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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Water vapor budget associated to overshoots in the tropical stratosphere: mesoscale modelling study of 4–5 August 2006 during SCOUT-AMMA" *by* X. M. Liu et al.

Anonymous Referee #1

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The manuscript basically describes a model study of tropical deep convection penetrating into the stratosphere and its impact on the water vapour entry across the tropopause. The model is a nested mesoscale model used and described in previous work. The study is focussed on two convective systems during the AMMA 2006 summer campaign. The model output is compared (or validated) to satellite observations and indirectly also to balloon soundings made downwind of the convective systems. The results are compared to other studies from mesospheric models but different regions.

Generally, the paper is clearly structured and well written. The overall chain of arguments is sound; however, there are a number major questions arising or revisions necessary in my opinion. These changes might impact the general conclusions of the study, in particular quantitatively.

Major comments:

Quantitative comparison with satellite data: The authors emphasize the validation on the location and timing of the modelling, which give –despite several discrepancies discussed in the manuscript – good agreement with the observations. For the highly-resolved vertical extent, and equally important the quantitative comparison of the water abundance injected into the stratosphere, no evidence can be given. Therefore, the amount of water entry in the model remains highly uncertain as not validated. An indirect quantitative assessment could be done using data of measured overshoots (e.g. Corti et al., 2008 and Kelly et al., 1993), in comparison with the model overshoots in Figure 13b.

Initial profile in Figure 13: The initial water profile used for the calculations is one from the SH during the NH winter (eg from Brazil, as the use of the BRAMS ('B' stands for Brazil) might suggest: During AMMA, water profiles do not have 3 ppmv at the tropopause, followed by an increasing gradient above (see Khaykin et al., 2009 and Schiller et al., 2009). I think, that the calculation have to be repeated with a realistic water profile for Africa, and there might be strong changes in the excess water calculated from this Figure. Same applies for temperature, though I imagine that the authors might have used the actual one (and hopefully not a climatological one from Brazil).

Comparison with balloon data: The downwind balloon data are only linked via trajectories to the (modelled) convective (Chad) system, as explained in Khaykin 2009 and 30 hours separated in time. On page 3999, lines 10-14, the authors stae, that they loose the ability to track the overshoot signal when leaving the grid 3 area. It would be necessary to show (I know, the computing expenses are against that), how the

overshoot signal really develops down to the balloon domain, whether it still remains detectable or whether it's smeared-out. But with the current method, the observations do not give a validation of the model as both cases remain unlinked for a quantitative comparison. Further, the balloon data seem to be less convincing than the authors try explain: The main problem for me is not the absolute discrepancy between the more or less coincidental water profiles, but their vertical displacement; I would also encourage the authors to plot the temperature profiles of these soundings in this Figure: Referring to Khaykin 2009, the water enhancement is at the cold point tropopause and its upper past ranges only a few hundred meters above that altitude. So it's not the most convincing overshoot event compaed to other profiles shown in Kahykin 2009, but also in Schiller et al. 2009 in the same period.

Minor comments and recommendations:

(page, line)

(3977,3) 'Overshooting convection is likely to be one of the key processes controlling . . .' better: 'is assumed to be one of the processes controlling . . .'; many studies do not see overshoots as important for the water entry, so it's not justified to use the term 'key process' in connection with 'likely'

(3978,14) and (3980,20): There are more recent studies which show rathe 0.7%/y increase (Scherer et al., ACP, 2008) and/or a decrease after 2000 (Randel et al., 2006, Fueglistaler et al., 2005) well connected to tropical tropopause temperatures.

(3979,1) Gettelman (also in reference list)

(3979,9) 'mainly over land': Gettelman et al. 2002 report also a maximum over the Pacific which is not seen in study of Liu and Zipser. So, this statement might depend on the instrument used.

(3980,14) 'non negliglible' should be replaced by 'still detectable'

(3980,17) Seidel (also in reference list)

(3982, 1st paragraph) I recommend omitting the detailed description of micro-SDLA, in particular that of the CH4 and CO2 channels, which are not used here. Should be consistent to the length of the FLASH description. Is there a reason, why the authors suspect the artefact being in micro-SDLA data rather than in FLASH? Referring to my 3rd major comment, a comment on the vertical displacement should be made, as well as temperature profiles included in Figure 1.

(Figures 2 and 4) Would be helpful if names of countries are included as in the following figures, as not all readers are able to detect African countries just from the contours of their borders.

(Figure 3) latitude/longitude lines should become thicker, and numbers larger

(3987,18) water vapour sonde or radio sonde?

(3990,9-10) Fig. 7a,c,f and Fig. 7 a,c,e

Figure 7) The choice of the colour code let the comparison appear to be worse than it is: I recommend to use white for 0-0.1, light pink for 0.1-1, orange 1-2 and so on to the darkest colour for highest rates.

(Figure 8) colour code cannot be resolved in the relevant range (blue)

(Figure 9) I recommend to use a logarithmic colour code as the relevant startsopsheric intrusion is not sufficiently resolved. I assume that BRAMS can resolve by far more than 0.1 g/kg, which would be helpful if shown.

(Figure 13) Panels should be enlarged (task for type setting by ACP office)

(3996,14) '. . . 10 ppmv in filaments in the lower stratosphere . . .'

(3996,15) Fig. 13b

(3999,13)'Thus a high resolution is mandatory to properly transport the hydrated maximum far from the overshoot': Evidence for this should be demonstrated. See also 3rd

major comment.

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