Author Reply to Referee #1 Comments on MS Number acp-2009-484
[Author Comment on behalf of all Co-Authors (AC)]

Title: **Absorption Angstrom Exponent in AERONET and Related Data as an Indicator of Aerosol Composition**

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General author comment: We thank the anonymous referee for his or her efforts in reading the ms and offering comments that have helped us improve it. Our specific responses (in blue) follow each referee comment below.

Anonymous Referee #1

This paper makes the case that aerosol composition can be determined using aerosol absorption Angstrom exponent and aerosol extinction Angstrom exponent.
Response: We appreciate the positive tone of this comment, but we feel it somewhat overstates the case we have made. We feel the following excerpts from the abstract and Section 5 are more accurate:

"AAE values describing the full aerosol vertical column are strongly correlated with aerosol composition or type…. These results are consistent with, and extend, previous results from diverse air, ground, and laboratory studies using both radiometric and in situ techniques, which showed that the fractions of black carbon, organic species, and mineral dust in aerosols determine the wavelength dependence of absorption. The AERONET results reported here extend the previous results to a large, globally distributed data set describing the full vertical column of aerosols, which can contain layers of different aerosol types.
"Ambiguities in aerosol composition or mixtures thereof, resulting from intermediate AAE values, can be reduced via cluster analyses that supplement AAE with other variables, for example extinction Angstrom exponent (EAE), which is an indicator of particle size. Together with previous results, these results strengthen prospects for determination of aerosol composition from space…."
The key phrases here are
- "strongly correlated with aerosol composition or type" and
- "Ambiguities … can be reduced"

in contrast to the Referee's "composition can be determined"

Using the author's technique, the aerosol compositions are classified as dust, biomass burning, and urban industrial. The authors make the case in a simple way, and their technique seems convincing. I am therefore recommending publication with minimal changes.
Response: Thank you.

Here are a few suggestions:
(1) Many of the readers are not going to be knowledgeable about the field campaigns that form the basis of Figure 1. I would therefore add a table to the text that summarizes these campaigns. The table could list the campaign, date, location, and major goals. of the campaign. The table might be referenced in the text at the top of page 21790,

where the words “region to region” are found. I wanted to know more about these regions!
Response: Excellent suggestion. We have edited the sentence starting 5 lines below Eq. (1) to read:
“Figure 1 summarizes the Bergstrom et al. (2007) results, and Table 1 summarizes locations and other characteristics of the campaigns in which the results were obtained”

and have inserted the following table:

Table 1. Attributes of the campaigns that produced the results in Figs. 1-3

Campaign name	Acronym	Location	Dates	Research focus
Tropospheric Aerosol Radiative Forcing Observational Experiment	TARFOX	US Atlantic coast	Jul 1996	Aerosol radiative forcing
Puerto Rico Dust Experiment	PRIDE	Puerto Rico	Jun-Jul 2000	Sahara dust in Caribbean
Southern Africa Regional Science Initiative	SAFARI	Southern Africa	Aug-Sep 2000	Dry season aerosols
Aerosol Characterization Experiment-Asia	ACE-Asia	Asian Pacific coast	Mar-May 2001	Asian Pacific aerosol
International Consortium for Atmospheric Research on Transport and Transformation	ICARTT	New England Atlantic coast	Jul-Aug 2004	NE US and downwind aerosols
Megacity Initiative: Local and Global Research Observations	MILAGRO	Mexico City to Gulf of Mexico	Mar 2006	Mexico City and downwind aerosols

(2) The earth’s total aerosol loading consists of a lot of sea salt (SS) aerosol (second in mass after dust). It would be interesting to speculate where the SS aerosol would lie on Figure 5. My guess is that it would form another distinct cluster (low AAE, low EAE). If this is the case, then the method might be useful for detecting this class of aerosol – another point in its favor.
Response: We inserted the following at the end of Section 2:
“**A note on seasalt aerosols.** Seasalt aerosols can be important at many coastal and oceanic sites, and indeed Dubovik et al. (2002a) include results from a 12th site, Lanai, HI (not shown in our Figure 4 or Table 2), which they designate as oceanic (i.e., expected to be dominated by aerosols of maritime origin, with some influence of Asian dust and pollution in Spring--as later documented by Eck et al. (2005)). We have excluded the Dubovik et al. (2002a) Lanai results from this paper because many studies

of seasalt optical properties (e.g., Shettle and Fenn 1979, WMO 1983, Koepke et al. 1997, Hess et al. 1998, Tanre et al. 1999) indicate negligible absorption (hence undefined AAE) for the AERONET wavelength range (440-1020 nm). Indeed, the AERONET-retrieved SSA values at Lanai are within a standard deviation of 1.00 (specifically, 0.98, 0.97, 0.97, 0.97 ±0.03 at 440, 670, 870, and 1020 nm, where the 0.03 is the standard deviation of the 150 SSA retrievals at Lanai. Moreover, as pointed out by Dubovik et al. (2002a), the small AOD at Lanai (AOD(440 nm) usually less than 0.15) causes the AERONET retrieval uncertainty for aerosol absorption and SSA to be significantly larger than for the other sites, where SSA retrievals were restricted to cases with AOD(440 nm)≥0.7. Thus, the technique emphasized in this paper, of using AAE as an indicator of aerosol composition (or even combining AAE and EAE, as in Section 3) is not applicable to pure seasalt aerosol, because of undefined AAE. Even in the case of seasalt mixed with enough absorbing material (BC, OC or dust) to produce a well defined AAE, that AAE would be characteristic of the absorbing material, not seasalt. However, another approach, applicable to the optical data sets from AERONET and the other techniques described in this paper, would be to identify as seasalt aerosol those cases with SSA≅1 and EAE small (hence particles large). As shown by Figure 1 and Table 1 of Dubovik et al. (2002a), another characteristic of the oceanic site Lanai is relatively small retrieved values of both real and imaginary refractive index. This is an example of information that could be used to identify seasalt in multidimensional clustering analyses, described further in the following section."

(3) I hope the figures are more legible in the final published version. My old eyes needed a magnifying glass to read some of the figure legends (Fig 1 in particular).
Response: Figs 1 and 4 are multiframe figures that were designed to be full pages in ACP (i.e., image size ~7.7" high x 6.8" wide, with room for caption below). Unfortunately, publication in ACPD required them to be shrunk to ~4.6" high by 4.4" wide to fit on the ACPD side-reading pages. (Hence, image area was reduced by more than a factor 2.5, from 52 to 20 square inches.) We will ensure that they are printed as full-page in ACP, which will restore them to their original legibility.

Typos:
(1) Line 6, page 21797. I think a closing ")" is missing.
(2) Figure 2. "acronym" should be "acronyms".
Response: Both changes made.