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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Profiling of fine and coarse particle mass: case studies of Saharan dust and Eyjafjallajökull/Grimsvötn volcanic plumes" *by* A. Ansmann et al.

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General comments:

The idea to use the polarization lidar technique along with Sun photometer measurements is very promising. It was demonstrated, including the work under reviewing, that such an approach is able to provide more accurate data. Personally, I found the method of separating dust and nondust profiles of backscattering to be ingenious, well grounded and very promising as well. For an experienced reader, it follows from figures of the discussion paper and of the paper Tesche et al. (2009b) that the assumption of externally mixed aerosols is well grounded. The experimental data (Ch.3) are interesting and useful. I recommend that the paper be published in ACP after minor revisions.

The specific comments below do not cast any doubt on good quality of the work under reviewing. Their aim is rather to underscore some important point for future works.

Specific comments:

1) Page 13365, lines 8 - 12. It well known that Raman lidar technique provides important and useful data.

At the same time, the claim that the Raman lidar technique provides "benchmark–like" data is greatly exaggerated. (Hereinafter, the quotation marks are used for the text from the discussion paper.) Unfortunately, the majority of the Raman-lidar community researchers, when they deal with aerosols, do not pay sufficient attention to the fact that the problem of numerical differentiation is known to be ill-posed in the sense that small perturbations in the function to be differentiated may lead to large errors in the computed derivative. As a consequence, one can found papers, published in highly ranked journals, where particle extinction profiles are oversmoothed. For example, in such a paper, one can see a well pronounced peak on a backscatter profile. The peak is due to an aerosol layer. But, the peak had disappeared on the corresponding extinction profile as if extinction and backscatter profiles vary independently and do not mainly follow variations of the aerosol concentration. Such oversmoothing can be avoided by the use of more sophisticated algorithms like proposed in the papers [1 – 3]. At the same time, the question whether the Raman lidar technique will be able to provide really benchmark–like data even with sophisticated algorithms needs further investigations.

2) Page 13366, line 14. It is difficult to understand reasons why the proposed approach is "more general". The algorithm employs only a few parameters derived from the photometer observations (the aerosol optical thicknesses and the column-integrated volume concentrations of two modes). There were proposed much more sophisticated approaches (see, e.g., [4]).

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3) Page 13371, lines 27 – 29. The relative uncertainties of the backscatter coefficients are done in the papers Tesche et al. (2009b) and Ansmann et al. (2011b); the detailed error-discussion is done by Tesche in [5, Ch. 8.1]. The estimated uncertainties can be used for cases when the two modes have backscatter coefficients of the same order.

The following example is done for the height of 2 km (see page 13400 Fig.2 of the paper under reviewing), i.e., for the case when the coarse mode largely dominates the fine mode. When the a priory depolarization-ratio of the coarse mode is taken to be of 0.35 (all other parameters being the same) the retrieved value of the fine-mode particle backscatter coefficient is three times higher; when that a priory parameter is taken to be of 0.29, the retrieved value of the fine-mode particle backscatter coefficient becomes negative. In other words, nonlinear properties of used equations can sometime lead to much higher errors than it follows from standard estimations.

4) The depolarization ratios of dust and nondust modes are introduced as free parameters in the paper Tesche et al. (2009b) and [5]. The used values are justified by published experimental data. It is also worth noting that some constraints on variations of those parameters follow from measured profiles of backscatter coefficient and particle linear depolarization ratio.

5) Page 13372, lines 5 - 12. The overall relative uncertainties are underestimated. Please, use the standard "JCGM 100:2008" [6, Ch.5] to provide more reliable estimations on the base of the relative errors indicated on the lines 5 - 12.

6) Eqs. (3) – (4) and Figures 2 – 5 (panels c, d, e). As a matter of fact, the extinction-coefficient- and the mass-concentrations profiles are proportional to the corresponding backscatter-coefficient profiles at the wavelength of 532 nm. Thus, there is no much difference between the curves of the same color on the panels c, d, e. This leaves some doubts about the usefulness of the results knowing the large variability of aerosol integral-parameters as functions of microphysical characteristics. Moreover, the information from other lidar wavelengths is lost. When nonlinear algorithms are avoided,

the method of linear estimation seems to be much more promising (see, e.g., [7] and references therein).

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