

***Interactive comment on “A dynamic climate and ecosystem state during the Paleocene-Eocene Thermal Maximum – inferences from dinoflagellate cyst assemblages at the New Jersey Shelf” by A. Sluijs and H. Brinkhuis***

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**AUTHOR COMMENT**; detailed reply to the referee comments We thank referee 1 for his/her positive review and constructive comments. They have enabled us to improve the quality of the manuscript tremendously. Below we discuss all points raised by a reply after the comment by the reviewer.

Appy Sluijs and Henk Brinkhuis

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Review of manuscript of A. Sluijs and H. Brinkhuis, "A dynamic climate and ecosystem state during the Paleocene-Eocene Thermal Maximum – inferences from dinoflagellate cyst assemblages at the New Jersey Shelf"

Anonymous Referee #1

Received and published: 16 June 2009

#### GENERAL COMMENTS:

The paper by Sluijs and Brinkhuis provides abundant new information on the paleoenvironmental significance of cyst-forming dinoflagellates during the Paleocene-Eocene Thermal Maximum (PETM), an extreme greenhouse interval of the Earth's history. Particular emphasis is given to identifying the factors that govern the distribution of the Apectodinium plexus, a group of dinoflagellate cysts with a distribution pattern that is intimately linked with the PETM. Through the integration with information from other, previously published paleoenvironmental proxy data (i.e., TEX-86 paleothermometry, grain-size distribution, magnetic susceptibility), and supported through statistical methods (CCA, PCA), the authors successfully aim at further refining our understanding of the series of events that characterize this extreme warming event. Overall, I consider the paper to be well suited for publication in "Biogeosciences". With regard to its scientific significance, I consider it to be of very high quality: The paleoenvironmental information that the authors deduce from dinoflagellate cyst assemblages on the New Jersey shelf represents a significant step forward in the use of fossil dinoflagellate cysts as proxies in paleoceanography and paleoclimatology. The applied methods appear well selected, and the results are thoroughly discussed. With regard to the quality of presented results, I found it somewhat difficult to decipher the information on some of the figures (specifically, Figs. 2a-b and 3a-b) because these are only available in a very small size (possibly due to the layout of "Biogeosciences Discussion", in which case this limitation would obviously not be within the responsibility of the authors); otherwise, the quality of the figures is very high. The text is generally well structured and

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well written – my only criticism here being that some sentences are quite long and sometimes somewhat convoluted, with the result that readers may lose track of what the authors are trying to convey. The title clearly reflects the contents of the paper, as does the abstract.

SPECIFIC COMMENTS: Introduction, Line 5: I suggest to add a reference to the IPCC report here.

Reply: done

Introduction, Line 15: Please specify on the warming: Do you mean globally, or in the high latitudes, or in the tropics?

Reply: global. Now indicated

Material, Line 12: "closer to the paleoshoreline" – than what? I presume that it is meant with respect to Bass River, but please rephrase in order to maximize clarity.

Reply: done

Processing and Analyses, Line 14: I suggest to add a reference to Pross and Schmiedl (2002, Marine Micropaleontology 45, 1-24) here because that paper presents a paleoenvironmental interpretation of Paleogene dinoflagellate cyst assemblages based on principal component analysis, which makes it a precursor of the work of Sluijs and Brinkhuis.

Reply: We have included this, and another reference in a new sentence at statistical analyses.

Dinocyst distribution patterns, Line 13: "Just prior to the onset of the PETM" – how much earlier (in kyrs) is meant here? Please specify.

Reply: Approximately 5 kyrs, which is now included.

4.1.1, Temperature, Line 1: To substantiate this statement, please give reference for

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an observation of this phenomenon in Recent dinoflagellate (cyst)s.

Reply: done

4.1.3, Heterotrophy, Lines 17-19: The sentence states that "several authors" have suggested heterotrophy for Apectodinium, but only one reference (i.e., Bujak and Brinkhuis, 1998) is cited. Because the paleoecology of Apectodinium is a major issue of the entire paper, I would like to see more references of papers that comment on the potentially heterotrophic nature of Apectodinium.

Reply: We included several more references

4.1.3, Heterotrophy, Page 5174, Line 9: This increase in nutrient availability in shallow-marine settings should be documented palynologically by an increase in the pollen and spore flux (as a result of an enhanced hydrological cycle). Do the authors see such a signal in their data? I realize that they comment on this phenomenon later in the manuscript, but I suggest to discuss this aspect here.

Reply: Unfortunately, as discussed in the MS, we have recorded only trace amounts of terrestrial palynomorphs in our samples. Following this comment by the referee, we have included this aspect in the discussion on the mechanism of marginal marine eutrophication.

A variable climate state during the PETM?, first paragraph: Please make clear (in this paragraph and elsewhere) if you are dealing with relative or absolute (i.e., cysts per gram) abundances.

Reply: we have included the subsentence 'both in the relative and absolute quantitative records (Figures 2 and 3)'

Synthesis/concluding remarks, Lines 24-26: Although the authors clearly indicate that they are entering the realm of speculation here, they may be taking things a little too far here. Is there any analogy for such a scenario elsewhere in the geological record? If yes, this would have the potential so seriously strengthen their case. How about shifts

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in atmospheric circulation patterns resulting from the overall warming as a potential cause?

Reply: There is no analogue, as far as we know, especially because we do have evidence for at least seasonal river run off. As indicated, this is just a speculation and we have no further evidence for it.

Sections 4.11, 4.1.2, 4.1.3, 4.2, and 4.3: These sections – and thus the clarity of the entire ms – might benefit from brief summaries given after each individual sections.

Reply: We have chosen not to include separate summaries for all sections, because most of them are not extremely long. The last paragraph of the section on heterotrophy in Apectodinium has been revisited to act as a summary paragraph because the section is rather long.

#### TECHNICAL CORRECTIONS:

Reply: We have corrected all below points.

Introduction, Line 17: Replace "measured" by "documented". Material, Line 13: Replace "indicated" by "indicates". Material, Page 5168, Line 5: Replace "in" by "by". Dinoflagellate cyst ecology and grouping of taxa, Line 24: Replace "chemophysical" by "physicochemical". Page 5169, Line 3: Delete "and differences in those details". Page 5169, Line 9: "first-order". Page 5169, Line 10: "physicochemical, not "physiochemical". Page 5170, Line 4: Delete "of". Page 5170, Lines 8-12: Sentence too long! Page 5169, Line 24: "Prior to the PETM, assemblages both at Wilson Lake and Bass River are dominated...". Page 5172, Line 4: "quasi-global". Also, delete comma in front of Apectodinium. Page 5172, Lines 9-10: Cut into two sentences. Page 5172, Line 20: Add "at that time" after "taxon". Page 5173, Line 22: Delete "suggesting that they are related". Page 5176, Lines 6-9: Long sentence, please divide into two sentences. Page 5176, Line 21: Replace "But" by "However, ". Page 5178, Line 1: "associated to the precessional cycle". Page 5178, Line 16: "invoke". Page 5179, Line 20: "Milankovitch".

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Page 5179, Line 22: Delete "do". Page 5180, Line 21: Delete "s" in "cysts". Page 5181, Line 25-27: Give references for stratigraphic occurrences. References: It appears that the journal title "Palaeogeography, Palaeoclimatology, Palaeoecology" is consistently abbreviated as "Palaeogeogr. Palaeocl." Is this (which strikes me as rather unusual) really the format of Biogeosciences? Please check. Table 1: Please delete the "a" in front of many comments in the "Description" column. In the column "Remarks", please replace "not truly outstanding" by "not truly clear". Also, please rephrase the last statement in this column ("tentative correlation, not truly" – is this supposed to be a complete statement?).

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