

Atmos. Chem. Phys. Discuss., referee comment RC2
<https://doi.org/10.5194/acp-2022-671-RC2>, 2022
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Comment on acp-2022-671

Anonymous Referee #2

Referee comment on "Ground solar absorption observations of total column CO, CO₂, CH₄, and aerosol optical depth from California's Sequoia Lightning Complex Fire: emission factors and modified combustion efficiency at regional scales" by Isis Frausto-Vicencio et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-671-RC2>, 2022

GENERAL COMMENTS

This paper analyzes measurements from an EM27/SUN FTIR during the 2020 wildfire season in California. The EM27/SUN measurements are in generally good agreement when compared against TROPOMI satellite CO columns and AOD from a nearby AERONET station. The EM27/SUN measurements are also used to estimate emission factors (CO, and CH₄) and modified combustion efficiency. The paper then estimates that 2020 wildfires made up 13.6% of CH₄ emissions in California, based on emission ratios of CH₄/CO₂ and a reported estimate of CO₂ emissions from wildfires.

Overall, the paper is well-written, and presents new data and interpretation that contributes to knowledge on wildfire emissions. I have provided specific comments below, which describe where the manuscript could be improved, for example by addressing areas where content is a bit confusing, fully describing all figures and tables, using uncertainties throughout the paper, and making the discussion more complete. I recommend publication of the paper, with minor revisions.

SPECIFIC COMMENTS

Line 25: When are 2020 CH₄ emissions expected to be available? (Consider updating to 2020, if the estimates are available before publication.)

Lines 26, 94, 557: "a novel application" – this statement is vague and, and should specify what is novel about the application compared with previous studies.

Line 62-64: "observations... focus on aerosol burden from smoke plumes with limited attention to trace gases..." This isn't entirely true - the paper should indicate that there have been a number of studies that have looked at trace gases emitted from fires using satellite data, including ratios of species and estimation of emissions for CO, NO_x, NH₃ (see for example, Griffin et al., AMT 2021; Adams et al. ACP 2019; Whitburn et al., Atmos. Env., 2015 and references therein).

Line 65 : "... present a new technique..." Is ground-based FTIR is a particularly new technique?

Line 91: "... satellite greenhouse gas observations..." perhaps replace with "... observations of CO..."

Line 97: I found this section a little bit difficult to follow. Recommend giving an overview of the various instruments involved (e.g., describing of Fig 1 to a high level) and the description of the fire to the top of the section (before Sect. 2.1), and then using the subsections to give the technical details. I would recommend that you describe/name the fires here and then use consistent naming throughout the document. (For example, the name "Shotgun" fire is used in some places - is this the same as the "North Complex" fire in Table E1?)

Line 150: Should panels b, c of the figure be referenced/described here?

Line 163: "... for a novel evaluation..." - is this evaluation novel? Has TROPOMI CO not been evaluated under smoky conditions before?

Line 180: Should Sect 2.4 be moved into an appendix, since it mostly references methods described elsewhere?

Line 295: For the comparisons against TROPOMI should uncertainties be included in the fits, etc?

Line 307 (and similar statements lines 500, 546): "These results suggest an overestimation of 9.7% X_{CO} from TROPOMI observations of wildfires." Is there evidence that the difference is due to overestimation from TROPOMI? Or could this be due to differences in sampling or biases in the EM27/SUN data? Is there an uncertainty attached to the 9.7%? Also, what is the reported uncertainty in TROPOMI measurements and in the EM27/SUN measurements? Is 9.7% within the range of uncertainties? Is this bias consistent with previous studies?

Line 332 (Figure 4): Can figure 4 be added to figure 2 as a panel? Could be helpful to see all the timeseries together and would reduce the number of figures needed.

Line 339: "McMillan et al. (2008) found values..." should the word "values" be replaced with "slopes"

Line 340: "... 40 to 74..." should units be provided for this?

Lines 339-343: I find the discussion in these sentences a bit confusing and could be organized a bit more clearly. For example, are the values from McMillan et al of 44-74 the same as the values that are for clean region described further down the paragraph?

Line 348 (Figure 5 caption): There is no "teal line" on the figure – does this mean the "teal markers"?

Line 356: "... a steady MCE as X_CO, X_CH4, and AOD increased, indicating influence of smoldering combustion" Please elaborate – why does this indicate smoldering?

Lines 365-371: The discussion on EFs should be merged with the discussion on lines 458-464. I also find parts of the discussion a bit hard to follow. Which studies were included in the table and why? Which values are most relevant for comparison against the present study? How does Lueker et al., 2001 compare to the results in this study?

Line 372 (Table 1 caption): Should mention the present study in the caption, e.g., "Summary of past airborne studies, and the present study..."

Line 381 (Figure 6): Do panels a-e add value to the paper? Is the same/similar information captured in the broader timeseries in Fig 2?

Line 388 (Figure 7): If including this figure in the paper, should describe its relevance in the text.

Line 389 (Sect. 3.5 title): This section title is vague. Perhaps split Sect. 3.5 into two sections (one section about ratios for livestock vs wildfire emissions and another section about estimating total methane emissions from wildfires in California?)

Lines 401-4110: I found the discussion of the different ratios difficult to follow, and could use a rewrite for clarity. For example on line 407, "Similar ratios... were found in Hanford..." – I assume this means ratios similar to the non-wildfire ratios?

Line 414-415: "... dairy farm operations are the dominant source of CH₄ during fire and non-fire periods." This seems to contradict the next sentence, which says that during the strong smoke influence period, CH₄ from the smoke is dominant. Clarify.

Line 416: "The immense scale..." recommend starting a new section (or at least a new paragraph) here.

Lines 430-435 and 635-640: Please provide a bit more information about how Table E1 was filled in. Why is the ER from the study in table E1 (0.0084) different from the ER given in line 362 (0.0073)? How were the ERs derived from the EFs in the literature? How were uncertainties propagated? Which values in Table E1 correspond to Pritchard and which correspond to Xu? Were there any cases where both Xu and Pritchard had different ER values for the same vegetation, and if so how did you choose which to use? (Also, check that everything is consistent between the text and the appendix: Line 434 references Xu 2020, but line 634 table caption references Prichard 2020 and Xu 2022).

Lines 454-457: Repetitive - delete summary of the work and save this for the conclusion/abstract?

Lines 471-487: This discussion feels a biased toward FTIR measurements. What are the drawbacks to FTIR measurements compared to the other methods? Is there information that can be provided by aircraft that can't be provided by FTIR? Do all of these methods have similar uncertainties in, e.g., emission factors? Are the FTIRs more difficult to operate than say continuous ground-based in-situ analyzers? Is there potential for satellite (especially the next generation of satellites), modelling, or other methods to add to knowledge on fire emission factors as well?

Line 491: "with great resolution" – subjective (remove or replace this).

Line 520-529: Can more context be provided on the discussion of wildfire emissions of CH₄? Are there other estimates of CH₄ emissions from wildfires in the California or is a data gap? When discussing possible climate feedbacks, is it expected that a lot of CH₄ is emitted from fires globally? Are CH₄ emissions from fires considered, for example, in IPCC reports?

TECHNICAL CORRECTIONS

Line 490: "12. Smoke event" (delete the period after 12)