Reply to Anonymous Referee # 2 Comment on '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'

General comments:

This manuscript attempts to understand the mechanism of how wind and temperature in the boundary layer affects the horizontal and vertical distribution of particles. The topic is critical, and the method is scientifically sound. I suggest accepting the publication after the following revisions.

We would like to thank the Anonymous Referee # 2 for the assessment of our manuscript and for sound and constructive comments. We took into all account comments and suggestions, and performed revision of the manuscript, trying to clarify all issues. The referee's comments are in black; our responses are in dark blue.

Major comments:

Line 54-60: The introduction part could be improved by providing discussion about the temperature and wind impacts on aerosol distribution, citing relevant work that used multiple lidars to study temperature, wind and aerosol, and discussing their findings.

Thank you for your suggestion! We have improved the relevant content. This part has been modified as follows (changes to the manuscript are indicated in red font):

"The distribution of particles is influenced not only by changes in source emissions but also by changes in meteorological factors, such as temperature and wind. It has previously been observed that a low boundary layer height and complex vertical distributions of aerosols, temperature and relative humidity were the main structural characteristics of haze days (Huige et al., 2021). Previous studies have confirmed that different types of temperature inversions have different impacts on particles in the boundary layer (Wallace et al., 2009; Wang et al., 2018). The depth and temperature difference of the inversion is a key factor in the predictions of surface $PM_{2.5}$ concentrations (Zang et al., 2017). It has previously been observed that wind fields play an important role in transboundary-local aerosols interaction (Huang et al., 2021a; Huang et al., 2021b). Recent evidence suggests that wind shear was an important factor in terms of PM_{10} vertical profile modification (Sekuła, P., et al). The concentration of particulate matter also shows characteristics of wind-dependent spatial distributions in which pollutant transport within the GBA city cluster is significant (Xie et al., 2019). Hence, the issue of how meteorological factors affecting the distribution of particles has received considerable critical attention."

Line 99-111: it would be useful if the authors can describe how to keep the different spatial and time resolutions of the three kinds of lidar systems consistent in this study.

Since the spatial resolutions of the data from the micro pulse lidar and the Doppler wind profile lidar are different, we interpolated the data to make them match each other vertically when

calculating extinction coefficient at different wind speeds in 3.3.1. As for the data from the Raman temperature profile lidar, we maintain the original spatial and temporal resolution when plotting. This information has been added to 3.3.1.

A brief discussion about the uncertainties would be useful.

Thank you for your suggestion! The quality of data from the lidar system was checked before using in our study. Results show that the percentage difference between data provided by the lidar system and data from the Shenzhen meteorological tower was less than 15%, which indicates a sufficient accuracy of the lidar instrument. This information has been added to 2.2.

Line 170: "Therefore, the value of the extinction coefficient near the ground during the day was generally low…". This is an interesting statement as the surface layer PM2.5 concentrations during daytime are typically higher than nighttime (average). The aforementioned statement seems to give a different perspective. It would be great if the authors can explain this a bit.

According to our observations before, the concentration of particulate matter near the ground is generally lower during the day than at night. Boundary layer height is generally higher in the daytime. The high solar radiation intensity during the day results in significant surface warming and thus stronger thermal convection in the vertical direction. Therefore, daytime conditions are more favorable for the vertical dispersion of pollutants. However, concentrations of particulate matter are also related to local emission intensities and regional transport, and observations may vary from region to region.

Minor comments:

Line 73: insufficient reference to support line 72: in the past few years, several …

We have added more reference of this topic.

Line 121: what is the value of the Zc in this study?

Zc is variable, ranging from 10-15 km, and depending on the signal intensity. This information has been added to 2.3.

Line 131-136: what is the horizontal resolution of the meteorology data used in HYSPLIT?

We used the meteorological data of the Global Data Assimilation System (GDAS) at the spatial resolution of 0.25° in HYSPLIT. This information has been added to 2.4.

Line 184: It would be useful to describe how to observe the layer of elevated depolarization ratio layer in Fig 3(a)?

We are sorry that we made a mistake. In this version of the manuscript it should be Figure 4(b). we

have modified it. Thank you very much for the correction!

"Wind speed at lower altitudes was relatively low, which was beneficial to regional transport…" should be further elaborated.

Thank you for your suggestion! We have modified this sentence as follows (changes to the manuscript are indicated in red font):
The domination of weak wind in the boundary layer was beneficial to inter-city transport of particles. It brought particles from cities located upstream, to the location of our observation, and allowed particles to stay longer without being blown quickly downstream.