

Interactive comment on “High-ozone layers in the middle and upper troposphere above Central Europe: potential import from the stratosphere along the subtropical jet stream” by T. Trickl et al.

Anonymous Referee #1

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This paper describes analysis of high ozone episodes observed in layers in the mid-troposphere over Europe using trajectory modeling techniques, and attributes some of this ozone to stratospheric sources following influx associated with the subtropical jet stream. It describes a number of case studies when mid-tropospheric layers containing high ozone were observed but could not previously be explained, and it resolves these by attributing them to stratospheric influence over longer timescales than had previously been considered. It demonstrates that this mechanism is important, but does not extend as far as quantifying the impacts.

I found the manuscript very interesting but somewhat difficult to follow. It is heavily

C12616

descriptive, containing a high level of detail and revealing a very thorough analysis of some high-quality atmospheric measurements. However, the scientific contributions are not immediately clear, and are in part obscured by the level of detail in the description. The authors need to extract the novel scientific aspects of this study (the focus on long range transport of ozone from shallow intrusions, and the importance of influx along the subtropical jet stream) and stress these more strongly. At present there is too much emphasis on explaining observational details and too little on providing valuable insight into the processes involved. Considerable effort has gone in to the high-quality analysis described, but the resulting paper needs some reorganization if it is to make a substantial scientific contribution. It needs to state explicitly how it advances the state of knowledge beyond the earlier published analyses that are cited, and how it might be extended to provide insight into the mechanisms involved or into the magnitude of their impacts (even if this is not followed up here).

The topic of the paper is clearly appropriate for publication in ACP and is likely to be of interest to readers. However I would recommend revision and believe that considerable clarification is needed before it is ready for publication. Specifically, I recommend that the case studies section is rearranged, and provide further suggestions below.

General Comments

The paper would be substantially clearer if the authors explained their hypothesis clearly and in detail to start with, and then used the case studies to support their assertions. I would suggest that these three case studies are combined so that the situations can be compared and contrasted right from the start, and that the subsections then introduce the different analysis approaches. Currently the case studies are described sequentially (one per subsection) and the analysis approaches are applied to each (one per sub-subsection), and the thread of the paper therefore jumps about too much. While there is much detail of interest in each case study, it is easy for the reader to lose their way because the level of detail distracts from the main thread of the argument.

C12617

Many aspects of the case studies have been described in earlier publications, so the authors need to be more selective about what is shown here. I appreciate that some attempt has already been made at this, e.g., by omitting the lidar time series figures of the first two case studies, which are published elsewhere, but this omission actually makes the case study descriptions more difficult to follow, as it requires extensive reference to previous papers to follow the arguments. This paper should focus on the aspects of the study supporting the current arguments alone (although the lidar profiles are required to provide context).

The written style of the paper is formal and educated, but the phrasing is awkward and long-winded in many places, and there are elements of narrative (e.g., at the start of section 3.1.4) that are unnecessary. In many places the ideas could be expressed more clearly and concisely without loss of information, and I have identified some issues below.

There are too many cross-references, both forward references to explanations occurring later in the text and to previous studies. While this is useful for the expert searching for specific details, it is not helpful for the general reader who is looking for a coherent scientific story running through the paper.

If 20-day simulations are available, it would be good to focus only on these. Sections 3.1.3 and 3.3.3 currently introduce the 15-day simulations first and then describe the 20-day simulations; it is not clear why this is necessary or what this adds, and it makes the text more difficult to follow.

There is no discussion of the reliability of the trajectories used here. Given the uncertainty in the meteorological data and the propagation of errors over the long timescales considered, it would be useful to present some assessment of reliability, or to cite previous studies that have assessed this.

Very little use is made of the Lagranto analysis except in Case 1. Can this be tied in better for the other case studies? Again, it would be clearer if this analysis was

C12618

discussed for all case studies at once.

Specific Comments

The abstract needs to be rearranged. The scientific contributions of this paper are left until the last two sentences of the abstract, and the statements made here are vague. The new results of this study need to be stated clearly here.

30475, l.18: The first sentence of the introduction should be reversed so that the subject (dry air masses with high ozone) comes first.

30479, Section 2 describing the methods should be condensed, particularly the measurement details which are covered in previous papers. The section should focus on the new aspects of the analysis used in this paper.

30478 l.19 and 30491, l.13: It seems a little irregular to refer the reader to the earlier, non-peer reviewed ACPD version of this same manuscript for description of the cases not described here!

30488 l.24: the estimation of stratospheric influence here is crude. It would be helpful to provide some justification for this approach to provide the reader with a better understanding of the associated uncertainties.

Figures

There are a lot of figures in the paper, and combining some (e.g., Figs 2 and 3) would allow them to be compared and contrasted much more easily. If the three case studies are considered together, there would be much more scope for this, e.g., combining the retroplume, Lagranto and vertical profile figures so that the case studies can be compared under the same analysis approaches.

The retroplume summary figures (Figs 5 and 11) are not easy to interpret. It would be clearer to present the clustering as a probability density with the magnitude represented by the color or shading. The current method using circles is difficult to make

C12619

out, and neighboring circles overlap each other. The figure would be more legible if the ABL and STR panels from the three layers are each combined into one so that there are three lines on each panel.

The contribution plots (Figs 6 and 20) need to be replotted so that the axis labels are coherent (not "nearest integer").

Figs 7, 14 and 21: note in the caption that the variable shown is wind speed.

Other issues

admixed -> mixed into or mixed together (throughout text)

The word "rather" is overused, and the meaning is ambiguous in many places. Please replace it with "very" or "relatively" depending on context, and remove it where unnecessary. (throughout text)

30476 l.4: remove "e.g." and "on"

30476 l.6: remove "by us" (and cite study if needed)

30476 l.27/29: remove "even"

30477 l.9: "Quite differently" -> "In contrast" or "However"

30477 l.12: remove "on"

30477 l.19: "exhibits some similarity with" -> "is similar to"

30478 l.9: remove "also" and preceding comma

30478 l.16: remove "fifteen and now even"

30478 l.23: "We focus on presenting just three" -> "We present three"

30478 l.26: "as well as" -> "and"

30485 l.24: "representing an inverted atmosphere" not needed, remove.

C12620

30490 l.11: "not easily possible" -> "not easy" or "not possible"?

30491 l.25: The meaning of the sentence starting "The principal..." is unclear, please rewrite this

30493 l.6-7: Sentence not needed here, remove.

30499 l.15: "(in some cases: most)" confusing, please remove.

30502 l.15: hibernal -> winter

30502 l.24: rephrase "material" here

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 30473, 2010.

C12621