Atmos. Chem. Phys. Discuss., 13, C12371–C12378, 2014
www.atmos-chem-phys-discuss.net/13/C12371/2014/

Interactive comment on "Impact of tropical land convection on the water vapour budget in the Tropical Tropopause Layer" *by* F. Carminati et al.

Anonymous Referee #3

Received and published: 17 February 2014

In general, this paper focused on an important topic and the results are interesting. However, as detailed below, there are a number of major issues of this study, which needed to be addressed before it can be considered for publication in ACP. I recommend rejection of this paper in present form but encourage resubmission, to allow sufficient time for the authors to address these issues.

Major comments:

(1) Relating the 56 hPa (and even 100hPa) water vapor pattern (Fig. 2 and Fig 6) to deep convection is likely incorrect. The uncertainty in the water vapor retrieval at 100hPa and 56 hPa is 10% or larger. Any changes (e.g. Day-Night difference) less than 10% are insignificant. Note the 10% MLS retrieval uncertainty including biases,

which cannot be reduced by averaging.

(2) Using 6 small box regions (Fig 2 upper-right panel) near the tropics to come up with a conclusion (e.g. line 20 on page 33056) about stronger convection and more efficient moistening in the Southern Hemisphere is misleading. In the Northern Hemisphere (NH) deep convections are mostly over South Asia and Central America monsoon regions during JJA, while in the Southern Hemisphere (SH) deep convections are over South America, Central Africa and Western Pacific/maritime continent during DJF. The small boxes are all near the SH convection regions and thus are stronger during DJF. Away from the tropics, you will find the deep convection and water vapor moistening are the strongest in the NH, not SH (e.g. Sample-Figure 1).

(3) This study focused on the regional features but overlooked the influence of large-scale dynamics. Even though some of the regional patterns seen at 100hPa and 56 hPa may be real, they are not necessary related to the convection below. Unlike the ice water content (IWC), water vapor mixing ration (H2O) near the tropopause and lower stratosphere are strongly influenced by the large-scale dynamics/transport due to its long lifetime. Regional scale convections, such as those over the South America and Africa, do have an influence on H2O up to about 150 hPa altitude. At pressure $\leq$ 100hPa and in the lower stratosphere (e.g. at 56 hPa), the spatial distributions and time evolution of H2O, even at regional scale, are strongly influenced by the H2O transport (horizontal and vertical). For example, The following Sample-Figure 1 shows the time evolution of zonal mean H2O at 100 hPa and 215 hPa pressure levels. The patterns of 215 H2O follows the seasonal cycle of deep convection, while the seasonal cycle in 100 hPa H2O is dramatically different, due to horizontal transport of H2O into higher latitudes.

(4) The discussion of "tape-recorder" features (e.g. the phase-lag) in Fig 4 and Fig 5 are confusing, or at least not clear. The traditional "tape-recorder" refers to the vertical H2O transport into the stratosphere in the tropics [Sample-Figure 2]. In the tropics, the seasonal cycle is relatively weak at below ~147hPa. The tropopause and stratospheric

H2O are modulated both by temperature and large-scale transport. The seasonal variations of sub-tropical H2O are influenced by the summertime deep convections. In the northern sub-tropics [Sample-Figure 3], the JJA deep convections from South Asia and Central America monsoon can directly deposit (overshoot) H2O into the tropopause above 147 hPa altitude, followed by slow ascend into the lower stratosphere. At 56hPa level, the peak H2O has been transported away from the convection centers. In the southern sub-tropics [Sample-Figure 4], the DJF deep convections from Western Pacific, South America and Africa do not penetrate the tropopause. The cold temperatures at top of the convection, especially in the Western Pacific, are the cause of low water vapor near tropopause. The maxima H2O above $\sim$100hPa altitude [Sample-Figure 4] are phase-shifted to JJA, which indicate the H2O there are transported from the north. How these large-scale features impact the regional scale (e.g. the 6 small boxes in Fig 2) H2O at 100hPa and 56 hPa are not investigated and discussed in this study.

(5) In many places in the paper, the authors discuss “diurnal cycle”. Since MLS only make measurements twice a day at 1:30am and 1:30pm, we can only show “Day-Night” difference, but cannot actually resolve the diurnal cycle. The H2Oc curve in Fig 1 is for UT (upper troposphere) only, which is not necessary true in the tropopause and lower stratosphere.

Minor Comments:

In addition to the places already pointed out by referees 1 and 2, I have a few other minor comments.

(1) Page 33056 line 20: You should at least change “Southern Hemisphere” to “southern tropics”, because the results from small boxes shown Fig 2 upper-right panel can not represent the entire SH.

(2) Page 33061 line 14: Should be 215 hPa, not 220 hPa.

(3) Page 33061 line 25: Please specify which screening are used for this study, 2σ or 3σ? I recommend the 3σ screening should be used.

(4) Page 33062 line 1: Should be 215 hPa, not 220 hPa.

(5) Page 33062 Section 2.2: As discussed above, MLS observations cannot resolve diurnal cycle, most discussions of the diurnal cycle differences here Page should be changed to day-night differences.

(6) Page 333063 line 3: Note 5-10% is not a significant during to MLS uncertainty of 10%.

(7) Page 33063 line 19: Again, at least change “Southern Hemisphere” to “southern tropics” and change “Northern Hemisphere” to “northern tropics”

(8) Page 33063 line 27-28: Change “amplitude of the IWC diurnal cycle…” to “the day-night difference…”, since MLS can not resolve the diurnal cycle. (The amplitude of the diurnal cycle could be larger than the day-night difference observed by MLS).

(9) Page 33065 line 6: Change “…over land areas” to “…over tropical land areas”.

(10) Page 33066 line 5: Change “Water vapour in the Southern Hemisphere” to “Water vapour in the southern tropics”.

(11) Page 33069 line 2: Change “diurnal variation” to “day-night difference”.

(12) Page 33070 line 1-4: This sentence is not clear.

Overall, this paper studied a very important topic. However, it needs more work to make it appropriate for publication in ACP.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 33055, 2013.

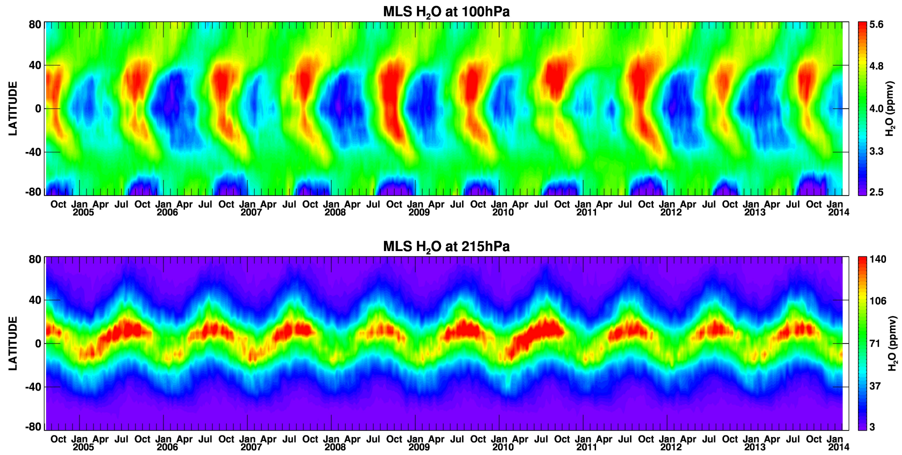

Fig. 1. Sample-Figure 1: Latitude-time sections of daily zonal-mean H2O at 100 and 215 hPa from MLS observation. Similar to Figure 4 in Jiang et al. (2010, JGR, doi:10.1029/2009JD013256)

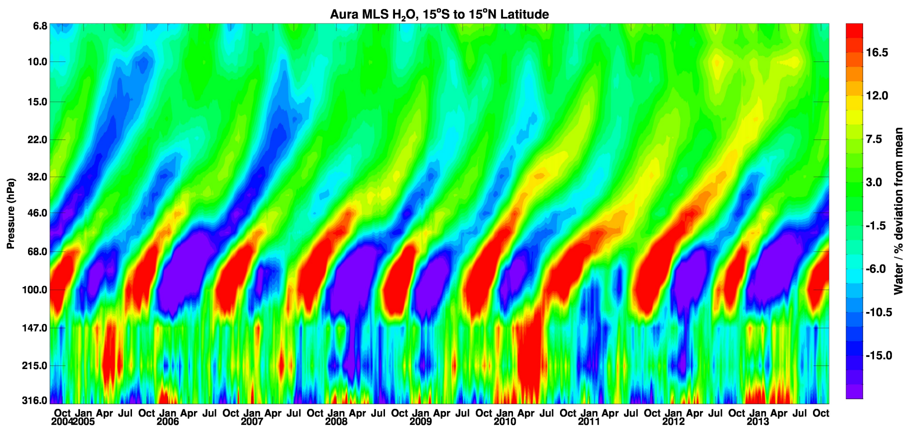

Fig. 2. Sample-Figure 2: Height-time section of tropical (15°S-15°N) mean daily H2O anomalies from MLS observations

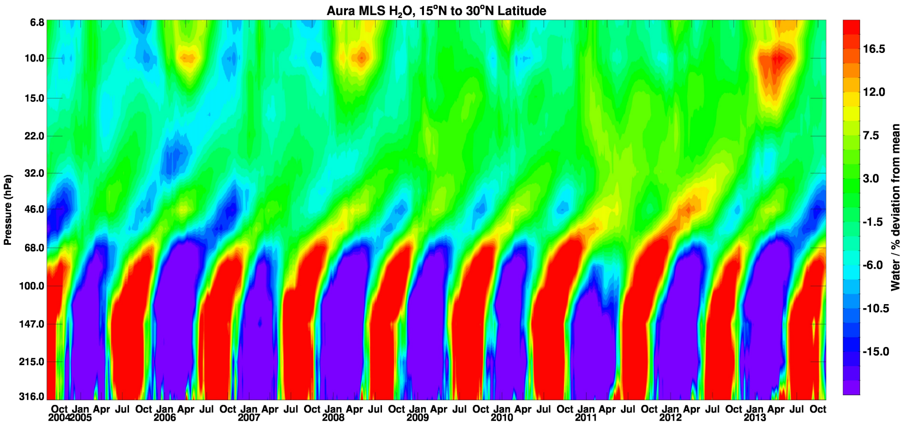

Fig. 3. Sample-Figure 3: Height-time section of northern sub-tropical (15°N-30°N) mean daily H2O anomalies from MLS observations.

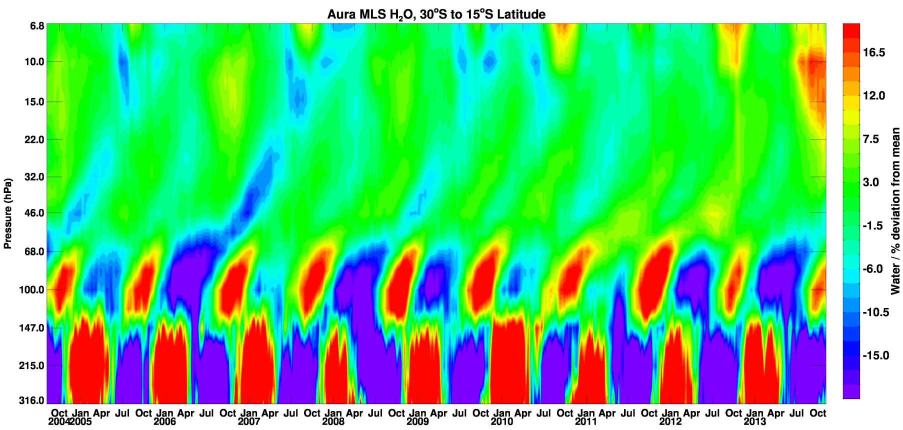

Fig. 4. Sample-Figure 4: Height-time section of southern tropical (30°S-15°S) mean daily H2O anomalies from MLS observations.