Biogeosciences Discuss., 11, C9449–C9461, 2015
www.biogeosciences-discuss.net/11/C9449/2015/

Biogeosciences
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Interactive comment on "Stable isotope paleoclimatology of the earliest Eocene using kimberlite-hosted mummified wood from the Canadian Subarctic" *by* B. A. Hook et al.

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Received and published: 11 September 2015

Response to: Interactive comment on "Stable isotope paleoclimatology of the earliest Eocene using kimberlite-hosted mummified wood from the Canadian Subarctic" by B. A. Hook et al. Anonymous Referee #2 Received and published: 8 September 2015

Response by Benjamin A. Hook (corresponding author) on 10 September 2015

The comments made here by Referee #2 (In Italics) have led to improvements in the clarity and presentation of the Results and Discussion section, as well as details regarding the samples. Here I respond to each comment, explaining the changes that have been made in the text. Following this response is the previous response to Ref-

eree #1. Finally, the track-changes document prepared for the comments of Referee #1 is included, with these additional changes in response to Referee #2.

1. I would say that the parts "1. Introduction" and "2. Methods" in the manuscript are comparatively quite clear and well-organized. The part "3. Results and discussion", however, would terrify the readers. The authors should tease apart major points and re-organize this large block into fractions with sub-titles as they did in the parts "1. Introduction" and "2. Methods". This way it would be easier for readers to grasp the major points and their reasoning as well. The "Results and discussion" section has been reorganized in a similar format as the "Methods" section, with subheadings for sections 3.1 Subannual-resolution study (P21 L379), 3.2 Annual-resolution study (P22 L426), 3.2.1 Tree-ring width and stable isotope correlations (P22 L427), 3.2.2 Oxygen isotope analysis (P24 L482), 3.2.3 Carbon isotope analysis (P26 L606), and 3.2.4 Dual-isotope analysis (P29 L750). Hopefully this will help to clarify the results for the reader. 2. Please give more details about the mummified wood and the tree rings the authors examined. Just one piece of wood? Or wood of many trees? The wood samples they examined were of one tree species or not? How did the authors select tree rings for their study? If tree rings were from different trees? Did different tree species respond the same way to the changing climatic factors? More details on the mummified wood sampling have been added to the Methods and Results sections (2.1 and 3.2.1) to clarify these questions (P15 L202-224, and P22-23 L429-459, respectively). We sampled six pieces of Piceoxylon wood (same species), which appeared very similar in color, and tree-ring pattern. The samples were extracted during the course of diamond mining with heavy machinery by the Ekati Panda mining crew, and we were not present during excavation, so we are unsure of whether the samples originated from the same tree or not. However, some of the ring width correlations are unusually strong ($R > 0.9$), suggesting that the samples originated from the same tree at different places in the bole, and were later separated either during burial or removal from the ground. Three of the six samples were used for isotope analysis, creating an 86 y long master isotope chronology to compliment the 92 y long tree-ring width chronol-

ogy. Hopefully these changes will make it clearer to the reader exactly which samples were used to construct these records. 3. Page 16280 Lines 15-24: logically it is not clear why PC1 corresponds with ΣZ-score and PC2 with ΔZ-score. When conducting Principal Components Analysis (PCA) on δ13C and δ18O, the first eigenvector (PC1) corresponded with the strongest relationship, which in this case is the positive correlation between δ13C and δ18O. I found that the PC1 time series was nearly identical to a time series created by adding the normalized δ13C and δ18O datasets together (ΣZ-score). Conversely, the second eigenvector is orthogonal to the first, and PC2 was found to be nearly identical to a time series created by subtracting the normalized δ13C and δ18O datasets (ΔZ-score). Adding two time series that are both influenced by a common climatic parameter should amplify that parameter. Conversely, subtracting those same series should minimize that factor, and amplify factors that the two time series do not share in common. For instance, if δ13C and δ18O are both influenced by relative humidity or stomatal conductance, summing their Z-scores should amplify that signal. Conversely, subtracting them should negate that signal and amplify other climatic factors such as sunlight availability (cloudiness) for δ13C, and source water δ18O for δ18O of cellulose. However, while the comparison of PC1 to ΣZ-score, and PC2 to ΔZ-score, is quite interesting to me, it is not essential for the purposes of this article – the paleoclimatology of the early Eocene, and tends to confuse things for the reader more than is necessary. Therefore, I have decided to remove references to the PCA results, and focus instead only on ΣZ-score and ΔZ-score parameters, because I feel these are more intuitively understandable. In the methods section (P20-21 L367-377), a few sentences explaining the similarity between PC1 and ΣZ-score, and PC2 and ΔZ-score were removed. Additionally, in the results section, references to PC1 and PC2 were removed, using instead the variables ΣZ-score, and ΔZ-score (P30-31 L778-812).

4. Page 16281 Line 4 and Line 14 and ...: As the R values are quite small (below 0.5), this kind of relation can be termed as significant? Despite the fact that the R-values for EPA3 vs EPA4 (0.38), and cross correlations of isotopes (0.27, 0.22, 0.23) are rather

low, they were identified as significant if the p-values identified in the text were less than 0.05. Of course, "significance" is somewhat subjective to the interpretation of the reader, and varies by different scientific fields. In most ecological studies, p-values of less than 0.05 are commonly accepted. In the text, we have made changes to indicate that instances in which p-values < 0.05 but > 0.01 are termed as "marginally significant", and those values < 0.01 termed as "significant" (P23 L436, P23 L452-455). P-values and R-values are listed along with each analysis in the results. Additionally, we will include the source data along with the manuscript so that the reader may replicate the analyses.

5. Page 16282 Line 13: This passage is really confusing. Was the stomatal conductance an important factor or not? If the first 4-8 tree rings were included, then the positive correlation would suggest that stomatal conductance was important. However, if these rings were omitted, there was no correlation, suggesting that stomatal conductance did not strongly affect the isotopes. Therefore, I have removed the statement "This suggests that stomatal conductance was an important factor in the physiological functioning of these trees (Saurer et al., 1995)" for clarification of this section, because it does not seem that stomatal conductance was as important as other climatic factors (P22 L430).

Minors: Page 16276 Line 26: delete one "delignification" For some unknown reason, this error (writing delignification twice) does not exist in my original manuscript copy, only one "delignification" exists, so I have made no change here.

Page 16278 Line 16: define in the text what is "ïĄěbiochem" in the equation (3) εbiochem is actually the same as εO (the biochemical fractionation factor) described earlier in the text. I have therefore changed εbiochem to εO in equation 3. (P17 L282)

Page 16278 Line22: define "MAT" when it first appears in the text This has been done for this instance and for the first appearance in every other section (i.e. Introduction, Methods, etc.) in the text.

Page 16281 Line 16: ïĄď18C? Please change. This has been changed to “δ13C”.

Page 16285 Line 15: define “gs” “as” has been changed to “because”

Additionally, I have made changes to the tree-ring numbering scheme, which was previously somewhat confusing because the text made references to the isotope chronology, which omitted the first 7 rings of the TRW chronology. In this version, all tree-ring (TR) numbers refer to the TRW chronology.

I would like to express my thanks to Reviewer 2 for their comments; which helped to improve the clarity of this manuscript.

All the best, Benjamin A. Hook

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/11/C9449/2015/bgd-11-C9449-2015-supplement.pdf

Interactive comment on Biogeosciences Discuss., 11, 16269, 2014.

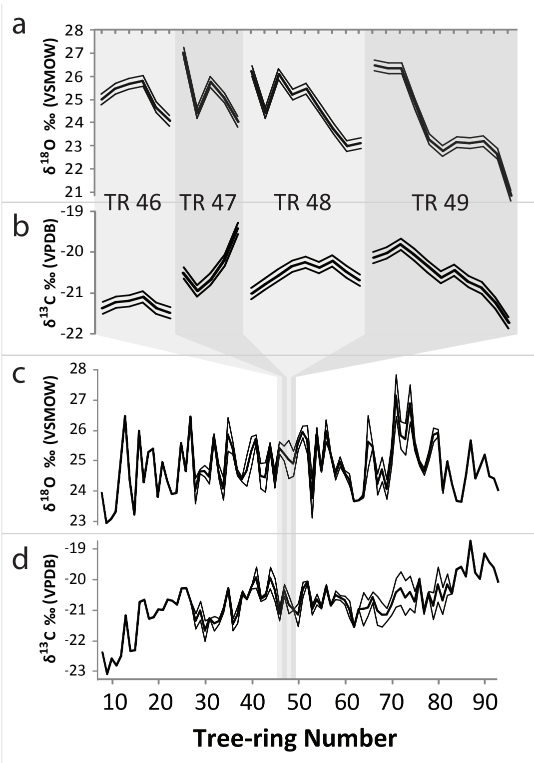

Fig. 1. Figure 1. Subannual and annual-resolution time series records of tree-ring cellulose δ18O and δ13C.

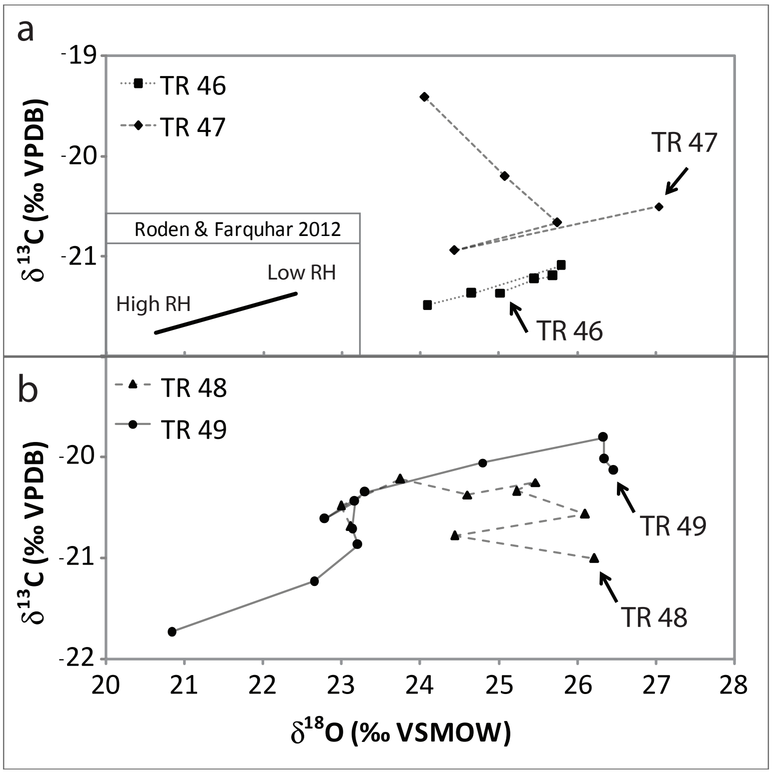

Fig. 2. Figure 2. Scatterplots of dual-isotope data for four tree rings (TR 46âĂŤ49), showing trends of δ18O and δ13C within a growing season.

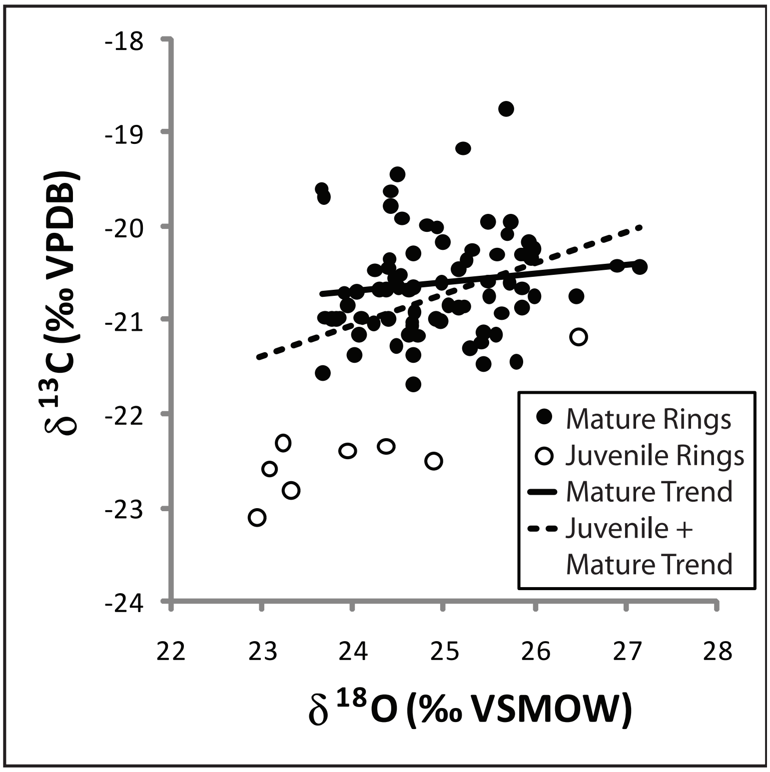

Fig. 3. Figure 3. Correlation analysis of dual-isotope annual dataset. δ18O and δ13C were significantly positively correlated (dashed trendline; Pearson's R = 0.36, P < 0.001, n = 86). However, if the first 4

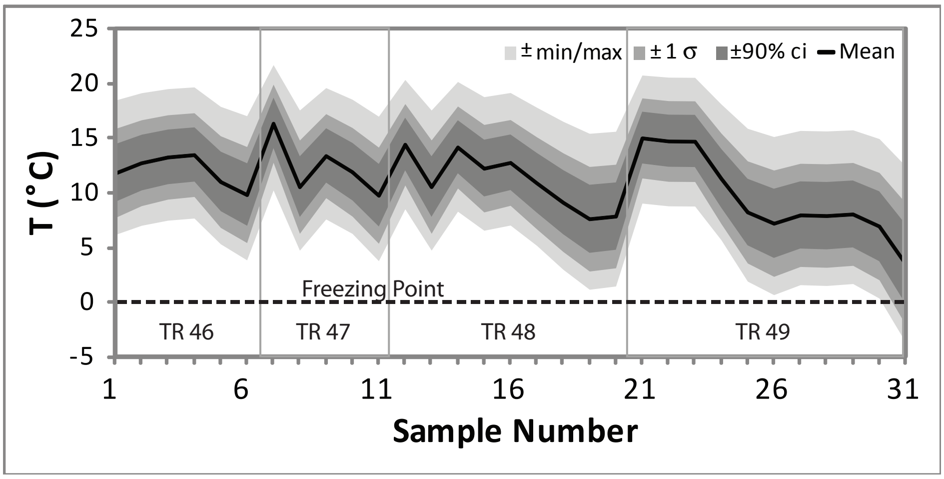

Fig. 4. Figure 4. Mean temperature (°C) of subannual data based on all δ18O-temperature reconstructions. Mean of all reconstructions (black line) is bracketed by 90 % confidence interval (± 90 % ci, dark gray

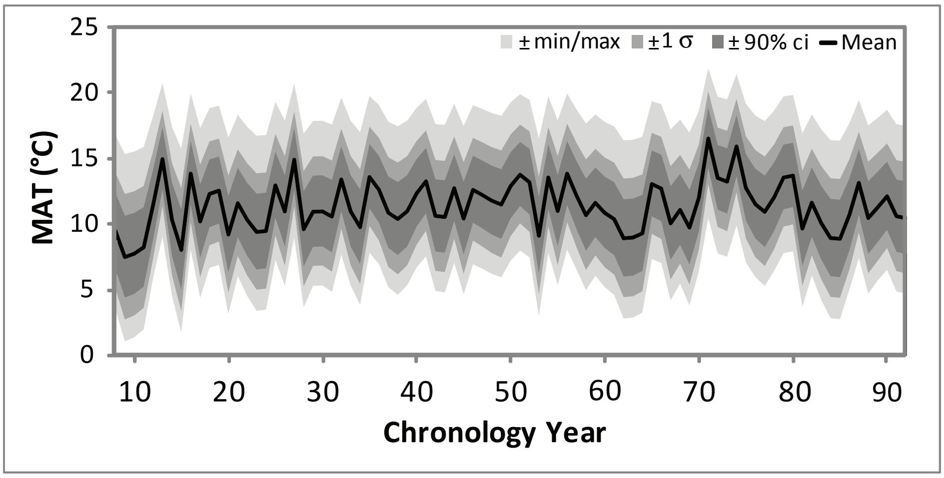

Fig. 5. Figure 5. Mean annual temperature (MAT °C) based on all δ18O-temperature reconstructions. Mean of all reconstructions (black line) is bracketed by 90 % confidence interval (± 90 % ci, dark gray fill),

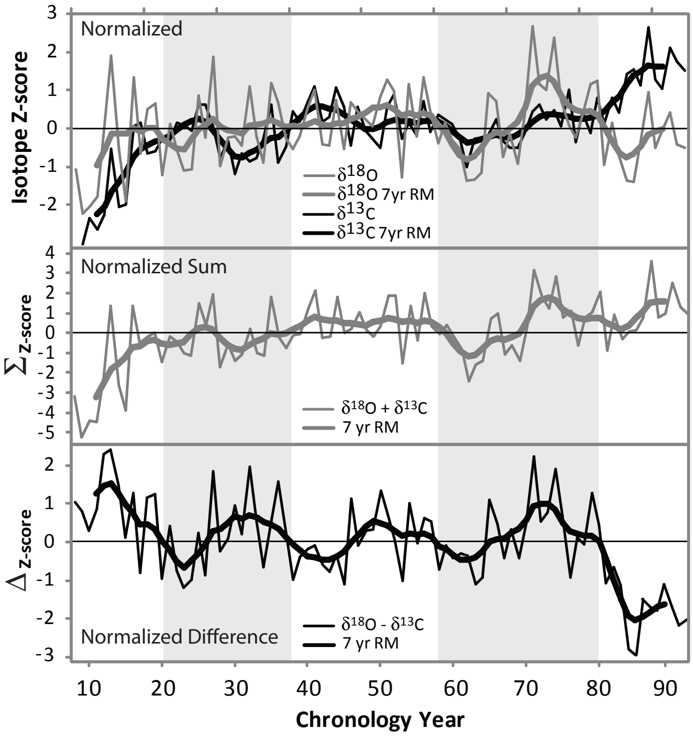

Fig. 6. Figure 6. Results of dual-isotope (δ18O and δ13C) analysis (n = 86).

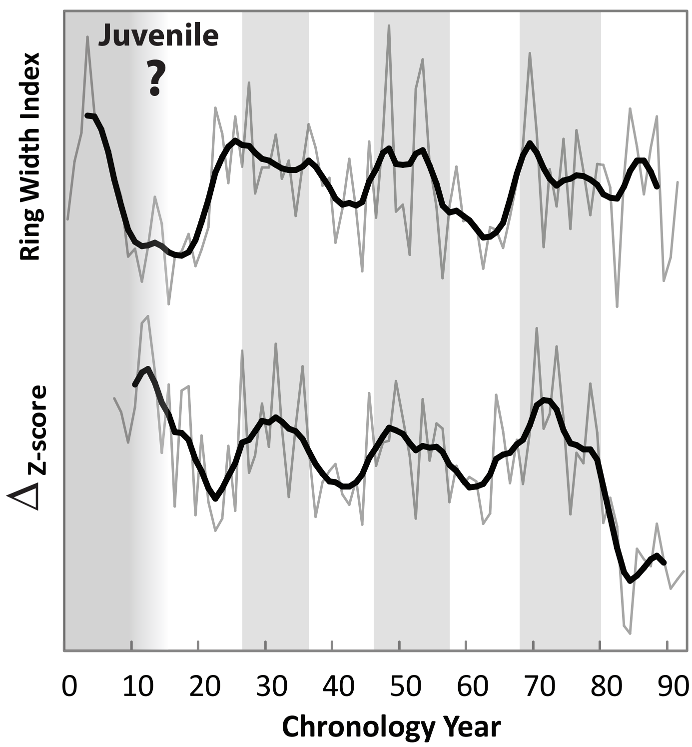

Fig. 7. Figure 7. Correspondence of Piceoxylon tree-ring width indices (RWI) and stable isotope chronologies. (Upper) Piceoxylon RWI (n = 92, gray line) with 7-year triangular running mean (bold black line)

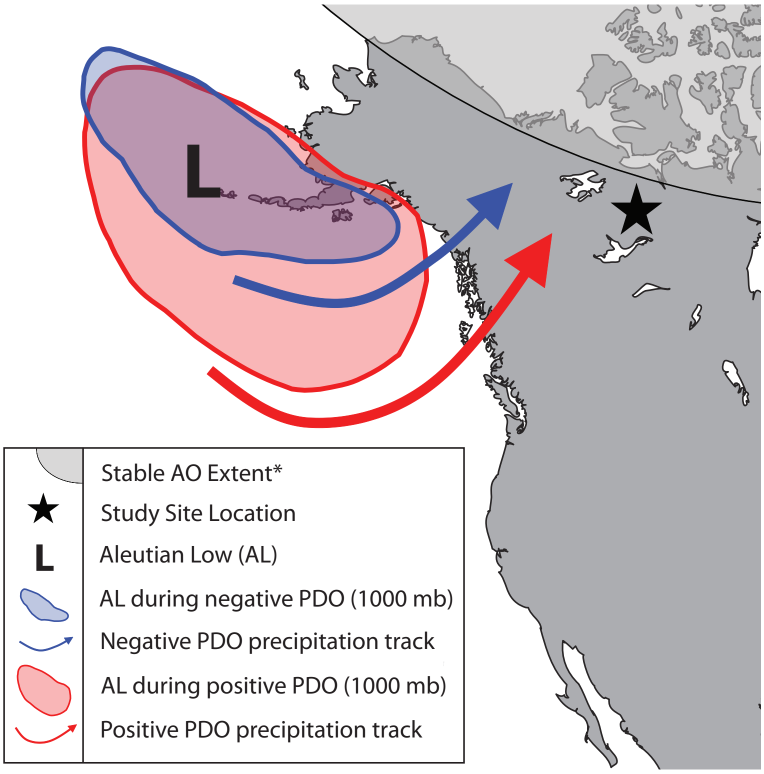

Fig. 8. Figure 8. Position and strength of Aleutian low-pressure system during positive and negative phases of the PDO in relation to study site. Hypothesized stable Arctic Oscillation during the Eocene depi