Reviewer #2 (Raquel Franco Cassino)

Review of the manuscript entitled "Vegetation and fire regimes in the Neotropics over the last 21,000 years"

The manuscript presents an excellent and timely synthesis, combining analyses of modern data with an extensive compilation of fossil records and archaeological evidence. The work is well written, clearly organized, and supported by high-quality figures that effectively convey the results.

Response #1. We are grateful for the comments from Raquel F. Cassino on our manuscript.

I would like to offer a few comments and questions that I hope may help to further strengthen the manuscript:

1-Definition of arboreal pollen

The authors calculated arboreal pollen (AP) percentages as the sum of woody taxa (trees and palms), excluding mangrove and aquatic taxa, fern spores, and unidentified types. This approach is widely used in paleoecological studies and serves as a valuable proxy for reconstructing past vegetation structure. However, given the floristic complexity of tropical ecosystems, I would like to kindly suggest that the authors provide further clarification regarding the taxonomic criteria used to define AP. Specifically, many plant families in these ecosystems include both arboreal and non-arboreal life forms, which may significantly influence AP percentages depending on how these groups were categorized. It would be helpful to know how the authors distinguished between arboreal and non-arboreal taxa within such families, and whether any standardized criteria were applied in this process.

For instance, I wonder whether the palm *Mauritia flexuosa* was considered part of the AP in the Cerrado records. Given that Mauritia palms are often highly abundant in local swamp environments (veredas), their inclusion could potentially inflate AP percentages without necessarily indicating a broader regional forest expansion. Clarifying this point would be particularly valuable for interpreting AP trends in relation to regional woody cover dynamics. Providing these additional details could enhance the transparency and reproducibility of the study, and also refine the paleoecological interpretations drawn from the AP trends.

Response #2. The ecological types are based on Neotoma standardized classification. We will include a spreadsheet with all used taxa and corresponding classification (TRSH – trees and shrubs, PALM - palms, UPHE – upland herbs) in the supplementary table.

We will modify it to read: *"For Neotoma records, arboreal pollen (AP), which serves as an indicator of tree cover relative to herbaceous vegetation, was calculated as the percentage of woody taxa (trees, shrubs (TRSH), and palms (PALM), considering taxa at the genus and family level) divided by the total sum of trees and shrubs (TRSH), palms (PALM), and herbs (UPHE), excluding mangrove and aquatic taxa, fern spores, and unidentified types. The classification of ecological groups used in these calculations follow Neotoma standardized classifications (Supplementary table 1). For manually extracted records, AP percentages were obtained from published pollen diagrams. Therefore, the criteria used to construct these AP curves may slightly differ from those applied in our calculations based on raw data. For instance, in CEB, Mauritia and Cyperaceae are often excluded from AP calculations, as these taxa are often over-represented due to strong local imprint from palm swamp vegetation (Barberi et al., 2000; Escobar-Torrez et al., 2023; Salgado-Labouriau et al., 1997). To maintain consistency for this specific region, we also excluded Mauritia and Cyperaceae from our AP calculations."*

Particularly for Central-Eastern Brazil (CEB), most records were manually extracted from published pollen diagrams. As such, we had to rely on the available AP curves, which may differ slightly from our calculation methods using datasets for which raw data were accessible (e.g., those obtained from Neotoma or Pangaea).

For example, in the case of Lagoa Feia (Cassino et al., 2020; Escobar-Torrez et al., 2023), we used the AP curve available in Escobar-Torrez et al. (2023), which we assume does not include Mauritia in the AP calculation.

In the Chapada dos Veadeiros record (Ferraz-Vicentini, 1999), *Mauritia* is rare and occurs in low percentages, so its inclusion or exclusion does not meaningfully affect the results. For other records, such as Cromínia (Salgado-Labouriau et al., 1997) and Vereda de Águas Emendadas (Barberi et al., 2000), we calculated AP using the sum of 100% excluding the "vereda" group. This was not the case for Lagoa Bonita (Barberi, 2001), in which we had initially included all AP, but will now correct the record by excluding the "Pólen de brejo e vereda" group. For Vereda São José (Cassino et al., 2018), available in Neotoma, we will remove *Mauritia* to ensure consistency with the manually extracted records from the region.

Nevertheless, the newly calculated AP composite closely resembles the previous one and does not result in any change to our interpretations (Fig. R2.1). Additionally, we will include a new precipitation curve based on speleothem records from a site located in the northern parts of CEB (Stríkis et al., 2011, 2018), providing further regional context.

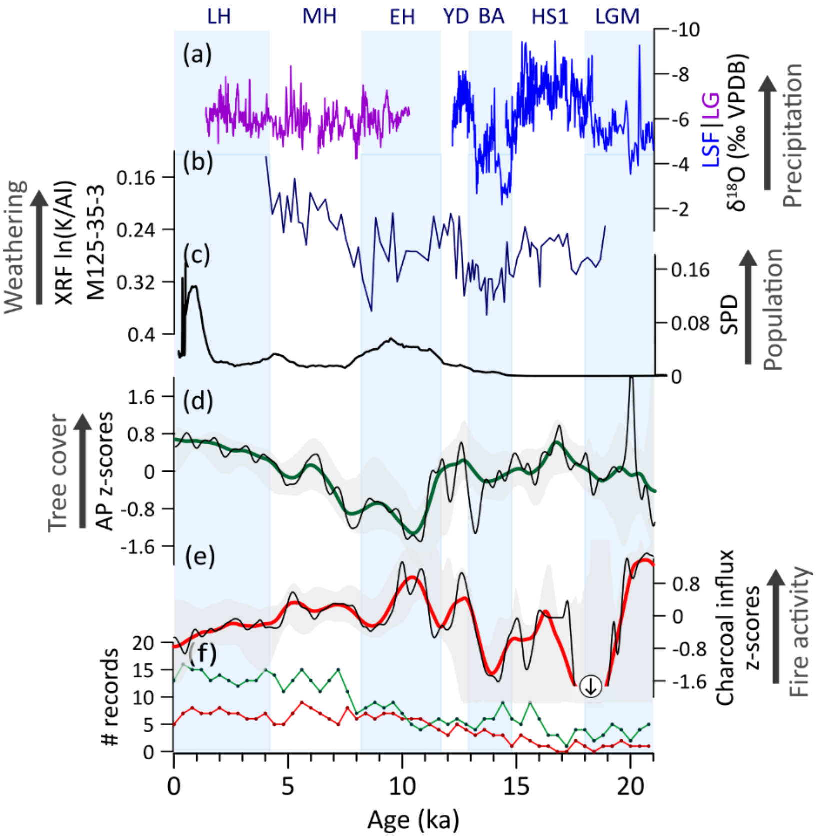

Fig. R2.1. Updated Fig. 9 – Central-eastern Brazil (CEB) vegetation, fire, climate regimes, and human occupation: (a) Speleothem δ18O from Lapa sem Fim (LSF) and Lapa Grande (LG) caves (Stríkis et al., 2011, 2018). Downcore ln(K/Al) from marine sediment core M125-35-3, which reflects changes in the clay mineral composition and increases with chemical weathering intensity and hence, moisture availability (Meier et al., 2022). (b) Summed density probability of ^{14}C ages from archeological sites in CEB (N = 481). (c) Arboreal pollen (AP) and (d) charcoal influx z-scores composites using 1000-yr (green and red, respectively) and 400 yr (black) smoothing half-window. Charcoal z-score negative anomaly reaching -2.2 is indicated by a circled arrow. Gray areas represent 2.5th and 97.5th confidence intervals. (e) Number (#) of records with available pollen (green) and charcoal (red) data in a 400-yr time bin.

References:

Barberi.: Mudanças paleoambientais na região dos cerrados do planalto central durante o quaternário tardio: o estudo da lagoa bonita (DF), University of São Paulo, 210 pp., https://doi.org/https://doi.org/10.11606/T.44.2001.tde-04112015-161453, 2001.

Barberi et al.: Paleovegetation and paleoclimate of “Vereda de Aguas Emendadas”, central Brazil, J. South Am. Earth Sci., 13, 241–254, https://doi.org/10.1016/S0895-9811(00)00022-5, 2000.

Cassino, et al.: A Late Quaternary palynological record of a palm swamp in the Cerrado of central Brazil interpreted using modern analog data, Palaeogeogr. Palaeoclimatol. Palaeoecol., 490, 1–16, https://doi.org/10.1016/j.palaeo.2017.08.036, 2018.

Cassino, et al.: Vegetation and fire variability in the central Cerrados (Brazil) during the Pleistocene-Holocene transition was influenced by oscillations in the SASM boundary belt, https://doi.org/10.1016/j.quascirev.2020.106209, 2020.

Escobar-Torrez et al.: Long-and short-term vegetation change and inferred climate dynamics and anthropogenic activity in the central Cerrado during the Holocene, J. Quat. Sci., https://doi.org/10.1002/jqs.3567, 2023.

Ferraz-Vicentini.: História do Fogo no Cerrado: Uma Análise palinológica, 1999.

Salgado-Labouriau et al.: Late quaternary vegetational and climatic changes in cerrado and palm swamp from Central Brazil, Palaeogeogr. Palaeoclimatol. Palaeoecol., 128, 215–226, https://doi.org/10.1016/S0031-0182(96)00018-1, 1997.

Stríkis, et al.: Abrupt variations in South American monsoon rainfall during the Holocene based on a speleothem record from central-eastern Brazil, Geology, 39, 1075–1078, https://doi.org/10.1130/G32098.1, 2011.

Stríkis, et al.: South American monsoon response to iceberg discharge in the North Atlantic, Proc. Natl. Acad. Sci. U. S. A., 115, 3788–3793, https://doi.org/10.1073/pnas.1717784115, 2018.

2-Charcoal data scaling

The use of z-score transformation for scaling charcoal data, as applied by the authors, is a widely accepted and established method in paleo-fire research, allowing for effective comparison of variability within and between records. However, recent studies (e.g., McMichael et al., 2021; Gosling et al., 2021) have highlighted some potential limitations of z-score scaling, particularly its tendency to distort the structure of charcoal peaks by inflating small-scale peaks and minimizing the influence of large peaks. Moreover, as noted by McMichael et al. (2021), this method "does not retain a consistent value that represents the absence of fire across sites", which can be especially relevant in tropical ecosystems where documenting both the presence and absence of fire is critical for understanding fire regime variability.

As an alternative, proportional relative scaling has been suggested (Gosling et al., 2021), which transforms charcoal data to a 0–100 scale while retaining the zero value to consistently represent fire absence. This approach also avoids upweighting rare charcoal finds in otherwise charcoal-poor sequences, potentially providing a more ecologically meaningful representation of fire activity.

Given these recent discussions, I wonder whether the authors considered alternative scaling methods, and if so, what motivated the decision to apply the z-score transformation. I believe that elaborating on this methodological choice could be valuable for readers and for future studies in similar tropical contexts.

Response #3. We appreciate the suggestion regarding data scaling. We have considered the use of relative scaling (0–1) for both AP and charcoal influx data. For charcoal, the use of z-scores, as highlighted in the comment, is a widely accepted and established method in paleo-fire research. We chose to use z-scores as a meaningful way of comparing deviations from local norms, which is particularly valuable when comparing across sites with different vegetation types and fire regimes, as well as among studies with different methodologies for charcoal quantification. In contrast, relative scaling would potentially downplay or exaggerate local variations, especially if a site's maximum or minimum values are represented by outliers.

The approach proposed by McMichael et al. (2021) seems promising for regions or time periods with low or near absence of fire activity. However, for an intercomparison study like ours the chosen method must be able to also appropriately represent areas with substantial fire activity. These arguments lead us to choose z-scores.

Given your suggestion and to verify differences between the two methods, we produced new curves using PRS, as per McMichael et al. (2021) (Fig. R2.2) and PRS applying a base period (0.2 – 21 ka, PRS.bp). We compare these two relative scaling-based curves with our z-score curves. Importantly, we applied the base period to the PRS method to ensure consistency with our z-score calculations, which also rely on a defined base period. This, however, was not tested in McMichael et al. (2021).

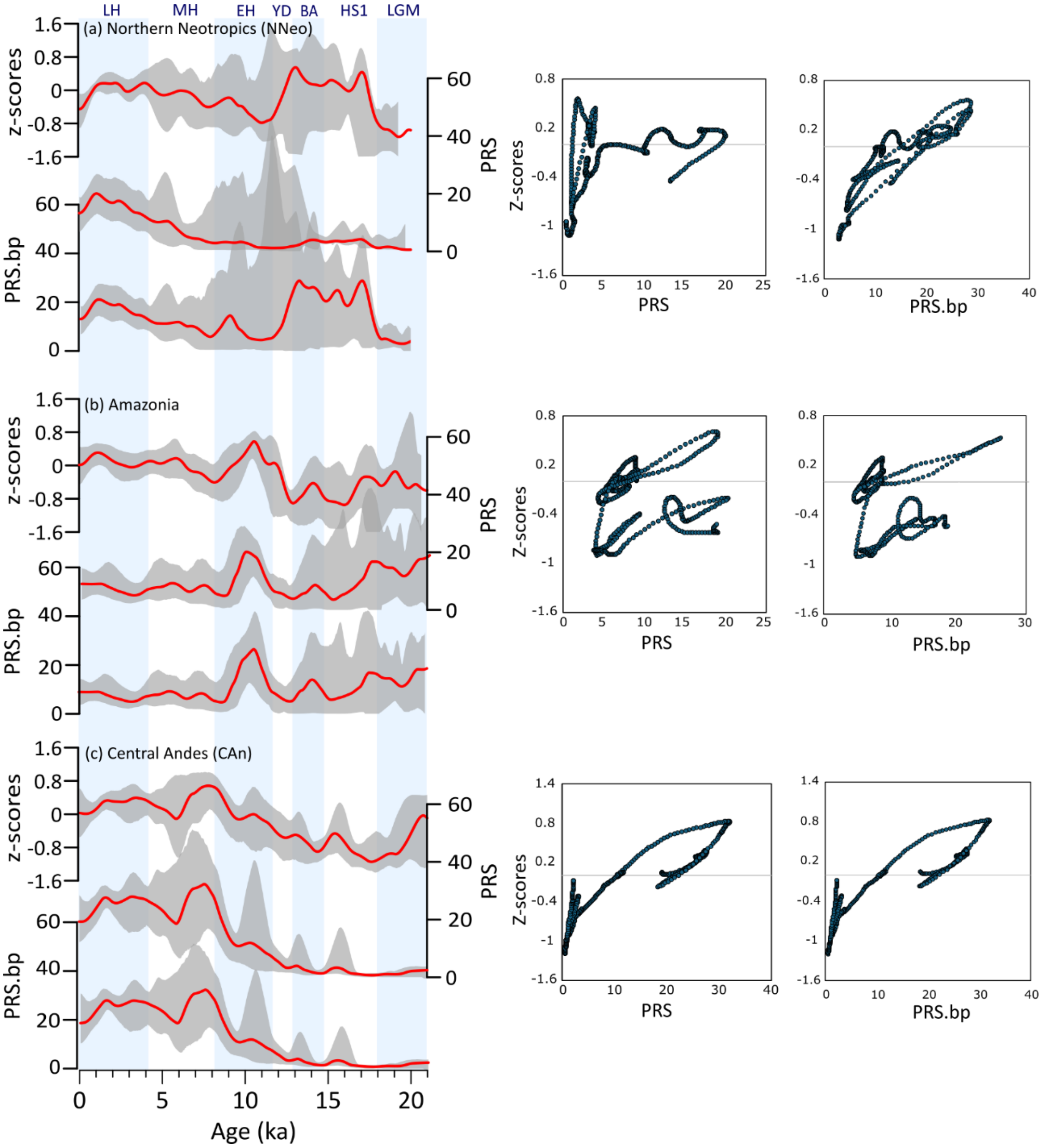

Fig. R2.2. Comparison of charcoal influx data transformed into z-scores with proportional relative scaling (PRS) and proportional relative scaling with a 0.2 – 21 ka base period (PRS.bp). All curves use pre-binning half-window of 20 yr and half-window smoothing of 1000 yr.

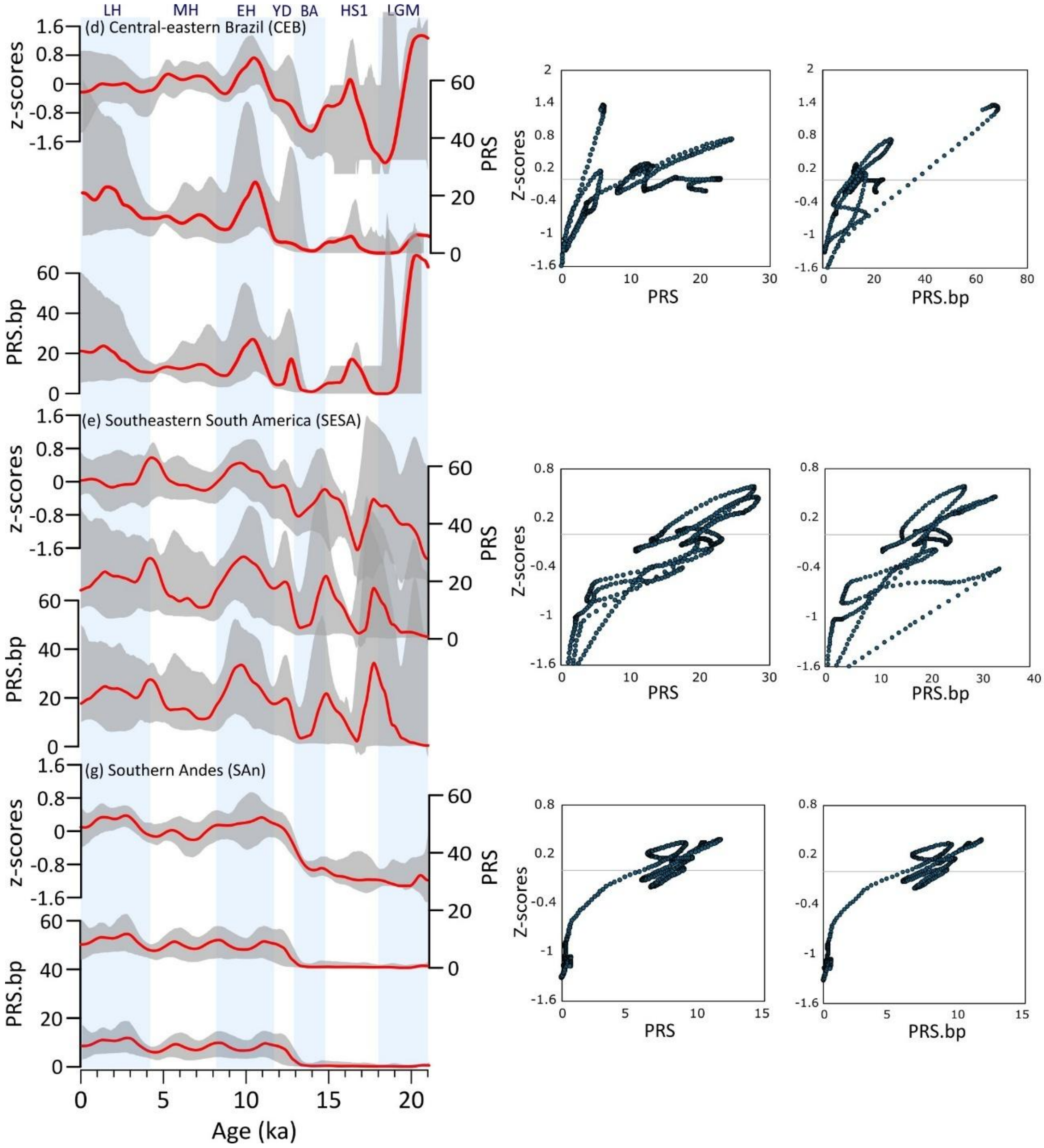

Fig R2.2. Continued.

These comparisons show that despite changes in the amplitude of variability, all regions hold mostly coherent patterns of changes and a similar temporal structure. However, some key differences also arise. We briefly discuss them below.

Although all composites for NNeo indicate increased fire activity between 18 and 13 ka and during the LGM for CEB, z-scores and PRS.bp suggest a stronger rise, while PRS shows only a mild increase. The use of base period produces very similar trends between both methods, which is particularly important when including records with peak values outside our time of interest. Moreover, variabilities during the Pleistocene are more sensitive to site-specific data, due to the low availability of records.

On the other hand, in Amazonia, although the overall temporal patterns are similar across methods, a key divergence is observed: both PRS and PRS.bp suggest higher fire activity during the LGM compared to the Holocene, whereas z-scores indicate the opposite trend. In this case, z-scores seem more consistent with the known long-term fire history in the region. Several Amazonian records spanning Pleistocene ages suggest higher fire activity during the Holocene (Blaus et al., 2024; Bush et al., 2004; Colinvaux et al., 1997; Fontes et al., 2017; Hermanowski et al., 2012). An exception is southwestern Amazonia, where high charcoal concentrations occur during the Pleistocene, followed by a decline in the late Holocene as rainforest expanded (Burbridge et al., 2004).

Given that Amazonia exhibited important discrepancies between methods and is the region in which PRS is likely to best perform due to its rare frequency of fire events, we tested both z-scores and PRS.bp with multiple settings by applying combinations of sizes for bin half-window (binhw: 1500, 1000, 500, 300, and 40 years) and smoothing half-window (hf: 3000, 1500, 1000, and 400 years) (Fig. R2.3). Results show that PRS.bp is more sensitive to binhw variations, with Holocene base levels increasing systematically with larger bin sizes. Notably, while for binhw of 40 and 300 Pleistocene values are usually higher than those of the Holocene, the opposite is produced by applying binhw of 500, 1000 and 1500 years. In contrast, z-scores remain stable across different settings, consistently showing higher Holocene fire levels and no systematic variation linked to bin size.

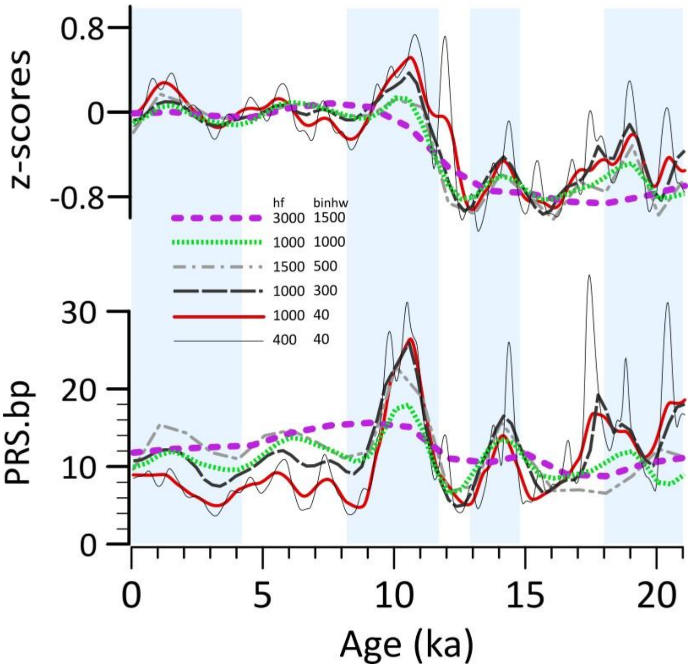

Fig. R2.3 Charcoal influx composites for Amazonia using z-scores and proportional relative scaling (PRS.bp; base period: 0.2–21 ka), applying different smoothing half-windows (hf) and bin half-window (binhw) lengths in years.

Considering these observations, z-scores appear more stable and better suited to capturing long-term trends in fire activity. While PRS seems very promising, particularly for regions such as Amazonia where fire activity is rare, it still requires further testing. For instance, how it performs across different regions and time spans, as well as its sensitivity to variations in base periods and binning parameters. Thus, we see strong arguments to keep z-scores. This brief discussion on the comparison between these two methods will be included in a Supplementary Information.

References:

Blaus, et al.: Climate, vegetation, and fire, during the last deglaciation in northwestern Amazonia, Quat. Sci. Rev., 332, 108662, https://doi.org/10.1016/j.quascirev.2024.108662, 2024.

Burbridge, et al.: Fifty-thousand-year vegetation and climate history of Noel Kempff Mercado National Park, Bolivian Amazon, Quat. Res., 61, 215–230, https://doi.org/10.1016/j.yqres.2003.12.004, 2004.

Bush, et al.: Amazonian paleoecological histories: one hill, three watersheds, Palaeogeogr. Palaeoclimatol. Palaeoecol., 214, 359–393, https://doi.org/10.1016/S0031-0182(04)00401-8, 2004.

Colinvaux, et al.: Glacial and Postglacial Pollen Records from the Ecuadorian Andes and Amazon, Quat. Res., 48, 69–78, https://doi.org/10.1006/qres.1997.1908, 1997.

Fontes, et al.: Paleoenvironmental dynamics in South Amazonia, Brazil, during the last 35,000 years inferred from pollen and geochemical records of Lago do Saci, Quat. Sci. Rev., 173, 161–180, https://doi.org/10.1016/j.quascirev.2017.08.021, 2017.

Hermanowski, et al.: Environmental changes in southeastern Amazonia during the last 25,000 yr revealed from a paleoecological record, Quat. Res., 77, 138–148, https://doi.org/10.1016/j.yqres.2011.10.009, 2012.

3-Relationship between tree cover, biomass, and fire

The interpretation proposed by the authors—linking positive correlations between tree cover and fire frequency to fuel-limited regimes, and negative correlations to moisture-limited regimes (e.g. lines 349-350; 421-422; 535-537; 554-555;574-575)—is broadly consistent with established ecological theory on fire-vegetation-climate interactions. This framework provides a useful lens for interpreting paleoecological data, particularly in ecosystems where fuel availability is a key constraint on fire activity.

Indeed, in ecosystems where fire regimes are typically fuel-limited, such as deserts, xeric shrublands, and dry savannas and grasslands, fire occurrence is constrained by low biomass production and the discontinuity of fuel, despite often dry climatic conditions (e.g., Krawchuk et al., 2009). In these cases, it is true that an increase in biomass is necessary to reach the threshold at which fire can propagate across the landscape (e.g., Pausas & Ribeiro, 2013).

However, it is important to recognize that this relationship is not linear. Once a certain level of biomass is reached—sufficient to produce continuous fuel loads—

further increases in biomass, particularly through increased tree cover, do not necessarily lead to higher fire frequency. In fact, dense woody cover can reduce fire frequency (which is acknowledged by the authors in lines 516-517) by suppressing the herbaceous layer, increasing shading and moisture retention, and creating microclimatic conditions less favorable to combustion (e.g., Staver et al., 2011).

Moreover, the assumption that increasing tree cover directly facilitates increased fire activity under fuel-limited conditions may not always hold. In some cases, both variables—tree cover and fire frequency—could increase independently as parallel responses to external climatic drivers. For instance, a scenario in which warmer temperatures promote tree expansion, while drier conditions simultaneously enhance fire frequency, could result in a positive correlation that does not necessarily reflect a causal, fuel-mediated link. Such a situation might be relevant to the patterns observed in some of the analyzed regions.

Conversely, in cases of negative correlations, it is important to consider that a reduction in fire frequency could also be a precondition for tree cover expansion, rather than its consequence (e.g., Staver et al., 2011). These alternative causal pathways underscore the importance of considering the directionality of the relationships and the potential influence of external climatic factors.

Additionally, it is crucial to emphasize that in many fire-prone ecosystems, especially savannas, herbaceous fuels—notably C4 grasses—are the primary drivers of fire regimes, while woody biomass plays a secondary role (e.g., Bond & Keeley, 2005). Therefore, correlations between tree cover and fire activity may not fully capture the dynamics of fuel availability and fire propagation (the authors seem to consider throughout the ms that arboreal cover (interpreted from AP) equals biomass growth and fuel availability).

Overall, the interpretations made by the authors are reasonable within their theoretical framework, but incorporating these additional ecological nuances could further strengthen the discussion and provide a more comprehensive understanding of the complex interplay between vegetation dynamics and fire regimes.

Response #4. Following specific comments from Reviewer #1 (Nicholas O'Mara), we will have fixed this generalization of AP as biomass. We will include in the methods that AP is relative to herbaceous vegetation:

"*Arboreal pollen (AP), which serves as an indicator of tree cover relative to herbaceous vegetation, was calculated as the percentage of woody taxa (trees and palms, considering taxa at the genus and family level) (TRSH and PALM) divided by the total sum of trees and shrubs (TRSH), palms (PALM), and herbs (UPHE), excluding mangrove and aquatic taxa, fern spores, and unidentified types.*"

We will also fix part of the CEB section 5.2.5 in order to account for the importance of herbaceous vegetation to fire dynamics, as follows:

5.2.5 Central-eastern Brazil (CEB): "*In CEB, long-term tree cover changes are negatively correlated with fire activity. This pattern points to a feedback mechanism in which herbaceous vegetation facilitates fire activity, while fire, in turn, contributes to the dominance of herbs by limiting tree encroachment. Conversely, moisture-driven development of woody formations leads to the suppression of fire, which further contributes to tree cover expansion.*"

Furthermore, we agree with the pointed concerns that fire activity and tree cover relationships are often multidirectional, and attributing clear causality is difficult, especially when both variables may be responding to the same external forcing. Thus, we will adapt the text to provide a more nuanced explanation about the potential forcings and tree cover-fire relationships:

5.2.6 Southeastern South America (SESA): "*This suggests that the intensified fire regime may have been driven by the long-term increase in fuel availability from woody biomass, or that both tree cover and fire responded to the same external forcing (i.e., deglacial warming). Nevertheless, in the short-term, fire likely acted as a limiting factor for tree cover development.*"

5.2.7 Extratropical Andes (ExTrAn) (this section before named "Southern Andes" will be renamed after changes related to our Response #3 to Reviewer #3, Paula A. Rodríguez-Zorro): "*The strong positive correlation between woody biomass and fire activity supports a fuel-limited fire regime in the region, and/or suggests that observed increases in tree cover and fire activity were both driven by deglacial warming (Fig. A1f). Nevertheless, peak fire activity in the region is currently achieved at intermediate levels of both woody and herbaceous biomass (Holz et al., 2012), supporting the role of increasing woody vegetation in creating optimal conditions for fire. Human populations started to expand after the ACR and likely also contributed to the intensification of the fire regime (Fig. 11d) (Perez et al., 2016; Salemme and Miotti, 2008).*"

4-Potential role of megafauna extinction:

One additional factor that may have influenced vegetation structure and fire regimes in the Neotropics during the late Quaternary is the extinction of megafauna at the Pleistocene-Holocene transition (or later - e.g. Faria et al., 2025). Large herbivores are known to play a critical role in shaping vegetation through grazing, browsing, and trampling, thereby modulating fuel loads and fire regimes (Gill et al., 2009; Doughty et al., 2016). The disappearance of these animals in (some parts of) South America may have contributed to changes in woody cover and fuel accumulation, potentially influencing fire dynamics independently or synergistically with climatic and anthropogenic factors. While I understand that this topic may be beyond the primary scope of the manuscript, I wonder whether the authors considered this as a possible additional driver in some regions, or whether any of the available paleoecological records reflect such transitions.

Response #5. We appreciate the insightful comment. Although this aspect was not considered in our continental-scale analysis, it raises an important point that we will acknowledge in the revised text. Quantifying the impact of megafauna remains challenging due to the limited availability of downcore records across Neotropics that directly assess megafaunal population changes, vegetation and fire (e.g., Bush et al., 2022; Raczka et al., 2018, 2019; Rozas-Davila et al., 2016, 2021).

We also consider these ecological changes as secondary to the major climatic shifts associated with Termination 1, as many of the observed trends can be correlated with substantial changes in temperature and precipitation during this period and during the Holocene to increasing human activities. Nevertheless, it is plausible that megafauna played a competing role in limiting fuel accumulation and constraining the encroachment of woody taxa in open savannas and grasslands. We will include remarks on these effects in the discussion and include references on the role of megafauna and grazing.

For instance:

5.2.1 Northern Neotropics (NNeo): "*Although millennial-scale climate and vegetation changes importantly affected megafaunal populations in NNeo, the extent of megafaunal impacts in the region, and the consequences of their extinction on fire and vegetation dynamics remain unclear (Dávila et al., 2019; Rozas-Davila et al., 2021).*"

5.2.2 Amazonia: "*The impacts of megafaunal extinction also initiated long-term changes in both nutrient distribution and species turnover (Doughty et al., 2013, 2016a). However, its correlation with overall tree cover and fire regime changes remains elusive for the region.*".

5.2.5 Central-eastern Brazil (CEB): "*Additionally, human activity probably also contributed to tree cover and fire trends during this period, as archaeological records show well-established occupations from ca. 13 ka onwards and expanding population in the EH. Furthermore, the megafauna functional extinction during this period may have contributed to changes in vegetation composition (Raczka et al., 2018) and potential increase of fuel loads (e.g., Gill, 2014). This effect, however, may have been secondary, as a decrease in tree cover is opposite to the expected response by megafaunal extinction alone (Doughty et al., 2016b; Macias et al., 2014).*"

5.2.6 Southeastern South America (SESA): "*The presence of a diverse megafauna may have further contributed by restricting both woody encroachment and fuel accumulation (Furquim et al., 2024; Macias et al., 2014; Prates and Perez, 2021; da Rosa et al., 2023)*."

References:

Bush, et al.: A palaeoecological perspective on the transformation of the tropical Andes by early human activity, Philos. Trans. R. Soc. B Biol. Sci., 377, https://doi.org/10.1098/rstb.2020.0497, 2022.

Doughty et al.: The impact of the megafauna extinctions on savanna woody cover in South America, Ecography (Cop.)., 39, 213–222, https://doi.org/10.1111/ecog.01593, 2016.

Furquim, et al.: Interactive effects of fire and grazing on vegetation structure and plant species composition in subtropical grasslands, Appl. Veg. Sci., 27, 1–13, https://doi.org/10.1111/avsc.12800, 2024.

Gill.: Ecological impacts of the late Quaternary megaherbivore extinctions, New Phytol., 201, 1163–1169, https://doi.org/10.1111/nph.12576, 2014.

Macias, et al.: Grazing and neighborhood interactions limit woody encroachment in wet subtropical savannas, Basic Appl. Ecol., 15, 661–668, https://doi.org/10.1016/j.baae.2014.09.008, 2014.

Prates and Perez.: Late Pleistocene South American megafaunal extinctions associated with rise of Fishtail points and human population, Nat. Commun., 12, 1–11, https://doi.org/10.1038/s41467-021-22506-4, 2021.

da Rosa et al.: A Look into the Past: Fossils from the Campos Sulinos Region, in: South Brazilian Grasslands, Springer International Publishing, Cham, 45–81, https://doi.org/10.1007/978-3-031-42580-6_3, 2023.

Raczka, et al.: The collapse of megafaunal populations in southeastern Brazil, Quat. Res. (United States), 89, 103–118, https://doi.org/10.1017/qua.2017.60, 2018.

Raczka, et al.: A human role in Andean megafaunal extinction?, Quat. Sci. Rev., 205, 154–165, https://doi.org/10.1016/j.quascirev.2018.12.005, 2019.

Rozas-Davila, et al.: The functional extinction of Andean megafauna, Ecology, 97, 2533–2539, https://doi.org/10.1002/ecy.1531, 2016.

Rozas-Davila, et al.: When the grass wasn't greener: Megafaunal ecology and paleodroughts, Quat. Sci. Rev., 266, 107073, https://doi.org/10.1016/j.quascirev.2021.107073, 2021.

Final remarks

Overall, I believe this manuscript makes an important and valuable contribution to our understanding of long-term vegetation and fire dynamics in the Neotropics. It integrates multiple lines of evidence in a thoughtful and rigorous way, and I am confident it will be a useful reference for researchers working in this field. I appreciate the opportunity to revise this study and hope my comments are helpful to further refine this already excellent manuscript.

We sincerely thank Raquel F. Cassino for her thoughtful comments and the careful evaluation of our manuscript.

Minor comments:

Lines 237 - 241: replace “use” by “used”

Agree.

Line 436: “which suggests the influence “of” different mechanisms”

Agree.

Line 441: “Furthermore, while δ18O in ice and speleothem cores suggest primarily reflect rainy season precipitation” - remove “suggest”.

Agree.

References:

Bond, W.J., & Keeley, J.E. 2005. Fire as a global ‘herbivore’: the ecology and evolution of flammable ecosystems. Trends in Ecology & Evolution, 20(7), 387–394.

Doughty, C. E., Wolf, A., & Malhi, Y. 2016. The legacy of the Pleistocene megafauna extinctions on nutrient availability in Amazonia. Nature Geoscience, 9, 800–803.

Faria, F. H. C., Carvalho, I. S., Araújo-Júnior, H. I., Ximenes, C. L., & Facincani, E. M. 2025. 3,500 years BP: The last survival of the mammal megafauna in the Americas. Journal of South American Earth Sciences, 153, 105367.

Gill, J. L., Williams, J. W., Jackson, S. T., Lininger, K. B., & Robinson, G. S. 2009. Pleistocene megafaunal collapse, novel plant communities, and enhanced fire regimes in North America. Science, 326(5956), 1100-1103.

Gosling, W. D., Maezumi, S. Y., Heijink, B. M., Nascimento, M. N., Raczka, M. F., van der Sande, M. T., Bush, M. B., & McMichael, C. N. H. 2021. Scarce fire activity in north and north-western Amazonian forests during the last 10,000 years. Plant Ecology & Diversity, 14(1), 89–99.

Krawchuk, M.A., et al. 2009. Global pyrogeography: the current and future distribution of wildfire. PLoS ONE, 4(4): e5102.

McMichael, C. N. H., Heijink, B. M., Bush, M. B., & Gosling, W. D. 2021. ‘. Frontiers in Biogeography, 13(1), e49431

Pausas, J.G., & Ribeiro, E. 2013. The global fire–productivity relationship. Global Ecology and Biogeography, 22(6), 728–736.

Staver, A.C., Archibald, S., & Levin, S.A. 2011. The global extent and determinants of savanna and forest as alternative biome states. Science, 334(6053), 230–232.

Citation: https://doi.org/10.5194/egusphere-2025-1424-RC2