

Comment 2

Gerald Dickens, jerry@rice.edu, Received and published: 19 March 2019

Apologies, but things got scrambled in .pdf conversion. I now also see that Carlos Jaramillo gave commentary. His main critical point is the same as mine: basically, how do you know you are looking at PETM? Recent papers by Slotnick et al. (NZJGG, 2015), Laurentano et al. (COP, 2015), Luciani et al. (COP, 2016) and Westerhold et al. (Paleo. Paleo. 2018) really highlight this issue. The MS should very much be rewritten to address this, although as noted, a very good paper can emerge irrespective.

Jerry

Dear Jerry,

Thank you very much for your interest in our study and your insightful and helpful comments. We really appreciated this and hope that the revised manuscript meets your expectations.

Katharina

– Page 1 – Lines 8-9: There remains zero evidence that the massive carbon input caused the warming during the PETM. Rather, all evidence suggests a coupled system where warming and carbon input are linked in positive feedback. Rewrite, especially as it ultimately relates to the MS content.

- Agreed. We acknowledge that this wording is clearly misleading and shouldn't appear in the abstract or the manuscript. As a result of major rewriting of the manuscript, the abstract has been changed significantly and this part has been deleted from the abstract.
- In addition, we carefully checked the remaining manuscript for this misleading causality, but couldn't detect any further records.

– Page 2 – Line 17: Change “shelves” to “continental slopes”. Phase boundary constraints do not allow gas hydrate to occur on continental shelves.

- We followed the suggestion of the reviewer and changed the wording accordingly. (p. 2, ln. 20)

Lines 20-21. This should be reworded. As highlighted by Sluijs and Dickens (2012), there is a major difference between the local expression of the global CIE across the PETM, and what occurred to exogenic carbon cycle (where mass balance comes into discussion).

- We acknowledge this comment and extended this paragraph in order to be more careful to distinguish local preserved CIEs vs. the global carbon cycle perturbation. (p. 2, ln. 24-29). This adds to a major part of the review #2, being concerned about carbon signal mixing and the local vs. global significance of the record to the global CIE that we address in section 4.1.

Line 27: Importantly note that coastal wetlands are generally a location of transient carbon storage on the time scale relevant to the PETM. Carbon is generally not buried in these environments on the >10,000 year time scale, especially when considering changes in sea

level, although there are obviously some good examples (aka the present-work). The current writing sort of recognizes this – it's the word "sink" that is problematic.

- We agree with the comment that coastal peatland can act as both, sources and sinks of carbon on different timescales. We followed the suggestion of the reviewer and changed the wording to dampen the emphasis of wetlands being a carbon sink. (p. 2, ln. 32 – p. 3, ln. 3)

– Page 3– **Lines 3-16: It should be noted that spikes in Apectodinium abundance occur during other hyperthermals of the early Paleogene. The key to the PETM is that there is a special marker species (*A. augustum*) that seems to have existed only during the PETM. Without documenting this dinocyst, the stratigraphic record shown could be one of the proximal hyperthermals (e.g., HI/ETM2).

- Please see reply below.

– Page 5– **Lines 30-31: As above, it has not been demonstrated that this horizon is, in fact, the PETM. Importantly, though, at one level it does not detract from the MS significance, because there is a growing view that the main hyperthermals are related and have similar systemic responses. If it cannot be conclusively proven that the interval is the PETM, this should be stated. There should then be some key rewriting and an additional paragraph that notes that much is written with an assumption, but most of the basics would also apply if the interval was instead another lesser but major early Paleogene hyperthermal.

- This is a major issue that has been similarly addressed by all reviews. We acknowledge that in the first version of the manuscript a clear assignment of our detected CIE to the PETM might have been too bold.
- We acknowledge this by
 - (1) adding a whole new section (now section 2) to the manuscript in order to describe the available age constraints and the pitfalls/discrepancies of them in more detail (section 2; p. 3, ln. 13 – p. 4, ln. 10)
 - (2) being more careful in our wording while describing solely the CIE and not unequivocally relating the CIE to the PETM, ETM2 or any other Early Eocene hyperthermal (section 4.1; p. 7, ln. 20-24).
 - (3) discussing tentatively the possible assignment of the CIE to the PETM vs. any other Early Eocene hyperthermal (section 4.2; p. 8, ln. 16-20)
- We rephrased major parts of section 3.1, now section 4.1 (p. 6/7) and included a statement that we compare the European wetland records despite the possibility that they may reflect different hyperthermal events in section 4.2 (p. 7, ln. 31 – p.8, ln. 6) and 4.4 (p. 12, ln. 25-29).
- In order to place our results in a more regional framework, we still perform the comparison with nearby lignite sites (Cobham, Vasterival) in which the reported CIEs have been assigned to the PETM. We feel, in agreement with this comment, that this comparison might still be valuable to detect similar behaviors of these Paleogene wetlands during carbon cycle perturbations. However, we now clearly state that there is no sufficient proof that these records are time-equivalent as they all have their limitations when it comes to age assignment (in section 4.1, 4.2 and 4.4).

Starting about Line 18, the reading gets awkward, because not always clear what constitutes a paragraph.

- We appreciate this comment and checked the formatting of the manuscript as well as the composition of the paragraphs to provide better clarity/readability to the reader. Adding to the comment and reply above, this paragraph has been largely rewritten (p. 6/7).

– Page 6– Lines 15-16: Note that the good and intriguing ideas presented by Trampush and Hajek do not really apply to most deep-sea records, from which the duration has been estimated.

- We appreciate this comment very much. We use this study to demonstrate that each record, especially terrestrial records, can be subject to large variability in proxy signal recording. However, as the available age constraints of the Schöningen Formation, also used by Brandes et al. (2012) to deduce sedimentation rates, are currently rather weak and a major change of the manuscript is the description of the CIE rather than its assignment to the PETM, we do not feel that calculation of the event duration in such an environment can be robust. Therefore, we deleted parts of this paragraph.

**Line 24+: This is interesting, but all hinges on the correct stratigraphy, something that has to be bolstered better.

- We address the possibility that the detected CIE is related to the PETM, but similarly to any other Early Eocene hyperthermal in an open way to the reader (p. 7, ln. 20-24; p. 7, ln. 31 – p.8, ln. 6; p. 8, ln. 16-20; p. 12, ln. 25-29).
- As stated above, we – despite assessing the CIE in a more open way, not relating it to a particular hyperthermal – feel that it is still valid and useful to make such a regional comparison with other nearby Early Eocene lignite records. To provide clarity to the reader about this, we included short statements in section 4.2 (p. 7, ln. 31 – p.8, ln. 6 and p. 8, ln. 16-20) and section 4.4. (p. 12, ln. 25-29)
- The comparison of the detected CIE with the reported PETM-related CIEs (Cobham, Vasterival) reveals some striking similarities between these records. As a consequence, one can hypothesize that these records reflect either the same hyperthermal event (presumably the PETM as the Cobham and the Vasterival records are assigned to it), or, alternatively, Early Eocene carbon cycle perturbations/hyperthermal events affecting wetlands along the paleo-North Sea in a similar way.
- In regard to this, we are aware of a third hypothesis namely that all three CIE records reflect the same hyperthermal that is NOT the PETM. However, we try to be as careful as possible without judging upon pitfalls of other studies.
- Overall, we feel in agreement with this comment that this comparison might still be valuable to detect similar behaviors of these Paleogene wetlands during carbon cycle perturbations.

– Page 11 – Line 2: Okay, except then, the prominent CIE was not caused by the burning of peat. Overall, this is important and relates to the initial comment above – the CIE and associated massive carbon input was very likely mostly/partly a response to major changes in Earth systems not the primary driver.

- We agree with this comment and try to be careful in phrasing this relationship.