Author Reply to Referee #2 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**

Authors: P. B. Russell, R. W. Bergstrom, Y. Shinozuka, A. D. Clarke, P.F. DeCarlo, J. L. Jimenez, J. M. Livingston, J. Redemann, B. Holben, O. Dubovik, and A. Strawa

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.

General comments:

With the employment of aerosol Absorption Angstrom Exponent (AAE) and Extinction Angstrom Exponent (EAE), the authors tried to determine aerosol compositions from AERONET and space-borne measurements. The combination of AAE with EAE extends the application of widely used AERONET data and provides a straightforward way to classify aerosol types into urban industrial, biomass burning, and dust from the cluster analysis. The results are convincing and solid. I recommend publication after stated revisions.
Response: We appreciate the positive recommendation but feel this synopsis overstates what we have actually attempted and accomplished. In particular, "the authors tried to determine aerosol compositions from … space-borne measurements " goes beyond our pointing out that Glory APS promises retrievals leading to multiwavelength AAOD, which would have potential for determining aerosol composition from space, especially if combined with the additional Glory and non-Glory information stated in the abstract. In an effort to prevent other readers from inferring too much, we have replaced, in abstract and Sections 4 and 5, "Glory … promises retrievals" by "Glory …seeks to provide retrievals".

We also feel that the Referee's statement "combination of AAE with EAE … provides a straightforward way to classify aerosol types into urban industrial, biomass burning, and dust from the cluster analysis" neglects the partial overlap of Urban-industrial and Biomass-burning clusters in Fig. 5. This partial overlap (i.e., ambiguity) was the motivation for our suggesting that multidimensional cluster analyses, using more variables retrieved by AERONET, Glory APS, or other spaceborne sensors, may be necessary, and have potential, to reduce remaining ambiguities. We have now specifically mentioned this ambiguity (i.e., partial overlap) by adding a parenthetical note at the end of this sentence in Section 3: "This suggests the value of combining several different types of remotely sensed information in multi-dimensional cluster analyses to derive the most information on aerosol type (e.g., to reduce the ambiguity resulting from the partial overlap of the biomass burning and urban-industrial clusters in Fig. 5)."

1. More detailed information about the data shown in Figure 1 and Figure 2 are necessary. About 6 different campaigns were included in these two figures, but no brief introduction about any of these campaigns and the measurements. It's very hard for the

Deleted: ResptoRefereeCommentsAPCRussell2009.doc

Deleted: 2:30:54 PM

audience to fully understand the results without any background knowledge about the experiments and how the data were obtained.
Response: Very good point, also made by Referee #1. Please see our response to Referee #1's suggestion (1) above.

2. Figure 4 showed data collected from 11 AERONET sites. However, the authors didn't provide any discussion about the data. Are those data the annual mean results or just for specific season? For example, over Maldives, the switch of Indian monsoon will bring different aerosols to the site, more marine aerosols during summer and more continental aerosols in the winter. Thus, different AAE value and SSA spectral pattern at different period might be observed at one site. For the site with distinct aerosol sources, it's crucial to identify the air mass and aerosol sources.
Response: Another very good point. The information is in Dubovik et al. (2002a), but the reader shouldn't have to go there to track it down. We have inserted in Section 2:

"We have color-coded the results in Figure 4 according to the aerosol type designations of Dubovik et al. (2002a), which apply to SSA retrievals restricted at some sites to certain months, as detailed in Table 2."

and added the following table:

Table 2. Color coding of sites/periods in Figure 4, with designations by Dubovik et al. (2002a). SSA retrievals were restricted to cases with AOD(440 nm)>0.7, so that surface albedo has negligible effect on retrieved SSA. See also footnotes for further restrictions and their effects.

Color	Site	Period	Designation	N*
Black	Goddard Space Flight Center, Greenbelt, MD	Jun-Sep 1993-2000	Urban-industrial	200

Deleted: ResptoRefereeCommentsAPCRussell2009.doc

Deleted: 2:30:54 PM

Black	Creteil/Paris, France	Jun-Sep 1999	Urban-industrial	40
Black	Mexico City	All months 1999-2000	Urban-industrial	300
Black	Maldives (INDOEX)	Jan-Apr 1999-2000	Mixed†	150
Green	Amazonian forest		Biomass burning	250
	- Brazil	Aug-Oct 1994-1994		
	- Bolivia	Aug-Oct 1998-1999		
Green	South American cerrado, Brazil	Aug-Oct 1993-1995	Biomass burning	315
Green	African savanna, Zambia	Aug-Nov 1995-2000	Biomass burning	700
Green	Boreal forest, US and Canada	Jun-Sep 1994-1998	Biomass burning	250
Red-brown	Bahrain-Persian Gulf	All months 1998-2000	Desert dust	100#
Red-brown	Solar Village, Saudi Arabia	All months 1998-2000	Desert dust	250
Red-brown	Cape Verde	All months 1993-2000	Desert dust	300

*Number of SSA retrievals

†The restriction of SSA retrievals to conditions with AOD(440 nm)>0.7 effectively restricts Maldives retrievals to conditions of pollution transport from India.

#Restricted to conditions with EAE(440,870 nm)≤0.6, to exclude industrial pollution.

3. The effect of sea-salt aerosols on the results is missing. For the sites over the remote ocean and near the coast, large amount of sea-salt will be detected and mixed with other aerosols. The existence of sea-salt particles might affect aerosol size, EAE value, and SSA spectral dependence. More discussion about the impact of sea-salt aerosols on the findings is needed.
Response: See our response to Referee #1's suggestion (2) above.

4. Figure1 and 4 are not well presented. The markers are confusing.
Response: We think the main source of the problem is the shrinkage for ACPD described above in response to Referee #1's suggestion (3). However, we are also looking into making the markers larger and/or more distinct.

5. One important publication showing SSA spectral dependence from AERONET data is missing: Eck, T. F., et al. (2005), Columnar aerosol optical properties at AERONET sites in central eastern Asia and aerosol transport to the tropical mid-Pacific, J. Geophys. Res., 110, D06202, doi:10.1029/2004JD005274.
Response: Reference added and cited twice in Section 2.

Deleted: ResptoRefereeCommentsAPCRussell2009.doc

Deleted: 2:30:54 PM