Reply to Referee 1:

Referee comments on "Decadal Changes of Connections among Snow cover in West Siberia, Eurasia Teleconnection and O_3-related meteorology in North China" by Zhicong Yin et al.

This study makes a full investigation about connection between snow cover/EU teleconnection and O_3 pollution in north China. The April-May snow cover in West Siberia was proposed as a preceding climate driver that influenced the summer surface O_3-related meteorology in North China during 1980–1998, and the associated physical mechanisms were also explained by comparing the periods before and after the mid-1990s. The results of this study could provide a reference for the seasonal prediction of O_3. This paper is well written and organized. I recommend it to be published in ACP after several minor corrections.

1. Based on the content in the main text, the O_3-related meteorology (OWI) is focus on summertime. I would suggest to clarify the specific season in the title, which will give a more direct expression about the seasonal prediction mechanism.

Reply:

We have added the specific seasons in the title as suggested.

Revisions:

Title: Decadal Changes of Connections among **late-spring** Snow cover in West Siberia, **summer** Eurasia Teleconnection and O_3-related meteorology in North China.

2. The high level O_3 concentrations before mid-1990s are considered to be connected with the positive phase of EU teleconnection. While, after mid-1990s, the northward shift of snow cover results to the insignificant connections between snow anomalies, EU pattern and O_3. What is the possible reason for the change point of mid-1990s? That is, why 1990s was selected as the turning point in this study. Is it based on the statistical analysis or some physical mechanisms?

Reply:

(1) As shown in Figure 3c, we calculated the 21-year sliding correlation coefficient between SC_{WS} and OWI. The results showed that the correlation coefficient was **significant before the mid-1990s and insignificant after the mid-1990s between SC_{WS} and OWI**. Therefore, according to the significance of the correlation coefficient, we directly divided the study period into two equilong periods.

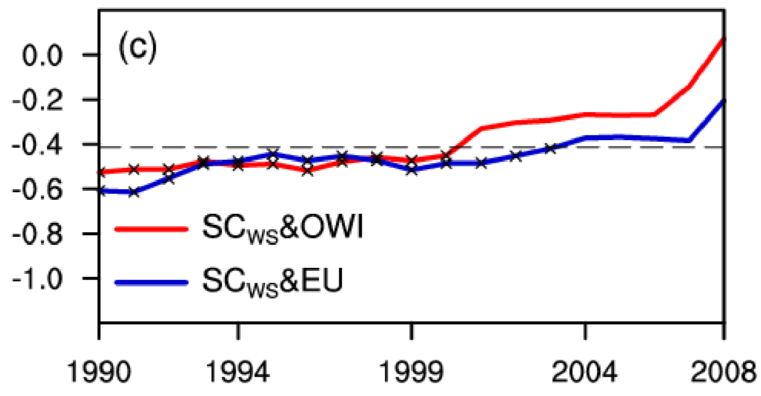

Figure 3c. The 21-year sliding correlation coefficients between SC_{WS} and OWI (red), EU (blue). The black dotted line (crosses) indicates (exceeded) the 95% confidence level. The linear trend is removed.

(2) In addition to mathematical statistics, the physical mechanisms were also explained. The main point is, **compared to P1**, **the south edge** of the area with high concentrations **of snow** (>85%) in late spring **shifted northward** by approximately 2° in latitude **during P2** (Figure 4a).

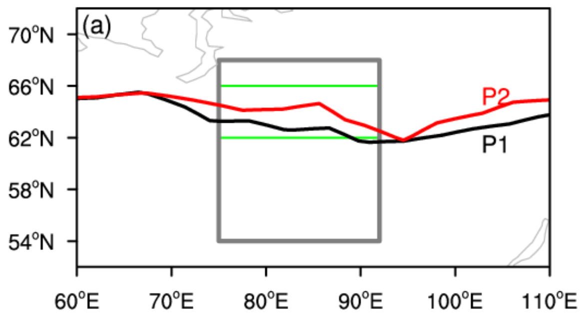

Figure 4a. The south edge of the 85% snow cover concontration during 1980–1993 (black) and during 2004–2018 (red). The gray (green) box represents the key area used to calculate the NHF_{WS} (SCsw) index.

(3) Actually, many previous studies have pointed out mid-1990s was a turning point of correlation relationships, such as Yin and Wang (2018), Wu et al., (2009) and Zhang et al., (2020). In our study, we also only tracked the signal to the south edge of April-May snow cover. Indeed, the reasons why the turning points generally occurred in mid-1990s were still unclear, but needed further researches.

Related References:

Yin, Z. C., and Wang, H. J.: The strengthening relationship between Eurasian snow cover and December haze days in central North China after the mid-1990s, Atmos. Chem. Phys., 18, 4753–4763, https://doi.org/10.5194/acp-18-4753-2018, 2018.

Wu, B. Y., Yang, K., and Zhang, R. H.: Eurasian snow cover variability and its association with summer rainfall in China, Adv. Atmos. Sci., 26, 31–44, https://doi.org/10.1007/s00376-009-0031-2, 2009.

Zhang, R. N., Sun, C. H., Zhu, J. S., Zhang, R. H., and Li, W. J.: Increased European heat waves in recent decades in response to shrinking Arctic sea ice and Eurasian snow cover, npj. Clim. Atmos. Sci., 3, 7, https://doi.org/10.1038/s41612-020-0110-8, 2020.

3. Some detailed information about the calculation of OWI index in Line 105 are suggested to add. E.g., how to normalize the meteorological variables. The absolute value of observed O_3 concentration and OWI should be included to indicate the robust of OWI.

Reply:

Because the magnitude of each sub-index in OWI varied greatly, which would influence the effect of OWI, we need to normalize the meteorological variables to eliminate the impact of dimensions. **The normalized process is to divide the anomaly by the standard deviation.** And the robust relationship between OWI and observed MDA8 has been verified by Yin et al. (2019). The variations in the daily observational MDA8 and OWI from 2007 to 2017 are showed in Figure R1. **The correlation coefficient between the observed MDA8 and daily OWI was 0.61 for the period 2007-2017.** It meant that the change of OWI agreed well with that of ozone concentrations.

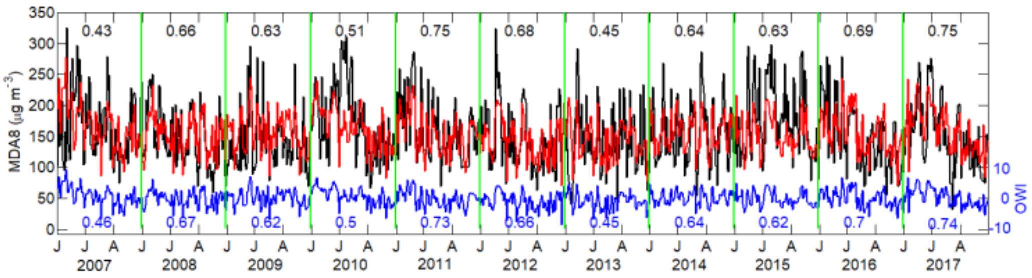

Figure R1. The variation in the daily observational SDZ MDA8 (black), fitting SDZ MDA8 (red), and OWI (blue) from June to August during 2007–2017. The numbers are the correlation coefficients between the observational SDZ MDA8 and fitting SDZ MDA8 (red) and OWI (blue).

Related References:

Yin, Z. C., Wang, H. J., Li, Y. Y., Ma, X. H., and Zhang, X. Y.: Links of climate variability among Arctic Sea ice, Eurasia teleconnection pattern and summer surface ozone pollution in North China, Atmos. Chem. Phys., 19, 3857–3871, https://doi.org/10.5194/acp-19-3857-2019, 2019.

Revisions:

Lines 103-107: In this study, we employed the ozone weather index (OWI) during 1980–2018, which has been defined by Yin et al. (2019; 2020b) and was proven to be a comprehensive and effective index determining the maximum daily average 8-h concentration of ozone (MDA8 O_3). **The correlation coefficient between the observed MDA8 and daily OWI was 0.61 for the period 2007-2017 (Yin et al., 2019).** The formula for OWI in North China is as follows:……

Lines 111-113: ….and the DTI is the area-averaged difference between the temperature at the surface (37.5°–47.5°N, 110°–122.5°E) and at 200 hPa (37.5°–50°N, 110°–127.5°E). **The normalized process is to divide the anomaly by the standard deviation.** These meteorological factors were selected based on ……