In this study, the authors examined relationship between the snow cover over East Europe and West Siberia (SCES) and the number of haze days in December in central North China (DHDCNC). They found changes in SCES can contribute to DHDCNC through influencing soil moisture and land surface radiation during 1998–2016 but the effects are negligible during 1979–1997. This work is interesting and merits publication after following comments addressed.

General Comments:

1. **The authors explained how changes in soil moisture and radiation lead to the atmospheric circulations worsening dispersion conditions. There are a lot of meteorological fields and effects including in the mechanism. It is better to add a diagram illustrating all the effects.**

Reply:

A new diagram was drawn to make the understanding easier. In "Conclusions and Discussions", we mentioned that "To exemplify the associated mechanisms during 1998–2016, a diagram was drawn and supplemented as Figure S3."

Revisions:

In "Conclusions and Discussions"

……To exemplify the associated mechanisms during 1998–2016, a diagram was drawn and supplemented as Figure S3.

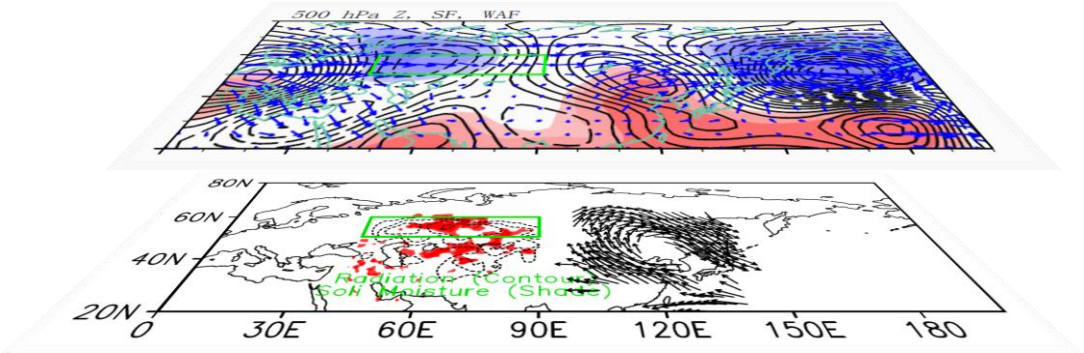

Figure S3. Diagram of the associated physical mechanisms. Near surface, the ON radiation (contour) and soil moisture (shade) were influenced by the SC_{ES}. On the mid-high level, the teleconnected Rossby wave-like pattern propagated into the Central North China, representing by Z500 (shade), stream function (contour) and wave activity flux (arrow). Finally, the local anti-cyclonic circulation near surface (arrow) led to weak ventilation conditions in December.

2. **The authors examined the relationships of SCES and DHDCNC based on the analysis of correlation coefficient. So one question raises, is it possible that they are independent but covary with each other driven by other factors (e.g., climate change).**

Reply:

The emphasis of this study was the **interannual variation** of haze days and its relationship with snow cover. Thus, during analyzing, the linear trend was removed.

In our study, we assumed that the energy consumption linearly increased in the recent years. On such hypothesis, the human activities (also including **the climate change**) mainly impacted the long-term trend of DHD_{CNC}. **After removal of the linear trend, the interannual variability of haze pollution should be mainly the result of climatic anomalies.**

In the revisions, the authors also **supplemented some previous studies on the long-term trend of haze pollutions**, i.e., the impacts of climate change.

Revisions:

In "Introduction"

……For the long-term trend of haze pollution, Wang and Chen (2016) illustrated the roles of climate change on the in eastern China and emphasized the effects of the Arctic sea ice. Cai et al (2017) analyzed the weather conditions conductive to Beijing severe haze more frequent under climate change. There were also previous studies on the interannual variation of haze and associated climatic conditions. The possible physical processes in the atmosphere that caused this the haze events……

3. **The author mentioned Eurasian snow cover has been increasing over the last two decades (Cohen et al. 2012). What is the mechanism for the increasing SCES.**

Reply:

An associated reference was cited to answer this question. "Different from the declining trend of Arctic sea ice, Eurasian snow cover has been increasing over the last two decades (Cohen et al. 2012), probably due to **the increased southward**

moisture transport from the melted Arctic Ocean (Deser et al., 2010)."

Revisions:

In "Introduction"

Different from the declining trend of Arctic sea ice, Eurasian snow cover has been increasing over the last two decades (Cohen et al. 2012), probably due to the increased southward moisture transport from the melted Arctic Ocean (Deser et al., 2010)……

Deser, C., R. Tomas, M. Alexander, and D. Lawrence. 2010. The seasonal atmospheric response to projected Arctic sea ice loss in the late twentyfirst century, J. Clim., 23(2), 333–351, doi:10.1175/2009JCLI3053.1.

4. **In addition, based on the positive correlation coefficient between SCES and DHDCNC, does that mean the increasing snow cover in Eurasia lead to the increasing aerosol pollution in China during recent decades? If so, it is more interesting and the authors may discuss more about it.**

Reply:

In this manuscript, we used the haze days to **represent the general of haze pollution**. During 1998–2016, the accumulated snow cover significantly intensified the haze pollution in Central North China by atmospheric teleconnection.

Specific comments:

Line 26: typo '/'.

Reply:

The error has been corrected.

Revisions:

In December 2016, central North China (CNC, located at 30–41 °N, 110–120 °E),

Line 29: Recent studies found, in additions to emissions and climate change, aerosolmeteorology feedbacks have contributed the haze in China (e.g., Ding et al., 2016;Yang et al., 2017a).

Reply:

The advice was adopted. Some revisions and new references were added.

Revisions:

In “Introduction”

Beyond anthropogenic emissions, the atmospheric circulations (Yin and Wang 2017b) and **aerosol-meteorology feedback (Ding et al. 2016, Yang et al. 2017a)** have significantly contributed the severe haze in China.

Yang, Y., L. M. Russell, S. Lou, H. Liao, J. Guo, Y. Liu, B. Singh, and S. J. Ghan, Dustwind interactions can intensify aerosol pollution over eastern China, Nat. Commun., 8, 15333, doi:10.1038/ncomms15333, 2017a.

Line 37: Besides to less ventilation, transport of aerosols from upwind can also lead to regional aerosol pollution (e.g., Yang et al., 2017b).

Reply:

The advice was adopted. Some revisions and new references were added.

Revisions:

In “Introduction”

……Furthermore, the southerly anomalies that are characteristic of East Asian winter monsoons (Li et al. 2015; Yin et al. 2015) may have weakened the cold air and wind speed but enhanced **the transportation of humid air flow and aerosols (Yang et al. 2017b)**……

Yang, Y., Wang, H., Smith, S. J., Ma, P.-L., and Rasch, P. J.: Source attribution of black carbon and its direct radiative forcing in China, Atmos. Chem. Phys., 17, 4319-4336, https://doi.org/10.5194/acp-17-4319-2017, 2017b.

Line 124: How can surface upward motion appears in a sinking motion atmosphere. Upward motion sometimes means non-stagnation and strong dispersion. How can it accumulate aerosols?

Reply:

We have corrected the discussions about the vertical motion.

1. There was significant **upward motion near surface (Figure 5a), indicating weak convergences of the aerosols discharged in the circumjacent regions**. Actually, in winter, the weak convergence near surface was a classical synoptic situation resulting in severe haze pollution. This convergence could transport the aerosols discharged in the surrounding to the CNC area, but cannot disturbed the shallow boundary layer. **The converging and local aerosols both accumulated and reached a high concentration**.

2. The description of the sinking motion on the **mid-high level** was not precise and has been **deleted** from this manuscript on the premise that the conclusions were not affected. In a recent study, we have found that **the vertical motions below different parts of the anti-cyclonic circulation were also different**. It is inaccurate to simply describe the associated vertical velocity as sinking or ascending motion. Thus, we are going to write a new manuscript to discuss the associated vertical motions.

Revisions:

In "Possible physical mechanisms"

……The associated vertical velocity at the surface was upward (Figure 5a), indicating weak convergences of the aerosols discharged in the circumjacent regions. However, due to the shallower planetary boundary layer (Figure 5a), the converging and local aerosols cannot be dispersed into the upper atmosphere. The local convergences, combined with the weak surface wind (Figure 5b), easily enabled aerosols to accumulate over the CNC area……

~~The sinking motion caused by these anti-cyclonic anomalies could~~ ~~lead to the shallower planetary boundary layer (Figure 5a) and the rather weak dispersion capacity of atmospheric particulates. In contrast, t~~The associated vertical velocity at the surface was upward (Figure 5a), indicating ~~an ascending motion~~ convergences of the aerosols discharge in the circumjacent regions. However, ~~near the surface.~~ due to the shallower planetary boundary layer (Figure 5a), the converging and local aerosols cannot be dispersed into the upper atmosphere. The local ~~rising air~~convergences, combined with the weak ~~south~~ surface wind (Figure 5b), easily enabled aerosols to accumulate over the CNC area. Near the surface, the positive SLP anomalies were situated in the east of China and the western Pacific (Figure 5c). The stimulated southerlies overlapped with

Line 166: Why the "west wet-east dry" pattern leads to poor dispersion conditions?

Reply:

This is still an open question and beyond the scope of this study. In the final section, we discussed that this question should be **a future work** with numerical models.

Revisions:

In "Conclusions and Discussions"

……In this study, the varied relationship between the SC_{ES} and DHD_{CNC} and the associated physical mechanisms were analyzed, but more detailed investigations, **such as the internal processes driving how the soil moisture (radiative cooling) impacted the atmosphere in the following December, were not included in this study and should be conducted with numerical models in future work**……

Line 172: What is the direction for positive longwave and shortwave radiation defined in this study? Also, the authors should make clear that they are the surface net radiative fluxes.

Reply:

The upward radiation is positive. The description on the radiation dataset was improved to make it clearer.

Revisions:

In "Datasets and methods"

……the vertical wind, the **surface** net longwave radiation and the **surface** net shortwave radiation **(upward radiation is positive)** data were downloaded from……