

Response by the authors to referee number 2

Dear Reviewer,

We are thankful for Your comments.

General Comments:

In general, the manuscript "Understanding the aerosol information content in multispectral reflectance measurements using a synergetic retrieval algorithm" by Martynenko et al, is written in an appropriate style, is relevant to the AMT community and is worth publishing. However, the text should be improved for clarity. This can be achieved by 1) removing repetitive sentences (especially in the abstract and conclusions), 2) including a more explicit presentation of the motivation and goals of this paper, 3) expanding the discussion of the assumptions made, and 4) expanding discussion of how the results and the conclusions drawn from the results differ from previous work mentioned in the paper

Specific Comments:

p. 2580 Lines 1-25: Abstract should be a bit more compact and explicit in stating the goals and findings of the paper. This work is built upon earlier work by Holzer-Popp. Please explain how this work differs from and/or builds upon this work.

Answer for general comment and first specific comment: The motivation of the present investigation is to explore aerosol type information content with the help of principal component analysis. This theoretical analysis is performed for a large number of scenarios with various geometries and surface albedo spectra for water, soil, vegetation etc. When the surface albedo spectra and AOD is accurately known and clouds are absent or are corrected, SCIAMACHY reflectance measurements have 2 to 3 degrees of freedom that can be attributed to aerosol type parameters. This was the main result from Holzer-Popp et al. 2008 work. The present work goes further in investigation of the correspondence of derived DFS to distinction of aerosol type. The capability of the SYNAER algorithm to discern aerosol types is investigated using the distribution of the models in the space of weights of the principal components. This is a new step in comparison with previous Holzer-Popp et al. 2008 paper.

The main assumptions on aerosol retrieval which have been made are as follows:

1. Particles are assumed to be spherical
2. There are 40 aerosol mixtures which are assumed to cover natural variability of aerosol in troposphere
3. The error measurement of the spectrometer is considered to vary between 0.01-0.0003% of measured reflectance.
4. The PCA for SYNAER algorithm relies on a-priori data for surface albedo spectra and AOD, which are derived from the previous retrieval step. The AOD and albedo uncertainties are excluded from the present error analysis.

Corresponding changes will be added in revised version of present paper.

p. 2583 Lines 16-21: please expand the discussion of the key assumptions made

for this paper: 1) that the aerosol models cover the natural variability of tropospheric aerosol and 2) that the surface albedo is accurately known and the presence of clouds can be completely excluded or corrected. Especially for the second assumption, it would be nice to have more discussion about whether this is feasible and what the associated error is for these assumptions.

Aerosol models:

The set of 40 mixtures is meant to model all principally existing aerosol types and allow for some variability in the composition of each type. This set of mixtures has proven to provide a fit in the SCHIMACHY spectra retrieval which is in many cases at a 0.01% noise level. There is no desert dust mixed with biomass soot aerosol type in predefined types of the aerosol mixtures.

Clouds:

Cloud Screening in SYNAER is achieved through an adaption of the Advanced Very High Resolution Radiometer (AVHRR) Processing scheme Over cLOUDs, Land and Ocean (APOLLO), described in Saunders and Kriebel (1988), Kriebel et al. (1989, 2003) to AATSR at 1 km pixel resolution. This cloud screening scheme to AATSR has been adapted with two shortcomings, which have to be accounted for in order to derive an accurate cloud mask for aerosol retrievals.

First, heavy aerosol load over oceans (mainly mineral dust, to minor parts smoke plumes from wildfires) is classified as “cloudy” by APOLLO and these AATSR pixels are then not used for the retrieval of AOD in SYNAER, leading to somewhat too small AOD values in the dust belts. The second shortcoming is an improper detection of shallow cumulus cloud cover over land due to a simple temperature threshold test for the rejection of cloudy pixels in order to not classify desert surfaces as low clouds. (for details see Holzer-Popp et al., 2002a)

In the present theoretical study in order to eliminate cloudiness problem we are concentrating only on clear sky pixels and assuming no error due to cloud correction.

Surface albedo:

In order to retrieve AOD with an accuracy of 0.1 the surface albedo of the treated dark field should be known with an accuracy of 0.01 (see e.g. Holzer-Popp et al., 2002a). To achieve this accuracy in an automatic retrieval procedure over land for AATSR (over ocean a different scheme is used, which is described in Holzer-Popp et al., 2002a), dark fields are selected from a combination of thresholds for the normalized vegetation index NDVI and the reflectance R1.6 in the mid-infrared at 1670 nm and that R0.670 is estimated using R1.6 correlation.

Corresponding changes will be added in revised version of present paper.

Technical Comments:

p. 2580 Line 24: consider replacing “is able to provide for 2 to 4 degrees: :” with “is able to provide 2-4 degrees: :”

OK

p. 2581 Lines 2-3: Second sentence paragraph 1 of introduction is awkward:

Replaced with: But there is a limited number of retrieval methods which are capable to retrieve and classify different aerosol types.

p. 2581 Line 20: remove “or”

OK

p. 2581 Line 21: consider replacing “or derived quantities: : :”, with “or provide derived quantities: : :”

OK

p. 2582 Line 8: usage of word “partly” is unclear, consider removing it

OK

p. 2582 Line 23: usage of word “following” is unclear, consider removing it

OK

p. 2583 Line 11: consider replacing “allows to derive” with “allows one to derive” or “allows the derivation of”

OK

p. 2585 Line 3: Veihelmann et al (2007) is cited but not included in the reference list, this should be corrected

Veihelmann et al (2007) will be added in revised version of paper

p. 2587 Line 20: “Further to the earlier study” is awkward, consider re-wording “In addition to previous findings, or Building on earlier work: : :”

OK

p. 2588 Line 3: usage of word “tends” is ambiguous

replaced with: The information content of measurements is a monotone function of satellite angle.

p. 2588 Lines 10-11: correct “distribution of histograms are” to “distributions of histograms are” or “distribution of histograms is”

OK

p. 2589 Line 20: consider replacing “But” with “However”

OK

p. 2591 Lines 1-3, Lines 9-10: Sentences are nearly identical, please reword or remove to avoid repetition.

Lines 9-10 reworded: However, when two DFS are available, sometimes there is a problem to discern anthropogenic polluted aerosol.

p. 2597 Figure 4 could be improved by included a legend in the figure. Also, consider revising the colors and/or line types as the blue and black lines are difficult to distinguish from one another.

OK

p. 2598 Figure 5a caption, last line should be corrected “are quit good distinguishable” should be changed to “are distinguishable from one another”

OK

p. 2602 Figure 6c title “WIES” is unclear and should be changed to “MEADOW”

OK