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Atmospheric Measurement Techniques Discussions
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Interactive Comment

Interactive comment on "Hygroscopic growth of atmospheric aerosol particles based on active remote sensing and radiosounding measurements" *by* M. J. Granados-Mu noz et al.

Anonymous Referee #2

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General

The goal of the paper is to quantify the impact of particle water uptake on the optical properties of the aerosol in the vertical column. Lidar/sun photometry and radiosounding is integrated in this careful investigation. Two case studies with comparably low and moderate amounts of hydrophobic dust are discussed. The title of the paper may suggest a more general study, not just based on two cases only. That should be made more clear, may be even in the title.

The paper focuses on a modern atmospheric science topic and the contents are well

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Interactive Discussion

Discussion Paper

written. The literature is well reviewed. My comments may help to improve the discussion and thus the paper. However, why is that paper not sent to ACP? It is a paper on application rather than on the development of a new measurement technique.

Details:

P10294, L12: Please provide information for the relative humidity (40% to 80%, 60% to 90%, . . . ?) for the enhancement factors of 2.10 and 3.90.

P10294, L24: In the retrieval of the volume concentration the refractive index must be assumed, and the refractive index changes with increasing amount of water in the particles towards the refractive index for water. Is that considered in the study? Did you check the resulting uncertainty by neglecting this effect?

P10300, L5-15: The procedure to obtain the volume concentration profile must be explained in more detail. Sun photometer data are probably inverted by assuming a fixed (height-constant) set of refractive index parameters. But in the vertical, the true refractive index is continuously changing. So, the assumption of a height-independent refractive index causes errors in the LIRIC approach as a whole. The consequences for the retrieved volume concentrations must be discussed. We need a discussion on the uncertainty here. Changes in the volume concentration with increasing relative humidity may just be the response to the erroneous refractive index assumption. On the other hand, it should be possible (by using a Mie scattering model), to check whether the increase in particle backscatter and extinction coefficient is consistent with the increase in volume concentration.

P10301,L1: Why is a simultaneous decrease of the beta AE and depol. ratio an indication for larger and more spherical particles? Did you perform Mie scattering modeling to show how large the effect on the Angstroem value is when the size distribution is slightly changing (shifted) by water uptake. I believe this is necessary to show that based on modeling, because my feeling (no knowledge) is that the changes in the size distribution are so small that the response of the wavelength dependence of the optical

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properties is almost not visible.

Furthermore, why should the particles (here dust) become more spherical? If they are hydrophobic, nothing will change with increasing relative humidity. And even if they attract some water, will that really change their shape. So, please keep the speculative discussion a bit more open for other possibilities.

May be your retrieval of the particle backscatter coefficient (with fixed, height-indendent lidar ratio) is erroneous. The error is then also a function of height, the error is stronger for 355nm than for 532nm and changes with height when using the Klett algorithm! And this height-dependent error shows then up in the Angstroem retrieval, but also in the retrieval of the particle depolarization ratio (which is a function of the retrieved backscatter coefficient)! So, at the moment, for me it is not clear whether we see a clear atmospheric effect or whether the found features are just introduced by errors in the backscatter and depolarization ratio retrieval!

P10301, L29: The height-independent water vapor mixing ratio obtained with radiosonde is the most important quantity to convince the reader that you detected one and the same aerosol mixture, and that changes in the aerosol mixture with height are the response to water uptake. Thus in the figures, I would show the optical and microphysical properties always together with the radionsonde water vapor mixing ratio profile, ... not only with the relative humidity (as done in Figure 3). Both parameters should be shown in Figure 3.

P10303, L6: So, here we introduce how important the chemical composition is and that it changes with water uptake, which then will change the refractive index characteristics...... That must be clearly stated. Please provide a consistent picture....

P10305, L22 Again, the Klett-Fernald procedure....: although the relative humidity is continuously increasing, water uptake takes place, chemical composition, refractive index, and size distribution changes... , you select height-independent lidar ratios of

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65 and 70sr (in agreement with AERONET observations, performed hours before. . .). Did you check by Mie scattering calculation whether the impact of relative humidity is low on lidar ratio, but still significant for backscatter Angstroem exponent? May be check the paper of Ackermann, 1998 (J AO Tech?). He computed some lidar ratios as a function of relative humidity. However, if the particles are absorbing (and your lidar ratios of 65 to 70sr point in this direction) the lidar ratio may drop to values for non absorbing particles (around 40sr) when they attracted a lot of water so that the water fraction dominates when the relative humidity is close to80% and higher. So, there are many sources that introduce uncertainties in the entire approach. With the wrong backscatter coefficients (because of wrong lidar ratio profile) you may get wrong Angstroem exponents and wrong particle linear depolarization ratios. . ...

Figure 1:

Why do you show single scattering albedo, more useful would be the refractive index (real part and imaginary part)?

The AERONET time series (a, b) indicate changing aerosol conditions after 1800 (UTC?). Do you have lidar measurement before sunset (may be around 1600UTC), to estimate the change in AOT from, e.g. 1600UTC to 2000UTC, based on lidar (that would support the use of AERONET data)?

Figure 2: If you have lidar observations over the entire day, please show them and indicate the data analysis period by white vertical lines. Please state in the caption that all features in the color plots are aerosol related (top), or if clouds were present (bottom), and also state that you cloud-screened the data before used in the investigations of the water uptake effect, in the caption.

Figure 3: I do not believe the small error bars in the backscatter plot (a) and Angstroem plot (c), because of the lidar ratio uncertainty. . .., lidar ratio is assumed in the retrieval to be height-constant, but is probably height variable. After sunset you do not have AERONET AOT values, so even the numbers 65 and 70sr may not describe properly

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the situation.

As mentioned, show water vapor mixing ratio, too. . ..

Figure 4: Backward trajectories show that there must also be a strong maritime component in the aerosol mixture. . ... These maritime particles may dominate the observed hygroscopic features. And if the marine particles become partly dry, when the humidity decreases below 50% then they may become (sea salt component) non spherical, and may explain the slightly enhanced depolarization ratio? At least the backward trajectories do not just show the impact of desert dust.

Figure 6: Can we really trust the LIRIC results in these cases of complex mixtures and changing microphysical properties and composition. . . At least, the discussion should mention the problems, so that the reader can decide what to believe and what is rather uncertain. . .

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 10293, 2014.