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Comment on acp-2022-447

Anonymous Referee #1

Referee comment on "Estimation of biomass burning emission of NO_2 and CO from 2019–2020 Australia fires based on satellite observations" by Nenghan Wan et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-447-RC1, 2022

The study presents an analysis of satellite-measured CO and NO_2 for the Australian 2019/2020 wildfire season using TROPOMI. The authors use the satellite-measured enhancement ratio near fires in southeast Australia, as well as for two northern Australian regions, to derive a proxy for combustion efficiency and calculate emission factors for large regions.

Overall the manuscript is well written and the analysis rigorous. Satellites provide an opportunity to determine emissions over larger areas than field campaigns or laboratory studies. The results and methodologies presented here have the potential to be applied to other regions and for other years. I have several comments to be addressed below, roughly in order of importance.

Main Comments:

1. The temporal period (November 2019- January 2020) chosen was aligned with the maximum burning in southeast Australia (Area 3). The fire season in Areas 1 and 2 are usually different to Area 3. The peak burning season in Area 1 and Area 2 occur in September – October, while Area 1 usually peaks December – January (Russell-Smith et al., 2007, https://doi.org/10.1071/WF07018). The peak wildfire emissions in Areas 1 and 2 were likely not captured in this study. Consequently, the comparison of Area 3 and Areas 1 and 2 (e.g. on page 9) compares a mid-burning season (SE) with a late-burning season (NW). Additionally, 2019 was an an usually low year for biomass burning in Northern Australia, so the season may not be representative of the region on average. Please clarify the motivation for including Areas 1 and 2 and the timing in this study.

2. L172: Concerning the appropriateness of an 850 hPa average height when aerosol layer height is unavailable. Please explain why it is appropriate to use 850 hPa as an average for all three regions. There were some very large pyrocumulus events in the 2019/2020 fire season. For example, does the average change appreciably if the pyrocumulus events

are removed? Additionally, is 850 hPa used for Northern Australia, where pyrocumulus are rarer?

3. Please clarify why it is appropriate to compare total column CO and tropospheric NO_2? For example, can you be confident you are capturing the same air masses.

4. Section 3.1

- Please describe or clarify how recirculating plumes are avoided in emission ratio calculations.
- L183-184: Please clarify what specifically was used to determine upwind direction – a visual inspection of aerosol layer height, CO maps, ERA wind direction?
- CO and NO_2 also have strong anthropogenic sources – a comment about how this is accounted for would be valuable.

5. L191-192: Were there fewer fires in Northern Australia during 2018/2019 compared to 2019/2020?

6. Section 3.2: I seem to have missed the description of the rotation of wind directions to align the pollution plume, as shown in Figure 2 c).

7. Describe the "grand" or overall emissions ratio calculation in section 3.1.

8. Figure 9 – please add a description of the different color lines to the figure.

9. Why was the Griffin et al. (2021) aerosol correction not applied to TROPOMI NO_2 retrievals here? It seems like this would improve the results for the NO_2 emission ratios.

Technical Corrections:

L109: seldom □ sparse

L306: does “grand emission ration” mean “overall emission ratio”?

L341: filed □ field