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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol spectral absorption in the Mexico City area: results from airborne measurements during MILAGRO/INTEX B" *by* R. W. Bergstrom et al.

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Author Reply to Referee's comments for MS Number acp-2009-772

Title: Aerosol Spectral Absorption in the Mexico City area: results from airborne measurements during MILAGRO/INTEX B

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General author comment: We thank the anonymous referees for their efforts in reading the manuscript and offering comments that have helped us improve it. Our specific

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Responses follow each referee comment below.

Anonymous Referee #1

General comments: The title of this paper is an excellent description of its contents: Aerosol absorption in the Mexico City area using data from MILAGRO/INTEX B. The paper looks specifically at single scattering albedo (SSA) and aerosol absorption optical depth (AAOD) inferred from aircraft data. The results are discussed by themselves and also compared with the results of others. The paper is well-focused and important, and merits publication in ACP, subject to the items discussed below. These items are suggestions to improve the paper's exposition; I found no scientific flaws to address.

Specific comments:

(1) Section 3.2: The flux divergence technique requires the measurement of net fluxes at two different levels at the top and bottom of an aerosol layer. I think it would be a good idea to spell out the altitude of the top layer, so the reader has some idea of the thickness of the layer over which flux divergence is calculated. I think this request is particularly applicable to section 5.2, where the altitudes of the bottom levels of the flights are provided, but not the top level. It would be good, also, to provide the layer thicknesses in the legend of Figure 5.

Response: The upper altitude height has been added.

(2) Section 4.0.2: Is the value for the asymmetry parameter assumed? If so, what might be a typical value at, say, 500 nm?

Response: Yes, the asymmetry parameter is assumed. The value at 500 nm was assumed to be 0.7 and we have included that value in the text.

(3) Section 4.0.2: End of third paragraph. What does "scaled the total column amount in the same ratio as the aerosol optical depth . . ." mean?

Response: What we are assuming is that the concentration of NO2 has the same

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vertical distribution as the aerosol extinction coefficient. We have changed the text to make that clear

(4) Section 5.1: Fifth and sixth paragraphs. Some of the AAE values given in the text don't jive with the corresponding values in Table 1. For example, the text state that "the extinction Angstrom exponents for this day were 1.0 and 0.8 west and east", but the table list different values for the extinction Angstrom exponents (EAE). Need to check the text and table carefully.

Response: We have corrected the table.

Technical comments:

(1) First sentence under "5 Results". Need a space between "13 March" and "and".\

Response: The correction has been made

(2) Table 1. Need "**" in front of second footnote.

Response: The correction has been made

Anonymous Referee #2

General comments: The paper describes combined airborne measurements of spectral solar irradiance (using Solar Spectral Flux Radiometer, SSFR instrument) and spectral aerosol extinction optical depth (AOD, using Ames Airborne Tracking Sunphotometer, AATS) during MILAGRO campaign in March 2006. The measurements are combined with high resolution radiative transfer (RT) model to infer spectral aerosol single scattering albedo (SSA) and aerosol absorption optical depth (AAOD) in 350nm and 1622nm spectral region outside of strong gaseous absorption lines. The methodology is sound because good quality data (SSFR and AATS) are utilized with state of the art RT model to derive spectral dependence of SSA and AOT, which potentially opens up new applications for remote discrimination of aerosol types (e.g black carbon versus organic carbon or dust). Paper analyses results from 5 flights; 2 over Gulf of Mexico

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and 3 over MCMA. Since there is little measurements of spectral aerosol absorption, especially in UV spectral region (AERONET inversions provide SSA and AAOT measurements at 4 visible and SWIR wavelengths 440nm, 670, 870 and 1020nm) the results are important and appropriate for publishing in ACP MILAGRO special issue. Especially interesting are SSA and AAOT retrievals in UVA spectral region (350-400nm) that indicate enhanced aerosol absorption attributed to organic carbon and/or dust. The SSA and AAOT results agree reasonably with other mostly ground based studies at MCMA and other locations that are well discussed. I found absorption results at SWIR wave- lengths less convincing because of typically small AOD values, when the retrievals are highly uncertain. However, there is proper acknowledgement of this problem and the error bars in the figures correctly reflect the difficulties.

To my opinion the SSA retrieval method needs to be described either in section 3.2 or , perhaps in a separate section, which gives necessary background and explanation of equation (1).

Response: We appreciate the comment and have added more background and explanation of equation (1).

Although the results presented in figures 3-6 contain sufficient details, the description is mostly in terms of extinction Angstrom Exponent (EAE) and absorption Angstrom Exponent (AAE). Both AAE and EAE are oversimplified approximations of the spectral dependence of AOD and AAOD, especially when combing UV and visible spectral regions. It is not surprising that using different wavelength pairs one can obtain different AAE and EAE values. Fitting second degree polynomial to the AOD or AAOD spectral dependence would provide better results.

Response: This is an important issue and we have added some more discussion in the text. The definition of the AAE and EAE as the derivative with respect to the wavelength is not an oversimplification. What is an oversimplification is to assume that the derivative is constant over a large spectral region. The comment that a fit with more

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curvature will produce better results is correct. The absorbing aerosols in the Mexico City atmosphere are complex mixtures of elemental carbon, dust and organic carbon and the resulting spectral absorption coefficient will have more curvature that a simple linear power law fit. In Table 1 we show the AAE for 350 – 500 nm and for 500 – 1000 nm region. Except for one case the constant AAE fits are fairly good (r2 between 0.88 and 0.99). Our point isn't that constant AAE or EAE values are the best fits to the spectral optical properties of the aerosols but that they contain useful information about the nature of the absorbing material.

I suggest tightening text and using abbreviations throughout (e.g. Fractional absorption – FA).

Response: We have used some more abbreviations and have tried to tighten the text.

I recommend publishing the paper in ACP with minor corrections aimed at improving the text.

Specific comments 27548, 15 provide references for DOSORT RT, Rayleigh OD, spectroscopic constants. What surface albedo has been used?

Response: We have added the references. The surface albedo was taken from Coddington et al (2008).

27550, 3.2 Describe retrieval of SSA

Response: We have added some more discussion.

27552, 25 Use AAOD abbreviation, " AAE fit for the [350] to 500nm region"

Response: AAOD was added; 300 nm was replaced by 350 nm.

27553, 25 ". . .with the thickness of the [aerosol] layer above the airplane . . ."

Response: The change was made

p.27556, 15 Last sentence not clear.

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Response: We have rewritten the sentence to make it clearer.

27557, first sentence: " . . .compared the [filter sample absorption] results . . ."

Response: The change was made

Next paragraph, 1st sentence: remove repetitive words : "the absorption data with ". Second sentence is not needed.

Response The repetitive words were removed. However, we believe the second sentence is needed.

15: AERONET only provides SSA and AAOT at wavelengths longer than 440nm. Therefore higher AE and lower AAE are expected.

Response: The comment in noted and we have adjusted the text.

7. Conclusions 5: - [350]-500nm region

Response: 300 was replaced by 350

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