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Interactive comment on "Impact of aerosol hygroscopic growth on retrieving aerosol extinction coefficient profiles from elastic-backscatter lidar signals" *by* Gang Zhao et al.

Anonymous Referee #1

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The work by Gang Zhao et al. investigates the effect of aerosol hygroscopicity on the aerosol extinction-to-backscatter (lidar) ratio for the analysis of elastic backscatter lidar measurements. The authors explore implications of using a constant lidar ratio and suggest that a lidar-ratio profile that has been adjusted for relative humidity effects would be more suitable.

While the authors address a relevant issue, there seem to be several flaws in this study that lead me to recommend rejection of the manuscript:

1. The lidar ratio is an aerosol-type dependent parameter. Values for different

aerosol types have been measured in very different environments under varying relative humidity. From these measurements, the lidar ratio of a certain aerosol type can generally be defined with a rather low standard deviation. This would not be the case if humidity effects would be as strong as described in the manuscript. Also, lidar observations are always at ambient conditions and rarely at the low relative humidities that are used by in-situ instruments.

2. The authors extrapolate the height profile of the dry particle number size distribution from measurements at the surface. In my opinion, the authors are merely replacing any uncertainty that might be introduced by using a constant lidar ratio with the much more complex uncertainty of extrapolating dry surface measurements to a height profile, humidifying these size distributions and transforming them to optical data (i.e. lidar ratios).

3. Independent profile measurements of the particle number size distribution, the extinction coefficient, and indeed the lidar ratio are needed to properly assess the merits of this work.

4. The finding that increasing relative humidity increases the lidar ratio is not intuitive. While the increased particle size is producing a larger fraction of forward scattering compared to the dryer particles, it is the ratio of extinction coefficient (scattering plus absorption) to backscatter coefficient that determines the lidar ratio. In fact, the backscatter coefficient increases stronger in relation to the extinction coefficient when particles grow in size by taking up humidity. This manifests for instance in the low lidar ratio of 20 sr for water droplets. The highest lidar ratios are usually related to highly absorbing particles, rather than humidified ones.

5. It is not described how the lidar ratio has been obtained. Also, it is not clear from the figures which results are simulated and which measured.

Recommended reading:

- Müller, D., A. Ansmann, I. Mattis, M. Tesche, U. Wandinger, D. Althausen, and G. Pisani (2007), Aerosol-type-dependent lidar ratios observed with Raman lidar, J. Geophys. Res., 112, D16202, doi:10.1029/2006JD008292.
- Burton, S. P., R. A. Ferrare, M. A. Vaughan, A. H. Omar, R. R. Rogers, C. A. Hostetler, and J. W. Hair (2013), Aerosol classification from airborne HSRL and comparisons with the CALIPSO vertical feature mask, Atmos. Meas. Tech., 6, 1397-1412, doi:10.5194/amt-6-1397-2013.
- Groß, S., M. Esselborn, B. Weinzierl, M. Wirth, A. Fix, and A. Petzold (2013), Aerosol classification by airborne high spectral resolution lidar observations, Atmos. Chem. Phys., 13, 2487-2505, doi:10.5194/acp-13-2487-2013.

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