

The manuscript ‘Temperature seasonality in the North American continental interior during the early Eocene climatic optimum’ by Hyland *et al.* presents new clumped isotope, soil geochemistry and paleofloral data from a section spanning the EECO from the Green River Basin. The authors use these proxies to reconstruct both mean annual, winter, and summer temperatures, and therefore to reconstruct Eocene seasonality in this region, and how seasonality changed over the EECO. Perhaps the most interesting finding is that seasonality during the peak EECO was similar to today, calling into question the hypothesis that past greenhouse intervals such as this were characterised by an ‘equable’ climate (warm/hot, but low seasonality). The data are interesting, and the subject of Eocene climate is certainly of relevance to a wide number of researchers across several disciplines. Therefore, the manuscript would certainly be suitable for *Climate of the Past*. Nonetheless, I offer several suggestions for clarification, especially regarding uncertainty in the seasonality reconstructions. Lastly, I suggest that the model and discussion surrounding future climate change detracts from the focus of the manuscript and could be omitted.

### Substantive comments

- Overall the authors do an excellent job of considering the uncertainties in the proxies utilised here, and as such I recommend that there should be clarification in the discussion of what is being reconstructed. My main issue is that there are no data on cold month mean temperature (CMMT) for the EECO, such that seasonality, i.e. the difference between WMMT and CMMT, is assumed to be twice the difference between mean annual temperature (MAT) and WMMT. The authors are honest about this (Tab. 1), and I agree that it is encouraging that MAT falls approximately midway between CMMT and WMMT in the pre-peak-EECO interval, but there is no *a priori* reason to assume that CMMT did not increase disproportionately during the EECO, and as such EECO seasonality is not really constrained here. I recommend rewording the abstract, discussion and conclusions accordingly.
- I found the discussion of seasonality under future climate scenarios to be a distraction from the rest of the manuscript. My suggestion would be to deal with this topic separately given that the Eocene data do not necessarily inform us of the accuracy of the CMIP5 model ensemble into the future. A more interesting comparison, if the data are available, would be to compare these seasonality reconstructions to the EoMIP model ensemble rather than RegCM3 alone (which would also allow some uncertainty to be placed on the model seasonality).

### Minor comments

- Section 2.1.1. For people like me, who are not familiar with the details of the use of soil geochemistry as a paleoclimate indicator, it would be useful to include a few sentences on how robust this proxy is to diagenetic alteration (e.g. through interaction with groundwater).
- Line 167. Please specify what you mean by ‘are corrected’ in this sentence. Do you mean that following the PBL correction the  $\delta_{47}-\Delta_{47}$  slope is also used to make a correction? If so, what is the gradient?
- Lines 177-180. Please clarify these sentences. The Kelson equation would certainly result in significantly different temperatures compared to at least some other calibrations [e.g. Zaarur *et al.*, 2012], depending on what is meant by ‘moderate’. And why preliminary?
- Section 2.2. The introduction and description of the model results is extremely brief which is ok given that these data are previously published (although a few more details would be helpful), but what I did miss was an explanation of why this model was chosen for comparison. Why not one (or the ensemble) of EoMIP simulations?

- Line 317. It would be useful to elaborate on what is meant by ‘isotopic data’. Is it that the clumped isotope results look reasonable, or do you mean calculated  $\delta^{18}\text{O}_w$  look reasonable? If the latter, state what these are in the text in this paragraph (perhaps around lines 323-326).
- Lines 363-366. This sounds encouraging except that a  $\pm 3^\circ\text{C}$  uncertainty in both WMMT and CMMT results in a seasonality uncertainty of  $6^\circ\text{C}$ , given that presumably there may be systematic biases across the reconstructed interval?
- Section 4.2. Somewhere near the beginning of this section please state how EECO and pre-EECO seasonality were calculated. Are the seasonality estimates derived by comparing the mean of (e.g.) all CMMT data to the mean of all WMMT data for that interval? Judging by eye, there seems to be no difference between EECO and pre-peak-EECO MAT and WMMT if all the data are averaged.
- Lines 397-398. It was not clear to me the first time I read this whether the numbers in brackets refer to the modern or Eocene seasonal range, especially on line 397, reword for clarity.
- Lines 396-401. As you state earlier, both MAT and WMMT may be cool-biased though, so the agreements and uncertainties discussed here only apply if this is not the case. Consider reemphasising this.
- Lines 433-435. This sentence is worded too strongly. There are no reconstructions of CMMT during the EECO, but moreover the WMMT proxy in the EECO is different to the WMMT proxy in the pre-peak-EECO interval. This latter issue is especially problematic given that the clumped and paleobotanical evidence are not in agreement in the interval for which both are available. I fully sympathise with the authors in that continental climates are difficult to reconstruct, and as I said before, the recognition and discussion of uncertainties in this manuscript is excellent overall. However, I recommend stating these issues more clearly at this point in the text including a more thorough discussion of whether the peak and pre-peak EECO seasonalities are really distinguishable from each other.
- Figure 4. Either remove the left half of the peak EECO bar at the bottom of the figure or shade it white so that it is clear that this has not been reconstructed. Please clarify whether the tick marks represent the midpoint between CMMT and WMMT or whether they are placed at the location of the mean MAT estimates.
- Supplement. Please given ages with all reconstructions and not just heights, or at the very least state at which heights the peak EECO occurred.

### **Typos**

- Line 122 ‘elements’.