

Dear Reviewer,

we thank for your very valuable comments. We revised our paper in light of your comments (in black). The answers are shown below in red.

Best wishes,

Pohl et al.

The paper is dedicated to improved retrievals of aerosol characteristics from SCIAMACHY limb observations. Compared to the previous version of (Malinina et al., 2018), the algorithm has been improved, and implemented to measurements not only in the tropics, but also on the entire globe.

The measurements that allow retrieval of information about aerosol particle size distributions are limited, while this information is important both for evaluation of climate response and also for retrievals from satellite measurements. This paper provides a valuable contribution to this topic.

The paper is well-structured and well-written. I recommend it for publications. Please find my minor comments below.

#### COMMENTS.

About assumption of fixed number density. While further in the text it becomes clear what you mean by “fixed number density”, the first mentioning of this creates many questions (for example, P.3). It is worth to add something like “details are provided below ” with the first mentioning the fixed number density assumption.

We adapt respective sentences:

Abstract: This assumes a fixed number density profile → This assumes a number density profile that does not change during the retrieval.

p3: ... by assuming a fixed number density. → A number density profile is assumed that does not change during the retrieval.

Conclusion: ... assuming a fixed number density profile. → The assumed number density profile does not change during the retrieval.

A related question: have you tried a maximum a posteriori inversion with three parameters retrieved (Bayesian approach with a priori information)? After obtaining the estimates of the parameters with your two-parameter retrievals, this might be a working approach.

We thank you for your suggestion. Unfortunately, such an approach is not working. The results of the 2-param retrieval (first inversion) depend on the a priori number density. That means, uncertainties in the a priori number density are largely adapted by the two retrieval parameters. Using these results in the 3-param retrieval (second inversion) will not iterate properly for the following reasons:

- 1) The determination of a solution is complicated by the fact that neither the a priori values (due to the a priori N dependence in the 2-param retrieval) nor the a priori covariance values (due to the lack of better knowledge) have to be correct in the 3-param retrieval.
- 2) A 3-param retrieval is already complicated in itself. The differences between simulated and measured radiances can be largely minimized by adjusting only 2 parameters. The third PSD parameter usually provides only little additional information. Thus, we do not get sufficient sensitivity for all 3 parameters.

Concerning point 3, we have added the following sentences at an appropriate position:

„While  $r_g$  and  $\sigma_g$  are derived, N remains unchanged at the initial profile for two reasons.

First, the spectral signatures of the three parameters are strongly correlated. Changes in measured limb radiances can be largely described by adjusting only two PSD parameters. The third PSD parameter usually provides only little additional information. That means, a multitude of aerosol PSD profiles result in the similar measured limb radiance. Fixing one PSD parameter restricts this unambiguity and gives more weight to the other two PSD parameters when responding to the given limb radiance. Second, ...“

Line 78. “ ...on the entire globe, here”. “here” is not needed

Done.

Line 190 “Either” -> “either”

Done.

Line 245: It is better to use the word “data” instead of “products”

We have added the word „data“ to the heading → Aerosol data products.

(And have also adapted other text passages, accordingly.)

Figure 3. It would be useful to add letters near the triangle indicating volcanic eruptions, and to provide a table listing them.

Done.

Figure 8. Please indicate dates of volcanic eruptions in the figure, for example, by adding vertical lines.

Done.

Line 693: Please provide the link to the dataset.

Done.