Reply by referee #2 to the responses of the authors

Response:

Indeed we agree that the equations 2 to 5 need to be improved. In Eq 3 alpha'_m should be just alpha_m and the extra fraction in eq 4 was removed. The changes will be submitted in the new version of the manuscript.

Reply:

The presentation of the equations is improved, but I still have trouble with your notation.

The prime symbol has not the same meaning for all variables. I would suggest to use the prime symbol (') only for alpha and P. The z' and dz' inside the integrals should be then replaced by another letter, maybe a greek letter...

Equation 5 looks different compared to the first version. I presume the new one is the correct one.

Response:

A more detailed description of the scence used will be provided in the revised version of the manuscript.

Reply*:*

How does the LWC profiles provided by DALES look like? … almost linear so that alpha increases according to z ^ 2/3, like in Donovan et al. 2015?

Response:

The negative value at 190m height is related to the difficulty of accurately retrieving extinction by the slope method in the cloud base region. The values close to the cloud base (one bin below to the beginning of the cloud base) are almost always giving negative values (since in this area the true cloud extinction is not constant and is indeed rapidly increasing in a relative sense). For this reason, we can only use the slope method within the cloud, where the extinction is not changing as rapidly in a relative sense, to estimate alpha_0. We know that the slope method is only strictly valid if the extinction is constant. However we chose an altitude as deep into the cloud as the SNR allows. This helps ensure that relative extinction is constant enough so that the boundary value extinction is accurate enough to be useful in the backward Klett solution. Note: Klett, 1985 (https://doi.org/10.1364/AO.24.001638) showed that extinction profiles below z_{o} can rapidly converge to the true results in optically thick conditions even with somewhat large errors in \alpha_{o}. This explains our results. Figure 2 is presented to show exactly this effect: it is only possible to use it higher within the cloud. This issue will be better explained in the revised version of the manuscript.

Reply:

It is true that the extinction does not change in the higher bins as fast as for the cloud base region, but to assume it as zero will mostly result in an underestimation of alpha_0' and thus of the retrieved extinction coefficient.

From section 4.4, should I understand that the 95% accuracy means that you get values 5 % smaller than the real ones? The underestimation should be cleary stated in the abstract and in the conclusions as it is a very important aspect about the retrieval scheme.

Response:

The black line from Fig 2 presents only the retrieval of the extinction in accordance with the slope method, in the whole retrieval this method is only used to retrieve the value of alpha_0 and initiate the inversion. Therefore, the blue solid line form Figure 4 and black line from figure 2 are not the same.

Reply

Please explain this clearly on the text... That Figure 2 shows the retrieved alpha' when one assumes Eq. (7) for the whole range, i.e. alpha=-1/2 d ln(ATB)/ dz. And not by using Eq. (5).

What should I get from Figure 2? That the normalization height is chosen where the slope method delivers the closest value to the true extinction profile? i.e. the blue line?

Finally two questions to Figure 5 and 6:

In Figure 5, why do you select such large ranges for tau up to 15 and for the error up to 30%?

In Figure 6, what is here A_alpha, the accuracy? the slope?