Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
https://doi.org/10.5194/acp-2021-651-RC2, 2021

Comment on acp-2021-651

Anonymous Referee #1

Referee comment on "Spatial variability of air pollutants in a megacity characterized by mobile measurements: Chemical homogeneity under haze conditions" by Reza Bashiri Khuzestani et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-651-RC2, 2021

This manuscript describes mobile measurements of PM mass and composition, inorganic gases, and organic vapors on haze and non-haze days in Beijing. I like the study design, which focuses on quantifying the broad spatial patterns by repeatedly driving a ring road. This is in contrast to many previous mobile sampling studies that focused on obtaining neighborhood-level details at high spatial resolution.

However, I have some major criticisms that need to be addressed:

(1) Amount and representativeness of data: The analyses (all figures except Fig 4) rely on only two days of data (November 14 and 18, 2018). Additionally, the authors primarily discuss midday concentrations on those days. For example, Fig 1 show data from the midday drives between 11:00 am and 12:30 pm local time. Since each drive takes around 70 minutes, this means that the majority of the analysis focuses on one or two drives on each of two days.

The authors claim some large conclusions (they imply that their results are representative of all haze days and all clean days). They therefore need to show more than a small slice of data on two days. The results they present here are for two days, and therefore not necessarily representative of broader conditions in Beijing. A revised version of the manuscript should include analysis from multiple clean and haze days to get a better sense of how robust the results are.

While writing this review I looked up a 2018 calendar. November 14 was a Wednesday, and November 18 was a Sunday. I am unfamiliar with the typical Chinese workweek or people's activity patterns in Beijing, but it seems like there is a good chance that most of this paper's analysis compares a single working day to a single non-working day.

(2) Interpretation of spatial homogeneity on the haze day: The authors need to provide readers with a better sense of meteorological conditions on the clean versus haze days, and how those conditions relate to their interpretation of the mobile measurements. My assumption is that the haze days have low wind speed and perhaps a low mixing height, whereas the non-haze days are windier and better mixed. That seems to be the case from the data shown in Figure S3, but the authors need to include some of that context in the manuscript.

Since the haze day has lower wind speed and presumably poorer mixing, I would expect significant spatial variability, especially for primary emissions. I might even expect larger spatial gradients on haze than non-haze days because of poor dispersion. Instead, the authors explain the more homogeneous conditions on the haze day as a result of "regional transport." That doesn't make sense to me as an explanation, since the haze day seems to be a case of stagnant air where local emissions are trapped.

The local emissions seem to be significant. Figure 4 shows that there are strong enough local emissions on the clean day to replenish pollutant concentrations after the boundary layer rises in the morning (e.g., hydrocarbon concentrations are higher from 12-14 and 14-16 than from 10-12). Thus, if emissions were similar on the two days, one would expect a larger daytime increase in concentrations, not a flat profile. If the haze day was a non-working day (Sunday, see comment above), emissions would be very different, and would have a major impact on the temporal patterns.

(3) With the exception of Figure 4, the authors do not show any temporal variations. I would expect that there is a lot to learn from comparing spatial patterns at different times of day (e.g., morning rush versus midday). Not showing this data in more detail seems like a major missed opportunity.

Additional comments:

(1) Figure 1a and 1d show the spatial variation of PM1 concentrations on two days. This figure is supposed to show that there is more variability on the clean day, however that is not obvious given the scaling of the symbols. The two days both look homogenous to me.

(2) Lines 129-130 note that most of the OA spatial variability on the clean day is due to variations in POA. However, the CV for OOA mass concentration (0.76) is similar to the CV for HOA (.79). This suggests that OOA is also variable. Though, as the authors note, I would expect OOA to be more spatially homogeneous. Perhaps this high CV for OOA points to some misapportionment of other OA types as OOA.

(2) Fig 4 - Make it clean which panels are haze versus clear days. I assume that grey shading is for the haze days.

(4) Fig 4 - how many days are in each plot? Please be clear about how much data is being shown.