

Interactive comment on “Sensitivity of a leaf gas-exchange model for estimating paleoatmospheric CO₂ concentration” by Dana L. Royer et al.

Anonymous Referee #1

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General comments: Fossil leaf gas-exchange based CO₂ models are currently going through the “rigorous testing” phase and as the authors of this paper point out, this mechanistically, rather than empirically calibrated proxy, shows considerable promise. It is therefore of high relevance that studies, such as this one, are presented that provide quantification of potential confounding factors. In this case, the authors test three potential confounding factors (photorespiration, leaf temperature and canopy position) and provide quantifications on how these factors influence final CO₂ estimates. They are capable of eliminating two of these factors as insignificantly affecting CO₂ estimates (photorespiration and leaf temperature). The third factor, canopy position, is determined to strongly skew CO₂ estimates, but the authors point out that it is possible to

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identify leaves that grew in lower canopy positions, based on leaf micromorphology and an uncharacteristically wide $\delta^{13}\text{C}$ range. This paper is a relevant contribution towards quantification of the potential error in fossil leaf gas-exchange based CO₂ models, and apart from minor suggested amendments, I have no problem with seeing this study being published.

Specific comments: In the materials and methods section, the authors lay out the specific ways that they are testing modern plants for potential bias in reconstructed CO₂. In the appendix all the specific plants are listed with their input values and reconstructed CO₂. However, from reading the methods section I get the impression that not each plant is being tested for the same potential confounding variable (photorespiration, leaf temperature and canopy position). It would be very helpful if there was a table that outlines specifically which plants were tested for what, or at least that this was made clear in the appendix, because in the main body of text it is hard to follow.

In several places in the manuscript, including the abstract, it is mentioned that the random error propagation of the Franks et al. gas exchange model is better than uncertainty estimates of other leading paleo-CO₂ proxies. It would be very helpful for the untrained reader to see some proof of this statement in the form of a table that lists 1) the different CO₂ proxies, 2) a method of error quantification, 3) the actual amount of uncertainty in those CO₂ proxies and 4) the references to the case studies where this was tested. Such a table would lend credibility to the statement that gas-exchange models are quantifiably better than other CO₂ proxies.

Final specific comment is on the title itself, for which I would like to suggest that the authors include what specifically is being tested. I.e. “Sensitivity of . . . CO₂ concentration to x, y & z”. There are other variables that the model is sensitive to and I believe the title would be more informative if the specifics were included.

Technical corrections: I could not find any spelling or styling errors in the manuscript. The paper is very well constructed and easy to follow.

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