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Climate of the Past Discussions

Interactive comment on "Paleobotanical proxies for early Eocene climates and ecosystems in northern North America from mid to high latitudes" *by* Christopher K. West et al.

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We thank Lydie Dupont for her review and supportive comments on our manuscript. Below we respond to Dr Dupont's comments.

1. An important reason to study the Eocene is its high levels of atmospheric carbon dioxide. Please mention this aspect in the beginning of the Introduction.

Author Response: We will add some text to the introduction regarding the broader importance of studying the early Eocene, including elevated CO2 levels, and how it informs us of the global response of physical and biological systems to global climate

change.

2. I think that the more general readership of CP would need a little bit more explanation about the data. I assume that the data include only macro fossils, i.e. leaves, but this is nowhere explicitly stated. This is necessary because the BA-analysis is based on NLR-analysis, which is normally used with pollen data. If the BA-analysis is based on pollen data too, that fact should be mentioned and discussed as the taphonomy of pollen data differs strongly from that of fossil leaves.

Author Response: Our study indeed uses only data sourced from fossil megaflora; however, we do compare our data to some prior studies from contemporaneous high latitude sites that were based on pollen (Table 3). We will add a statement to section 2.1 Fossil Plant Localities that clearly explains to the reader that the data for our study was sourced from fossil megaflora.

3. It also would be helpful to mention which taxa are dominant/important in the assemblages of the sites described.

Author Response: Fossil megafloras from 19 different localities from Washington, British Columbia, Alaska, and the Canadian Arctic were used for this study. In our view, providing a site to site list of dominant taxa would not improve upon the manuscript. Instead, this would serve only to highlight: (1) a number of common taxa that can be found across all sites and which serve to link the polar broad-leaf forests of the high latitudes with the coniferous deciduous forests of the middle latitudes; and, (2) that various taphonomic factors are, as expected, at work across a broad range of sites over a broad latitudinal range that modulate differences between fossil assemblages. We feel it would be more appropriate, and in keeping with the focus of the paper, to explain more clearly in the text that the assemblage data can be found in the supplied references, where each of these sources list and discuss the assemblages in detail.

4. It is not clear if the new work in this study concerns the statistical analysis only, or that also new botanical analysis has been carried out. If new botanical analysis has

been carried out, the method section has to be complemented.

Author Response: The reviewer raises an important point. Our study does include data and analyses from previous studies, but also includes new leaf physiognomic analyses of fossil floras from the Canadian Arctic and British Columbia. We will edit the appropriate section in the introduction to more clearly outline for the reader that new and existing data are used for our study. In addition, we will provide text that indicates which sites had new analyses conducted for this study.

5. I suggest to change the sequence of section 2.3. Please, explain the physiognomic and bioclimatic analysis first and then the combination of ensemble climate analysis.

Author Response: We agree that this sequence may be more logical. We will edit the text as recommended and place the leaf physiognomic and bioclimate analysis methods before the explanation of the ensemble climate approach.

6. Please leave out the decimals of the temperature and precipitation estimates as they are obviously not significant.

Author Response: One decimal place is appropriate for temperature, as it correctly indicates the precision of our estimates, the precision of the underlying calibration data, and the uncertainty of the estimates. Retaining one decimal for temperature is also consistent with how temperature estimates are reported across multiple research teams for these proxies and, importantly, as used in climate model-proxy comparisons – so has been retained for reasons of consistency and also to correctly show the precision of the estimates. We will, however, remove the decimals from the precipitation values as their precision does not warrant the decimal values.

7. In the discussion, I miss an important point, which has been already discussed by the first author in an earlier paper (West et al. 2015) but should not be forgotten. The photic regime of the poles (more diffuse summer light than at lower latitudes) might result in bigger leaves and, therefore, precipitation estimates might have been

overestimated.

Author Response: We will add a brief statement to the discussion that outlines the influence of this potential bias to precipitation estimates.

8. The tables and Fig. 1 could include more information. Please, indicate in the caption of Fig.1 and also in Table 2 the categories 'Mid-latitude Upland' etc. as used in the paper.

Author Response: We will edit the captions for figure 1 and table 2 to include this information.

9. Please, give a more precise age indication in Table 1 and also give an indication of the ages of the data summarized in Table 3.

Author Response: Precise age data are available for some of the fossil localities used for this study, as they have received considerable attention or are easily accessible; however, some fossil localities do not have precise age data. For this reason, we feel that the ages as listed in Table 1 are as precise as is possible at this time, and sufficiently accurate for the purpose of this study. We agree that ages would aid in the presentation of data in Table 3 and will add the published ages to this table.

10. Specific Comments:

Lines 110-112: needs a reference; please give an estimate of polar displacement.

Author Response: We will add several references to this statement as requested; however, as the estimate of displacement is not uniform from the mid-latitudes to the high-latitudes, and depends on the method and model used to estimate displacement, we feel that adding a specific value (or range of values) would serve only to introduce confusion into our text and would not improve upon our interpretations. We therefore include only a general statement on polar displacement.

Line 227: Physg3brcAZ is not mentioned in Yang, but mentioned in Jacques et al.

2011.

Author Response: The Physg3brcAZ CLAMP dataset was first mentioned in Wolfe (1993). As the datasets have been subject to improvement over time, Yang et al. (2015) represents the most up-to-date improvement of the CLAMP method, which saw the inclusion of a global dataset, and as such includes a recent review of the methodology behind the datasets themselves. However, we recognize that Yang et al. (2015) does not specifically mention the Physg3brcAZ or GRIDMet3brcAZ datasets employed for our study. We will revise the reference on line 227 to cite not only Yang et al. (2015), but also Yang et al. (2011) – a prior study that discusses the CLAMP Online architecture and specifically discusses the datasets used for this study – as well as the original paper by Wolfe (1993) where the Physg3brcAZ dataset was introduced. Jacques et al. (2011), a study primarily focused on detecting monsoonal climate signals in physiognomic data, does reference the Physg3brcAZ CLAMP dataset; however, this would be an incorrect source to cite in this case, so we have added Yang et al. 2011.

Line 228: GRIDMet3brcAZ: Yang mentions GRIDMetGlobal378_HiRes. Is that the same dataset?

Author Response: GRIDMetGlobal378_HiRes is not the same dataset as GRIDMet3brcAZ. However, please see our above response.

Line 305: 3.1.2 (instead of 3.2.2)

Author Response: We will correct this. Thank-you for catching this oversight.

Line 433: please, mention the kind of fossil evidence.

Author Response: We will add a short list of fossil examples to the text as requested.

References:

Jacques, F.M., Su, T., Spicer, R.A., Xing, Y., Huang, Y., Wang, W. and Zhou, Z.: Leaf physiognomy and climate: are monsoon systems different? Glob. Planet. Change,

76(1–2), 56–62, 2011.

Wolfe, J.A.: A method of obtaining climatic parameters from leaf assemblages. US Government Printing Office, (No. 2040-2041), 1993.

Yang, J., Spicer, R.A., Spicer, T.E. and Li, C.S.: 'CLAMP Online': a new web-based palaeoclimate tool and its application to the terrestrial Paleogene and Neogene of North America. Palaeobio. Palaeoenviron., 91(3), 163, 2011.

Yang, J., Spicer, R.A., Spicer, T.E., Arens, N.C., Jacques, F.M., Su, T., Kennedy, E.M., Herman, A.B., Steart, D.C., Srivastava, G., Mehrotra, R.C., Valdes, P.J., Mehrotra, N.C., Zhou, Z., and Lai, J.: Leaf form – climate relationships on the global stage: An ensemble of characters, Global Ecol. Biogeogr., 24, 1113–1125, 2015.

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