We are very grateful for the insightful comments from the reviewer, which have allowed us to clarify and improve the manuscript. We addressed the reviewer's comments with the comments marked in black and our response in blue.

Reviewer comments:

Overall, this work presents a compelling study of the quasi-biennial variability of fire characteristics over southern Mexico and Central America (SMCA) and demonstrates the role of fire-precipitation interactions at both interannual and sub seasonal timescales in shaping the observed patterns. The manuscript is well-written and the main results are clearly highlighted throughout the text. All the figures are appropriately labeled and captioned; it's evident that the authors have devoted significant effort to effectively communicating their results.

I'm flagging this manuscript as a major revision because there are a couple of important areas (see major comments below) that deserve a more careful examination. However, once these are addressed, I'll be happy to review the revised manuscript's suitability for publication.

Major comments:

Although in L200-201 the authors acknowledge that "fuel availability might play a role in the interannual variation of fires," they do not explore this further since LAI, their surrogate for fuel load, does not show any correlation with fire characteristics. In the model world, this would be fine. However, in general, it has been conclusively demonstrated (see https://journals.ametsoc.org/view/journals/bams/84/5/bams-84-5-595.xml and https://www.publish.csiro.au/wf/WF19087) that, for arid and semi-arid regions, antecedent precipitation in 1-2 years prior to a major fire season shows significant correlations with burned area by promoting the growth of highly flammable fine fuels. Ignoring the effect of precipitation variability on fuel availability might artificially enhance the estimated amplification of the quasi-biennial cycle by the short timescale feedback. I recommend at least discussing this potential source of bias.

Moreover, besides good physiological reasons for not using LAI, specifically that it does not account for variability of vegetation density on the surface, the AVHRR record used in the analysis also suffers from measurement issues due to orbital change and sensor degradation (see Section 3.4.2 in https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018RG000608).

I recommend that the authors explore other remote-sensed predictors such as: -- maximum GPP instead as illustrated in this paper https://iopscience.iop.org/article/10.1088/1748-9326/ac8be4

or, -- fractional land cover as used in https://gmd.copernicus.org/articles/16/3407/2023/gmd-16-3407-2023.html; fractional land cover for the SMCA study region may be found here: https://2018mexicolandcover10m.esa.int

We thank the reviewer for this comment. We have checked all three additional datasets recommended by the reviewer and eventually chose gross primary productivity (GPP) as a proxy for fuel load in the revised version. The fractional land cover data used in Buch et al. (2022) is obtained from the National Land Cover Dataset (NLCD), which only provides annual observations for the years 2004, 2006, 2008, 2011, 2013, 2016 and is not sufficient to reveal the interannual characteristics of fuel load. The second land cover data provided by the link, however, directs us to a new website https://worldcover2021.esa.int/, and the global land cover product is only available for the year 2021. Hence, we used the MODIS version 6.1 GPP products obtained from Terra and Aqua platforms (MOD17A2H and MYD17A2H) as a proxy for fuel load.

Figure R1 shows the interannual variation of the regional mean GPP over the SMCA region in the month (March) prior to the fire season. The quasi-biennial variability is not obvious as seen in GPP data (figure R1). Values of GPP in some odd-numbered years (years with strong fire activities) are weaker compared to adjacent even-numbered years, e.g., in years 2003, 2005, and 2013. The correlation between regional mean GPP and fire-consumed dry matter is even slightly negative. Similar results are found when using maximum GPP in March or 8-day composites of GPP prior to the fire season as a proxy for fuel load. Hence, with the use of the additional proxy for fuel load, we could exclude the possibility that fuel load primarily contributes to the quasi-biennial variability of fire activities, further inferring the weak influence of antecedent precipitation on the quasi-biennial variability of fire by indirectly modifying the fuel availability.

We have now revised the previous manuscript as below:

Line 102-107: "We used the MODIS version 6.1 gross primary productivity (GPP) product (MOD17A2H), which measures the growth of the terrestrial vegetation as a proxy for fuel load. A cumulative 8-day composite of NPP values is provided with a 500m pixel size. The average GPP in the month (March) prior to the burning season is examined."

Line 210-214: "After having examined the GPP (surrogate for fuel load) prior to the burning season, we found little evidence regarding the role of fuel availability in contributing to the interannual variation of fires (Fig. S3). Lower values of GPP are found in some strong fire years compared to their adjacent years, e.g., the years 2003 and 2005. Correlations between regional GPP and fire-consumed dry matter are even slightly negative."

Figure R1. Temporal variations of the regional mean GPP averaged over the SMCA region in the month (March) prior to the peak burning season.

The authors should also emphasize the fact that meteorological conditions, such as mean temperature and precipitation during a fire season, are a clear confounder to any estimated amplification from the short timescale feedback. That is, although they clearly illustrate using model experiments that there is a fire-enhancing precipitation pattern contrast between strong and weak fire years (Fig. 9c), it's not quite clear what the magnitude of this effect is relative to the average difference in expected burned area due to meteorological variability between these years. One potential way to explore the magnitude of the short-term feedback could be through artificially suppressing aerosol-radiation interactions (as in Huang et. al. 2023) and comparing burned areas among similar strong fire years. A careful analysis of this point in the Results or Discussion section would suffice if running new model experiments is cumbersome.

We thank the reviewer for the comment. We agree that a direct estimate of changes in burned areas (or fire-consumed dry matter) would be useful to quantify the contributions of short-time feedback to the quasi-biennial variability of fire activities, which can be achieved by using climate/weather models with an interactive fire module. Nevertheless, in Huang et al.'s (2023) work, this is estimated based on an empirical relationship between the fire weather index (FWI, as a function of meteorological variables) and burned areas instead of online simulations of fire-climate interactions. Basically, they first constructed a linear regression relationship between the observed burned areas and FWI from ERA5 reanalysis using long-term historical data ($y = ax + b$, where y refers to burned areas and x refers to FWI). They then conducted sensitivity simulations with and without aerosol-radiation interactions using the Weather Research and Forecasting Model (WRF) and calculated the difference in FWI between the sensitivity simulations. Eventually, based on the regression equation and the simulated fire-induced difference in FWI, they roughly inferred the change in burned areas that are induced by fire-weather feedback.

Here in the revised version, we followed Huang et al.'s (2023) work and examined the relationship between the observed fire-consumed dry matter from GFEDv4.1s data and FWI from ERA5 reanalysis during 2003-2019. In our work, as precipitation is found to be a dominant contributor to the interannual variability of fire activities, we also examined the relationship between the observed fire-consumed dry matter and precipitation over 2003-2019. As shown in Fig. R2, fire-consumed dry matter is highly correlated with both FWI and precipitation with correlation coefficients of 0.8 and -0.7 respectively.

The estimated change in fire-consumed dry matter induced by the precipitation-fire feedback is around 15.3% (3.36Tg relative to the total difference in fire-consumed dry matter of 22Tg between years with strong and weak fire activities). It should be cautioned with the large uncertainty for this estimate because of multiple feedbacks involved at the global scale and large biases for simulated meteorological variables at regional scales in global climate models. We admitted the limitation and added more discussion regarding this issue including emphasizing the importance of using interactive fire-climate models to quantify the contributions of short-term feedback. See Line 467-473 in the revised manuscript:

Line 467-473: "Moreover, though we demonstrated positive feedback between fire-emitted aerosols and precipitation exists on short timescales, to what extent this feedback contributes to the quasi-biennial variability of fire activities remains unquantified due to the absence of coupled fire-climate interactions in current model simulations. Future efforts to quantify how different factors and feedback work together to shape the quasi-biennial variability of precipitation and fire activities using interactive fire-climate models would further benefit the prediction and management of fire activities over the SMCA region."

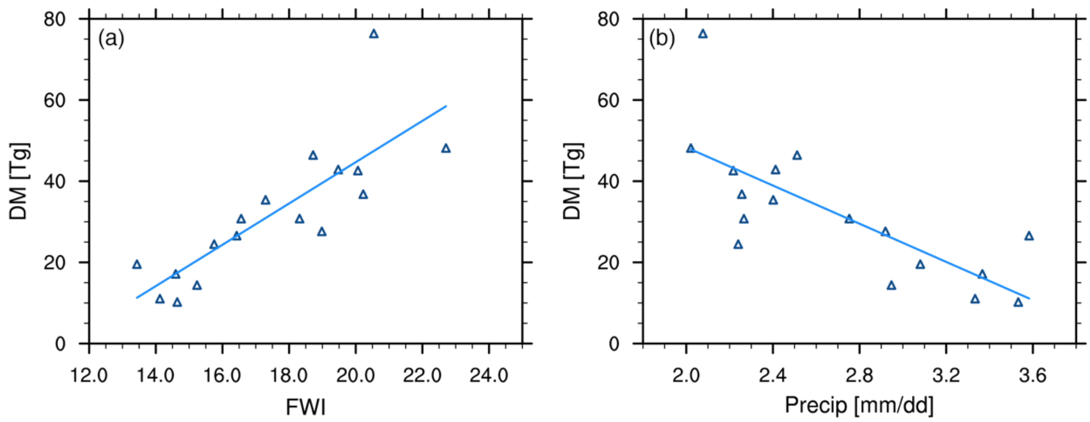

Figure R2. Scatterplots indicating the relationship between the regional sum of fire-consumed dry matter and regional mean (a) fire weather index and (b) precipitation in peak burning seasons over the SMCA region during 2003-2019. Triangles represent values in individual fire seasons and the lines are the linear regression lines.

Minor comments:

L78: Change "characteristic" to characteristics

This has been corrected.

L79-80: Use present tense to maintain consistency throughout the paragraph; specifically change "explored" and "provided" to explore and provide respectively

This has been corrected.

L90: Is "fire consumption" correct here? It might be fuel consumption or fire-consumed fuel instead. Please verify.

We thank the reviewer for the suggestion. We have changed “fire consumption” to either “fire-consumed dry matter” or “fire consumption of dry matter” in the revised manuscript.

L103: Change "previous" to prior

This has been corrected.

L135-136: What is the specific way in which the fire inventory is modified but anthropogenic emissions are kept unchanged? Consider adding a 1-2 sentence clarification

We thank the reviewer for the comment. In the CESM2 model, fire emissions and anthropogenic emissions are specified separately in different files. This has been clarified in the revised manuscript.

L162: Clarify if the difference in fire-consumed dry matter mentioned here is for one particular year or the whole study period.

We thank the reviewer for the comment. We have clarified in the revised manuscript that the difference refers to the difference in the average of fire-consumed dry matter between odd-numbered and even-numbered years.

L165 and L173: Omit "basically" -- the sentences read fine without it

The has been revised.

L202 and L210: Rephrase "fire consumption" as suggested above

This has been revised accordingly.

Fig. 2: I'm not sure if it's easily feasible with the current analysis set up, but including an additional plot of fire counts in the study region between 2003 and 2019 will help in visually emphasizing fire prone areas

We thank the reviewer for the suggestion. We provided the spatial distributions of fire-consumed dry matter in the supplementary information (Fig. S2) to help illustrate the spatial features of fire activities.

Fig. 2: make the stippling bolder/bigger as it's hard to see the pattern in presence of colors

This has been revised accordingly.

In Fig. 3 are the temperature and precipitation anomalies calculated with respect to the 2003-2019 mean? Please clarify in the caption

This has been revised.

L383: Typo in "quai-"

This has been revised.