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Climate of the Past Discussions

CPD
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Interactive Comment

Interactive comment on "The $p\mathrm{CO}_2$ estimates of the late Eocene in South China based on stomatal density of *Nageia* Gaertner leaves" *by* X.-Y. Liu et al.

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Liu and colleagues present a CO2 estimate for the late Eocene based on stomatal distributions. Paleo-CO2 is obviously a topic with broad interest, although the importance of the current work is somewhat limited because it is a single estimate from a time period with existing paleo-CO2 estimates.

The following points need to be addressed:

1. The raw data consists of 13 leaves: nine extant leaves from five different herbaria specimens, and four fossil leaves. This is a thin data set. The four fossil leaves are really at the cusp for making a statistically meaningful paleo-CO2 estimate (a minimum

of five leaves is typically recommended). As for the extant leaves, couldn't a large sample from living trees be made? This would help to document the natural variability of stomatal distributions in the species; the current data set is inadequate in this regard.

2. Kouwenberg et al. 2003 (p. 2623, line 23) recommends for conifers that have ordered rows metrics related to the number of stomata per unit length. The authors should try this. Several other related points: by convention, non-stomatal bearing areas are typically excluded when calculating stomatal density and stomatal index (e.g., the bands between the stomatal rows); did the authors do this? How do your paleo-CO2 estimates compare when using the other four possible extant calibration points? It would be helpful to know this variability. And finally, Franks et al. (2014, Geophysical Research Letters) proposed recently a new paleo-CO2 method that does not require extant calibrations and follows plant physiological first principles, not ad-hoc calibrations. The required measurements are stomatal density, stomatal size, and leaf d13C. Your Nageia fossils would be an ideal application of this new method.

3. The age constraint for the fossils is only given as "late Eocene". How was this age determined? The age uncertainty should be included in Figures 4-5 (i.e., the late Eocene is a fairly long interval).

4. Because the stomatal ratio approach is semi-quantitative, it is largely misleading to report 95% uncertainty bands. Also, this uncertainty analysis does not take into account uncertainty in the SR-RCO2 transfer function (i.e., the authors assume no uncertainty)

Other more minor points:

There are many grammatical errors (I have not flagged them)

Abstract: "This is the first paleoatmospheric estimates for the late Eocene of South China using stomatal data." This statement (first late Eocene estimates from S. China) isn't important enough to warrant inclusion in the abstract.

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Abstract: "Results suggest that the mean CO2 concentration was 391.0 +/- 41.1 ppmv or 386.5 +/- 27.8 ppmv during the late Eocene" It is not clear from the abstract what the difference is between these estimates (different methodology? multiple outcrops?).

p. 2616, line 20: The EECO is not the same thing as the PETM.

p. 2617, line 11: None of these four cited studies present CO2 estimates from the late Paleocene or Eocene.

p. 2618, line 28: "overlooked" is not the best word here.

p. 2619, line 9: How does an equation "adapt"?

p. 2619, line 20: How is a group "special"?

p. 2620, line 27: "nearest living relative (NLR)" or "nearest living equivalent (NLE)" are the two common acronyms here.

p. 2624, line 22: These fossil layers are not described. What is the thickness between layers? What is the sedimentary setting? How much time may be represented between layers?

p. 2623, line 25: No, one of the specimens collected between 1932 and 1936 (306 ppm CO2) is closest to the fitted equation (see figure 3a-b)

p. 2624, line 6: GEOCARB III is an outdated model; GEOCARBSULFvolc is that latest version (Berner 2008; or see Royer et al 2014 Amer J Sci). Also, remember that the stomatal ratio is calibrated to the GEOCARB model, so you are not making an independent comparison here.

Table 6: These references will be helpful:

1. Huang, C., Retallack, G.J., Wang, C., and Huang, Q., 2013, Paleoatmospheric pCO2 fluctuations across the Cretaceous-Tertiary boundary recorded from paleosol carbonates in NE China: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 385,

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p. 95-105.

2. Hyland, E.G., and Sheldon, N.D., 2013, Coupled CO2 -climate response during the Early Eocene Climatic Optimum: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 369, p. 125-135.

3. Hyland, E., Sheldon, N.D., and Fan, M., 2013, Terrestrial paleoenvironmental reconstructions indicate transient peak warming during the early Eocene climatic optimum: Geological Society of America Bulletin, v. 125, p. 1338-1348.

4. Roth-Nebelsick, A., Grein, M., Utescher, T., and Konrad, W., 2012, Stomatal pore length change in leaves of Eotrigonobalanus furcinervis (Fagaceae) from the Late Eocene to the Latest Oligocene and its impact on gas exchange and CO2 reconstruction: Review of Palaeobotany and Palynology, v. 174, p. 106-112.

5. Roth-Nebelsick, A., Oehm, C., Grein, M., Utescher, T., Kunzmann, L., Friedrich, J.-P., and Konrad, W., 2014, Stomatal density and index data of Platanus neptuni leaf fossils and their evaluation as a CO2 proxy for the Oligocene: Review of Palaeobotany and Palynology, v. 206, p. 1-9.

6. Erdei, B., Utescher, T., Hably, L., Tamás, J., Roth-Nebelsick, A., and Grein, M., 2012, Early Oligocene continental climate of the Palaeogene Basin (Hungary and Slovenia) and the surrounding area: Turkish Journal of Earth Sciences, v. 21, p. 153-186.

7. Franks, P. J., Royer, D. L., Beerling, D. J., Van de Water, P. K., Cantrill, D. J., Barbour, M. M., and Berry, J. A., 2014, New constraints on atmospheric CO2 concentration for the Phanerozoic: Geophysical Research Letters, v. 41, 2014GL060457.

8. Maxbauer DP, Royer DL, LePage BA. 2014. High Arctic forests during the middle Eocene supported by moderate levels of atmospheric CO2. Geology, 42: 1027-1030.

Interactive comment on Clim. Past Discuss., 11, 2615, 2015.