Review for Atmos. Chem. Phys. 15, 35237–35276, 2015

'Optical and microphysical characterization of aerosol layers'
by

Giannakaki et al.

The presented paper gives a lidar based examination of the optical and microphysical properties of urban/industrial aerosols and biomass burning aerosols at Elandsfontain, South Africa. Lidar measurements in this region are rare. The paper is in general well-structured and well written and therefore suitable for publication in ACP. However I have a few points that should be answered before publication.

General points:

In Section 2 the authors report about trace gas measurements and show a global distribution in Figure 1. These measurements and Figure do not have an impact on the further analysis and inversion of the lidar data and should be omitted to make space for some other analysis which are missing in this paper, for example a case study of urban/industrial aerosols and more information about the mixed biomass burning layers.

The authors state that the uncertainties of the extinction coefficient are in the order of 10-30%. Later they make assumptions of differences in the size of the particles mainly indicated by differences of the Angstroem exponent. How are these assumptions and the Angstroem exponents affected by the general uncertainties of the extinction coefficient?

The authors should report more about their uncertainties; what do they consider for their analysis of the uncertainties. Which parameters are not considered? If possible they should do an error analysis for all reported and considered measurement cases.

The authors classify there aerosol types mainly based on trajectory analysis. How these classifications are connected with lidar based classification schemes (Burton et al., 2012, Gross et al., 2013, or at 355 nm: Gross et al., 2015, Illingworth et al., 2015)? Please add this in your publication.

How is the assumption of less absorption for biomass burning conform with the lidar ratio of 52 sr compared to 92 sr for industrial/urban aerosols?

How do you calibrate your depolarization measurements? How does this calibration method affect your results? Please report in you publication.

How do the uncertainties in the single measurement parameters affect the result of the inversion algorithm?

Are the +/- values the mean uncertainties or the standard deviation? Please add this information in your publication.

Instead of showing the trace gas measurements the authors should show a figure with AOD, extinction coefficient or backscatter coefficient for one day prior to one day after their biomass burning case study as that seems to be an important point and mentioned in the text.

A case study showing a urban/industrial aerosol case and a mixed biomass burning case is missing. Especial important would be to see the differences in transport way, extinction coefficient or AOD, and layering for the different cases.

The authors should give more evidence that the mixed biomass burning cases are not miss-classified. The measurements presented (e.g. in Figure 5) show almost the same values as what is classified as aged biomass burning aerosols in Illingworth et al., 2015. Furthermore Amiridis et al., 2009 reported that the optical properties of biomass burning aerosols alter during aging.

It is also not clear to me what really should happen with the dust particles. How would this affect their shape and optical properties? The authors should give more references and evidence for their assumption.

Is the assumption of mixture of dust and biomass burning also conforming in the lidar ratio? The authors report quite low lidar ratios compared to the referenced studies which they use as hint for their assumption. How these assumptions do are supported by results of optical modelling (e.g. Gasteiger et al., 2011 for the referenced measurements)?

Considering the last points a detailed case study should be added. This case study should also include information (satellite / reports) of dust activation and a connection to trajectory analysis including the mixing layer height and trajectory height.

Specific comments:

Abstract:

Change ‘proper ties’ to ‘properties’.

Change ‘single scattering, albedo’ to ‘single scattering albedo’.

Why not give also the lidar ratio at 532 nm?

AE for biomass burning is not consistent with Table 2.

Section 2:

Which is the range of full overlap?

Section 3:

Please constrain your assumption of ‘fresh smoke’; give references.

Section 4:

Do you really mean anthropogenic here? Give references for this assumption.

Figure 2:

Add ‘of fire’ to indicate which hot spots you mean.

Figure 3:

How does a quicklook with 15 km height resolution go conform with a reported vertical resolution of 30 km?

Figure 4 / Section 3:

I cannot see that airmasses are coming either from northeasterly or northwesterly direction. A more detailed trajectory analysis including also the mixing layer height and trajectory height along the way would give more evidence at which part of the transport aerosol uptake took place.

Figure 5:

How do you explain the increase of the backscatter ratio at 355 nm with height?

What is the vertical resolution of this data?

Figure 7:

Change your labeling from ‘Depolarazation’ to ‘Depolarization’.

Figure 8:

The labeling is not readable. Please change.