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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impacts of East Asian Summer and Winter Monsoon on Interannual Variations of Mass Concentrations and Direct Radiative Forcing of Black Carbon over Eastern China" *by* Yu Hao Mao and Hong Liao

Anonymous Referee #2

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In this work authors attempted to study the impacts of the interannual variation of Eastern Asian summer and winter monsoon on variations of black carbon (BC) mass concentrations and direct radiative forcing (DRF) in Eastern China during 1986-2006. Overall this paper is quite lengthy and reads more like a technical report. The results presented in the paper solely rely on model simulations lack of any observational evidences or cross-validation with previous modeling studies of BC. Some issues with respect to the method descriptions sound vague. The clarification of these issues is critical to understand comprehensive results presented in this study. I recommend the major revision of the paper before the possible acceptance of ACP by addressing my

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Discussion paper

following comments.

Major comments:

1. The methodology used in this study simply followed previous studies [Zhu et al., 2012; Yang et al. 2014]. That's fine. The results of BC are not surprising to me at all since BC is one of important fine aerosol types (i.e., PM2.5) discussed in Zhu et al. [2012]. It might be more interesting to emphasize the change of special characteristics of BC (e.g., whether or how the change of cloud layer between weakest and strongest Eastern Asian monsoon impacts on the BC absorption and DRF).

2. The results presented in the paper solely rely on model simulations lack of any observational evidences or cross-validation with previous modeling studies of BC. This makes me wonder how the modeled BC mass concentrations in this work compare with historical observations available in Eastern China, especially during JJA and DJF (i.e., the seasons authors focus on in this work).

3. Authors presented major results based on the difference between weakest and strongest Eastern Asia summer monsoon in Section 3 (covering Fig. 1a, Fig. 2a1, 2b1, Fig. 3a, . . .) and then from the difference in winter monsoon in Section 4 (covering Fig. 1b, Fig. 2a2,2b2, Fig. 3b, . . .). However, no discussions (linked to changes in winds or circulation patterns, etc) were made on the difference between summer and winter monsoon, which makes two sections sound like separate stories.

4. Majority results in this work (i.e., Fig. 4-12, Table 2-5) highly reply on the difference between weakest and strongest Eastern Asia summer monsoon (in Section 3). The selection of five weakest and strongest years in this work is slightly different with previous studies [Zhu et al., 2012; Yang et al. 2014] that used the same GEOS-4 met fields of 1986-2006 without any explanations. Please explain why authors choose different monsoon years as adopted in Zhu et al. 2012 and Yang et al. 2014.

5. On Page 5 Line 26, should 1980-2010 be 1986-2006, which overlaps the period

between GEOS-4 and MERRA?

6. On Page 8 Line 5-6, authors mentioned numerous studies have shown that the intensity of EAWM. . .. . .but they only cited one reference of Yan et al. (2009). It sounds contradictory.

7. In Section 3 and 4, authors enclosed values in the parenthesis but did not describe how they calculate these values, for instance the range of percentages on Page 8 Lines 22-23. Please add the clarification.

8. On Page 10 Lines 19-20, what is the cause of the different pattern of BC concentration between GEOS-4 and MERRA shown in Figure 5a?

9. On Page 11 Lines 2-3, how does the convergence cause the increase in BC concentration and anticyclone wind pattern cause the decrease in BC concentration?

10. On Page 11, Lines 8-10, I understand the convergence accompanied with the descending air prevents surface BC to the upper troposphere, causing the increase in surface BC. But I don't understand why the upward mass flux of BC also increases under the condition of convergence. Could you explain it?

11. On Page 11 Line 13, please describe the method you calculate horizontal mass fluxes at the four lateral boundaries in details. Clearly, the net effect does not equal to the fluxes summed with values from four lateral boundaries. How do you calculate the net effect of horizontal mass fluxes over the specific region?

12. On Page 11 Lines 23-25, why is there larger inflow at the east and north boundary and smaller outflow at the south and east boundary?

13. On page 11 Lines 27-29, where do these two numbers (i.e., 0.09 and 0.27 kg/s) come from? Do you average them over the entire domain? Please specify the region your numbers are based on?

14. On Page 13, Lines 4-5, could you clarify what is the direct radiative forcing effi-

ciency of BC? BTW, did you notice that the shift of the center of the highest BC DRF from weakest to strongest? Could you explain what is the cause of the shift?

15. On Page 13, Lines 18-21, please add quantitative metrics to quantify the change of BC DRF in northern and southern China.

16. On Page 13, Lines 26-27, how do you distinguish the DRF of BC between non-China emission and local sources? Did you offline run the radiative transfer model? If yes, please describe it in the section of method.

17. On Page 14, line 22, could you show PBLH in the supplement? Also explain how PBLH changes surface BC concentration.

18. On Page 15, Lines 23-24, what is the cause of the different response of BC concentration to the summer and winter monsoon in southern china?

19. On Page 17, lines 21-24. I cannot tell the lower column burden of tropospheric BC from your Figure 5b. It appears that the BC profile increase at all altitudes. Is it related to the change of clouds?

20. On Page 17, Lines 24-27, why is DRF lower in the weakest monsoon years in southern china even though both BC surface concentration and column burden are higher, compared with the strongest monsoon years?

21. On Page 20, besides simply reporting what you conclude in this work, could you add some discussion about why eastern Asian summer and winter monsoon change BC concentration and DRF in northern and southern China differently? Is this difference important to contribute to the air quality regulation in different regions of China?

22. On Page 5 Lines 17-18, BC is assumed externally mixed with other aerosol species in this model. Could authors discuss the uncertainties of your results based on this assumption? How do results change if BC is partially internally or internally mixed with other aerosol species?

Minor comments:

1. Page 11 Line 12, change “summary” to “summarize”.

2. Figure 1, add the description of r31y and r21y.

3. Figure 4, please move the row of a2 above b1 since you discussed a2 ahead of b1 in the context.

4. Figure 10, please label a1, a2, b1, and b2 in Figure.

5. Figure 12, How do you distinguish BC concentration attributed to non-China emissions and local China sources in the model? Please specify in the description of the model.

References:

Yang, Y., Liao, H., and Li, J.: Impacts of the East Asian summer monsoon on interannual variations of summertime surface-layer ozone concentrations over China, Atmos. Chem. Phys., 14, 6867–6880, doi:10.5194/acp-14-6867-2014, 2014.

Zhu, J., Liao, H., and Li, J.: Increases in aerosol concentrations over eastern China due to the decadal-scale weakening of the East Asian summer monsoon, Geophys. Res. Lett., 39, L09809, doi:10.1029/2012GL051428, 2012.

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