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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Verification of anthropogenic VOC emission inventory through ambient measurements and satellite retrievals" *by* Jing Li et al.

Anonymous Referee #3

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Summary and recommendation

Li et al. compile a new VOC emissions inventory for the Beijing-Tianjin-Hebei metro area, and validate it against in-situ VOC concentrations and satellite-derived emissions within the region. The new VOC observations and emission inventory are within the scope specified by ACP, representing a contribution to "substantial new data." In the present version of the manuscript there are some weaknesses in the analysis comparing the new inventory to the validation datasets. I will recommend publication once these issues are addressed.

General Comments

As the first reviewer said, the activity data is important for the construction of the inventory, and it is also not clear to me where this is sourced from. This information definitely needs to be provided in the main manuscript.

In section 3.2, much of the focus was comparing the speciation of the emission inventory based on CO ratios at the PKU site. This ultimately depends on how representative the PKU site is at the spatiotemporal scale of comparison. The PMF results remove a lot of these complications by decomposing the variability into a set of dominant modes corresponding to source types that can more easily be compared to the sector-based speciation in the inventory. This is likely a more quantitative comparison of the skill of the inventories speciation, and thus should be a greater focus.

I also so no temporal validation of the emissions inventory. The discussion of Fig. 14 in section 3.4 seems to indicate there is no temporal variation in the emissions inventory, which would be a major weakness considering the seasonal variation showed by the top-down satellite inventory. If there is no seasonality then I believe this must be included before final publication. The seasonality in total VOC emissions must be validated against the satellite inventory, and the sector based emissions can be assessed by comparing against the PMF source factor weightings.

Specific Comments

Figure 1: Please indicate the Beijing, Tianjin, and Hebei regions separately on the middle panel of the figure, as these are referenced individually throughout the text

Line 201: "Its [HCHOs] column concentration is directly related to emissions"

This also depends on the lifetime of the precursor VOC.

Line 233: "Figure 5 presents the averaging mixing ratios..."

Also indicate in the text that Figure 5 is showing observations at the PKU site

Line 241: "Figure 6 presents the time series of VOC mixing ratios . . ."

I am not sure what this paragraph/figure is getting at. There are a range of factors driving the variability in the instantaneous observations, including stability of the boundary layer, diurnal/seasonal variation in emissions, transport to the site etc. The point of using the observations is to validate the inventory. For instance, one could put the inventory into a chemical transport model and test if it can replicate the site variability in VOC concentrations. Short of doing something like this, I am not sure what the Figure is trying to show.

Line 251: "Benzene and toluene were important VOC..."

Barletta et al. (2005) discussion Benzene/Toluene ratios of different combustion sources from a survey of Chinese cities. Perhaps your discussion here can reference this in relation to the different sources.

Reference Barletta et al. (2005) "Volatile organic compounds in 43 Chinese cities" https://doi.org/10.1016/j.atmosenv.2005.06.029

Line 266: "Table 2 lists the emission ratios for individual VOCs. . ."

The following 2 paragraphs make the implicit assumption that emission ratios of the VOCs in the 0.25x0.25 degree grid box surround the PKU site are representative of the concentration ratios of VOCs within the site. In general I think it is difficult to assess this in a quantitative way without modelling. For instance, transport from surrounding grid boxes may be important. Also the diurnal structure of emissions will also play a role - sources that have relatively higher night-time emissions will have an outsized impact on the concentration ratio, due to the higher boundary layer stability and reduction in chemical processing. It is for reasons such as these that I find a comparison of the concentration ratios vs. emission ratios difficult.

Line 277: "the annual emissions of many OVOCs and halocarbons were much lower..."

Here it is suggested that OVOCs are underestimated by the emission inventory. However secondary production through the oxidation of precursor VOCs will have a similar

impact.

Line 317: "The PMF receptor model. . ."

Here in Figure 9 I would like to see a comparison between the source profiles derived from the PMF against their attributed sources from the inventory. I believe this is a more reliable test on the inventory speciation.

Line 323: "Figure 10 illustrates source contributions percentages..."

In Figure 10 it would be useful to compare the source contribution percentages derived from the PMF to those from the inventory, to address whether the inventory can or cannot replicate the temporal variations in source categories. Instead of using the Pie charts you could make a bar graph like the one in Fig. 5, putting the results of the inventory next to the observations, or just show the absolute VOC source totals as coloured lines for the four months. Doing this, you probably dont need to make the yearly comparison (Fig 11).

Line 385: "The temporal resolution of the satellite-derived emissions inventory. . ."

It would be useful to compare the temporal resolution of the EF-inventory to the satellite. If it is not there then it needs to be considered.

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