

## **Reply to Referee #1**

### **General comments:**

*The impact of external thermal forcing induced atmospheric circulation changes on air quality is an important issue in atmospheric environment study. Focusing this scientific issue, this manuscript presented an interesting finding on two pathways of thermal forcing sources in the North Atlantic region (R1) and the western North Pacific region (R2) drive the interannual variations of autumnal haze pollution in the air pollution region of North China via the tele-connection analysis and AGCM simulation, which could improve our understanding and prediction on air quality change in China, Asia and the Northern Hemisphere. This manuscript falls within the scope of ACP. I suggest the minor revisions before it is published as follows:*

**Reply:** Thank you for your positive comments. We have revised the manuscript based on your comments/suggestions. Below is our point-by-point reply to these comments/suggestions (italic is for original comments and non-italic is our replies).

### **Specific comments:**

**1)** *Please add the discussions on the tele-connection pattern from the R1 region to North China in connection with North Atlantic Oscillation, and the R2 region in association with Western Pacific Warm Pool.*

**Reply:** Thanks for your comment. We have added two relevant references and corresponding discussions. Please see **Lines 208-211** and **Lines 241-242** in the revised manuscript for the discussions.

(Lines 208-211) “Intriguingly, from the surface projection of the above quasi-barotropic teleconnection pattern, a positive phase of North Atlantic Oscillation-like pattern (Hurrell and Deser, 2009) can be discerned which is part of the teleconnection.”

(Lines 241-242) “with its large portion belonging to the region of Western Pacific Warm Pool (You et al., 2018).”

### **Reference:**

Hurrell, J. W., and Deser, C.: North Atlantic climate variability: The role of the North Atlantic Oscillation, *J Marine Syst*, 78, 28-41, 10.1016/j.jmarsys.2008.11.026, 2009.

You, Y. C., Cheng, X. G., Zhao, T. L., Xu, X. D., Gong, S. L., Zhang, X. Y., Zheng, Y., Che, H. Z., Yu, C., Chang, J. C., Ma, G. X., and Wu, M.: Variations of haze pollution in China modulated by thermal forcing of the Western Pacific Warm Pool, *Atmosphere*, 9, 314, 10.3390/atmos9080314, 2018.

**2)** Please modify the lines 20-21: the joint impacts can greatly enhance the likelihood of a higher  $AHD_{BTH}$ . Observational and simulation evidence suggests that SST anomalies can affect the variation.....

**Reply:** Thanks for your comment. The modification was done. Please see Lines 19-22 in the revised manuscript.

Lines 19-22: “When the autumnal SST warming in R1 and R2 are both significant, the likelihood of a higher  $AHD_{BTH}$  is greatly enhanced. Observational and simulation evidence demonstrated how SST anomalies over R1 and R2 influence variation of  $AHD_{BTH}$  via two different pathways.”

**3)** Lines 191 and 193, please add “surface air” before “temperature”.

**Reply:** Thanks for your suggestion. We have added “surface air” before “temperature”. Please see Lines 194 and 196 in the revised manuscript.

**4)** Please add the box outlines the research domain of the BTH region in Fig. 7.

**Reply:** Thanks for your constructive suggestion. We have added the blue dashed box outlining the research domain of the BTH region. Please see Fig. 7 in the revised manuscript.