Answer to Referee #2

We thank the referee for the careful reading the manuscript and the kind suggestions to improve it. Please find our answers to the specific comments and technical corrections below. Answers are typed in cursive letters and new text is typed in smaller letters.

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?

- *To emphasize this aspect, we added the following information to page 3 line 20:*

For the determination of the particle backscatter coefficient and particle extinction coefficient during night-time the Raman method (Ansmann, 1992) was applied.
During daytime the Fernald-Klett method (Klett, 1981, Fernald, 1984) was used, but in this study only the Raman derived profiles were taken into account.

- *The valid altitudes for the Raman channel derived aerosol extinction profiles start at 1.5 km height. Below 1.5 km the data are effected by the geometric overlap. The overlap function could not be determined due to very high aerosol load at these altitudes (see page 4, line 3-6). Therefore, the extinction profiles below 1.5 km were extrapolated downwards using the backscatter profiles derived by the Raman method, where the overlap effect is eliminated by the ratio of two channels. To clarify we added this information in the text on page 4 from line 3:*

The lidar data presented here are without any overlap correction. The overlap function could not be calculated due to permanently high aerosol load in the atmosphere over the PRD. However, to be able to calculate the AOD from the lidar profiles, the Raman backscatter profiles were fitted to the Raman extinction profiles at the heights below 1.5 km height. The Raman backscatter profiles are not affected by the incomplete overlap since a ratio of two channels is used in the respective algorithm.

- *The average time to calculate the extinction coefficient profiles was 2 to 3 hours. This is written in the text at page 2 line 32, just before the overlap paragraph.*

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?

- *Nov 19, Dec 24, Jan 5, Feb 6, Mar 12, Apr 9, Mai 21, Jun 10, total number is 106. The same profiles were used for the statistics in Fig 6, 7, and 9.*
- *The number of profiles used in Table 1 are now added to the table caption.*

- *The number of single extinction profiles used for Fig 5 is less (99) and is described in chapter 3.3, at page 7:*
    line 13: The mean November-December profile was calculated from 35 single profiles.
    line 16: The mean January-February profile is resulting from 11
    line 21: The mean March-April profile calculated from 20 single profiles
    line 26: The mean May-June profile was calculated from 33 single profiles

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?

- *These blue lines indicate "no signal", i.e. the laser is off due to a rain event or caused by insects flying through the rain sensor. This was mentioned in the text (page 6, line 10). However, for convenience, we added a comment to the figure caption as well.*

Fig. 2: Attenuated backscatter coefficient at 1064~nm (upper) and volume depolarization ratio (lower) for the 5-day period from March 23 to March 28, 2012. The blue, vertical lines in the plots occur when the laser is automatically switched off due to rain events. This may also be caused by insects flying through the rain sensor.

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?

- *Yes, these high depolarization ratios are observed in the lower part of the upper aerosol layers. The color scale may be misleading here concerning regions with low aerosol backscattering. It can be better seen in the profiles in Figure 3. We are confident that the data evaluation is correct.*

4. In Fig.3, the lower lidar-ratios (<40 sr) and higher depolarization ratio (_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?

- *Below 1.5 km the geometric overlap of the lidar system is uncomplete. See also answer to question 1.*
- *The aerosol free layer for the Raman calculation is visually determined. Generally, heights above the aerosol layers are used where the signal to noise ratio is still high. These heights lie usually around 10 km altitude. This was also the case for the data in Fig 3.*

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?

- *The single particle extinction profiles are calculated from 2-3 hour Raman measurement. See also answer to 1) above.*

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

- *Also here, 2-3 hour averaged measurements were used for to calculate the profiles. The top heights of the lofted aerosol layers were identified visually from the backscatter coefficient profiles. The top height was defined were the backscatter coefficients reach*

the molecular background and the lower boundary of the lofted layer was set to the minimum in the backscatter coefficient profile between the PBL and the lofted layer. We added this point as follows:

The top heights and the depths of the lofted aerosol layers are shown in Fig.5. Both values were identified visually using the backscatter coefficient profiles. The top height was defined were the backscatter coefficients reach the molecular background and the lower boundary of the lofted layer was set to the minimum in the backscatter coefficient profile between the PBL and the lofted layer.

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"?

- *Also here the data points are the same values for the 2-3 hours averaged profiles. The classification is based on the values obtained from lidar observations during recent years, especially in the frame of EARLINET and PollyNET. The respective literature is cited in the discussion of these Figures.*

- *Pollution mixtures in contrast to pollution refers to depolarisation ratios between 5% and 10%. These are caused by larger or more spherical particles. This aerosol type is discussed on page 9 line 6-10 in the chapter 4.2.*

- *Burning products include particles from biomass burning, industrial burning or domestic burning. We replaced the expression by "particles from burning processes" at two incidences.*

  Page 9, line 22 : … smaller particles from burning processes that contain soot.
  Page 9, line 29: … for urban particles and particles arising from burning processes.

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.

- *Yes that is right. Most of the observed aerosol layers origins from local sources. This is part of the results of the trajectory analysis on page.*

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.

- *The time average for each profile is always 2-3 hours. The total number of profiles used is the same as before, but some profiles show more layers, so that the total number of upper-layers used was 147. Trajectories were calculated for three, sometimes five altitudes for each profile. Thus, the total number of 413 trajectories arises. Also here, the maximum number of profiles per day was restricted to four (see manuscript page 4, line 1-2)*

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.

- *Due to the incomplete overlap, we cannot evaluate the particle extinction coefficient inside the PBL (see also answers to 1 and 4 above). This affects also the lidar ratios at 355 and 532 nm and the extinction Angström exponent. The depolarisation ratio is always below 5%, so only the statistics of the backscatter Angström exponent are left. Thus, another plot would not give much information. We prefer to concentrate this study on the lofted aerosol layer.*

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?

- *We were referring to the wind direction that is following with the Asian monsoon. This might not be made clear here. New part of the sentence:*

…and is consistent with the general wind circulation dominated by the Asian monsoon.

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

- *Long calculation time of the trajectories does not exclude that the aerosols come from sources close by. Our statement is based on the optical properties that were observed by the lidar measurements. We have adapted the text accordingly:*

These particles are mainly locally and regionally produced. During the summer monsoon season, they may also be mixed with particles of marine origin from the close-by sea. Dust mixtures into the pollution aerosol transported from sources further away was only observed in one case.

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. - *done*

2. Page-1, Line-8, please delete the word "even". - *done*

3. Page-1, Line-9, "aerosol" should be "aerosol types". - *done*

4. Page-1, Line-11, please add "%" behind the number "3.7". - *done*

5. Page-1, Line-12, you may say the mixture of fine and coarse-mode aerosols. - *done*

6. Page-1, Line-13, the word "mainly" should be "main".

– We wanted to express what is 'most of the time' = 'mostly' present in the atmosphere above PRD. We replaced 'mainly' by 'mostly'.

7. Page-2, Line-9, please add the word "for" in front of "most of the time in the PRD". *- done*

8. Page-3, Line-21, please revise the word "is increasing" with "increases*".*

 - We changed "is including" with "includes" -We did not find "is increasing"

9. Page-3, Line-26, please delete the word "also". *- done*

10. Page-4, Line-1, this sentence is confused.

– We changed the sentence:
To avoid over-representation of long lasting cloud-free periods with constant aerosol conditions, the number of considered profiles per day during such periods was reduced to a maximum number of four.

11. Page-6, Line-22, "04:30 h" should be "04:30 am". *- done*

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)." *- done*

13. Page-8, Line-9, please delete the word "depths" after " 3 km". *- done*

14. Page-8, Line-13, the word "is" should be 'are". *- done*

15. Page-9, Line-30, the word "6%" should be "6 sr". *- done*

16. Page-11, Line-11, the word "calculate" should be "calculated". *- done*

17. Page-11, Line-22, please add "sr" behind the number "50.7". *- done*

18. Page-12, Line-7, the number "042" should be "0.42". *- done*