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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.

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Answer to Referee#1

Preliminary remarks: We have chosen in the revised manuscript to use colored text each time a change has been made, so that the reviewer can notice immediately where revisions are.

Taking into account referee#2 and D. Grosvenor comments, we have made significant changes in the text and had a new Figure (now Fig. 15). It shows the total water strato-

spheric mass change due to the overshoot of the Chad case, so that we can evaluate the amount of water that remains in the stratosphere. This has implied changes at the end of the abstract, in section 5.1 (comment on Fig. 15) and in the comparison with the Aïr case (section 5.2). The main key findings are also summarized in the conclusion. Please be aware that in Fig. 14, we have added the water vapor fluxes for the 380 K and 390 K for a direct comparison with the work of Chaboureau et al., (2007). New comments on this are given in section 5.1. The title of the paper has also been changed.

Following the recommendation of D. Grosvenor's comment, each time mixing ratios from other studies are given, the sizes of the domain have been added. We have also added in Table 3 the lower and the upper limit of the water mass that remains in the stratosphere for both cases. It is compared to mass budget estimations given in D. Grosvenor's comment and in the recent publication of Iwasaki et al. (2010) based on satellite observations, a new reference in the manuscript. These new findings are now mentioned in the abstract and in the conclusion.

Now we answer point by point to referee #1.

Major comments :

- Referee#1 points a lack of validation for the vertical extend of the simulated overshoot. He suggests to uses data from e.g. Corti et al., (2008) to validate our simulation. This reference has been added here for comparison while discussing figure 13, at least to comment the maximum mixing ratios and the associated ice water content shown in Figure 1 of Corti et al. (2008), though we underline that the region of the overshoots reported in Corti et al., 2008 is different. The order of magnitude of our calculated IWC and the measurements reported in Corti et al. (2008) are the same. Another question raised in the paper that cannot be answered yet is how much the impact of an overshoot is reproducible? To what extend the amount of water injected here and the ice content can be comparable from one case to another? We tentatively argue here that from one case to another one, the conclusion can be different. So detailed comparison with data from other regions is maybe not the best way to validate our simulations. Thus we have chosen to add a few lines in the 4.1 section (validation of the Chad case), and a few lines while discussing Fig. 13 (section 5.1) to show that the ice content is realistic in our simulation. Please also note that in the comment of Figure 13, we refer to measurements of total water during AMMA (Schiller et al., 2009) and to measurements of total water above the Hector cloud reported in Chemel et al. (2009).

- The second and main major comment from referee#1 is about the relatively low water vapour mixing ratio chosen to initialize the BRAMS model for the Chad case, with respect to what is expected in Africa. Referee#1 is afraid that this might influence our calculations. Here we recall that the water vapour initialization as well as the temperature initialization, are from the ECMWF reanalyses (using AMMA sondes) and not from a Brazilian climatology. The assimilation of sondes not only from west Africa, but also from Chad and from Ethipia are done in the reanalyses. This is why in the initialization of our simulation domain, differences can be found between the Niamey region and the southern Chad region. We have checked that at the location of Niamey at the initial time of the Chad simulation (18:00 UT on August 3), the water vapor profile was compatible with the measurement during AMMA (typically 4.5 to 5 ppmv in the LS), as shown in the attached Fig Ref#1.1. Be aware that the results presented here are above southern Chad, and can be different from what is typically measured in the Niamey area. Actually, looking in more details about the ECMWF initialization, we have looked at what would have been the initialization if we had started the simulation at 00 UT on August, 3rd, 06 UT, 12 UT and 18 UT. The Figure shows that the UTLS water concentration from ECMWF southern Chad region decreases regularly to 18 UT where our simulation starts. This is due to the assimilation of radiosondes in the centre of Africa which measure a temporary drying of the atmosphere in this region.

- The third major comment concerns the advection of the hydrated plume. As mentioned later, we have plotted the time evolution of the maximum of total water in the

hydrated plumes. It appears that there is no significant gap of the quantity while the plume exits Grid 3 and enters the grid 2 domain. Actually, there is a faster decrease immediately after the hydrated plume exits the Grid 3 domain, but this trend is no longer observed when we examine the signal with a longer time-scale, which was not performed in the ACPD study. Thus any reference to this lower resolution effect has been removed in the text and part of the last paragraph of section 5.1 has been rewritten. However, we cannot rule out an effect of the change in the grid resolution: the slow but regular decrease in the maximum mixing ratio of total water could also be due partially to a resolution effect. To save computing time, we could not follow the advection of the hydrated signal until the time of the measurement above Niamey (August 5, 18:00 UT). Instead, we have checked the position and the maximum mixing ratio of the rest of the hydrated plume over Cameroon/Nigeria border at the time when the simulation ends (the plume is in the Grid 1 domain with a 20 km resolution. Though the hydrated plume is still clearly identifiable, the local maximum is $\sim$0.7 ppmv higher than the environment. Once again, we cannot rule out an effect of the coarse resolution. A sentence has been added in the text on this point after the comment of Fig. 16.

Other comments : P3977, L3: "Overshooting convection is. . ." The proposed change has been done.

P3978, L16: We have added "This tendency is still debated since Scherer et al. (2008) estimate a 0.7 % increase but Randel et al. (2006) rather conclude a decrease after 2000." after "which is believed to be partially due to water vapour transport across the tropical tropopause."

The "Gettelman" correct spelling has been checked all along the manuscript.

P3979, L9: We have added "even if Gettelman et al. (2002) conclude that the maximum occurs above the pacific region." after "As also seen by the TRMM Precipitation Radar and Lightning Imaging Sensor, these injections occur mainly over land".

P3980, L14: We have changed "is non negligible at local scale" to "is still detectable at the local scale".

P3980, L17 and after : we have changed all the "Siedel" to "Seidel".

P3982, L1: Now we just mention that Micro-SDLA is able to measure CH4 and CO2 but we have removed the technical aspects of the measurements of these species. We suspect that the artifact is in micro-SDLA rather than in FLASH because most of the H2O measurements during AMMA/SCOUT-AMMA are closer to the FLASH measurements than the micro-SDLA measurements This is now mentioned in the text. About the vertical displacement, we had previously used the geopotential height for the FLASH data rather than the GPS altitude. We have plotted a new Fig. 1 expressed in GPS altitude for both instruments. Although proposed by referee#1, we have not added a temperature profile in Figure 1 since the main aim of Figure 1 is to show the hydrated layer just above 17 km. As shown later in the study, the cause for this hydrated layer is likely due to an event which happened far upwind from Niamey, so a temperature profile from Niamey is not so relevant.

P3987, L18: we have changed "water vapour sonde" to "radio sonde".

P3996, L14: we have added "in filaments" after "10 ppmv".

P3996, L15: we have changed "12b" to "13b".

P3999, L10: "However, once in Grid 2 (4 km horizontal resolution), the hydrated signal is lost rapidly.".As mentioned earlier, we have removed anything related to this.

P3999, L13: "Thus a high resolution is mandatory (necessary) to properly transport the hydrated maximum far from the overshoot." See above.

Figure corrections and remarks: Fig. 1: The Altitude scale for FLASH has been converted into GPS altitude. Fig. 2: countries names (Niger, Chad, Sudan and Central Afr. Rep.) have been added Fig. 3: A new figure has been plotted including latitude and longitude labels. Fig. 4: Country names (Niger, Chad, Niamey and Nigeria) have been added. Fig. 5: latitude and longitude labels have been added. Fig. 7 and Fig. 10: We

have changed the color scaled as proposed by referee#1 from light colors to darker colors Fig. 8: We are aware of this lack of resolution for the color scale chosen. However, we decided to keep this choice because the most important point to be shown by this Figure is the good agreement in time between the modeled and the observed overshooting activity, especially for the overshoot of interest discussed in K2009. Fig. 9 and 12: Color code has been changed and more mass mixing ratio levels have been added for the stratosphere. Fig. 13: The figure caption has been complemented as asked by referee#2. As for the size of the Figure in the ACPD version, the authors are not responsible for it.

Fig. Ref#1.1 caption: Water profiles in the BRAMS Grid 1 domain of the Chad case deduced from ECMWF AMMA reanalyses at different locations (Niamey or Southern Chad) and times (August 3 at 00 UT, 6 UT, 12 UT and 18 UT). The 18:00 UT time corresponds to the time when the Chad case simulation starts.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 3975, 2010.

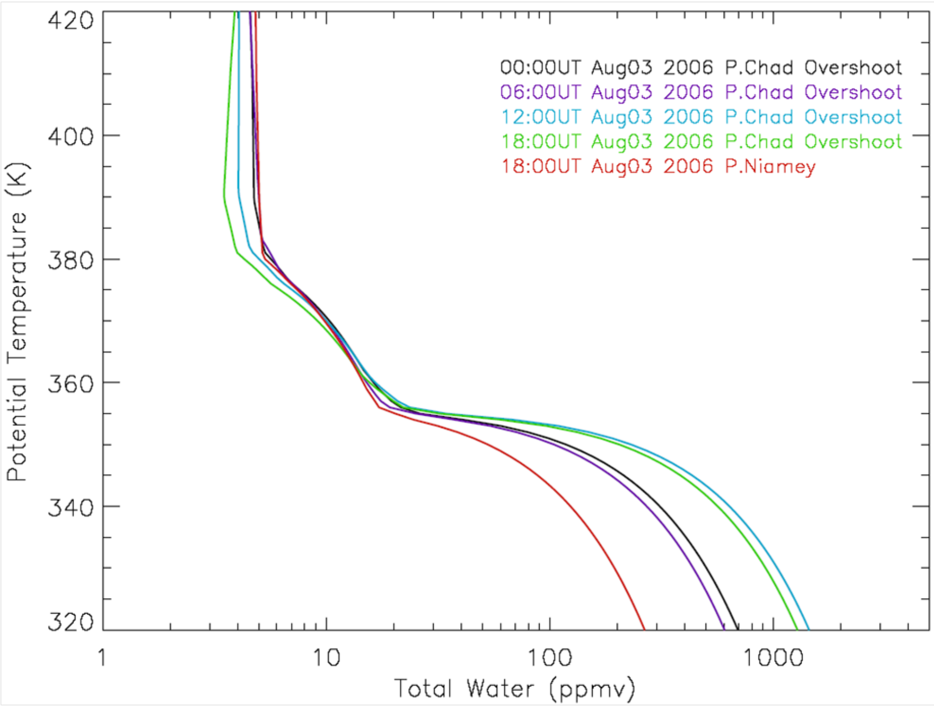
00:00UT Aug03 2006 P.Chad Overshoot
06:00UT Aug03 2006 P.Chad Overshoot
12:00UT Aug03 2006 P.Chad Overshoot
18:00UT Aug03 2006 P.Chad Overshoot
18:00UT Aug03 2006 P.Niamey
Potential Temperature (K)
420
400
380
360
340
320
1
10
100
1000
Total Water (ppmv)

Fig. 1.