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Atmospheric Measurement Techniques Discussions



# *Interactive comment on* "Trend analysis of the Aerosol Optical Thickness and Ångström Exponent derived from the global AERONET spectral observations" *by* J. Yoon et al.

**Anonymous Referee #2**

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Review for Atmospheric Measurement Techniques

Title: Trend analysis of the Aerosol Optical Thickness and Angstrom Exponent derived from the global AERONET spectral observations

Authors: J. Yoon, W. von Hoyningen-Huene, A. A. Kokhanovsky, M. Vountas, and J. P. Burrows

General Comments:

This paper presents some interesting results of the temporal trends in aerosol optical



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depth (AOD) and Angstrom Exponent (AE) from AERONET measurements at several sites that have enough long-term data. Given the high accuracy of these sunphotometer observed AOD, this analysis is an important contribution to the issue of trends in AOD as inferred from various satellite sensor data, which have been published in recent years. For the most part the analysis of the AOD and AE are relatively robust, however I have many issues with the methodology that the authors utilized to separate the total AOD into fine and coarse mode components. The idea of looking at the fine and coarse mode AOD trends is a good one and could be very valuable. The use of the Gobbi et al. (2007) classification methodology to determine fine/coarse breakdown is problematic since it relies on 2 channel computations of AE that are subject to large errors from the uncertainty in AOD of $\sim$0.01. This is especially true of the 675-870 nm wavelength range AE since the AOD values of these 2 wavelengths are quite close in magnitude therefore the AOD errors of 0.01 can result in very large errors in AE (675-875), especially for lower AOD values. Another issue is the use of the Dubovik et al. (2002, not 2001 as in your paper; D02) table statistics in your analysis, since spherical particle shape was assumed for all aerosols (including dust) and quality control was poor at that time in AERONET (even Version 1 quality checks had not yet been established and now the current Version 2 quality checks are even more rigorous). For example the desert dust sites of Bahrain, Solar Village and Cape Verde all include seasons with significant fine mode aerosol from industrial sources (oil industry in the Mid East; biomass burning in the Sahel) and therefore the 'dust' statistics in D02 are more representative of mixtures of dust and fine mode combustion aerosols. Examples of miss-characterization of fine/coarse mode AOD from Figure 5 include AE of Oceanic aerosol of $\sim$1.2, when Smirnov et al. (2002) has shown that AE for marine aerosol is typically $\sim$0.3-0.7; another is AE of 1.4 in the upper part of Fig 5 as the dividing line between 50% fine/coarse modes when Eck at al. (2010) has shown that the 50% fine-coarse mode point for mid visible wavelength occurs at $\sim$0.75 AE (440-870 nm), based on the latest Dubovik retrievals. Therefore, I strongly suggest replacing the current fine/coarse mode designation with the fine/coarse mode AOD values determined



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by the Spectral Deconvolution Algorithm (SDA) of O'Neill et al. (2003). These values of fine/coarse AOD are much more robust (based on quadratic fit of the AOD spectra in 5 channels from 380 to 870 nm, minimizing AOD errors), and also agree well with the Version 2 Dubovik retrievals of fine/coarse mode AOD (see Eck et al., 2010 Figure 3 b and d.). The SDA values of fine/coarse mode AOD are computed and available from the AERONET website (use the Level 2 data if you do follow this suggestion).

Additionally, in some places the English is very awkward and confusing (some examples given in Specific comments below), therefore I urge the authors to have a native speaker thoroughly read the entire manuscript with grammar and sentence structure in mind.

I recommend that this paper be published after significant revisions and suggest that it could make an important contribution to the literature.

Specific Comments:

Page 5326, line 16 : "...over regions dominated by emerging economy or slash-burn agriculture..." 'emerging economy' is somewhat awkward English.

Page 5326, line 25 : Increase of anthropogenic aerosol over what time period? Should also mention that the impact of aerosols on climate is uncertain even if trends are flat, due to large uncertainties in direct effects (aerosol properties uncertainty) and very large uncertainties in multiple indirect effects.

Page 5328, line 10-12 : AOT is measured by AERONET not retrieved. You should also state the high accuracy of AOD data from AERONET, $\sim$0.01 in the visible and near infrared (Eck et al., 1999).

Page 5328, line 22 : NO is a somewhat poor choice of acronym for number of observations, suggest using nt as on page 5332.

Page 5330, lines 11-13 & lines 19-20: Poor English, reword these sentences.



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Page 5330, lines 11: Either here or elsewhere please specify whether you only used the Level 2 AERONET data that is cloud screened and quality assured.

Page 5330, lines 18-19: The black line in Figure 2 is very difficult to see against the dark blue background, please use another color.

Page 5332, lines 2-5: Please mention that variability of the aerosol itself can and does occur which also lead to increased standard deviations, not just an effect of clouds.

Page 5333, lines 23-24: No need to duplicate the entire Dubovik et al. (2002) table in your paper, referencing is sufficient.

Page 5336, lines 12: Sulfur pollutants are also hygroscopic and therefore also enhanced by higher RH in summer. Also there is not an 'absence' of rain in summer in Europe, it does rain so please consult rainfall climatology statistics to make a more accurate statement

Page 5337, lines 1: You have omitted mention of biomass burning aerosols in West Africa from November-March (Johnson et al., 2008) which as important aerosol source in the region in this season.

Page 5337, lines 9: Give a reference for the in situ measurements showing a decrease in dust over time.

Page 5338, lines 14-16: Note that these desert sites both have low cloud cover therefore the variability in AE and AOD is caused in part by AOD variability and mixture variability of dust an pollution.

Page 5339, lines 8-9: No, dust events do not occur in Beijing in summer, they occur in spring.

Page 5340, line 18: Please mention that the Asian dust transport to Mauna Loa occurs in spring. The Dubovik et al. 2001 is an inappropriate reference for this, more specific to this phenomenon is Perry et al. (1999) or Eck et al. (2005).



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Page 5340, line 25-27: Consider analyzing the Mauna Loa data with the Mar-May dust season excluded in order to focus on background the upper tropospheric plus stratospheric trend in AOD.

Page 5341, line 1: Please add a new subsection title here since Mauna Loa is no longer being discussed in this paragraph.

Page 5341, line 5: Not really, since meteorology may be the principal driver of some trends. I think this sentence should be rewritten.

Figure 7. This is the most important figure in the paper, but it is of such small size that it is difficult to read. Please enlarge this figure.

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Interactive comment on Atmos. Meas. Tech. Discuss., 4, 5325, 2011.