

Comment 1

Carlos Jaramillo, jaramillo.pollen@gmail.com

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Dear Carlos,

Thank you very much for your interest in our study and your thoughtful comments on our manuscript. We hope that we could meet your expectations in the revised manuscript.

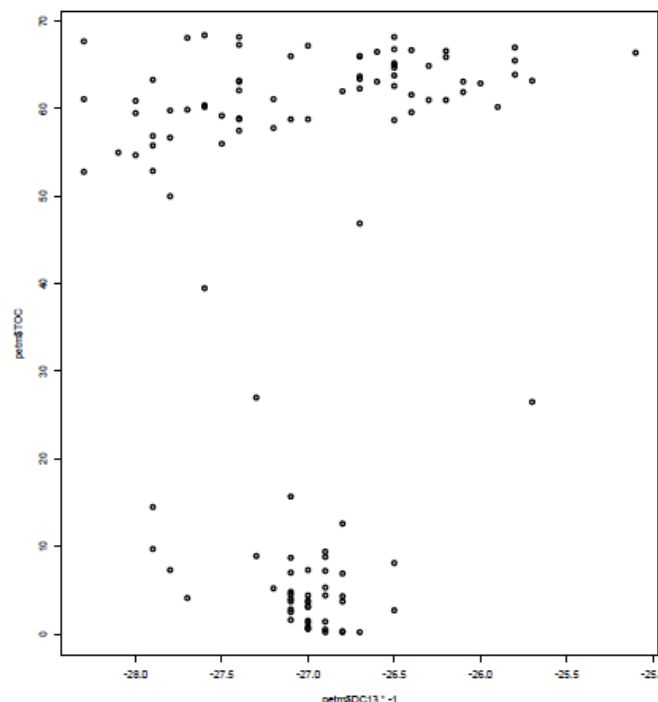
Katharina

This manuscript presents an interesting dataset, but there several problems that need to be solved before it can be published, including:

1. Raw palynological counts must be presented (rather than percentages)

- We acknowledge that these data should be presented and follow this suggestion. The raw palynological counts can now be found in the Appendix (section SI3, table SI3).

2. Because D13C values of bulk sediments can be affected by the total organic carbon of a sample (Wing et al Science 310, 993, 2005), the Wing residuals method (Wing et al Science 310, 993, 2005) needs to be used rather than the actual bulk value. In other words, the residual rather than the bulk needs to be plotted against the stratigraphy. I did a plot of TOC and D13C, see attached, and there seems to be a TOC-D13C correlation at both high and low TOC values.

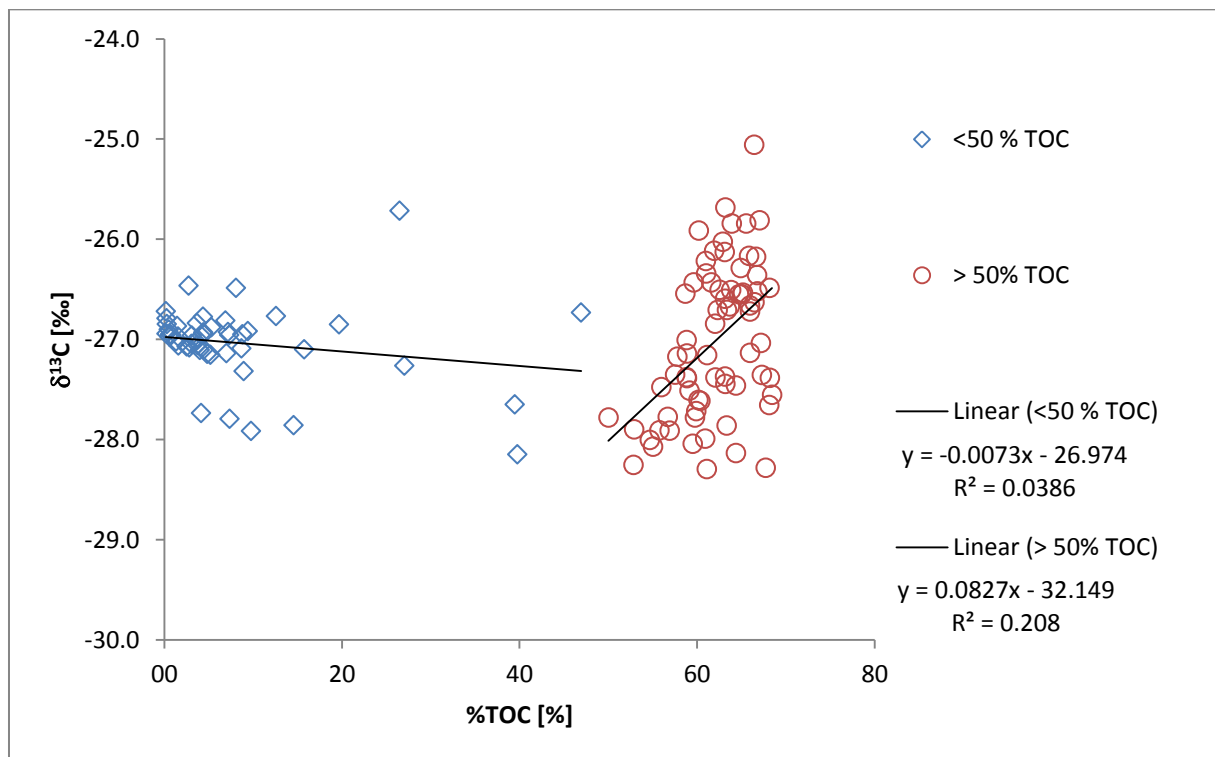
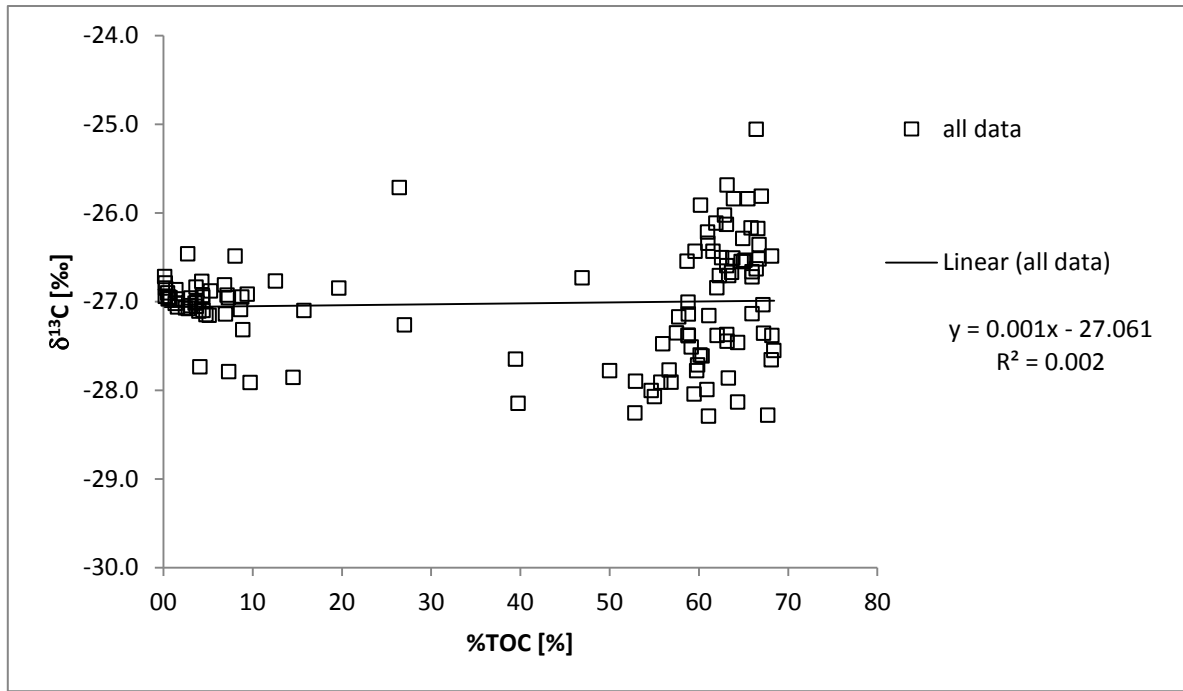


- We appreciate this comment as this method is a valid approach for carbon isotope ratios of soil TOC and %TOC (Wing et al., 2005) and very interesting to apply to our dataset.

- In brief, we find that a **direct assignment of this approach is not possible due to the very different nature of the two settings** (lignite seams/marine sediments and mud-rock paleosols). We deduced %TOC vs. $\delta^{13}\text{C}_{\text{TOC}}$ relationships from our data set and found very different results to Wing et al. (2005). In particular, we found no relationship across the whole data set ($R^2 = 0.002$), a moderate positive linear relationship for samples with %TOC >50% (lignite seams) ($R^2 = 0.208$), and again no relationship for samples with %TOC <50% (marine interbed) ($R^2 = 0.039$). If we nevertheless apply these “transfer functions” (for details see below), we **maintain the deduced negative carbon isotope excursion**.
- In summary, we feel that exploring on such a relationship in lignite samples and/or modern peat samples would go beyond the scope of this paper, but consider this an interesting approach that needs further investigation.

In detail:

- Wing et al. (2005) found a strong negative exponential relationship between %TOC and $\delta^{13}\text{C}_{\text{TOC}}$ in mud-rock paleosol samples in the sub-groups of PETM ($R^2 = 0.623$) and Paleocene-Eocene ($R^2 = 0.618$) samples. For comparison, modern soil samples show a coefficient of determination of 0.952.
- Plotting our data (with the %TOC as the independent variable and $\delta^{13}\text{C}_{\text{org}}$ as the dependent variable), **no such relationship could be determined** (see plot below). The coefficient of determination (R^2) is 0.002 and a F-test revealed no statistical relationship between these two variables.
- Considering only lignite values with %TOC > 50% yields a moderate positive linear relationship ($R^2 = 0.208$) that is statistically significant (F-test). Considering values of %TOC < 50% (marine interbed, with typical %TOC <10%), we found a weak negative linear relationship ($R^2 = 0.039$) that is statistically not significant (F-test).
- Applying the deduced regressions (as transfer functions) *-even though the second regression is not significant-* to our data set in order to plot the residuals from expected $\delta^{13}\text{C}_{\text{TOC}}$ values, **maintains the deduced negative carbon isotope excursion**. The magnitude is slightly reduced at the CIE onset with -1.22 ‰ (compared to -1.66 ‰) and CIEs of -1.01‰ (-1.27 ±0.29 ‰, “mean-mean”) or -1.37‰ (-1.74 ±0.46 ‰, “mean-most negative value”).



3. Something is not quite right about the PETM thickness. There are 180 meters for the Lower Eocene in the section (fig 2, and fig 3 of Brandes et al paper). Early Eocene spans 8.2 my, that would give 45Ky per meter, and 10 meters would be about half a million years, that is twice to three times the span of the PETM. Brandes did a basin modeling analysis and ages for the modeling were derived from “interpolated from literature data” (Table 2). And the “literature data: in the paper refers to “According to these sources, a sample from slightly above the Main Seam has been assigned to dinoflagellate zone D5b (Ahrendt et al., 1995), the base of which is dated to about 54.8 my b.p. (Kothe, 2003). The latter age may thus serve as an approximation for the base of the Main Seam (Gurs et al. ,2002) and the

Schoningen Formation. A radiometric age of 46 my b.p. and dinoflagellates indicative of zone D9na have been derived from slightly below the Heidberg unit by Ahrendt et al. (1995) and Lietzow Ritzkowski (1996, 2005a), but a discrepancy is caused by the fact that according to Kothe (2003), dinoflagellate zone D9a ranges from 50.51 to 48.5 my b.p”.

It seems that 1) the Brandes modeling is not independent as it relies on the ages, and 2) ages themselves have discrepancies. If zone D5b is slightly above Main seam, it would imply for the PETM to be below, not above the Main Seam. The most difficult task when working the PETM is having strong evidence of the precise stratigraphic location of the PETM. It should be fully demonstrated. This manuscript requires a much stronger argument to support the position of the PETM. For instance, it would very useful to have the D13C1 record of the entire early Eocene to see if the long-term negative excursion of the EETM is recorded.

- Both points raised in this comment are correct: 1.) the modeling presented by Brandes is not independent of the age constraints and 2.) the ages have its own discrepancies.
- Concerning 1.) Brandes et al. (2012) performed basin modelling of the Schöningen basin/rim syncline with a focus on the basin burial history. They found: “A clear decrease in sedimentation rates through time can be observed. In the early phase of basin evolution, the sedimentation rates were high, with values of 60–80 m/Myr during the formation of the Main Seam and Seams 1 and 2. Subsequently, the sedimentation rates decreased to 32–56 m/Myr during the formation of Seams 3–9.” (Brandes et al. 2012, Basin Research, 24, p. 709). Therefore we applied a sedimentation rate of 60-80 m/Ma to our records (comprising Seam 1 and Seam 2), rather than an average sedimentation rate.
- However, due to major rewriting of the manuscript now focusing on the description of the CIE rather than its assignment to the PETM, we do not feel that calculation the event duration in such an environment is robust or required and, therefore, we deleted parts of this paragraph.
- Concerning 2.). The weakness of the age constraints has also been noted by the reviewers and in short comment #2. We therefore address this more prominently in the manuscript by including a separate section (section 2, p. 3/4).

4. A simple inspection of the pollen data is not enough. The palynological analysis requires a statistical test to support the conclusion that there is little change across the PETM. For example, a multidimensional scaling could be run using the Chao-dissimilarity index to test if the differences within PETM samples are as high as differences among pre, post and PETM samples.

- We appreciate this valid request and followed the suggestion of the reviewer. Non-metric multidimensional scaling was performed for the pollen and spore data set without algae using the Bray-Curtis dissimilarity and the Wisconsin double standardized raw data values.
- More details are given in the method section (section 3.3: p. 5, ln. 30 - p. 6, ln. 9) and the results section (section 4.3, p. 11, ln. 1-9 and p.12, ln. 15-18). In addition to this, we included a new figure 6 showing the results of the NMDS analysis.

Page 2 line 9: A. augustum

- We followed the suggestion of the reviewer and inserted “augustum” (p. 3, ln. 23).

Page 5: line30 to Page 6 line 16: this part should be rewritten with more care, in the view of the main comment about the definition of this interval as the PETM

- We appreciate this valid request. As stated above, we rewrote the manuscript in order to 1) describe the detected CIE, 2) give hypothesis about the interpretation of the CIE and 3) make a more tentative comparison of the existing lignite records (see reply above).

Page 6 line 12: add a reference here for the PETM duration

- Due to the major changes in this section of the manuscript, the questionable paragraph has been deleted.