We thank Dr. Xu for her thoughtful, valuable and detailed comments and suggestions that have helped us improve the paper quality. Our detailed responses (Blue) to Dr. Xu's questions and comments (*Italic*) are listed below.

Reviewer #2:

This paper studied the patterns of global burned area, burned fraction, fire count, and fire intensity based on selections of remote sensing products. This paper also investigated the 12 fire-prone regions of their variations in fires, emissions, and how meteorological indicators of temperature, precipitation, relative humidity, and soil moisture impacted fires activities.

We thank Dr. Xu for the detailed evaluations and valuable comments. We have gone through all the comments and revised the original manuscript based on the suggestions and comments.

General comments:

1. My first concern is the statement of the research subject in this paper. This title and the writing of the paper were about wildfires while all the data used for this paper were not specifically just of wildfires. I need the authors to provide the definition of wildfires and evidence to prove the right use of the data (data for other fire types, e.g. prescribed fires, were removed in this analysis). Otherwise, the subject and the corresponding statements need to be changed to fires/biomass burning emissions.

We thank the reviewer for the constructive suggestions. We have thought about this problem and carefully read the existing literature, and found that there is no reliable method to accurately distinguish fire and wildfire at a large spatial scale. We fully agree with the reviewer's idea and changed the relevant expression of the full manuscript to biomass burning emissions and change wildfires to fires. In addition, we still retain a few "wildfires" in the manuscript, which mainly follows the description in the corresponding references.

2. I am also questioning the conclusion that wildfire burned area has decreased slowing over the last 20 years (line 17-18, 173). There was large difference of magnitude of the two burned area datasets and sometimes the trend was also different (year 2003-2005). The trend of FireCCI data is more stable than the MCD64 trend. Additionally, what does the data look like for the year 2020 and would it affect the results?

These are good questions. The conclusion that the burned area has decreased slowly in the past 20 years in our study is credible, and the results in relevant studies are also consistent with our conclusions (e.g., Forkel et al., 2019; Zheng et al., 2021). However, there are differences in fire activities among different regions, and the burned area in some regions shows an increasing trend, such as the western United States and Siberia. To present the research results more clearly and accurately, we added the change trend of burned area in 12 regions as Figure 4 in the manuscript.

As for the difference between FireCCI and MCD64, we re-examined the data analysis and calculation process, and added the results of burned area in 2020. After careful inspection, we found some errors in our previous computer programming, which led to big differences between the two sets of data in Figure R1. After correcting those errors, the results are consistent now which still prove that the burned area shows a decreasing trend.

Forkel, Matthias et al., Recent global and regional trends in burned area and their compensating environmental controls. Environ. Res. Commun. 1, 051005. https://doi.org/10.1088/2515-7620/ab25d2. 2019.

Zheng, B., Ciais, P., Chevallier, F., Chuvieco, E., Chen, Y., Yang, H. Increasing forest fire emissions despite the decline in global burned area, Sci. Adv., 7, eabh2646, https://www.science.org/doi/10.1126/sciadv.abh2646, 2021.

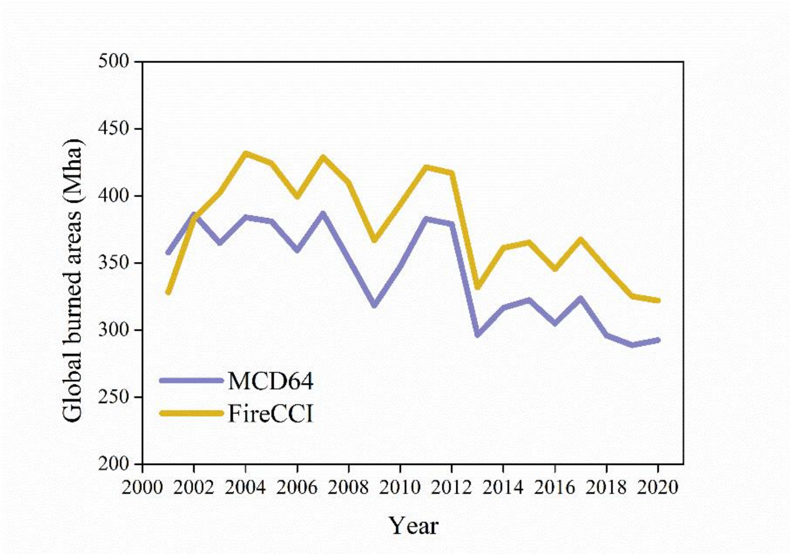

Figure R1. Global burned areas derived from MCD64 and FireCCI.

3. I am concerned about the conclusion that "the increase in temperature in the northern hemisphere's middle and high latitude forest regions was primarily responsible for the increase in wildfires and emissions". This study has only looked at the four types of meteorology data and related them to fires. This conclusion could be misleading.

We agree and thank the reviewer's comments. The meteorological variables selected in this study are indeed limited, and it is difficult to reflect all the causes of fire. However, the cause of fire is complex, even in terms of natural causes, the current research can hardly completely clarify it. So, our existing conclusions are based on the factor analysis results of this study on the one hand, and refer to the evidence in relevant studies (Engelmann et al., 2021; Jolly et al., 2015; Zhu et al., 2021) on the other hand.

Although the above studies also indicate that the increase of temperature leads to the increase of wildfires in the Arctic and Siberia, we have corrected the relevant description with a weak tone to be more reliable based on the suggestions of the reviewer at Lines 29-31: "**Correspondingly, the increase of temperature in the northern hemisphere's middle and high latitude forest regions is likely the major cause for the increase in fires and emissions, while the change in fires in tropical regions was largely influenced by the decrease in precipitation and relative humidity.**". In addition, we also revised the relevant description in the discussion section.

Engelmann, R., Ansmann, A., Ohneiser, K., Griesche, H., Radenz, M., Hofer, J., Althausen, D., Dahlke, S., Maturilli, M., Veselovskii, I., Jimenez, C., Wiesen, R., Baars, H., Bühl, J., Gebauer, H., Haarig, M., Seifert, P., Wandinger, U., and Macke, A.: Wildfire smoke, Arctic haze, and aerosol effects on mixed-phase and cirrus clouds over the North Pole region during MOSAiC: an introduction, Atmos. Chem. Phys., 21, 13397–13423, https://doi.org/10.5194/acp-21-13397-2021, 2021.

Jolly, W., Cochrane, M., Freeborn, P. Holden, Z. A., Brown, T. J., Williamson G. J., and Bowman, D. M. J. S.: Climate-induced variations in global wildfire danger from 1979 to 2013, Nat Commun., 6, 7537, https://doi.org/10.1038/ncomms8537, 2015.

Zhu, X., Xu, X., and Jia, G.: Asymmetrical trends of burned area between eastern and western Siberia regulated by atmospheric oscillation, Geophys. Res. Lett., 48, e2021GL096095. https://doi.org/10.1029/2021GL096095, 2021.

4. The third paragraph (line 59-70) in the introduction section could be reduced to one sentence and add to the first paragraph. This is one aspect of fire impacts and not a directly interest of this paper. The introduction part also lacks discussions about the current studies like this study, e.g., on global and regional fires and emissions. Some suggested readings:

Andela, N., Morton, D. C., Giglio, L., Chen, Y., van der Werf, G. R., Kasibhatla, P. S., ... & Randerson, J. T. (2017). A human-driven decline in global burned area. Science, 356(6345), 1356-1362.

Giglio, L., Randerson, J. T., & Van Der Werf, G. R. (2013). Analysis of daily, monthly, and annual burned area using the fourth‐generation global fire emissions database (GFED4). Journal of Geophysical Research: Biogeosciences, 118(1), 317-328.

van Wees, D., van der Werf, G. R., Randerson, J. T., Rogers, B. M., Chen, Y., Veraverbeke, S., ... & Morton, D. C. (2022). Global biomass burning fuel consumption and emissions at 500 m spatial resolution based on the Global Fire Emissions Database (GFED). Geoscientific Model Development, 15(22), 8411-8437.

We thank the reviewer's valuable suggestions.

For the first point regarding the third paragraph, we carefully discussed it among the coauthors and think that it has important scientific value in this study. On the one hand, it shows the importance of fire and its emissions, and provides the latest research evidence. On the other hand, it proves the close relationship between fire and human society. Together with the description of the relationship between fire and natural environment in the second paragraph, they become the detailed discussion in the first paragraph of the introduction. Thus, we kept it in the revised version.

For the second point, we have made further discussions by following the suggestions of the reviewer at lines77-91: "**In terms of BA, forest fires made up the majority of the area burned in Equatorial Asia, followed by the North America. Savanna fires were extremely prevalent in Africa and considerably less in South America. Farmland fires were the most prevalent in Europe and the Middle East, while grassland fires were dominant in Central Asia and South America (Giglio et al., 2013; van Wees et al., 2022). The majority of the world's regions,**

particularly those with forests in mid- and high-latitudes, will see a future with a higher danger of wildfires as global warming progresses (Yu and Ginoux, 2022; Zhu et al., 2021).

In the past decade or so, although the reduction of man-made fires in tropical areas has led to the reduction of the global area of over-fire, the trend in other regions is on the rise, the frequency of extreme wildfire events is increasing, and the difference in seasonal variation is more obvious (Bowman et al., 2020; Senande-Rivera et al., 2022; Zheng et al., 2021). Several recent studies (Huang et al., 2023; Xu et al., 2022) have found that the BA of wildfires in the West Bank of the United States and the Indo-China Peninsula in Southeast Asia has increased and has significant synoptic scale changes, and the strongest frequency spectrum is in the time scale of 1 week and 2 weeks, respectively. The former is controlled by wind speed and humidity, while the latter is mainly modulated by rainfall (Huang et al., 2023).".

5. *The methods and analysis of geographical detectors are not clear. How can the geographical detectors explain the percentage of the causes of fires?*

We apologize that we did not make it clear. In combination with the reviewer's suggestions in Specific comments, we have added the method description, equation and references of geographical detector at lines 182-193: "**We use geographic detector to quantify the contribution of meteorological conditions (temperature, relative humidity, soil moisture, and total precipitation) to fire changes in different regions. The geographic detector can explain the degree of variability of various independent variables (x) to dependent variable (y). The q statistic in the calculation results indicates the degree of interpretation of the corresponding variable and its value range is 0-1 (Eq.1). The larger the q is, the stronger the explanatory power of (x) to (y) is. The geographic detector model has currently been used extensively in research for quantitative attribution analysis (Wang et al., 2016; Zhang et al., 2019). Detailed description of this model can refer to the studies by Wang et al. (2010, 2016).**

$$q = 1 - \frac{\sum_{h=1}^{L} N_h \sigma_h^2}{N\sigma^2} \qquad (1)$$

where h = 1, …, L is strata of y (burned area and intensity) or x (meteorological variable); N_h and N are the strata h and the number of units in different fire regions; σ_h^2 and σ^2 are the variance of the strata h and y value in the fire region respectively.".

Specific comments:

1. *Line 21: "summer and autumn as the reasons with the most frequent wildfires worldwide". Is "reasons" a typo? "seasons"?*

   Sorry for the typo and we have corrected it.

2. *line 24-26: "absolute amount of CO_2 produced by wildfires is the largest" is obvious according to the emission factors used in the emission models. I would recommend remove*

this from the abstract.

We agree with the reviewer and have removed it.

3. *Line 84-85: Why "debatable"? What are the observation inversion data?*

Sorry for the confusion. What we want to express here is that the fire emission information still has great uncertainty, and thus the research based on model simulation is likely more inaccurate than the research based on observation data. We modified the description at Lines 93-96: "**Meanwhile, the information regarding the emissions of various compounds caused by fires still has great uncertainty, and the model simulation results are likely more inaccurate than the observational data (Zhang et al., 2016; Zheng et al., 2021)**.".

4. *Line 90: "investigate the causes" is not appropriate.*

Corrected.

5. *Line 154: Why the month with 80% of the annual average burned area is the fire month?*

This is a good question.

Here we refer to the study of Archibald et al. (2013). In their research, a monthly climatology of burned area was first produced from the entire time series. The monthly burned areas were then ranked, and the average fire season length was defined as the number of months required to reach 80% of the total average annual burned area (analysis of values from 70% to 85% showed that the results were not sensitive to the threshold chosen). Therefore, we have adopted 80% as the threshold in this study, and have also added the reference at lines174-176: "**The month with 80% of the annual average burned area is the fire month, and the fire month number is the duration of the fire season (Archibald et al., 2013)**.".

Archibald, S., Lehmann, C.E.R., Gómez-Dans, J.L., Bradstock, R.A.: Defining pyromes and global syndromes of fire regimes, Proceedings of the National Academy of Sciences, 110, 6442-6447, https://doi.org/10.1073/pnas.1211466110, 2013.

6. *Line 164: I understand that Wang et al. (2010, 2016) provided a detailed explanation of q statistic. I would recommend adding a description of q statistic in this context for better reading experience.*

We appreciate this comment and have added the description as suggested.

7. *Line 171-174: Please add more explanation about the BA results and the difference from the two datasets.*

We thank the reviewer for the detailed suggestions. As replied in General comments, we have corrected Figure 1. Now, the burned area calculated by the two sets of data is consistent, and the burned area has shown a downward trend in the past 20 years.

8. *Line 255: How the relative changes calculated? Why using this index to investigate the*

regional differences?

This is a good question. Taking FEP as an example, *y* represents the relative changes, *a* represents absolute value of FRP in a region, *b* represents average value of FRP in 12 regions. The calculation process is shown in this equation: $y=(a-b)/b$. As shown above, this method can represent the relative change of the average state of a region compared with that of multiple regions. We have given the absolute values of fire area and emission change in different regions in the study (Figs. 4, 6 and 7), so we use the method of relative change to further explore the differences of 12 regions.

9. *8: how the annual trends were calculated? I didn't find the "*" in the figure represents that the trend has passed the 95% significance test.*

If we understand correctly, what the reviewer want to say here is Figure 8.

In this study, the trend analysis was carried out for the temperature, total precipitation, relative humidity and soil moisture at the global scale using the Mann–Kendall (M–K) τ test, with Sen's slope method. In this study, Sen's slope was applied to evaluate the strength of the trend value; then, the M–K statistical test was employed to test whether these estimated trends were significant at a given significance level. The relevant calculation process can refer to the research of Gui et al. (2021). We also added relevant descriptions at lines 169-172: "**In addition, the trend analysis was carried out for the climate data at the global scale using the Mann-Kendall (M-K) statistical test, with Sen's slope method. Specifically, Sen's slope was applied to evaluate the trend value; then, the M-K statistical test was employed to test whether these estimated trends were significant at a given significance level (Gui et al., 2021).**".

Yes, the grid points in the figure that passed the 95% significance test were indeed marked with the "*". Maybe it is not clear due to the limitation of color setting and picture frame, so we updated the Figure.

Gui, K., Che, H., Li, Lei, Zheng, Y., Zhang, L., Zhao, H., Zhong, J., Yao, W., Liang, Y., Wang, Y., Zhang, X.: The significant contribution of small-sized and spherical aerosol particles to the decreasing trend in total aerosol optical depth over land from 2003 to 2018. Engineering. https://doi.org/10.1016/j.eng.2021.05.017. 2021.

10. *Line 481: the link didn't work for me.*

Corrected.

11. *Figure S3-6: why only the period of 2001-2009?*

Sorry for the confusion. They are actually for the period of 2001-2019. In this study, the year in Figure S3-6 represents the starting year, that is, the sliding average result of 10-year from the starting year. In other words, taking 2001 in the figure as an example, the column of 2001 in the figure shows the result of sliding average from 2001 to 2010. We have added annotations in the figure and added specific descriptions in the title, as shown in the figure below.

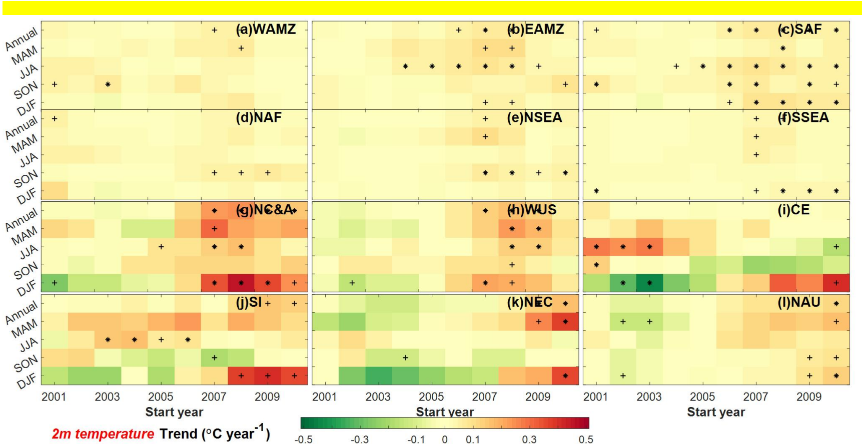

Figure S3. The 10-year sliding average change trend of temperature in typical area. The "*" and "+" in the figure represent that the trend has passed the 95% and 90% significance tests. The year in the figure represents the starting year of the sliding average calculation.