Harning and colleagues present new biomarker and foraminifera proxy data from two sediment cores from the North Iceland Shelf that are combined with previously published proxy data to investigate the oceanic front migrations and associated productivity changes during the last 8 ka. The multiproxy records show clear signals that are investigated also by means of statistical analyses. The various temperature, productivity and sea ice proxy results are well explained and allow an assessment of spatiotemporal changes in the positions of the Arctic Front and Polar Front during the Holocene. The manuscript is well written, clear and concise, and the figures are of high quality. Even though the major findings do not appear as surprising, the study will be of interest for a broad readership interested in North Atlantic/Nordic Seas paleoceanography and paleoclimatology as well as in intercomparisons between different organic geochemical and micropaleontological proxy methods. Therefore, I find the manuscript suitable for publication in Climate of the Past.

Reviewer 2,

Thank you very much for your time and effort reviewing our manuscript. Below we address each of your individual comments and provide tracked changes where relevant in the attached revised manuscript.

Kind regards, David Harning et al.

I only have a few comments that might help improving the manuscript.

General comments:

The time intervals for which specific front positions and productivity regimes are reconstructed and discussed are inconsistent. For example, the intervals described in the abstract range from 8 to 6.1 ka and 6.1 to 3.8 ka, while the discussion is subdivided into intervals from 8 to 6.3 ka and 6.3 to 3.4 ka. This is confusing and should be revised. It would also be helpful to indicate the early, mid and late Holocene in the figures showing the time series. Also, the time intervals for the four Holocene time slices shown in Fig. 7 could be specified in each panel.
Thank you for highlighting this inconsistency! The boundaries should be 6.1 and 3.8 ka based our data analysis presented in this manuscript and have now been edited accordingly. The 6.4 and 3.5 ka boundaries mentioned in the introduction are after Kristjánsdóttir et al. (2017), and we only point them out to highlight that previous research has found similarly time boundaries that separate distinct paleoceanographic conditions. We have also added these time intervals to the four time slices in Fig. 7 to improve clarity. As Reviewer 1 noted, the earliest time interval is not actually “Early Holocene” so referring to specific dates is preferrable.

The statistically identified regime shifts are quite different in the various proxy records, probably related to the constraints of the statistical analysis as described in section 3.5. Would it be possible and useful to calculate regime shifts for multiple records combined?
We certainly acknowledge the limitations of the statistical regime shift analyses and differences between proxy records. However, we do not feel comfortable combining proxy records (e.g. Arctic front proxies and Polar Front proxies) as it may introduce artificial changes that may only arise from the composites. At this point, we prefer to keep the regime shift analyses as they are and re-emphasize the limitations within the Materials and Methods Section 3.5.

The authors refer to first-order, orbitally driven decrease in northern hemisphere summer and annual insolation as the dominant forcing of the Holocene migration of the Arctic and Polar Fronts (lines 399-406). This section is rather short and it would be useful to explain in more detail how the decrease in insolation led to shifts in the ocean fronts. Furthermore, millennial-scale changes in NADW formation and AMOC strength are briefly mentioned, especially with respect to the SST variability in core JR51-GC35 during the Middle Holocene, but considered as not important control of the progressive migration of the fronts (lines 402-406). However, the frontal proxies in core MD99-2269, including %T. quinqueloba, HBI III and %N. iridea, do reflect millennial-scale variations with rather rapid changes, as depicted by several regime shifts in those records (Fig. 6). Could this not be seen as indication that the migration of the Arctic

and Polar Fronts also responded to millennial-scale changes in oceanic and/or atmospheric circulation, for example related to the subpolar gyre circulation? I feel that the discussion of the forcings in section 5.4 should be expanded a little bit.
We appreciate this suggestion and have expanded the text slightly to more explicitly acknowledge that although there are certainly other controls on higher frequency changes (e.g. NADW, AMOC, NAO), the overarching goal of this paper was to explore the long-term changes reflected in our LOESS-smoothed records. Future work is needed to understand the higher frequency changes in these records and their relation to other atmospheric and oceanic circulation patterns, which we hope to pursue at a later stage.

Specific comments:
Line 18: Perhaps replace "stabilized" by "was located".
Following Reviewer 1's suggestion, we have edited this to "migrated to".

Line 20: Perhaps specify that the Arctic and Polar Fronts have moved back "northward" to their current positions.
Good clarification, which has now been edited.

Line 37: Revise "advect" ("advects").
Edited, thank you.

Lines 95-96: The sedimentation rates and resulting temporal resolution of the proxy records could be mentioned here.
We agree this is relevant information to include and have edited Section 3.1 accordingly.

Lines 140-144: The link between the TR25 index and spring phytoplankton blooms as well as the equation for calculating the T25 were established based on samples from the Barents Sea only. A word of caution and a reference to Kolling et al. (2020) (Biomarker distributions in (sub)-Arctic surface sediments and their potential for sea ice reconstructions, G-cubed 21, https://doi.org/10.1029/2019GC008629) may be appropriate regarding the application of this proxy in other regions.
We discovered this publication after initial submission and agree that it is important to mention the potential complexity of the T25 proxy. However, samples were not included from Iceland, which certainly warrants further investigation with modern samples.

Line 178: "between select"; This sentence may be revised.
'Select' has been removed.

Line 278 and elsewhere: N. iridea should be in italics throughout the manuscript.
N. iridea has now been italicized where mentioned, thank you.

Line 352: Specify if "radiocarbon reservoir ages" were inferred for surface and/or deep water?
These radiocarbon ages are based on benthic foraminifera, meaning that they reflect deep water reservoir ages. This has now been clarified in the text, thank you.

Line 377: "and from toward"; This sentence needs to be revised.
'From' has now been deleted.

Fig. 1: Add a reference (Schlitzer, 2020) to the caption for the use of Ocean Data View.
Reference added, thank you.

In summary, the manuscript by Harning et al. is well written and contains high quality data that are potentially important new contributions to understanding natural ocean climate variability. I would be happy to recommend publication of this manuscript in Climate of the Past, if the authors address the comments and questions.
Thank you again for your positive and encouraging review of our manuscript!