

Influence of the North Atlantic Oscillation on European tropospheric composition: an observational and modelling study
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In this paper, the authors combine multiple satellite observations with CTM simulations to characterise the overall distribution of 3 chemical species, NO₂, PAN and O₃. Whilst the presentation of satellite observations and CTM simulations is clear, the overall aim of the study is too generic – “to investigate the impact of the NAO circulation on tropospheric composition”. As a result, the main conclusion of the paper is also very general and does not, in its current form, constitute a new finding. I recommend that this paper undergoes significant major revisions.

General comments

1. Abstract and introduction: The structure of the introduction does not move on from what is known already, towards the issue that remains unknown and will be studied. As a result, it is not possible to determine the innovative aspect of this research. The authors need to state clearly which gap in the scientific knowledge this paper aims to fill and set out some specific research questions or hypothesis.
2. Results: The authors have chosen to present the results in 2 sections. First the observations of tropospheric composition (section 3.1) and second the model simulations of tropospheric composition (section 3.2). Currently, use of the CTM simulations to ‘diagnose the relationships seen in the satellite data’ relies on the CTM composite wind fields. A similar result could be achieved using re-analysis wind fields. What is the additional benefit of using a complex CTM?
3. The main conclusion is that the NAO is an ‘important driver of winter-time atmospheric composition across Europe’. As the authors themselves state in the introduction, several previous studies have reached the same conclusion and therefore this is not a novel result. Please can the authors focus their research question and use the high quality datasets available to them to answer it.

Specific comments

1. Page 2 line 16: ‘altitude’ is usually used as a vertical distance measurement but here it could be interpreted as a latitudinal distance. Can this be re-worded to make its use clearer?
2. Page 2 line 18: The authors refer to transport from the troposphere into the UTLS. As part of the troposphere is in the UTLS by definition, should troposphere be mid-troposphere here?
3. Page 3 line 10: Here and elsewhere the authors refer to enhanced westerly circulation as ‘storm tracks’. Of course, the low-level eddy driven westerlies can be used as a proxy for the storm track but it should be stated that this is the assumption here.
4. Page 3 line 12: ‘re-orientation’ should be reorientation I think.
5. Page 4 line 10: The authors here claim that they are building on previous work but it is not clear from the introduction specifically what research question(s) they are addressing (see also general comment 1).
6. Page 4 line 14: What is the advantage of higher resolution and more frequent observations? How does this allow the authors to discover that was not known before?
7. Page 4 line 24: What time period is used to normalise the pressure data? Also, why does the study focus on wintertime only? In some situations November data is included, but not in all, why isn’t the same period used for all of the data?

8. Page 5 line 28: The 10km wind composites during different phases of the NAO are included in figure 1 but only briefly referred to in the text. Why were these figures included and how do they relate to the subsequent analysis?
9. Page 6 section 2.2: This section details the satellite observations used in the study. However, as the authors have not motivated their decision to focus on PAN, NO₂ and O₃ in the introduction, it reads like a list of available data sources, rather than the necessary data needed to answer the research question posed. Why are these observations rather than others used in the paper?
10. Page 7 section 2.3: This section appears to contain a lot of information that is not necessary to interpret the results or to reproduce the study. For example, the representation of many chemical species not used in this study are described. Please can this be re-written to focus on the information needed to support the results and conclusion of this specific study.
11. Page 8 line 20: How many satellite overpasses are used to create figure 2. Is the noisy data a result of the sampling frequency? If the satellite data were averaged over larger spatial areas would this help with the signal to noise problem?
12. Page 9 line 11: Do the authors have a physical mechanism to explain the lack of significant anomalies in fig 2d? The equivalent CTM simulation (fig 7d) shows significant positive anomalies across western Europe. What is the reason for this difference? Can the CTM be used to understand better the lack of relationship seen in the observations?
13. Page 10 line 13 and page 14 line 16: How does the higher tropopause aid vertical transport of PAN into the UTLS? Is the UTLS a region that moves with the tropopause or is it defined to be a fixed altitude region?
14. Page 14 line 29: Here the authors claim that the CTM PAN and satellite observed PAN have 'some similarities'. Comparison of figures 3c and 10c, and 4c and 11c, show very different spatial patterns. What is the reason for this? Does this mean that the CTM cannot be used to diagnose the relationships seen in the observations as they cannot reproduce the broad features observed during different phases of the NAO?
15. Page 20 line 8: Please remove 'successfully' from this sentence. It is up to the reader, not the authors to judge the success of the paper.