

## ***Interactive comment on* “Validation of water vapour transport in the tropical tropopause region in coupled Chemistry Climate Models” by S. Kremser et al.**

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### **General**

Kremser et al. present an analysis of dehydration in the TTL in two GCMs, and compare with results obtained from ECMWF ERA40. They use trajectory calculations to determine the Lagrangian cold point (LCP) distribution, and consequently water vapour mixing ratios at entry into the stratosphere. This technique has been successfully applied to assimilated data from ECMWF, and this extension to GCM output is a welcome contribution. The paper shows that previously noted patterns of LCP distributions also

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exist in the results based on GCM output, but that the details of the patterns differ. No attempt is made to work out why they differ. Since both GCMs are based on the ECHAM family, one might have expected the large scale features of temperature distribution (stationary tropical waves) and circulation to be very similar. Also, no attempt is made to link the Lagrangian estimates with the model's own water vapour transport into the stratosphere, though it is noted that the latter may be affected by non-physical issues such as problems in the advection scheme. Since climate studies are carried out with the advection schemes, and not with trajectory calculations, it would be important to know how different the results are. The revised manuscript should show such a comparison. Also, the title of the paper is inappropriate, and the word 'Validation' needs to be replaced with something like 'comparison'. This study does not validate, neither in the sense that it shows that two measures are equal, nor in the sense that a validation is a comparison with a generally accepted 'true' measure (I doubt that the results based on ERA40 are generally accepted as the 'truth'). Provided the revised manuscript resolves these issues - and the ones listed below, it may be published in Atmos. Chem. Phys.

### Specific comments:

Abstract:

P11000/L18: Replace 'reproduced' with something like 'similar'.

P11000/L22: Replace 'satisfactory'

P11000/L25: I cannot see evidence in the manuscript for 'excessive mass flux'. Probably you want to say something else?

P11001/L1: Replace 'underestimated' with 'lower'.

Introduction:

P11002/L1-2: Awkward. Give credits for stratospheric circulation to Brewer and to Holton et al. 1995 (which is missing altogether in the bibliography!). In the context of

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stratospheric water vapour, Fueglistaler et al. 2005 can then be cited for showing that stratospheric water is indeed in agreement with what one expects from a large-scale transport perspective.

P11002/L8: No need to cite Gettelman and Forster here, this is what the TTL is by definition.

P11002/L13: The reference here should be Holton and Gettelman, not Gettelman and Holton. Moreover, this is a pure modelling study and certainly cannot be used to back the claim you make here; hence remove it.

P11002/L19: This is a pointless sentence! The cold point is by definition the coldest point; also, please note that it should be the 'final' or 'last' dehydration point, not just 'dehydration point'!

P11002/L22: Replace 'behind' with 'after'.

P11005/L11: Again, credits here should go to Holton et al. 1995.

P11005/L15: This statement is wrong. Diabatic trajectories do not give inaccurate results because of convection. What you probably wanted to say is that the trajectories that use only *radiative* heating rates, give wrong results.

P11006/L10: Please give the vertical resolution for the tropical, not the extratropical region.

P11077/L22: Diabatic trajectories show less dispersion, which does not implicitly mean that they better represent reality! More importantly though is that the subsequent comparison is somewhat arbitrary - if you want to make a statement about differences between the GCMs and ERA40, then the trajectories should be computed with the same method. At least, you should also show the results from the kinematic ERA40 trajectories (which should be easy, since you say that you have calculated them).

P11008/L7: Theta=365K is actually very close to the tropopause, I'd remove the brack-

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eted remark (upper troposphere). Have you thought about the problem arising from the differing temperature biases in the models and ERA40 when using a fixed potential temperature level? Would it not be better to use some difference in pot. temperature relative to the pot. temperature of the cold point? (The same also applies for the residence time calculation, mentioned on page 11009//L6.)

P110010/L5-8. This 'fractional water' is not useful, please just show the distribution of the LCP. (It is pointless because it is misleading - an area where it is very cold will show up as an apparently 'unimportant' area, even though it may be the area where most water is removed (this problem is generic to all studies of a tracer budget: do you want to emphasize where most of the tracer comes from, or do you want to emphasize where most of the tracer gets removed. In any case, it does not help your discussion of ENSO later in the paper.)

P11012/L10ff: The effect of ENSO on entry mixing ratios and the distribution of LCP is extensively discussed and explained in Fueglistaler and Haynes (2005) and should be referenced here. (In particular, see their Figure 2c and 2d; the latter shows the effect of ENSO very clear.)

Conclusions: Again, in your discussion please remember that you compare with results based on ERA40, but you do not show observations, and consequently absolute statements like 'Overall the distribution is much too zonal and water vapour contributions from Africa are too high.' (P11018/L13) should be avoided.

#### **Additional references:**

Fueglistaler, S., P.H. Haynes (2005), Control of interannual and longer-term variability of stratospheric water vapor, *J. Geophys. Res.*, 110 (D24), D24108, doi:10.1029/2005JD006019.

Holton, J.R., P.H. Haynes, M.E. McIntyre, A.R. Douglass, R.B. Rood, and L. Pfister

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(1995), Stratosphere-troposphere exchange, Rev. Geophys., 33, 403–440.

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