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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Long-term climatology of air mass transport through the Tropical Tropopause Layer (TTL) during NH winter" *by* K. Krüger et al.

K. Krüger et al.

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Answers to the anonymous reviewer # 2:

We would like to thank reviewer 2 for his valuable comments, which helps to improve our paper. First we want to answer the general comments before the detailed point by point answer is given below.

General comments:

1. The concept of Q(LCP): We have used the concept of the LCP to make our study comparable to previous published TTL transport papers. To be consistent within our paper we also investigated the Q (LCP) fields. We will add the vertical dependence

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of the LCP more clearly. The LCP is also important for VSLS as it marks the point at which they reach the stratosphere and of how much water vapour they will contend. The duration time and the amount of water vapour of air parcels within the TTL before and after that cold point determine the chemical life times and processes of VSLS reaching the stratosphere. This discussion will be added in the ms. For the discussion of water vapour trends in the paper see also comments on reviewer 1.

2. A detailed study on natural variability e.g. combined ENSO and QBO cycles will be part of a separated paper. We will add the secondary circulation of the QBO and some more details; see also the comments on reviewer 1.

3. Values at the sub-tropics are mainly larger because only few trajectories were sampled at these regions, so there might not be reliable. This information will be stated clearer in the corresponding text phrase.

Detailed comments answered point by point:

Abstract: - The acronyms will be written out; the tape recorder is removed according to reviewers 1 suggestion.

- During the QBOE phase minima of saturation mixing ratio lying over the western Pacific are 25 % drier (0.5 ppmv anomaly of 2.0 ppmv) than during neutral years. Numbers will be added in the figure text.

-entry points is removed.

- Representation in models added.

- Konopka et al 2007 study will be added in the ms.

- changed to large set

- This sentence is added as this point seems to be not clear to many scientists, who are not familiar with trajectory or Lagrangian studies. This was asked by a reviewer before.

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- Fu Q und Liou K N (1992). On the correlated k_distribution method for radiative transfer in nonhomogeneous atmospheres. JAS, 49, 2139-2156. Fu Q und Liou K N (1993). Parameterization of the radiative properties of cirrus clouds. JAS, 50, 2008-2025.

- For the trajectory and the radiation calculations:

- The tropopause defined by the minimum saturation mixing ratio which was measured and then compared with the CPT (see Zhou et al 2001).

- The values for e can considerably vary if you don t use a formula for the measured or modelled temperature range see a detailed discussion on differences between some formulas in U. Leiterer et al 1997 (Beitr. Phys. Atmosph. Vol. 70). The Sonntag formula performs very well as shown by Leiterer et al 1997 and in our companion study by Immler et al 2007a (JGR).

- Yes, the info is added as well.

-tropical belt removed.

-p. 13995, l. 3: vertical winds:

The winds fields and heating rates are all given on pressure coordinates whereas the trajectory tool is calculated on isentrope coordinates. In contrast to other trajectory models (e.g. CLaMS) the input data are not explicitly transformed on theta-coordinates. An interpolation is just carried out for a given trajectory position. In summary the vertical wind is not directly transferred into a heating rate but indirectly:

1. p(n+1) = p(n) + w

2. Interpolate p(n+1) in Theta(n+1) and p(n) in Theta(n)

1 and 2 is carried out for the trajectory calculations based on vertical winds, where n designates the trajectory time step. For a detailed discussion see the PhD thesis by Susann Tegtmeier 2007: http://opus.kobv.de/ubp/volltexte/2007/1211/ or the submitted

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JGR paper by Tegtmeier et al 2007.

- p. 13995, l. 13: Will be changed.

- changed to concentrated.

- Text changed to is systematically colder than ERA40 data by 1K. A discussion will be then given in section 4.

- Done.

- Solar cycle mechanisms will be shortly described.

In the following rest of the reviewer list, the typos will be all changed but not mentioned anymore.

- Data inhomgeneities were recorded by the SPARC newsletter, Simmons et al 2005, Uppala et al 2005, Manney et al 2005, Tegtmeier, 2007 etc. These data inhomogeneities are a well known phenomena. They consist of:

1. Steps in the time series due to the 4 stream calculations by ERA40 which were run on different but parallel super computers. 2. Steps due to the direct assimilation of AMSU radiances since 1998. 3. Artificial oscillations in temperature in the stratosphere due to the assimilation technique. These effects are more pronounced in 3DVar than in 4DVar.

- Brunn and Krüger citation: This should become an own paper. The results can not be added in this paper here. See also comments on reviewer 1.

- Changed to: in the upper part of the TTL

- The numbers for the solar cycle temperature changes are added in the conclusions.

- The point here is to distinguish between Eulerian (Zhou et al) and Lagrangian studies (e.g. this study).

- The last sentence will be shifted above.

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- LCP, see our general statement above. The air mass sampling over the cold region (Western Pacific) between the standard opECMWF and ERA40 input data (black and red lines in Fig. 1f) is very similar as Fig. 1f clearly demonstrates. These input data are used for Figure 3 as well. The largest differences arise from the temperature differences itself. Comparing daily CPT data over the tropical belt reveals systematically colder opECMWF data compared to ERA40 by -1.2 K, which varies up to -5K on daily data. This is in good agreement to the difference shown in Fig. 1 and 3.

- Figure 4: Thanks, the figure quality will be controlled at the end.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 13989, 2007.