Dear Luis Guanter,

The authors wish to thank you for your interest in our paper and your comments, which have definitely contributed a lot to improving the quality of the content and presentation of our new manuscript.

I have read with interest this innovative paper about the retrieval of aerosol properties from O2-A and O2-B measurements. Some comments/questions which might be considered by the authors for a future version of the manuscript.
1) Covariation of AOD and aerosol height with other atmospheric parameters in the O2-A and O2-B windows
A convincing illustration of the benefits of using combined O2-A and O2-B measurements to disentangle aerosol height parameters from AOD and surface albedo is provided in Sections 3 & 4. However, it could be illustrative to extend the sensitivity analysis to other parameters which could potentially have similar spectral effects as AOD and aerosol height.

We admit, a clear error analysis taking into consideration covariation between different parameters involved was not provided in the previous manuscript. We have now included a section presenting information content and error analyses, which take into consideration three different sets of a priori covariances, and the errors introduced due to varying levels of constraints applied to the state vector elements.

We have analyzed the information content for three surface types, for retrieval set-ups consisting of the A- and B-bands alone as well as for combined use of the A- and B-bands to arrive at a more quantitative result on the benefit of the latter. This analysis also highlights the benefit of constraining surface reflectance parameters when accurate information can be had about them. A discussion of a posteriori covariances shows the accuracy with which different parameters can be retrieved and underpins the conclusion we draw from the information content analysis about the benefit of applying constraints on the surface reflectance.

We estimate, at each constraint level considered, the smoothing error (using the averaging kernel matrix) that would be introduced into each of the retrieved parameters due to errors in our fixed quantities, in particular, the spectral gradient of the AOT (which can change with respect to the microphysical parameters of the prevailing particulate matter) and the assumed lambertian albedos around the A- and B-bands, respectively.
Additionally we use the gain matrix to analyze the impact of measurement bias on the retrieved quantities.

In particular, how would e.g. surface pressure (not mentioned in the text) and single scattering albedo (fixed to climatology values) affect these two spectral windows? It could be anticipated that the spectral Jacobians for the separate windows could be very similar to that of AOD and the height parameters, and therefore interfere in the inversion, although this covariation might break down by the simultaneous inversion of the two windows as proposed. Some analysis in this line could be a good add-on to the paper.
Unaccounted changes in both the surface pressure and single scattering albedo would produce a bias between our measured and modeled observations, which, through the gain matrix, can be used to analyze their impact on the retrieved quantities.

We have not delved greatly into error caused by surface pressure, since we expect its value to be marginally small compared to other sources of uncertainty in our retrieval problem. We include the surface pressure predicted by ECMWF over Kanpur in our forward model calculations, which we expect to reliably limit surface pressure error (see Salstein et al., 2007). We also use altimetric data to correct for small changes in surface altitude, which likewise are l unlikely to cause substantial error in our case, given the relatively flat terrain around Kanpur.

The impact of the single scattering albedo is far-reaching, even though we have excluded the single scattering albedo, \omega, of the aerosol from our state vector, opting instead to ``fix'' it to the value dictated by the climatology (occasionally changing the assumed aerosol type to achieve a better fit with measurements over Kanpur). This is because we expect to see considerable anti-covariance between the AOT and \omega, making it difficult to separate their effects. However, we notice that the error introduced by the assumption of an absorbing aerosol like Type IA3 (\omega = 0.89) when the true aerosol is closer to a more scattering type like IS1 (\omega = 0.95), can cause large error (upto 50%) depending on the aerosol optical thickness and viewing geometry. We have attempted to ameliorate such errors in our case-study retrievals by occasional use of other aerosol types, mainly IS1, when our principal assumption of the IA3 aerosol type fails to achieve an acceptable convergence. Uncertainties in the single scattering albedo have not been accounted for in our sensitivity study, since our main aim in this paper has been to demonstrate the vertical information contained in the A- and B-bands. However, it would be very interesting to explore this in the future, preferably by supplementing the current measurement vector with measurements made at a larger number of wavelengths that are spaced spectrally farther from each other. The current application to SCIAMACHY does not allow for this approach, due to strong channel-to-channel radiometric irregularities.

2) Modeling of surface reflectance
Surface reflectance (rather than albedo!) in O2-A and O2-B is apparently set to values estimated from a clear-sky acquisition and assumed constant along the year. Since seasonal changes in reflectance might bias aerosol estimations, it might be good to show to what extent surface reflectance (or the BRDF) can be considered constant along the year. It might be possible to do this using the MODIS BRDF-Albedo Model Parameters product (MCD43A1, https://lpdaac.usgs.gov/products/modis_products_table) for the tile containing the Kampur area (presumably h25v06). Albedo kernels could be combined with real illumination angles to generate a time series of directional reflectance values for MODIS channels 1 and 2 (centered around 650 and 860nm, respectively). A bit simpler than this is to just assume a Lambertian surface and use the MODIS Nadir BRDF-Adjusted Reflectance product (MCD43C4) provided as 5600m resolution, lat/lon projection and 16 Day composites.
These are very good ideas, but they are also more time-consuming than we can afford at this time. For the moment, we can only supply an analysis exploring the error introduced in the retrieval due to an error in our estimate of the surface reflectance.

3) Inversion scheme Providing some more information on the optimal estimation set-up would enable the reproducibility of the proposed methodology. In particular, due to its critical role in the retrieval performance, the reader might appreciate a more detailed description of S_\epsilon (instrument error characterization, forward model error). It could also be useful to see some information on S_a (diagonal?) and on the posteriori covariance matrix from some representative inversion.

Clear information has been provided in the new manuscript on

1. the state vector,

2. the measurement vector,
3. the a priori state vector parameters,
4. the a priori covariance matrix,
5. the measurement covariance matrix,
6. the a posteriori covariance matrix (for arbitrarily chosen demonstrative cases)
7. elements of the averaging kernel matrix (arbitrarily chosen demonstrative cases)

with several other input parameter details to enable a reproduction of our results by other researchers.

Other:
- Fig. 1-4 - what are the input reference values for AOD and the height parameters? - Fig. 5&6-eitherAOTorODused.

Fig 1-4: This data has been supplied in the new manuscript. The Jacobians have been computed for a biomass aerosol scenario (BL3) having optical thickness \tau_{700}=1.0, peak height z_p=3 km, and \sigma_p=0.7.

Fig 5-6: The same term "aerosol optical thickness" has been used uniformly now.