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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Reduction in biomass burning aerosol light absorption upon humidification: roles of inorganically-induced hygroscopicity, particle collapse, and photoacoustic heat and mass transfer" *by* K. A. Lewis et al.

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Response to General Comments:

1) While we agree that there are a number of figures in the manuscript, the authors and coauthors feel that all are needed to adequately present and interpret the information contained within, and we are very hesitant to combine figures and further decrease their size and readability. This is discussed further with respect to individual figures

below.

2) The following paragraph has been added to the conclusion (P15273 L21) to provide a summary of our interpretation of the results and some quantification of the three competing mechanisms increasing or decreasing light absorption:

"Three mechanisms altering light absorption measurements were discussed; the magnitude of these are summarized here: Particle collapse within typical particle size range gives a decrease in absorption by as much as 6%, but also shows and increase as fractal dimension approaches three. Modeling efforts from the literature indicate absorption enhancements of around 50% for black carbon cores with weakly absorbing coatings. Particle morphological differences limit the conclusions that can be made from coated sphere theory. Mass transfer without correction leads to as much as 20% reduction of absorption from the real value for aerosol with large inorganic content. The tentative conclusion is that mass transfer associated with photoacoustic measurement of aerosol light absorption is the mechanism that best explains the observed reduction of aerosol light absorption with RH."

The limited information we have regarding size distribution of the light-absorbing aerosol fraction does not allow for further modeling based on size distributions and non-BC mass contribution.

3) This question of size distributions and the "Raspet limitation of continuum flow" can only be answered through laboratory experiments, since we do not have the size distribution of aerosol fraction giving rise to light absorption. It is an excellent idea for follow-on work.

4) Uncertainty bars have been added to Figures 2 and 4 to address measurement uncertainties in the photoacoustic measurements. See further information on this topic below in discussion of changes made to Figs. 2 and 4.

5) The calculated "salt/aqueous surface fraction" represents a result of the theory de-

veloped incorporating mass transfer effects based on light absorption measurements. Use of this theory should not be limited in additional applications.

P15249 L25: To indicate that not all light absorbing particles are from incomplete combustion this line has been changed to read: "Light absorbing particles are often formed by incomplete combustion of carbonaceous materials . . ."

P15250 L10: The following line has been added to better summarize the additional factors contributing to the variability in combustion aerosol radiative impact: P15250 L12: "Additional variability in the radiative impact of biomass burning aerosol is provided by a number of factors including combustion conditions and morphological properties of the aerosol particles, as well as other factors discussed in this manuscript: the fractal dimension and collapse of the particles and effects of aerosol aging such as coating enhancement."

P15254 L22: "base line" has been changed to "baseline".

P15260 L25: The bimodal distribution of palmetto combustion products could indicate uneven internal mixing as well as external mixing. P15260 L23 has been changed to read: "The separate growth of particles with increasing RH into "more" and "less" hygroscopic modes indicates some degree of external mixing and/or uneven internal mixing within the palmetto smoke aerosol (Carrico et al., 2005; Zhang et al., 1993)."

P15272 L8: The following clarification has been added to address the question of the relevance of a polynomial fit in Figure 15: P15272 L8: "The polynomial fit is included simply as a guide to the eye and is not meant to convey functional dependence. A hand-drawn curve representing the data would also suffice for our purpose."

P15272 L9: It is quite true that spread in the data points should not be related to the polynomial fit. P15272 L8/L9 has been changed to read: "The spread in the points is attributable to inaccuracies in the RH measurement on the photoacoustic instrument."

Also, to answer the second related question, the 'inaccuracies' are in the measurement

of RH.

P15272 L15: Thank you for bringing up this point regarding the different deliquescence points of different salts. The following line has been added to include discussion of this influence: P15272 L15: "As different salts will have different deliquescence points, the shape of the "aqueous solution fraction" curves may be influenced by multiple salts responding at different RH levels."

Figures 1 and 3: The authors and coauthors feel that the variability with RH in measured light scattering and absorption values for each fuel type is an important factor in our discussion of smoke properties, and therefore wish to include all three fuel types in three different panels. Additionally, we are reluctant to combine Figs. 1 and 3 due to the inevitable shrinkage and loss of readability it would cause. Therefore, Figs. 1 and 3 will be left as is.

Figure 2: A f(RH) = 1 line has been added for visual reference.

Figure 4: A key as been added so the reader can see which points relate to which fuel type.

Figures 2 and 4: Error bars have been added to a point representing each of the three fuel types in Figs. 2 and 4 to better represent the observed variability. The following explanation of calculated uncertainty has been added to the Fig. 2 caption: (P15281) "Uncertainty in fRH, sca measurements (and fRH, abs measurements in Fig. 4) are determined assuming 5% relative uncertainty in photoacoustic measurements." And to the Fig. 4 caption: (P15283) "Error bars are as in Figure 2."

Figure 5: Percent mass has been added to the sections of the first pie chart in each panel.

Figures 6 and 7: It is the authors' view that reducing Figs. 6 and 7 in the manner suggested by Referee #1 presents images of too few particles so that the variability in morphological properties of the individual aerosol particles is even less well represented. We would prefer to keep Figs. 6 and 7 as they are to show that the combustion particles vary in size, shape and fractal-like nature.

Figure 9: Similar to the discussion of Figs. 6 and 7 above, the authors are disinclined to zoom in and focus on fewer particles in Fig. 9 because we appreciate that the figure shows the variability of organic composition in individual particles.

Figures 8 and 10: A more obvious fuel type title has been added above each three-panel figure. The authors believe that readability of Figs. 8 and 10 will be reduced too much if the figures are combined into a single 6 panel figure, and would prefer to have them remain separate.

Figure 11: A g(RH)=1 line has been added for visual reference.

Figure 13: The authors understand the point of view of Referee #1 but feel that the figure as it is best represents our intentions for including it in the manuscript. We would prefer not to further interpret the data, as it is not our own.

Figure 15: The y-axis label of Fig. 15 has been changed to read ‘aqueous solution fraction’ to dispel confusion.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 15247, 2009.