

## Response to Reviewer 1

We sincerely thank the reviewer for their time, and constructive feedback on our manuscript. We have carefully addressed all suggestions and implemented the corresponding changes, which have substantially identified areas for improvement of the manuscript. We acknowledge the identification of several important conceptual, structural, and issues that require substantial revision. The reviewer's comments are listed in **black**, followed by our response in "blue", with updated manuscript in "blue".

### MAJOR GENERAL COMMENTS

A major issue throughout the manuscript is the interchangeable use of the terms NH<sub>3</sub> "emissions", "concentrations", and "total column", which are not equivalent. This conceptual confusion seriously undermines the soundness of the data and the interpretation of the results. Additionally, the document contains internal inconsistencies that raise concerns about its scientific rigor, making it challenging to evaluate its conclusions.

We agree with the reviewer that the inconsistent use of these terms was a major weakness of the manuscript. In the revised version, we have corrected the terminology throughout the entire manuscript to ensure the consistency. The term "emission" and "concentration" is no longer used unless explicitly referring to values reported in external literature. The study is based only on the concatenated NH<sub>3</sub> total column density retrieved from IASI reported in (molecules cm<sup>-2</sup>). Therefore, no direct inference on the surface concentration or emission fluxes is made from the satellite data. In the revised manuscript we have addressed the inconsistencies and strengthen the scientific rigor of the manuscript including:

- Harmonize terminology (total column) throughout the text that include figures, tables etc.
- Provide explicit and consistent definition of the geographical areas in Guatemala (departments).
- Ensure that figure information, section references, and methodological description are aligned.
- Result and interpretation are now in section 3 and 4.

The manuscript is written in a very repetitive style, where similar ideas are repeated both within paragraphs and across sections where they do not belong. Furthermore, the manuscript does not follow the standard structure typically found in scientific writing. These patterns remind me of other manuscripts written using extensive AI assistance. While I do not believe the use

of AI is necessarily a reason for rejection, the authors should clearly describe the extent to which AI was used for data retrieval, analysis, interpretation, and writing.

Overall, the manuscript would greatly benefit from a revision that addresses the issues outlined above. Some specific examples of these issues are detailed below.

We thank the reviewer for raising this point, the manuscript has been substantially restructured to follow the ACP structure and format. Where section 2 now strictly contains data source and methodological description, with all interpretative statement removed. Section 3 presents result only, without discussion or conclusion. And section 4 has been rewritten to focus on interpretation, implication and comparisons avoiding repetition of results. Regarding the AI was used solely for language refinement and clarity. All data retrieval, processing, analysis, interpretation and scientific conclusions were performed by the authors.

#### SPECIFIC MAJOR COMMENTS

**Section 2.1 (Data Analysis).** This section is an example of not following the common manuscript structure, as it is a summarized narrative of the methodology, mixed with results and conclusions. This type of section is not usually found. Furthermore, results and conclusions are not supposed to be included in a Methodology section.

We thank the reviewer for the constructive suggestion. In the revised manuscript we have rewritten Section 2 Data and methods. The section 2.1 has been replaced with a new Section of Study location, describing the study area and geographical context including the departments of Guatemala. The methodological content previously presented in Section 2.1 (Data analysis) has been relocated in Section 2.2 (IASI NH<sub>3</sub> satellite-based data observation), which now describes only the concatenated IASI NH<sub>3</sub> total column and data processing. All results and interpretative statements have been removed from Section 2 and are now presented in Sections 3, respectively.

**Section 2.3 (ESRI Land Cover Class Map).** “The... LUC dataset... derived from Sentinel-2 satellite imagery...” and “The LULC ... dataset, based on data from the European Space Agency’s Sentinel-2 mission”. The above sentences are repetitive and appear in the same paragraph: This is only one example of repetitive writing found throughout the manuscript; there are several more.

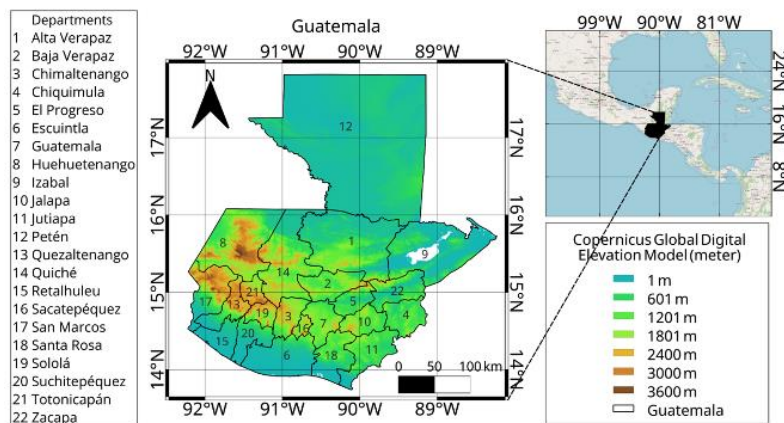
We thank the reviewer for point out this issue. The repetitive paragraphs have been removed throughout the manuscript, the section 2.3 where redundant information of ESRI LULC dataset and Sentinel 2 were consolidated into one concise description. Similar revision has been applied across other sections to improve clarity (L176–L183).

## REVISED MANUSCRIPT (L176–183)

The ESRI Land Use Land Cover (LULC) 2020 dataset, released in June 2021, was developed using deep learning models trained on more than 5 billion manually labelled pixel samples derived from the European Space Agency’s Sentinel-2 satellite imagery with 10 m spatial resolution (Karra et al., 2021), enables land cover mapping at both national and local scales. According to (ESRI, 2021) these training samples were collected from 24,000 image tiles globally, each measuring  $510 \times 510$  pixels, and reflect a wide range of land surface types. The LULC 2020 product is classified into nine classes: Water, Trees, Flooded vegetation, Crops, Built area, Bare ground, Snow/Ice, Clouds, and Rangeland (Karra et al., 2021). In this study, the analysis was restricted to classes related to Water, Trees, Flooded vegetation, Crops, Built area, and Rangeland.

**Figure 1.** Regions mentioned in the text, such as Petén and Quiché, should be indicated on the map to help readers follow the discussion more easily.”

We have modified the Figure 1 adding Guatemala’s departments on the map in the revised manuscript (L113).



**Figure 1: Departments of Guatemala and elevation (m) from Copernicus Global Digital Elevation Model.**

L150 “Atmospheric total column measurements of NH<sub>3</sub> were obtained...”. L184 “To identify spatial patterns in atmospheric NH<sub>3</sub> emissions...”. Both NH<sub>3</sub> observations (total column and emissions) are mentioned in section 2.4, but only the retrieval of the NH<sub>3</sub> total column is described. Regarding NH<sub>3</sub> emissions, either the authors are using this term as equivalent total column, or they are omitting how they obtained the total column. In the rest of the document, “total column”, “emissions”, and “concentration” are used interchangeably.

We thank the reviewer for this important comment. We agree that the terms: “total column”, “emission” and “concentration” were used previously interchangeably, this may have caused confusion. In the revised manuscript, we describe only the term of “total column” as it derived from IASI. For the section 2.2 IASI NH<sub>3</sub> satellite-based (L115–L150), all satellite based NH<sub>3</sub> observations are consistently described as NH<sub>3</sub> total column measurements derived from IASI. The term “emissions” has been completely removed, as no emission fluxes are derived in this study, and the term “concentration” is no longer used to describe satellite observations. In addition, Section 2.3 Cluster analysis of NH<sub>3</sub> (L150–L175) now clearly states that the k-means clustering is applied to NH<sub>3</sub> total column.

**L216** “Correlation analyses between these variables and atmospheric NH<sub>3</sub> concentrations were performed to better understand the meteorological drivers influencing NH<sub>3</sub> variability across Guatemala.” The “Pearson correlation analysis” is also mentioned in L109; however, the manuscript presents no quantitative correlation analysis. There is only a qualitative comparison between the meteorological conditions and the NH<sub>3</sub> data described in the following sentence: L407 “... which points to a general inverse relationship where higher NH<sub>3</sub> concentrations tend to coincide with lower PBLH values, and vice versa.”

We thank the reviewer for pointing this out. We agree that the previous version of the manuscript didn’t explicitly present the quantitative results of the Pearson correlation analysis. To address this, we have now included a quantitative value between NH<sub>3</sub> and meteorological variables, including fire counts. In the revised manuscript the correlation coefficient is reported in the discussion section (L427–443) and a correlation matrix in the supplementary material Fig. S5. Regarding the relationship between NH<sub>3</sub> and BLH is now supported by the reported correlation and correction related to height were made. Table S6 supports Summary statistics of annual and climatology monthly distribution of meteorological variables of boundary layer height (m), relative humidity (%), temperature (°C), and precipitation (mm) from ERA5 reanalysis. In addition, variables not directly discussed were removed from the correlation analysis (surface pressure (sp), Nitrate Dioxide (NO<sub>2</sub>) and Sulphur Dioxide (SO<sub>2</sub>)) to keep consistency on atmospheric NH<sub>3</sub> total column.

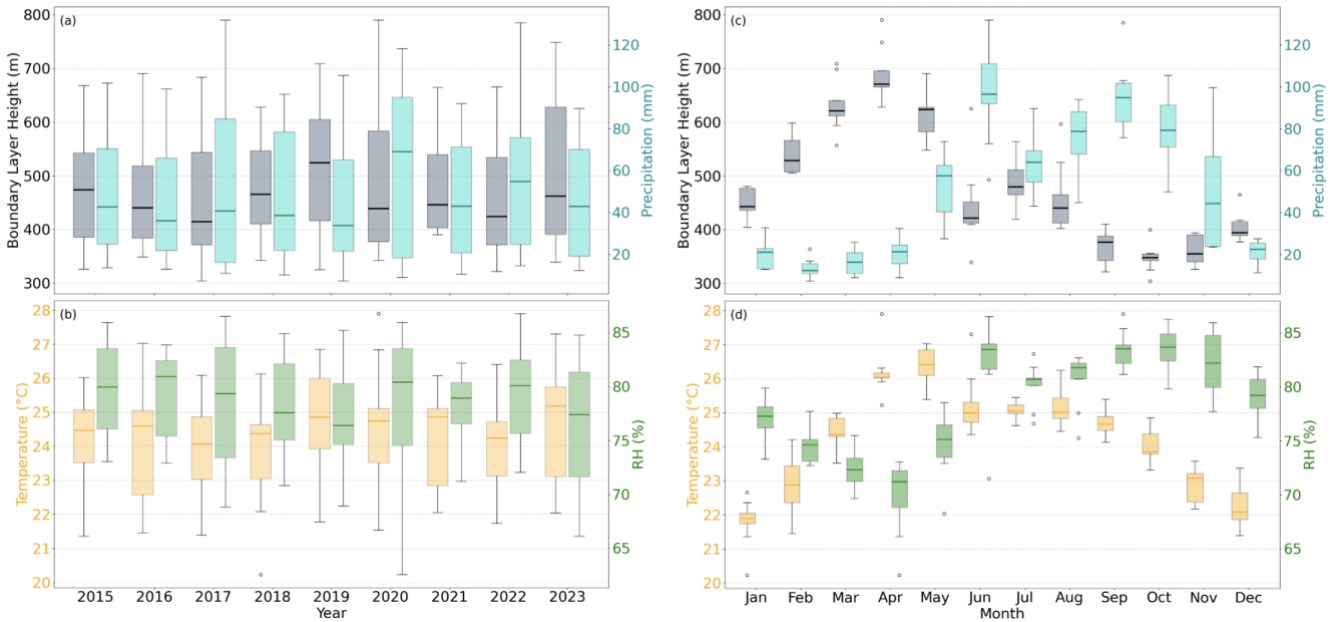
## **REVISED MANUSCRIPT (L346–L362)**

### *3.4 Meteorology*

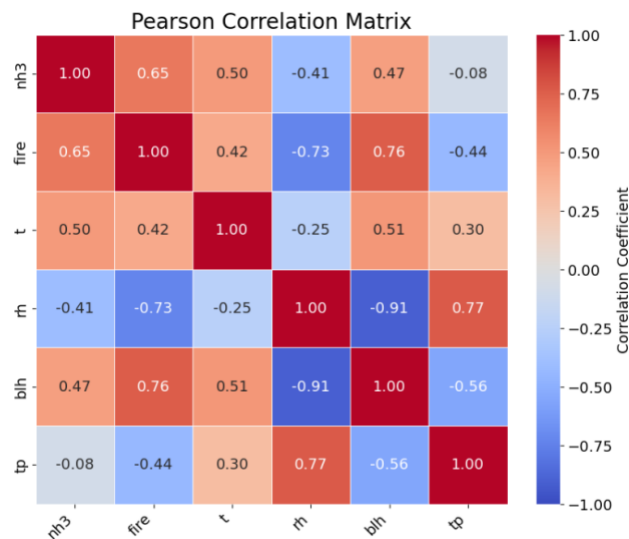
*Figure 7 illustrates the variability of meteorological variables derived from monthly scales over Guatemala from ERA5. Fig. 7 (a,c), exhibit the BLH and precipitation. The BLH shows fluctuations with the highest median recorded in 2019 (524 m), in contrast to the lowest median observed in 2017 (415 m) which also demonstrated the minimum value (305 m) (Table S6). The maximum vertical value was detected during 2020 (791 m) indicated a large data range. At the monthly scale, April shows the highest BLH (median 671 m) and lowest during October (median 348 m). Furthermore, the precipitation indicates that the annual distribution of monthly totals presents the highest median values recorded in 2020 (69 mm) and 2022 (55 mm), while the lowest median is observed in 2019 (34 mm) which also shows the minimum value (7.5 mm). The maximum monthly exceeds*

130 mm (2017 and 2022). The monthly climatology presents peaks medians precipitation in the month of June (97 mm), and September (95 mm), while the lowest in February (13 mm).

Fig. 7(b,e) presents the air temperature and relative humidity. The warmest median temperature during the year 2023 (22.8°C), whereas the maximum temperature was detected during 2020 (27.9°C). The coldest temperature was recorded during 2018 with 20.2°C. Additional, the warmest month is May (median 26.4°C) and the coldest is January (21.9°C). Relative humidity showed the highest median observed during 2016 (81%), while the lowest median year was 2019 (76%), the minimum year detected was 2020 with 63%, this also showed the largest vertical values. The years 2017 and 2022 exhibit the maximum values with 87%. The month medians indicate the lowest in April (mean 71%) and the highest in October (mean 84%).



**Figure 7: Boxplot distribution of meteorological variables over Guatemala (2015–2023) from ERA5 reanalysis, (a, c) show boundary layer height (m) (gray) and precipitation (mm) (turquoise), (b, d) relative humidity (%) (green) and temperature (°C) (yellow).**



**Figure S5: Pearson correlation matrix of NH<sub>3</sub> and different variables: fires, temperature (t, °C), relative humidity (rh, %), boundary layer height (blh, m), total precipitation (tp, mm).**

**The following paragraph** is internally inconsistent (L273 - L280): “The concatenated data from IASI A/B/C data of spatial distribution of annual mean of NH<sub>3</sub> emissions...” “A consistent spatial pattern of elevated NH<sub>3</sub> concentrations was observed...”

Thanks very much for your suggestion, in the revised manuscript (L241–L247) we have made the corrections.

### REVISED MANUSCRIPT (L241–L247)

*The spatial distribution of NH<sub>3</sub>, exhibited a consistent area-wide pattern characterized by elevated values in specific areas. Persistent hotspots are observed in the northern (Petén), north-central (Quiché, Alta Verapaz, and Izabal), and along the southern coastal department of Escuintla. Conversely, lower annual mean NH<sub>3</sub> dominate in the central midlands, including the departments of Totonicapán, Sololá, Chimaltenango, Sacatepéquez, Guatemala, Jalapa, and Jutiapa. Interannual variability in hotspot intensity is evident, with particularly values over Petén, Alta Verapaz and Quiché in 2016 and more widespread increases across Petén, Quiché, Alta Verapaz, Izabal and Escuintla in 2020. Notably, even in years with lower annual means such as 2018, increased NH<sub>3</sub> total column were still evident in Petén, Alta Verapaz, Izabal and Escuintla.*

**L273** “The concatenated data from IASI A/B/C data of spatial distribution of annual mean of NH<sub>3</sub> emissions across Guatemala from 2015 to 2023 exhibited a consistent pattern of elevated emissions in the northern and southern regions. A consistent spatial pattern of elevated NH<sub>3</sub> concentrations was observed, with discernible hotspots in the northern, north-central, and southern regions of the country. Conversely, the central midlands and highlands consistently displayed lower emission rates

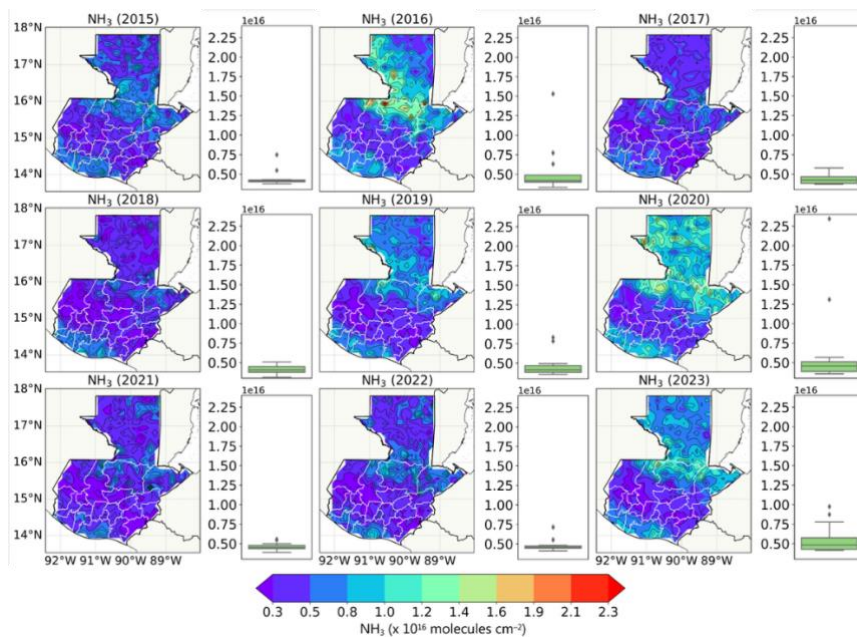
throughout the period." Please define terms such as “northern and southern regions”, “north-central and southern regions“, and “north-central and southern regions“; otherwise, it is difficult to corroborate the description in the text. For example, I do not see the “consistently elevated NH<sub>3</sub> concentrations in the northern regions” that is mentioned. Also, “NH<sub>3</sub> concentrations” are mentioned, but Figure 2 declares to show only “NH<sub>3</sub> emissions”. In addition, the methodology section never mentions how the concentrations are determined. It seems, then, that both terms are being incorrectly used interchangeably.

Thanks very much for your suggestion, in the revised manuscript we have removed all the references of emission and concentration, now consistently refer to NH<sub>3</sub> total column. Spatial description regions to improve geographic clarity have been explicitly defined with the departments name (annually and monthly climatology). Additionally, in the revised manuscript we included in the methodology section that we worked only with the concatenation NH<sub>3</sub> total column.

### **REVISED MANUSCRIPT (L235-L247)**

*Fig. 2 shows the annual variability of NH<sub>3</sub> total column over Guatemala from the period 2015 to 2023. The respective boxplots show the distribution of monthly NH<sub>3</sub> values within each year. The medians reveal a NH<sub>3</sub> with a minimum of  $2.90 \times 10^{15}$  molecules cm<sup>-2</sup> in 2021 and a maximum of  $2.33 \times 10^{16}$  molecules cm<sup>-2</sup> in 2020 (Table S1). While the median values show an increase of NH<sub>3</sub> notable during 2020 ( $4.66 \times 10^{15}$  molecules cm<sup>-2</sup>) and 2023 ( $4.33 \times 10^{15}$  molecules cm<sup>-2</sup>). Consistently, the standard deviation varied considerably between years, reaching a peak in 2020 of  $5.83 \times 10^{15}$  molecules cm<sup>-2</sup>.*

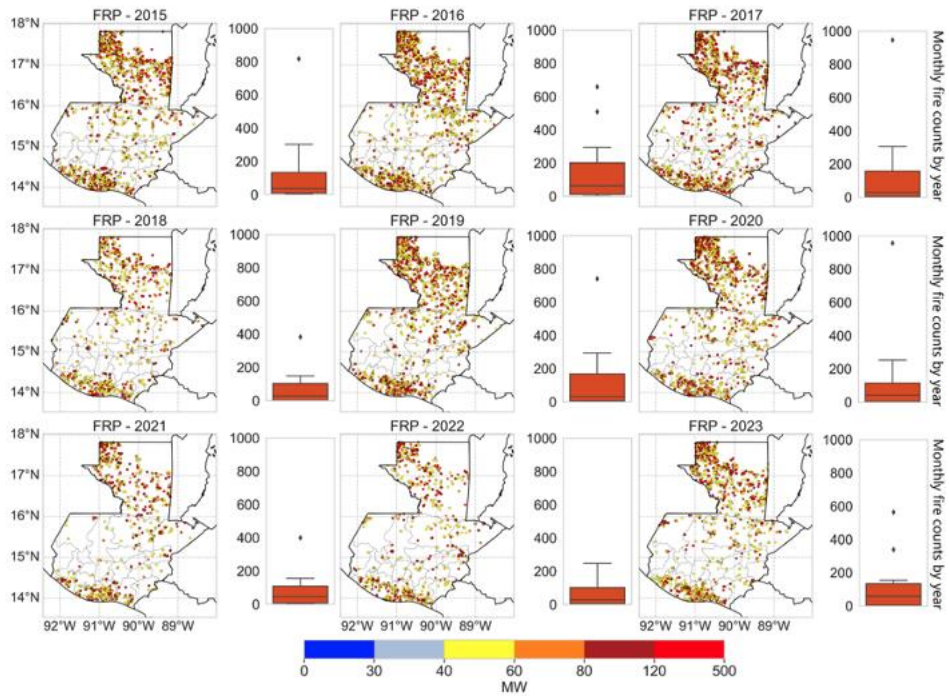
*The spatial distribution of NH<sub>3</sub>, exhibited a consistent area-wide pattern characterized by elevated values in specific areas. Persistent hotspots are observed in the northern (Petén), north-central (Quiché, Alta Verapaz, and Izabal), and along the southern coastal department of Escuintla. Conversely, lower annual mean NH<sub>3</sub> dominate in the central midlands, including the departments of Totonicapán, Sololá, Chimaltenango, Sacatepéquez, Guatemala, Jalapa, and Jutiapa. Interannual variability in hotspot intensity is evident, with particularly values over Petén, Alta Verapaz and Quiché in 2016 and more widespread increases across Petén, Quiché, Alta Verapaz, Izabal and Escuintla in 2020. Notably, even in years with lower annual means such as 2018, increased NH<sub>3</sub> total column were still evident in Petén, Alta Verapaz, Izabal and Escuintla.*



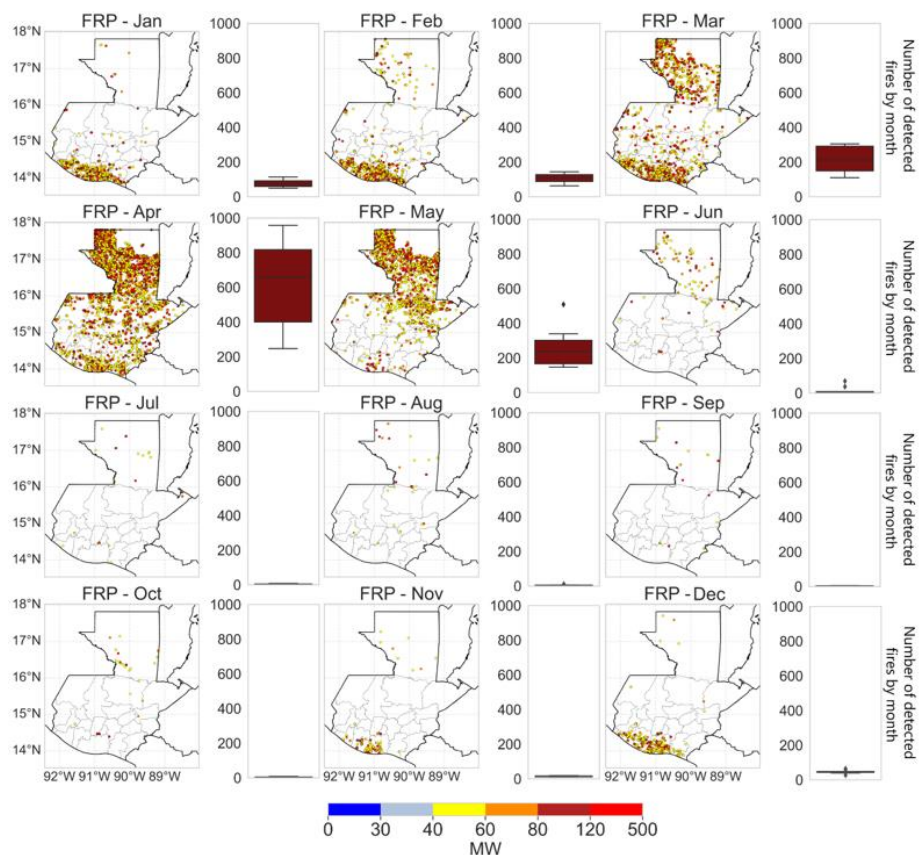
**Figure 2: Annual means area-wide and boxplot of  $\text{NH}_3$  emission total columns ( $\times 10^{16}$  molecules  $\text{cm}^{-2}$ ) over Guatemala (2015–2023) from concatenated IASI A, B and C.**

**Figure 5.** What are the boxplots showing? FRP or fire counts? Units in the vertical axis are missing.

We thank the reviewer for pointing this out. Figure 5 shows the annual distribution of monthly fire counts. The boxplot shows the area-wide monthly fire counts for each year. The vertical axis is fire count (number of detections) and not FRP, which was used only as a filtering criterion. In the revised manuscript for fires (L309-L344), the y axis has been labelled as monthly fire counts by year. We also included in Figure 6, that present the monthly climatology of detected fires, and the boxplot exhibits the area-wide of number of detected fires for each month across all years. This is supported by Table S4 and S5 summarize the statistics of detected fires.



**Figure 5: Annual distribution of monthly fire counts over Guatemala (2015–2023), MODIS fire detection filtered by nominal confidence level  $\geq 70\%$  and FRP  $\geq 40$  MW, the Boxplots represent the area-wide monthly fire count for each year.**



**Figure 6: Monthly climatology of detected fires over Guatemala (2015–2023), MODIS fire detection filtered by nominal confidence level  $\geq 70\%$  and FRP  $\geq 40$  MW, the boxplots represent the area-wide distribution of number of detected fires across all.**

**L419** “a monthly means detected by IASI A ( $2.32 \times 10^{16}$  molecules/cm<sup>2</sup>), B ( $2.48 \times 10^{16}$  molecules/cm<sup>2</sup>) and C ( $2.43 \times 10^{16}$  molecules/cm<sup>2</sup>). “Why are the three values shown? Everywhere else in the manuscript, only one value (I guess it is the average of the three) is shown.

We thank the reviewer for this comment. The individual values are originally reported for completeness, however, this information was inconsistent with the rest of the manuscript, and this might lead to confusion, where analyses are from the concatenated IASI A/B/C rather than by averaging the three sensors. In the revised manuscript, the text has been corrected, and the monthly were calculated from the merge dataset.

### REVISED MANUSCRIPT (L369-L375)

*NH<sub>3</sub> anomalies were observed in Guatemala in April 2020, marking the highest recorded monthly mean (Fig. S3). This peak is particularly remarkable as it occurred shortly after the implementation of COVID-19 lockdown measures (March 2020).*

*The monthly mean spatial distribution of concatenated NH<sub>3</sub> in April 2020 ( $2.3 \times 10^{16}$  molecules cm<sup>-2</sup>), indicates distinct hotspots concentrated in the northern (Petén), north-central (Quiché) and southern (Escuintla) areas. The highest values were observed in the department of Petén, reaching up to ( $6.4 \times 10^{16}$  molecules cm<sup>-2</sup>) (Fig. 8). The corresponding environmental conditions, including wind vectors meter per second ( $m s^{-1}$ ), with a strong easterly wind ( $\sim 3 m s^{-1}$ ) dominated the northern region, facilitating long-range transport of NH<sub>3</sub>, while central Guatemala experienced moderate to stagnant wind conditions.*

**Figure 9.** Units on the color scale are inconsistent: ppmv (unit of concentration) is not equivalent to molecules/cm<sup>2</sup> (units of total column).

We thank the reviewer for point this out. We agree that the units represent different quantities and should not be interchangeable. In the old version the vertical profiles from CAMS we expressed in ppmv, while IASI total column in molecules cm<sup>-2</sup> that are not dimensionally equivalent. In the revised manuscript CAMS vertical profiles are now consistent and reported in mass mixing ratio ( $kg kg^{-1}$ ). Also, both Fig. 9(a) zonal mean and Fig. 9(b) vertical and latitudinal profile uses to illustrate the NH<sub>3</sub> structure in ( $kg kg^{-1}$ ), rather than for quantitative comparison with IASI total column. The colour scale and associated units have been corrected (L381-L396).

Furthermore, we have integrated the aspect regarding the vertical and latitudinal profiles from CAMS mass mixing ratio ( $kg kg^{-1}$ ), in the methodology section (L141-L148).

#### **REVISED MANUSCRIPT (Methodology, L141-L148)**

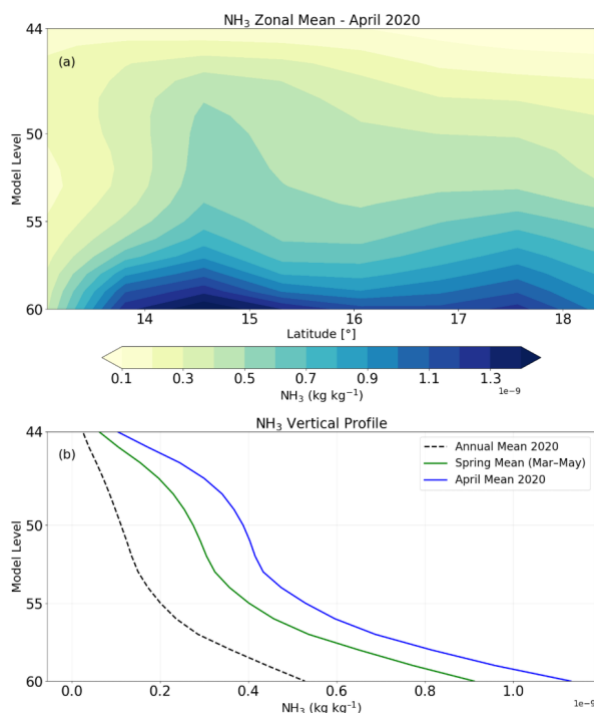
*“Additionally, NH<sub>3</sub> vertical profiles data were obtained from the ECMWF, Atmospheric Composition Reanalysis 4 (EAC4), produced by the Copernicus Atmosphere Monitoring Service (CAMS). This global reanalysis provides NH<sub>3</sub> with mass fraction in the air, provided as a mass mixing ratio ( $kg kg^{-1}$ ), the model is defined by 60 hybrid sigma-pressure levels. It provides a detailed representation of the atmospheric structure, particularly near the surface ( $\sim 0-100 m$ ) where most emissions occur (Inness et al., 2019). These reanalysis datasets incorporate satellite observations and model simulations to provide globally consistent, spatially and temporally resolved atmospheric composition data (Flemming et al., 2017; Inness et al., 2019). In this study, the CAMS analysis of vertical structure and latitudinal distribution of NH<sub>3</sub> during a specific period of interest, rather than for a quantitative comparison with satellite of total column densities.”*

#### **REVISED MANUSCRIPT (Result, L381-L396)**

*The vertical and latitudinal distribution of atmospheric NH<sub>3</sub> over Guatemala was analysed using zonal means and area averaged vertical profiles in mass mixing ratios ( $kg kg^{-1}$ ). Figure 9a shows a zonal mean cross-section of NH<sub>3</sub> kg throughout the atmosphere (vertical axis, model level 60 to 44) along the latitudes of Guatemala as a zonal mean during April 2020. It highlights a greater abundance of NH<sub>3</sub> in both the northern and southern areas. Furthermore, the NH<sub>3</sub> vary with both latitude*

and altitude, the highest  $\text{NH}_3$  are observed at lower model levels primarily confined near the surface (below approximately level 56). The highest  $\text{NH}_3$  values are found between  $14^\circ\text{N}$  and  $15^\circ\text{N}$  latitude.

Fig. 9b further illustrates the area-average vertical profiles of  $\text{NH}_3$  for April (blue line), spring (March – May, green line) and the annual mean 2020 (black dashed line). The vertical profile of  $\text{NH}_3$  shows the April 2020 mean (blue line) with  $\sim 1.0 \times 10^{-9} \text{ kg kg}^{-1}$ , the spring mean (March–May 2020, green line) of  $\sim 0.9 \times 10^{-9} \text{ kg kg}^{-1}$  and the annual mean for 2020 (black dashed line) with  $\sim 0.5 \times 10^{-9} \text{ kg kg}^{-1}$  respectively.



**Figure 9:** (a) zonal mean of  $\text{NH}_3$  mass mix ratio ( $\text{kg kg}^{-1}$ ) total column ( $\times 10^{16}$  molecules  $\text{cm}^{-2}$ ) across latitudinal bands (model level 60 to 44) for April 2020 and (b) vertical profile of  $\text{NH}_3$  mass mix ratio ( $\text{kg kg}^{-1}$ ) for April (blue line), spring (March – May, green line) and annual mean 2020 (black dashed line) over Guatemala from global reanalysis CAMS.

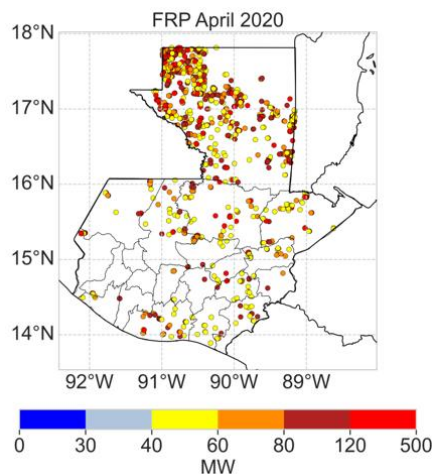
**L466:** “April 2020 recorded the highest number of active fires across Guatemala throughout the entire study period (957), representing...” The reported number of fires in April 2020 (957) does not match Figure 10a, which shows only 85, approximately.

We thank the reviewer for this comment. In the revised manuscript the fire text has been made consistent throughout the document and supplementary material. Previously the value reported was approximately 85 fires, that corresponds to the monthly mean number of detected fires for April 2020, this value now has been removed from the manuscript to avoid

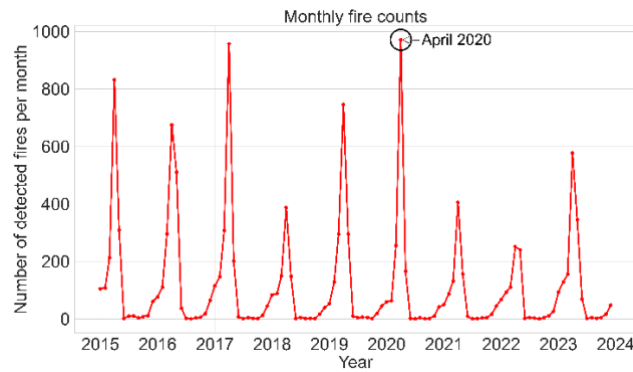
confusion. The Figure 10 shows the spatial distribution FRP filtered. The total number of detected fires for that month is 957, which is consistent with the value reported in L466 (Old Version), this further supported by the supplementary materials, Table S4 where it presents the maximum monthly fire count for 2020, Table S5 for the month of April show the same value, and Figure S6, present the time series of total number of detected fires per month where the highest number of fires is 957.

#### REVISED MANUSCRIPT (L438-L408)

*Fire activity in spring 2020 showed an anomalous peak compared to the long-term pattern (Fig. 10). As mentioned above, March to May indicate a general increase phase in fire activities in Guatemala. April 2020 recorded the highest monthly total number of detected fires across Guatemala throughout the entire study period (957). The spatial distribution of FRP distribution illustrates widespread, affecting specifically in the northwestern (Petén) accounting for 674 detected fires (Table S7, Fig.S7), central-north (Quiché, Alta Verapaz, Izabal), and southern areas (Escuintla, Santa Rosa, and Jutiapa). The corresponding burned areas patterns further confirm the extension of the fire's activities during the month, with the most extensive land burned occurred in the department of Petén.*



**Figure 10: April 2020 shows the spatial distribution of area-wide of fires detected over the study period over Guatemala (2015–2023), using MODIS fire detection filtered by nominal confidence level  $\geq 70\%$  and FRP  $\geq 40$  MW.**



**Figure S6:** Total number of detected fires by month from MODIS filtered by a nominal confidence level  $\geq 70\%$  and fire radiative power  $\geq 40$  MW over Guatemala (2015–2023), with April demonstrated the highest number of fires during the study period.

**L474:** The term “climatological peak” is illogical, as April 2020 represents an exceptional event.

We thank the reviewer for this comment. The term "climatological peak” has been removed and replaced in a text that explicitly refers to the highest fire activity in April 2020, without implying a climatological maximum (L399–L405).

**L475:**” This case study demonstrates that April 2020 was... an expanded spatial footprint compared to other years.” There is no data demonstrating how April 2020 compares to other years.

We thank the reviewer for this comment. We agree that the previous text implied a comparative of April 2020 with other years. In the revised manuscript, we have removed the statement that mentioned “expanded spatial footprint compared to other years” and now focus exclusively on the case study of April 2020 based on the observed information (L399–L405). The timeseries filtered of total number of detected fires by month from MODIS, and it was moved to the supplementary material (Fig. S6).

**Figure 11.** All the discussion in this section is about April of 2020 as a case study, so why is April combined with May data in this figure?

We thank the reviewer to mention this inconsistency. In the revised manuscript we moved the previous Fig. 11 to the supplementary materials Fig. S7. To show the Burned (red) areas only during the month of April 2020. For the result and discussion section regarding the fire activity during April 2020, the previous months of March and May have been removed to avoid confusion to ensure consistency and mainly focus solely on the case study (L399–L405).

**Section 4 (Discussion)** The Discussion section mainly repeats the Results and provides no additional interpretation or new insights. A substantially shorter version of this section could be included as the summary required by ACP in the Conclusions section.

We thank the reviewer for this comment. In the revised manuscript we have restructured to focus the interpretation, and broader implication to improve clarity, reduce redundancy and strength the interpretation of the results. While the conclusions section now presents a concise summary of the main findings, (Result L410–497), (Conclusion L498–516).

#### OTHER COMMENTS

**L23.** The statement “Continuous satellite monitoring is essential to ... support strategies to reduce biomass burning” seems unrealistic and is not supported by the analysis shown in the manuscript.

We thank the reviewer for this comment. We don’t evaluate the mitigation strategies. Therefore, in the revised manuscript the sentence was deleted to avoid overstated policy implications (L23).

**L87 and L141** (maybe more lines). “Environmental Systems Research Institute (ESRI)” The ESRI acronym was defined on line 87, so it does not need to be defined again on line 141. In fact, once the acronym is defined, the full name should not be used again. There are several other cases similar to this in which the acronyms are not used correctly (i.e. next comment).

In the revised manuscript “Environmental Systems Research Institute (ESRI)” is defined only once at its first occurrence, and all subsequent references use the acronym ESRI.

**L249** “Moderate Resolution Imaging Spectroradiometer (MODIS)” The acronym MODIS is defined in L249, but it is used several times before this line.

In the revised manuscript the “Moderate Resolution Imaging Spectroradiometer (MODIS) it is now defined at its first mention and subsequent reference using the acronym.

**L261** “The respective boxplots reveal a generally stable NH<sub>3</sub> concentration throughout the study period.” L269 “... indicating substantial variability and peak emissions.” Both sentences in the same paragraph are contradictory.

**L278 - L281.** The information was already stated in the previous paragraph.

We thank the reviewer to highlighting this inconsistency. In the revised manuscript we separated the background months from the extreme variability months (Old version L261). In addition to this, the redundant statement regarding spatial patterns (Old version L278-L281) has been removed to avoid repetition (L234-L247).

### **REVISED MANUSCRIPT (L235-L249)**

*Fig. 2 shows the annual variability of  $\text{NH}_3$  total column over Guatemala from the period 2015 to 2023. The respective boxplots show the distribution of monthly  $\text{NH}_3$  values within each year. The medians reveal a  $\text{NH}_3$  with a minimum of  $2.90 \times 10^{15}$  molecules  $\text{cm}^{-2}$  in 2021 and a maximum of  $2.33 \times 10^{16}$  molecules  $\text{cm}^{-2}$  in 2020 (Table S1). While the median values show an increase of  $\text{NH}_3$  notable during 2020 ( $4.66 \times 10^{15}$  molecules  $\text{cm}^{-2}$ ) and 2023 ( $4.33 \times 10^{15}$  molecules  $\text{cm}^{-2}$ ). Consistently, the standard deviation varied considerably between years, reaching a peak in 2020 of  $5.83 \times 10^{15}$  molecules  $\text{cm}^{-2}$ .*

*The spatial distribution of  $\text{NH}_3$ , exhibited a consistent area-wide pattern characterized by elevated values in specific areas. Persistent hotspots are observed in the northern (Petén), north-central (Quiché, Alta Verapaz, and Izabal), and along the southern coastal department of Escuintla. Conversely, lower annual mean  $\text{NH}_3$  dominate in the central midlands, including the departments of Totonicapán, Sololá, Chimaltenango, Sacatepéquez, Guatemala, Jalapa, and Jutiapa. Interannual variability in hotspot intensity is evident, with particularly values over Petén, Alta Verapaz and Quiché in 2016 and more widespread increases across Petén, Quiché, Alta Verapaz, Izabal and Escuintla in 2020. Notably, even in years with lower annual means such as 2018, increased  $\text{NH}_3$  total column were still evident in Petén, Alta Verapaz, Izabal and Escuintla.*

## References

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