Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-1085-AC1, 2021

Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Mixing at the extratropical tropopause as characterized by collocated airborne H_2O and O_3 lidar observations" *by* Andreas Schäfler et al.

Andreas Schäfler et al.

andreas.schaefler@dlr.de

Received and published: 16 February 2021

The comment was uploaded in the form of a supplement:
https://acp.copernicus.org/preprints/acp-2020-1085/acp-2020-1085-AC1-supplement.pdf

---

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1085, 2020.

ACP 2020-185: Mixing at the extratropical tropopause as characterized by collocated airborne H2O and O3 lidar observation

by Schäfler et al.

Reply to review #1 by Laura Pan

Dear Laura Pan, we are grateful for the positive review and the recognition of our work. We appreciate that you consider the manuscript to be unique and of high value and that it contributes to the state of art of this research topic. We thank you for the valuable suggestions and comments that helped us to improve our manuscript. Below, we answer each comment using a blue font. At the end we added an updated version using track changes. Please note that all references to lines refer to this revised version.

Transport and mixing near the extratropical tropopause associated with the jet dynamics, relationship between the meteorological background and the chemical distribution in the extratropical upper troposphere and lower stratosphere (ExUTLS) have been an active line of research for multiple decades. An important development in the past two decades is the use of tracer-tracer correlation. This line of work has been largely fueled by new observations from new satellite and especially research aircraft data. The analysis presented in this work expands the horizon using the new generation of airborne lidar observations that provided co-located ozone and water vapor measurements in a two-dimensional cross section intersects a region of active jet dynamics and stratospheric intrusion. The authors did an excellent analysis to connect the 2D ozone and water vapor observation with all major prior studies when limited in situ sampling or coarse satellite data were available. The analysis combining the tracer space diagram and geometric space distribution using this unique 2D data is a significant contribution to the topic of ExUTLS research, and it could serve as a road map for analyzing future observations in this layer. Given that the modeling community is working toward improving spatial resolutions of the chemical transport and/or chemistry climate models to resolve the tropopause region, the method demonstrated here can be applied readily for processspecific model evaluations.

In summary, the new data presented is unique and of high value. The analysis presented contributes to the state of art on the topic of research. The large set of analysis details are presented in excellent clarity. I do have a few comments and suggestions below for the authors' consideration. Major comments and suggestions:

1) It is too much of a missed opportunity not to include lapse rate tropopause in the analysis. An important question in the work of ExUTLS transport and STE is the relationship between various tropopause definitions, in particular, definitions of the dynamical tropopause and the temperature lapse rate based thermal tropopause from WMO. Chemical discontinuity and tracer-tracer relationship is a unique way to shed light on the physical behavior revealed by the relationship of the two definitions. The work did an excellent job diagnosing the dynamical tropopause using PV gradient versus fixed PV surface. It would be very valuable to diagnose the vertical discontinuity at the tropopause represented by the temperature lapse rate (discontinuity of the static stability) and PV contours, and the chemical mixing versus discontinuity associated with the conditions where they agree or show large separation. In this direction, it is worthwhile to present the Lapse rate tropopause on the cross section, and to show additional LRT relative profiles in Fig. 4. I understand that you don't have vertical legs for in situ measured temperature profiles but ERA5 300m resolution data should be able to provide a good approximation.

Fig. 1.