We sincerely appreciate the referees for their valuable and insightful comments on our manuscript. The feedback is instrumental in enhancing the quality and clarity of our research. This response document provides a detailed account of the changes implemented in relation to each specific comment from the referee. For ease of reference, referee comments are presented in black, while author responses are highlighted in blue, with modifications to the manuscript in italic font.

Referee #1

Thank you for your revisions in response to our reviewer comments. I feel that all mine have been satisfactorily addressed. I just have a few minor additional comments of a technical nature:

- The citation of Smith et al. (2001) for LPJ-GUESS-SIMFIRE at line 153 should be replaced with Knorr et al. (2016, Nature, https://www.nature.com/articles/nclimate2999).

Corrected. Thanks.

- L373: "employs the" should just be "employ"

Corrected.

- L383: "complex" should be "complicate"

Done.

- L383-386: Various corrections needed in this sentence. Suggested rewrite: "The fire-vegetation feedbacks further complicate this problem, with more complex dynamic vegetation models being slow to reach equilibrium after disturbances. The choice of prescribed or dynamic vegetation could also play a role; note that among all the process-based models, CLASSIC, VISIT, and ELM used prescribed vegetation while all others used dynamic vegetation."

Corrected. Thank you for the suggestion.

- L387: "institute" should be "institutes".

Corrected.

Referee #2

I greatly appreciate the authors' efforts in responding comprehensively to my comments. I have a couple of very minor additional clarifications below, which relate to parts of new text added to the manuscript, but otherwise am happy to recommend the paper be accepted for publication in GMD.

Additional minor/technical comments (line numbers refer to clean version of revised manuscript):

L26-28 "In the past two decades, satellite-derived data suggest that the global total burned area has declined by over 20%, primarily attributed to human influences. The continental United States has emerged as a hotspot for wildfires..." - These statements individually are absolutely fine, but possibly now reads a little oddly as the second sentence no longer really follows on from the preceding sentence. The authors are very welcome to keep it as is, but they could consider changing the following sentence to "*However*, the continental United States has emerged as a hotspot for wildfires..." to make for (in my opinion) a slightly more punchy introduction. Entirely at the authors' discretion though.

Thanks for the suggestion. We have added a "However" before the second sentence for a better flow.

L181-183 "Lightning, population density, and GDP data are resampled to 0.25°×0.25° spatial using bilinear interpolation and annual temporal resolution using the nearest neighbor method" - I want to double check that this revised description is correct, specifically re. the lightning dataset. The authors state that they use the NASA LIS/OTD 2-hourly lightning climatology, and so the idea of using nearest neighbour interpolation to resample this to an annual value, before then re-interpolating it to a monthly value (which is what the ML fire model uses as input), seems slightly odd. A nearest neighbour interpolation of 2-hourly lightning data would correspond to picking a single 2-hour time period and using that value for the whole year, which seems unnecessary when the 2-hourly data could just be used to directly calculate a monthly-mean climatology to drive the model with. It also seems at odds with the authors' description in the response to reviewers document, where they indicate that nearest neighbour interpolation was used to interpolate values which were already at annual resolution, like the GDP and population density, to monthly values to use as inputs to the model - which makes more sense. So, I just wanted to check whether this sentence in the revised manuscript is correct.

Thank you for pointing out this important distinction; this is indeed a valuable clarification. The lightning data are treated differently from the population density and GDP datasets. Specifically, the population density and GDP datasets are provided annually, and since their monthly variations are considered less relevant for fire prediction, each annual value is simply assigned uniformly across all months within the corresponding year. In contrast, the lightning data, originally available as a 2-hourly climatology from NASA LIS/OTD v2.2, are first aggregated by summing the 2-hourly data into monthly climatological means. These monthly climatologies remain constant and are repeated uniformly across all years of the simulation period, disregarding interannual variations. We have revised the manuscript text as follows to accurately reflect this approach:

The 2-hourly climatology lightning flashes data from NASA LIS/OTD v2.2 at 2.5° resolution are used to calculate the number of natural ignitions. Lightning data are aggregated by summing the 2-hourly data to derive monthly climatological means, and these monthly climatologies are repeated across all years, disregarding interannual variations. The annual gridded population density data is acquired from Goldewijk et al. (2017), while the GDP per capita is from the World Bank (https://data.worldbank.org/), which are assigned constant values for all months within each corresponding year. All datasets are spatially resampled to a 0.25°×0.25° grid using bilinear interpolation.