Anonymous Referee #1

We thank the Reviewer for the constructive comments and suggestions. We shall revise the manuscript accordingly, and we address the comments as follows.

Specific comments：

1. In the reply P16 line377–379, there is no clear explanation about how the difference in transmission time between the two satellites affects the detection of agricultural small fires. The authors only highlights that the algorithm of FY3D's adaptive threshold can effectively capture small fires and has high spatial resolution in the far infrared band, and high accuracy for large fire detection. The authors should further explain why FY3D is more capable of detecting small fires compared to MODIS from the algorithm principle.

Response: We added more details to explain the capacity of FY-3D in detecting small fire. Please refer to the Line 135, 146, and 151.

Revision:

1. “First, FY-3D introduces an adaptive threshold using automatic identification algorithms for fire spot detection, which calculates the background temperature as the mean temperature of all the background pixels within each 3×3 window. If fewer than 20% of the pixels are identified as cloudless, the window size is expanded to 5×5, continuing up to 51×51 in order to accommodate more data (Chen et al., 2022). This approach eliminates the limitations posed by fixed thresholds in the MODIS and VIIRS algorithms, which set T4 to greater than 360 K (320 K at night) and fixed the moving window size at 21×21 (Giglio et al., 2016).”.

2. “Finally, FY-3D employs a far-infrared band with a high resolution of 250 m, and channels 24 and 25, which has a higher resolution than MODIS (1 km) (Zheng et al., 2023). The far-infrared band has a higher sensitivity to large fires or high-brightness fire events and can distinguish differences against background brightness temperatures (Zheng and Chen, 2020).”.

3. “Overall, the FY-3D GFR product has an accuracy of 94.01% globally, as calculated using fire detection after eliminating errors based on visual checks conducted using SMART (Visual Check) in 2019. It has accuracies of 94.61, 94.12, 90.63, 91.76, and 92.69% for Southern Central Africa, Eastern Central South America, Siberia, Australia, and the Indo-Chinese Peninsula, respectively (Chen et al., 2022). Specifically, owing to the removal of the underlying surface interference in China, FY-3D has accuracies of 79.43% and 88.50% for accuracy and accuracy without omission (Chen et al., 2022). These accuracies were determined by comparing the results of a large-scale field experiment conducted jointly by the State Grid Corporation of China and China Meteorological Administration with the GFR product, thereby calculating the accuracy, including and excluding mis-judgments. This comprehensive assessment took place throughout 2020 across five provinces in China—Guangdong, Guangxi, Yunnan, Guizhou, and Hainan—utilizing a combination of real-time satellite data and ground-truth validation to evaluate the suitability of these fire detection products. These accuracies are significantly higher than those achieved by MODIS, which are 74.23 and 79.69%, respectively (Chen et al., 2022).”.

2. According to the statement from the authors, FY-3D was able to enhance the detection of small fires compared to MODIS, but the analysis of the results did not indicate how much the estimated emissions increased due to the FY-3D detection product for the small fires.

Response: We added analysis of the results to explain the analysis of the small fire by FY-3D detection product. Please refer to the Line 501. We added the comparisons of small fire detects in FY-3D and MODIS in supplements. Please refer to the Figure S2 and S3.

Revision: "While, the average annual estimated OBB emissions exceed those reported by GFED by 617.14 Tg C/year. These discrepancies are probably related to small-scale fire events. For instance, the largest difference is observed in the SHAF region, exceeding by 248.01 Tg C/year, followed by SHSA (190.28 Tg C/year) and SEAS (103.92 Tg C/year). In the SHAF region, compared to MODIS active fire, FY-3D GFR detects more small fire points (Figure S2, Figure S3 (a), Figure S3 (b)), which are isolated within 5-kilometer resolution pixels. However, in this area, the majority of fire events are large-scale incidents, which means that although small fires are more numerous, they contribute minimally to the total emissions. Furthermore, fire events in SHSA (Figure S3 (c), Figure S3 (d)) and SEAS (Figure S3 (e), Figure S3 (f)) are primarily triggered by human activities, consisting of small-scale incidents that are significantly linked to the overall emissions. In contrast, areas frequently affected by large-scale fire events show relatively smaller discrepancies, such as TENA (99.05 Tg C/year), NHAF (51.94 Tg C/year), and other regions including NHSA, AUST, CEAM, MIDE, EURO, and EQAS (all under 15.00 Tg C/year).".

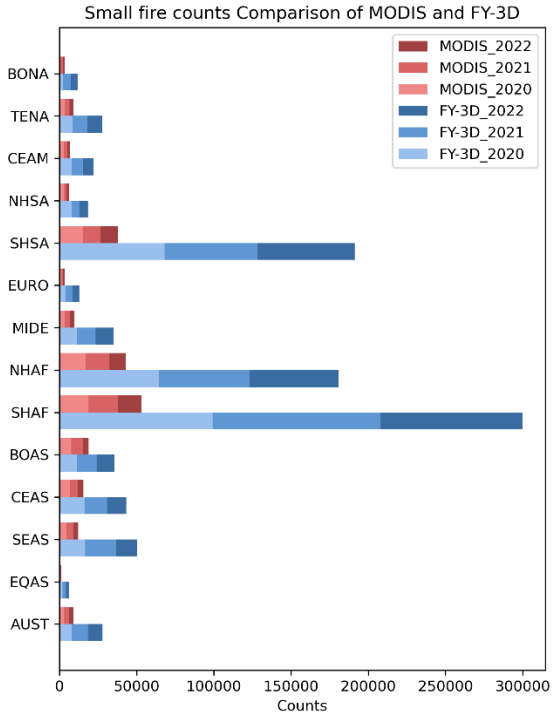

Figure S2. Small fire count in 2020-2022 between MODIS active fire and FY-3D GFR

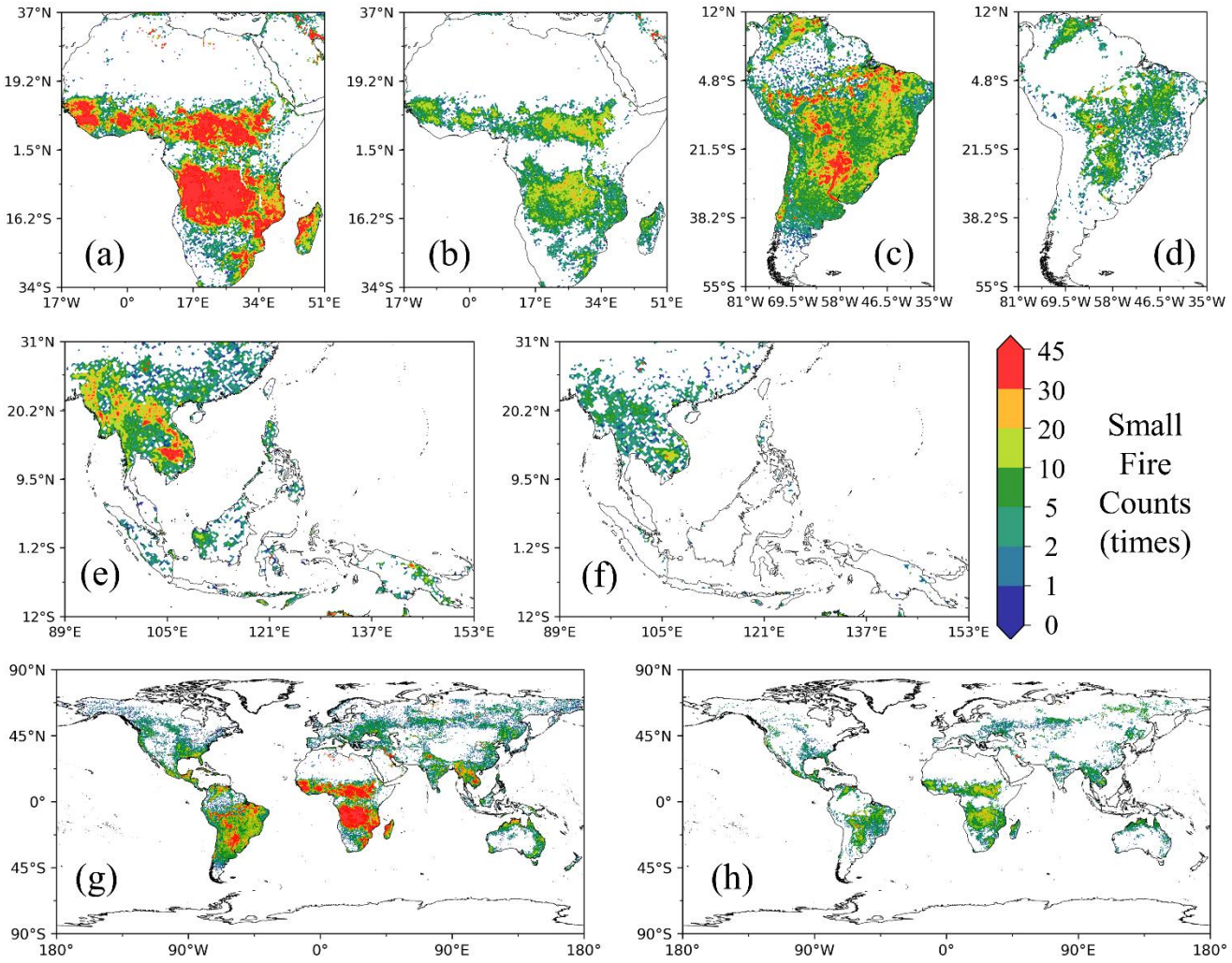

Figure S3. Small fire counts in 2020-2022. (a) FY-3D GFR in Africa. (b) MODIS GFR in Africa. (c) FY-3D GFR in South America. (d) MODIS active fire in South America. (e) FY-3D GFR in Southeast Asia. (f) MODIS active fire in Southeast Asia. (g) FY-3D GFR in Global. (h) MODIS active fire in Global.

Anonymous Referee #2

The quality of the revised manuscript remains below the standard expected for publication in the ESSD journal. Numerous inconsistencies, spelling and grammatical errors, scientific inaccuracies, unclear references, and unrelated citations persist throughout the manuscript. Specifically, the 'Introduction' and 'Materials and Methods' sections suffer from poor presentation, characterized by lengthy and convoluted sentences, as well as disjointed transitions.

During the previous round of revision, it appears that the authors addressed only the errors pointed out by the reviewers without proactively seeking to identify and rectify similar issues elsewhere in the manuscript.

While the 'Methods', 'Results', and 'Discussion' sections present scientific findings, they fail to significantly advance the field beyond the utilization of a different satellite active fire product. Many of the methodologies employed in this study rely on outdated knowledge and overlook recent developments.

Based on these observations, I do not recommend publication of the manuscript in its current form. A substantial overhaul of both the textual presentation and scientific discussion is imperative for future consideration of this manuscript for publication.

Below, I outline some of the issues observed in the 'Introduction' and 'Materials and Methods'. Please note that this list is not exhaustive, and it is essential for the authors to enhance the overall clarity and coherence of the manuscript.

We thank the Reviewer for the constructive comments and suggestions. We have revised the manuscript accordingly, and we address the comments as follows.

Specific comments：

P1 L16-17: "Global high–resolution satellites can detect active fires, enabling a more accurate estimation of these emissions."

Regarding the term 'more accurate', it's important to specify what the comparison is being made against. Without a clear comparison, the statement lacks clarity.

The phrase 'these emissions' is ambiguous as it doesn't specify which emissions are being referred to. It would be helpful to clarify that these emissions pertain to those from Open Biomass Burning (OBB) to enhance the reader's understanding.

Response: We clarified and rephrased the sentence for better understanding.

Revision: "A global emission inventory based on high-resolution satellite fire detection enables an accurate estimation of OBB emissions.". Please refer to Line 17.

P1 L19: "satellite and observational biomass data"

While "satellite biomass data" is a type of observational data, the phrase "satellite and observational" is redundant. Consider using "satellite-derived biomass data" or "observational biomass data" to avoid redundancy.

Response: We changed "satellite and observational" into "satellite-derived biomass data". Please refer to Line 21.

P1 L19: "vegetation index–derived spatiotemporal variable combustion efficiencies"
Consider revising "spatiotemporal" to "spatiotemporally" for grammatical correctness.
Response: We changed "spatiotemporal" into "spatiotemporally". Please refer to Line 21.

P1 L20: "The average annual OBB emissions for 2020–2022 were…"
Specify that these values are estimates derived from the study rather than presented as absolute facts. For example, consider revising to "The average annual estimated OBB emissions for 2020–2022 were..."
Response: We changed "The average annual OBB emissions for 2020–2022 were…" into "The average annual estimated OBB emissions for 2020–2022 were ...". Please refer to Line 22.

P1 L23-27:
The average annual OBB emissions for different regions have different precisions, ranging from 0 (e.g., 13 for EURO), 1 (e.g., 165.7 for TENA), to 2 (e.g., 72.71 for BONA). These inconsistencies in precision across different regions negatively impact the scientific credibility of the study.
Response: We standardized precision to eliminate inconsistencies. Please refer to Line 25.
Revision: "the average annual estimated OBB for 2020–2022 were 72.71 (Boreal North America; BONA), 165.73 (Temperate North America, TENA), 34.11 (Central America; CEAM), 42.93 (Northern Hemisphere South America; NHSA), 520.55 (Southern Hemisphere South America; SHSA), 13.02 (Europe; EURO), 8.37 (Middle East; MIDE), 394.25 (Northern Hemisphere Africa; NHAF), 847.03 (Southern Hemisphere Africa; SHAF), 167.35 (Boreal Asia; BOAS), 27.93 (Central Asia; CEAS), 197.29 (Southeast Asia; SEAS), 13.20 (Equatorial Asia; EQAS), and 82.38 (Australia and New Zealand; AUST) Tg C/year.".

P1 L28: "the lion's share of total emissions"
While "lion's share" is a colorful and idiomatic expression, it may not be the most appropriate choice for a scientific journal. Scientific writing typically aims for clarity and precision, avoiding figurative language or colloquialisms that might distract from the data or findings being presented.
Response: We combined the question "P1 L28", "P1 L29-30", "P1 L31", and "P1 L32-34" as follows.
We newly added and modified the following contents. Please refer to Line 30.
Revision: "Overall, savanna grassland burning contributed the largest proportion of the annual total carbon emissions (1,209.12 Tg C/year; 46.74%), followed by woody savanna/shrubs (33.04%) and tropical forests (12.11%). SHAF was found to produce the most carbon emissions globally (847.04 Tg C/year), followed by SHSA (525.56 Tg C/year), NHAF (394.26 Tg C/year), and SEAS (197.30 Tg C/year). More specifically, savanna grassland burning was predominant in SHAF (55.00%, 465.86 Tg C/year), SHSA (43.39%, 225.86 Tg C/year), and NHAF (76.14%, 300.21 Tg C/year), while woody savanna/shrub fires were dominant in SEAS (51.48%, 101.57 Tg C/year). Furthermore, carbon emissions exhibited significant seasonal variability, peaking in September 2020, and August of 2021 and 2022, with an average of 441.32 Tg C/month, which was higher than the monthly average of 215.57 Tg C/month.".

P1 L29-30: "with marked increases observed in August and September (annual average 441.32 Tg C) compared to other months"

According to Figure 4, OBB emissions in September did not have 'marked increases' from that in July (in fact, 2021 July emissions were higher than that in 2021 September). Avoid subjective terms like "marked increases" unless they are supported by the data.

Response: We clarified and rephrased the sentence for better understanding. We combined the question "P1 L28", "P1 L29-30", "P1 L31", and "P1 L32-34" as follows. Please refer to the Response to Specific Comment P1 L28 above and Line 30.

P1 L31: "This surge in carbon emissions is…"

Choose a more neutral term than "surge" to describe the increase in carbon emissions. Perhaps "significant rise" or "notable increase" would be more appropriate.

Response: We changed "surge" into a more neutral term to describe the increase in carbon emissions. We combined the question "P1 L28", "P1 L29-30", "P1 L31", and "P1 L32-34" as follows. Please refer to the Response to Specific Comment P1 L28 above and Line 30.

P1 L32-34: "Fires in savanna grasslands were predominant in the NHAF, contributing to 77% of emissions during January–April, whereas in the SEAS, woody savanna/shrubs (52%) and tropical forests (23%) were the primary sources."

This sentence only presents detailed results from this study without any scientific explanation and discussion. I think it should belong to the results section, not here in the abstract.

Response: We clarified and rephrased the sentence for better understanding. We combined the question "P1 L28", "P1 L29-30", "P1 L31", and "P1 L32-34" as follows. Please refer to the Response to Specific Comment P1 L28 above and Line 30.

P2 L40-41: "Forest clearing, accidental fires, firewood burning, agricultural residue burning, peatland burning and straw burning are among the major fire types worldwide"

The fire types listed here are not well organized. 'Straw burning' is a type of 'agricultural residue burning'. It's redundant to list both items. 'Accidental fires' represent one of the fire sources (not types). Also, you forgot to list the burning type that consumes most of the global burned area: savanna/grassland/shrub fires. Please organize the fire types more efficiently and eliminate redundancy.

Response: We reorganized the fire types, removed the redundancy and ensured all major types are covered. Please refer to Line 51.

Revision: "The burning of forests, shrublands, grasslands, crop residues, and peatland constitutes the major types of fires worldwide"

P2 L44: "However, some regions worldwide are…"

Since there is no clear contrast in the preceding sentences, avoid using "however" here.

Response: We changed “However” into “In addition,”. Please refer to Line 55.

P2 L44-46: “...experiencing a notable increase in fire incidents (Richardson et al., 2022), such as, the Amazon rainforest fires (Pivello, 2011), Australian bushfires (Jegasothy et al., 2023), and wildfires in the United States (You and Xu, 2023), which are large–scale fire incidents that occur multiple times annually.”
Remove the comma after "such as". Also please clarify what does “...which are large–scale fire incidents that occur multiple times annually” refer to.
Response: We removed the comma after “such as” and clarified regarding the referenced incidents. Please refer to Line 56.
Revision: “… such as the Amazon rainforest (Pivello, 2011), Australian bush (Jegasothy et al., 2023), and the United States (You and Xu, 2023), where large-scale fire incidents occur periodically and frequently (Kolden et al., 2024).”.

P2 L50-52: “The burned area method demonstrated good accuracy in quantifying larger fire events, which is based on the burned area, the available biomass fuels burned in fields, the fuel-related combustion efficiency, and emission factors.”
Consider changing “the burned area method” to ‘the burned area based fire emissions method”. Also, please clarify what the relative pronoun “which” refers to.
Response: We changed “the burned area method” to “the burned-area-based fire emission estimation method”, and clarified regarding the referenced incidents. Please refer to Line 62.
Revision: “The burned-area-based fire emission estimation method, which is based on the burned area, available biomass fuels burned in the fields, fuel-related combustion efficiency, and emission factors, has demonstrated good accuracy in quantifying larger fire events.”.

P2 L52-54: “As well as other open-access databases, such as the Global Fire Emissions Database (GFED) and the Fire INventory from NCAR (FINN) (Jiang et al., 2012; van Wees et al., 2022)”
This is not even a complete sentence!
Jiang et al 2012 is not a good reference for FINN and van Wees et al 2022 is not a good reference for GFED.
Response: We completed the sentence and changed the reference for FINN and GFED. Please refer to Line 66.
Revision: “This method has been widely used in databases such as the Global Fire Emissions Database (GFED) (van der Werf et al., 2017) and the Fire INventory from NCAR (FINN) (Wiedinmyer et al., 2023).”.

P2 L57: “the Global Fire Assimilation System (GFAS) (Di Giuseppe et al., 2017).”
Replace Di Giuseppe et al., 2017 with a better reference for GFAS.
Response: We changed a better reference for GFAS. Please refer to Line 76.
Revision: “the Global Fire Assimilation System (GFAS) (Kaiser et al., 2012).”

P2 L57-58: “this approach has a drawback in that it tends to overestimate emissions during localized fire events.”
Specify what is meant by 'localized fire events' and why the FRP approach tends to overestimate emissions in such cases.

Provide more clarity and context.

Response: We added a definition of "localized fire events" and provided more information and background to explain this. Please refer to Line 69.

Revision: "A method based on fire radiative power (FRP) can enhance the detection and quantification of small fire events by measuring the energy released during combustion (Filizzola et al., 2023). However, these approaches can overestimate emissions from localized fire events, which are intense, small-scale fires that may not reflect wider fire activity (Nguyen et al., 2023). For example, Fire Emissions and Energy Research (FEER), based on FRP, reported that the global total particulate matter emissions were approximately 55% higher than those estimated by the GFED (Ichoku and Ellison, 2014). Similarly, the Global Fire Assimilation System (GFAS) using FRP estimated global and regional combustion values exceeding those of the GFED by approximately 126 Tg C/year during 2003-2008 (Kaiser et al., 2012).".

P2 L60: "the Fengyun–3D (FY–3D) satellite offers spatial resolutions of 250 and 1000m…, which, when compared to MODIS, significantly enhances its capacity…"

For clarity, it might be better to say a satellite 'has spatial resolutions' instead of 'offers spatial resolutions'. The structure of this sentence is also not optimal and needs revision.

Response: We changed the "offers spatial resolutions" into "has spatial resolution", and changed the structure of this sentence. Please refer to Line 79.

Revision: "Similar to the MERSI-2 instrument, the Fengyun-3D (FY-3D) satellite has spatial resolutions of 250 and 1000 m at the nadir (Yin et al., 2020), which is more advantageous in detecting and monitoring various active fire events compared with MODIS (Zheng et al., 2023).".

P2 L64: "This resulted in an impressive overall accuracy rate"

In scientific writing, it's generally advisable to maintain a tone of objectivity and avoid overly subjective or emphatic language such as 'impressive' in this sentence.

Response: We deleted "impressive" in the sentence.

P3 L72-73: "Therefore, employing the FY–3D GFR product and allocation approaches for small fires is expected to yield reliable estimates of OBB emissions."

Strengthen the causal relationship between the preceding sentence and this one (since you are using 'therefore' here)

Response: We accepted the suggestion for strengthening the causal relationship. Please refer to Line 90.

Revision: "Although the Landsat Fire and Thermal Anomaly (LFTA) product has a finer spatial resolution, its lower temporal resolution limits its global coverage to only 16 days; thus, large numbers of fires with short durations are missed. Given these limitations in the monitoring frequency with the LFTA product, employing the FY-3D GFR product and allocation approaches for short fires are expected to yield reliable estimates of OBB emissions.".

P3 L73-74: "Many studies treat F as a constant based on regional land cover types, neglecting the actual spatial and

temporal variability (Wiedinmyer et al., 2011)"

Many recent studies have already explicitly addressed the spatial and temporal resolution of fuel loads.

Methods that utilize fuel load parameterization based on regional land cover types do not necessarily neglect spatial and temporal variability; they simplify the spatial and temporal representation for computational efficiency.

Response: We clarified the representation of spatial and temporal variability. Here we want to stress the variabilities of F within each land type, which means that the F of each land type change from pixel to pixel. We revised the expression as follows. Please refer to Line 96.

Revision: "Many studies have adopted a static approach to F (Chang and Song, 2010; Zhou et al., 2017; Puliafito et al., 2020; Shi et al., 2020), assigning constant values based on regional land-cover types. This methodology overlooks the inherent spatial and temporal variability of F within each land type, which changes continuously and dynamically (Wiedinmyer et al., 2011).".

P3 L74-75: "the combustion factor (CF), which represents the proportion of small biomass burned in a fire event, is typically assumed to be constant without considering the fuel status and humidity conditions (Pfeiffer et al., 2013)"

This definition of CF seems different to what I know. Please review the definition of CF to ensure accuracy and clarity. Pfeiffer et al., 2013, focuses on a fire model for global biomass burning, which may not be the most appropriate reference for the CF approach used in observation-based global emissions calculations.

Response: We changed the definition of combustion factor and replaced the reference. Please refer to Line 100.

Revision: "The combustion factor (CF), which denotes the ratio of consumed fuel to total available fuels, is typically a linear variable within a specific range when considering the fuel status and humidity conditions (van der Werf et al., 2006; Wiedinmyer et al., 2011).".

P4 L98-99: "where Ei (g/m2) represents type i emissions at location x, which is equal to the product of the burning area B (m2) at time t and location x, biomass F (g C/m2) at location x, CF (expressed as a fraction), and the emission factor EF (g/kg) for type i pollutants."

The units of the variables in Equation 1 do not align: multiplying the units of B, F, CF, and EF does not result in the unit of E.

Response: We changed the units in Equation 1. Please refer to Line 124.

Revision: "where E_i (g) represents pollutant type i emissions at location x, which is equal to the product of burning area B (m^2) at time t and location x, biomass F (kg/m^2) at location x, CF (expressed as a *fraction*), and the emission factor EF (g/kg) for pollutant type i .".

P4 L100: "FY–3D global fire spot monitoring data based burned area (B)"

Please acknowledge that the active fire spot data is used as a proxy for burned areas in this section. Clarify the difference between these two datasets and the uncertainties resulting from this approximation to provide a more comprehensive understanding.

Response: We clarified the difference between burned area we used and active spot fire. Please refer to Line 165.

Revision: “The location, timing and burned area of the fire events used in the GEIOBB were determined globally using the FY-3D GFR product (Chen et al., 2022). Processed fire event detection data Fengyun Satellite Remote Sensing Data Service Network of National Satellite Meteorological Centre (http://satellite.nsmc.org.cn/PortalSite/Default.aspx), which estimated the actual area of fire spots based on radiation in different infrared channels. When the mid-infrared channel was not saturated, it was used to estimate the sub-pixel fire spot area and temperature. Otherwise, a far-infrared channel was employed for the estimation (Zheng and Chen, 2020). These data offer daily fire detection at a 1-km resolution, including the location, time, burned area, and confidence level (Liu and Shi, 2023). Furthermore, multiple counts of the same fire may have been recorded on a single day, leading to data duplication. To address this issue, we performed a global identification and removed multiple daily detections of the same fire pixels and data with confidence levels below 20%. Specifically, we removed single daily fire detections within a 1-km radius of another fire detection. Thus, only one fire per 1 km2 of a hotspot could be counted per day and was reset on the next day (Wiedinmyer et al., 2023).”.

P4 L101: “ Chines polar–orbiting meteorological satellites.”
Correct the typo "Chines" to "Chinese"
Response: We changed “Chines” to “Chinese”. Please refer to Line 129.

P4 L102-103: “It (FY-3D) is at an altitude of 836 km and was launched on November 15, 2017 and published on may, 2020.”
What do you mean by saying a satellite (FY-3D) was “published”?
‘may’ should be changed to ‘May’.
Response: We changed “may” into “May” and changed “published” into “became accessible”. Please refer to Line 131.
Revision: “It was launched on November 15, 2017, at an altitude of 836 km, and the data became accessible in May 2020 (Li et al., 2017).”

P4 L106-107: “FY–3D introduces the adaptive threshold and eliminates the limitations by fixed thresholds of MODIS and VIIRS algorithms”
The ‘fixed thresholds’ are not clearly described. There are multiple thresholds used in the spectral and contextual test in the MODIS/VIIRS algorithm. Specify which specific fixed thresholds are being referred to. Provide more detail to enhance understanding.
Response: We added more detail about the “fixed thresholds” and the differences between algorithms. Please refer to Line 135.
Revision: “First, FY-3D introduces an adaptive threshold using automatic identification algorithms for fire spot detection, which calculates the background temperature as the mean temperature of all the background pixels within each 3×3 window. If fewer than 20% of the pixels are identified as cloudless, the window size is expanded to 5×5, continuing up to 51×51 in order to accommodate more data (Chen et al., 2022). This approach eliminates the limitations posed by fixed thresholds in the MODIS and VIIRS algorithms, which set T4 to greater than 360 K (320 K at night) and fixed the

moving window size at 21×21 (Giglio et al., 2016).".

P4 L111-112: "the far–infrared channel employed in FY–3D has a high resolution of 250 m, higher than MODIS with 1 km, resulting in higher accuracy in big fire detection"
Explain in more detail how the higher resolution of the far-infrared channel in FY–3D may lead to increased accuracy in detecting big fires.
Response: We added more detail about far-infrared channel in in detecting big fires. Please refer to Line 146.
Revision: "Finally, FY-3D employs a far-infrared band with a high resolution of 250 m, and channels 24 and 25, which has a higher resolution than MODIS (1 km) (Zheng et al., 2023). The far-infrared band has a higher sensitivity to large fires or high-brightness fire events and can distinguish differences against background brightness temperatures (Zheng and Chen, 2020).".

P4 L113: "the FY–3D GFR product achieves an accuracy of 94.0% globally"
Define the metric used to determine accuracy and provide information on the reference datasets. Specify the variables compared and the methodology used to derive the accuracy percentage.
Response: We added the method used to determine accuracy. Please refer to Line 151.
Revision: "Overall, the FY-3D GFR product has an accuracy of 94.01% globally, as calculated using fire detection after eliminating errors based on visual checks conducted using SMART (Visual Check) in 2019. It has accuracies of 94.61, 94.12, 90.63, 91.76, and 92.69% for Southern Central Africa, Eastern Central South America, Siberia, Australia, and the Indo-Chinese Peninsula, respectively (Chen et al., 2022).".

P4 L116: "for accuracy and accuracy without omission"
Define "accuracy without omission" to ensure clarity and understanding.
Response: We added more details about "accuracy without omission" to ensure clarity and understanding. Please refer to Line 155.
Revision: "Specifically, owing to the removal of the underlying surface interference in China, FY-3D has accuracies of 79.43% and 88.50% for accuracy and accuracy without omission (Chen et al., 2022). These accuracies were determined by comparing the results of a large-scale field experiment conducted jointly by the State Grid Corporation of China and China Meteorological Administration with the GFR product, thereby calculating the accuracy, including and excluding mis-judgments. This comprehensive assessment took place throughout 2020 across five provinces in China—Guangdong, Guangxi, Yunnan, Guizhou, and Hainan—utilizing a combination of real-time satellite data and ground-truth validation to evaluate the suitability of these fire detection products. These accuracies are significantly higher than those achieved by MODIS, which are 74.23 and 79.69%, respectively (Chen et al., 2022).".

P4 L126: Table 1
'((NOAA-20))' should be '(NOAA-20)';
Explain the values within the parentheses (for TMAX)?

Give a definition for TMAX, SNR, and NEdT

Response: We changed "((NOAA-20))" into "(NOAA-20)" and added the definition for TMAX, SNR, and NEdT under Table 1. Please refer to Supplements Information (SI) Table S1.

Revision: "TMAX means maximum temperature, SNR means signal-to-noise ratio, and NEΔT means noise equivalent differential temperature.".

P5 L129-130: "Previous studies on emission inventories based on wildfire areas were mostly used to assess F by defining different fire types in different areas"

Clarify the meaning of the sentence (or rephrase it) for better understanding.

Response: We clarified and rephrased the sentence for better understanding. Please refer to Line 181.

Revision: "Previous studies based on burned areas have distinguished F by categorizing it according to regions of different fire types (Wiedinmyer et al., 2011).".

P5 L136-139: "This fusion method combines the high accuracy of ground observation data with wide coverage of satellite data to produce reliable and precise global biomass products. Using this method, it is possible to overcome the limitations of a single data source, thereby enhancing the accuracy and reliability of biomass estimation."

Tone down the language describing the fusion method (such as 'effective', 'reliable', 'precise') to avoid overconfidence. While the approach of combining different data streams can help mitigate limitations of using a single data source, it may introduce additional uncertainties.

Response: We toned down the language describing the fusion method. Please refer to Line 189.

Revision: "This fusion method combines the high accuracy of ground observation data with the wide coverage of satellite data to generate global biomass products. Using this method, it is possible to overcome the limitations of using a single data source, thereby enhancing the accuracy of biomass estimations.".

Actually, the produced biomass map of by using this fusion method had a root mean square error (RMSE) 15–21% lower than those reported in Saatchi et al. (2011) and Baccini et al. (2012). We newly added the following content to clarify it. Please refer to Line 203.

"A combination of 2118 other ground measurements and Lidar data to validate observations, and showed that the fused map had a root mean-square error (RMSE) that was 15–21% lower than those reported by Saatchi et al. (2011) and Baccini et al. (2012)."

P5 L139: "This study used multi–source data, including NDVI, tree cover (TC), and satellite and observational AGB, to …"

NDVI is never defined in the manuscript.

Again, satellite AGB is a type of observational AGB. So it's redundant to say 'satellite and observational AGB'.

Response: We have defined NDVI in previous manuscript. Please refer to the existing material in Line 122.

We changed "satellite and observational AGB" into "AGB". Please refer to Line 193.

P5 L143: "GEE platform"

GEE is not defined.

Response: We changed "GEE platform" to "google earth engine platform". Please refer to Line 195.

Revision: "…Google Earth Engine platform".

P5 L144: "so we combined the global aboveground and belowground biomass carbon density maps"

Provide a more detailed description of the global aboveground and belowground biomass carbon density maps to enhance understanding, as they are core datasets for fuel loading used in the study.

Response: We clarified and rephrased the sentence for better understanding. "Global Aboveground and Belowground Biomass Carbon Density Maps for the Year 2010" is the product name for the AGB data. Please refer to Line 198.

Revision: "AGB data were obtained from the Global Aboveground and Belowground Biomass Carbon Density Maps for the Year 2010 product (https://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1763) provided by Spawn and Gibbs (2020). This dataset uses thousands of satellite data points and ground measurements to produce a biomass map with a 1-km resolution (Spawn and Gibbs, 2020). A combination of 2118 other ground measurements and Lidar data to validate observations, and showed that the fused map had a root mean-square error (RMSE) that was 15–21% lower than those reported by Saatchi et al. (2011) and Baccini et al. (2012). We used the AGB for 2010, annual TC, and NDVI data, and linearly stretched the fuel loading for other years.".

P6 L147: Equation 2

*Verify the accuracy of Equation 2, as it appears to lead to a discrepancy. For year 2010, this equation lead to 2*AGB, while AGB is defined as AGB data in 2010. I guess there should be an additional coefficient of ½ in the equation.*

Response: We corrected the equation 2. Please refer to Line 213.

Revision:

$$F(x,t) = \left(\frac{NDVI_{now} + TC_{now}}{NDVI_{2010} + TC_{2010}}\right) * AGB \quad (2)$$

P6 L149: "TC2010 is the tree cover in 2020"

Confirm the correct year for TC2010, as it appears to be a typo.

Response: We changed "TC_{2010} is the tree cover in 2020" into "$NDVI_{2010}$ is the mean value of NDVI in 2010". Please refer to Line 215.

P6 L154: "Typically, CF is set as a constant"

Revise to reflect the evolving understanding in recent studies, which often employ parameterizations to account for spatial and temporal variations, rather than assuming a constant CF.

Response: We changed the wrong description. Please refer to Line 220.

Revision: "Typically, the CF is set as a linear variable within a specific range, which may lead to biases in emission estimations and generate significant uncertainties. Although some studies used TC to quantify CF and explain its spatial

and temporal variations (Wiedinmyer et al., 2006; Qiu et al., 2016; Bray et al., 2018; Wu et al., 2018), previous research has mainly focused on areas with herbaceous vegetation cover, where the TC ranges from 40% to 60%.".

P6 L159: "A major influence on fire discharge in the framework is the surface condition…"
Clarify the terms 'fire discharge' and 'framework'
Response: We clarified and rephrased the sentence for better understanding.
Revision: "The fire type at the location of the fire event has a major influence on OBB."

P6 L159-160: "Different landtypes exhibit different biological qualities and correlations."
Clarify the term "biological quantities" for better understanding.
Response: We removed this incorrect sentence for better understanding.

P6 L162-163: "reclassified the original 17 classifications, and reclassified the results to reorganize the subsurface types into seven categories"
Revise for clarity and organization. Consider splitting the sentence for improved readability.
Response: We clarified and rephrased the sentence for better understanding.
Revision: "We reclassified the original 17 classifications into 7 categories to better differentiate fire types; grasslands and savannas (V1), woody savannas or shrubs (V2), tropical forests (V3), temperate forests (V4), boreal forests (V5), temperate evergreen forests (V6), and crops (V7).".

P6 L167-168: "we amalgamated the reclassification outcomes of V3, V4, V5, and V6 into a forest type category, designated V1 and V2 as woodlands, and assigned V7 to crops"
Clarify the two-step process of aggregation for better understanding.
Explain the relationship between grassland and woodland and how the original classifications were aggregated to represent grassland.
Provide rationale for not directly aggregating the MCD12Q1 classifications to the final categories of forest, woodland, and cropland.
Response: In the calculation of CFs, we classified fire types into 4 categories, which can reflect the extent of burning of each land type. Currently, this is the most concrete and detailed classifications. However, EFs of each species of different fire types vary, we classified them into 7 classes to accurately estimate the OBB emissions. Throughout the whole text, our analysis were based on 7 classes of different fire types.

P6 L173: "We incorporated the VCI to ascertain fuel moisture conditions"
Define 'ascertain' for clarity
Response: We changed the "ascertain" into "assess".

P6 L176: Equation 4

Capitalize the variable 'vci'

Response: We changed "*vci*" into "*VCI*" in Equation 4. Please refer to Line 250.

P7 L177: Equation 5

Justify the changes made to Equation 5 compared to Equation 10 in Ito and Penner, 2004, to provide clarity on the modifications and their impact on the model.

Response: We provided the justification for changes in Equation 5 compared to previous equations. Please refer to Line 241.

Revision: "For grassland fires, a change in the NDVI is usually associated with the occurrence of fires, especially in dry seasons or in areas prone to wildfires. Generally, a decrease in NDVI may indicate deteriorating vegetation health, which increases the risk of fires because dry or withered vegetation is more prone to burning. We introduced the vegetation condition index (VCI) to determine the fuel moisture conditions, which were used to measure the vegetation drought conditions by calculating contemporaneous changes in NDVI as a metric for assessing the contemporaneous conditions of vegetation. We supplemented our research based on Ito and Penner (2004) by replacing the percentage of green grass from the total grass with the VCI, which was computed using the NDVI with a time interval of 16 d at a spatial resolution of 1 km for the period of 2020–2022. In addition, we introduced a compensatory term to mitigate the impact of tree cover on grassland fires."

P7 L178-179: "NDVImax the maximum value of NDVI in the same period in the previous 3 years"

Explain the rationale for using the previous 3 years as the reference period for NDVImax to provide context for the choice of this time frame.

Response: We clarified and rephrased the sentence for better understanding. Please refer to Line 252.

Revision: "where $NDVI_{now}$ is the mean value of the month before a single fire event, $NDVI_{max}$ is the maximum value of *NDVI* for the same period in the previous three years of the fire event, and $NDVI_{min}$ is the minimum value of *NDVI* for the same period in the previous three years of the fire event."

P7 L180-181: "conducted an analysis based on the partitioning provided"

Clarify what is meant by "partitioning provided" to ensure understanding.

Response: We added the clarification of "partitioning provided". Please refer to Line 255.

Revision: "For forest fires, we used moisture category factors (MCF) to measure forest moisture and conducted an analysis based on the partitioning of MCF values (very dry: 0.33, dry: 0.5, moderate: 1, moist: 2, wet: 2, and very wet: 5) provided by Anderson et al. (2004)."

P7 L182: " function fitting was executed"

Whether the 'function fitting' is referring to the 'power function fitting'?

Provide details on the data used for the fitting. I understand VCI was calculated from MODIS NDVI, but where is the MCF data coming from?

Response: We changed “function fitting” to “power function fitting”. We added the details on the data used for the fitting. Please refer to Line 257.

Revision: “We used the VCI as a criterion for assessing wetness and dryness and discovered that it approximately conformed to the power function distribution characteristics of VCI.”

P7 L182-183: “For grasslands, the VCI could be directly calculated and utilized.”

Clarify the relevance of including information about grasslands in a paragraph focused on deriving CF for forest fires.

Response: Since this sentence is duplicated and appeared in “For grasslands…” part. Please refer to Line 241. Therefore, we removed the incorrect description.

P7 L189: “Here, EF in Tabel 2 was assigned according to the LCT”

Correct the typo "Tabel" to "Table"

Although the data sources in Table 2 have been added in the revised manuscript, a description of the method (e.g., the original data approach, the aggregation algorithm) is still needed here.

Response: We changed the “Tabel” to the “Table”, and added the description of the method and data. We combined the question “P7 L189”, “P7 L191”, and “P7 L194-195” and as follows. Please refer to the Line 266.

Revision: “The measurements of EFs in different regions for grasslands and savannas, woody savannas or shrubs, tropical forests, temperate forests, temperate evergreen forests, and crops were reviewed and tabulated by Akagi et al. (2011), whereas those for boreal forest fires were obtained from the averages reported by Akagi et al. (2011) and Urbanski (2014). The EFs for maize, sugar, and rice crop fires were taken from the averages reported by Akagi et al. (2011), Fang et al. (2017), Liu et al. (2016), Santiago-De La Rosa et al. (2018), and Stockwell et al. (2015). The BC EFs of BC for crop fires were sourced from Kanabkaew and Kim Oanh (2011) and those for wheat fires were obtained from Cao et al. (2008). In addition, the emission factors of NO2, PM2.5, and PM10 for the crop fire were derived from Li et al. (2007), and the EF from the crop was the average of maize, sugar, rice, and wheat. The EFs values are presented in Table 1.”.

P7 L191: “However, other EF measurements were also used when locally measured EF data were not available.”

Specify which dataset contains the locally measured EF data and clarify the meaning of "other EF measurements" for better understanding.

Response: We added the description of the method and all data used of EF. We combined the question “P7 L189”, “P7 L191”, and “P7 L194-195” and as follows. Please refer to the Response to Specific Comment P7 L189 above and Line 266.

P7 L194-195: “Finally, the EF for the following seven land types of other database were updated”

Clarify the reference data used for updating EF values and provide additional context on the update process for clarity.

Response: We clarified the reference data used and added context on the update process for clarity. We combined the question “P7 L189”, “P7 L191”, and “P7 L194-195” and as follows. Please refer to the Response to Specific Comment

P7 L189 above and Line 266.