

## ***Interactive comment on “Latitudinal differences in the amplitude of the OAE-2 carbon isotopic excursion: $p\text{CO}_2$ and paleoproductivity” by E. C. van Bentum et al.***

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General comments – The study of Bentum and colleagues presents a new  $\delta^{13}\text{C}$  record of sulfur-bound phytane ( $\delta^{13}\text{C}_{\text{phytane}}$ ) from the OAE-2 interval at Site 1260 that resolves the well-known carbon isotope excursion with an extraordinarily large magnitude of 7 permil. Differences in the isotopic fractionation between the inorganic carbon reservoir and  $\delta^{13}\text{C}_{\text{phytane}}$  records of four sites in the Central Atlantic Ocean (Site 1260, Site 367, Tarfaya and Site 603B) are interpreted to reflect a tropical-subtropical gradient in surface-water productivity. Furthermore, the authors calculated a drop of atmospheric  $\text{CO}_2$  from 1750 to 900 ppm during OAE-2 based on TEX86-derived sea

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surface temperatures (SST) and the  $\delta^{13}\text{C}_{\text{phytane}}$  record from Site 1260B. The occurrence of an intermittent brief cooling interval is interpreted to reflect the climatic response of atmospheric  $\text{CO}_2$  reduction by enhanced rates of organic carbon burial.

Specific comments – The consideration of a regional pattern in changes of surface productivity is a very interesting approach. However, I think the quality of the paper can be improved if some additional aspects will be addressed.

(1) The main result of this study rests on the discrimination of the magnitude of carbon isotopic fractionation between a global component that represents enhanced rates of organic carbon burial and a regional productivity-related component. The contribution of organic carbon burial is estimated to have been 2.5 permil based on inorganic carbon  $\delta^{13}\text{C}$  records. Although this value is widely accepted in the scientific community, it is founded on analyses of chalk and limestone which all experienced a certain degree of burial diagenesis. Here, I want to make aware that the only pristine inorganic OAE-2  $\delta^{13}\text{C}$ -record we know to date has a magnitude of 4 permil (Voigt et al. 2004). This higher magnitude is identical with values derived from terrestrial organic matter that reflect changes in the isotopic composition of the atmosphere and therefore the global component of the OAE-2 excursion (Barclay et al. 2010). A higher magnitude of the global OAE-2 excursion would have significant influence on the calculation provided in this study.

(2) The temporal relationship between atmospheric  $\text{CO}_2$  reduction and surface water cooling as feedback of  $\text{CO}_2$  sequestration is not as well constrained as the authors have stated it. This becomes especially evident from the data presented for Site 1260 in Figure 6. The initial  $\text{CO}_2$  rise occurred in pre-OAE-2 times while the rise in SST that should be associated, is related to the initial phase of OAE-2. A similar temporal offset is evident for the proposed relation between declining atmospheric  $\text{CO}_2$  values and SST. While the  $\text{CO}_2$  reduction is related to the initial OAE-2, the SST cooling is significantly delayed. According to the available astronomical age models of OAE-2 (Sageman et al 2006, Voigt et al. 2008) these temporal offsets are in the order of

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10s to 100 kyr. Such long time spans are not consistent with the response time of the ocean-climate system today and are also not supported by results OAE-2 ocean-climate modeling (Flögel et al. 2011).

(3) Another question that arises from the proposed relation between productivity, organic carbon burial and atmospheric CO<sub>2</sub> reduction is, why is the cold event such a brief pulse, while high organic carbon burial rates and low atmospheric CO<sub>2</sub> concentrations persisted through the entire OAE-2 interval? Are there additional mechanisms involved?

(4) Site 1260 is the most condensed OAE-2 succession among all sites along the Demerara Rise transect (Erbacher et al. 2005, Hardas and Mutterlose 2006). The probability that the OAE-2 interval is completely recorded, as stated in paper, is rather low.

Technical comments – A list of corrections is already provided by the two previous reviewers. Here, I will only add some additional points:

Page 6194, line 15 – Somewhat unclear. Which carbon isotope record is meant with “this carbon isotope record”?

Page 6196, line 5 – The “sandy limestones” are foraminiferal packstones (Nederbragt et al. 2007).

Figure 4: The latitudinal  $\delta^{13}\text{C}$  gradient of recent organic matter (Rau et al. 1982) appears as a straight line. What is the data base for it? Does it reflect data from two single sites or represent it the linear regression of results from many sites? The different length of arrows needs to be explained in the figure caption.

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