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Comment on acp-2022-138

Anonymous Referee #2

Referee comment on "Technical note: Use of $PM_{2.5}$ to CO ratio as an indicator of wildfire smoke in urban areas" by Daniel A. Jaffe et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-138-RC2, 2022

This manuscript describes a new method to determine the relative contribution of smoke to observed $PM_{2.5}$ during wildland fire smoke season. Following Liang et al, 2017, the authors use $PM_{2.5}$/CO to categorize smoke and non-smoke influenced days. In contrast to the overhead HMS smoke product from satellite measurements that can misrepresent conditions on the ground due to inadequate (or nonexistent) retrieval of near-surface smoke concentrations, the $PM_{2.5}$/CO method uses in-situ ground measurements typically present at regulatory surface monitoring sites. After determining the $PM_{2.5}$/CO ratios for urban and smoke aerosol by comparing Monte Carlo simulations to observations, the authors estimate relative contribution of smoke to $PM_{2.5}$ for smoke-influenced days, finding that indeed all the $PM_{2.5}$ exceedance days during the period of study have high influence of smoke. Because the simulation is trained on local conditions, the values reported here may not be widely applicable, but the method can be applied to other sites to identify and estimate relative smoke influence. This manuscript describes the development of methods for interpretation of atmospheric data, but with a limited scope of one study location where all PM2.5 exceedance days are from smoke, so its publication as a Technical Note is appropriate. I recommend publication with minor revisions below:

- Discussion of previous work may be improved by description of the various units for normalized enhancement ratios (NERs).
  - $\Delta PM_{2.5}/\Delta CO$ in g/g vs ug m^{-3} ppm^{-1}: Inclusion of the scale factor may be appropriate.
  - Ambient ug m^{-3} vs STP ug sm^{-3}: Confirm that all values are reported at standard volume to compare like-to-like.
  - $PM_{2.5}$ vs $PM_{1:}$ Studies using Aerosol Mass Spectrometers (e.g. Kleinmann et al., 2020, and Garofalo et al., 2019) will report non-refractory PM_1.

I acknowledge that choosing a convention will not have any bearing on the analysis, since this manuscript recommends performing the complete analysis for a particular location. Therefore, any definitions or units of PM will be consistent. However, uniformity in discussion of previous results and between the abstract and main text is appropriate.

- Ln 115: The authors state "Using the $PM_{2.5}$/CO ratio to segregate the data, we find an improved correlation of PM and CO in the lower range of ratios, compared with using the HMS alone as an indicator (Figure 2)."

In Fig. 2, the R^2 values for the smoke days indicated by HMS smoke and PM2.5/CO>30 for the entire range seem comparable, while the R^2 values for the non-smoke days are less comparable, indicating the main difference between these methods is in the lower PM2.5 concentration range, well below the NAAQS. At these lower concentrations, the HMS smoke product is less likely to capture conditions at the surface and produces false negatives and positives for smoke-influence. To me, a major strength of the ratio method is the improved sensitivity and specificity in identifying smoke days at these lower concentrations. To highlight this, an SI figure explicitly showing the PM to CO correlations or an inset of $PM_{2.5}$/CO vs CO that better shows this lower range would be helpful. Additionally, or alternatively, making the dots smaller or with some transparency might allow the reader to better see the differences in the two methods at low concentrations in Fig. 2. Table 2 indicates that only a net change of 2 days between methods, but it seems that more than 2 dots have changed color between Fig. 2a and 2b. Can you add how many days switch categorization (and in which direction)? I also suggest adding the NAAQS to Fig. 2 to show that both methods successfully identify exceedance days. Further explanation and slight tweaks to the figures for the low concentration data will further support the authors' assertation that the $\Delta PM_{2.5}/\Delta CO$ method is generally a more robust indicator of surface smoke than satellite-based measurements.

A new development is the use of a Monte Carlo simulation to estimate $PM_{2.5}$/CO ratios for smoke and urban influence separately in order to estimate the relative contribution of smoke to observed $PM_{2.5}$.

- How sensitive are the Monte Carlo results to the chosen $PM_{2.5}$ and CO backgrounds and how do they compare to the non-smoke days (from either and both methods) from the Sparks site in 2019?
- The ozone discussion is limited and the numbers in line 190 do not seem to match the numbers in Table 1.

Careful reading for grammatical errors and missing references (e.g. Briggs et al., 2016) will improve readability.