

## ***Interactive comment on “Continuous vertical aerosol profiling with a multi-wavelength Raman polarization lidar over the Pearl River Delta, China” by Birgit Heese et al.***

### **Anonymous Referee #2**

Received and published: 4 November 2016

#### General comments:

This manuscript presents a statistical analysis for the aerosol optical properties of the polluted atmosphere over the Pearl River Delta, Guangzhou, China, using a multi-wavelength Raman and depolarization lidar and a sun-photometer during November 2011 to mid- June 2012. Multiple range-resolved optical parameters of aerosols are characterized with the monthly and seasonal average, such as the extinction and backscatter coefficient, lidar ratio and depolarization ratio. In particular, the statistics and type classification for the lofted aerosols are analyzed. Overall, the paper is well organized, but some details on the statistical methodology are missed and the English writing needs to be improved.

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Specific comments:

1. Generally, the capability of Raman-channel detecting aerosol extinction profile is quite limited in the daytime due to the sky noise. Some related information are missed in the manuscript as follows. What are the valid altitudes for the Raman-channel derived aerosol extinction profile in the daytime and night-time? What's the range of lidar geometric overlap function (GFF) (where the  $GFF=1$ )? How long is the time average for calculating aerosol extinction coefficient? Are all the aerosol extinction profiles in this manuscript derived from the Raman-channel in the night?
2. For the statistical analysis such as the monthly average in the Table-1 and Fig.5 and Fig.7, How many days data for each month?
3. In Fig.2 (upper panel), there are a lot of strips or lines that show very small values the whole profile or from the surface to free troposphere (e.g. at 00:00 24/03/2012). They seem artificial; what reasons cause them? In Fig.2 ((lower panel), the clean layers of 2-km altitude show consistently higher depolarization ratios over the days. They seem not in the lower layers of aerosols, it is difficult to understand them. Did you check the possible distortion or nonlinearity of weak signals at those clean air layers?
4. In Fig.3, the lower lidar-ratios ( $<40$  sr) and higher depolarization ratio ( $\sim 15\%$ ) at 2-km altitude are doubtful since the Angstrom exponents vary little over the altitude. Why are the aerosol extinction coefficient profiles cut below 1.5 km altitude? When calculating the aerosol backscatter profiles with the Raman and elastic-scattering signals, how do you determine the free aerosol or clean-air layer? What heights are generally used?
5. In Fig.5 or in the Line 9 of Page-7, are the single profiles of extinction the daily or hours averaged? Are they calculated from the Raman-channel in the night only?
6. In the Section 4 Lofted aerosol layers. How do you define a lofted aerosol layer, visually or using a threshold of aerosol extinction against the molecular value? Because of

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the temporal-spatial variations of lofted aerosol layer, how do you take the layer height, using hourly or daily averaged profile?

7. In the Section 4.2 Aerosol classification, In Fig.7, are the data points the daily averaged values? Those circles marked for the aerosol types seem arbitrary or not objective based on some thresholds of aerosol optical parameters. What are your methods or any thresholds of aerosol optical properties for classifying these aerosol types? For the given type of aerosols, what is the difference between the “Pollution” and “Pollution mixture” aerosol? “Burning product” is a little confused, “biomass burning”?

8. In the Section 4.3 Origin of the aerosol layers- trajectory analysis, The lofted aerosols below 1200-m are probably from the local nocturnal residual layer since they are so low or in the PBL, thus they are probably not from the long-range transport.

Page-10, Line-12, a total number of 413 backward trajectories was obtained. It seems that they are not the daily averaged profiles since your total observation days are less than this number. How long is the time average for a lidar profile? That means that on some day you might have a lot of aerosol profiles while on other days you might only have one or none.

9. In the Section 4.4, If possible, the statistics of PBL aerosols optical properties can be given for the comparisons with the aloft aerosols because the PBL aerosol pollutants are more related to the human health or draw more attentions.

10. In the Section 5 Conclusion, Page-12, Line 22-23, authors mention “This was also observed in Guangzhou and is consistent with the Asian monsoon circulation in the region.” There are no enough discussions about the effects of Asian monsoon circulation on the aerosols. how does the Asian monsoon affect the aerosols?

Page-12, Line 26-27, “The particles are locally and regionally produced and are only seldom mixed with transported particles from further away.” This is not consistent with the Figure 8 (b) and (c), even Figure 8 (a). For instance, in Fig.8(b), the cluster-3 for

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the long-distance transport shows 31% percentage against the 38% of the Cluster-1.

Technical corrections:

1. Page-1, Line-6, two “observed” appear in the sentence. Please delete the first one and move “by the sunphotometer” afterward to the second “observed”. Please give the wavelength for the aerosol optical depth and lidar-ratio.
2. Page-1, Line-8, please delete the word “even”.
3. Page-1, Line-9, “aerosol” should be “aerosol types”.
4. Page-1, Line-11, please add “%” behind the number “3.7”.
5. Page-1, Line-12, you may say the mixture of fine and coarse-mode aerosols.
6. Page-1, Line-13, the word “mainly” should be “main”.
7. Page-2, Line-9, please add the word “for” in front of “most of the time in the PRD”.
8. Page-3, Line-21, please revise the word “is increasing” with “increases”.
9. Page-3, Line-26, please delete the word “also”.
10. Page-4, Line-1, this sentence is confused.
11. Page-6, Line-22, “04:30 h” should be “04:30 am”.
12. Page-8, Line-2, please revise the sentence or just say:  
“The top heights of the lofted aerosol layers range from a few cases of 1.5 km to 5 km (Fig. 6).”
13. Page-8, Line-9, please delete the word “depths” after “3 km”.
14. Page-8, Line-13, the word “is” should be “are”.
15. Page-9, Line-30, the word “6%” should be “6 sr”.

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16. Page-11, Line-11, the word “calculate” should be “calculated”.

17. Page-11, Line-22, please add “sr” behind the number “50.7”.

18. Page-12, Line-7, the number “042” should be “0.42”.

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