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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieval of aerosol absorption properties using the AATSR satellite instrument: a case study of wildfires over Russia 2010" *by* E. Rodríguez et al.

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This discussion paper is/has been under review for the journal Atmospheric Measurement Techniques (AMT). Please refer to the corresponding final paper in AMT if available.

Retrieval of aerosol absorption properties using the AATSR satellite instrument: a case

study of wildfires over Russia 2010

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General Comments:

This manuscript presents a newly developed algorithm, applied to the top-of-atmosphere data collected by AATSR sensor on board ESA's ENVISAT, for the simultaneous retrieval of mid-visible aerosol optical depth (AOD) and single-scattering albedo (SSA) of the large-scale wildfires occurred in Russia in August 2010. The algorithm relies on the optimum fit between the satellite-measured and model spectral reflectance where the model reflectance is obtained by mixing the four assumed components of aerosols, i.e., weakly and strongly absorbing fine mode particles, and coarse mode dust and sea salt aerosols. While the total AOD resulted from mixture of all four components, the algorithm infers SSA of fine mode aerosols since the fraction of dust and sea salt components were assumed to be constant. Through sensitivity analysis author shows that for moderate to large aerosol loading the TOA reflectance in the visible channels exhibit a distinct sensitivity to the selected aerosol model which forms the physical basis for inferring the SSA. The algorithm is tested with the AATSR data collected for the 2010 Russian wildfires events for which the AATSR-retrieved SSA was compared against that of AERONET and OMI. While the agreement between different sensors was found reasonable (within 0.03-0.04) for larger SSA values (>0.9), large discrepancies have been noted for lower SSA (<0.9).

While the overall quality and structure of the manuscript look OK, it requires improvements and clarity in several aspects. First, the title of the paper is somewhat mislead-

ing. The present technique works only for the fine mode biomass burning aerosols at moderate to large aerosol loading which should be emphasized in the abstract and conclusion. Second, the paper lacks the uncertainty analysis of the AOD and SSA retrieval to the assumption of surface albedo and different possible mixtures of aerosol model. A section discussing the uncertainty in the AATSR retrieval is required. Third, the co-location approach adopted to match AATSR with AERONET and OMI too liberal and inappropriate. Further comments on co-location scheme are given in the "specific comments". Fourth, the differences between AATSR-AERONET-OMI are not studies in detail. For instance, how the discrepancies between different sensors behave as a function of AERONET AOD and OMI-measured UV Aerosol Index? Fifth, it is unclear how author uses OMI single-scattering albedo data in comparison against AATSR. Recommendations related to OMI data are given in the "specific comments". Sixth, showing a global plot of SSA for September 2010 retrieved with an algorithm primarily designed to capture biomass burning aerosols could be a mistake. Restricting the present analysis to the Russian wildfire events, central Africa, and Amazon will put the paper back to its track. Also, comparing AATSR SSA retrieval against AERONET and OMI over Africa and Amazon regions will help in understanding the relative biases.

Author needs to work on above issues in order to improve and sharpen the paper. Listed below is specific comments that should be addressed in the revised version. Upon receiving satisfactory response and improved manuscript from the author, I will further evaluate and may reconsider its publication in AMT.

Specific Comments:

Page 9839: Title: Consider changing the title of the paper to something like: "Retrieval of biomass burning aerosol absorption properties..."

Page 9840: Abstract: Abstract should be initiated with a sentence on the AATSR on board ENVISAT satellite stating its channels and capability of aerosol retrieval.

Page 9840, Line 13: Here, the results of the sensitivity analysis shown in Figure 1

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should be referred by stating that at moderate to higher aerosol loading it is possible to discriminate the aerosol type or model using the TOA spectral reflectance which forms the basis of the SSA retrieval.

Page 9841, Line 23: Torres et al. (2013) introduced an updated version of the OMI/OMAERUV algorithm in which the observations from A-train sensors CALIOP and AIRS have been ingested for the improved retrievals of AOD and SSA in the near-UV region.

Page 9842, Line 2: biomass burning regions.

Page 9842, Line 13: Add here something like this: "Later in the paper, we show that the mixture of aerosol models or types has a pronounced effect on the TOA reflectance. Thus the aerosol mixture which provides the best fit between simulated and measured reflectance can be used to infer the single-scattering albedo."

Page 9842, Line 16: for wildfires over western Russia...

Page 9843, Line 28: The radiative transfer calculations are time consuming and therefore the look-up-tables are created for certain...

Page 9845, Line 12: The message of Figure 1 can be delivered more effectively if the % change in the TOA reflectance is plotted against the AOD instead of absolute reflectance versus AOD.

Page 9846, Line 1: "...our main interest is in testing the possibility to retrieve SSA..."

Page 9847, Line 11: Given an error of 0.03 in SSA, an error in AAOD could be 30%. For instance, for an AOD and SSA of 1.0 and 0.9, respectively, the AAOD would be 0.1. Now, a perturbation of plus/minus 0.03 in SSA would provide AAOD of 0.07/0.13 which is 30% deviation from the reference case.

Page 9848, Line 27: The lower values of SSA only indicate the presence of absorbing aerosols. Lower SSA along with higher AOD values indicates larger concentration of

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absorbing aerosols.

Page 9849, Line 7: Why such a big spatial-temporal window? For satellite AOD validation such as performed for MODIS, MISR, and OMI aerosol products, 0.5 deg square region for spatial averaging and plus/minus 30 minutes for temporal average of AERONET data are selected which have become a well-accepted standard. For OMI vs. AERONET SSA comparison such as recently carried by Jethva et al. (2014)-JGR, a spatio-temporal scheme with 0.5 deg square region for averaging OMI retrievals and plus/minus 3 hours for averaging AERONET inversion in time.

Page 9849, Line 18: What are the expected uncertainties in the AATSR AOD retrieval? These error bars should be drawn in the Fig 5a.

Page 9850, Line 7: Fig 5 SSA plot shows outliers for larger SSA values (>0.92) where AATSR retrieves significantly lower SSA in comparison to AERONET inversion. Make sure the text is correctly written.

Page 9850, Line 18: How do the OMI SSA retrievals in the near-UV region being converted to 0.555 micron? Extrapolation? Author should be cautious while comparing OMI-retrieved SSA against AATSR. Though, OMI derives SSA for lower values of UV aerosol index, the uncertainty in the SSA can be larger than 0.03 for UV-AI values lower than 0.5 [Jethva et al., 2014]. Also, OMI does not retrieve SSA for low values of UV-AI (<0.3) where it employs single-channel algorithm for which it assumes a fully scattering aerosol model with SSA of unity. Under these conditions, OMI reports SSA of 1. These retrievals should not be included in the spatial averaging of OMI data. For SSA comparison, I strongly recommend including only those OMI retrievals with observed UV-AI greater than 0.5.

Page 9851, Line 1: rephrase this statement.

Page 9851, Line 15: The ADV algorithm assumes a fixed fraction of coarse mode aerosols, i.e., dust and sea salt, the present technique, therefore, derives the SSA of

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fine mode biomass burning aerosols. Applying the current algorithm globally would be inappropriate particularly over dust regions, i.e., Sahara and Arabian Peninsula. I would suggest replacing the global picture of SSA with three sub-plots, each showing SSA distribution over central Africa, South America, and Russia. Since the ADV retrieval of SSA is processed for entire globe for September 2010, it is desirable to compare it with AERONET and OMI for above-mentioned three regions.

Page 9863, Figure 4: Three plots showing AOD distribution in the first panel and same for the SSA in the bottom panel would be better for comparison.

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