**General comment**

Overall, the revised manuscript shows noticeable improvements. However, there are several key points raised during the first-round review have not yet been adequately addressed.

I strongly recommend that the authors provide a clear and direct response to each of these previously raised points, indicating precisely where the revisions have been implemented in the manuscript (e.g., by referencing specific line numbers). This will greatly facilitate the cross-checking process and ensure transparency in the revision. Not just answering "Yes, I will adjust..."

Additionally, the authors should exercise greater attention to detail in presenting information to avoid inconsistencies or errors—such as the total number of models, the number and names of predictors, table headers, and the agreed-upon terminology. For example, the term Gross Primary Productivity Index (GPPI) should consistently be replaced with Monthly Ecosystem Productivity Index (MEPI) as previously agreed.

Lastly, the manuscript's structure should be refined. Specifically, the explanation of model validation using observational data should precede any presentation or discussion of model predictions. This adjustment will enhance the logical flow and clarity of the results section.

Please refer to the detailed comments provided below for point-by-point feedback.

**Detailed Comments**

**L1** "A statistical global burnt area model tailored for integration into Dynamic Global Vegetation Models"

> At this review stage, I personally find the current article title still not yet fully firm-particularly with regard to the mention of DGVM integration, which, based on your manuscript, has not yet been technically implemented (still an intention).
>
> Referring to your response to the first-round review, particularly at points **L14** and **L378**, I would suggest revising the title to better reflect the actual scope of the study. For instance:
>
> "**Development of a Biophysical and Socioeconomic-Based Generalized Linear Model for Global Burned Area Simulation**", or
>
> "**Development of a Biophysical and Socioeconomic-Based Statistical Model for Global Burned Area Simulation within a DGVM-Compatible Framework**"
>
> I hope this suggestion is helpful for your consideration, as the title plays a crucial role in accurately representing the core contribution and scope of your research.

**L31** "The model presented should be compatible with most, if not all, DGVMs used to develop future scenarios."

> **Please delete this sentence.**

This sentence could unintentionally weaken your argument, as it may suggest uncertainty regarding the model's compatibility with DGVMs.

Hope you'll consider to apply my suggestion on (**L1**) - indicating that it has been developed within a DGVM-compatible framework, without overstating its level of integration. This allows readers to understand that while integration with DGVMs is feasible, it is not necessarily straightforward. In practice, successful integration requires careful consideration of technical aspects, including differences in programming languages, data structures, and input–process–output mechanisms.

For instance, although it is quite complicated and challenging, SPITFIRE has been successfully implemented across multiple DGVMs within the FireMIP project, but such integration has required significant technical adaptation. Your model, if developed within a compatible framework, can follow a similar pathway.

**L37** "Notably, climate change has led to more severe fire weather in large parts of the world and record fires have recently occurred in Australia and Canada, burning more than 15 million and 7 million ha (Jain et al., 2024; MacCarthy et al., 2024)."

As previously suggested **(first round review L36),** I recommend including one historical burned area data for Australia and Canada for years prior to 2024 to provide a clearer basis for comparison.

Additionally, since the previous sentence states that "climate change led to more severe fire weather," it would strengthen the argument to include a temporal analysis of fire weather conditions in both countries. This would help substantiate the claim by demonstrating how fire weather patterns have evolved over time in response to climate change.

**L127** In Figure 1, the label currently reads "Monthly burnt area **GFEDv5**." To ensure consistency in the use of abbreviations throughout the manuscript, please standardize the format - either use GFED5 or GFEDv5 consistently across all figures, tables, and text.

**Additionally,** please clarify whether the prediction process is part of the Model Evaluation procedure or not?

If not, I suggest separating the Model Prediction process as a distinct subsection following the Model Evaluation. This will help to clearly distinguish between performance assessment and forward-looking application.

**In the Model Prediction section, please specify the temporal coverage** of the prediction- for example, from which year to which year the model was used to simulate burned area- and provide a clear rationale for this time frame.

**L131** Monthly BA data for the periods **2002 and 2018** were derived from monthly mean fractional BA from the GFED5.

Please clarify whether this refers to the entire period from 2002 to 2018 (inclusive), rather than only the years 2002 and 2018. If so, I recommend revising the sentence to accurately reflect the time range, such as:

"Monthly BA data for the period 2002–2018 were derived from the monthly mean fractional BA provided by GFED5."

**L151** Please review the formatting and content of Table 1 carefully:

1) The table caption should be placed above the table, in accordance with standard journal formatting conventions.
2) Please ensure that the "Repeat Header Row" option is enabled. Currently, the header on pages 7 and 8 differs from that on page 6. The column headings should consistently read "Temporal Resolution" and "Source", not "Temporal" and "Predictor".
3) Additionally, please include appropriate citations for the PGC and AGB data sources in the table to ensure transparency and proper attribution.
4) I recommend adding an additional column titled "Temporal Coverage". This will help clarify the specific years associated with each predictor dataset used in the analysis and enhance the transparency and reproducibility of the study.

**L157** "We used **eight** vegetation predictor variables…"

On Line 158, only **six** vegetation predictors are listed, whereas Table 1 includes **nine** vegetation-related predictors.

Please review and clarify the exact number of vegetation predictors used in the analysis to ensure consistency across the manuscript.

**L166** I recommend reviewing the opening phrases of each paragraph in this sub section or other section if any. The phrase "we used" is repeated frequently, which may reduce the overall readability and stylistic variation of the text.

Additionally, please consider improving the logical flow and continuity between paragraphs to ensure a more cohesive narrative. Enhancing transitions and reducing redundancy will help maintain reader engagement and strengthen the overall presentation of your work.

**L249** I would like to reiterate a key point from the first round of review: **I recommend avoiding the use of the phrase "seamless integration into DGVMs."**

This is not a matter of opposition to the idea itself, but rather a concern about accuracy and scientific rigor. In the current study, you have developed a Generalized Linear Model (GLM) under the DGVM framework, with the intention that it may be integrated into DGVMs in the future. However, as the model has not yet been implemented or tested within an actual DGVM - nor validated across multiple DGVM platforms - the claim of "seamless integration" is not currently supported by sufficient evidence.

For this reason, I suggest using more cautious and evidence-based wording to reflect the current status of your model development and its potential for future integration.

**L251** The sentence "Calibration of the model utilized data from 2002 to 2010 while testing utilized data from 2011 to 2018" should be revised for clarity and consistency.

First, please explicitly mention that the data used are from GFED5.

Second, kindly verify the accuracy of this statement, as Figure 1 indicates that GFED5 data from 2002–2010 were used for model training, while data from 2011–2018 were used for model evaluation.

Lastly, I recommend using terminology consistently throughout the manuscript. Please choose a uniform set of terms - such as training, testing, calibration, evaluation or validation, and ensure that their usage aligns with standard definitions, as each term has a distinct meaning in modeling studies.

**L266** The sentence "A total of 25 model runs were conducted, each…" appears to be inconsistent with the information provided in Table A1, which lists 26 models.

Please clarify whether 25 or 26 model runs were actually performed and ensure consistency throughout the manuscript.

**L628** Could you please explain why you moved Table 2 (initial manuscript) to the appendix as Table A1 in the current revised version?

In my view, the information presented in Table A1 is essential to the core content of the manuscript, as it outlines the structure and configuration of Models 1 through 26 - an integral part of the model development process presented in this study. Including this table in the main text would improve clarity and allow readers to more easily follow the comparisons and results throughout the paper.

If the relocation was in response to a specific request from another reviewer, I might understand the consideration. Alternatively, if necessary, guidance from the editor may be helpful in determining the most appropriate placement for this table.

**L289** The sentence "The initial models (Model 1 to Model 3) progressively include more variables, however, a noticeable jump in deviance explained when PNTC is added (Model 3: 0.5298)." Should be improved for clarity and consistency.

While it is understandable that "Model 3: 0.5298" refers to the deviance explained by Model 3, the current phrasing may be unclear to some readers. I suggest rephrasing the sentence to explicitly state that Model 3 explains 52.98% of the deviance or adjusting the deviance writing style on the sentence.

Additionally, there is inconsistency in how models and their deviance values are presented in this sub-section. For example, "Model 15 (~0.5664789)" in Line 295 follows a different format.

Please revise the entire section to ensure a consistent and reader-friendly presentation of model identifiers and their corresponding deviance explained values.

**L300** The phrase "and consisted of other variables that we don't have future projections for (e.g., RD)" is not sufficiently formal for a scientific manuscript.

I suggest rephrasing it to something more appropriate, such as:

*"and included variables for which future projections are currently unavailable (e.g., RD), due to the lack of established projection models or datasets."*

This revision would provide a clearer and more scientifically sound justification. If possible, please support this statement with references or evidence to strengthen the rationale for excluding such variables from future scenario modeling.

**L635** Could you please explain how the predictor formula in each model is determined, the reasons for summing or multiplying the predictors? **This question was asked since the first review round (L277) but I couldn't find the explanation in the revised manuscript.**

I believe it would be helpful - for both myself and the broader readership, to provide a clear rationale for the modeling approach used. Specifically, Models 1 to 12 apply only the sum of predictor variables, while subsequent models begin incorporating multiplicative interactions between predictors.

**Was this modeling structure formula based on established references, or was it determined subjectively defined by the authors?**

As a modeler, particularly from the perspective of DGVM applications, this distinction is crucial. In DGVMs, each variable or parameter is typically defined through well-established empirical or mechanistic relationships, reflecting biophysical, physiological, and ecological processes. The interactions between environmental drivers - such as soil, vegetation, disturbance, and atmospheric variables, lightning – as well as anthropogenic driver such as population density - are governed by interdependent equations grounded in process-based understanding.

Therefore, introducing mathematical operations such as summation or multiplication without a strong theoretical or empirical basis may present challenges for future model integration and validity. Arbitrary combinations may not align with the underlying mechanisms of DGVMs and could compromise the scientific robustness of future applications. I encourage the authors to explain and clarify the conceptual or empirical justification for the mathematical formulations applied in each or overall model structure.

I suggest adding this explanation in **Section 2.4**, positioned sequentially *before* explanation about model performance assessment.

**L325** "Predictor variables were Gross Primary Production Index (GPP)…"

It appears that the term **Gross Primary Production Index (GPP?)** is still used in several parts of the manuscript, despite your agreement in the first-round review's response (see comment L200) to consistently use MEPI, as also shown in Figure 3.

For clarity and consistency, I recommend revising the manuscript to uniformly refer to this variable as MEPI throughout the text, figures, and tables.

**L330** Please search additional references related to similar GLM modeling that have similar or lower explained deviance values than yours, and providing explanations to strengthen your results that the values are accepted. **This point has been asked since the first review round (L308) but I couldn't find any change in this section.**

The comparison with Haas et al. (2022), which reports a deviance explained value of 69%, may inadvertently weaken the presentation of your own model's performance (56.8%).

Since this comparison appears in Section 3 (Results), I recommend reconsidering its inclusion. The Results section should primarily focus on presenting your own findings, while comparative analysis with previous studies would be more appropriately placed in the Discussion section - if sufficiently supported.

If no additional references or contextual justification are available to frame this comparison constructively, it may be better to omit it altogether to maintain a focused and balanced presentation of your results.

**L345** Figure 4: As previously mentioned in the **first-round review (see comment L24**), it is necessary to present a comparison between the observed and predicted burned area data before displaying the map titled "Predicted Burnt Area: 2011–2018."

In general modeling practice, model performance should be evaluated prior to making and presenting predictions. This includes comparing observed and predicted data using spatial analyses or summary statistics, and ideally supported by visualizations such as scatter plots.

If the model demonstrates satisfactory performance, the presentation of the spatial prediction for the 2011–2018 period will be better justified and more scientifically robust.

**L356** Figure 5: Could you please clarify whether the predicted burned area shown covers the period from 2002 to 2018, or only from 2011 to 2018 only?

Kindly ensure that your response is consistent with the point raised in comment **L127**. If the prediction only covers a subset of the years, please adjust the graph accordingly to reflect the correct prediction period.

Additionally, I recommend improving the x-axis labeling by clearly indicating both the start and end years. If space is limited, consider using italicized text or reduced font size so that all years (e.g., 2002–2018) can be displayed legibly. This will enhance clarity and make the graph more reader-friendly.

**L361** Please write the full name of the abbreviation SHAF, SHSA, NHAF, CEAS and so on (because it has not been explained before). **This point has been asked since the first review round (L338) but I couldn't find any additional information.**

For improved clarity and accessibility, I recommend including the full definitions of all of these abbreviations used in Table A2.

**L370** Figure 6b presents the validation results of the selected model through a comparison between observed and predicted burned area data.

I suggest repositioning this figure before Figure 4, as it is more appropriate to present and discuss model validation prior to showing the prediction outputs. This will improve the logical flow of the results section.

Please also clarify the temporal coverage of the comparison: for example, confirm that both GFED5 and model data span 2011–2018, and specify whether the comparison is based on annual average data.

Additionally, please revise the figure caption to include this information and improve clarity.

This comment is closely related to your response to **point L345.** I recommend to show the scatter plot comparison between predicted and observed GFED5 data on the Supplementary file in accordance with this Figure 6 to increase the validation clarity.

**L393** Figure 8. This figure presents the results of model validation using seasonal observation data.

In line with my previous comment, I recommend combining both the annual and seasonal validation results into a single figure to facilitate direct comparison and enhance clarity. Once the validation results are clearly presented and discussed, you may proceed with displaying and interpreting the prediction outputs.

This revised order will improve the logical flow of the results and allow readers to better assess model performance before evaluating its predictive capabilities.

**L395** Section 4. Discussion

I recommend maintaining the subsection title 4.1. Main Drivers of Global Burned Area to help clearly categorize and structure the Discussion section.

**As noted in my first-round review (comment L372),** my suggestion was to delete only the intervening paragraph between the main section title (4. Discussion) and subsection 4.1, not the subsection itself.

Therefore, the structure should be:

4. Discussion

4.1. Main Drivers of Global Burned Area

**L396** I recommend removing the sentence "We found a DGVM-compatible parsimonious global statistical model made of FWI, PNTC, PTC, TPI, MEPI, HDI, VAT, and NDD."

Placing this statement at the beginning of the paragraph may be inappropriate, as the claim of "DGVM-compatible" is not yet strongly substantiated within the manuscript.

Instead, I suggest focusing the paragraph on discussing the main drivers of global burned area, in line with the theme of subsection 4.1. This will ensure better alignment with the section's objective and maintain a coherent flow of discussion based on the model results.

**L459** The sentence *"Our model has contributed novel insights to the existing understanding of the factors influencing global fire trends (Joshi and Sukumar, 2021; Kraaij et al., 2018; Mukunga et al., 2023)"* remains vague and insufficiently supported.

Could you please explain whether they say that your model contributed novel insights to the global fire trends?

As previously noted in my first-round review **(comment L432),** but authors didn't make any change on this point. This claim should be substantiated by explaining how your model offers novel insights. Simply stating the contribution without elaboration or contextual comparison weakens the impact of your findings.

I recommend strengthening this statement by clearly articulating what specific advancements or new perspectives your model provides - such as integrating novel predictor combinations, improved spatial resolution, or enhanced predictive accuracy - and then positioning these insights relative to previous studies.

A clearer structure could be:

"Our model has contributed novel insights to the existing understanding of the factors influencing global fire trends because "reason A" (Reference), "reason B" (Reference), so on if any. Previous studies, such as Andela …"

**L468** "This highlights the significant influence of HDI in projecting the purported negative global ire trend".

The response provided by the authors to comment **L442 in the first-round review** does not appear to be fully implemented in the revised manuscript. While the authors agreed to include

a discussion on HDI regional classification to improve the logical flow between sentences, this has not been clearly reflected in the current version.

For example, the sentence **"This highlights the significant influence of HDI in projecting the purported negative global fire trend."** is immediately followed by **"HDI is a rather broad socioeconomic indicator, which we assume acts as a proxy for factors..."**

The connection between these two sentences is weak, and the paragraph lacks a transitional explanation or regional perspective that would justify the claim. I recommend adding a brief discussion on HDI variability across regions or classifications (e.g., low-, middle-, high-HDI countries), and how this influences fire trends. This addition would strengthen the coherence of the paragraph and enhance the reader's understanding of HDI's role in your model.

**L496** "Globally, our model predicts a notable peak in burnt areas during February and August."

Could you please include a cross-reference to an image that states this?

**L512** Could you please provide evidence to support this assertion that it is due to climatic conditions in those regions? You can compare seasonal fire patterns and climatic conditions in those regions and discuss the result in this sub-section. **This point has been asked since the first review round (L471) but I couldn't find any additional information.**

Author responded "Evidence supporting the assertion that climatic conditions influence fire dynamics in specific regions will be provided by comparing seasonal fire patterns with climate variables."

This can be addressed with a relatively straightforward approach. I suggest plotting the seasonal fire pattern alongside the relevant seasonal climate variables discussed in this section, to strengthen your argument.

You may include this plot as a supplementary figure, and provide an appropriate cross-reference to it within the main text.

**L587** "We sought … , both globally and regionally."

I recommend deleting the first paragraph of the Conclusion section, as it is not appropriate to restate the research objectives in this part of the manuscript. As mentioned in my **first-round review (comment L531),** the Conclusion should focus on explaining how the research objectives were achieved, based on the results and discussion presented.

I suggest starting with a concise summarizing statement such as:

Line 592 "We present a parsimonious statistical model specifically tailored for global burned area simulation."

Please remove the phrase "with the goal of integration into DGVMs" at this point, should emphasize demonstrated outcomes rather than intentions.

Then after Line 592, please discuss points 1) how the major drivers in the model you use, how the major drivers accommodate the fire incident or burnt area factors. 2) how the model can be integrated in DGVM and 3) how your model performs against interannual and seasonal observational data - global and regional.

**Note:** Please ignore the quotation 1), 2) and 3) -> my intention writing the quotation number to make ease the explanation of your research objective sequentially. Please write the content in a continuous, flowing narrative that cohesively summarizes how the model addresses and fulfills the research objectives.

**L604** "We hope that our research outcomes will stimulate a more rigorous implementation of global fire models within DGVM frameworks."

Please rewrite the sentence, perhaps something like this would be better

"The parsimonious statistical model developed in this study has demonstrated strong performance in simulating global burned area patterns. With further development, it holds potential for integration into DGVMs to enhance the representation of fire dynamics…"