Reply to Gang Zhao

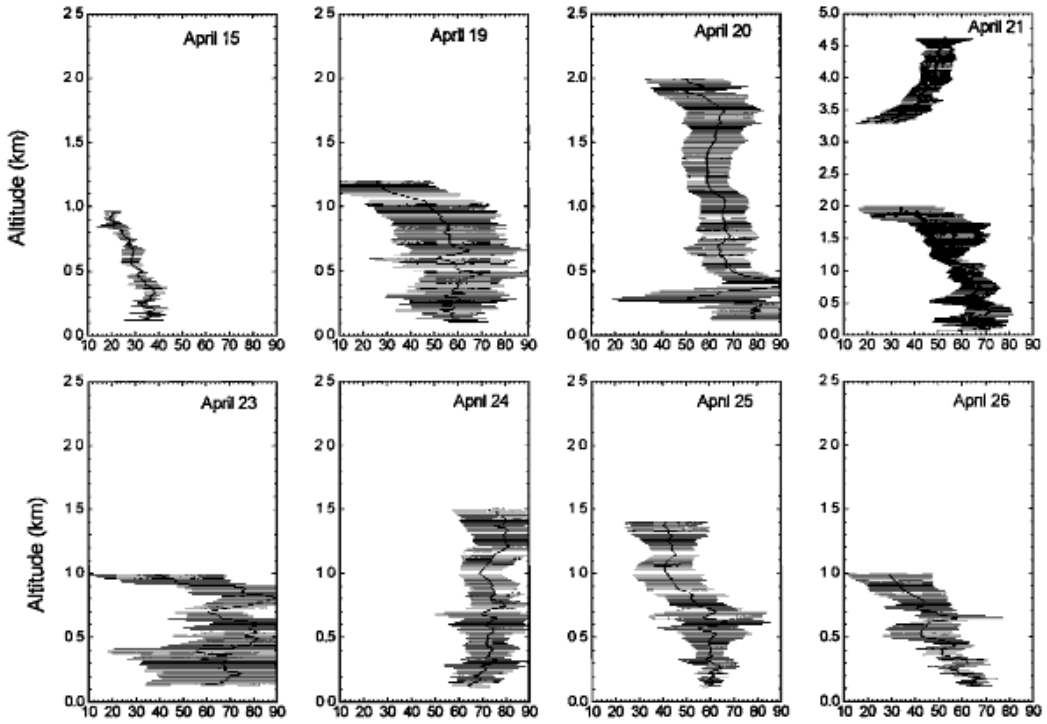
I was faced as Editor of this paper with one reviewer who recommended rejection and another who recommended only minor typos. I therefore have to review the paper carefully myself before deciding whether to accept it. I was hoping that in your revised submission you would take careful note of the critical reviewer's comments, but in fact you have chosen to ignore them and make only very small changes. I also note your disrespectful tone towards the reviewer in your reply.

My conclusion is to accept the paper subject to major revision, to make the argument in the paper much clearer. I think the work is good, but the paper is confusing, for two main reasons. The first is that the reader has to read section 4 to understand section 3, and the second is the issue of the increase of LR with height.

The first problem can be addressed in a number of ways. Firstly, rewrite the paragraph on p. 3 (l68 -76) to set out more clearly the aims of the paper. What you are presenting is a sensitivity study into the assumption of constant LR that underpins the Klett inversion method, using a large dataset of measured aerosol profiles to inform that study. Then explain how the rest of the paper helps achieve your aim. Secondly, take more care in section 3 to let the reader know exactly what you are doing – some suggestions are given below.

Part of the critical reviewer's problem arises from the fact that it is common knowledge in the lidar community that aerosols have a lidar ratio in the range 30 – 70 sr while clouds are more like 20 sr. In your reply to the reviewer's comments you say that you don't understand why 'This manifests for instance in the low lidar ratio of 20 sr for water droplets'. Yet there is an entire community of lidar scientists who use a canonical value of 18.8 sr in stratocumulus to calibrate their lidars! (See O'Connor et al 2004 for details). So the idea that the lidar ratio grows as the particles humidify needs to be more carefully introduced and argued in the paper. The Salemnik paper is interesting but derives lidar ratio by assuming that α and β are constant with height – something you explicitly argue against! The variations in RH in that paper come from measurements on different days, which of course will have different aerosol populations. An intriguing result, but using that as a basis for your argument is, to say the least, questionable.

In your response to the reviewer you also say that 'Ferrare et al 1998 also found that the lidar ratios can vary from 60 to 90 sr when the RH increases from 40% to 90%'. Your reference is to Part 2 of a pair of papers. But in Part 1, fig.1 shows the following measurements:



First of all the ratio is variable from day to day, and secondly it most certainly does not increase in the boundary layer – in fact in most cases it decreases. How is this consistent with your calculations that the particles will grow?

I would like you to pay more attention to this point, and to present more details (and more results) of the way you calculated particle growth and scattering. It would also help if you used your figures more carefully, by referring to them earlier in the paper – by the time I got to the figures I was thoroughly confused. I realise that your Mie scattering calculations give the results they do, but you do need to justify them in the context of previous measurements and calculations of LR variation. Mie scattering codes are notoriously tricky, and the results sensitive to the number of terms used in the summations. Raman lidars and HSRLs have provided real profiles of LR so the evidence is out there.

a) L.91-97 this paragraph would make more sense if you referred to fig.3 at this point (it would become fig.1)
b) I find section 3.1 very confusing. I cannot decide whether you used one aerosol and BC size distribution or many of them (in fact it becomes clear later that it's many but it would help to say how many). This would be much clearer if you provided figures showing exactly what aerosol and BC distribution (or distributions) you did use. You could also show some examples of how the distribution changes with RH. You give a lot of references here but the consequence is that essential material is missing and the reader cannot follow your argument.
c) At the end of this section you introduce the LR enhancement factor. This is crucial to understanding your paper as it is the quantity that goes into your retrieval. You need to expand this paragraph and explain to the reader that this is the key quantity that you get from your Mie modelling. Reference to fig 2 would be helpful here. It is not until equation 5 on p.8 that I understood where this paper was going.

d) Section 3.2. It is a reasonable assumption that the dry aerosol and BC distributions remain constant in the mixed layer, but your calculations are not confined only to the mixed layer. You need to discuss the effect of using this assumption beyond the mixed layer.
e) Section 3.4 A couple of introductory sentences here would help the reader understand that you are comparing two methods of constraining LR using sunphotometer data.
f) Table 1. The results of this section are unsurprising – accumulation mode aerosol contribute most to lidar scattering – but the method used is flawed. If the regression were done using backscatter or extinction it would be meaningful (since these are additive) but because LR is a ratio the underlying linear equation upon which the regression analysis is based ($LR_{tot} = \Sigma\alpha_i LR_i$) is not correct.
g) Section 4.3. I have read this several times but I am none the wiser. What are you trying to do here? It seems you are generating a LR using a forward model based on an LR enhancement parameterisation, then using the same parameterisation in a retrieval scheme to derive the profile. Is that correct? If so it says nothing about the robustness of your parameterisation, merely about the accuracy of your retrieval.

I also have a lot of small comments on the language etc but these can be dealt with later.

References

Ewan J. O'Connor, Anthony J. Illingworth, and Robin J. Hogan, A technique for autocalibration of cloud lidar, J. Atmos. Ocean. Tech., 21, 777, 2004.
R.A. Ferrare, S .H. Melfi, D.N. Whiteman, K.D. Evans, and R . Leifer, Raman lidar measurements of aerosol extinction and backscattering 1. Methods and comparisons. J. Geophys. Res. 103,19663,1998.