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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Particle size distributions from laboratory-scale biomass fires using fast response instruments" *by* S. Hosseini et al.

Anonymous Referee #1

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This study reports characteristics of fast time-dependent particle size distribution from lab scale biomass fires for southwestern US fuels. The study was carried out in the combustion facility at the USDA Forest Service's Fire Science Laboratory (FSL), Missoula, MT. The study claims to be the first of its kind in providing details regarding the evolution of particle size distribution in wildland fires, and a way to separate out size distribution characteristics with respect to the flame Modified Combustion Efficiency (MCE).

Major Concerns:

1) The study uses two different sizing techniques to measure particle size – mobility and aerodynamic. However, no where in the manuscript do the authors define and/or briefly introduce – a) the basic concepts and equations governing the two sizing tech-

niques, and b) the working of the FMPS and the APS. I strongly suggest the authors to also include citations when introducing these concepts in the manuscript. OP-FTIR spectrometer also requires a brief introduction and citations for readers' convenience.

2) The study fails to convince the reviewer about the reliability of the measured size distributions. It is a well accepted fact that flaming combustion produces fractal-like particles. Fractal-like particles will show significant differences in the size distributions measured by mobility and aerodynamic techniques. These are not real discrepancies; instead, they merely capture the different dependence of both equivalent diameters on the fundamental particle properties. This phenomenon has been observed in the measurement of ambient aerosol. Please refer to (Chakrabarti, B., Singh, M., and Sioutas, C. (2004). Development of a Near Continuous Monitor for Measurment of the Sub-150 nm PM Mass Concentration,Aerosol Sci. Technol. 38(S1):239–252.) That said, I would like the authors to provide some basic information on:

a) Whether any charge correction was used when measuring the mobility size distribution of the particles. It is very likely that multiple charges could affect the size distribution retrievals of the already charged smoke particles. This could cause error in determining the peak of the particle geometric mean diameter.

b) A logical explanation as to why the major modes of their size distribution as measured by the FMPS are smaller than what has been observed by previous studies conducted in the USDA FSL (e.g. Chakrabarty et al. (2006)). What was the flow regime of these particles? Flow regime is very important information as it helps determine the dynamic shape factor information of the particle. The dynamic shape factor directly affects the particle mobility diameters. For e.g. a fractal-like particle experiences a larger drag force but the same electrical force compared to its volume equivalent sphere, so it is "sized" as a mobility-equivalent sphere that is larger than its volume-equivalent sphere. I strongly suggest the authors to think on these lines and justify their observation. This will give clarity to the readers.

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3) The distinguishing of the modes of combustion using slopes of MCE vs. geometric mean diameter fails to provide any insight to the readers. Why should this technique prevail over the commonly used technique of using only MCE values? First off, there has been no error analysis done for the size distribution measurements done in this manuscript. Secondly, the authors never provide any convincing argument – laid on a strong theoretical foundation – regarding the validity and reliability of their measurements. In Fig. 9(c)., the trend of the graph is different than that of Fig. 9(a) and (b). Why? It seems to me that the spacing of diameters in the y-axes in Fig. 9 is very narrow, such that any error introduced in the particle size distributions could mess up the whole MCE vs. geometric mean diameter trend. That is why I strongly suggest the authors to flesh out the details of their particle size distribution methodology and then claim the MCE vs. geometric mean diameter trend.

4) In Figure 6, the authors claim that the particles larger than 0.5 micron attribute to 30% of total volume measured by APS and FMPS. Again, this study involves measuring fractal-like particles from flaming phase, which implies that the size distribution will show significant differences in the size distributions measured by mobility and aerodynamic techniques. That said, I would want to see an error bar introduced in the "30%". During the course of this experiment, the authors never take into account of the effect of flow regime on aerodynamic diameter measurement. Significant corrections apply in the APS for large fractal-like particles with Reynolds number greater than 0.5, because in this case the drag is non-Stokesian. Secondly, relative humidity (RH) could also affect the measurements, and hence, information on RH could be very helpful. Thirdly, for fractal-like particles of same density, their mobility diameter is greater than their aerodynamic diameter (refer to Baron, P. A., and Willeke, K. (2001). Gas and Particle Motion. In Aerosol Measurement:Principles, Techniques, and Applications, edited by P. A. Baron and K. Willeke. Wiley, New York). Therefore, it could be very well possible that the total volume be greater than 30%. I would like to see all these issues addressed in the manuscript.

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Minor comments:

1) In the abstract, the abbreviations (like US, USDA, vs.) need to be spelled out.

2) Section 3.1: How did the authors ensure that the burns were similar to actual or real burning condition as claimed?

3) Section 3.1 2nd para – Please elaborate on the other indicators (other than the MCE) the authors used to segregate the mode of combustion during each burn.

4) Section 3.1 2nd para – Shouldn't it be "geometric mean diameter" instead of "geometric diameter". If no, then how did the authors calculate the geometric diameter for flaming phase particles (fractal-like)?

5) Section 3.1 3rd para – "of" after "Analysis" needs to be added.

6) Section 4: Typo – "partcle" in " Time averaged partcle concentrations. . .."

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 8595, 2010.