Response to Reviewer 2:

Comments:

Black carbon is a crucial component of aerosols in the atmosphere and the corresponding hygroscopicity is important for studying their CCN, IN and lifetime properties. In this study, the hygroscopic properties of BC parties from different fuel and aging process were measured. The results is interesting and convincing. I recommend this manuscript to be published after some major revisions.

Reply: We would like to thank you for the time and effort spent in reviewing the manuscript. Your valuable comments are helpful for improve our manuscript. The following is a point-by-point response to all the comments, and the manuscript has been revised substantially according to your comments.

Major Comments

Q1. One of the major concerns is the basic microphysical properties of the generated BC particles from different types. Are there any size distribution and morphology information about the DBC and UBC? These properties are important for understanding the hygroscopicity of the BC.

A1. We added the results of TEM experiments on various soot samples and the TEM images of soot samples are shown below. All soot samples consisted of typical spherical particles, which formed long chainlike agglomerates as reported in other studies (Han et al., 2012; Liu et al., 2010). The diameter distribution of soot particles based on TEM analysis are also shown below. Particles exhibit a relatively uniform particle size distribution.

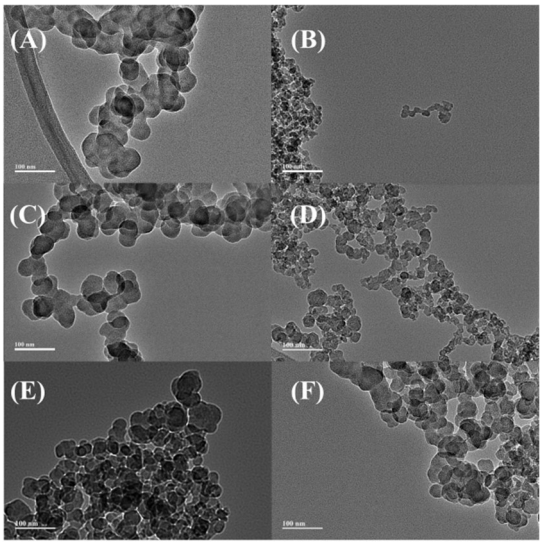

Figure 2. TEM images of n-hexane flame soot (A), decane flame soot (B), toluene flame soot (C), diesel soot (D), U-soot aggregates (E) before and (F) after aged with 5 ppm of SO_2 for 10 h.

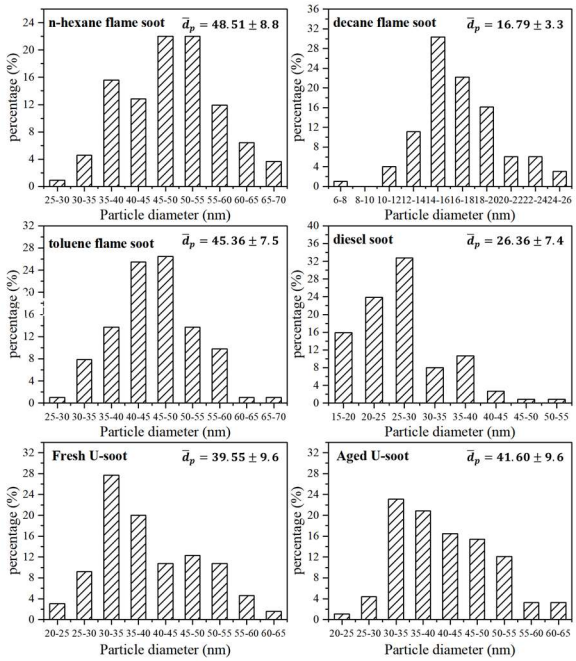

Figure 3. Diameter distribution of n-hexane flame soot, decane flame soot, toluene flame soot and diesel soot and U-soot particles before and after aged with 5 ppm of SO_2 for 10 h.

These discussions have been added in the revised manuscript (Line 154-167).

Q2. The VSA measure the hygroscopic properties of the BC. I didn't get the information that the measured results represent the BC particles of bulk information or single

particle? The author mentioned that the mass of BC under dry conditions was typically 1-5 mg. Please give us the size information of BC particles as the size is a very important parameter that relate the hygroscopicity with the mass increment.

A2. The vapor sorption analyzer (VSA) has been introduced and applied to study hygroscopicity of atmospherically relevant particles in previous work (Gu et al., 2017). This instrument consists of two main parts: (1) a high-precision balance used to measure the mass of samples and (2) a humidity chamber in which temperature and RH can be precisely regulated and also monitored online. The VSA measurement results in a mass change during water absorption of the bulk black carbon powder. Size distribution and morphology information about the soot samples are showed in Figure 2 and 3. These discussions have been added in the revised manuscript (Line 154-167).

Minor Comments:

Q1. Maybe a table is enough for figure 3.

A1. Thanks for your suggestion. The ratio of OC/EC of soot samples has been listed in the Table 2 and the OC/EC figure is deleted. (Line 221):

Table 2. Mass concentration of SO_4^{2-} and NO_3^- and the ratio of OC/EC of soots.

Soot	Mass concentration of SO_4^{2-} (μg mg^{-1})	Mass concentration of NO_3^- (μg mg^{-1})	OC/EC
n-hexane flame soot	0.00	0.19	0.41±0.02
toluene flame soot	0.00	0.18	0.24±0.04
decane flame soot	0.00	0.22	0.16±0.06
DS	11.46	1.44	0.14±0.02
U-soot	2.55	0.24	0.12±0.03
U-soot aged 2h	4.83	0.20	---
U-soot aged 6h	7.14	0.19	---
U-soot aged 10h	9.61	0.20	---

Q2. In section 3.1 there are five types of BC particles. Why are there only three type of

BC presented in section 3.2?

A2. In section 3.1, the inorganic ions present in five different black carbons were analyzed using IC. The findings revealed that DBC and UBC contained significant amounts of SO_4^{2-} and NO_3^- ions. On the other hand, the three prepared black carbons exhibited minimal levels of inorganic ions. Thus, the three prepared black carbons were chosen to investigate the impact of factors other than inorganic ions on the hygroscopic properties of black carbon. Because inorganic components affect the hygroscopicity more significantly than OC and microstructure, the information of OC and microstructure of DBC and UBC was not shown.

Q3. As best as I know, the hygroscopic properties of BC particles were not directly related with the ice nucleation activation of BC in this study. The author mentioned the ice nucleation activation for many times but I don't think they necessary.

A3. Thanks for your suggestion. Due to its lack of relevance in the article, the mention of black carbon's ice nucleation property was deemed inappropriate and subsequently removed.

REFERENCE

Gu, W., Li, Y., Zhu, J., Jia, X., Lin, Q., Zhang, G., Ding, X., Song, W., Bi, X., Wang, X., and Tang, M.: Investigation of water adsorption and hygroscopicity of atmospherically relevant particles using a commercial vapor sorption analyzer, Atmospheric Measurement Techniques, 10, 3821-3832, 10.5194/amt-10-3821-2017, 2017.

Han, C., Liu, Y., Liu, C., Ma, J., and He, H.: Influence of combustion conditions on hydrophilic properties and microstructure of flame soot, J Phys Chem A, 116, 4129-4136, 10.1021/jp301041w, 2012.

Liu, Y., Liu, C., Ma, J., Ma, Q., and He, H.: Structural and hygroscopic changes of soot during heterogeneous reaction with O-3, Physical Chemistry Chemical Physics, 12, 10896-10903, 10.1039/c0cp00402b, 2010.