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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Source attribution of black carbon and its direct radiative forcing in China" *by* Yang Yang et al.

Anonymous Referee #1

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The authors used the CESM model with a source-tagging method to quantify the source attributions for BC direct radiative forcing (DRF) and concentration as well as polluted events. They found that in addition to regional emissions within China, emissions outside China also contribute to a large portion of BC DRF over China. This study could improve the understanding on BC pollution in China and provide implications for policy makers. Before this manuscript can be considered for publication, I have a few comments that need to be addressed by the authors.

1. One critical factor influencing BC direct radiative effect is its optical properties (absorption and extinction cross section, asymmetry factor, and single scattering albedo). Recent studies (e.g., He et al. 2015, 2016b) showed that BC optical properties vary significantly (by up to more than a factor of two) due to different coating structures and aging stages during BC aging process, which further affects direct radiative effect. (1)

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Discussion paper

Could the authors add some discussions on this aspect with reference to these recent studies, for example, potential uncertainty in their results caused by this factor? (2) Could this variation in BC optical properties due to coating structures contribute to the model biases in BC AAOD simulations as discussed in the first paragraph of Section 3.2? (3) It would be helpful if the authors could add more details on how the MAM3 model computes BC optical properties. For example, does it assume a core-shell structure for internally mixed BC?

References:

He, C., et al. : Variation of the radiative properties during black carbon aging: theoretical and experimental intercomparison, Atmos. Chem. Phys., 15, 11967-11980, doi:10.5194/acp-15-11967-2015, 2015.

He, C., et al. : Intercomparison of the GOS approach, superposition T-matrix method, and laboratory measurements for black carbon optical properties during aging, J. Quant. Spectrosc. Radiat. Transf., 184, 287–296, doi:10.1016/j.jqsrt.2016.08.004, 2016b.

2. For BC emissions, a number of global and regional emission inventories have been developed, which showed large uncertainties and differences among each other (e.g., Fig. 4 in Wang et al., 2014). It would be helpful if the authors could discuss the uncertainty associated with the emission inventory used in this study and how this inventory compares with previous ones for both inside and outside China, since the authors pointed out that emissions outside China also contribute a lot to BC DRF in China.

Reference:

Wang, R., et al. : Trend in Global Black Carbon Emissions from 1960 to 2007, Environ. Sci. Technol., 48, 6780−6787, doi: 10.1021/es5021422, 2014.

3. Another important factor affecting BC simulations is aging process, which directly

alters BC wet scavenging and lifetime. As pointed out by some recent studies (e.g., Oshima et al., 2009; He et al., 2016a), applying microphysical BC aging schemes could significantly improve simulations of BC concentrations compared with simplified aging parameterizations. (1) Could the authors briefly describe how BC aging is treated/computed in their model? (2) It would be helpful if the authors could briefly discuss the BC aging effect on their results with reference to these recent studies. (3) The authors mentioned in Lines 255–256 that model biases in BC concentration over China is likely due to inaccurate emissions and wet scavenging. Could this bias also be caused by model uncertainty related to BC aging? Some discussions would be useful.

Reference:

He, C., Li, Q., Liou, K.-N., Qi, L., Tao, S., and Schwarz, J. P.: Microphysics-based black carbon aging in a global CTM: constraints from HIPPO observations and implications for global black carbon budget, Atmos. Chem. Phys., 16, 3077-3098, doi:10.5194/acp-16-3077-2016, 2016a.

Oshima, N., et al. : Aging of black carbon in outflow from anthropogenic sources using a mixing state resolved model: Model development and evaluation, J. Geophys. Res., 114, D06210, doi:10.1029/2008JD010680, 2009.

4. The authors derived BC AAOD from AERONET observations by using the method in Bond et al. (2013). However, a recent study by Schuster et al. (2016) pointed out some weaknesses and problems related to the Bond et al. (2013) method. Could the author briefly discuss this issue? How would this affect the results in this study?

Reference:

Schuster, G. L., et al. : Remote sensing of soot carbon – Part 2: Understanding the absorption Ångström exponent, Atmos. Chem. Phys., Âă16, 1587–1602, Âădoi:10.5194/acp-16-1587-2016, 2016.

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