This paper represents a valuable exercise in investigating biomarkers and sea ice proxies in Ross Sea environment, important for continuing the focus on these topics first established by Thomas et al., 2019 and Ashley et al., 20021. Of particular interest is the effort to identify and organically characterize specific biomarkers of different phytoplankton groups and to use them for comparative analysis of bacterial activity in sediments.

Supplemental Pangea dataset (.xlsx) is nice while the in the Supplement Biomarker sediment (.pdf) maybe some basic description, focus on the Appleby, 2001 method, could be useful.

We thank the reviewer for the valuable feedback, which has strengthened this paper significantly. More information about lead dating techniques has been added to the manuscript as follows: "Age models were derived using ^{210}Pb dating. ^{210}Pb is produced in the atmosphere via decay of ^{222}Rn, then deposited onto the ocean surface and scavenged from the water column by settling particles, accumulating in seafloor sediments where it decays with a half-life of 22.3 years (Appleby, 2001). Total ^{210}Pb activity was determined indirectly by measuring its granddaughter ^{210}Po via alpha spectrometry (Flynn, 1968) and assuming secular equilibrium between ^{210}Pb and ^{210}Po in sealed samples. This provides a proxy for total ^{210}Pb activity, which was used to calculate excess (unsupported) ^{210}Pb after subtraction of supported ^{210}Pb, assumed to be in secular equilibrium with in situ ^{226}Ra.

Sediment samples from cores BC02, BC03, and BC04 were analysed at the Institute of Environmental Science and Research Limited (ESR) in Christchurch, New Zealand for ^{210}Po using alpha spectrometry (Appleby, 2001; Flynn, 1968). Sedimentation rates and sediment ages were calculated following Appleby (2001). Briefly, the sedimentation rate was calculated from the least-squares fit slope of excess ^{210}Pb activity plotted on a logarithmic scale against depth. Raw ^{210}Pb profiles showed evidence of a surface mixed layer in BC02 and BC04, consistent with bioturbation observed in the core logs. The uppermost two samples from BC02 and one sample from BC04 were therefore excluded from the least-squares regression. No mixed layer was identified in BC03, and all samples were retained. The constant flux and constant sedimentation rate (CFCS) model was applied, as sediment bulk density data were unavailable, precluding the use of mass-depth calculations required by alternative models such as CRS. Errors were estimated by Monte Carlo simulations using the R package 'serac' (Bruel et al., 2020).

The CFCS model produced age estimates between 1856-2007 (± 37 years at the base) for BC02 (Table 1, Figure A2), with each centimetre of sediment representing approximately 4 years; sampling resolution was every 18-37 years. For BC03, age estimates spanned 1843-2008 (± 5 years at the base), with ~3.6 years per centimetre and a sampling resolution of

~24 years. BC04 was dated to 1794-2007 (± 21 years at the base), with ~3.3 years per centimetre and sampling every 27-36 years."

I'd like to point out that the general section on cores, the sedimentological and descriptive reports (cores logs, photos of laminations and a general descriptions) are underdeveloped while some important environmental evidences inserted in a paleoclimatic context are missing. In particular, the important section on polynyas, their importance and their evolution is sparse. Furthermore, some specific expertise are taken for granted, making the article highly specific and lacking in flow and descriptiveness.

We thank the reviewer for these comments. We have renamed section 2 "Methods and Samples" and included general descriptions of the cores: "The three box cores (BC02, BC03, BC04) and the gravity cores (GC72, GC78, GC80) were mainly composed of olive grey diatomaceous mud, with evidence of bioturbation throughout (Figure 1). Crude lamination is observed at 42-45 cm in BC03 and at 0-5 cm in BC04 (Figure 1). Only the top 0-1 cm of the gravity cores (GC72, GC78, GC80) were subsampled and are composed of olive grey diatomaceous mud and no noticeable sediment loss or disturbance was observed during coring and recovery." We have also added core logs of RS14-BC02, RS14-BC03, and RS14-BS04 (Figure 1) and X-ray images of the three box cores have been added to an appendix (Figure 2).

Thank you for this comment regarding polynyas. We have added a sentence at the beginning of the introduction to highlight the importance of polynyas in the Ross Sea. "High primary productivity is observed across the Ross Sea, especially in three seasonal biological hotspots, Terra Nova Bay, McMurdo Sound, and the central Ross Sea, where different phytoplankton classes dominate (Arrigo & van Dijken, 2004; Arrigo et al., 2015; Bolinesi et al., 2020; Mangoni et al., 2017). These hotspots are closely associated with polynyas, areas of open water surrounded by sea ice that form and evolve seasonally due to persistently strong winds, which drives early phytoplankton blooms by allowing light penetration and promoting water column stratification (Mezgec et al., 2017; Truax et al., 2024)."

Paleoclimatic context has been added to several places in the manuscript, including:

- The abstract, "The 200-year period is investigated as it provides a natural baseline before the onset of the warming and rising atmospheric CO_2 associated with industrialisation. Understanding how phytoplankton communities and sea ice responded during this transition is critical for contextualising recent and projected change."
- The introduction, "This 200-year period encompasses the final stages of prolonged cooling across Antarctica from 1200 to 1900 CE (Stenni et al., 2017), during which

cooler temperatures and stronger katabatic winds promoted an enlarged Ross Sea polynya and higher primary productivity prior to 1875 CE (Rhodes et al., 2012). In the Ross Sea, this period of enhanced polynya activity was followed by an increase in seasonal sea-ice duration (Rhodes et al., 2012; Tesi et al., 2020; Truax et al., 2024). Following this, industrialisation has led to warming and rising atmospheric CO2 from the mid-1800s. Understanding how phytoplankton communities and sea ice responded during this climatically significant transition is therefore critical for contextualising recent and projected change."

- The discussion, "The last 200-years encompasses a period of cooling in Antarctica from 1200 to 1900 CE (Stenni et al., 2017), as well as subsequent rising CO2 associated with industrialisation where concentrations went from 312 parts per million (ppm) in 1958 to over 400 ppm in 2014 when the cores were collected (Pétron et al., 2026)"
- Conclusion, "This time interval encompasses the final stages of cooling in Antarctica, during which atmospheric and oceanic dynamics influenced polynya evolution in the Ross Sea (Rhodes et al., 2012), as well as increasing CO_2 since the Industrial Revolution. The three cores offer an opportunity to examine biosiliceous and organic records during this period and to assess the long-term behaviour of biomarkers, bacterial activity, and preservation processes."

We acknowledge the reviewer's comment that specific expertise was taken for granted in places. To address this, we have expanded the Methods section to include additional detail on the ^{210}Pb dating approach (as noted above) and have expanded the 'Proxy Rationale' section to provide more context for the specific biomarkers and diatom species used in this study.

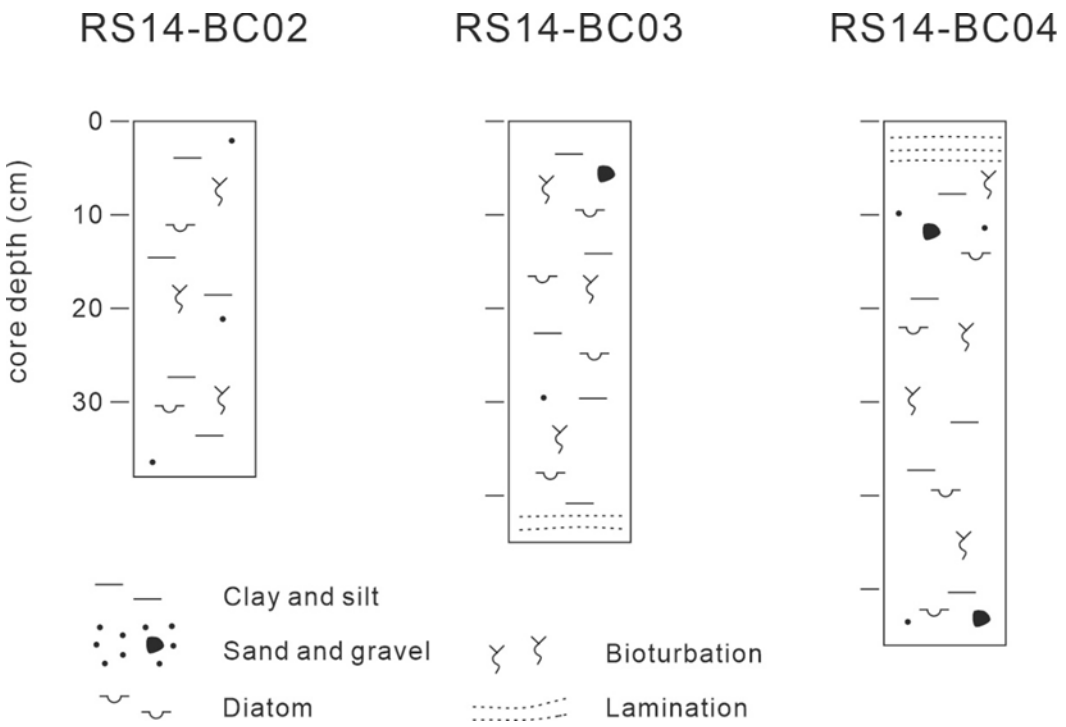

Figure 1: Core logs for RS14-BC02, RS14-BC03, and RS14-BC04 from the southwestern Ross Sea, Antarctica. Lithology and sedimentary structures shown against depth (cm).

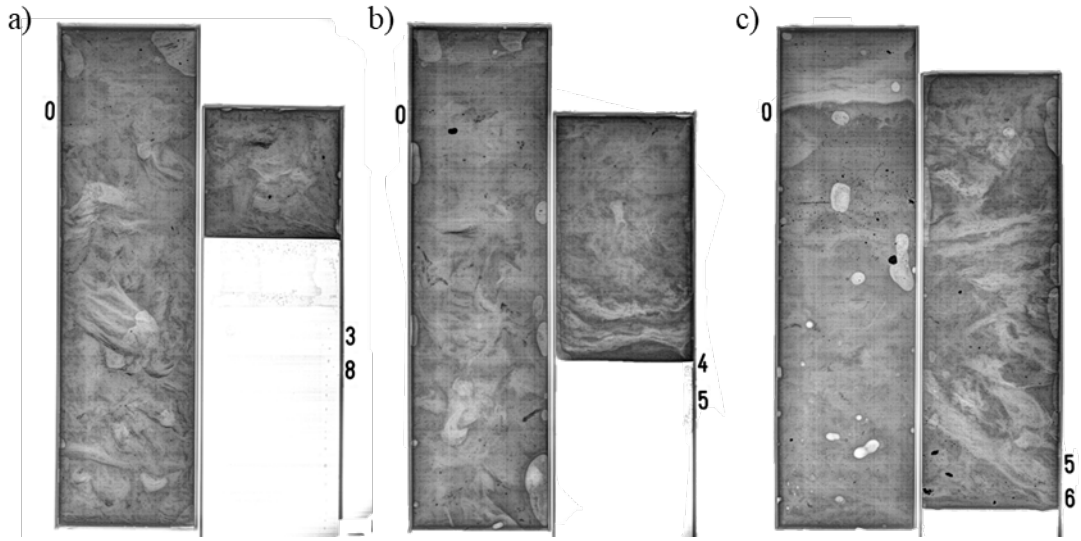

Figure 2: X-radiographic images of RS14-BC02 (a), RS14-BC03 (b), and RS14-BC04 (c). Depth (cm) is noted beside each X-ray. Images were taken on 1 cm thick sediment slabs with Softex M-100W X-ray source and NTB EZ-320 digital X-ray scanner, and were processed with iX-Pect EZ imaging software.

While reading the final part of the article, there is some confusion in defining diatom assemblages such as 'sea ice', 'pelagic diatoms', ‘dwelling diatoms’ or 'centric open water diatoms. A quick diagram (like Table 2.), providing the Groups/assemblages and the species

that define each of them, could help. Selective dissolution before and after deposition is a little underestimated.

Thank you for this comment. We have structured section 2.6 in an easier way to follow. Each group of diatoms are introduced in the format: "The [group name], comprising [species], [environmental conditions reflected], [presence in surface waters and underlying sediment] (citation)." A section has also been added on the preservation of diatoms in Antarctic coastal settings: "Antarctic shelf waters are among the most productive marine environments (Arrigo et al., 2008). Water depths are generally less than 1,000 m, while sedimentation is rapid and episodic (Kim et al., 2015; Schloss et al., 1999). Consequently, diatom preservation is typically excellent, and sediments are characterised by exceptionally high biogenic silica contents (Chiarini et al., 2019; Denis et al., 2009; Dunbar et al., 1998; Gilmer et al., 2025; Ledford-Hoffman et al., 1986; Presti et al., 2003)."

Perhaps a more structured mathematical/statistical analyses as a Cluster Analyses and a Principal Component Analyses (PCA), could be produced on the complete datasets (at least for surface samples), aiming a more quickly highlight of the main variance groups and their correlation (most significant elements)

We thank the reviewer for this suggestion. We have conducted a Principal Component Analysis (PCA) on the biomarker and diatom dataset (n = 27 samples) to better highlight the main sources of variance and the relationship between the key variables. The PCA is included as a new figure (Figure 3), and we have used the results to strengthen our arguments throughout the manuscript (see examples below).

The first two principal components (Dim1, Dim2) together explain 57.3% of the total variance of the dataset (Figure 3), indicating that this two-dimensional summary captures the majority of the variability among samples. The PCA reveals three main groupings. First, *Fragilariopsis curta* and $C_{24:0}$ vectors are positively corrected (r = 0.80) which are associated with heavy pack or fast ice, likely reflecting greater sea ice cover, later melting, and stronger stratification. Second, *Chaetoceros* resting spores, open ocean, and cold water centric diatom groups vectors are positively correlated which are associated with less icy conditions, thinner sea ice cover, including fast ice allowing the production of the Sea Ice diatom group, as well as earlier melting, and episodic disruption of stratification. Third, the fatty acids and HBIs have also grouped together, with negligible correlation to either diatom grouping, likely reflecting shared post-depositional processes such as degradation. The sterols (dinosterol, brassicasterol) show moderate positive correlations with the *F. curta*/$C_{24:0}$ group (r = 0.46-0.58), weaker than $C_{24:0}$ (r = 0.80), and consistent with their

comparatively low reactivity and limited downcore decrease (Vorrath et al., 2019; Rontani et al., 2019; Rontani et al., 2012).

The PCA results have been added throughout the manuscript. For example the methods section has an added subheading 'Statistical analysis' which reads as follows: "To assess the main sources of variance and relationships among biomarker and diatom variables, a Principal Component Analysis (PCA) was performed on the combined datset (n = 27) in R (version 4.4.1; R Core Team, 2024) using prcomp, with variables log transformed (log(x+1)). Variable contributions to the first two dimensions were calculated and visualised using the factoextra package (version 1.0.7; Kassambara et al., 2020), with results displayed as a colour gradient on the correlation circle (Figure 3)."

We have also added a subsection to the results: "A PCA of the biomarker and diatom dataset (Figure 3) resolved 57.3 % of total variance across the first two dimensions (Dim 1 = 37.8 %, Dim 2 = 19.5 %). Three groupings emerge. First, the *F. curta* group, $C_{24:0}$, and the sterols (dinosterol, brassicasterol) plot together, with $C_{24:0}$ showing a strong positive correlation with *F. curta* (r = 0.80) and a strong negative correlation with *Chaetoceros* resting spores (r = -0.67), while dinosterol and brassicasterol show more moderate correlations with the same variables (r = 0.58 and -0.40; r = 0.47 and -0.33, respectively). Second, *Chaetoceros* resting spores, the open ocean group, the centric cold water group, the sea ice diatom group, the *F. cryophilic* group, and *T. antarctica* plot in the opposing quadrant, consistent with a negative correlation with the first group. Third, the fatty acids, and HBIs cluster together and show negligible correlation with either diatom grouping (r = -0.19 to 0.11), indicating these variables are statistically independent of the ordination axis separating the two diatom groupings, with the notable exception of $C_{24:0}$ which does not align with the rest of the fatty acid group."

The results have also been added throughout the discussion, for example in the section describing how environmental conditions are a driver of fatty acid and HBI variability: "Based on its strong positive correlation with the *F. curta* diatom group (r = 0.80), and the known sea ice diatom fatty acids $C_{24:1\omega11}$ and $C_{24:1\omega9}$ (Nichols et al., 1986), we propose $C_{24:0}$ as a candidate sedimentary biomarker of sea ice change in the southwestern Ross Sea. This contrasts with Ashley et al. (2021), who also measured $C_{24:0}$ in modern sediments, and attributed it to an open-water diatom source in an East Antarctic setting (Adélie Land), highlighting that the source and behaviour of this compound may differ regionally."

The conclusion and abstract have also been updated to highlight these results.

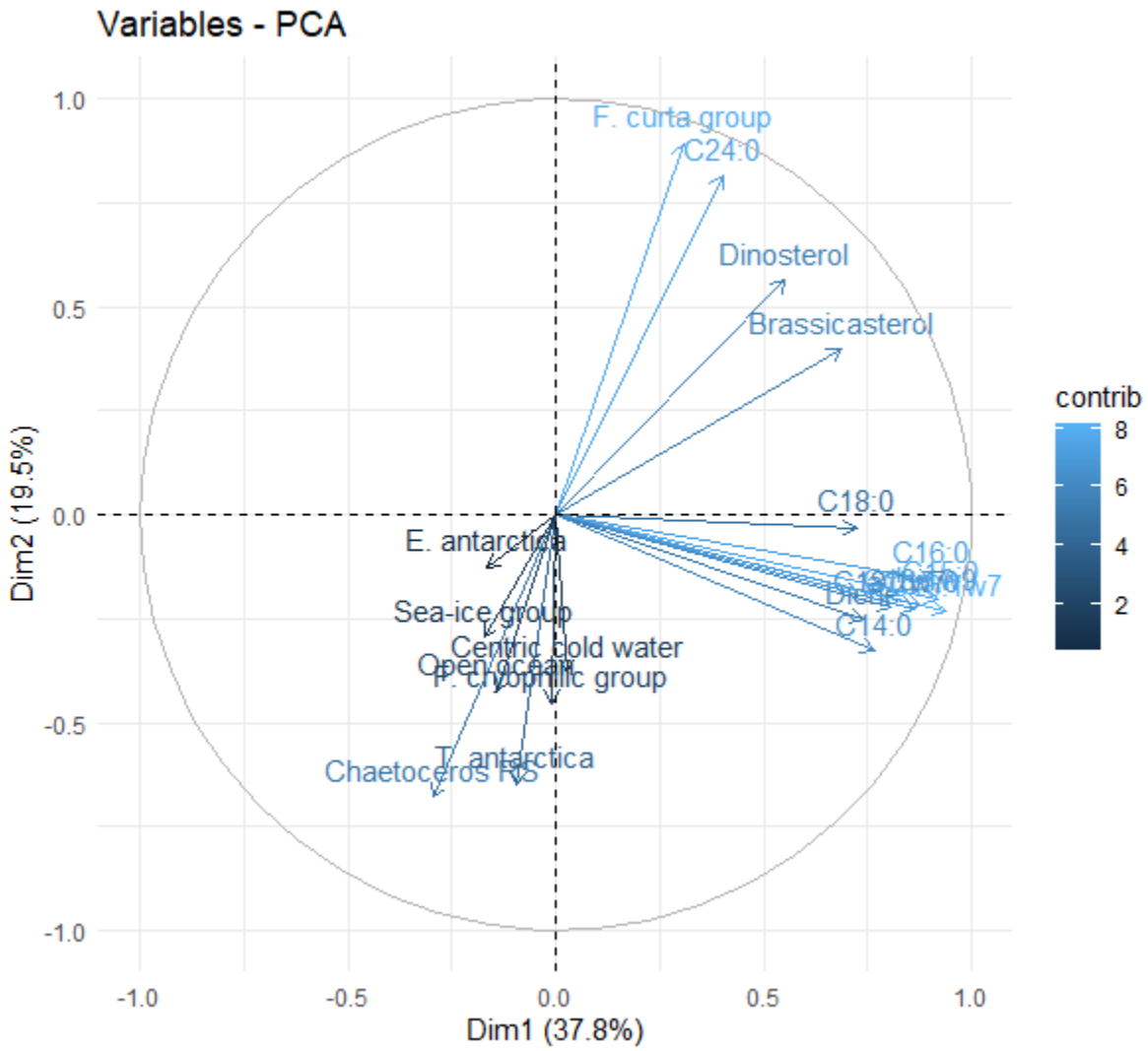

Figure 3: Principal Component Analysis (PCA) of biomarker and diatom variables (n = 27), showing the correlation circle for the first two principal components (Dim1 = 37.8 %, Dim2 = 19.5 % of total variance). Arrow color indicates the contribution of each variable to the plotted dimensions.

The general section on cores is underdeveloped, and the sedimentological and descriptive report on the environment and paleoclimatic context is sparse. In particular, the important section on polynyas and their evolution is underdeveloped. Furthermore, some skills are taken for granted, making the article highly specific and lacking in flow and description.

See response to comment above.

List of corrections/suggestions:

L14: Please, revise the Abstract after the revision, enriching it with a better paleoclimatic framework

Thank you for this comment. We have added some context for the 200-year time period

into the abstract. For example, the following sentence was added: “Longer baseline records are required to understand sea ice, phytoplankton productivity and community composition, and the resulting impacts on climate. The 200-year period examined here spans the final stages of the Little Ice Age and the subsequent warming and rising atmospheric CO_2 associated with industrialisation. Understanding how phytoplankton communities and sea ice responded during this transition is critical for contextualising recent and projected change.”

L23: Why the Ross Sea polynyas aren’t mentioned? As they are so important for the productivity and water masses circulation in the Ross Embjment, many highlighting publications exist on this topic; some fleeting mentions are present later in the texe but it seems important mention here too. See some examples even in the .pdf: Truax et al., 2024 https://doi.org/10.1016/j.quascirev.2024.108635; Falco et la., 2024 Deep–SeaResearch, II, 218,105429

See reply to earlier comment.

L107: Please, add the cores RX or, at least, some photos of these crude sediment laminations

We thank the reviewer for this suggestion. We have added a core log figure (Figure 1) to Section 2.1 illustrating the sedimentary characteristics of cores BC02, BC03, and BC04, and included a brief core description in the text. X-ray images have also been added to the supplementary materials (Figure 2).

L109: As GC72, GC78 and GC80 present a good core sediment record (944 cm, 821 cm and 721 cm respectively) why do you present only the surface (top) sediments? Was it not possible to submit records relating to the same box corers time gap? If not, why?

We thank the reviewer for this comment. Sampling of the gravity cores was limited to the surface (core top) samples, as these were the only samples processed for biomarker and diatom analysis within the scope of this study. Subsampling the upper sections of the gravity cores to match the box core timeframe would indeed provide valuable replication and is recommended for future work. Unfortunately, this was not possible within the constraints of the current study. The core tops, however, provide a better regional picture.

Table 1: in the Age column is CE Common Era? Equivalent to d. C.?

Thank you for this comment. We have clarified that “CE” refers to Common Era (equivalent to d.C.) in the Table 1 caption.

L118: Hard to under stand for non-experts: the transition from ^{210}Pb to $^{210}Po_{supported}$ is not immediate. Please, a brief explanation from Appleby, 2001 (or in Sup Mat.) could help in understanding the geochronological chain and methodology.

We thank the reviewer for this suggestion. We have revised the methods section to include a brief explanation of the geochronological chain, noting that ^{210}Pb is produced in the atmosphere via decay of ^{222}Rn, deposited onto the ocean surface, scavenged from the water column, and accumulates in seafloor sediments where it decays with a half-life of 22.3 years (Appleby, 2001). We have also clarified the relationship between ^{210}Pb and ^{210}Po explaining that ^{210}Po is measured as a proxy for total ^{210}Pb activity and assuming secular equilibrium between the two isotopes in sealed samples. We believe these additions provide sufficient context for non-expert readers without overburdening the methods section.

Fig. 1: Please highlight the presence of different polynyas (biological hotspots and important high salinity shelf areas - HSSW production areas). Is there any known morphological, atmospheric or oceanic dynamic explanation for the presence of >0.8% sea ice cover in the BC04, BC03 and GC78 cores collection area?

We thank the reviewer for this comment. The polynyas (McMurdo Sound and Terra Nova Bay) are highlighted on Figure 1. Regarding sea ice cover at the core locations, sea ice is present ~60-80 % of the time, and increasing to >80 % further offshore (Matsuoka et al., 2021; Spreen et al., 2008). This elevated cover, relative to the nearby McMurdo Sound and Terra Nova Bay polynyas, reflects northward sea ice transport by katabatic winds and ocean currents, which advects ice away from these polynyas and causes it to accumulate against the Drygalski Ice Tongue (Arrigo et al., 2004; Brett et al., 2020). We have added a brief clarifying sentence to the manuscript: “Sea ice cover at the core sites is high (60-80 %, increasing to >80 % farther offshore) relative to the adjacent McMurdo Sound and Terra Nova Bay polynyas (Matsuoka et al., 2021; Spreen et al., 2008), reflecting northward advection of sea ice by katabatic winds and ocean currents, which accumulates against the Drygalski Ice Tongue (Arrigo et al., 2004; Brett et al., 2020).”

L153: instrument available from which Institution?

The following sentence has been adjusted in the manuscript: “Samples were analysed on a gas chromatography mass spectrometer at Earth Sciences New Zealand (GC-MS; Agilent Technologies, model: 7890A and 5975C).”

L187: Absolute Diatom Abundances (ADA) were calculated for each sample while diatoms were ….

Thank you for this comment. We have added the following sentence to the manuscript: "Absolute diatom abundances (ADA) were calculated by scaling counted valves to the total processed sample volume and normalising to sediment dry weight, yielding concentrations expressed as valves per gram of dry sediment (Crosta et al., 2008)."

L192: 2.7 Proxy rationale

We thank the reviewer for identifying this error. The section numbering has been corrected.

L219: please, which species or Group, have you found them in your samples?

We thank the reviewer for this comment. We have revised the text to name a few specific diatom species that were identified as major Brassicasterol producers by (Rampen et al., 2010), such as *Stauroneis constricta, Phaeodactylum tricornutum, and Dickieia ulvacea.* However, none of these species were observed in our diatom assemblages, and we have made this explicit in the revised text.

L222: a refuse … than what? dinoflagellates?, L230: refuse: *Fragilariopsis obliquecostata*

We thank the reviewer for identifying these errors. The incomplete sentence at L222 has been completed to read "dominated by diatoms rather than dinoflagellates". The species name *Fragilariopsis obliquecostata* has been corrected at L230.

L231: do you intend the 'Sea ice dwelling diatoms' reported at L365? If yes, please pay attention in defining the Groups and in keeping the same definition throughout the article

The sea ice dwelling diatom heading at L365 explores potential diatom sources of fatty acids. We have added a section on the relationship with the diatom data to ensure that the same definition is used throughout. The following sections were added to the L365 heading:

"Downcore, concentrations of $C_{24:0}$ most closely follows trends in the *F. curta* group (Figure 4), and while *F. curta* is not a sea-ice dwelling diatom and can even represent open water or seasonal ice (Allen et al., 2022), the group which comprises of *Fragilariopsis curta, Fragilariopsis cylindrus*, and *Fragilariopsis vanheurckii*, indicates the presence of heavy fast or pack ice, with a late melting late season (Armand et al., 2005), suggesting a sea ice driver source for these compounds (Figure 4).

"Interestingly, the Sea Ice group, comprising of *Entomoneis spp., Nitzschia stellata, Synedropsis fragilis, Synedropsis recta*, and *Synedropsis hyperboreoides*, did not closely follow

with the sea ice diatom biomarkers. This may reflect their relatively low abundance (typically <4 %), which could limit their contribution to bulk fatty acid signatures dominated by more abundant taxa."

L235: … and iceberg drift

Thank you, we have added this to the manuscript.

L251: refuse: section 2.7

This change has been made, thank you.

Fig. 2: maybe to specify in Sup. Mat. how chromatogram works and the meaning of 'Retention time' is better

Thank you for the suggestion. Rather than adding this explanation to the Supplementary Materials, we have included a brief definition of retention time in the Methods section, where the GC-MS analysis is described. The following text has been added: "Lipids were identified by retention time (time taken for a compound to elute from the GC column), total ion current (TIC) mass spectra output, and fragmentation patterns. Biomarker concentrations were quantified using the TIC integrated peak area of each compound and known concentrations of an internal standard, then normalised to the TOC content of the sediment."

Table 3: absolute diatom abundance (ADA)

Done

Figs 4: for an easier reading, please set the name of the cores and the polynya location

Thank you for this suggestion. We have adjusted the figure, which now has core name labels and a label for McMurdo Sound (Figure 4).

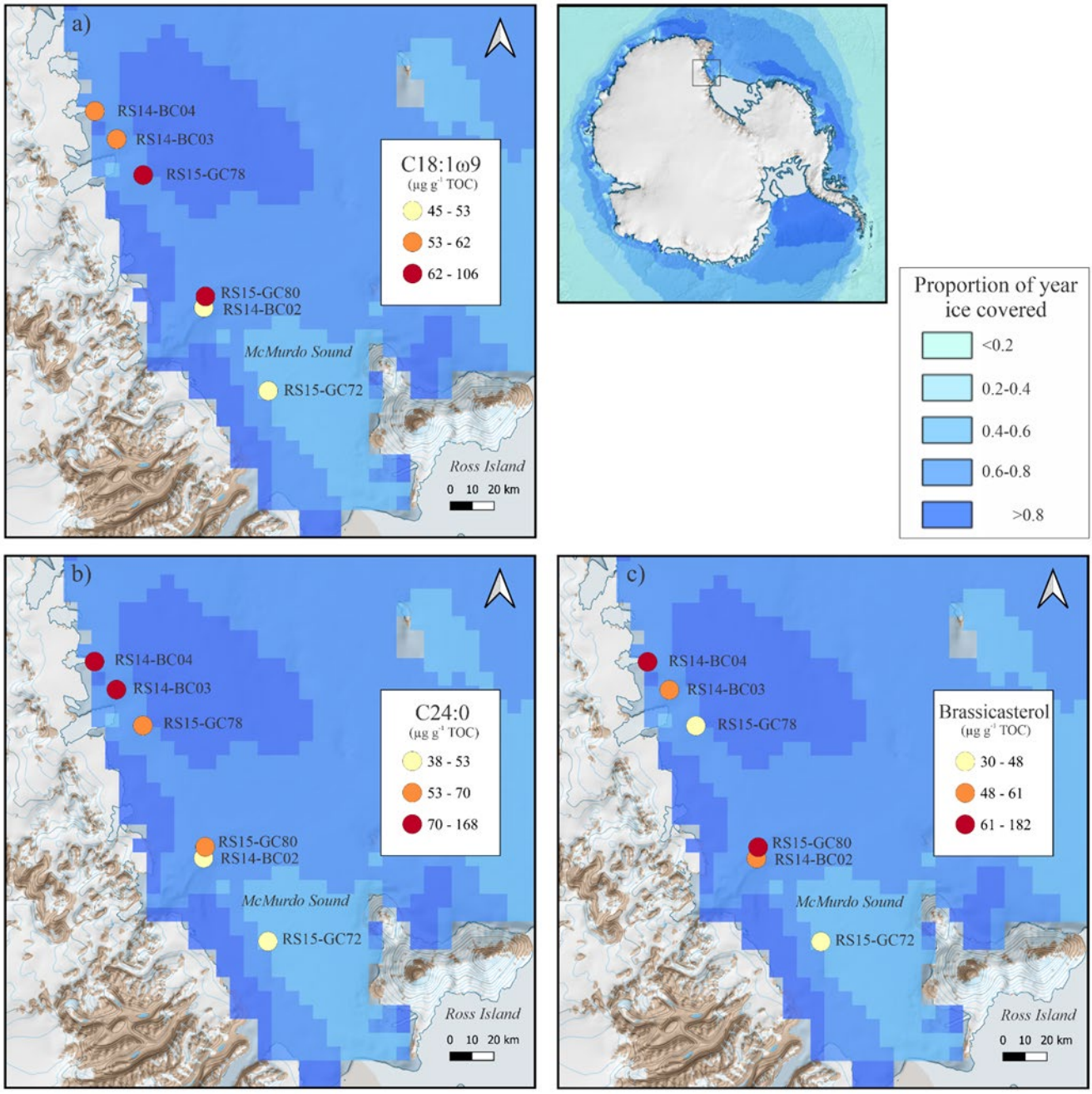

Figure 4: Spatial distribution of selected phytoplankton derived biomarkers in core top sediments (0-2 cm depth). (a) $C_{18:1\omega9}$, (b) $C_{24:0}$, and, (c) brassicasterol. Areas with lighter blue colours have open water more often throughout the year, whereas dark blues are covered with sea ice for most of the year based on sea ice concentration data between 2002 and 2011 at 6.25 km resolution. Base map sourced from Quantarctica (Matsuoka et al., 2021). Sea ice data source: Spreen et al. (2008).

L301: Please, offer the complete list of the fifty-eight species

We thank the reviewer for this comment. The complete list of species, along with all other data presented in this study is available at PANGAEA (de Jong et al., 2026),

https://doi.org/10.1594/PANGAEA.989298. We have added the following sentence to the manuscript to highlight where the data can be found: "Fifty-eight species or groups of species were identified in the sediment samples. The complete list of species and data is available at PANGAEA (de Jong et al., 2026)."

L303: absolute diatom abundances or ADA values

Done

L309: please, explain better in discussion, why in your opinion, 'centric cold-water diatoms' decrease northward

The following sentence has been added to the discussion: "Centric cold water diatoms also decrease on a south to north gradient, away from the polynya, likely reflecting the decreased productivity as a result of delayed sea ice opening above the northern core locations, which provides a shorter growing season and influences the release of nutrients and the stratification of the water column."

L310: is biological hotspot equivalent to the McMurdo polynya?

Yes biological hotspot in this context was referring to the increased productivity in the McMurdo polynya. We replaced 'McMurdo biological hotspot' with 'McMurdo polynya' for clarity.

L311: Why not also analyze the cores, specifically the same time frame? Are there any sedimentological peculiarities in the core record?

We thank the reviewer for this comment. Biomarker and diatom analysis was limited to the 27 samples provided for analysis, which did not include additional downcore samples from the gravity cores over the same timeframe, as this was beyond the scope of the study. We acknowledge this as a limitation of the study. Regarding sedimentological peculiarities, the cores are predominantly composed of olive grey diatomaceous mud with evidence of bioturbation throughout. Notable exceptions include crude laminations observed at 42-45 cm in BC03 and at 0-5 cm in BC04. A core log figure has been added to Section 2.1 to illustrate these sedimentary characteristics.

L316: Have you considered the impact of selective dissolution (which is already active along the water column and in the 20 cm down the sediment)? CRS, spores in general and *E. antartica* are selectively favore dover the others (x es. *F. cylindrus* and ctyophilic forms) … have you found *T. antartica* spores or vegetative cells?

We thank the reviewer for raising this important point. Yes, we did find *T. antarctica* spores, specifically the cold water variety, consistent with what is expected for this region (Crosta et al., 2004). Vegetative cells of *T. antarctica*, however, were rarely observed in the sediment, likely due to vegetative cells being cast off during spore formation (Doucette et al., 1983; Fryxell et al., 1981). Regarding the concern about selective dissolution: several independent lines of evidence argue against strong dissolution, focusing, or winnowing in our samples:

1. Assemblage composition: despite being relatively lightly silicified, fragile diatoms such as *F. cylindrus* and sea-ice associated taxa (e.g. *Haslea, Banquesia*) are present. The co-occurrence of these delicate forms alongside larger, more robustly silicified diatoms would not be expected if selective dissolution were significantly biasing the assemblage.
2. Preservation state: valves show little fragmentation, and ultrastructural features (ornamentation, areolae, etc.) are well preserved, indicating minimal dissolution.
3. Depositional setting: production in this region is high, and export to the seafloor is rapid (Kim et al., 2015; Schloss et al., 1999).. Combined with shallow water depth and high water column silicic acid concentrations, these conditions favour good preservation and argue against significant dissolution (Chiarini et al., 2019; Denis et al., 2009; Dunbar et al., 1998; Gilmer et al., 2025; Ledford-Hoffman et al., 1986; Presti et al., 2003).

Taken together, we believe the assemblage is broadly representative of the original biogenic silica flux. Details about preservation have been added to the manuscript as detailed in previous response.

Fig. 6: For an easier reading, please set the name of the cores and the polynya location

Thank you for this suggestion. We have adjusted the figure which now has core name labels and a label for McMurdo Sound in the same format as Figure 4 above.

L330: Perhapes a Cluster Analyses and a Principal Component Analyses (PCA) could be produced by putting together the biomarkers and diatom assemblages datasets (at least for surface samples). This to more quickly highlight the main variance groups and their correlation (most significant elements).

See response to earlier comment about Principal Components Analysis above.

L345: In the Conclusions, you consider *Phaeocystis antartica* as ‘pelagic‘ but is it ‘Haptophytes’? here is not specified … better explain

We have revised the text in the conclusion to refer to Phaeocystis antarctica at the group level as "haptophytes" for consistency, replacing "pelagic diatoms, *Phaeocystis antarctica*, and sea ice diatoms" with "pelagic diatoms, haptophytes (e.g. *Phaeocystis antarctica*), and sea ice diatoms".

L358: the reference is missing

Thank you for pointing this out. The following sentence has been revised and a reference has been added; "First, PUFAs are preferentially assimilated by zooplankton from their phytoplankton diet and are incorporated into zooplankton tissues before reaching the seafloor (Dalsgaard et al., 2003)"

L365: Sea ice dwelling diatoms are usually pennate diatoms, frequently characterized by the presence of raphe (*Navicula* sp., *Pleurosigma* sp., *Nitzscia* sp., even *Fragilariopsis* sp.. ...) (Zhang et al., 2025; https://doi.org/10.1101/2024.11.18.624199) Do you intend F. cryophilic Group?

More controversial is to consider *F. curta* as 'sea ice dwelling diatom' since it can also be a 'open water/seasonal ice' transitional form but not specific dwelling into the ice, except as a seed carried by strong polar winds or as stucked into the new forming ice .... (Tetzner et al., The Cryosphere, 16, 779–798, 2022; https://doi.org/10.5194/tc-16-779-2022; Allen et al., Geosciences 2022, 12, 282. https://doi.org/10.3390/geosciences12080282)

We thank the reviewer for this comment. We have added further clarification to the 4.1.1 Biomarker sources subheading to make it clear that the *F. curta* is not a sea ice dwelling diatom but that it can indicate the presence of heavy fast or pack ice (Armand et al., 2005). We also clarified that we are comparing the *F. curta group*, which comprises of *Fragilariopsis curta, Fragilariopsis cylindrus*, and *Fragilariopsis vanheurckii* with the fatty acids, rather than *F. curta* on its own. We also added a sentence to highlight that the 'sea ice diatom group' did not match with the sea ice fatty acid biomarkers: "Interestingly, the sea ice diatom group, comprising of *Entomoneis spp., Nitzschia stellata, Synedropsis fragilis, Synedropsis recta,* and *Synedropsis hyperboreoides*, did not closely follow with the sea ice diatom biomarkers. This may reflect their relatively low abundance (typically <4 %), which could limit their contribution to bulk fatty acid signatures dominated by more abundant taxa."

L408: Spreen et al., 2008)

Thank you, the extra bracket has been removed.

L464: Before these results, please, add some general notes on cores' highlights and differences among the cores (Fig. 7) as ADA values, diatom and biomarker variations,

photos of the laminations in BC03 and BC04 with some sedimentological/environmental comment or note (even basic)

We have added a short introductory paragraph to Section 4.2 summarising the overall patterns in ADA, diatom assemblages and biomarkers in BC02, BC03, and BC03, and provide brief sedimentological comment on the lamination observed in BC03 and BC04. We have kept this to a single orientating paragraph, as the detailed patterns are discussed later in Section 4.2. The added text reads: "Downcore records from BC02, BC03, and BC04 show both shared patterns and site-specific differences in diatom assemblages and biomarker concentrations over the last ~200 years (Figure 8). Total diatom abundance is stable downcore in BC02 and BC03, and decreases in BC04, while most fatty acid biomarkers show a general decline in the upper ~20 cm across all three cores, consistent with early post-depositional degradation. Several diatom groups (e.g., *F. curta* group, *Chaetoceros* RS) and sea ice biomarkers ($IPSO_{25}$ diene) show more gradual, longer-term downcore trends. BC03 and BC04 also show crude lamination (42-45 cm and 0-5 cm, respectively; Figure 1, Figure A1), which may reflect reduced bioturbation under more persistent sea ice cover at these sites."

L496: Assuming readers are familiar with Antarctic paleoenvironmental and paleoclimatic issues related to the time period examined is, in my opinion, counterproductive. This, in fact, excludes readers who are not specifically and thoroughly informed from easily understanding the study conducted. Therefore, it would be better contextualize:

As in 1950 the atmospheric CO_2 concentration was approximately 311 parts per million (ppm), this data can be considered the moment in which the critical threshold of 300 ppm has been exceeded for anthropogenic factors. I think it's worth highlighting (from climate.nasa.gov)

A sentence has been added to section 4.2 to highlight the importance of the 200 year record: "The last 200-years is a critical time period to contextualise recent and projected changes in phytoplankton communities and sea-ice as it encompasses a period of cooling in Antarctica from 1200 to 1900 CE (Stenni et al., 2017), as well as subsequent rising CO2 associated with industrialisation during which concentrations went from 312 parts per million (ppm) in 1958 to over 400 ppm in 2014 when the cores were collected (Pétron et al., 2026)."

L503: It's a guess: if it's degraded, the result is not certain. Maybe better: 'suggesting little changes in phytoplankton ....., despite increasing sea-ice influence in this coastal part of the Basin (References indicating this trend...)

We agree that the this interpretation is uncertain given the degraded fatty acid signal. We have revised the text to “which may suggest” and added references supporting the increasing sea ice trend in the southwestern Ross Sea coastal region.

Fig. 8: in c) … *F. curta* (%)

The figure has been updated to italicise *F. curta.*

L515: area characterized by the variable presence of coastal polynyas (Falco et al., 2024)

This has been added to the beginning of the conclusion.

L516: Suggestion:

… (with a minor error of 2 decades max). This centennial time gap (1794-2007 years) represents the time during which the atmospheric CO2 has increate since the first human Industrial Revolution and includes the final part of the colder Little Ice Age interval, during which controversial atmospheric and Ross Sea oceanic dynamics promoted polynyas evolution (Lagorio et al., 2025; Truax et al., 2024; Tesi etal., 2020; Stenni et al., 2017; Mezgec et al., 2017; Rhodes et al., 2012). BCO2, BC03 and BC04 cores offer the opportunity to analyze the biosiliceous and organic records during this period, suggesting a relatively low variability, and allow to test long-core behavior of biomarkers, bacterial activity and preservation processes.

It seems nice to highlight this for a better paleoclimatic contextualization.

Thank you for this comment. This section of the conclusion now reads: “Three sediment cores along a north-south transect were sampled at decadal resolution and dated using 210Pb dating, with the longest core representing years 1794-2007 (± 20 years at its base). This centennial time interval encompassed the period of increasing atmospheric CO2 since the Industrial Revolution, as well as the final stages of cooling in Antarctica, during which atmospheric and oceanic dynamics influenced polynya evolution in the Ross Sea (Rhodes et al., 2012). The three cores offer an opportunity to examine biosiliceous and organic records during this period and to assess the long-term behaviour of biomarkers, bacterial activity, and preservation processes.”

L530: little repetition: Trends ….. reveal an increase in sea ice extent in the southwestern Ross Sea …
Done

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