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Climate of the Past Discussions

Interactive comment on "Carbon isotope excursions in paleosol carbonate marking five early Eocene hyperthermals in the Bighorn Basin, Wyoming" *by* H. A. Abels et al.

Anonymous Referee #2

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This manuscript aims to take a step back at the earth system through the behavior of the Paleogene hyperthermals. I appreciate the broad scope and comparative approach of looking at different carbon isotope excursions in different archive materials to try to understand the overall system. They compare new terrestrial records of I1 and I2 in comparison with ETM2, H2 and then also look at the PETM. They find that all five events show linear relationships between foram and bulk sediment carbonate carbon isotope shifts. The four younger and smaller hyperthermals also seem to track linearly between terrestrial and records. All of these relationships are linear and through the origin. The PETM terrestrial-marine comparison, on the other hand, does not fall on the line with the other hyperthermals. Linear extrapolation of the relationship for the 4

smaller events would predict a terrestrial soil carbonate CIE of ∼9.5‰ for the PETM, whereas what is observed is ∼6‰

The authors explore the potential for a large change in pCO2 to change carbon isotope discrimination in plants and drive the mismatch observed for the PETM. The other reviewer found several things to query in their analysis. I would hope that the review process will enable these questions to be resolved.

I think the very interesting result that could perhaps be emphasized more strongly is that there appears to be a non-linear response on land and not in the ocean. The marine-marine comparison behaves more linearly than the terrestrial-marine comparison. There may be many reasons for this, and the paper explores primarily pCO2, although they mention a few others. I wonder if these other factors might be more explicitly or more fully explored.

I would encourage publication of this paper once any remaining issues with the estimated effects of pCO2 are dealt with. I would also encourage some greater discussions of other potential sources of non-linear response in the PETM.

Specific comments P 1861 line 5- states that C3 plants are "typically fractionated by -24‰ to-28‰ compared to atmospheric CO2". This is not correct. The authors are confusing carbon isotope fractionation (or discrimination) with carbon isotope values. The fractionation is on 20 ‰ relative to an atmosphere of ∼-8‰ which gives the value of ∼-28‰ (although it is not a strict subtraction.) To correct this they can simply say that plants are typically depleted in 13C relative to atmospheric CO2 and typically have carbon isotope ratios of -24 to-28‰(Note that this for carbon isotope ratios of modern atmospheric CO2).

P1870, Line 15- 19, These sentences confused to me. Can you break up the first one and make them crystal clear to the reader?

P 1871, line 16- Cite Diefendorf et al 2010 here and perhaps tip hat to efforts to look at

the effects of precipitation changes on carbon isotope ratios in plants.

P 1872, l 15, table 1, and Figure 5 caption all refer to a measured CIE in n-alkanes without properly referencing the source of this data or stating which n-alkane CIE they are referring to. For the Bighorn Basin, n-alkane data was presented in Smith et al., 2007. It was later analyzed in Diefendorf et al., 2010. The values for n-alkane CIE's varied depending on chain length. I think they authors are using C29. It would be helpful if this was stated. So the citations for the data itself (p 1872, table 1 and figure 5) should be to the original source of Smith et al., 2007. The analysis of the data, e.g. in relation to the effects of changing rainfall on carbon isotope ratios of plants should refer to Diefendorf et al., 2010.

Figure 5 is confusing. Perhaps a simple table accompanying the figure would help. Some sample changes in pCO2 could be used with associated calculated change in the carbon isotope ratio of plants and the inferred effect on carbonates.

In the modeling, I wasn't clear whether the change in pCO2 was also being allowed to influence the carbon isotope ratio of the soil carbonate through invasion? If so, this could be made a bit clearer.

Interactive comment on Clim. Past Discuss., 11, 1857, 2015.