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Comment on acp-2021-170

Anonymous Referee #2

Referee comment on "Reduced light absorption of black carbon (BC) and its influence on BC-boundary-layer interactions during "APEC Blue"" by Meng Gao et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-170-RC2, 2021

General comments:

The current work investigated the impacts of changes in BC mixing state during APEC on air quality and meteorology in November 2014 in Beijing. The scope of the research is of interest and well suited to the current journal, *Atmos. Chem. Phys.* However, the manuscript is not acceptable in its current form, because the model they used cannot answer the authors' question (please see Comment #1). The manuscript is well written and the logics is fine. It proves that the authors are certainly experts of air quality modeling and aerosol feedback processes. However, they may not well understand aerosol mixing state modeling. The simulation setup is not appropriate and so the recalculation is required. It is recommended for the authors to invite additional expert(s) for the support of relevant simulation setup. Anyway, the manuscript will be accepted in the current journal, after the authors adequately address the following comments, conduct additional simulations, and revise the manuscript accordingly. The general comments are as follows:

1. The simulation setup what the authors named as "core-shell" is assuming 100% of all components mixed with BC, which never happens. This is not the case of Beijing but in Tokyo, only a small fraction (15%) of sulfate and nitrate mixed with BC (Miyakawa et al., 2014; https://doi.org/10.1080/02786826.2014.937477). Thus, there is even a possibility that the reality could be closer to what they named as "externally mixing (0% of aerosols mixed with BC)" than "core-shell (in fact 100% aerosols mixed with BC)". Anyway, the model they used cannot simulate the fractions of secondary particles mixed with BC. The reviewer recommends to use other models which can consider/resolve BC mixing state or assume fractions of BC mixing for the optical calculation of WRF-Chem that are obtained from observation in Beijing (Zhang et al., 2018) or simulation by other BC-mixing-state-considering/resolving models.

Specific comments:

Introduction

2. 44-45: "In addition to contributing considerably to particulate matter and degraded air quality". BC usually contributes only 10% or less to the total PM mass. Can it be "considerably"?

3. Fourth paragraph of Introduction: There are plenty of studies regarding BC mixing state in Nicole Riemer's group using PartMC/MOSAIC. For the three-dimensional modeling, the author might as well cite Matsui et al. (2012) https://doi.org/10.1029/2012JD018446, as the model domain they used are close to those of the current study. There is a mixing-state resolving model called MOSAIC-mix, Ching et al. (2016) https://doi.org/10.1002/2015JD024323, which is the same aerosol module as the authors used. I have read an article reporting that PartMC/MOSAIC is coupled with WRF-Chem. The reviewer does not know if these mixing state resolving/considering models are open to community, but if so, these can be an option for the authors to tackle with the issue raised in the study.

Method

4. Sect. 2.2: Eqs. (11)-(13) are just a general description of the calculation method of aerosol optical properties, which are less important. The last sentences of Sect. 2.2 (Ln.168-170) should be rather elaborated using equations, as it is essentially important for the current study.

5. Judging from Eq.(14), dust is included in the simulation, which is also a light-absorber. How do the authors treat the light absorption of mineral/anthropogenic dust particles?

6. Sect. 2.3: Which wave lengths of AAOD (observation and simulation) did the authors use in their study?

Results

7. Sect. 3.1: Better to compare AOD also, which might be able to partly answer why simulated AAOD was underestimated.

8. Sect. 3.2: rBC is not an indicator of BC aging, but just the relative concentrations of BC and components other than BC. Aging of BC depends not only on abundance of secondary components but also on relative abundance of BC-containing and BC-free particles. If BC-

free particles exist more, the secondary components condensed more toward the BC-free particles, which do not contribute aging of BC.

9. Sect. 3.3: E_ab is not indicting the light-absorption enhancement of BC, but indicting the difference of AAOD between 100% internal mixture with BC assumption and 0%.

Throughout the manuscript

10. The paper assumed clear-sky conditions for the whole analysis period. If there are no cloud during the period, please describe it. The reviewer is curious to see the simulated (with different sensitivity tests) and observed solar radiations during the period.