidence that platelets grow quite large already while still suspended in the water column (Hoppmann et al., 2015b). To what degree an in-situ growth of platelet crystals and consolidation processes that go beyond regular freeze-in of the topmost part of the platelet layer by heat conduction to the atmosphere play a role at Atka Bay still needs to be investigated. In any case, the platelet layer is an efficient buffer between the fast ice and the incoming warmer water in summer (Eicken and Lange, 1989), so the lack of noticeable fast-ice bottom melt is expected. Oceanographic (winter) data is sparse, and the monitoring at Atka Bay has recently been extended to also include regular CTD casts, whenever the (challenging) conditions and time constraints allow. An analysis of available CTD data in Atka Bay is currently ongoing, and will be shown in a future dedicated study."

Line 341, add "of" before "the platelet".
#changed as suggested

Line 347, replace "Massom et al. (2018) has" with "Massome et al. (2018) have"
#changed as suggested

Line 352, add a comma after "bay" and replace "strongest" with "strong".
#changed as suggested

Line 353, add "is observed" after "(Figure 6)". Remove the comma after "both".
#changed as suggested

Line 354, remove space between "8" and "a".

#changed as suggested

Line 355, remove "watch".
#changed as suggested

Line 358, replace "9-year's time series " with "9-year time series".
#changed as suggested

Line 361. Rates should be expressed as a quantity per unit time, i.e. m year-1.
#changed as suggested

Line 362, replace "shelfs" with "shelves"; remove "even".
#changed as suggested

Figure 8a – use units of m to be consistent with other plots. Figure 8a does not show a correlation between 2-meter air temperatures and snow accumulation. Rather it shows a scatter plot comparing these two variables. The authors should include a linear regression if they want to show correlation.
Units have been changed to m. We included a linear regression now.

Figure 8 caption. State the dates of the two surveys and whether all sampling sites were included, and confirm that the MET data are averages between these two dates.

This figure includes measurements throughout the entire analysis period (2010-2018) as well as from all sampling sites. To clarify that, we changed the caption to read:
"Scatter plot comparing (a) the average 2-meter air temperature (see Section 2.4) and the snow accumulation between two consecutive surveys, and (b) increasing (positive values) and decreasing (negative values) fast-ice extent and platelet-layer thickness between two consecutive surveys. The analysis includes all measurements at all sampling sites throughout the study period from 2010 to 2018. Blue circles and red crossed denote the respective mean and maximum values within the time frame between the consecutive measurements. Colored solid lines in Figure (b) show the linear regression between both parameters with the respective correlation coefficients R."

Replace "Chapter" with "Section".
#changed as suggested

Line 367, add "of" before "fast-ice".
#not changed

Line 407, this sentence is confusing, please re-word.
#has been changed to read "Examining the spatial distribution of snow over the bay, the considerably lower snow depth at ATKA24 compared to all other sampling sites is striking, and most likely related to the proximity to the ice-shelf edge in approximately 1 km distance."

Line 412, replace "reveals" with "revealed".
#changed as suggested

Line 431, replace "plate" with "platelet".
#changed to "platelet layer"

Line 434, replace "caused" with "led to".
#changed as suggested

Line 446 + 447, this sentence is confusing, please re-word.
#This has been changed to read "Considering the large sea-ice thickness of around 2 m, as well as the insulating effect of the thick snow cover on top, the contribution of heat conduction to the atmosphere to sea-ice growth is likely very limited. Instead, it is highly likely that dynamical growth as well as growth related to the consolidation of the platelet layer dominates the thickening of the perennial fast ice, …". We hope that this is more clear.

Line 453, replace "on" with "of".
#changed as suggested

Line 479, replace "to quantify" with "for quantifying".
#changed as suggested

Line 482, remove the space before "ice" in "sea- ice".
#changed as suggested

Line 488, replace "principle" with "principal".
#changed as suggested

Line 542, I found online that this publication date should be cited as 2016, but the Polarforschung date is 2015?
#The year has been changed to 2016.

References:

Leonard, G. H., C. R. Purdie, P. J. Langhorne, T. G. Haskell, M. J. M.Williams, and R. D. Frew (2006), Observations of platelet ice growth and oceanographic conditions during the winter of 2003 in McMurdo Sound, Antarctica, J. Geophys. Res.,111, C04012, doi:10.1029/2005JC002952.
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Dempsey, D. E., Langhorne, P. J., Robinson, N. J., Williams, M. J. M., Haskell, T. G., & Frew, R. D. (2010), Observation and modeling of platelet ice fabric in McMurdo Sound, Antarctica, J. Geophys. Res., 115, C01007, doi:10.1029/2008JC005264.
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Mahoney, A. R., A. J. Gough, P. J. Langhorne, N. J. Robinson, C. L. Stevens, M. J. M. Williams, and T. G. Haskell (2011), The seasonal appearance of ice shelf water in coastal Antarctica and its effect on sea ice growth, J. Geophys. Res.,116, C11032, doi:10.1029/2011JC007060.
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Hughes, K.G., Langhorne, P.J., Leonard, G.H., Stevens, C.L., (2014), Extension of an Ice Shelf Water plume model beneath sea ice with application in McMurdo Sound, Antarctica, J. Geophys. Res., 119, 8662–8687, doi.org/10.1002/2013JC009411.
#This reference has been included.

Price, D., Rack, W., Langhorne, P. J., Haas, C., Leonard, G., and Barnsdale, K., (2014), The sub-ice platelet layer and its influence on freeboard to thickness conversion of Antarctic sea ice, The Cryosphere, 8, 1031–1039,doi.org/10.5194/tc-8-1031-2014.
#This reference has been included.

Robinson, N. J., Williams, M. J. M., Stevens, C. L., Langhorne, P. J., & Haskell, T. G. (2014), Evolution of a supercooled ice shelf water plume with an actively growing subice platelet matrix, J. Geophys. Res., 119, 3425–3446. doi.org:10.1002/2013JC009399.
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Brett, G.M., Irvin, A., Rack, W., Haas, C., Langhorne, P. J., Leonard, G. H., (2020), Variability in the distribution of fast ice and the subâˇARˇ ice platelet layer near McMurdo Ice Shelf, J. Geophys. Res., doi: 10.1029/2019JC015678.
#This reference has been included.

#We decided to not include the following suggested references:

Wongpan, P., Langhorne, P. J., Dempsey, D. E., Hahn-Woernle, L. (2015), Simulation of the crystal growth of platelet sea ice with diffusive heat and mass transfer, Annals of Glaciology, 56:69, 127 – 136, doi:10.3189/2015AoG69A777.

Buffo, J. J., Schmidt, B. E., Huber, C. (2018), Multiphase Reactive Transport and Platelet Ice Accretion in the Sea Ice of McMurdo Sound, Antarctica, J. Geophys. Res., 123, 1, (324-345), doi:10.1002/2017JC013345.

Smith, I. J., Gough, A. J., Langhorne, P. J., Mahoney, A. R., Leonard, G. H., Van Hale, R., .. Haskell, T. G. (2015), First-year land-fast Antarctic sea ice as an archive of ice shelf meltwater fluxes, Cold Regions Science and Technology, 113, 63–70, doi.org/10.1016/j.coldregions.2015.01.007.

Cheng, C., Adrian Jenkins, Paul R. Holland, Zhaomin Wang, Chengyan Liu and Ruibin Xia, (2019), Responses of sub-ice platelet layer thickening rate and frazil-ice concentration to variations in ice-shelf water supercooling in McMurdo Sound, Antarctica, The Cryosphere, 10.5194/tc-13-265-2019, 13, 1, (265-280).