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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Filamentary structure in chemical tracer distributions near the subtropical jet following a wave breaking event" *by* J. Ungermann et al.

Anonymous Referee #2

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The authors discuss the nature and chemical composition of small-scale structures observed near the subtropical jet by the CRISTA-NF limb sounder during a Geophysica flight. New is the two-dimensional, spatially quite well resolved description of such structures which enables the identification of different types of air masses converging around the tropopause. The paper is well written and structured.

However, I found the manuscript partially too descriptive and finally I had the impression that a further step in the data interpretation was missing ... "there must be more in the data". Thus I would like to see my comments considered before I can advocate publication.

Major concern

In my opinion, besides the nice 2-D visualization of the structures, the scientifically most exciting observation is the different chemical composition of the filaments/structures, e.g. the dislocation of the features in O3, PAN, and HNO3 in the eastern cross-section. This should be better carved out. I suggest the following:

- For better discern the features for the reader, combine the 3 figures 5-7 in one (5a-c) and locate them on top of another on one page (in which you need the caption for the x-axis only in the lowest graph). Can you somehow lay all three trace gas distributions one over the other, e.g. by using contour plots with a different colour for each gas and only 3-4 contour lines per gas (as graph 5d)?

- From the tracer-tracer-correlation plots one should learn more. First, flip x- and y-axis. O3 is usually on the y-axis to visualize the transition into the stratosphere. The colours in the Figs. 11, 12, 13 are not well chosen, especially the light and dark purple are badly distinguishable, at least on printed hardcopies. I haven't understood from where exactly the air masses in Fig. 11 come from. Did you just show a data subset with the limits given in the box? With these limits you must get a L-shape tracer relationship, independent on the data. Then I haven't understood the sense of this figure. Is the source region of the light purple data points really so small so that the interpretation of the PAN/O3 slope as (chemically generated) enhancement ratio is valid? May it also be possible that the slope simply reflects spatial gradients in the trace gases? . . . which would make the interpretation of the slope senseless.

- The most exciting air mass is the green one in Fig.12. O3 is 200-300 ppbv and thus stratospheric, but PAN as tropospheric tracer is likewise enhanced and reaches up to 500 pptv. The green air masses thus characterize exTL air, right?! I am not an expert in PAN chemistry, but how the PAN is formed there. React e.g. certain aldehydes or oxygenated VOCs with O3, so that PAN was in-situ formed? Simple mixing of air masses in the exTL do not form such strange tracer inter-relationships. Or is O3 wrong,

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i.e. too high?

Minor concerns

p.5040, l.22. “chemically inhomogenous UTLS region”. Change it (although I assume what you want to say)

p.5048, l.23ff. “This filament . . .”. Try graph d (see above) to visualize possible displacements

p.5050ff. It is hard to reconstruct what air mass is just meant. Thus, define in a list the different air masses with the relevant colour and ever use this definition in the text, e.g.

- “tropospheric (blue)”

- “high-stratospheric (red)” . . .

p.5053, l.15. This ozone threshold of 175 ppbv is far too high for an ozone tropopause threshold value which is (seasonally dependent, typically between 70 and 130 ppbv). That is, the given categorization of air mass types and their names in Table 2 are definitely not correct.

p.5053.l20 – p.5054.l3. This review on the sources of PAN is something for an introduction and not for the discussion.

p.5054.l4-11. A L-shape relationship especially of O3 with CO and H2O is only seen in the subtropics at sufficiently high altitudes, but e.g. never in air masses originating polewards of $\sim 40^{\circ}$, simply as basically everywhere there is an exTL (characterized by a non-L-shape transition from trop to strat air). Rephrase it.

p.5054ff. (Also in this respect,) I do not see the sense of the given discussion of the PAN-O3 slopes. What can we learn from them? Something on chemical processing, see also my comment above? PAN is a medium-lived compound; thus, the slopes in the exTL and the background above the exTL should tell us something about transport/mixing times. Is the stratospheric background of ~ 50 pptv real? PAN is quite

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different to CO, as LT air is poor and UT air is rich in PAN. Thus, the information we gain from PAN should be different to the one from CO.

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