

Interactive comment on “A record of Neogene seawater $\delta^{11}\text{B}$ reconstructed from paired $\delta^{11}\text{B}$ analyses on benthic and planktic foraminifera” by R. Greenop et al.

Anonymous Referee #2

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this work aims at proposing a new approach to determine the B isotopic composition of the oceans over the past 25 Ma. This is one of the three pillars of the atmospheric pCO₂ reconstruction over geological timescales from B isotopes in marine carbonates. The two other pillars are the pH dependence of the B isotopic fractionation and the change of seawater alkalinity. Even if the few $\delta^{11}\text{B}_{\text{sw}}$ reconstructions published so far all point to a slow increase during the last tens of Ma, they are all based on models and assumptions that are sometimes difficult to ascertain. In that, any effort to provide new and independent approach is the most welcome for the scientific community. Since it is definitely a tricky task, any effort of developing new approaches has therefore to be acknowledged. The past $\delta^{11}\text{B}_{\text{sw}}$ modeled in this study is based on new B isotopic

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data on paired planktic and benthic foraminifera. Two scenarios have been tested to derive $\delta^{11}\text{B}_{\text{sw}}$: the first one assumes a constant pH gradient along the seawater depth-profile and the second one uses $\delta^{13}\text{C}$ data to model possible variation of the seawater pH depth-profile. Even claimed to be a new approach by the authors, using paired foraminifera living at different depths in the water column was first introduced by Pearson and Palmer (1999). The originality of the present work is the attempt to anchor this approach with other data ($\delta^{13}\text{C}$) and climate model. Finally, the present work ends with a model of evolution of the marine $\delta^{11}\text{B}_{\text{sw}}$ very close and consistent with the previous work, which is already fine, but the large scatter of data (Fig 9) makes possible any $\delta^{11}\text{B}_{\text{sw}}$ value between +42‰ and +32‰. After data smoothing (which statistical meaning being questionable from a so small database), the authors end with a narrow range of possible values which spreading approaches the uncertainty of previous approaches (see fig. 10). This is then a bit disappointing and this could be easily corrected if the paper starts with a more upfront position and objective of their work in comparison to previous ones. This starts in the abstract: one of the most discussed issue of using B isotopes in carbonates to reconstruct past seawater pH is first the actual relationship between the B isotopic fractionation and the pH. So far, many works have provided “calibration curve” using different foraminifera species, and they all come with differences attributed to “biological effect”. Another point is the B speciation in carbonates and the actual process of B incorporation. I personally think that most of the published $\delta^{11}\text{B}_{\text{sw}}$ are actually consistent and what we need now is a more accurate model that will narrow the range of possible values. The present work also needs to acknowledge that the approach based on paired foraminifera living at different depths in the water column was first proposed by Pearson and Palmer in 1999! Later, sensitivity tests carried by Pagani et al. (2004) showed that this approach is rather inaccurate.

In Fig. 1 is presented a simplified B cycle in the ocean but, presented as it is, there is a large imbalance between inputs and outputs: the B inputs by precipitation is one order of magnitude higher than the sum of all the others. Then, either this input flux is bal-

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anced by output by seasalts or evaporation of gaseous B and then this loop is that fast that it must be taken into account, or atmospheric B derives from a continental source and a huge output flux is missing. One possibility is that the atmospheric B content (certainly in gaseous form and not seasalts) derives from anthropic activities, which are irrelevant for reconstructions on geological timescales. Whatever, the explanation is, the B marine cycle like presented in fig. 1 at least useless if not wrong. I would therefore strongly suggest to revise this figure and the corresponding text, in particular lines 66-71 where the atmospheric fluxes are discussed.

There is one thing that we can taken for sure is the very long B residence time in the oceans. This is held by the very high B concentration in seawater (about 500 times more concentrated than river waters). Therefore, whatever the model or indirect determination of the $\delta^{11}\text{B}_{\text{sw}}$, large and rapid variation of $\delta^{11}\text{B}_{\text{sw}}$ like those mentioned in line 86 are unrealistic as long as we do not identify a huge B flux, missed so far, that may have affected the B cycle over geological time scales.

A map of the sampling location would be appreciated

In equation (1), I think that ϵ (biological effect) would be appropriate and add in the text a discussion about the different calibration curves

section 2.2 is a succession of hypothesis and calculation made from a series of embedded models, which is certainly the best way to make estimation with our present knowledge, but a discussion of the possible errors propagated is critical here in a much more detailed and argued way than proposed in section 2.5. In particular, from what data is derived the estimation of ± 0.05 pH of the error made on the $\delta^{13}\text{C}$ -pH relationship (line 381)?

It is difficult to follow the section 3.2. The important information is finally given in the last 5 lines of this section. Please shorten and clarify

This is a bit frustrating to see $\delta^{11}\text{B}_{\text{sw}}$ values and discussion of them only in the last 2

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pages (lines 484-537). I would strongly suggest to shorten some of the previous parts and strengthen this last one.

One important point is the validation of the model and the statistical treatment made on the models d11Bsw values. At first sight, fig. 9. looks far from being convincing: a large scatter of the data, which looks like not providing strong new constraints and a significant restriction of the possible data by smoothing the small dataset?

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