In this study, the authors examined evaluate the roles of aerosol-radiation interaction (ARI), aerosol-cloud interaction (ACI), black carbon (BC) and none BC (non-BC) aerosols in the formation and maintenance of the heavy fog event in early 15 December 2013 in the Yangtze River Delta (YRD) region in eastern China using WRF-Chem model. They found that ARI dominates this fog-haze episode while the effects of ACI are negligible. BC plays a more important role in fog formation than non-BC aerosols, inducing temperature contrast over land and sea and transports moister air to the YRD region. The topic of this study is interesting and the manuscript is well written. I would suggest publishing after addressing my comments below.

My main concern is the method to distinguish the role of BC and non-BC. First, the authors turned off ARI and ARI+ACI to separate the roles of ARI and ACI, which is reasonable. Then the authors compare the simulation with ARI+ACI turned off and with anthropogenic BC emission removed to separate to roles of non-BC and BC, which could be inappropriate. These roles were quantified using different methods and comparing them could lead to an apple and orange comparison. Without BC emission, the internal mixing state could be changed, the impact of BC on vegetation could be changed, chemistry on aerosol surface could be changed, besides the BC-radiation and BC-cloud interactions. To separate the role of BC and non-BC, I would suggest the authors do another parallel simulation with all aerosol emissions turned off. Or at least discuss the biases of the results.

Minor comments:

Page 1 Line 24: ‘heave’ -> ’heavy’

Page 2 Line 15: In addition to impact on PBL, recent study also found BC can change land-sea thermal contrast and weaken the East Asian winter monsoon (Lou et al., 2019), which mechanism is very similar to this study, as well as large-scale circulations (Yang et al., 2019).

Page 4 Line 26: Please clarify that how did the authors turn of ARI and ACI in the model. What variables they excluded or fixed in model?

Page 5 Line 4: Please provide the sites or data reservoir where the authors got all these data.

Figure 4: It should be days 2,5,6,“9”.

Page 6 Line 22: underestimated during the occurrence of fog in Nanjing “in the model”.

Page 6 Line 26: a possible enhancement of the formation of secondary aerosols through aqueous phase or heterogeneous reactions “in the real world”.

Page 7 Line 23-28: I am confused that why temperature over the sea was less sensitive to the reduction of incoming solar radiation but sensitive to aerosol warming effect? Both of them are changes in radiative fluxes. Large heat storage capacity only implies that ocean is insensitive to heat or cooling effects (changes in radiative fluxes) compared to land. Instead, Lou et al. (2019) found that BC-induced heating over Bohai Sea, Yellow Sea, and East China Sea evaporated low cloud and increased high cloud, leading to larger warming over oceans east of China mainland.

Page 8 Line 30: The BC impact on surface temperature depends on vertical location of BC and also depends on models.

Page 9 Line 2: What does “other forcings ” mean.

References:

Lou, S., Y. Yang, H. Wang, S. J. Smith, Y. Qian, and P. J. Rasch, Black carbon amplifies haze over the North China Plain by weakening the East Asian winter monsoon, Geophys. Res. Lett., 46, 452–460, doi:10.1029/2018GL080941, 2019.

Yang, Y., S. J. Smith, H. Wang, C. M. Mills, and P. J. Rasch, Variability and timescales in the climate response to black carbon emissions, Atmos. Chem. Phys., 19, 2405-2420, doi:10.5194/acp-19-2405-2019, 2019.