

## ***Interactive comment on “Influence of temporally varying weatherability on CO<sub>2</sub>–climate coupling and ecosystem change in the late Paleozoic” by Jon D. Richey et al.***

### **Anonymous Referee #2**

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This paper improves the CO<sub>2</sub> proxy record for the late Paleozoic and compares CO<sub>2</sub> variations to other Earth system indices. Considerable care has been taken in assembling this record and evaluating it statistically, which is much appreciated and it will be a useful resource for the community. The paper also adapts previous modeling to assess what has driven the changes in CO<sub>2</sub>, and concludes that a change towards more reactive silicate lithology is necessary, for which there is independent support. Overall in my opinion it is a good, clear paper that needs little revision. I do have some minor revisions to suggest:

Line 39: typo “DiMichele, 2104”

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Line 67: note the DOI address here does not currently work

Line 78: it is a bit confusing that this paper appears to cite itself? Again on line 137.

Line 112: Estimates of mean annual temperature are used to help determine past CO<sub>2</sub> levels. Any circularity should be considered here when going on to link the CO<sub>2</sub> estimates to climate.

Line 118: The Donnadieu paper cited is about the Cretaceous? Surely the model runs are not from that work?

Line 170: “307 and 304.5 Ma” should read “307 until 304.5 Ma”?, “<400 to ~200 ppm” also a bit confusing.

Line 173: missing subscript in CO<sub>2</sub>

Line 269: “Notably, the 10-Myr pCO<sub>2</sub> nadir raises a paradox as to what was the primary CO<sub>2</sub> sink(s) at the time given that the CO<sub>2</sub> sinks of the Pennsylvanian were no longer prevalent. This paradox reflects the waning denudation rates of the CPM by the early Permian”. Note that Joshi et al. (2019) in GRL have run climate model simulations for the earliest Permian and find higher silicate weathering rates as the denudation rate wanes. They argue that denudation rates are not a strong control on silicate weathering in mountains where the rate is high. Perhaps a weaker relationship between denudation and silicate weathering may help explain the paradox identified here?

Line 284: The comparison to Macdonald et al. is a little different in timing: their suture length reconstructions are small after 300 Ma.

Line 306: “rapid (0.000043/Myr)” use standard form here perhaps?

Line 319: “our modeling results indicate that this is not compatible with proxy inferred moderate surface conditions of the late Carboniferous” I would imagine many of the model parameters are not known well enough to really rule this out? Perhaps a more tentative statement here?

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