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Interactive comment on “Separating mixtures of aerosol types in airborne High Spectral Resolution Lidar data” by S. P. Burton et al.

Anonymous Referee #2

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Review for Atmos. Meas. Tech. Discuss., 6, 8269-8309, 2013

‘Separating mixtures of aerosol types in airborne High Spectral Resolution Lidar data’

by

S. P. Burton, M. A. Vaughan, R. A. Ferrare, and C. A. Hostetler

This manuscript presents a technique to determine the partition of the single aerosol types in a two-type mixture to the total aerosol backscatter/extinction coefficient by lidar remote sensing. Although the separation of the different aerosol types and their fraction to the aerosol mixture by lidar optical properties is not new itself the paper provides some new aspects to that topic. The paper is well written and interesting to

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read.

The authors should address some (minor) points and questions before final publication:

Page 8270, line2: Are there no better methods for aerosol source attribution?

Page 8271, line6: As this sentence is not restricted on HSRL-1 measurement the Reference to Gross et al., 2013 and/or Gross et al., 2011 should be added.

Page 8271, line 11: Give a reference for the statement that aerosol layers are frequently mixtures (e.g. Ansmann et al., 2011, Tesche et al., 2011, David et al., 2013, ...)

Page 8272, line 25-29: General question for better understanding: Does the multivariate normal distribution of the (pure or mixed) aerosol type automatically link the 'newest measurement' to the right type/mixture or is there also a kind of threshold defining the 'beginning' of one mixture and the end of another?

Page 8273, line 8: Please give the references of these earlier papers.

Section 3: The idea of linearizing the equation for the different intensive optical properties for the mixture is a great idea; however, the main equations defining the intensive optical properties of aerosol mixtures used in this section are not particular new. The equations are based on the same heritage as Gross et al, 2011a/b (using extinction-to-backscatter ratio and particle linear depolarization ratio for aerosol type separation), Gasteiger et al., 2011 (giving the basic formula for calculating the extinction-to-backscatter ratio and the particle linear depolarization ratio of aerosol mixtures) and Tesche et al., 2009/2011 (using particle linear depolarization ratio for quantifying the fraction of the single type to the aerosol mixture). Equations can easily be calculated from those former publications to the one building the base for the linearization in this publication. A link to those former publications should be added.

Section 4 (page 8281, line 15-16, page 8282, line 19-21): As I understand the author uses different mixing ratios for the different measurement dimensions / variables. Should not the mixing ratio be the same for all used variables when regarding the same

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aerosol mixture?

Equation 33: Variables and indices are not defined.

General comment to Section 5-7: The authors compare their values for dust with former findings, but they do not compare the findings for other 'pure types' with former findings. Perhaps some links can be added as well. Further a reference to Esselborn et al., 2009 and/or Tesche et al., 2009 should be added for fresh Saharan dust close to the source region.

Page 8286, line 25: A reference for the loss of large particles during transport should be given here.

Page 8287, line 11: The link to model and aerosol optical properties is missing. Is not the measurement accuracy (in addition to the variability of the optical properties for the pure aerosol types) a main point for uncertainties in mixing ratio and partitioning results? The impact of measurement uncertainties and overlap of the multi-normal distributions for different mixing ratios on the partitioning result should be discussed in more detail.

Page 8287, line 11-13: If the ellipses would not line up well with the data, is it not possible, that the mixture does not consist of the two assumed aerosol types, or that the mixture consists of more than two types?

Page 8288, line 1-20: The papers of Sugimoto and Lee, 2006 and Tesche et al., 2009 deal with spherical and non-spherical and dust and non-dust particles, respectively. But the studies of Gasteiger et al., 2011, Gross et al., 2011 and Tesche et al., 2011 use general formulations for the mixing problem. The former two papers also use multi aerosol parameters, the latter describes the partitioning of maritime/marine and smoke aerosols and is therefore well comparable. A link to those studies should be added.

Page 8289, line 6: What is meant by 'scalar values' at this point?

One last general question: How do the authors assign the measurement to the different

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mixing ratios? This is not completely clear.

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