Interactive comment on "In situ aerosol optics in Reno, NV, USA during and after the summer 2008 California wildfires and the influence of aerosol coatings" by M. Gyawali et al.

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Reply to Reviewer #4 (comments for Atmos. Chem. Phys. Discuss., 9, C3996–C3999, 2009, In situ aerosol optics in Reno, NV, USA…by Madhu Gyawali et al.).

Please refer to the Author Comments for description of the added materials and for the notations AC1, AC2, etc that are used here in the reply to the particular reviewer questions.

Reviewer comments are given in bold type-face. Our replies are given in plain text.

The influence of wildfires on the aerosol optical properties (the absorption and extinction coefficient, the Ångström exponent of absorption and of the single scattering albedo) was studied at Reno Nevada during the summer 2008. July was taken as highly affected by fire smoke, whereas August was largely unaffected by fire smoke. Comparisons with laboratory burned fuels are also briefly discussed and simulations of the Ångström exponent of absorption for various core sizes, shell sizes and two shell refractive index are presented. Generally, it is quite difficult to be sure that the measured aerosol properties described in the paper really prove the presented conclusions, so that a great effort has to be put in the paper and in the sections structure. The scattering and extinction being also measured at 2 wavelengths, the presentation of their Ångström exponents would give information on the aerosol size allowing a clearer discussion of the simulations results. As stated by the authors in the introduction, filter based absorption measurements have numbers of artifacts and a measurement of the Ångström exponent of absorption with another method and for various aerosol types is precious information.

Reply;

The answer of the first part is given in the section structure below. The scattering Ångström exponent is affected strongly by absorption, and so is not always a reliable measure of particle size.

Section 2: According to referee #2 comments, the reasons for the classification between fire smoke influence and normal month is not apparent in the paper and has to be clarified.

Reply:

We agree and have revised the manuscript to add some additional description of the measurement. See **AC4**, **AC5**, and **AC6** for revised Measurement and analysis, and Aerosol extinction variation.

No trajectory or chemical analysis was needed to verify the source of the aerosol in July or August. In July, the source was clearly the wildfires in Northern CA based on the wind directions and the intensity of the smoke from this source (more information can be found at [http://en.wikipedia.org/wiki/Summer_2008_California_wildfires, as given in the manuscript). In addition, inhabitants of Reno were acutely aware of the heavy smoke burden as breathing conditions were at times unhealthy. In August, the measurements were similar to those obtained in previous years, and the prevalence of local urban sources dominated in that case. For the purposes of this paper, which concentrates on aerosol optical properties as a consequence of the chemical mixture, we do not need detailed chemical analysis to arrive at our main conclusions. Figure 1(a) shows clearly the vast smoke source from the fires in Northern CA, and their trajectory towards Reno. This figure was representative of the smoke source and wind directions for the month of July. The optical phase diagram in Figure 6 also shows the distinction between the unusual smoky month of July and the more normal month of August.

Section 2.1: The comparison between the July and August results is presented as average (mean or median??) diurnal cycles. The presentation of the absorption, scattering and extinction time series would be useful for several reasons: first it will give an insight of the fluctuation of the optical aerosol parameters, second, the influence of wildfire smoke could be visible, allowing to estimate how much July is affected and August unaffected by fire smoke. In this section, a clear description of the usual diurnal cycles of summer months (that are influenced by fire smoke each years) and their explanation (expansion of the boundary layer, increase wind speed, rush hours. . .) should be first given with references. Then the particular cases of July and August 2008 will be better understood.

Reply:

The comparison was based on mean diurnal cycles. We compared August 08 diurnal averages with those of previous years when deciding the August 08 was “normal”.

Section 2.2: as expressed in the section title, the ALAOC estimation sounds very naive. This model presupposes that the measured aerosol particles are only formed of BC cores with organic carbon shell, what is not proved in this paper. If particles have other chemical composition, their absorption wavelength dependence will not always follows the ïA¸nˇ -1 power law dependence and the presented ïA¸c´ALAOC will no more be a measure of ALAOC but a measure of the difference of the absorption wavelength dependence from the ïA¸nˇ -1 power law. It should be also discussed why ALAOC diurnal cycle is similar for both July and August to the extinction diurnal cycle.

Reply:

See **AC3** for added clarification of ALAOC, and **AC10** for revised Simulations and Discussion. The diurnal cycle reflects boundary layer development. The ALAOC for July is quite different than for August. ALAOC is a naïve concept because absorption depends on aerosol size, morphology, mixing state and chemistry. Previous use of LAOC in the literature often emphasized only aerosol chemistry.

Section 2.3: The greater absorption at 405 nm (limit of UV) due to LAOC should be referenced. An inversion of the usual wavelength dependence of the SSA during July is observed. Such an inversion of also observed in presence of mineral dust and is mostly due to the aerosol size in this case. This SSA wavelength inversion should therefore be closer discussed, since it can be an interesting phenomenon. The diurnal cycle of SSA is similar for both July and August and shows a minimum at the same time of the August extinction maximum. An explication of both these observations should be given.

Reply:
See **AC8** for added reference. We didn't have dramatic dust storms impacting aerosol optics during this study. The cause for the diurnal cycle of SSA was given in the section 2.3 of the manuscript.

Symbols and colors similar for all figures (particularly between Fig. 2 and Fig. 4) should be chosen
Reply:
Agree and changed.

Section 2.4: The following statement "mixing, coating and coagulation of BC with organic and inorganic aerosols affects its absorption in the diluted state" should be better explained and/or proven: becomes this effect greater during the boundary layer expansion ? Why ? Does this effect only explains the diurnal cycle of the AEA?
Reply:
Boundary layer development during daylight hours coincides with the time of greatest photochemical change as well.

Next sentence is for example also not clear: the enhancement (of what ?) might be slightly greater for 870 nm than for 405 nm at this time (around 17h or during all the later part of the day), consistent with low AEA values (which ones?)
Reply:
The enhancement of absorption for 870 nm (as mentioned in the manuscript in line 25 page 14065, due to slightly greater values of the imaginary part of the refractive index at longer wavelengths). Consistent with the low AEA values in the later part of days in August (this can be inferred from the explanation of diurnal variation of AEA presented in the same section).

Section 2.5: the comparison with laboratory experiment is interesting. It seems that in August the AEA remains constant whereas the SSA varies from 0.7 to about 1, and in July the SSA remains more or less constant whereas the AEA varies from 1.4 to 2.2. This observation should be explained and related to other results such as all the diurnal cycles to obtain a clear idea of all the influence of fire smoke

Reply:
The analysis of SSA variation is described in the manuscript in section 2.3.

Section 2.6: "Electromagnetic theory" is not a sufficient explanation to understand how the simulation was performed. Sufficient explanations or references should be available to reproduce the simulation. I also like to have a reference for the geometrical limit of AEA being zero, since I never found it myself. The authors should also explain that a constant refractive index as a function of the wavelength, as chosen for the core refractive index in the simulation, involves a ïA¸nˇ -1 dependence of the absorption coefficient. Finally, the color scheme of Figures 8 and 9 does not help to see the increase of decrease of AEA.

Reply:

See **AC10** for Simulations and Discussion.

The AEA approaching zero for geometrical limit has implicitly been discussed in Bond (2001) .

Conclusion: Some very important statements (for example " the organic coating need not be intrinsically brown to observe effects commonly referred to as those caused by brown carbon light absorption" or " the diurnal variation of aerosol extinction suggests that vertical development of the boundary layer is delayed under smoky conditions, likely due to reduction of the solar forcing at the surface" or "particle absorption could be in the surface area regime at 405nm, whereas it could be in the volume or resonance regime for 870 nm for sufficiently large particles") are only given in the conclusion and are not presented, discussed or explained previously in the paper, so that the reader cannot be convinced at al.

Reply:

We agree with this comment. Detail explanations are presented in the revised manuscript. See **AC4, AC5**, and **AC10.**

Reference for the specific reply

Bond, T. C.: Spectral dependence of visible light absorption by carbonaceous particles emitted from coal combustion, Geophys. Res. Lett., 28, 4075-4078, 2001.