Dear Prof. Dr. Christoph Knote, 21/07/2023

Thank you for giving us another opportunity to submit a revised version of our manuscript titled *Plume detection and estimate emissions for biomass burning plumes from TROPOMI Carbon monoxide observations using APE* v1.1 to EGU. We appreciate the time and effort you have dedicated to providing valuable feedback on our manuscript.

We are submitting the revised manuscript with a major revision based on the comments and suggestions from the second referee. Again, the manuscript has been rewritten to make things clearer. No changes have been made to the software or the data that was previously reported. The only new addition to the manuscript is section 3.2.2 on ERA5 uncertainties as suggested by the referee.

The detailed reply to Referee 2 can be found on the following pages.

We look forward to hearing from you in due time regarding our submission and to respond to any further questions and comments you may have.

Sincerely,
Manu Goudar
SRON Netherlands Institute for Space Research, Leiden,
The Netherlands

Dear Referee,

We would like to thank you for the constructive comments and recommendations on our manuscript. We have done several changes to the manuscript. Our replies to the comments are given below. The original comments are numbered, given in black and the answers are given in blue. The adjustments in the revised manuscript are specified in detail below where the page and line numbers refer to the revised manuscript.

1. The results presented show that this algorithm 1) can find plumes from approximately 4% of the fire clusters identified (where fire clusters are groups of 10 or more fire counts detected by VIIRS) and 2) produce emission estimates for that 4% of cases. That 4% value is never disclosed in the text. An unexplained 97.7% value is provided instead; more on this below.
    a. The Algorithm Application section states "our analysis confirms the applicability of our algorithm to other areas with a confidence of 97.7% of the cases." This statement is unclear and not supported by any explanation in the text. From the Conclusions section: "APE can reliably detect and estimate emissions automatically for 97.7% of the cases." This one is misleading, plain and simply. This issue was already identified in the first review; no satisfactory action was taken by the authors.
    b. The authors have not explained where the 97.7% value comes from, neither in the two versions of the manuscript nor in their responses to the first review. This reviewer's guess follows.
    c. (From Table 1) 221 "visual inspection" cases are approximately 97.7% of 226 "emission estimation" cases. The 221 "visual inspection" cases represent less that 4% of the 5562 "fire clusters" identified in VIIRS data.

Changed:

To quote a data yield of 4% does not adequately describe the situation. To evaluate the APE performance, the mission and observation aspects of TROPOMI must be separated from the algorithm.

1. TROPOMI data with a plume signature were only available for 16% of VIIRS counts. This is a data feature and not an algorithm feature and can be attributed to cloud coverage and the detection limit of TROPOMI. We are completely transparent about this in the manuscript in "Data preparation" section and the "Algorithm application" section. We believe saying "we only detected 4% of the fire counts" leads to misrepresentation of the algorithm.
2. "The 16% of VIIRS counts have TROPOMI plume signature" is highlighted in the manuscript in lines 12, 419-422.
3. Furthermore, we have reworded and made it clearer what 97.7% represents. We highlight that 97.7% is the true positive confidence in the APE's output. This shows that the output of APE can be trusted with 97.7% certainty.
4. Changes related to the above statements have been made in several places in the manuscript. Specifically, see lines 12-14, 284-292, 419-422.

2. The resulting emission estimates are not compared to any measurements; thus their validity remains unknown. Negative emission values are questioned and deemed invalid, as they should. Positive emission values are not questioned.
   Changed: To the best of our knowledge, no independent, high-quality estimate of CO point-source emission is currently available. Therefore, directly comparing the emissions with independent data is difficult. We discuss this in the paper referring to Sherwin et al. (2023) who validated satellite CH4 data using controlled emission releases of point sources of methane for detection and quantification. No such validation can be done on CO. However, Rowe et al., (2022) did show that the integrals of TROPOPMI CO data along the plume transects were ≈7.2% higher than the aircraft measurements after corrections for a few fires in the US. However, they do not report emissions. Thus, direct comparisons are difficult. We do add a paragraph about this. See lines 333-339.

3. The revised version still has language issues such as mismatched subjects and verbs, missing prepositions, abbreviations in the main text, typos, etc.
   Changed. The manuscript has been checked by a native speaker.

4. The revised text contains repetitions, e.g., the narrative on the number of cases appears in Abstract, Algorithm Application, and Conclusions, as well as in Table 1.
   Changed: Complete narrations of the cases in different sections have been changed in the manuscript. The complete analysis can only be found in Section 3.2, and Conclusions and Abstract briefly summarize the same.

5. The manuscript states that errors introduced by the wind data cannot be calculated due to lack of wind uncertainty information. Please note that the ERA5 ensemble data (members, mean, and spread; provided with the ERA5 data) describe uncertainties in the observations.
   Changed: Following the editor's suggestion, a new section has been added on ERA5 random uncertainties. However, we note in the manuscript that the ERA5 ensemble data only approximate random uncertainties and so, no information on the systematic errors or biases can be derived (see Section 3.2.2, see also (https://confluence.ecmwf.int/display/CKB/ERA5%3A+uncertainty+estimation).

Sincerely,
Manu Goudar,
SRON Netherlands Institute for Space Research, Leiden,
The Netherlands