We thank the anonymous reviewers for providing helpful comments and suggestions on this manuscript. The responses to the Referees comments are found below.

Referee #1

Major comments:

1. *A description of the ventilation systems and how ventilation can affect concentrations (mechanical, natural, …) in section 2.1 is needed.*

   Please refer to comment #1 from referee #2.

2. *Section 2.2. Three particulate matter samplers were simultaneously used. How do they compare? How the Angstrom exponent was calculated for particles deposited on a glass fibrous filter? The estimation of optical properties from particles collected onto filters has been criticized in the literature.*

   While three particulate matter samplers were used in the manuscript, each collected samples for a specific analysis. The Minivol sampler collected particulate matter onto a 47mm quartz fiber filter for OC and EC quantification. The low-volume sampler collected particulate matter on a polycarbonate filter for elemental composition and gravimetric analysis. Their comparison can only be obtained through the chemical mass balance (EC+OC+trace elements compared to gravimetric analysis), which yielded good agreement. The third sampler was a high volume sampler which had a different size cut (PM10), therefore its gravimetric results cannot be directly compared to the low-volume sampler. As for the impact of different size cut on PAH quantification, please refer to comment #5 from reviewer #1. The second part of the question is discussed on comment #2 from reviewer #2.

3. *Section 3.1.1. How OC and EC correlate each other? Which are the minimum OC/EC ratios in the OC vs. EC plots (lower line)?*

   Given the homogeneity of the fleet traversing the JQ tunnel, there has been little variation in OC:EC ratios in this tunnel (1.59 ± 0.09, line 13, page 20848). The minimum OC:EC ratio observed in the JQ tunnel was 1.49. Conversely, the OC:EC ratios in the RA tunnel presented a larger variability, probably due to variable contribution on the fleet composition (0.49 ± 0.12, line 23, page 20848). The minimum observed value in the RA tunnel was 0.37.

4. *Page 20850. The conclusions drawn from the application of EFs should be regarded as rough, because there may be large differences between the composition of UCC and the local soil.*

   Please refer to comment #9 from referee #2.

5. *Section 3.1.2. The first paragraph is strange, concerning the formation processes of PAHs. It should be noted that PAH concentrations reported in this study are lower limits of the "real" concentrations, since most PAHs are in the gaseous phase. Only PAHs with 5 or more benzenic rings are predominantly in the particulate phase. Also, it should be emphasized that Rogge et al. presented PAH ratios for vehicles representing the American fleet at that time (more than 20 years ago), whereas the present study refer to vehicles powered by different fuels and expressing another reality. PAH were determined in filters from a high-volume sampler with a PM10 inlet, but mass percentages are reported to PM 2.5 !*

The first paragraph of Section 3.1.2 has been replaced by the following text:

"PAHs in the atmospheric samples are the organic compounds that present the greatest concern for human health. They are stable forms of hydrocarbons and are mostly formed during the incomplete combustion and pyrolysis of fossil fuels or wood and from release of petroleum products (Manahan, 2005). The emission of PAHs is a function of engine type, load and age, fuel type and quality, PAH accumulation in lubricant oil, lubricant oil combustion and driving mode (Ravindra et al., 2008). The PAH in the environment are present in both particulate and gaseous phases. Their distribution between both phases is dependent on molecular weight, ambient temperature, their concentration and particle composition (Guarieiro et al., 2014). In the present study only particle phase concentrations are reported, which for lower molecular weight PAH are certainly substantially underestimating total PAH concentrations but for high molecular weight PAH concentrations are close to total concentrations as observed in other emission studies (Ho et al., 2009)."

Furthermore, the following text has been added to the third paragraph of Section 3.1.2.

"Since few studies have been performed in Brazilian tunnels, a comparison is done with the literature, despite the different fuels used."

As for the comparison with previous literature on observed ratios and on the impact of 10 um size cuts for PAH sampling, please refer to comments #11 and #10 from referee #2.

6. *Page 20853. It is not clear why ratios of 1.6 and 1.5 have been used to convert OC to organic matter.*

Please refer to comment #12 from referee #2.

7. *Section 3.2. The interpretation of volatility classes must be made with caution because the thermogram profiles are highly dependent on the thermal protocol. In addition, artifacts (quartz fiber filters are highly adsorptive) may interfere.*

Please refer to comment #4 from referee #2.

8. *Table 2. Why different numbers (N) of samples have been analyzed for different elements?*

The number of samples indicated on Table 2 refers to compounds/elements observed above the detection limit, thus may change for a given element.

9. *Figure 10. Try to apply a statistical rejection test to the point (80,18).*

Please refer to comment #14 from referee #2.

10. *Conclusions. This section should present a compilation of the major findings and not a discussion or comparison of results with those of the literature.*

Some of the discussion presented in the Conclusions Section has been removed or shortened. Please refer to comment #5 from referee #2.

Minor comments:

11. *Abstract, line 24. Delete "in the JQ tunnel"*

Text altered accordingly.

12. *Introduction, line 19. considerable amount.*

Text altered accordingly.

13. *Page 20849, lines 6-7. Review the construction of this sentence.*

A dot was inserted instead of comma. The revised text reads:
"Given the fact that many brake linings use Sb_2S_3 up to at least 5–7 % by weight (Garg et al., 2000), Sternbeck et al. (2002) proposed a diagnostic ratio…"

14. *Section 3.4.2, line 23. Change "particulated" to "particles "*

Text altered accordingly.

A mixture of American and British styles is used. Examples: sulphur (UK), characterization (USA)
Text altered accordingly.

Referee #2

Major comments:

1. *The authors offer no discussion of background corrections for their measurements. The ventilation of the tunnel is not described explicitly, but we know that outside (background) air enters the tunnel through some mechanism (e.g., by fans or by the motion of traffic). I am unsure of typical PM2.5 concentrations in Sao Paolo, though it is reasonable to assume that, at least for the RA tunnel, the PM2.5 measurements are significantly above background levels. However, even if PM2.5 in the tunnel is well above concentrations outside of the tunnel, the presence of non-vehicular particles could have significant impacts on measured OC/EC ratios, the apportionment of specific ions, and measured optical properties. All of these are presented without background correction, and without discussion of background concentrations.*

The JQ tunnel does not possess an external mechanism for ventilation, resulting in air exchange essentially driven by the motion of traffic. This feature leads the midpoint of the tunnel (~1km from the entrance/exit) to be an environment strongly dominated by vehicular emission. Carbon monoxide (CO), for example, has been observed during the filter collection periods to be on average 4.6 times higher inside the tunnel (5.4±1.0 ppmv) relative to outside (1.2±0.3 ppmv). Further evidence corroborates the dominance of aerosols emitted from light-duty vehicles traversing the tunnel relative to outside contamination. BC, for example, has been previously reported in Sao Paulo with daily averages ranging from 1.1 µg m^{-3} to 2.7 µg m^{-3} (Backman et al., 2012). Such concentration range, impacted by both heavy- and light-duty vehicles, is considerably lower than observed inside the JQ tunnel (8.7±1.4 µg m^{-3}). As such, it is clear that the aerosol population is a result of direct emissions of the fleet traversing the tunnel. Therefore, the authors propose the following text modification (underlined), on the first paragraph of page 20847.

"During the study period, over 930 000 vehicles circulated in both tunnels. In the JQ tunnel, cameras registered the traffic allowing LDVs, UCVs and motorcycles to be counted a posteriori. Given that the vehicle velocity was not measured in the JQ tunnel, traffic congestions events were flagged based on the driving pattern. In the RA tunnel, categorized traffic volume (LDV, HDV) and speed were measured using ground sensors. The LDV were defined to be those with a wheel pair distance smaller than 5.5 m and vice versa for the HDV (generally this translates to the situation where LDV are lighter than 3.5 t). Figures 3 and 4 show the traffic weekday diurnal variation on the JQ and RA tunnel, respectively.

Both tunnels can be considered not to be strongly influenced by background aerosol population. Whereas the RA tunnel is located in the outskirts of Sao Paulo, without important local sources of aerosol, the JQ tunnel does not possess an active ventilation mechanism. As such, the air exchange in the latter is essentially driven by the motion of traffic, resulting in strong concentration gradients between inside and outside the tunnel. Carbon monoxide (CO), an important tracer for vehicular combustion, has been observed during the filter collection periods to be on average 4.6 times higher inside the tunnel (5.4±1.0 ppmv) relative to outside (1.2±0.3 ppmv). Furthermore, due to traffic restrictions of heavy-duty

vehicles in the sampling area, the atmosphere outside the JQ tunnel is largely impacted by LDVs, i.e., the same source profile as inside the tunnel. As such, subtraction of background (outside) signatures would certainly lead to mischaracterization of LDVs emission. In the following, particulate matter chemical composition, size distribution and optical properties are presented."

2. *Page 20846 - You need to justify how the Angstrom exponent of particles collected on a filter in the MAAP is applicable to suspended aerosol. There are numerous studies that are highly critical of using particles trapped on a filter to infer optical properties. One such reference: Subramanian et al (2007), Yellow beads and missing particles: Trouble ahead for filter-based absorption measurements, Aerosol Sci. Technol., vol 41, p 630-637*

We believe that the referee meant "absorption coefficient" instead of "Angstrom exponent". To clarify, the scattering Angstrom exponent characterizes the spectral dependence of particle scattering coefficients, and was used to calculate particle scattering coefficients (measured at 450, 550 and 700 nm) at the same wavelength as MAAP's particle absorption coefficients (637 nm). This was stated on pages 20845 and 20846.

Concerning to filter-based measurements of particle absorption coefficients, we are aware that the accuracy of this technique has been under debate in this decade. Moreover, as stated in the Moosmüller et al. (2009) review paper, the quantitative measurement of aerosol light absorption is still a challenge. Filter-based measurements are prone to artifacts due to filter loading effects, changes in particle and filter morphology upon particle deposition and optical interaction of deposited particles and filter medium. Photoacoustic and refractive index-based measurements may suffer from some interference due to light-induced particle evaporation. Recent cavity ring-down techniques are promising, but require an integrated nephelometer to obtain aerosol light absorption through extinction-minus-scattering, and in-depth testing and intercomparison with photoacoustic and other techniques still needs to be improved. As such, all particle absorption measurement techniques show advantages and drawbacks.

Among filter-based instruments, results from aerosol absorption photometer intercomparisons have shown that MAAP compares excellently with the photoacoustic reference (Müller et al., 2011; Sheridan et al., 2005). MAAP has the unique feature of measuring simultaneously the optical attenuation and reflection of deposited particles from several detection angles, minimizing the artifacts related to multiple scattering effects (Petzold et al., 2005).

We agree that a simple mention of the accuracy of MAAP measurements would improve the manuscript. Therefore, we propose the inclusion of the following sentence in the first paragraph of page 20846:

"The MAAP instrument measures simultaneously the optical attenuation and reflection of particles deposited on a glass fibrous filter from several detection angles to retrieve the aerosol light absorption (Petzold et al., 2005). This unique feature among other commercially available absorption photometers leads MAAP to minimize filter-based method artifacts related to multiple scattering effects, resulting in excellent comparisons with photoacoustic methods (Müller et al., 2011; Sheridan et al., 2005)."

3. *Page 20846, Line 17 - How variable is the MAC of the MAAP filter substrate? Kirchstetter and coworkers showed that for the aethalometer, which works under similar principles, the "default" MAC did not describe their data obtained from a propane burner and they introduced a scaling*

factor of 0.6 to account for this difference. Also the calculation in equation 2 assumes no change in particle morphology when it is captured on the filter tape.

Aerosol MAC depends on particle composition, size, mixture and wavelength of incident light. Ambient aerosols may show a range of MAC values, so that any constant value assumed is a generalization, although necessary to at least describe a representative MAC value. The variability of MAC in JQ tunnel was discussed on Section 3.4.1. Usually, filter artifacts are caused by high filter reflectance, which is interpreted as light absorption by aerosols in instruments that only measure transmittance trough a particle loaded filter, like the Aethalometer mentioned by the referee. Therefore, transmittance-only aerosol photometers tend to overestimate particle absorption coefficients, and need to be corrected (e.g., Collaud Coen et al., 2010). MAAP minimizes this artifact by measuring reflectance in addition to transmittance, subtracting the signals.

Concerning to the questio relative to equation 2, the parameters actually measured by the MAAP photometer are: light transmittance and reflectivity by particles and filter substrate, providing the calculation of particle absorption coefficients. The manufacturer opted to report BC concentrations instead of aerosol absorption as the final product, through equation 2, which is in fact a simplification. By using equation 2 we simply converted BC concentrations back to aerosol absorption, which was the actual measurement. To address the referee observation, we propose the following changes to paragraph #2 on page 20846:

"MAAP evaluates optical absorption by aerosol particles, but the manufacturer opted to report black carbon (BC) equivalent concentrations instead, assuming a constant mass-specific absorption cross-section (MAC) of 6.6 m^2 g^{-1}. The relationship between σ_{abs} and BC mass concentration is provided by the manufacturer as:

$$BC = \frac{\sigma_{abs}}{MAC}$$

This generalization does not take into account variations of MAC as a function of particle physical and chemical properties, nor changes in particle morphology upon deposition on the filter substrate. For the analysis of particle optical properties, BC concentration was converted back to absorption coefficient, which is the actual MAAP measurement, through equation 2. Further discussion of the instrument corrections and site-specific MAC values is given on Sect. 3.4.1."

4. *Section 3.2 and Figure 7 - I have several concerns about this section. First, while the temperature steps in the OC/EC analysis should give some information about the RELATIVE volatility of the OC fractions from each tunnel, the authors do not provide much information to give context to Figure 7. Were any calibration runs, with known material, conducted in order to determine that a volatility difference exists between the JQ and RA samples, and is driving the differences in thermograms? The sucrose recommended as a calibration standard for the Sunset OC/EC can desorb during multiple temperature steps, depending on the specific desorption program used. This suggests that OC desorption temperatures are not directly correlated to volatility. No convincing argument is made that the thermograms are truly indicative of organic aerosol volatility. The differences in thermograms could be due to differences in aerosol loading on the different filters, or could be the result of artifacts (which could be indirectly related to loading). Since these are*

bare quartz filters, there should be substantial vapor-phase artifacts, especially for the lower concentration conditions in the JQ tunnel, and these artifacts are not discussed.

The reviewers have raised indeed highly relevant points towards the interpretation of the collected data through its thermogram analysis. Although some relevant scientific output certainly is contained in such analysis, its link to volatility is not as direct as led to believe. After much consideration the authors have decided not to include such discussion in the current manuscript, but rather develop such important topics in an upcoming work focusing specifically on filter and real-time characterization of urban pollution in Sao Paulo. The discussion and Figure 7 have been eliminated from the text.

5. *Figure 11 and related discussion on page 20857 - I disagree that the changes in aerosol optical properties are the result of gas/particle partitioning. A more likely explanation is that changes in these quantities over the course of the day are driven by the number of vehicles in the tunnel, and therefore the dilution ratio of fresh exhaust. During the overnight hours, when vehicle volumes are low, there will be a high fraction of background air in the tunnel. As the vehicle volumes climb during the day, there is a higher fraction of exhaust in the tunnel and less background air. The diurnal changes you are observing are likely the differences in optical properties between exhaust (at midday) and regional background air (overnight).*

After careful revision we encountered an issue with the Nephelometer time stamp, as it was not corrected to local time. The revised data is shown on Fig. 1, and Section 3.4.2 was updated accordingly:

"In the recent literature, several studies have focused on mass concentration, chemical speciation and BC content of aerosols released by vehicular emissions. Nevertheless, only a few aim to characterize aerosol optical properties like scattering coefficients and albedo (e.g., Japar et al., 1981, 1984). Since aerosol optical properties can usually be measured with high time resolution, it can provide insights on aerosol dynamical processes. Moreover, the single scattering albedo is an intrinsic aerosol property, and a key parameter to determine the effect of vehicular particulate emissions on the radiative balance and climate. To our knowledge, this study provides the first report of single scattering albedo for particles released by vehicular emissions from a blend of gasoline and ethanol fuels.

The median diurnal cycle of aerosol optical properties inside the tunnels are shown on Fig. 11. In the RA tunnel, aerosol light scattering diurnal variation follows very closely HDV traffic as a result of high particle number emission factor. As previously mentioned, absorption measurements at the RA tunnel could not be validated due to the exceedingly high black carbon concentrations. Nevertheless, using the EC determined from filters and a MAC of 6.5 m^2 g^{-1}, determined in the JQ tunnel, an average light absorption during filter sampling (08:00 - 20:00) of 770 Mm^{-1} has been calculated. As such, an average single scattering albedo of 0.31 can be estimated for the RA tunnel.

In the JQ tunnel, the aerosol light absorption and scattering presents a strong enhancement during the first morning hours, following the traffic intensity (Fig. 3). Correspondingly, ω_0 decreases from 0.65 to 0.5. The ω_0 values observed overnight reflect reduced vehicular emissions, being comparable to previously reported ambient measurements in the SPMA (0.59-0.76, Backman et al., (2012)). Throughout most of the day, single scattering albedo remains close to 0.5, with exception at 10:00 LT, when ω_0 close

to ambient values are observed. Such peak arises from a daily traffic direction inversion, which reduces traffic and modifies air exchange pattern, increasing shortly the importance of background aerosol.

The ω_0 of 0.5 associated to the LDV Brazilian fleet is considerably higher than previously measured in tunnels. Japar et al. (1981) indicated an average albedo of 0.43 for particles released from gasoline powered vehicles and of 0.28 from diesel powered vehicles. Strawa et al. (2010), on the other hand, measured an average albedo of 0.31 for light duty gasoline fuelled vehicles in tunnels in the U.S. The chemical composition of the different fuel combustion sources has impacts on the chemical properties of the emitted aerosols, as well as on dynamical processes that subsequently change aerosol physical properties such as the single scattering albedo. More studies are necessary to investigate this issue."

The third paragraph of page 20860, from the Conclusion section, has been modified to reflect the changes performed in Section 3.4.2:

"The average particle count yielded 73 000 cm^{-3} in the JQ Tunnel and 366 000 cm^{-3} in the RA tunnel, with an average diameter of 48.4 nm in the former and 38.7 nm in the latter. As such, the vast majority of submicron aerosol particles are found in the nucleation mode in both tunnels, providing a large surface area for condensation and with important health effects. Besides aerosol size distribution, instrumentation for optical properties measurements was deployed on both tunnels. In the RA tunnel, aerosol light scattering diurnal variation follows very closely HDV traffic as a result of high particle number emission factor. Median values range from 150 Mm^{-1} up to 400 Mm^{-1}. As stated previously real-time light absorption measurement was not possible in the RA tunnel, however, using the EC determined from filters and a MAC of 6.5 m^2 g^{-1} determined in the JQ tunnel, an average light absorption during filter sampling (08:00 - 20:00 LT) of 770 Mm^{-1} was calculated. A single scattering albedo of 0.31 was estimated for the RA tunnel. The aerosol light absorption in the JQ tunnel was observed to range from 20 Mm^{-1} up to 80 Mm^{-1} whereas light scattering ranges from 50 Mm^{-1} up to 100 Mm^{-1}. A single scattering albedo of 0.5 is associated to the circulating fleet in the JQ tunnel, mainly composed of ethanol and gasohol fuelled LDVs."

Minor comments

6. *Page 20843, Lines 1-5: biomass burning is a globally important source of OC and EC. I think that this text is trying to state that in megacities EC is usually dominated by vehicle emissions, but instead it seems to imply that biomass burning is not an important source.*

The text has been altered as such:
"Other EC sources such as biomass burning emit at much lower rates and are relevant, on a local scale, only in wild fires events or wintertime in rural or urban areas (Gelencsér et al., 2007)."

7. *-Page 20843, Line 14 - what does "Tunnel 3" of the RA tunnel mean?*

The text has been altered as such:
"Sample collection was carried out in two tunnels located within the SPMA: the Jânio Quadros (JQ) tunnel and the Tunnel #3 of the Beltway Rodoanel Mário Covas (RA)."

8. *Page 20845 - Is there any impact of running the MAAP at reduced flow? My understanding is that the default flow rate for this instrument is 16.7 LPM. It seems like lowered flow rate would increase your detection limit (reduce sensitivity) for measurements collected at 1 minute resolution.*

MAAP's standard flow rate is 16.7 LPM, but the instrument manual recommends a minimum flow of 8.3 LPM. Results from intercomparison workshops between aerosol photometers indicated that differences in the MAAP absorption coefficients operated at flows between 16.7 and 10 LPM are not significant (Müller et al., 2011).

9. *-Page 20850, Line 9 - It is probably more appropriate to say that samples with enrichment factors close to 1 are assumed to be crustal. It's not clear that the enrichment factor can positively identify the sources, as it would depend on the representativeness of the element ratios in UCC relative to the crustal composition in Brazil.*

The text was altered accordingly.

10. *-PAHs are determined from PM10, not PM2.5 filters. Does this bias the results? Since the fresh emissions in the tunnel are mostly in the fine range, are you mostly measuring background PAHs from the air carried into the tunnel by the motion of traffic?*

The authors agree that this topic must be addressed, so we propose the following text modification on the second paragraph of page 20851.

"Table 3 summarizes the PAH concentrations in the JQ and RA tunnels in the size ranges up to 10 μm. The higher size-cut of high volume sampler <u>might induce a bias, when comparing to PM2.5 samples, although PAHs are mostly found in the fine aerosol fraction. Oliveira et al. (2011), for example, have reported in tunnel measurements that over 98% of the PAH mass is found below 2.5 μm size range. As such, to assume that the observed ambient concentration is found in the fine aerosol size range induces an error that is largely surpassed by quantification uncertainties.</u>"

11. *-The discussion of the PAH ratios is lacking. eg., Page 20851, Line 24-25 notes the InP/(InP+BPe) ratio from Rogge. The current measurements of this ratio are significantly different, but the difference is not discussed.*

The values of the ratio InP/(InP+BPe) described in the submitted version of the manuscript were actually inaccurate. The correct values are 0.7-1.5 in the JQ tunnel and 0.24-0.91 in the RA tunnel, falling within previously reported values. Such values range corroborates the source identification despite considerably different fuel composition. The text has been corrected accordingly.

12. *-Page 20853 - what is the basis for the OM/OC of 1.6 for gasohol? This is not clearly explained.*

The authors agree that this topic must be addressed, so we propose the following text modification in the last paragraph of page 20852.

"The Organic Mass (OM) can be estimated from OC measurements through a multiplying factor dependent on the aerosol source and its level of atmospheric processing. Literature values of the OM : OC ratio in tunnel/freeway measurements impacted by gasoline and/or diesel fuelled vehicles emissions ranges from 1.2 (Allen et al., 2001; Kristensson et al., 2004; Grieshop et al., 2006; Huang et al., 2006; Landis et al., 2007) to 1.4 (Geller et al., 2005; Lipsky and Robinson, 2006; He et al., 2008). Such ratio reflects the composition of the organic aerosol itself, i.e., the contribution of H, O, S, N (not detected using the thermal-optical measurement) relative to the number of carbon atoms. Due to considerable fraction ethanol usage (and to a lesser extent, biodiesel) in Brazil, the organic aerosol associated with tailpipe emissions of the Brazilian fleet is expected to be more oxygenated than elsewhere, i.e., more oxygen (amu=16) and less hydrogen (amu=1) atoms per carbon. As such, an OM:OC ratio of 1.6 was chosen for the JQ tunnel and 1.5 for the RA tunnel. To our knowledge no direct measurement of OC:OM ratio has been previously reported on such emissions. The difference between $PM_{2.5}$ mass determined gravimetrically and the sum of identified compounds was labelled as "unidentified compounds"."

13. -Page 20853 - Does the sulfate concentration in the tunnel make sense based on vehicle volumes, typical fuel consumption rates and fuel sulfur contents, and typical conversions of SO2 to SO3 during combustion? There are numerous reference values that can be used to estimate sulfate in the tunnel.

The observed sulphate concentration is indeed quite consistent with literature reports. Such results on particulate, as well as gas-phase, emission factors are the subject of an upcoming work to be submitted in the near future. Further details on vehicular emission factors will be provided then.

14. -Figure 10 - The data seem to have much more scatter than an R^2 of 0.95 would indicate. To the naked eye the correlation does not appear that strong, and the fit seems to be influenced by the point with EC of 18 ug/m3.

The linear fit on the σ_{abs} *versus* EC loading has been applied using a y-intercept=0, under the assumption that in such environment all light absorption is due to EC. Given that the point with EC~18 µg m^{-3} seems to suffer from underestimation from the MAAP, a new plot has been created without this point (Fig. 2), indicating an improvement of R2 (0.97), and a MAC value of 6.5±0.3, in good agreement with a literature value of 6.6 m^2 g^{-1}.

15. Grammar notes -Page 20841, Line 19 "considerably amount"

The text was altered accordingly.

16. -Page 20851 - first paragraph of section 3.1.2 is thoroughly confusing. Are PAHs emissions the result of PAHs in the fuel or the combustion process itself?

Please refer to comment #5 from referee #1.

17. -Page 20856, Line 23 - "particles" instead of "particulated"

The text was altered accordingly.

References

Backman, J., Rizzo, L. V., Hakala, J., Nieminen, T., Manninen, H. E., Morais, F., Aalto, P. P., Siivola, E., Carbone, S., Hillamo, R., Artaxo, P., Virkkula, a., Petäjä, T. and Kulmala, M.: On the diurnal cycle of urban aerosols, black carbon and the occurrence of new particle formation events in springtime São Paulo, Brazil, Atmos. Chem. Phys., 12(23), 11733–11751, doi:10.5194/acp-12-11733-2012, 2012.

Collaud Coen, M., Weingartner, E., Apituley, a., Ceburnis, D., Fierz-Schmidhauser, R., Flentje, H., Henzing, J. S., Jennings, S. G., Moerman, M., Petzold, a., Schmid, O. and Baltensperger, U.: Minimizing light absorption measurement artifacts of the Aethalometer: evaluation of five correction algorithms, Atmos. Meas. Tech., 3(2), 457–474, doi:10.5194/amt-3-457-2010, 2010.

Guarieiro, A. L. N., da S. Santos, J. V, Eiguren-Fernandez, A., Torres, E. A., da Rocha, G. O. and de Andrade, J. B.: Redox activity and {PAH} content in size-classified nanoparticles emitted by a diesel engine fuelled with biodiesel and diesel blends, Fuel, 116(0), 490–497, doi:http://dx.doi.org/10.1016/j.fuel.2013.08.029, 2014.

Ho, K. F., Ho, S. S. H., Lee, S. C., Cheng, Y., Chow, J. C., Watson, J. G., Louie, P. K. K. and Tian, L.: Emissions of gas- and particle-phase polycyclic aromatic hydrocarbons (PAHs) in the Shing Mun Tunnel, Hong Kong, Atmos. Environ., 43(40), 6343–6351, doi:10.1016/j.atmosenv.2009.09.025, 2009.

Manahan, S. E.: Environmental chemistry, CRC press., 2005.

Moosmüller, H., Chakrabarty, R. K. and Arnott, W. P.: Aerosol light absorption and its measurement: A review, J. Quant. Spectrosc. Radiat. Transf., 110(11), 844–878, doi:10.1016/j.jqsrt.2009.02.035, 2009.

Müller, T., Henzing, J. S., de Leeuw, G., Wiedensohler, A., Alastuey, A., Angelov, H., Bizjak, M., Collaud Coen, M., Engström, J. E., Gruening, C., Hillamo, R., Hoffer, A., Imre, K., Ivanow, P., Jennings, G., Sun, J. Y., Kalivitis, N., Karlsson, H., Komppula, M., Laj, P., Li, S.-M., Lunder, C., Marinoni, A., Martins dos Santos, S., Moerman, M., Nowak, A., Ogren, J. a., Petzold, A., Pichon, J. M., Rodriquez, S., Sharma, S., Sheridan, P. J., Teinilä, K., Tuch, T., Viana, M., Virkkula, A., Weingartner, E., Wilhelm, R. and Wang, Y. Q.: Characterization and intercomparison of aerosol absorption photometers: result of two intercomparison workshops, Atmos. Meas. Tech., 4(2), 245–268, doi:10.5194/amt-4-245-2011, 2011.

Oliveira, C., Martins, N., Tavares, J., Pio, C., Cerqueira, M., Matos, M., Silva, H., Oliveira, C. and Camões, F.: Size distribution of polycyclic aromatic hydrocarbons in a roadway tunnel in Lisbon, Portugal., Chemosphere, 83(11), 1588–96, doi:10.1016/j.chemosphere.2011.01.011, 2011.

Petzold, A., Schloesser, H., Sheridan, P., Arnott, W. P., Ogren, J. and Virkkula, A.: Evaluation of Multiangle Absorption Photometry for Measuring Aerosol Light Absorption, Aerosol Sci. Technol., 39(1), 40–51, doi:10.1080/027868290901945, 2005.

Ravindra, K., Sokhi, R. and Grieken, R. Van: Atmospheric polycyclic aromatic hydrocarbons: Source attribution, emission factors and regulation, Atmos. Environ., 42(13), 2895–2921, doi:http://dx.doi.org/10.1016/j.atmosenv.2007.12.010, 2008.

Sheridan, P. J., Arnott, W. P., Ogren, J. a., Andrews, E., Atkinson, D. B., Covert, D. S., Moosmüller, H., Petzold, A., Schmid, B., Strawa, A. W., Varma, R. and Virkkula, A.: The Reno Aerosol Optics Study: An Evaluation of Aerosol Absorption Measurement Methods, Aerosol Sci. Technol., 39(1), 1–16, doi:10.1080/027868290901891, 2005.
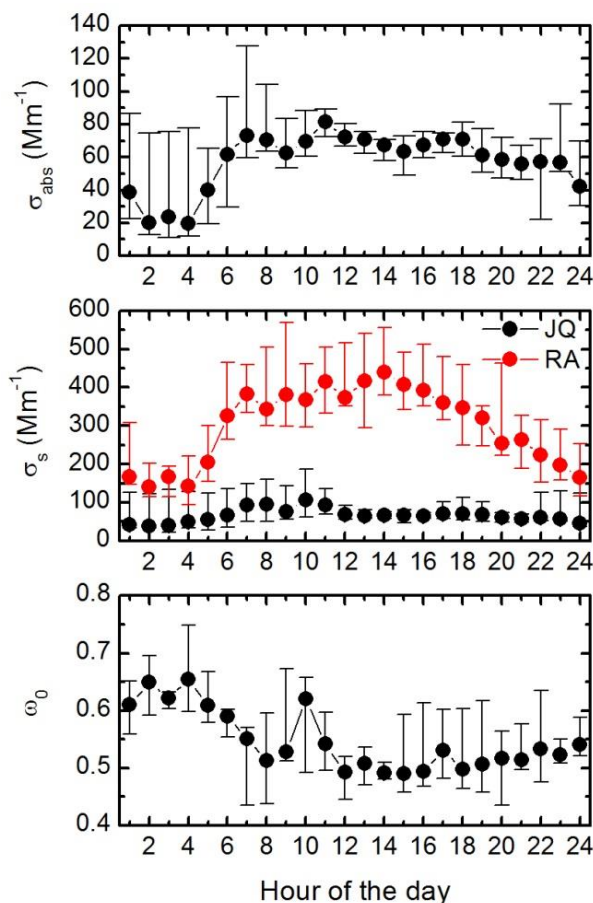
Figures

Fig. 1. Median values for (top) light absorption, (middle) light scattering and (bottom) single scattering albedo. The range bars represent the 10th and 90th percentile.
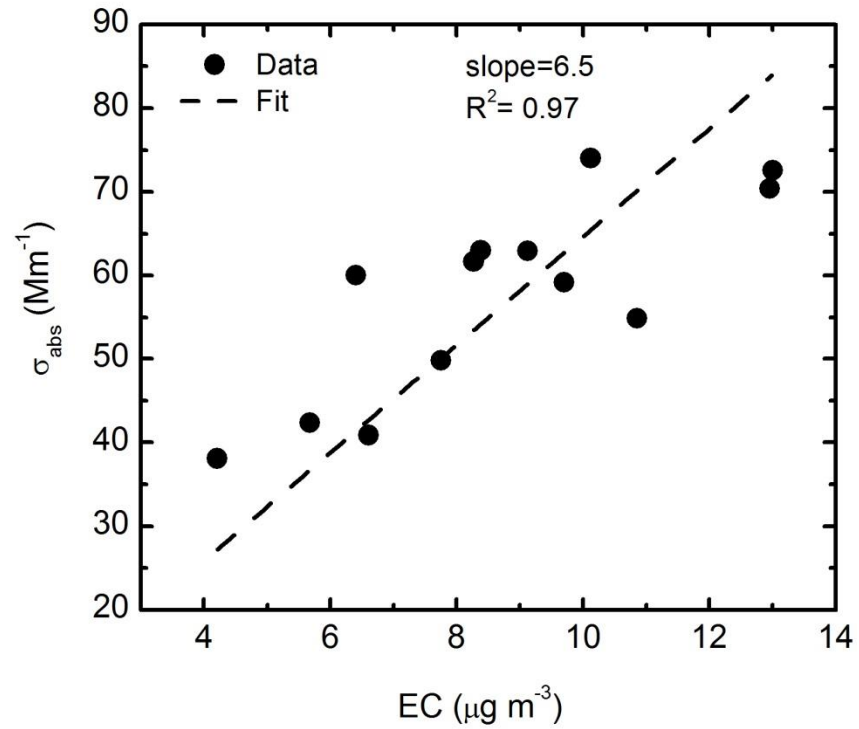
Fig. 2. Correlation between the light absorption measured by the MAAP and EC determined using the collected filters by means of a SUNSET analyser. The y-intercept of the linear fit was fixed to 0 and the point EC=18 μg m^{-3} removed.