

Reply to reviewer 1:

We thank the reviewer for the second review and feedback to improve our manuscript.

- Correlation stats appear reasonable. For the Mann-Kendall test, I was less intending that you would compare trends in phytoclasts and charcoal, and more intending that you might use that or a similar test to support your assertion that there is a trend at all. In lieu of performing an explicit test of trend vs no trend, I suggest that you minimize your discussion of visual trends (see notes in text). Thank you for the explanation. We have adapted the text to your specific comments to minimize the discussion on trends.
- Figure 1 & 5 accessibility are improved. In Fig. 5 the border around LP stars is fairly faint - I missed that addition in my first reading - perhaps you could enlarge it to improve readability further. Thank you for the suggestion, we have lowered the transparency of the border, which now appears darker and clearer and increased the line thickness.
- I suggest that you substitute '≈' for '≈', which is a clearer symbol for 'approximately'. I highlighted a few examples of this but did not highlight all." Thank you for the feedback, we kept ~ as a symbol for approximately, which we saw in all the recent papers published in Biogeosciences and hence in line with the style of the journal.

(Materials) L136: specify time periods again "The records from both the LPE and SPB are taken from..." Thank you for the feedback, we have adapted the text accordingly. (L110: "The records from both the LPE and SPB are taken from the Llanbedr (Mochras Farm) borehole...").

L203: "of likely multiple fires." Not entirely clear. Synchronous fires or multiple co-occurring fires.

We have adapted the text to clarify that the charcoal record here analysed records potentially synchronous fires on the different landmasses, but will also include multiple fires that did not co-occur in time, because each sample we analysed covers 2,000 years.

L167-L171 "...to reflect a regional expression of likely multiple fires. **These fires might have in part occurred synchronous, but** it is also important to note that one stratigraphic rock sample in this study represents a ~2 kyr average signal, which likely is more than the fire return interval at the time of deposition. **And thus represents an averaging of the overall fire signal through time and space.**"

L204 change ~ to the other symbol. See previous reply.

L205 op should be of. Thanks, changed this in the text.

L205 And (no full stop but comma). Thanks, changed this in the text.

L297 R or Matlab (RMatlab 2021). This has been done in Matlab, version RMatlab2021b (now cited in the reference list).

L299 more efficient to define an alpha $\alpha = 0.05$. Changed this as suggested.

L301 R or Matlab. And these are not in the references. This has been done in Matlab, version RMatlab2023b. Both references to the matlab versions of 2021 and 2023 have been added in the references.

L301 delete hypothesis or say null hypothesis. Thank you, changed this to null hypothesis.

L302 alpha instead of p. Changed this to α .

L305: correlation should be covariance. Thank you, have changed we have changed this to covariance.

L307: cite software PAST. Thanks, reference is added in the reference list.

L347: define XRF record. Defined XRF in the text.

L405-407” No parallel trends are observed between the abundance of terrestrial phytoclasts and the number of charcoal particles, which suggests that the abundance of charcoal is not a reflection of preservation and/or runo_ changes.” Change sentence as analysis are not based on trends but correlation and covariance.. Changed this to “No correlation or covariance exists between the abundance of terrestrial phytoclasts and the number of charcoal particles, which...”

L504: maybe more appropriate to say fuel compositions instead of fuel types. Changed the text to fuel compositions.

L556: suggest wet-winter instead of winterwet. This is common terminology in Jurassic literature from Rees et al. (2000) based on phytogeographies and climate belts. Therefore, we kept winterwet. With the first mention of winterwet we reference Rees et al. (2000). The Torsik et al. (2017) reference refers to the latitudinal position of the Mochras borehole in the Pliensbachian.

L580: grammar unclear. Suggestion “Furthermore, dense and connected fuel loads built up during the wet season... “. Changed the start of the sentence to clarify to: “Furthermore, these humid-loving plants would also...” L524.

L581: readily instead of easily. Changed.

L583: intensive, meaning intense or wide spread? Change this to intense.

L593: Suggest to delete TEX86 as it distracts/needs abbreviation. Deleted TEX86.

L640: delete space productivity/ aridity. Done.

L674: suggested change “spectrum of the fire frequency gradient” to “.. of the productivity/aridity and fire frequency gradients...” Thank you for the suggestion, we have adapted this in the text.

L676: change spectrum again. Changed this to L589-590“... and conditions during the LPE did not extend beyond the seasonal fire window into the arid part of the productivity/aridity gradient.”

Reply to reviewer 2:

I think the authors have done an adequate job for the most part of responding to the reviewers concerns and modifying the manuscript. Looking across the reviews and responses, there seem to be two issues that dominate: 1) the intermediate-disturbance hypothesis, how it works in detail when applied in the context of this paper; and 2) what might be called “deep time” charcoal analysis, how it’s done, and what it reveals, again in the context of the current paper. A lot of the “good stu_” is in the paragraph-length replies, however, and I’m not sure just how much of that made it into the paper. I found it hard to judge, because the line numbers cited in the authors’ response made almost no sense relative to those in the original manuscript, the

“track-changes” version, and the revised manuscript. (I don’t think this is the authors’ fault— there must be a better way for the manuscript-handling system to facilitate synchronization of those various versions.) The authors would be the best suited to do that, by reviewing their replies and asking “did this make it into the paper?” For example, I asked what an “enhanced hydrological cycle” was (on behalf of a potential reader), and the authors responded appropriately “Intensification of hydrolysis”, but left the manuscript unaltered. I don’t think we should rely on the reader having to go back to the reviews and replies.

We thank the reviewer for his second review, with helpful comments and insights for our manuscript. We have carefully checked all the comments and replies made by the three reviewers in the first round of review as suggested. Where in some instances not all information was transferred to the manuscript, we have now added this in as extra discussion for future readers based on the replies to the reviewers in the first round.

L402: “Smectite preferentially forms under a **warm** and seasonally arid climate..”

L407: “Pedogenic kaolinite preferentially forms in a hot climate (Chamley, 1989; Ru_ell et al., 2002).”

L173-187: “In this study we measure the abundance of microcharcoal and macrocharcoal as a proxy for fire activity. The size of charcoal fragments is often used as an indicator if the fires were proximal or distal to the deposition site. Often larger more proximal charcoal particles are found in terrestrial biomes and their depositional environments, in soils, lakes and mires. In contrast, smaller charcoal particles that are wind-blown could potentially end up in a marine environment, as well as in more distal terrestrial settings. However, experimental research showed that riverine transport has the potential to carry the larger charcoal particles further away from shore, with the smaller charcoal particles becoming water saturated at a shorter distance and settling down closer to the shoreline (Nichols et al., 2000). In addition to this, other studies have indicated that larger charcoal particles (up to 7 cm) can be windblown and travel up to 50 km from the original source, depending mainly on their morphology (Woodward & Haines, 2020). Combined, charcoal size, shape, properties, wind direction, plume height, but also riverine and marine transportation, all have a di_erent impact on the travel distance of di_erent charcoal size classes. Hence, in the context of this study, no inferences can be made about the di_erent size classes and therefore microcharcoal and macrocharcoal both serve as an overall indicator of fire activity.”

L404: “Kaolinite is indicative of an accelerated hydrological cycle and an intensification of hydrolysis, ...”

Elaborated on the charcoal signal (in line with reviewer 1): L167:L171: “...to reflect a regional expression of likely multiple fires. **These fires might have in part occurred synchronous**, but it is also important to note that one stratigraphic rock sample in this study represents a ~2 kyr average signal, which likely is more than the fire return interval at the time of deposition. **And thus represents an averaging of the overall fire signal through time and space.**”

L432: “...that orbitally driven changes in seasonal contrast **in hydrolysis** led to high fire activity.”

Addition in the SI Fig. 4 description L74-76: “In this deep-time fire study, the palynofacies are a proxy for potential changes in sedimentation rate, terrestrial run-o_ into the marine environment or organic matter preservation, of which there is no evidence.”

Technical comments:

I still think the description of the bandpass-filtered time series (Figs. 2 and 3 and related text) is incorrect. (It's not really a technical issue, just a science-writing one.) What is going on is that an input time series is being bandpass filtered (i.e. smoothed) to produce an output time series: input -> bandpass filter -> output (a bandpass-filtered time series). The “bandpass filter” is a statistical function, and what it produces is a “bandpass-filtered time series” (not, as in the figure captions, “bandpass filters” (line 287) or “orbital filters” (line 300). So, line 287 should read “The bandpass-filtered time series of the Ca-elemental XRF record or Ruhl et al...” and line 300 should read “The bandpass-filtered timeseries (of something) from Ruhl et al...”” Thank you for the feedback. We have changed this in the text accordingly.

L128-129: “(c) **The bandpass-filtered** Ca-elemental record in the depth domain from Ruhl et al. (2016) representing the 100 kyr and 405 kyr cycle.”

L318: “Finally, **the bandpass-filtered time series of the Ca-elemental** XRF record of Ruhl et al. (2016) indicate that the clay records shift dominance on a 405 kyr time scale.”

L436: “**The bandpass-filtered time series** representing the ~100 kyr cycle in the Pliensbachian of the Mochras core (derived from the Ca and macrocharcoal records),....”