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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modeling upper tropospheric and lower stratospheric water vapor anomalies" *by* M. R. Schoeberl et al.

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Response to Reviewers

Comment # and response

Reviewer 1

1) Fueglistaler et al, [2005] calls the path temperature minimum "the cold point." The minimum temperature may not be the dry point since the frost point is a function of temperature and pressure. This clarification has been added.

2) We use the net diabatic heating (not radiative heating) for everything. As mentioned in the paragraph above, this includes cloud heating and turbulent heating. Latent heat-

ing at these levels is very small, but is included. The net local heating rate is evaluated to initiate the parcels. I am not understanding the reviewers point – is the word "zero" missing? I added the word "local" in the text description.

3) "Why is the initialization level so different..." We think that the reviewer is confused by the dots in Figure 1 that simply illustrate the algorithm used to locate the surface used to initiate the parcels. We have added a sentence clarifying this point.

4) The zero heating contour has its own color as indicated in the caption – we don't think a color bar label is needed. In the new version of this figure, the contour is more visible.

5) year ranges fixed.

6) Although Gettelman et al. and Fueglistaler et al. showed that simple instantaneous dehydration and cooling could explain the grossest features of the stratospheric water vapor, their comparisons with the existing data show that the detailed agreement is mixed (e.g. Gettleman et al., Fig 2,3; Fueglistaler et al, 2005, Fig. 3). However, we thank the reviewer to bringing the Gettelman et al. paper to our attention – it was clearly neglected in our manuscript.

7) Yes dry bias is due to temperature – as noted.

8) "Asian Monsoon comment" Not clear what the reviewer suggests here

9) Yes, have added a sentence relating to the dynamics.

10) Only in the stratosphere (SD2010) – as now noted.

11, 12) This a valid clarifying point (monsoons contributing water vapor) and we agree with the reviewer that the current discussion could be misleading – so we have added a sentence making this point.

13) Yes – added 14) Clarification of figure 10 added. Parcels that do not enter the stratosphere but are dehydrated in the upper troposphere are of interest in their own

right but not the subject of this paper.

Reviewer 2

1) Abstract: ..convergence of air.. There is nothing complicated here. It is just that there is stronger heating at the tropopause which from mass continuity requires an acceleration of air upward – a convergence below that level and divergence above. We have modified the sentence to make this clearer.

Figure 1 has been replaced with improved figure including thicker orange lines and clearer labels. 17 km is an actual model level. Revised Figure 1 is included in this comment.

"Have you tested the impact of having of not assuming the water is instantly removed but instead falls and re-evaporates?" We have tested simple microphysical schemes (similar to Gettelman et al., 2002) and find that the results are fairly insensitive to a slower particle formation and re-evaporation. We are working on more elaborate schemes, but that is outside the scope of this paper.

Figure caption now states that the normalization is computed by using the zonal mean ratios between MLS and the model at each latitude.

Page 9660 comment. Convective moistening is required to explain the concentration of HDO in the stratosphere. Furthermore in SD2011 we showed that convective moistening can lift the water vapor concentration by about 0.5 ppmv. In Sherwood and Dessler's view it is the injection of ice that leads to the high monsoonal water vapor. On the other hand with improved assimilation techniques the monsoon tropopause has become warmer and thus injection of ice is not needed to explain the high water vapor. The reviewer is quite correct on this point and we have added a comment to clarify this issue in the manuscript.

Water vapor spectrum: the text states that we plot parcels above 380K – the stratospheric overworld. The model extends to 0.2 hPa [SD2010]. As stated the model fills

the stratosphere up to the upper level where parcels are "reflected" from the boundary. In SD2011 (Table 1) and SD2012 we compare the MLS mean mixing ratio with model runs. The stratospheric mean water vapor from MLS is 4.53 ppmv and we have added it to the figure caption but this comparison is not actually valid because water vapor from methane oxidation is not included in the calculation shown in the figure. We have added a clarifying point in the text.

The number in the color scale in Figure 6 are the number of parcels in the bin. We agree the caption should have included that statement and now does.

Antarctic dehydration: We agree that there are other mechanisms that lead to the asymmetry such as the descent of methane-produced water in higher in the NH relative to the SH. We have added the Rosenlof [1997] reference and modified the text to be clearer on this point.

Trends: There is a paper in review where we look at long term trends in models and our analysis.

Minor corrections are fixed – we appreciate the reviewer's suggested changes.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 9653, 2013.

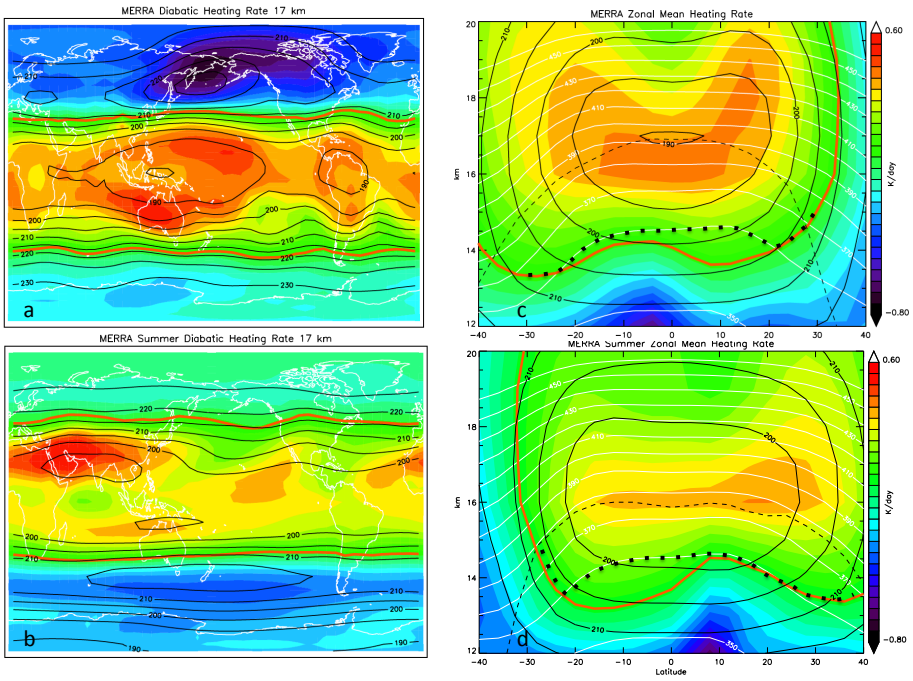

Fig. 1. Revised figure 1