Fabien Carminati
Research Assistant
Carminati@atmos.umd.edu
Office: 301.405.1168
Cell: 240.704.9922
University of Maryland - College Park
Department of Atmospheric and Oceanic Science
3415 Computer & Space Sciences Bldg
College Park, Maryland, 20742-2425
USA

Date: Friday May 2nd, 2014

To: Dr. Peter Haynes,
ACP Editor,
phh@damtp.cam.ac.uk

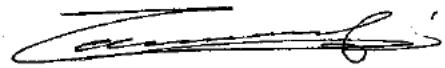
Re: Manuscript number acp-2013-902

Dear Editor,

We are once again very grateful for your interest and time to our paper "Impact of Tropical Land Convection on the Water Vapour Budget in the Tropical Tropopause Layer". We appreciate the new comments made by the referees that helped us to improve the paper further. Each of their questions has been answered as seen below. We have also carefully reviewed our writing style.

Sincerely,

Fabien Carminati



Editor Decision: Reconsider after minor revisions (Editor review) (25 Apr 2014) by Peter Haynes

Comments to the Author:

All three reviewers consider that the paper has been significantly improved in revision and recommend publication after further minor revision. Please consider the comments made by each reviewer carefully and provide a set of responses to each, indicating whether you have made corresponding changes in a further revised version of the paper, or not, in which case you should justify this. Please note that two reviewers consider that the writing style can be further improved. I expect to be able to make a decision on acceptance of a revised version of the paper myself, without further consultation with referees.

Report #1

Submitted on 17 Apr 2014

Anonymous Referee #3

I like the authors' responses to the reviewers and appreciate the extra (but necessary) work they put in for making this paper significantly better. I also notice this revised version has much improved English.

I agree with the authors' responses - they have addressed my questions adequately. However, I still have a concern about the term "northern and southern tropics" used in the paper. I understand it's refer to the regions slightly north and south of the equator, but to a reader not reading the paper carefully, it can be mislead to regions of subtropics or mid-latitudes (some papers refer tropics to the region of +/- 30 degrees). I suggest to add one sentence to clearly define the meaning of "tropics" in this paper, such as" "In this paper, we define tropics as the region within 10-degree N/S". Then the readers will know where to look when they read the term "northern and southern tropics".

Other than above, I recommend the paper to be published.

Response

As suggested by the referee, we clarified the term “tropics” by adding the following sentence (section 3.1 Methodology, page 10, line 16):

Note that we will refer hereafter to north and south tropics as the [0, 10˚N] and [0, 10˚S] latitudes, respectively.

Report #2

Submitted on 21 Apr 2014

Anonymous Referee #1

General comments:

After revision, I think the science part is good. Writing can still be tuned better.

Recommendation: minor revision

Minor comments:

Comment

1. P1, L 29. Larger day vs. night differences in the water vapor do not prove the stronger convective intensity. There are other factors that could play here, such as the diurnal variation phase differences, the local RH. Yes, you provided some RH graphs in the TTL, but how reliable are those? Even after you can clear out all those factors, you still cannot claim convective intensity is more vigorous in the southern tropics. All you could claim is that convection in southern tropics could have a larger impact on the TTL. Large impact ≠ stronger convection.

Response

The wording is indeed misleading. We mention in our conclusion that the larger impact of convection on the TTL and LS in the southern tropics only suggests "*that convective overshoots are less frequent or less vigorous in the northern tropics"*. Although several studies support this hypothesis, MLS alone does not sample sufficiently (on daily basis) the tropical atmosphere to assess this point. We reformulate the sentences as follows:

In addition, the relative amplitude between day and night is found to be systematically higher by 5–10% in the south tropical UT and 1-3% in the TTL than in the northern tropics during their respective summer, indicative of a larger impact of the convection on H_2O in the southern tropics.

We also modified the sentence page 15 line 20 accordingly:

Moreover, the larger amplitude of the H_2O D-N in the UT and TTL as well as the stronger cooling in the TTL and LS in the south tropical summer, particularly above South America, suggest a much more intense convection than in the northern tropics.

We also modified the sentence page 16 line 3 accordingly:

To assert the hypothesis of a daytime moistening in TTL over land areas, we computed H2O, IWC and temperature 2-month running averages, from 2005 to 2012, at 177, 100, and 56 hPa above the four south tropical regions (see Fig. 9) where the convection has the largest impact.

Comment

2. P5, L15, there are multiple places using "Figure", other places use "Fig.", pick one style and be consistent

Response

We kept the first "Figure" (page 4 line 28) and replaced all the following with "Fig.".

Comment

3. Fig. 3 has never been mentioned in the text. Why do we need that figure? Same applies to Fig. 5.

Response

This is wrong, Fig. 3 is mentioned in section 2.2 Tropical Water Vapour page 7 line 30. Fig. 5 is mentioned in section 2.3 Ice Water Cloud page 8 line 22.

Comment

4. Fig. 8, what is the unit of color scale? Top and bottom panels have different color scales, not sure how to compare them.

Response

As for Figs. 6 and 7, the unit is in percentage (%), we updated the Fig. 8 so that the unit appears in the title. Regarding the different color scale, we do not compare the D-N amplitude of convective versus non-convective days but its sign. The values of the color scale are indicative and not directly comparable since the non-convective dataset is composed of much less observations than the convective one (less than 10% and more than 40% of available data, respectively) and then subject to a sampling effect.

In order to clarify this point, we added in the text, page 14 line 19, the following sentences:

Note that the number of days falling in this category is much smaller than the number of significantly convective days (8% versus 42% of available data, respectively in South America, and 7% versus 29% of available data, respectively in Africa), their D-N amplitudes are thus not directly comparable. Nonetheless, we observe […]

Comment

5. Fig.6-8. I notice a seasonal phase shift of troposphere and stratosphere H2O at 125. It seems that the tropospheric H2O is peaking a slightly earlier every year. Is this real or just artifact of filtering? It urges the explanation.

Response

This shift is real and also observed in the unfiltered data. It is particularly visible on Figs. 7 a and b D-N (middle panels) over the north tropical America and maritime continent, where the peak in amplitude is shifted by 2-4 months after 2009. It is most likely resulting from the atmospheric circulation perturbation caused by the major 2009 ENSO (eastward displacement of the Walker cell and strengthening of the Hadley cell), although other unidentified processes may also play a significant role. We added the following sentence page 12 line 14:

These perturbations are accompanied by a 2-4 months shift in the D-Ns and anomalies in both hemispheres from 2009.

Comment

6. P13, L5, extra “the”.

Response

The extra “the” has been removed.

Comment

7. P14, large D-N water vapor means stronger convection? I am not quite sure if this is a solid reasoning.

Response

The section 4.2 page 14 is not based on a comparison of the convective strength. We compare the days that are most likely to be convective to the days that are least likely to be convective using as proxy the impact of the convection on the D-N in the UT (177 hPa). This approach helps us to emphasize how the TTL and LS are impacted during convective days.

Comment

8. P18, L2-3, separating the samples over land and ocean should not be difficult over these regions. However, the horizontal mixing would kill a lot of diurnal signal. I am not sure why mixing land and ocean would remove the diurnal signal if you have much stronger signal from land, unless you have dominate oceanic samples.

Response

The referee is right, in the South East Asia [60-120˚E, 0-20˚N] as well as in the Central America [60-120˚W, 10-30˚N] regions, land only represents a small fraction of the sample. A separation of continental and oceanic pixels would indeed be necessary for a study dedicated to these regions. But it is beyond the scope of the present paper.

Comment

9. The larger impact of convection on the TTL in southern tropics may be from the diurnal variation differences between Northern part and southern part of the continents. Northern Amazon could have diurnal peaks early and southern Amazon have more of large organized systems with influences to later time. Similar reason applies to the Sahel vs. Congo in Africa. What if more large mesoscale convectie systems could be found over Congo than Sahel (especially your box does not include west Sahel, where MCSs develops/matures), which leads to higher H2O amount to late evening. That does not necessarily mean convection over Congo is stronger than Sahel.

Response

The referee argument is correct, the time at which the convection develops may affect the D-N since we can only compare the MLS morning and afternoon overpass. Yang and Slingo (2010, Fig. 3) do show gradients in the brightness temperature and precipitation diurnal cycles over South America and Africa synonym of different peak convective time. However these gradients are East-West and not North-South. DJF south tropical America has similar brightness temperature and precipitation diurnal cycles compared to JJA north tropical America (and same for Africa), at least in our areas of study (boxes). Furthermore, difference in the peak convective time would not explain why Khaykin et al. (2013, Fig. 4) observe a larger cooling in the southern than in the northern tropics over South America and Africa.

Since the COSMIC GPS sample continuously the diurnal cycle of temperature, a different convective time with the same strength of convection in the northern and southern tropics would result in a temperature anomaly of the same amplitude but shifted in time, which is not the case.

Report #3

Submitted on 24 Apr 2014

Anonymous Referee #2

The authors have addressed all of my major concerns. In my opinion, the paper is suitable for publication subject to some minor revisions:

Comment

p.8, l.18-20: I agree with your conclusion that the D-N difference is likely not an artefact generated by the a priori, but I am not sure that it is appropriate to conclude from one year of a priori that the amplitude of the retrieved D-N at different levels are "almost certainly" under or overestimated. I would recommend either removing these statements or using less confident language (e.g., "may be").

Response

We agree with the referee comment and replace “certainly” by “may be”.

Comment

p.13, l.14-15: You write "Assuming that the daytime and the night-time MLS precisions are similar" -- could this assumption be verified, at least to leading order, by comparing the provided precision values for day and night profiles?

Response

As suggested by the referee, we compared the precision values for day and night profiles (over South America and Africa). We found that the relative difference between daytime and night-time precision is less than 1% at pressure smaller or equal to 100 hPa. This difference rises in the UT (up to 14% in the South tropical American box) but with no consequence on our analysis since the D-N signal in the UT is larger than the MLS precision.

Comment

p.13, l.17: I'm not sure that your exact meaning is clear here. Do the large number of near-zero cases really produce an underestimation of the D-N amplitude? If many of the differences are near zero, doesn't this suggest that the mean amplitude could also be near zero?

Response

The mean D-N is not underestimated but the deviation from zero resulting from drying or moistening of daytime relative to night-time that we use as a proxy of convection is. In an ideal case, the D-N would only be calculated for days with confirmed overshooting convective event in the box. This is what we statistically approximate when we consider the most significant cases (|D-N|> 20%) in Fig. 8.

We rephrased the sentence as follows:

They represent the insignificant cases and produce an underestimation of the D-N amplitude with respect to a theoretically D-N representative of the only impact of convective processes.

Comment

p.13, l.21: What is the justification for using 10% as the significance threshold, and for applying the same threshold at all three levels? Please provide a basis for using 10%, or (ideally) a more objective threshold.

Response

Although we expect systematic errors to be minimized for the reasons mentioned in the manuscript, we estimated that a threshold representative of the MLS precision in the TTL (10%) was the most appropriate option.

We modified the sentence page 13 line 21 as follows:

We consider to be significant all |D-N| greater than 10% (the MLS precision in the TTL).

Comment

p.13, l.24-25: If the convective influences act mainly in the vertical direction, then the significant D-N differences at higher levels should presumably be largely consistent with the significant D-N differences at lower levels. For example, are more than 80% of the days with significant D-N differences at 100 hPa also days with significant differences at 177 hPa? The discussion in Section 4.2 suggests yes, but it might be worth checking. Also, you may want to specify the collocation criteria for both day and night to be available -- is it just that you have some day and night retrievals within the 10°x10° grid?

Response

After verification, we found as expected that the D-N is consistent between the different levels. Over south tropical America, the |D-N| is greater than 10% in the UT 85% (83%) of the time when |D-N| is greater than 10% in the LS (TTL). Similarly, over south tropical Africa, the |D-N| is greater than 10% in the UT 81% (77%) of the time when |D-N| is greater than 10% in the LS (TTL). The statistics are of the same order in the northern tropics (75-79%).

For the uncertainties estimation, we computed on a daily basis a mean daytime profile from all profiles measured in the 10°x10° box at the 13:30 LT overpass and a mean night-time profile from all profiles measured in the 10°x10° box at the 01:30 LT overpass. When both were available, the D-N was calculated from the difference of these mean profiles. No further collocation is possible since one

overpass is an ascending node and the other one is a descending node meaning that the orbital track is different.

Comment

p.16, l.11: "aivailable" -> "available"

Response

Modified

Comment

p.18, l.18: "7.10^6" -> "7 x 10^6"?

Response

Modified

Comment

p.18, l.20: "CloutSat" -> "CloudSat"

Response

Modified

Comment

Fig. 1: You may want to remove the drop shadows from this diagram.

Response

Modified

Comment

Figs. 9 and 10: The red and green lines may be difficult to distinguish for some readers, especially for Fig. 10. One option would be to make temperature red and water vapor blue (many readers will expect this colour scheme anyway), and then make IWC grey so that it is more easily distinguished.

Response

Modified