Interactive comment on "Retrieval of aerosol optical depth and vertical distribution using O$_2$ A- and B-band SCIAMACHY observations over Kanpur: a case study" *by* S. Sanghavi et al.

Anonymous Referee #3

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General comments:

The retrieval of aerosol height information from passive satellite measurements in the oxygen absorption bands is an interesting topic and the authors have chosen a promising approach in exploiting both O2A and O2B in parallel. The goal of this work is at the same time very ambitious, which should be taken into account in the judgement of the results.

The existence of information about height and width of the vertical aerosol distribution in both oxygen absorption bands is demonstrated. However, the paper suffers from several shortcomings, most importantly the lack of a comprehensive discussion of error sources such as e.g. the aerosol model or surface pressure, a missing validation of the retrieved aerosol height parameters and little explanation for the relatively poor quality of the derived aerosol optical depth values. The title, abstract and conclusions of the paper are therefore somewhat misleading, since the impression of a successful retrieval of vertical aerosol distribution from SCIAMACHY data is given, which is actually not shown.

The paper should only be published after a thorough revision.

Specific comments:

Section 2:

You have chosen a lognormal profile but you don't provide a justification for this other than stating that you assume it is close to reality on average. Since the paper deals with remote sensing of the aerosol vertical distribution, a more detailed discussion of this question should be part of the manuscript. By looking at LIDAR data, such as provided by CALIPSO, one could easily assess whether other profiles are more suited (e.g. bimodal distributions). I guess SCIAMACHY does not provide enough information to aim at more complex profiles, but then this should be clearly stated in the text.

p. 6784, l. 22: The test for convergence as written in the text seems reasonable to me. But it is not the same as in formula (6).

Section 3:

This section provides quite some insight into the differing sensitivities in O2A and O2B, justifying the use of both bands in parallel. However, these sensitivities to your state vector elements have to be compared to the sensitivities to all possible error sources. What if an uncertainty of e.g. surface pressure causes a similar change of the signal

as one of your state vector elements? What if your aerosol model assumption fails to describe reality? All this needs to be considered (in Section 4 as well, see below).

Section 4:

You cannot test the robustness of the retrieval concept by just looking at the influence of instrumental noise, this can only be a first check. If your algorithm succeeds to retrieve the input within reasonable errors, you should assess all the other error sources (forward model parameters).

It would thus be important to test the influence of surface pressure, aerosol optical properties (single scattering albedo, Angstrom parameter, scattering phase function), temperature profile, surface reflectance, etc. Do the uncertainties of these parameters erase the sensitivity of the measurements to the aerosol vertical distribution?

In figures 5 -7, all three parameters are plotted at once, leaving the y-axes with three different meanings and a different scale for each plot (difficult to compare the deviations from the "truth lines"). Is there any chance to modify these plots?

If I understand it correctly, your study shown in figures 5 -7 is based on a single retrieval run for each case. Instead it should be based on a sufficiently large number of cases to illustrate the average error resulting from each error source. The success of a single retrieval run from a noisy measurement is rather random.

Section 5: I won't go into detail since I would recommend to revise the whole section. The retrieved aerosol height parameters are not validated and the retrieved aerosol optical depth values are not very reliable. The influence of clouds on the shown retrievals remains somewhat unclear to me. If the aim of the work is to derive aerosol information, it is crucial to filter out clouds, isn't it?

Section 6:

p.6794, l. 2: 1nm?

l. 11: "good retrievability": This is not shown in the sensitivity studies, only the influence of noise is shown.

It is not fair to state you found a "good agreement ... with CALIPSO measurements...". The fact that aerosols were found between 0 and 5 km by CALIPSO in later years, is not at all a validation / verification of your retrieval.

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