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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.

Anonymous Referee #2

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Review for Atmospheric Measurement Techniques

Title: Retrieval of aerosol absorption properties using the AATSR satellite instrument: a case study of wildfires over Russia 2010

Authors: E. Rodríguez, P. Kolmonen, T. H. Virtanen, L. Sogacheva, A.-M. Sundström, and G. de Leeuw

General Comments:

This paper presents satellite retrievals of aerosol optical depth (AOD) and single scattering albedo (SSA) that were made utilizing satellite data from the Along Track Scan-

ning Radiometer (AATSR). The aerosol generated from the major boreal zone burning events that occurred during the summer of 2010 in western Russia are the primary focus of this paper. In general I feel as though the data analysis is somewhat incomplete and also there is a lack of discussion of some of the limitations of the satellite algorithm. For example, the satellite algorithm applied here keeps the fine mode radius constant at geometric radius = 0.07 micron, a relatively small value, and only varies the refractive indices in order to retrieve the AOD and SSA. This approach of fixing the fine mode radius to a constant value is not typical within the satellite aerosol properties retrieval community, see numerous papers by Remer, Levy and Kahn for the MODIS and MISR retrieval algorithms. The issues associated with keeping the fine mode particle radius constant are not adequately discussed in the text. The large biases in retrieved AOD at high AOD levels shown in Figure 5 are very likely a result of the assumed particle radius being too small. For example, in Figure 6, the two AERONET retrievals of SSA shown for Aug 07, 2010 (Moscow_MSU_MO site) when AOD was very high, >3.2 at 440 nm and >2.4 at 675 nm have associated fine mode effective radius for these almucantar scans of $\sim$0.24 microns, at least twice as large as the assumed radius for the satellite retrieval. This underestimate in fine mode radius by AATSR for some cases is likely to be one of the primary reasons for the overestimate by AATSR of AOD for the high AOD cases, which could also then contribute to the underestimates of SSA retrieved by AATSR. It would be useful to plot the AATSR retrieved SSA as a function of AERONET measured AOD to confirm the large SSA biases of AATSR occur at high AOD. This seems highly likely as it is nearly the only way to achieve the very large overestimates of AAOD made from AATSR retrievals as shown in Figure 9.

Additionally, regarding the text discussion of Figure 6, the authors suggest that the SSA spectral dependence in the AERONET retrievals is possibly due to coarse mode dust signature. The authors did not mention that the fine mode fraction of AOD computed in these same AERONET retrievals was $\sim$0.98 at both 440 nm and 675 nm. Therefore these AERONET retrievals of SSA are of fine mode smoke at very high AOD, with only 2% coarse mode contribution to total AOD. Note that the lower SSA at 440 nm

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that sometimes occurs for weakly absorbing smoke can be due to increased organic aerosol absorption at shorter visible wavelengths, see the paper by Eck et al., 2009 that found a similar SSA spectra for high AOD smoke in Alaska. The large fine mode radius noted above for these Moscow cases in Fig 6 was also found for the Alaska smoke at high AOD levels and can be partly explained by larger aerosol coagulation rates at high concentrations, i.e. high AOD (see Colarco et al., 2004).

I recommend that this paper be reconsidered for publication after substantial revisions to address the issues I have raised above and also in response to the specific comments below.

Specific Comments:

Page 9841, line 16: Please note that in reality the SSA for aerosols (even pure black carbon) will never be lower that $\sim$0.2 due to diffraction effects.

Page 9841, lines 27-28: Note that northern India is not a biomass burning aerosol dominated region, as the other two are, since in northern India the aerosols emissions in most seasons are mainly dominated by fossil fuel combustion, and in the pre-monsoon season by dust.

Page 9842, line 2: Change 'biomass to burning' to 'biomass burning'

Page 9842, lines 18-19: Dubovik et al., 1998 is not a reference for the AERONET retrievals. The primary references for the AERONET retrievals are Dubovik and King, 2000 and Dubovik et al., 2006 neither of which you have cited here.

Page 9843, line 11: You can never eliminate surface reflectance effects in satellite retrievals since you can only minimize them. Therefore change 'eliminate' to 'minimize' and 'only' to 'mainly' in line 11.

Page 9843, line 29: 'there' should be 'here'

Page 9844, lines 10-11: Please give a few more details about the dust climatology

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applied in your algorithm. Is it a monthly mean climatology and what is the spatial resolution? What was the dust fraction for the Russian region analyzed in this paper?

Page 9844, lines 16-17: Please discuss in the text whether there is any accounting for ozone and nitrogen dioxide absorption in the AATSR retrievals.

Page 9847, lines 2-3: Please state here that the AERONET direct sun measurements of AOD are accurate to ∼0.01 in the visible and near infrared and ∼0.02 in the UV wavelengths (Eck et al., 1999).

Page 9847, lines 10-11: The statement you make about the accuracy of AAOD is not valid. Since the accuracy of AOD is 0.01 (for the wavelengths used in the almucantar sky scan retrieval) and since the uncertainty of SSA is 0.03 and furthermore AAOD=(1-SSA)*AOD then the accuracy of AAOD varies as a function of AOD magnitude.

Page 9847, line 12: 400 nm should be 440 nm

Page 9847, after line 13: It should be noted here that comparisons of in situ versus AERONET retrievals of SSA have shown excellent agreement, typically within ∼0.01to 0.02. See Leahy et al., 2007 for highly absorbing biomass burning aerosol comparisons, Schafer et al., 2014 for weakly absorbing fine mode aerosols, and Reid et al., 2005 for smoke from major biomass burning regions.

Page 9847, line 23: For the most probable wind direction do you mean the climatological average wind direction in August?

Page 9848, line 4: You say that you expected high SSA values. Please explain why you had the expectation of weakly absorbing aerosols (high SSA).

Page 9848, line 12-13: Please explain why you chose only low altitudes for the back trajectory analysis. Although 500 m is often chosen it is usually coupled with 1000 m or 1500 m to be close to the mid or upper mixed aerosol layer.

Page 9848, line 19: Explain why CALIPSO satellite lidar data could not provide some

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vertical profile information on aerosols here.

Page 9849, line 8: Your choice of +-10 hours for a time match between AERONET and satellite data is very large. Please give more justification for this in the text, especially since you say the large time differences may contribute to the scatter in comparison plots.

Page 9850, lines 10-16: Your discussion of Figure 6 data is cursory and fails to mention several key facts. The site name, AOD levels, fine mode fraction (computed from the retrievals), fine mode effective radius or volume median radius and Angstrom Exponents are missing and should all be given in the text and/or Figure caption. Also see comments above in 'General Comments' regarding Figure 6 and your conjecture about dust contributions.

Page 9851, lines 1-3: You suggest that +-3 hours differences between satellite measurements can result in significant differences in optical properties. This certainly contradicts your earlier stated choice of +-10 hours for AATSR versus AERONET time matching for comparison purposes.

Page 9851, lines 9-11: Please give a more specific and quantified comparison for the 'areas where the forest fires are.'

Page 9852, lines 23-25: However, the map you show in Figure 8 (top) suggests similar SSA values for both the Amazon region and southern Africa. This contradicts both in situ (Reid et al., 2005) and AERONET retrievals (Dubovik et al., 2002; Giles et al., 2012) that both show lower SSA values in southern Africa as compared to Amazonia. The discussion of this global map of SSA is much too brief and lacks significant analysis. I suggest you either remove this Figure or alternatively describe and analyze the SSA data in much greater detail, including comparison to values in the refereed literature.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 9839, 2014.