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Comment on acp-2021-457

Anonymous Referee #1

Referee comment on "Measurement report: Vehicle-based multi-lidar observational study of the effect of meteorological elements on the three-dimensional distribution of particles in the western Guangdong–Hong Kong–Macao Greater Bay Area" by Xinqi Xu et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-457-RC1>, 2021

The measurement report 'Vehicle-based and In Situ Multi-lidar Observational Study on the Effect of Meteorological Elements on the Three-dimensional Distribution of Particles in the Western Guangdong–Hong Kong–Macao Greater Bay Area' focuses on the analysis of data collected by different lidar systems which were mounted on a vehicle during several day-time research tours in the western Guangdong–Hong Kong–Macao Greater Bay Area in China. This dataset is complemented by ground based lidar measurements during night-time at the Haizhu Lake research base. The goal of the study is to characterize the typical vertical distributions of aerosols over the research area.

I consider such a measurement campaign as an important contribution to the understanding of pollution in Chinese metropolitan regions. However, the determination of three different types of vertical aerosol distributions from just three night-time lidar measurements in one specific month of the year seems to be cherry-picking and inadequate. For a possible publication in ACP I wished for a longer measurement period and an in-depth analysis of the observations which may fortify the stated hypotheses in this manuscript. In my opinion, the current manuscript is more like a data-paper or paper of first observations which may be published elsewhere in more appropriate journals like for example ESSD.

In addition to that I found much room for improvement when reading through the manuscript, i.e. in the description of the employed methods, in the presentation of the analyzed data, the interpretation of the collected data as well as in the discussion of the results. Unfortunately, some parts of the manuscript were also hard to review because of poor English language.

I strongly encourage the authors to thoroughly revise the submitted manuscript with regard to these points for a possible resubmission. I also encourage the authors to involve a native speaker for proofreading before resubmitting.

This is why I tried to do my best in outlining the specific points that motivated my decision and that should be considered when revising the paper.

General comments:

- As lidar is an active remote sensing technique and not an in-situ measurement technique, the phrase 'in-situ' in the manuscript/title is misleading.
- The abstract should be written in present tense
- The instrument platform has to be better described. In the current form of the manuscript the reader has no idea of the setup and the vehicle that was used. What type of car did you use? How have the instruments been mounted onto the car? How fast did the vehicle go? I guess you did not drive the vehicle with constant speed, but you had to adapt the speed of the vehicle to the traffic condition.
- The measurements of the research trips are only described on a half-page. I wished for an in-depth description and discussion of the collected data. What was the motivation for the chosen route that you drove along? How long does it take to drive the 320 km? Why did you only go during daytime? When did you start with the measurement-circle? In the morning hours? I can imagine that it makes a difference if you start measuring in the morning hours compared to starting in the afternoon hours.
- Even though you added the links to the webpages of the respective lidar systems, I wished for a more detailed introduction of the used instruments as well as of the instrument setup on the vehicle. What are the measurement uncertainties? What are the limitations of the instruments? How did the setup on the vehicle look like?
- Have the ground-based lidar observations at Haizu Lake Research Base been conducted with the same instruments that were also mounted onto the vehicle? Why don't you show time-height lidar plots from data collected on the vehicle? Why was some of the data collected in September 2019 and some of the data collected in September 2020? What was the motivation to choose only the month of September?
- Although this paper is a measurement report, it's vague to define three types of aerosol distributions from single observations in autumn. Would long-term lidar measurements at the Haizhu Lake Research Base be available to conduct a statistical analysis of the typical aerosol layering over different seasons of the year in the region? This would substantiate your hypotheses.
- Could you also discuss the possible impact of the topography on your measurements? The research area seems to be a basin surrounded by a quite hilly/mountainous region.
- You could go into more detail with analyzing the lidar data. What aerosol types do you observe? Could it be possible that marine sea salt contributes to the observed aerosol layers as you have observed a southerly component of the wind speed at low altitudes (especially during Type 1).
- Nearly all figures and their captions have to be revised, as many things remain unclear to the reader (for details see below).

Specific comments:

- Figure 1: For a better comparison and to condense the information shown you could use wind barbs and plot them in Figure 4.

- Formula 1: Please motivate why you have chosen a fixed value of $S = 50$ sr for the conversion to the extinction coefficient.
- What is k representing in formula (2). What depolarization ratio are you exactly measuring? According to the formula it is the volume linear depolarization ratio.
- Line 192: ‘...wind direction over the observation points...’ I don’t understand what points you mean. Which instrument was used for the measurements? Please clarify.
- Line 195: How exactly can low wind speeds at low altitudes act as a disincentive for regional transport at higher altitudes? Please explain in more detail.
- Line 208: Why did you choose 22 LT as starting time for your trajectory calculations? From the shown wind measurements, you already see that later in the night the wind (at 540 m) shifts to the South. I could imagine that a starting point later in the night would show a completely different result.
- Line 226: Aerosol is always suspended in the air, also when it’s located near surface. Please correct.
- Line 234: I don’t understand this sentence. What ‘unconverted primary particulate matter’ are you meaning? Sea salt? Depolarization predominantly depends on the shape of the particles.
- Chapter ‘Conclusion’ is rather a summary than a conclusion.
- Line 384: I guess that according to the ACP-Guidelines data should be made freely available in an online repository.

Specific comments to shown figures:

- Figure 1: Y-Axis – a sequential colormap instead of a diverging colormap would fit better? Where did you take the underlying Altitude data from? It’s not clear to the reader. The resolution seems to be quite coarse.
- Figure 2: Please label the colorbar and axes and add information at what wavelength AOD has been measured. Are the AOD-measurements averaged over time? Why do you only show vertically integrated point-measurements and no continuous and height-resolved measurements?
- Figure 3: Please label the shown axes and clarify from which model the wind field has been retrieved. Could you indicate the research area in these plots? This would make it easier for the reader to compare Figure 2 to Figure 3.
- Figure 4: Is the figure showing lidar measurements? Or is the data collected from a model? What is the y-axis showing? Depolarization ratio at 532 nm?
- Figure 5: Clarify meaning of Y-axis? Altitude above sea level or above instrument? Why does it only show 4 h of data and not 8 h like the lidar data in Figure 4?
- Figure 7: Please use SI-units: Kelvin instead of degrees Celsius and clarify meaning of Y-axis. Altitude above sea level or above vehicle? Please indicate the measurement uncertainty of the Raman-Temperature measurements.
- Figure 8: Same suggestions as for Figure 4.
- Figure 10: What is going on between 19 pm LT and 19:30 pm LT? Please modify the range of the colorbar to resolve the magnitude of the apparent updraft.
- Figure 11: Same suggestions as for Figure 4. Where are these periodic oscillations in the first half of the night in the lidar signals coming from? Is this a natural phenomenon or a measurement-artefact?
- Figure 12: Same suggestions as for Figure 5.
- Figure 14: Same suggestions as for Figure 7.
- Figure 15: From where has the wind speed data been taken? Please clarify in caption.