Karancz et al. reconstruct past ocean conditions for the past ~27 cal ky BP using a suite of geochemical proxies from a box and piston core collected from the south flank of Walvis Ridge in the South Atlantic. Multiple techniques are applied to reconstruct seawater temperature and pCO2, representing a major analytical effort by the author team.

There are some issues with the manuscript that should be addressed prior to publication, described in more detail below.

Response: Hereby we would like to thank the reviewer for the insightful comments which helped to clarify and improve the manuscript. Below we provide a detailed response to each of the comments.

1. There is an age reversal in the box core that complicates interpretation of the Holocene portions of all the geochemical records (~5-10 cal ky BP). The authors do not discuss the age reversal, keeping it in the age model (Fig. 3a), and suggesting a sedimentation rate of 0.01 cm/yr, or "Alternatively, the upper 10 cm bsf have constant ages due to bioturbation." This is not a clear or satisfying discussion of the observed radiocarbon ages in the box core. On the figure, there is also a note "winnowing (?)" with no discussion of winnowing in the main text. In addition, if the aim of the study is to gain insight into millennial scale events using the geochemical records from this core, then it could be worth investing in tighter age control through more radiocarbon dates per depth interval (e.g., at least 1 age control point per 2 ky; Guilderson et al., 2021). At a minimum, the box core's chronology is uncertain and the basis for splicing the box and piston core has not been clearly described (as noted by reviewer 1 in the previous comment).

Response: We agree with the comments on core stratigraphy from both Reviewer #1 and #2 and changed our age model strategy accordingly. We now use measured brightness (l*) of detailed line-scan pictures of sediment cores BC6 and PC8, added to the Supplementary material, to provide a stronger underpinning for the age model and tying the two cores together. For this figure and an additional figure showing the overlap of BC6 and PC8 based on Log(Ca/Ti) from XRF-scanning, please see our response to the first review comment from Jesse Farmer.

The upper 11 cm of box core BC6 covers 0.55 ka, with somewhat elevated Ca/Al, Ti/Al and Si/Al ratios (generated by XRF core-scanning). Enrichment of elements that preferably occur in coarse fractions and in heavy minerals is likely the result of the fine fraction being removed by winnowing (e.g., Karageorgis et al., 2005). Hence, we here may interpret the loss of the last 4.8 ka from the sedimentary record as an increase of winnowing activity. We will discuss the possibility of winnowing in the main text and include the figures with the XRF profiles in the Supplementary material.

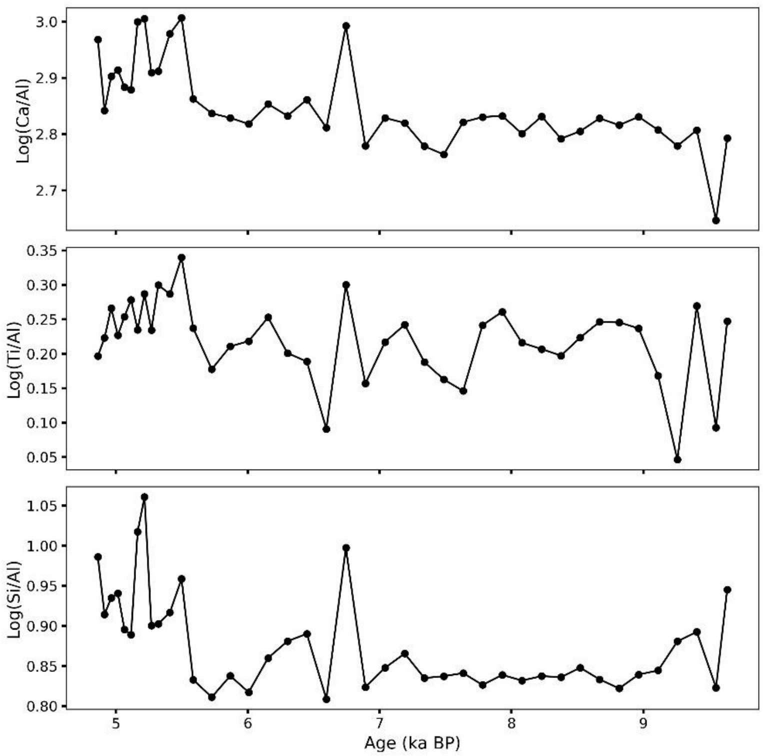


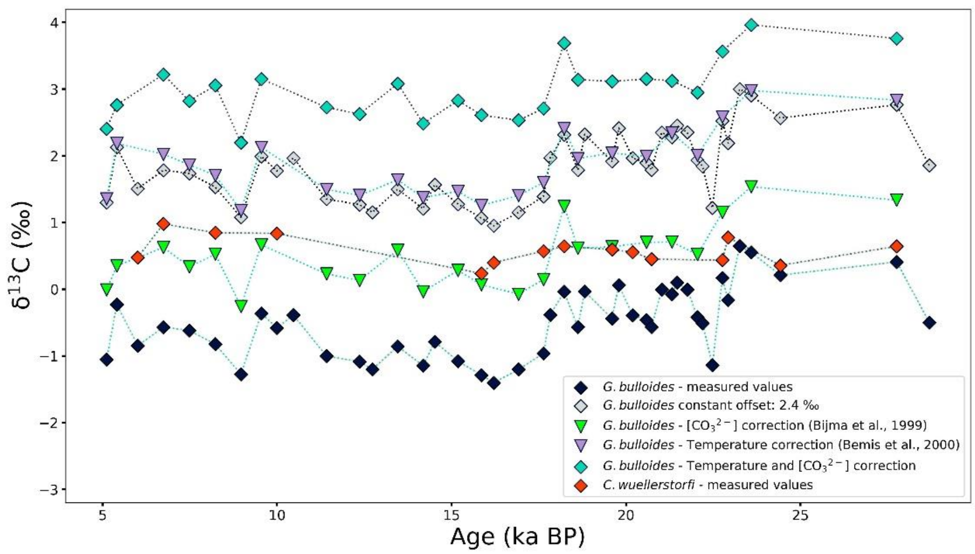
Figure S2. Log(Ca/Al), Log(Ti/Al), and Log(Si/Al) ratios (XRF-scanning element intensities) of 64PE450-BC6 plotted over the last 10 ka BP.

2. After going through the major effort of generating several complementary geochemical records, it is surprising that the authors do not synthesize the data to the full extent possible. The most prominent missed opportunity is that, if I understand correctly, the authors apply a uniform temperature correction across the whole G. bulloides carbon isotope record, from ~5 to 27 cal ky BP. Why not use the available Mg/Ca derived temperatures and the established temperature dependence of d13C for G. bulloides to get the most accurate values possible? There is a temperature-corrected curve in the supplement (Fig. S3), but it looks the same as the gray curve in main text Fig. 6C, which was created by applying a constant offset, so it appears not to have been created using the variable, reconstructed temperature estimates (it would be nice if the Fig. S3 caption could be updated to clarify that). There is also a carbonate-ion corrected curve in the supplement (Fig. S3), but it is not clear how the paleo carbonate ion values were determined or why this correction was not also applied to the record that was ultimately compared with benthic isotopes to assess changes in the soft tissue pump in the main text.

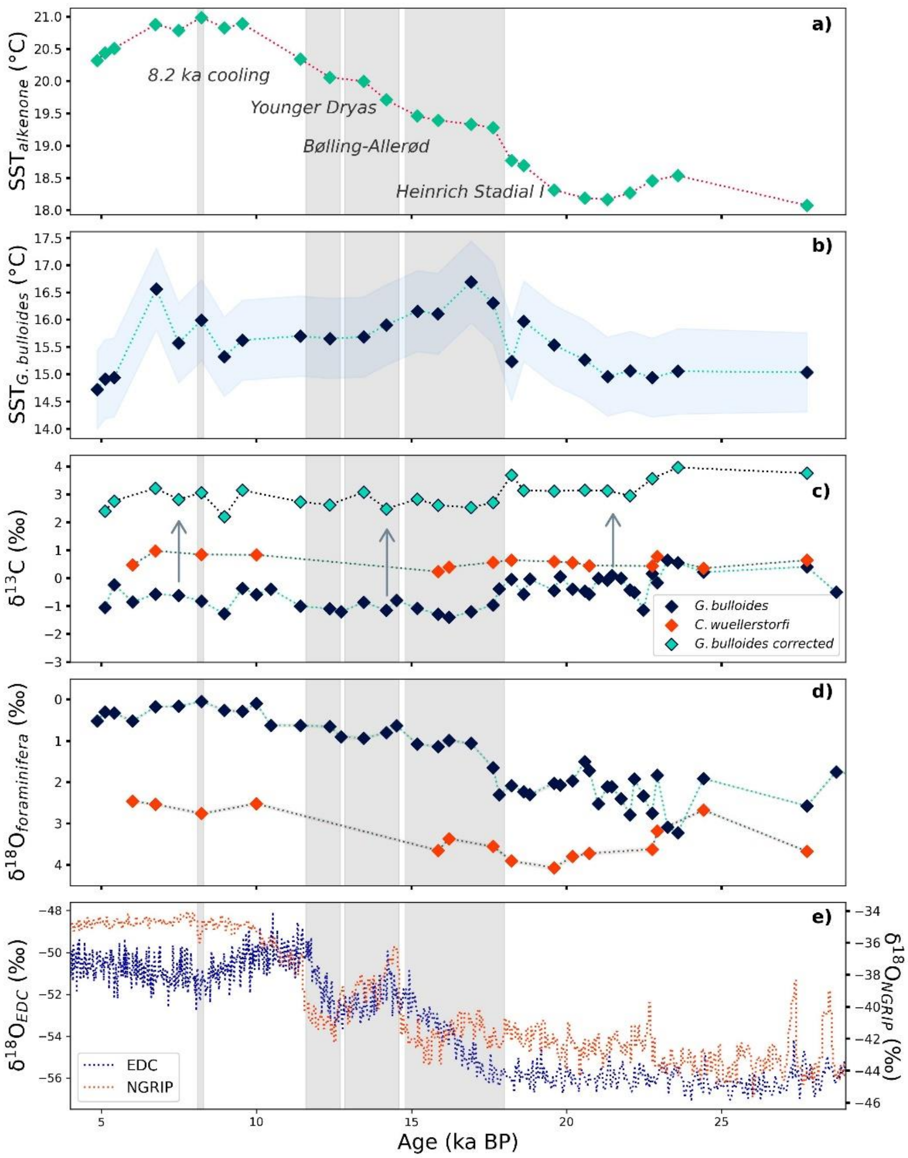
Response: We thank the reviewer for this comment and will change the graphs accordingly. The correction made in the original manuscript, using a constant value of 2.4 ‰, was already based on temperature corrections derived from Mg/Ca values, but not yet calculated for individual points. Hence, the values shown on Figure 6c are similar to those on Figure S3, but trends may differ somewhat. Temperature does not change much during the investigated interval (14.7 – 16.7 °C), corresponding to a $\delta^{13}C$ offset between 2.4 – 2.6 ‰. As the contribution of carbonate ion (and potentially other) effect to these offsets is uncertain, we applied a constant correction value which agrees well with the modern offset to the $\delta^{13}C$ values of DIC.

The carbonate ion corrected curve is based on [CO_3^{2-}] calculated from S/Mg values in the original manuscript. However, based on a comment from Reviewer #1, this approach will be removed and subsequently we will use a correction based on [CO_3^{2-}] derived from pH and total alkalinity.

Although the biological carbon pump cannot be quantitatively determined within this study, the trend in the observed planktonic $\delta^{13}C$ record is robust. Independently of the applied corrections, the difference between planktonic and benthic $\delta^{13}C$ values remains larger during the LGM compared to the Holocene. The curve showing the correction with constant value will be moved to the Supplementary figure, and Figure 6 in the main text will be modified to display combined correction for both temperature and [CO_3^{2-}]. Captions for both Figure S3 and Figure 6 will be adjusted accordingly.



Adjusted Figure S3. Measured $\delta^{13}C$ values of G. bulloides (dark blue diamonds), and C. wuellerstorfi (red diamonds), and $\delta^{13}C$ values of G. bulloides corrected for temperature (purple triangles; Bemis et al., 2000), [CO_3^{2-}] (green triangles; Bijma et al., 1999), and for a constant offset of 2.4 ‰ (grey diamonds, corresponding to the modern offset to $\delta^{13}C$ of DIC) plotted over the past 27 ka BP. Green diamonds display $\delta^{13}C$ values corrected for both temperature (derived from Mg/Ca; Bemis et al., 2000) and [CO_3^{2-}] (derived from pH and TA; Bijma et al., 1999).



Adjusted Figure 6: Reconstructed sea surface temperatures (SST) based on a) the alkenone unsaturation index, $U^{K'}_{37}$, and b) foraminiferal Mg/Ca, c) $\delta^{13}C$ analysed in benthic (C. wuellerstorfi) and planktonic (G. bulloides) foraminifera with corrected values, d) $\delta^{18}O$ of benthic (C. wuellerstorfi) and planktonic (G. bulloides) foraminifera, and e) $\delta^{18}O$ ice core record from EPICA-Dome C (EDC; Jouzel et al., 2007) and North Greenland Ice Core Project (NGRIP; North Greenland Ice Core Project members, 2004) shown for the past 27 ka BP. Corrected $\delta^{13}C$ values of G. bulloides marked with green diamonds are based on temperature (derived from Mg/Ca; Bemis et al., 2000) and $[CO_3^{2-}]$ values (derived from pH and TA; Bijma et al., 1999). Modern day SST at core site 64PE450-BC6-PC8 is approximately 20.7 ℃ (GLODAPv2023; Lauvset et al., 2024; Santana-Casiano et al., 540 2009). Grey shaded areas mark climate events as labelled on the uppermost panel. Blue shaded area in panel b) indicates the error propagated from temperature calibration uncertainty and ± 1σ standard deviation of the duplicate measurement of the samples. Analysis of the stable isotopes (panel c and d) provided an error smaller than the symbols shown on the figure. Arrows in panel c) indicate the direction of the correction on the planktonic foraminiferal $\delta^{13}C$.

3. In the discussion, the use of "intermediate" is confusing, sometimes being applied to G. bulloides records (which can live anywhere from the shallow surface down to a couple hundred meters) and sometimes being applied to benthic foraminiferal records. The cores were collected at 1375m water depth, which lies within the modern extent of AAIW in the region, so discussing the benthic foraminiferal records in the context of AAIW is reasonable and is also supported by prior studies. However, use of "intermediate" to describe the G. bulloides records is misleading, since there is no evidence that this species inhabits AAIW. Instead, G. bulloides tends to live very shallowly during the active upwelling season and extend more deeply in other seasons (e.g., Peeters & Brummer, 2002). Karancz et al. suggest, based on Mg/Ca-derived temperatures, that their Holocene bulloides are living at ~100-150m (~line 515), and this is shallower than the uppermost extent of AAIW. I'd strongly recommend using another word (like "subsurface") to describe the G. bulloides record, and reserve use of "intermediate" for AAIW alone.

Response: Thank you for pointing this out as the word "intermediate" has been indeed used in two contexts which may lead to confusion. We will rephrase the relevant sentences and use subsurface to describe data related to *G. bulloides*.

4. Considering the wide range of possible habitat depths (and seasonal variability) of G. bulloides, comparing G. bulloides d11B-derived pCO2 and alkenone-based pCO2 is not a robust approach for reconstructing an intermediate-to-surface pCO2 gradient.

Response: We agree and the differences observed here will have a minimum offset and cannot be interpreted quantitively. Still, *G. bulloides* living in the subsurface and migrating between approximately 50 to 400 m, represents a larger average water depth then the alkenone record (~upper 50 m). The depth difference between *G. bulloides* and alkenone-producers may vary seasonally (and also on longer time scales) but *G. bulloides* still represents carbon system conditions closer to those of the upwelled intermediate waters. We acknowledge that the water depth of pCO_2 values represented by *G. bulloides* -$\delta^{11}B$ are most likely not constant and this will be added in the Discussion.

5. The discussion would be strengthened by providing specific references and paleorecords when comparing their results with prior work. There are multiple instances (line 530 "changes known for the Southern Hemisphere"; line 500 "… general Southern Hemisphere temperature record") where paleoclimate patterns are alluded to but not cited or described specifically. Changes were not uniform across the SH during the last deglaciation and therefore it is essential that the authors are very explicit about what they are referring to.

Response: The discussion will be modified to include both Southern and Northern Hemisphere examples with specific references as the individual climate events also show similarities to the trends observed in Northern Hemisphere records.

lines 500 – 505: references for Southern Hemisphere showing a warming signal during the Younger Dryas e.g., Rühlemann et al., 1999; Singer et al., 1998; Bennett et al., 2000; Jouzel et al., 2007

lines 530 – 534: references for climate/temperature changes known for the Southern Hemisphere over the past 27 ka BP e.g., Johnsen et al., 1972; Blunier and Brook, 2001; Sugden et al., 2005; Jouzel et al., 2007; Brook and Buizert, 2018.

The data presented here represent an enormous amount of work, and they do have the potential to make a useful contribution to our understanding of paleoceanography in the South Atlantic. I hope that these comments are useful to the authors.

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