Review of acp-2022-692: Case study on the influence of synoptic-scale processes on the paired H2O– O3 distribution in the UTLS across a North Atlantic jet stream by A. Schäfler et al.

Summary

In the present manuscript the impact of synoptic scale weather systems and turbulent mixing are studied to better explain the distributions of water vapor and ozone in the tropopause region in the vicinity of the jetstream over the North Atlantic. This is done by combining LIDAR observations of these species, taken onboard the HALO aircraft during one research flight of the WISE campaign in 2017, with synoptic weather analysis, tracer-tracer correlations and back trajectories. This study can be regarded as extension of a previous paper of some of the authors where air masses have been classified along the observations. The focus of this paper is more to explain the origin of these air masses along with the atmospheric processes which determine the chemical composition. The authors identify seven major weather systems which affect the pathways of the probed air masses with high latitude air masses causing O3 filaments in the lower stratosphere, tropical cyclones affecting the water vapor distribution in the upper troposphere and the jet stream carrying mixed air masses towards the locations of the measurement.

Relevance

This study is a perfect show case to illustrate the complex interplay between tropospheric dynamics and the chemical composition of the UTLS in the extratropics. The study is of high value for the community, first because the DIAL obersvations provide such detailed information which are unique in the tropopause region. Second, the combination with Lagrangian analysis provides further insight in the pathways of air masses in the tropopause region and highlights the non-local but persistent effect of mixing on the chemical composition. Yet alone Figure 4 shows how diverse the air mass origin along a relatively short flight trajectory in the mid-latitudes can be!
I regard the quality of this paper as very high. The line of thoughts is laid out clearly, the question of the paper is expressed in a clear statement, the figures are illustrative and informative, and the conclusions follow from the analysis. I highly recommend publication in ACP. I have only a few minor and technical comments which the authors might address before final publication.

Suggestions

Minor

1. page 4, line 96 and page 5, line 42: Isn’t 10 days a bit long for the synoptic time scale? If I take the synoptic length

scale (1000 – 5000 km) and the characteristic wind speed of about 10-50 m/s, then I end up (optimistically) at around 5-6 days. I am curious whether there is a physical justification for the ten days which I miss here?

2. Table 1 (and associated weather system classification): Is there a specific reason why you refer to the jetstream as polar jet? Is it because of the altitude of the jet, like is it more present at lower levels while the subtropical jet is at higher levels? Has there been an additional subtropical jet (while the polar jet reaches latitudes down to 30°N according to the table).

3. page 5, line 35: Which quantity has been used for the vertical interpolation of the model data onto the aircraft trajectory: pressure, altitude or potential temperature?

4. Page 15, section 3.4, line 341ff: The fate of the O3 rich air at midlatitudes is studied using 8 trajectories. How trustworthy are these individual trajectories? Would it not be better to initialize a cluster of trajectories in the region of the eight starting points (with slightly altered initial positions)?

5. Page 21, line 438: What is meant with “enhanced turbulence probability”?

Technical

- Figure 1c: I assume the geopotential height contours are given in gpm. Which isolines are shown for the surface pressure? Same as in Figure 4?

- Page 6, line 163: “... but also …” => “...and also …”

- Figure 2: The Arctic Circle is difficult to spot (but is in my opinion not too relevant).

- Figure 3g: The figure shows max pressure, and the legend states mean pressure.

- Are the figures vector graphics? When zooming in the figures (since they often contain a lot of information!), they often pixaleted and small letters were diffficult to read.