

## ***Interactive comment on “Dynamic light absorption of biomass burning organic carbon photochemically aged under natural sunlight” by M. Zhong and M. Jang***

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### **Response to Referee 2**

We thank Reviewer 2 for valuable comments.

Referee comments:

This paper presents to some unique experiments on brown carbon from biomass burning emissions and is a nice contribution to the field. It also presents nice experimental procedures for assessing the optical properties of the organic carbon. I agree with the other anonymous reviewer that the conclusions for increases and decreases in MAC  
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are not necessarily justified by the experimental results. It seems that there needs to be some more analysis to justify these conclusions. Included in this is the concept already mentioned by reviewer 1; blank chamber runs are important baseline to consider.

#### **Response:**

Please find the response to comments 1.2 and 1.3 from reviewer 1.

1. The introduction is light on previous work. For example, treating BC and EC as equivalent, “BC is well know for its climate warming effect.” “...dynamic evolution under atmospheric conditions.” These examples should reference the most recent research that backs up these statements.

#### **Response:**

We have cited recent studies in the introduction section of the revised manuscript and reads now,

“... In this study, BC and elemental carbon (EC) are treated as equivalent (Bahner et al., 2007). BC is well known for its climate warming effect (Bond et al., 2013; Quinn et al., 2008; Jacobson, 2000). Light absorption of OC has been poorly understood mainly due to its complex chemical composition and dynamic evolution under atmospheric conditions (Jimenez et al., 2009; Rudich et al., 2007) ...” (Section 1, paragraph 1)

2. Can you be sure that collection of OC onto filters does not impact the properties you measure?

#### **Response:**

The method development for light absorption measurement of organic aerosol using RUV-IS has been published in our previous paper (Zhong and Jang, 2011). Light absorption of the filter sample has been calibrated using organic particles with known light absorption coefficient. The effect of particle scattering on light absorption has also been tested in the method development. The influence of particle scattering is

negligible on OC light absorption.

Reference: Zhong, M., and Jang, M.: Light absorption coefficient measurement of SOA using a UV-Visible spectrometer connected with an integrating sphere, Atmospheric Environment, 45, 4263-4271, 10.1016/j.atmosenv.2011.04.082, 2011.

3. Section 3.1: This method of attribution of absorption contains uncertainties recently assessed by Lack and Langridge (<http://www.atmos-chem-physdiscuss.net/13/15493/2013/acpd-13-15493-2013.html>). Please spend some time assessing all of your uncertainties in this paper. For example, the figure 2 caption mentions how the uncertainty was determined but does not say what the uncertainty in each component.

**Response:**

As stated in the paper of Lack and Langridge (2013), the uncertainties of AAE attribution method is minimized when the total absorption is dominated by OC. In our study, OC mass from smoldering combustion contributes higher than 95% of the total carbon mass (Table 1). We estimated AAE of BC from the filter sample which was extracted with organic solvent (methanol). The AAE value (1.03) in our study would be possibly underestimated compared to the AAE value (1.2) associated with BC coated with OC layer. The value of 1.2 is determined using particle size distributions and Mie theory from the ambient fire sample (Lack and Langridge, 2013). When 1.2 of AAE is applied to our data, OC light absorbance is reduced by about 5%. This change is relatively small compared to the errors originating from analytical instruments used in this study.

The uncertainties associated with OC mass absorption cross section in equations 1-3 are estimated using propagation of errors from OC/EC analyzer, UV-visible spectrometer, and the correction factor  $f$ . Uncertainty of OC/EC analyzer was determined by dividing  $0.5 \mu\text{g m}^{-3}$  (the absolute error) by the measured OC values. Uncertainty of UV-visible spectrometer was determined by dividing 0.002 (the absolute error) by the measured absorbance. The standard error of  $f$  is 8%, which is estimated from the linear regression of calibration data (Zhong and Jang 2011). The uncertainties associ-

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ated with  $MAC_{OC}$  have been updated in the caption in Fig. 2.

4. P20786 L26: What has been reported?

**Response:**

We modified the sentence as follows (Section 1, paragraph 6):

"Smoldering-phase burning has been reported to consume over 50% of biomass in temperate and boreal fires".

5. P20786 L27: Delete "the resulting". After "wood burning OC" add "emissions were", delete "was". P20786 L28: Delete "that exposure to" and make a new sentence "Natural sunlight was used as the radiation source".

**Response:**

This has been corrected (Section 1, paragraph 6) and reads now:

"In this study, wood burning OC emissions were photochemically oxidized using a large outdoor chamber ( $104 \text{ m}^3$ ). Natural sunlight was used as the radiation source."

6. P20787 L16: 4 inches in diameter?

**Response:**

Yes. We have changed from "a 4 inch alumina tube (0.5 meter in length)" to "an alumina tube (4-inch diameter, 1.6-foot length)". (Section 2.1, paragraph 2)

7. P20789 L19: Wood burning particles can contain inorganics also.

**Response:**

We agree with the reviewer. This sentence has been deleted.

8. P20791 L14: Why did you choose 600nm for the end point of integration?

**Response:**

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Beyond 600nm, the light absorption of OC is very weak. OC mainly absorbs UV and short visible light.

9. P20792: L2: Better term than "colorant"?

**Response:**

We have changed from "colorant" to "chromophores" (Section 3.2, paragraph 2).

10. P20792: L4: abundance of chromophores?

**Response:**

We has changed from "there are abundant of chromophores" to "there is an abundance of chromophores" (Section 3.2, paragraph 2)

11. P20793 L18: delete e on levoglucosane

**Response:**

This has been corrected (Section 3.5, paragraph 1).