Response to Referee #2

This is a study about pollutant distributions in the Arctic, as they relate to the atmospheric circulation patterns in the springtime. SLCPs; O3, NO2, CO, and aerosols (via AOD) were examined, and correlations were found between an increase/decrease in pollutants and types of circulation. Satellite (OMI, AIRS, CALIPSO) and reanalysis (CAMS, ERA5) datasets were used, and the 20 circulation patterns were determined using a Self-Organizing Map method for the 2007-2018 time period. O3 concentrations were found to have the opposite behavior as that of NO2 for the circulation types, and NO2 was found to be the most sensitive to circulation type than the other pollutants.

We thank the referee for the constructive comments that lead to the improvement of the manuscript. Please find below point by point reply to them.

General comments:

1. Lines 151-162: Can you please add an explanation or justification on why mean sea-level pressure is the only variable needed to characterize a distinct circulation pattern?

MSLP is a robust indicator of an atmospheric state in the Arctic, and captures and represents the circulation and flow patterns that affect the lower troposphere (Neal et al., 2016 and the references therein). This is important for studying the pollution transport processes that occur mostly in the lower troposphere and their subsequent impacts. We have also used geopotential height anomalies to see the coupling of the upper troposphere with the lower troposphere and we can clearly see that for the most part they agree with one another indicating a coupling between the upper and lower troposphere during the various circulation regimes investigated here. A discussion about this is added in the revised manuscript.

2. From Fig 1 – if I interpret it correctly, CT#20 is the most frequently occurring CT in March. And CT#1 & 4 are the most commonly occurring CTs in May. CT#6 and 7 are not very frequent in any of the 3 months. It would be helpful if the authors spent some time discussing which of the 20 CTs are the most common conditions and which are more rare and to further discuss that frequency in terms of the SLCP concentrations. If I've misunderstood and all 20 CTs have a similar frequency of occurrence, than the authors should explain that too.

We thank the referee for the suggestion and we agree completely with it. We have added a paragraph discussing the frequency of different circulation types in the revised manuscript. The CTs do not have similar frequency and the number of events in CT differs as well in each month. Therefore the weighting factor was used to compute the climatology to compute the unbiased anomalies.

In the revised manuscript, we have kept only 8 circulation types to avoid redundancy (please see our response to the similar issue raised by Referee #1). We hope this will improve the readability of the manuscript.

Minor comments:

Line 18: spell out acronym "MSLP".

- Mean Sea Level Pressure (MSLP) is spelled out.

Line 21: spell out acronym "AOD".

- Aerosol Optical Depth (AOD) is spelled out.

Line 94: "descend" should be "descent"?
- Corrected.

Figure 1: The captions says (a) and (b), but the figure panels aren't labelled with (a) and (b) but they should be. Otherwise, the caption should be changed to (top) and (bottom).
- Corrected.

The x-axis of both panels should be labelled ("number of days"?). The colour bar or the the lower panel is labelled "circulation type number", but I think it should instead be labelled "weighing factor", no?
- The X-axis in both subplots show the circulation type number, while the subplots themselves show the number of days each circulation type has occurred (top) and the corresponding weighting factor (bottom).

Line 262: add "and" between 'humidity, rainfall'.
- Corrected.

Figure 6: what's the unit on the O3 anomalies? Is it unitless VMR? Perhaps multiply by 10^9 and provide units of ppbv. Or else, add to the caption as you've done in Fig 8 ("The … volume mixing ratio anomalies…")
They are VMR. They are expressed in ppbv in the revised manuscript.

References:
Neal, R., Fereday, D., Crocker, R. and Comer, R.E. (2016), A flexible approach to defining weather patterns and their application in weather forecasting over Europe. Met. Apps, 23: 389-400. https://doi.org/10.1002/met.1563

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