

**We would like to thank the review for valuable suggestions and time. Our responses to the reviewer comments are given below.**

**Anonymous Referee#2 Received and published: 27 December 2016**

**Referee Comment:** Several assumptions are used when estimating the contributions of BC, BrC and lensing effect to total absorption coefficients. One of the assumptions is that the absorption enhancement from lensing is constant at all wavelengths, and this assumption is used in Approach 1 and 2. Another assumption is that clear coated BC has an AAE of 1.6, and this assumption is used in approach 3. According to references introduced by authors, these two assumptions are based on Mie calculation when all BC are core-shell mixed with other aerosol components. However, the mixing state of BC in this study is unknown. Obviously, the mixing state of BC will exert significant influences on the calculated contributions of BC, BrC and lensing effect. More analysis and discussions are needed to address the possible mixing the state of BC. I suggest that the authors estimate the influences of mixing state based on calculations in this study.

**Author Response:** We agree with the reviewer that mixing state of BC will have significant influence on estimated BC, BrC, and lensing fractional absorption for approach 3 where the AAE = 1.6 assumes all BC is internally mixed. However, mixing state is implicitly included in approaches 1 and 2. In these two approaches we measure the absorption enhancement and that measurement is of the aerosol in its actual mixing state, whatever that may be. Assuming that the absorption enhancement is the same at the different wavelengths is not affected too much by mixing state, though the actual absorption enhancement clearly is. The complications of mixing state is a major reason why we compare the BC, BrC, and lensing fractional absorption from different approaches, to see how much we can parameterize with no knowledge of the mixing state, which is often not known in practice. We investigate the extremes of how the mixing state of BC will affect the calculated values by comparing the result from approach 2 and approach 3. From equation 9 absorption from BrC is calculated as:

$$b_{abs_{\lambda_1-BrC}} = b_{abs_{\lambda_1-dry}} - b_{abs_{660-dry}} \times \left(\frac{660}{\lambda_1}\right)^1 \quad (\text{Alternate form of equation 7}) \quad (1)$$

This approach is equivalent to assuming BC is externally mixed (lensing is negligible) while approach 3 assumes the maximum effects from lensing (BC are core-shell mixed, as mention by the reviewer). On Page 11 Line 11 we have a subsection titled, “Alternate description of approach 2” that discuss this. By comparing the BrC absorption fraction from approach 2 and 3 we quantify the potential influence of mixing state of BC on calculated BrC fractional absorption.

**Referee Comment:** Results of parallel runs of thermally denuded channel and dry channel demonstrate that significant discrepancy exists (larger than 50 % which is at the outer limits of the Gaussian error curve) between measured absorption coefficients at 405 nm from two different photoacoustic absorption spectrometers. Though results of added experiments show that the dry 405 channel is better and absorption coefficient of the denuded channel is corrected according results of parallel runs, large bias still exist in measured absorption coefficient at 405 nm and this error will propagate into the calculation of AAE and influences the analytical results introduced in

this research. Hence, uncertainty analysis about calculated AAE should be given in the text to acknowledge the awareness of this problem.

**Author Response:** We agree with the reviewer that uncertainty in absorption measurement will propagate to the estimated AAE values. However, we estimated AAE from the slope of the least squares fit to the logarithm of absorption coefficient vs. the logarithm of wavelength at 405, 532, and 660 nm. As discussed in the paper, the uncertainties in absorption coefficient at 405, 532, and 660 nm are different. Given this complication, we decided to report one standard deviation of the slope as uncertainty in the AAE values.

**Referee Comment:** Title of table 1, “at 405 nm estimated from four different approaches”, it should be three approaches.

**Author Response:** We changed “four different approaches” to three different approaches.

**Referee Comment:** Caption of Figure 2, the unit of absorption coefficient should be included.

**Author Response:** The units of the absorption coefficient are now reported in the caption of Figure 2.