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Atmospheric Measurement Techniques Discussions

Interactive comment on "The performance of Aeolus in heterogeneous atmospheric conditions using high-resolution radiosonde data" *by* X. J. Sun et al.

Anonymous Referee #1

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The paper presents an interesting error analysis on spaceborne wind Doppler lidar observations (ESA, ADM mission, ALADIN). However, the paper is not well organized. The motivation for the entire work became not clear before reading the conclusions!

Major revisions are required.

Detailed comments:

The abstract is confusing when reading it for the first time.

The introduction does not provide a clear picture of what follows. Only after reading section 6 (summary andf conclusions), the motivation and layout of the paper contents

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became obvious. So please use the first four to five paragraphs of section 6 (Summary, conclusions and discussion) as the road map for the introduction.

It took me a long time of reading before I got an answer to my main question: Why do they use radiosonde data to simulate aerosol and cloud profiles? The motivation is not well described in the present version of the manuscript.

All in all, the introduction is much too long, ... and confusing. All the technical details in the first, second, third and fourth paragraph should be given in a new section (may be with title ALADIN). And then, as mentioned, please provide a paragraph with a clear motivation, why you use radiosonde data! Provide a clear outline of all the contents which follow. Give an overview of all the sections (why and what is present).

Section 2 is long, are all the details and equations needed to understand the rest of the paper? Please keep the paper as short as possible!

Again, Section 3 just starts without providing any motivating sentence in the beginning. It is strange to read that radiosonde data have been used to estimate aerosol backscatter along the radiosonde path . . . by using humidity parameter. As a lidar, radiosonde, and aerosol expert, I was asking myself, who is using such a strange and completely stupid approach (sorry for these words, but this was my first impression). After 15 years of field campaigns I can tell there is no general relationship between radiosonde profile data (temperature, humidity, winds) and aerosol profiles. Why should that be the case. Aerosol occurrence and particle concentrations depend on source distributions and transport ways, of course, and at a specific place you may see strong correlations in the meteorological profiles and aerosol profiles, but this changes from field site to field site..

Ok, after reading section 6, I began to understand: One can use this radiosonde/cloud/aerosol approach (even if not just state of the art in times with lidar networks and CALIPSO mssion) to characterize the overall error behavior of a spaceborne wind lidar.

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Sections 3.1 is too long. . . The presented long discussion is simply not needed in such a summarizing paper. If you use the Zhang2010 approach to identify cloud layers in radiosnde profiles, then it is sufficient to say that and one may then show one example and state that extended studies show the usefulness of the method. That is sufficient.

Section 3.2

The first paragraph is trivial and contains strange references in view of all the publication on EARLINET and CALIPSO work and aerosol field campaign lidar studies (see e.g., Gross et al., ACP 2013, Burton et al., ACP, AMT 2012-2014, all the SAMUM papers in the Tellus B special issues, 2009, 2011).

You state that the reference model atmosphere (RMA) is based on lidar data from 1989, so 25 years old data obtained with simple backscatter lidar!!! Unbelievable for an aerosol lidar expert! A huge number of publications on aerosol profiling with Raman lidars and HSRLs, partly in combination with photometer studies is available, CALIPSO data are avaibable. All these efforts provide a dense description of aerosol distribution around the world in many details especially in terms of backscatter, extinction, lidar ratio, depolarization ratio,. . .. And the AEOLUS community uses this rather old, and therefore questionable aerosol model. But ok, as said, for an ALADIN errors analysis it is not so important how strange the approach regarding the chosen aerosol profiles is (from my subject point of view).

Why do you then give such an extended overview of the hygroscopic behavior of aerosols and consequences for aerosol extinction. This all is well known and exhaustingly discussed in the literature. Keep the paper short, just state what you are using, provide some modern references, not just 45 year old references.

The discussion on aerosol lidar ratios is not state of the art (but sure, I did not expect the opposite). As mentioned above there are meanwhile so many papers on MEASURED lidar ratios (Mueller et al, aerosol type dependent lidar ratios, SAMUM papers in Tellus 2009, 2011, Burton papers on latest HSRL observations, many other papers

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from EARLINET, see Mona, Amiridis, Mattis etc), and you start the discussion with papers like Evans 1988, Ackermann 1998, Waggoner 1972, and Saleminik 1984. . .... The huge RH dependence from 19sr to 84sr has never been observed with modern lidars. You may find a comparably strong lidar ratio decrease with RH (due to a change in the chemical compostion, more water, changing the refractive index) from 60-70sr of dry absorbing particles to 40-50sr when they are swollen, but usually the decrease with humidity is much smaller and almost not visible in well mixed boundary layers.

But again, the text is rather long again here, please keep the discussion as short as possible. For your study it is just sufficient to know what you assume. Give an example for two lidar ratios (40%, 80% RH) that follow by using this unnecessarily complicated parameters to be considered in equation 28. . .

Section 3.3

Table 3 contains some characteristic backscatter and extinction values, but the most important parameter, just discussed in large detail, is not given: the lidar ratio! Lidar ratios for liquid-water-dominated clouds of 18 to 20sr may be fine, if we ignore multiple scattering. In lidar applications, multiple scattering has to be taken into account. Effective lidar ratios are then around 10sr (effective extinction values are easily a factor of two lower than the single scattering values in the case of a spaceborne lidar). Cirrus lidar ratios of 14 sr are already effective values (they are usually even lower and around 10sr, for an off-zenith lidar as ALADIN). However, in table 3 you provide single scattering extinction and backscatter values, then the respective lidar ratios are too low. Modern papers indicate single scattering lidar ratios around 25-30sr. PSC show lidar ratios aorund 20sr? Is there a reference for this? This is probably again an effective value, right?

So, clouds are water clouds at -17.16C (obviously 256 K) and ice clouds at temperatures if temp is -17.17 C (255.9 K). Note that one can have water clouds at -30C and also ice clouds at -10C as polarization lidar studies indicate. But of course for your

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study it is simply unimportant how strange (or crazy) the assumptions are. What about mixed-phase clouds?

Section 4.1. . .. please leave out this section completely. This is so long, and is simply not necessary for an ALADIN error analysis.

A short summary may be justfied, but is not needed.

Now (and thus too late), you start with comparisons with CALIPSO and CloudSAT. . .. In the case the lidar ratio discussion, there are modern look up tables for CALIPSO data analysis. Why did you at least not look in theses papers (Omar et al., JGR).

Sections 5 and 6 are fine.

All in all the paper is of low quality in its present form. And probably not all coauthors (e.g., Donovan) read the manuscript.

Major revisons are demanded. An important point is to shorten the paper drastically. This will make the paper more attractive.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 1393, 2014.

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