Response to Reviewer 2

Review #2

De la Vega et al presented a new calibration for boron isotopes in polar ocean planktic foraminifera Neogloboquadrina pachyderma/incompta using specimens from plankton tows. The authors explored why the slope of the calibration between d11B of foram and borate is larger than 1 and used new and published core top data to validate the new calibration.

The manuscript is well-written, and the new calibration is valuable to future paleo pH/CO2 reconstructions in the high-latitude oceans. We thank Reviewer #2 for their positive review of our manuscript.

The only major suggestion I have is to consider recalculating downcore pH/pCO2 from d11B reported in Yu et al 2013 and use this to further validate the new calibration. This is a valuable comment. However, applying our calibration to the downcore data of Yu et al (2013) is the objective of a subsequent manuscript that includes new downcore d11B data from the Nordic Seas. It will make more sense to recalculate Yu's data in the context of this forthcoming study, integrating pH/CO2 data on a regional North Atlantic scale. Consequently, we prefer not to include this recalculated data that would deserve an entire palaeoceanography section, context, and interpretation and we aim here to focus solely on the calibration.

However, to acknowledge the reviewer's point, we propose to add the following sentence to line 639. "*Applying the new calibration with a slope >1 to the downcore data of Yu et al. (2013), will elevate reconstructed surface seawater CO2. As a result, regions off Iceland in the polar North Atlantic may not have served as a sink of CO_2 to the atmosphere during the glacial and deglacial period as hypothesized in Yu et al. (2013). A detailed analysis of existing and new palaeoceanographic datasets will be the object of a forthcoming manuscript*".

Minor comments

L113: While I appreciate the advantage of a calibration based on plankton tows, I think it would be great to mention the caveat that the depths of the plankton tows are not necessarily the depth of calcification depths of the forams. We will add the following sentence to the revised manuscript: "*Furthermore, we acknowledge that the depth of the plankton tows does not necessarily represent the depth of calcification."*

Fig 1: DpCO2 is shown in this figure. Calculated d11B of borate or pH would be better for the map. We show delta PCO2 here because it is valuable for the application of the calibration to modern core tops and the calculation of CO2 in section 4.3.

Table 1: It would be great to have TA and DIC data in this table or in a supplementary table We will add TA and DIC in a supplementary table in the revised manuscript.

Show raw and TPB-corrected d11B for all samples. Maybe also add a supplementary figure showing the calibration with raw d11B data to demonstrate that the large TPB correction (for some samples) is not driving the slope of the calibration. The figure and table below (e.g., Figure 1, Table 1) shows the calibration with all samples without a TPB correction (left, samples with strong TPB contamination are given a 2‰ uncertainty to account for this lower confidence) and with TPB-corrected samples removed (right). In both cases the slope remains >1. We are happy to follow the reviewer's suggestion and will add the figures and table to the supplementary material. We will also add a section following lines 368 where we outline that the TPB correction does not influence the slope >1 phenomenon.

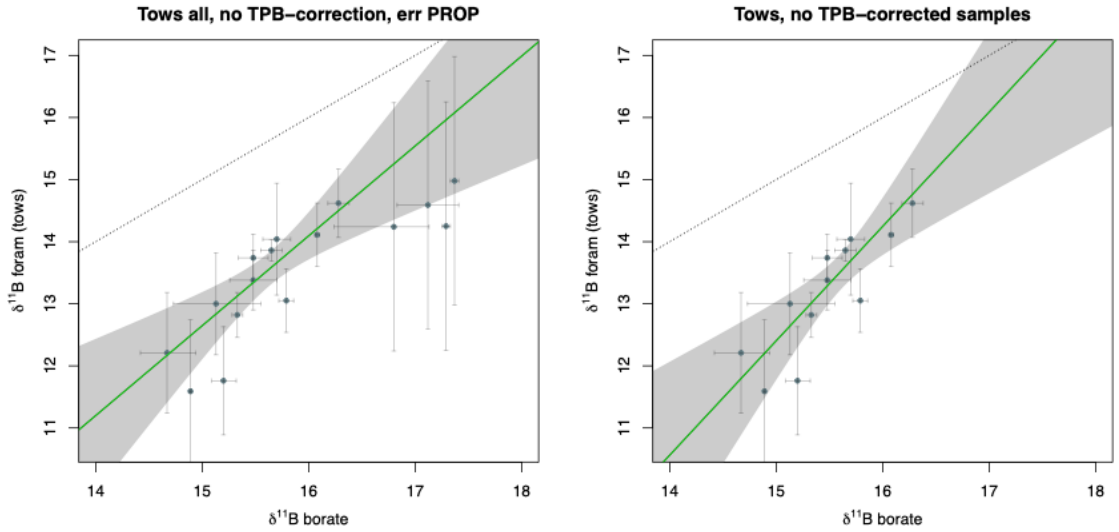

Figure 1: Left: tow calibration without the TPB correction. Right: Tow calibration without TPB-corrected samples.

Table 1: The slope and intercept for each case is indicated below, with a slope > 1 in both.

	intercept	**slope**	**mswd**
Tows (all sample with TPB correction), this study	-11.09 (+/-5.91)	1.58(+/-0.38)	0.579
Tows (with TPB-corrected samples removed), right figure.	-15.23(+/-7.31)	1.84 (+/-0.47)	0.700
Tows (all sample, no TPB correction), left figure.	-9.07 (+/-5.88)	1.45(+/-0.38)	0.663

L202-241: This part is mostly about deriving hydrographic data to calculate borate d11B. Consider moving these before L191 where the calculation of borate d11B was introduced. We will do as suggested in the revised manuscript.

L205: The logic of constraining the calcification depth is not clearly described. I recommend adding a sentence stating that the calcification depth is determined by "comparing the d18Oc with equilibrium d18O in the water column". We will do as suggested in the revised manuscript.

L210: N. pachyderma d18O, along with other data to decide calcification depth needs to be presented in a supplementary table. We will provide this data in a supplementary table as suggested in the revised manuscript.

L261: new paragraph before "Samples for boron..." We will amend this in the revised manuscript
L261: "boron [isotope] analysis"

L272: how the sigma is calculated is confusing. If the Anagnostou equation is employed, the sigma can be derived from 11B voltage and does not need to be derived from JCP-1 measurements. This is correct, the 11B voltage of each sample (not JCP-1) is used to determine the uncertainty. We will clarify this in the text as follows. "*The uncertainty is dependent on the boron content (Rae et al., 2011), i.e. the intensity of the ^{11}B signal of each sample*".

L278: Some reorganization is needed here. It is essentially an interlab measurement comparison, but AWI measurements have not been introduced at this point. Yes, that is correct. We will add a sentence at the beginning of section 2.3 to clarify this point in the revised manuscript

L280: "-"missing for d11B of AE120. We will amend this in the revised manuscript.

L302: Need to be reorganized. Triplicated measurements were mentioned before being introduced in L305. Yes, we agree. We will move the sentence from line 302 down one sentence to clarify this point.

L311: Unclear what 0.95+-0.47% is. It reads like this is the rsd for multiple El/Ca ratios, which would not be a proper way to report analytical errors. Yes, the reviewer is correct, these values refer to the RSDs reported in % associated with replicate analysis of the same sample. As part of the revisions, we will report the long-term average values of reference material (e.g., JCP-1 and NIST) measured at both AWI and Southampton labs also summarized in the table below. This comparison will also show that there are no significant interlaboratory offsets between AWI and NOC at Southampton for Mg/Ca.

Table 1: Comparison of El/Ca standards measured at NOC and AWI

Standards	**NIST-C**		**JCP-1 (uncleaned)**		
El/Ca	Stewart et al. 2020	NOC	Hawthorne et al. 2013	AWI	NOC (Stewart et al. 2016)
Mg/Ca	4.11±0.20	4.20±0.04	4.20±0.065	4.05±0.13	4.14±0.08
Ba/Ca	5.92±0.16	5.71±0.03	7.47±0.66	7.00±0.48	n/a

L355: i.e. not e.g. We will amend this in the revised manuscript.

L360: including the number of data points will be good. We will add the number of samples (e.g., n=16) in the revised manuscript)

L364-367: unclear as written. Suggest rephrasing. We will clarify this sentence in the revised manuscript to: *"Furthermore, the slope lies below the 1:1 δ11Bforam: δ11Bborate line. When assessing N. pachyderma samples by themselves (i.e. tows from the Labrador Sea) the slope is steeper at 1.82. However, both slopes and intercepts are within error of each other (Table 2)."*

Fig 2: explain what errorbars are in panel 1 and what blue shades are in panels c,d. We will clarify these points in the revised figure caption.

X axes for panels A,B: borate d11B or d11B_borate. We will change the axis as suggested in the revised manuscript.

Y axis for panel B: foram d11B or d11B_foram. We will change the axis as suggested in the revised manuscript

L383: there's no fig. 2e. Thank you for spotting this typo. We will correctly refer to Fig S1 in the revised version of this manuscript.

L449: not sure how applicable the Hönisch 2019 method is here. If ALK and DIC are lowered by 400 and 200 umol/kg, diffusion will elevate these concentrations. Maybe. Yes, the model proposed by Hönisch 2019 is a simple model ignoring any subsequent effects and processes such as diffusion. However, we feel that this thought experiment provides a valuable point in our discussion. We are happy to caveat this point in the revised version of this manuscript.

L481: replace ">>" We will amend this in the revised manuscript.

L620: Sentence not complete. Thank you for spotting this. We will remove the paragraph break that is separating this sentence from its end in line 621.