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Comment on acp-2021-458

Anonymous Referee #1

Referee comment on "Influence of springtime atmospheric circulation types on the distribution of air pollutants in the Arctic" by Manu Anna Thomas et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-458-RC1, 2021

This paper applies Self-Organizing Maps to sea level pressure fields to identify 20 circulation patters in the Arctic spring, and then analyzes the observed distributions of pollutants associated with these patterns. The analysis aims to demonstrate how the transport and distribution of pollutants in the Arctic varies depending on the circulation pattern and to provide an observation-based test of chemistry transport models. This is an original and interesting idea, and the Self-Organizing Map method is state-of-the-art. However, more discussion of uncertainties and sampling of the satellite data in the Arctic is needed. In addition, the inclusion of 20 different circulation patterns makes the results complicated to interpret. I list general and specific comments below.

General comments:

- The presence of snow and ice, as well as cloud cover, can pose challenges for satellite retrievals or affect how much data is available, potentially leading to sampling biases. Please include more discussion of the sampling and any uncertainties for each satellite product in the Arctic environment. If ground or aircraft-based observations are available to validate the findings, that would also strengthen the paper.
- Section 2 mentions that ozone at 925 hPa from CAMS is used in the analysis because of the lack of reliable lower tropospheric ozone observations. Does this mean that the CAMS ozone at this level is primarily model-based? Has it been validated for the Arctic? This should be discussed since it is relevant to whether this method provides an observation-based test of chemical transport models.
- What is the reason for allocating 20 circulation types? Could this number be reduced? The discussion often refers to multiple types together. For example, line 183 mentions 4 types under the influence of a strong anticyclone. Are these 4 still completely different patterns? It is also difficult to intuitively visualize the distinction between the 20 different maps presented in the plots, as the same main features seem to be present in multiple maps. If the number of maps were reduced, or perhaps the presentation of the plots organized to focus on a smaller number of clearly-distinguishable ones, the discussion would be easier to follow.

- One suggestion for presenting the main results more clearly is to include a figure that shows all of the pollutant anomalies (CO, NO_2, O_3, AOD) side by side for a couple of the main circulation patterns, so that the reader can easily see how anomalies in different pollutants relate to each other for a given circulation pattern.

Specific Comments:

Line 141: Please define TqJ

Line 167: Why is the weighting needed? To ensure each month of spring receives equal weight?

Line 171: It is stated here that only statistically significant anomalies are shown, but some figures (like Fig. 3) appear to show anomalies everywhere. How is significance or non-significance indicated?

Line 206: What does "those circulation types" refer to?

Lines 268-295: I find it difficult to relate this discussion to the large number of alternating positive and negative anomalies that appear in Fig. 7. Perhaps the analysis would be more convincing if multiple circulation types were grouped together to improve sample size and data coverage.

Fig. 1: A discrete colorbar might be easier to interpret.

Fig. 2: Streamlines might be a nice addition to help visualize the direction of transport