Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-570-RC2, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Measurement report: Evaluation of sources and mixing state of black carbon aerosol under the background of emission reduction in the North China Plain: implications for radiative effect" *by* Qiyuan Wang et al.

Anonymous Referee #2

Received and published: 24 August 2020

Summary:

This paper discusses measurements of black carbon (BC) made with an AE33 aethalometer and a SP-AMS in the North China Plain (NCP) during winter in 2017-2018. These observations are discussed in the context of recent emission reduction policies. Initial laboratory experiments were made of different fuel sources in an environmental chamber to develop a model to interpret the aethalometer measurements. This model was then applied to 2 months of measurements at a ground site, and the results are interpreted in the context of WRF-Chem modeling results to estimate relative

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contributions from regional sources and the BC radiative effect. The relative contributions of liquid fossil fuel sources and solid fuel sources were evaluated, and these relative sources were discussed in the context of their contribution to the regional BC radiative effect.

The observations and the analysis presented here are a valuable contribution to the literature, given the importance of BC as a climate forcer and the NCP as a significant anthropogenic source region for these aerosols. The conclusion that focusing on a reduction of BC from solid fuel sources could lead to greater gains than liquid fuels is an important conclusion for policy makers.

While it's clear that a significant amount of work went into the acquisition of measurements and the analysis of results presented in this study, the discussion is often challenging to follow. While each separate part of the measurements, analysis, and modeling were described in Section 2, it is often not clear which measurement or model contributed to the results discussed in Section 3. The paper would also benefit from a more clear discussion of the BC observations in light of best practices for discussing observations from different instruments established in the recent literature. In addition, the radiative forcing calculation is not clearly described.

General Comments:

Observations of BC with the different instruments used in the study should be more clearly distinguished (eBC, rBC) as discussed in Lack et al. 2014. This is an important issue when comparing observations between different instruments, as BC is operationally defined, and this point should be made clearly in the discussion. This is particularly confusing in the discussion of the source-specific AAE model, as it seems both observations from the aethalometer and the SP-AMS are used to determine the source-specific AAE values. It is also important in the context of the BC radiative effect calculation, as observations of BC mass loadings can differ by a factor of 2 or more when comparing different measurement techniques.

The discussion of the radiative forcing is not very clear, and I had a hard time following how this calculation was performed. More details need to be given. In addition, this appears to be a calculation of the BC radiative effect (rather than radiative forcing), as described in Heald et al. 2014.

Overall, the paper could benefit from English language editing.

Specific Comments:

The title is quite long.

Page 1, lines 23-25. It is unclear here how the “local emissions” differ from the “emissions in the NCP”. If this is meant to differentiate local emissions relative to regional emissions this could be more clearly stated.

A schematic of the instrument setup during the environmental chamber experiments and the measurement campaign could be a helpful addition. Additionally the map showing the location of the measurement site (S1) would be helpful in the main text.

Some more details would be useful for the observations from the source emission experiments in order that these could be more easily compared with other similar experiments. At what point during the burns was the emitted smoke measured? Do the values in Table 1 represent average values of the aerosol optical properties during the entire period of the burn? What does the “test number” in Table 1 refer to? Is this the number of experiments performed? This should be made clear in the caption.

I found the discussion in 3.1.1 and Figure 1 to be unclear. Given the range of values for AAE for the different fuel types shown in Table 1, the limitations of the aethalometer model, which assumes a single value for AAE for liquid fuels and solid fuels, should be more clearly discussed in the text.

Does Table 2 give observations from the SP-AMS? As this discusses the number of particles, that would seem to be the case but this should be clearly stated (e.g. by referring to rBC rather than BC).

Page 11, lines 13. How was this percent contribution determined? Is this from the WRF-Chem model or does this use the observed BC? Is the BC concentration shown in Figure 5 from the model results or from the observations?

Figure 6. It would be useful to replace the Region 1-6 labels shown in the figure with the names of the regions used in the text (or include this information in the caption).

Figure 8. It is unclear what the percentile range on the x-axis refers to. Is this with respect to the BC mass loading?

It would be useful to discuss the results in Section 3.3 in the context of the different BC source emissions discussed in Section 3.1

Are the results in Section 3.4 from the WRF-Chem model? It is not clearly stated in the text. Also it would be useful to provide some context for this estimation of the BC radiative effect in terms of previous calculations in the literature for the NCP region.

References:

Heald, C.L., Ridley, D.A., Kroll, J.H., Barrett, S.R.H., Cady-Pereira, K.E., Alvarado, M.J. and Holmes, C.D., 2014. Contrasting the direct radiative effect and direct radiative forcing of aerosols.

Lack, D.A., Moosmüller, H., McMeeking, G.R., Chakrabarty, R.K. and Baumgardner, D., 2014. Characterizing elemental, equivalent black, and refractory black carbon aerosol particles: a review of techniques, their limitations and uncertainties. Analytical and bioanalytical chemistry, 406(1), pp.99-122.

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