**Atmospheric
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Interactive
Comment

Interactive comment on "Retrieval of aerosol optical depth and vertical distribution using O₂ A- and B-band SCIAMACHY observations over Kanpur: a case study" *by* S. Sanghavi et al.

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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

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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. 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.

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.

3) Inversion scheme

Providing some more information on the optimal estimation set-up would enable the

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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.

Other:

- Fig. 1-4 - what are the input reference values for AOD and the height parameters? - Fig. 5 & 6 - either AOT or OD used.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 6779, 2011.