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Atmospheric Chemistry and Physics Discussions
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Interactive comment on "Mixing state of black carbon and its impact on optical properties and radiative forcing over East Asia" *by* Xiaoyan Ma et al.

Anonymous Referee #1

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General comments:

This manuscript presents that by employing a nested GEOS-Chem-APM with predicted black carbon (BC) mixing state, the authors examined the effect of mixing state on aerosol optical properties, radiative forcing, and heating rate over East Asia. The manuscript is well written, and the structure is clear. Indeed, understanding aerosol optical properties and radiative forcing will improve future predictions of aerosol climatic effect. However, there are two fundamental issues in this paper: 1. The most highlighted findings have already been presented in the authors' previous papers. The model development, black carbon mixing states and aerosol optical properties have been demonstrated in Yu et al. (2012) and Ma et al. (2012). For example, absorptive aerosol optical depth (AAOD) in the core-shell mixing experiment higher than the external mixing experiment has been shown in Yu et al. (2012). Many papers have studied black carbon mixing states and aerosol optical properties in regional or global models, or specifically in the geographic domain of East Asia. This manuscript does not address a different scientific question or give specific findings in their study compared to the previous works. For example, Grandey et al. (2018) have clearly shown that the representation of aerosol mixing state, size distribution and optical properties are the main causes of uncertainty in the strength of the cooling effect by exploring the representation of aerosols in a global climate model. They also presented similar conclusions regarding the aerosol direct radiative forcing, and the heating rate differences owing to black carbon mixing states. As to the geographic domain, East Asia, Zhuang et al. (2013), Sha et al. (2019), and many other papers have studied the aerosol mixing state and its radiative properties over China. Stevens and Dastoor (2019) even have one review paper on this topic. The authors need to do more literature review to highlight the unique findings in their work. 2. If the authors want to highlight the tool/model used in this study and quantify the mixing state of black carbon and its impact on optical properties and radiative forcing over East Asia, their numerical experiment is not sufficient, and the result is not statistically significant. For example, the monthly mean value in Table 1 should not just come from a one-month simulation in January 2014 with daily output. The comparison against observations in Figure 6 shows a lack of observational data during the study period. I think it could be improved if the authors expand their simulation to one year. A seasonal comparison would add value to this study owing to emission partition differences between BC and secondary species during each season. If computational cost is high, one month per season will provide a similar conclusion.

Based on the above reasons and considering that the authors need more time to rerun simulations and analyze data, I would like to reject this manuscript but encourage a resubmission after revisions.

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Discussion paper

Specific comments:

Lines 71-73: Many previous studies have discussed the core-shell mixing state of BC and its radiative properties and climate impacts. More literature review is needed. Line 80: Not necessary because there is no Section 2.2. Line 102: What is "CTM"? Line 107: Why choose January 2014? Line 112: What is "MIX"? Full name is needed. Lines 124-125: Reference? Why is it due to corn draw burning? Lines 166: Should explain how AAOD is calculated. Lines 179-180: They should be the modeled "daily" mean AOD and the AERONET "daily" results. Line 191: Should give a clear definition of absorption amplification (Aa). Lines 193-194: Abbreviation of the city seems not necessary. There are too many abbreviations in the paper. A list of abbreviations might be needed. Table 1: Should provide standard deviation as well.

Reference:

Ma, X., Yu, F., and Luo, G.: Aerosol direct radiative forcing based on GEOS-Chem-APM and uncertainties, Atmos. Chem. Phys., 12, 5563–5581, https://doi.org/10.5194/acp-12-5563-2012, 2012. Yu, F., Luo, G., and Ma, X.: Regional and global modeling of aerosol optical properties with a size, composition, and mixing state resolved particle microphysics model, Atmos. Chem. Phys., 12, 5719–5736, https://doi.org/10.5194/acp-12-5719-2012, 2012. Grandey, B. S., Rothenberg, D., Avramov, A., Jin, Q., Lee, H.-H., Liu, X., Lu, Z., Albani, S., and Wang, C.: Effective radiative forcing in the aerosol–climate model CAM5.3-MARC-ARG, Atmos. Chem. Phys., 18, 15783–15810, https://doi.org/10.5194/acp-18-15783-2018, 2018. Zhuang, B. L., Li, S., Wang, T. J., Deng, J. J., Xie, M., Yin, C. Q., and Zhu, J. L.: Direct radiative forcing and climate effects of anthropogenic aerosols with different mixing states over China, Atmospheric Environment, 79, 349-361, https://doi.org/10.1016/j.atmosenv.2013.07.004, 2013. Sha, T., Ma, X., Jia, H., Tian, R., Chang, Y., Cao, F., and Zhang, Y.: Aerosol chemical component: Simulations with WRF-Chem and comparison with observations in Nanjing, Atmospheric Environment, 218, 116982, https://doi.org/10.1016/j.atmosenv.2019.116982, 2019. Stevens, R.; Dastoor, A.: A Review of the Representation of Aerosol Mixing State in Atmospheric Models. Atmosphere, 10, 168, 2019.

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