Response to Editor Comments

We would like to thank you, as an editor, and also Eleri Evans for taking the time to review our manuscript again. Your comments and suggestions are very valuable and improved the quality of the manuscript. We are glad to hear our efforts in the revision process are appreciated.

All editorial comments were included additionally to the very detailed comments of Eleri Evans (we very much appreciate your efforts!). Please find more detailed answers for your additional concerns below in blue color. Page and line refer to the revised track changes document.

Your original manuscript was reviewed by two referees, and the revised one was reviewed by one referee. These referees and I concerned to identify driving forces from regional correspondences between coastline migration and environmental factors. You made excellent work to address our concerns. This point is no longer my concern. Also, clarify and readability of the manuscript were largely improved. So, first of all, I would like to thank authors' effort in this revision process. I have several more concerns, and many editorial suggestions. The referee also provided very thoughtful comments in pdf; these are mostly editorial, but suggest local restructuring from sentences to a paragraph level at several locations. Therefore, I request a minor revision. Please provide the track-change manuscript and a response letter when you submit the revised manuscript. No responses are necessary for purely editorial issues, but I would like to see responses to following relatively major issues. In the comments below, all page and line numbers refer the track-change manuscript.

1. I am somewhat confused with "ice shelf and glacier front" that appears so many times in the manuscript. P2L31 refers Nicholls et al. (2009) and says "ice shelves and glaciers are the floating extensions of the ice sheet". I cannot find this definition in that reference; if I am right, please delete this sentence/reference. Also, in my opinion, this definition is wrong. The glaciers are grounded. The term "glacier tongues" are sometimes used to refer fast-flowing part of an ice shelf that is fed by a fast-flowing glacier. However, for your work, I don't see a specific need to distinguish glacier tongues and other ice shelves. About one quarter of Antarctic coastline has no ice shelves and the ice sheet is terminated with grounded ice. Strictly speaking, the calving front does not refer most of these grounded-terminated margin. Please add more clarification on this issue and define terms used in this paper in Introduction. The manuscript is clear enough overall so that I don't see a strong need to change the terms entirely in this paper, but some clarification is necessary. You do not need to provide a long argument about terminology, but please make your own judgement which terms are most appropriate and provide a short summary in the response letter.

Thank you for mentioning this concern. We checked again on Nicholls et al. (2009). With our definition we referred to the following section in Nicholls et al. (2009), p.3:

"Ice shelves form when the ice at an ice sheet's oceanic boundary does not calve as icebergs at the point where it goes afloat (the grounding line) but remains connected to the grounded ice sheet. Ice shelves may thus be regarded as floating extensions of the ice sheet, and whether an ice shelf forms depends to a large extent on the coastal geometry"

But you are completely right, this definition relates to floating ice shelves and not grounded glacier termini. To make our definition clearer we changed the manuscript accordingly and shifted the definition to P2L43 for a better reading flow: "*The coastline of the Antarctic Ice Sheet is defined as the border between the ice sheet and the ocean (Liu and Jezek, 2004), extending along glacier and ice shelf*

fronts. Throughout this paper, we refer to floating glacier tongues and ice shelves when using the term "glacier and ice shelf front" as well as "calving front" and removed the definition of coastline at P5L111 to avoid repetition. Additionally, we address grounded and floating termini in the coastal change analysis more clearly: "*Directly calculating coastal change between these coastline products includes changes in floating calving fronts and grounded ice walls (as shown in Figure 1) even though the amount of change from grounded termini is small and prone to inaccuracies as limited due to the spatial resolution of the coastline product from 2009*." P5L122.

We hope this addition helps with clarification and emphasizes our focus on floating glacier tongues and not grounded glacier termini. If you still think this definition needs changes, please don't hesitate to contact us.

2. It is often said "front retreat", but more accurately I think the authors generally refer "front position movement", including both retreat and advance (e.g. P1L12).

Thank you very much for this comment. We checked our manuscript and changed the term "front retreat" to "front movement, fluctuation or change" where appropriate.

3. Most of geographical names mentioned in the paper are shown in Figs. 1 and 2, but not all. I commented below as I see this issue; please carefully review the manuscript and make sure that the all names are labeled in these figures. It is also helpful if relatively not-well-known names are assocaited with the name of regions, such as "xx glacier in Dronning Mauld Land" using the regional name shown in Fig. 1. At an appropriate location (end of Introduction, or first time when a geographical name is mentioned in the paper), please mention that all geographical names are shown in Figs. 1 or 2.

The geographical names are now all mentioned in Figure 1 or 2 (e.g. Nickerson, Larsen G Ice Shelf). Additionally, we refer to both Figures when introducing a new name so the reader can locate it in the map (e.g. in the discussion section).

4. Snowmelt is shown with the unit of mm w eq. per day. Why is this unit chosen? Snowmelt is examined over three months, December, January, and February, in 90 days in total (P7top). Is it better to show snowmelt in the unit of "mm water equivalent per year" (i.e. current value times 90)?

Changing the unit to year might be appropriate in some cases. In ours, there are two reasons why we chose melt per days instead of melt per year. ERA5 monthly means snowmelt data has the unit m w eq. per day which is why we decided to keep the unit "day" instead of "year". Additionally, most of the melt occurs within the selected months Dec, Jan and Feb but in some years, melt might occur beyond that time frame. Even though we could change the temporal value to year it would suggest we calculated the snowmelt mean for the entire year (and not only the summer months). To avoid this potentially misleading assumption we would like to keep the unit of days.

5. Section 4.8 present correlations between climate variables and calving front position movement. Are both 1997-2008 and 2009-2018 period data used together? And then why are the reference periods shown separately? This point should be better clarified in the text.

You are completely right, we used the data of both decades (1997-2008 and 2009-2018) together for the correlation. We explain this in 3.3 P9L240: "This created 14 different variables which were correlated with each other based on 188 observations (N=188). The number of observations is derived

from 94 assessed glacier basins with variable averages for the two different decades (1997-2008 and 2009-2018).“

The reference period (1982-1996) was not directly used for the correlation, as during this time frame no information on the calving front position is available. To still use this data as an indicator how the environmental conditions changed between the first/second decade and the reference time period we used the label “relative”. We show both, relative and absolute values as both indicate different conditions. Relative values indicate that a front retreated/advanced in conjunction with a variable that is higher/lower compared to the reference time period. In contrast, the absolute values just indicate that a front retreated/advanced in conjunction with high/low values of a specific variable. We added a sentence and the text reads as follows: “To also assess relative changes in the variables to previous times we subtracted the reference mean (1982-1996). This means the relative values indicate the change of an environmental variable within the first/second decade compared to the reference time frame“ (P9L229).

Minor issues.

We edited all mentioned minor issues in the revised manuscript. In some cases, additional explanations were necessary which we mention in blue color below.

P1L23: remove CDW (you don’t need to define it in Abstract).
P2L55-56: maybe better to explicitly mention ice rumples (pinning points), though it is included in bed topography in general.
P3L91: add “in Antarctic Peninsula” after Wordie Ice Shelf. Wordie is shown in Fig. 2 but still some geographical guide is very useful for readers.
P6L121: do not cite the dataset as NSIDC 1997 or such (there are several more cases when datasets are cited).
P6L126: change the title to “ERA 5 reanalysis data”
P7L148: change to “lateral resolution”?
P8L182: methods (plural)
P9L224: confusing. Better to say “for the three time periods 1982 – 1996, 1997 – 2008, and 2009-2018. The first period is used as the reference period to measure temporal changes in the following two decades.”
P11L255: change to West Antarctica. (I like your style not to use AP, EAIS, and WAIS in the main text, which is much easier to read than the other style so please keep it more consistent).
P11L259: confusing sentence. Maybe “Excluding these two ice shelves, the rest of West Antarctica …”
P11L261 and elsewhere: I am not an English native speaker but “within the first decade” sounds like you have data to show variability within the decade.
P13L291: cite Fig. 4 beginning of Section 4.3, not very end.
P14: change EAIS and WAIS to East Antarctica and West Antarctica at all locations in this section.
P14L310: Add Celsius at several locations(here -0.5oC and at the bottom of the page +0.25oC). Also change kelvin to oC here and at other places.
P15L32: cite Fig. 6 at the beginning of this section.
P15L334: cite Fig. 7 at the beginning of this section.
P17L354: Figure 8 (not 9).
P18LL365, 366, and 368ff: This is a good example. It is said “retreat” but is it better to say “position”?
P18L375ff: do not define r_summer or such, and write it like “(r = 0.18 for summer and r=0.23 for winter)”
P20L408: is it “exceptionally” positive? Better to be a bit more specific. The other two larger peaks are mentioned at another part of the paper, and now smaller peaks are referred as exceptionally positive.

P20L415: change to 1998/1999.
P20L417 and 419: Wordie Bay and Marguerite Bay are referred. Is it possible to call these bays using ice shelf names in Fig. 3? If you decide to refer these bays, add them to Fig. 2.
P20L427: typo? Surface melt instead of basal melt
P21L445: change to "increase surface melt"
P21L450-451: better to say "it remains unclear whether…."
P21L463: what is Larsen D-G?

P22L472: change to West Antarctica (Section 5.2 header)
P22L476: here and at many other places it is said "an entire area of xx". Do you need to say "entire area" at these locations? Is it clear enough if you say "an area of xx"?
P22L476: did you estimate the iceberg areas using BYU dataset? Then clarify the data source.
P22L479 and 480: change to A38 and A39, and A43 and A44.
P22L487: Did you measure it over the calving area or over the ice shelf including the calving area? Confusing.
P22L487 and 488: Here it is said Ronne-Filchner Ice Shelf, but it is refereed as Ronne Ice Shelf at other locations. Please keep it consistent.
P22L496: change "reference mean" to "reference period".
P23L522 Nickerson Ice shelf does not appear in Fig. 3
P23L526 change to East Antarctica
P23 bottom: cite Fig. 2
P24L543: typo? "in sea ice no wind direction"?
P24L544 and 545: change to "up to -1oC" and "up to -0.49oC" to keep this paper consistent.
P24L554: typo, CDW.
P24L561: can you be more specific than "more recent calving event"?
P25L568: change 1982-1996 to the reference period.

P25L578: change northern and southern to seaward and landward.
Unfortunately, landward and seaward is not appropriate for this geographical setting. We added the Mackenzie Bay (also added to Figure 1) for describing the location better.

P25L584: who is the authors? Revise this sentence for clarity.
P25L595ff: calving area along the Dronning Maud Land was analyzed in this paper, Goel et al. : Characteristics of ice rises and ice rumples in Dronning Maud Land and Enderby Land, Antarctica, J. Glaciol., doi: 10.1017/jog.2020.77, 2020. 1-15, 2020.
P25bottom: change +0.9 – 1.8oC
P26L619: change "measured changes" to "measured increases"?
P27L654 and 660: do you use "break-up events" to refer only tabular iceberg calving? If they are used to distinguish infrequent large calving events other more frequent calving events, it is fine. However, if otherwise, please revise them to calving events.

P28L684: add data source after "natural calving cycle"
We decided to re-phrase the sentence for a clearer understanding. The conclusion on the non-exceptional calving of the Ross and Ronne ice shelves is explained in Section 5.2 (P22L490ff) so we thought it would not be necessary to mention the references again as this would be unusual in the conclusion section. If you still wish for citing the references again we will include the references (Ferrigno et al., 2007; MacAyeal et al., 2001; Ferrigno et al., 2005).

P29L707: typo, CDW

Figures:

Figure 1: Add reference to LIMA mosaic. I suggest that Figure 1 shows regional names and non-ice-shelf names such as bays, whereas Fig. 2 shows all ice-shelf names. For example, it is unclear whether the label "Wordie" refers Wordie Bay or Wordie Ice Shelf (Fig. 3 also shows Wordie). Also "Shirase" appears both in Figs. 1 and 2, but it is said "Shirase Bay" in Fig. 1 and Shirase in Fig. 2 so it is clearer. Also, please consider whether bays are needed to refer in this paper.

We added the link to the LIMA Mosaic in the data availability section. To better distinguish between different features (ice shelves, bays, seas etc.) we used different colors and describe the color-code in the figure caption.

Figure 2: Add the boundary of EP-F and E-EP over the Ross Ice Shelf. Similarly add the boundary over the Ronne-Filchner Ice Shelf. This is an important boundary to distinguish EAIS and WAIS. To show the boundaries in the Peninsula more clearly, is it possible to add a zoom-up panel showing Peninsula?

Thank you for your advice. The boundaries between EAIS and WAIS were added to Figure 2 as well as a zoom panel for the Antarctic Peninsula. Additionally, Nickerson Ice Shelf and the remaining Larsen ice shelves are mentioned.

Figure 3: re-consider the colorbar used for the absolute plot. This colorbar is suitable to show positive/negative anomalies but not good to show absolute values. In the caption add "(1982-1996)" after "the reference mean" to improve clarify (you don't need to do it every time but it is the first time to show the reference mean/period).

The color bar for the absolute temperature was updated to an increasing color scheme.

Figs. 4, 5, and 7 do not show the reference period (probably for space saving purpose). However, I think another panel showing the reference period is very useful, particularly for Fig. 7 because general wind direction is useful when "weaken easterlies" or "strengthen westerlies" are said. If space is still your concern, consider adding the reference panel as the supplement.

We decided to add the absolute values for those figures to the supplement for space saving purposes. Please have a look at the edited supplementary file.

Fig. 6: change the top right panel title to "Reference" (now it is said "long-term"). If you keep this unit, clarify in the caption that snowmelt is measured over 90 days from December to February.

We added the term "reference" and mentioned the calculation over the summer months in the caption.

Fig. 7: do not define acronym in the caption. Remove CDW from here and define CDW in the main text.

Done.

Figure 8: use background color to show the reference and following two decades. The dash bars do not work well for this purpose. Also, update the reference for SAM; the data are shown to 2018 here, but the data source was published in 2003. Is this correct?

Thank you for this hint. We cited the method paper on the SAM Index calculation but now also added the website where the data can be downloaded. Additionally, instead of the dashed lines we use color panels for a better visualization of the different periods.

Table 2: the second table top left cell shows “total”. Typo? Maybe “basin” or just keep it empty.

Thank you for this comment. “Total” was related to entire retreat and advance in contrast to the annual values above. But you are completely right that this is misleading at this point. We changed “total” to “region” to be consistent with the table above.