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Climate of the Past Discussions

Interactive comment on "Influence of temporally varying weatherability on CO_2–climate coupling and ecosystem change in the late Paleozoic" *by* Jon D. Richey et al.

Anonymous Referee #1

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Richey J.D., et al: Influence of temporally varying weatherability on CO2-climate coupling and ecosystem change in the Late Paleozoic.

Journal: COP

Overview The question addressed in this manuscript concerns the carbon dioxide evolution at different time scale over the course of the Late Paleozoic (313-273Ma). Two pCO2 trends are presented and discussed, i) short-term intervals of rising/falling CO2 with a good time calibration and ii) a long trend (from 360 to 270Ma) driven by the weatherability of the Earth's surface. The first trend has been provided by a multi-proxy record offering a good temporal resolution while the long term reconstruction has been

obtained using a complex climate-carbon model exploring effects of tectonic and lithology (mafic rocks) and calibrated by the 87Sr/86Sr record. In addition to these points, the authors discuss interplays between Earth's climate (Late Paleozoic Ice Age) and ecosystem perturbations.

Scientific Interest Deep time climate and ecosystem reconstructions are challenging. Understanding how Earth's climate, tectonic and ecosystem modifications are linked represent an interesting advance. Consequently, this paper is an important contribution. Overall the article is well written however the discussion can be improved (not enough well organized). I identified several areas requiring clarification (listed below). These problems being easily solvable, I recommend a minor revision (ranked by order of importance).

Recommendation: Minor revision

(1) The discussion is not very clear. Indeed short-term variations and long-term processes are included in same sub-sections without to distinguish between modeling results and proxy (for instance lines 191-225 introduce modeling results while lines 226-243 present short-term pCO2 variations and biological turnovers. I do not think this presentation is very clear for the reader, indeed these parts have no links (or there is something lacking)). Moreover the discussion about ecosystem perturbations is interesting but has a modest impact to understand links between paleo-pCO2 and biological events. To highlight their results, the authors may consider to split their discussion (long-term vs short term) or creating a new sub-section for presenting modeling results.

(2) A few sentences of the discussion need to be rephrased or revised in order to reflect that initiation and deglaciation CO2-thresholds are different due to the climate hysteresis. Indeed the authors tend to consider the "CO2 glacial threshold" as an absolute value which determines the climate state of the Earth. The line 299 is correct because the final pCO2 (case at 270Ma, blue dote fig.5) is far above the glacial threshold however elsewhere even if the simulated CO2 overcomes the proposed glacial threshold,

that does not mean the termination of the Late Paleozoic Ice Age. ex : line 314 (the sentence can be removed) ex : line 383-390 (this issue can be solved by adding error bars for age determination for each steady state - indeed boundary conditions used to force climate models have their own uncertainties, especially paleomagnetic data used to reconstruct paleographies)

(3) fig.3b. the chosen colour are misleading and implicitly suggests "anomalies". Moreover authors seem to assume two climate states characterized by a threshold close to 400ppmv of CO2. This point needs more explanation (why this threshold is so different compared to values used in fig.5 and published by Lowry et al. 2014 ?)

(4) line 167. I don't understand how the duration of the "interglacial phase" has been estimated (104 yr). S6 suggests a range of values for the sedimentation rate. Why the duration does not seem to be affected by uncertainties (or explain why the duration does not depend on geological parameters)? In addition could you precise if the proposed duration (104 yr) is the mean value or the maximal value (or something else)? A brief paragraph summarizing limitations will be helpful for readers not familiar with this method.

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