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Comment on acp-2021-411

Anonymous Referee #3

Referee comment on "Mixing state of refractory black carbon in fog and haze at rural sites in winter on the North China Plain" by Yuting Zhang et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-411-RC2, 2021

Comments on "Technical note: Mixing state of refractory black carbon in fog and haze at rural sites in winter on the North China Plain" by Zhang et al.

In this paper, authors reported the measurement results of refractory black carbon (rBC) measured using a single particle soot photometer (SP2) in relation to the meteorological variabilities in winter season on the North China Plain. A co-located instrument, high-resolution aerosol mass spectrometer (HR-AMS) measured the chemical composition of submicron non-refractory species in addition to rBC, which was beneficial to discuss the changes in the coating of rBC particles. Furthermore, a wide range of air temperature detected during the observation period is a unique feature for investigating the changes in the particle microphysical properties of rBC under different meteorological conditions. The topics with which this paper deals meet the scope of Atmospheric Chemistry and Physics. There are some points to be addressed before accepting this manuscript. Please consider the following comments for the revision.

Major Comments

Mentions about the impacts of droplet collision and WBF process

In this study, air near the surface level was sampled for the SP2. It is hard to connect the observed changes in the size distributions of rBC particles near the surface level to the process in cloud. Authors referenced the papers with respect this topic (e.g., Ding et al., 2019). Ding et al. (2019) conducted the observation in cloud at a high-altitude site, indicating their results were based on the direct evidence from in-situ characterization of in-cloud scavenging of rBC particles. Ground-level measurements can be affected by not only the wet deposition process but also the horizontal advection. Authors need to clarify the differences between this and referred previous studies. So, this description especially in Abstract and Conclusion seems overstating the observational results, and should be removed if not further verified.

Data analyses of the coating thickness of rBC particles

As authors indicated in P14 L. 380-383, and previous studies (Schwarz et al., 2008a; Zhao

et al., 2020) suggested, the coating thickness of rBC-containing particles with the core diameter smaller than 140-150 nm is not quantitatively evaluated because the light scattering signals originated from such small rBC particles does not exceed the noise level. Descriptions on relative and absolute coating thickness (RCT and ACT, respectively) for the size range of core diameter from 70-500 nm in section 3.3.1, and figures 5 and 6 (also S4 and S5) included such misleading results, even though authors noted this point in the manuscript. These results should not be included in order to minimize the misinterpretation by readers. Please consider the necessary modification to prevent readers from misunderstanding the results provided in this study.

The analyses of RH and temperature dependence of mixing state and light absorption properties.

Air temperature widely varied from < -8ºC to > 4 ºC, indicating that the parts of the data sets were obtained in the subcooled and supercooled condition at the same RH level. When RH dependence shown in Figure 9 is separately analyzed by the condition of the air temperature (maybe lower or higher than 0ºC), the discussion will be more insightful.

Minor Comments

P2 L47; "appropriate" should be "favorable".

P3 L79; adsorption efficiency must be absorption efficiency.

P4 L80; Does the thermal effect mean the direct effect of BC (heating the atmosphere)?

P4 L106; "relative, absolute" should be "relative and absolute".

P5 section 2.1; Please describe the relative humidity conditions for the aerosol measurements, HR-AMS and SP2.

P5 L126–127; To the best of my knowledge, "soft black carbon tube" is not widely used in the aerosol research community. Please describe the details about this product (manufacturer, what are the beneficial points to use this instead of other types of tubes, and impacts to the SP2 deployments (what is "black carbon" here, and does this make no contamination?))

P5 L136; Only the detection of the incandescence signal cannot lead to derive the information about the boiling point temperature. In the SP2 community, the ratio of the signals observed at the detectors for narrow and broad wavelength bands is used for estimating the color temperature of thermal radiation from rBC-containing particles.

P7 section 2.2.3; Uncertainties to estimate the optical properties using the Mie theory is related to not only simple assumption of shell-core structure of rBC-containing particles but also spherical shape of rBC particles. This point should be included.

P15 L399; "an uncoated rBC core diameter" is more simply Dc, isn't it?

P15 L417; "refraction index" must be "refractive index".

P16 L448; "clear noon-low and morning and evening-high pattern" is a lengthy phrase and hard to understand. Please rephrase this into more appropriate and easy-to-understand expression. Similar phrases are found in elsewhere (e.g., P17 L467). This also should be modified accordingly.

P17 K 463; “an opposite trend” is not appropriate, because their relationships do not seem anticorrelated.

P18–19 section 3.5; The evaporation of aerosol components is discussed in relation to increases in the air temperature from around zero to higher. To the best of my knowledge, at least for ammonium nitrate, the temperature around zero is still favorable condition sustaining the existence of particulate phase nitrate. The discussions described here seems too simplistic. Please refer the studies about the researches on the equilibrium of submicron aerosols (e.g., Morino et al., 2006) and discuss more carefully this part.

P19 L516; “u nder” (space between u and n) should be modified.

P20 L 558; Does “non-homogeneous” mean “heterogeneous”?

References for this comment.

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