Reply to the Comments of the Referee #2

1. My main criticism of this study is that the authors did not consider the impacts of reduced emissions in the future under RCP4.5 scenario on pollution risk. The haze pollution risk should relate to the aerosol concentrations. For example, higher background concentration lead a higher pollution risk with the same AEC. Thus, a discussion about how the pollution risk changed due to changes in emission is at least needed.

Reply: As pointed out by the Referee, the haze pollution risk does be related to the aerosol concentrations. However, what we discussed here focused on the atmospheric carrying capacity which is associated with wet deposition and ventilation and provides a condition to transport and dilute pollutants. It does not reflect real emission characteristics. Since there is no chemistry/aerosol module coupled in our experiments, the contribution of emissions to pollution change under RCP4.5 scenario cannot be calculated. In responding to the comment, we added a short discussion to address it in the manuscript.

2. Line 124- In the equation (1), how could authors distinguish the intensity of rainfall? The wet deposition with 10 mm/hour (and no precipitation in other 23 hours) should be different with 10 mm/24 hour.

Reply: We used 6-hourly data for the AEC calculation, so short-duration (no longer than 6 hours) and long-duration events can be roughly distinguished. Due to large volume of the outputs from ~120-yr simulations by regional climate model, the time resolution of the model output is limited especially for those 3D variables (e.g. geopotential height, wind speed).

3. Line 175-176 Why the AEC is underestimated over the southern Xinjiang and overestimated over parts of North China? Which one is the major reason? Simulated precipitation, wind speed, or boundary layer depth?

Reply: Similar to the contribution analysis in section 5, we applied the same method to investigate the contribution of different factors to the simulated AEC biases (Fig. S1). Overall, the simulation bias in boundary layer depth is the major factor for the simulated AEC bias over most parts of China (Fig. S1d).

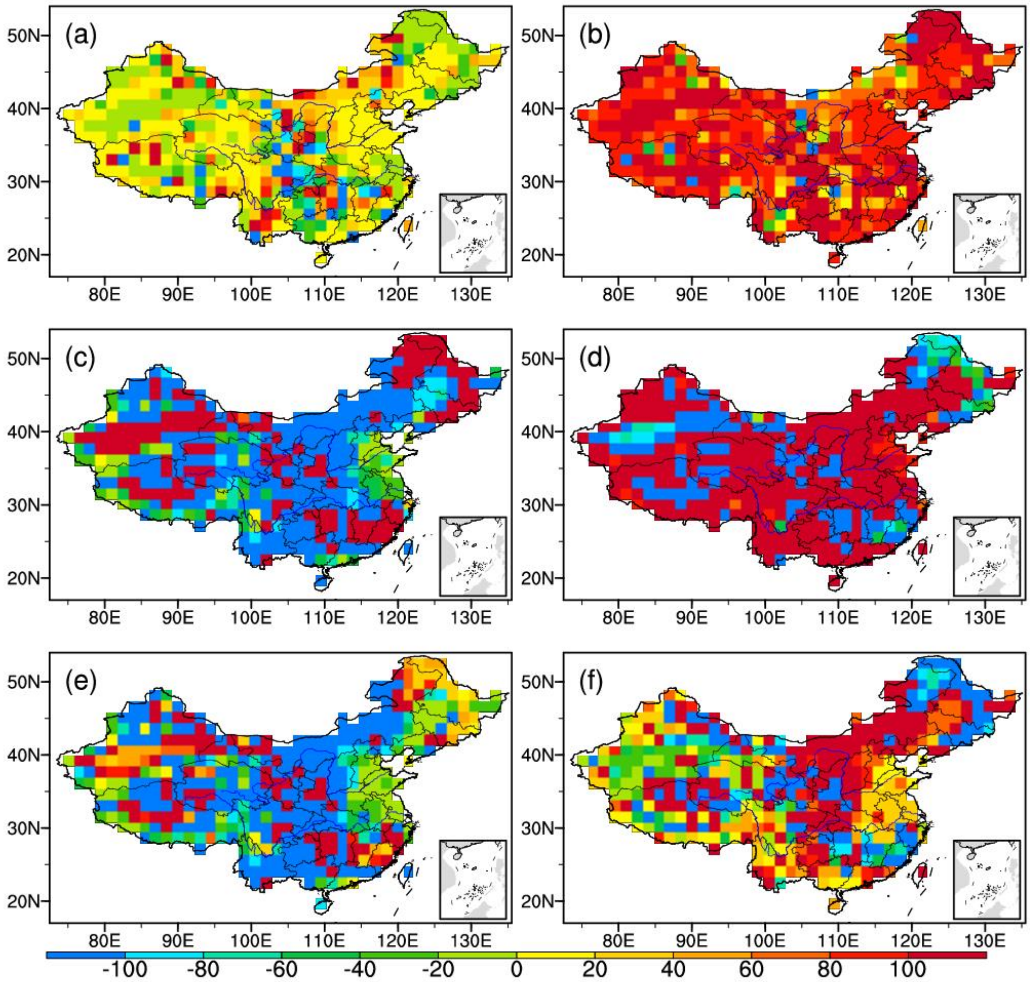

Figure S1. Relative contributions (unit: %) of individual components to annual AEC biases based on the ensemble results. (a) precipitation, (b) ventilation, (c) wind speed averaged with the boundary layer, (d) boundary layer depth, (e) nonlinear term, (f) transient term.

4. Line 217- "Southwest China, northern North China, Northeast China: : :" A map is needed.

Reply: A map has been added in the revised manuscript (Fig. S2).

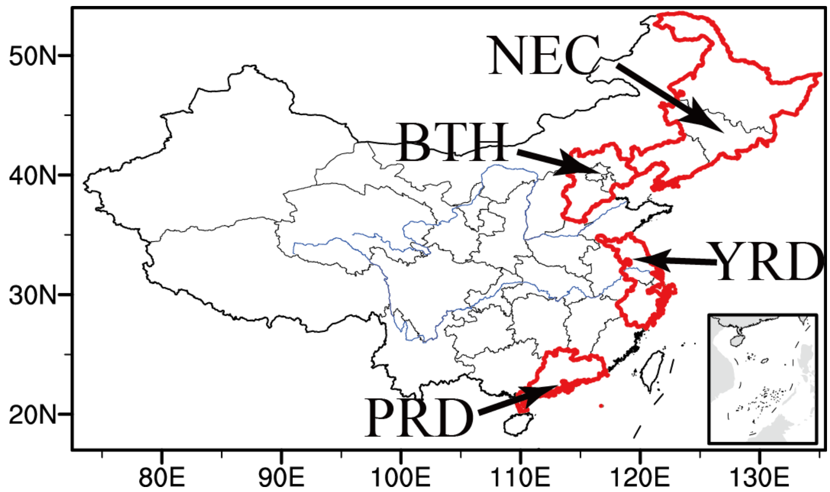

Figure S2. Four main economic zones of China, Beijing-Tianjin-Hebei region (BTH), Northeast China (NEC), Yangtze River Delta economic zone (YRD), and Pearl River Delta economic zone (PRD)

5. Line-304-306. Missing WVD bar in Fig.7b in JJA during the middle of the 21st century.

Reply: The percentage change of WVD in JJA during the middle of the 21st century is very small (0.008%), so the bar looks “missing”.

6. Line 364- Change “dominant” to “important”. I don’t think the annual 20%-30% could described as “dominate role”.

Reply: Changed.

7. Line 392-400. In addition to the wind speed and boundary layer depth, will the wind direction change in the future? Does it also have impact on the air environment carrying capacity and haze pollution potential?

Reply: As mentioned above, what we concerned in this study is the atmospheric carrying capacity that is only related to wet deposition and ventilation. The change of wind direction should be important. For example, the pollution from upwind emission sources could impact the air quality in some locations downwind. The wind direction may also change in the future. However, this topic is beyond the scope of this study. A short discussion has been added to clarify this issue in the manuscript.