Reply to Anonymous Referee 2

We thank the reviewer for her/his helpful comments on the manuscript. In the following, reviewer's comments are in italics, authors' responses are in normal font.

General comments:

The paper analyses the impact of two case studies of tropical cyclones (Corentin and Enawo) over the Indian Ocean on the TTL composition, with a particular focus on the water vapor consequent anomalies. In both cases, the authors identified positive anomalies of water vapor in the upper troposphere that could be traced back to the convective activities linked with the tropical cyclones. In the Corentin case the balloon launch revealed also a dry layer around 100hPa and a wet anomaly at 68 hPa (linked to transport of wet El Nino influenced-air from the South East Indian Ocean) while the second balloon launch did not reveal any significant perturbation near or above the tropopause from the tropical cyclone Enawo. The paper presents a detailed description of the hydration/dehydration impact of the two events making use a variety of observations and trajectory studies and gives a comprehensive analysis of the possible contributing processes. I agree on the publication of the paper in ACP with some revisions required.

We thank the reviewer for the positive assessment.

One main concern is on the structure of the paper that, at the present state, makes it very difficult to follow the logic of the work. The paper in fact is made of several long and detailed sections that sometimes are missing a clear statement on which is the main information to retain. The sections are therefore hard to connect and this is also made more difficult by their organization itself. I would advise to put in an uninterrupted sequence all the sections regarding the profile measurements for the two events, including the FLEXPART study (that is indeed supporting the analysis and is instead put toward the end of the paper). The monthly and climatological water vapor distributions and the CFH and MLS comparison can be on separated sections or moved elsewhere in a way to not interrupt the logic of the two events analysis. Some sections are very long as well, like the 4.4. that puts together the RHice analysis, the temperature anomalies and the distribution of deep convective clouds; it may be worth to separate them in subsections.

In response to your comment and reviewer #1's, we have modified the order of the sections in the revised manuscript, and the length of the sections have been reduced. The section that describes the FLEXPART model is now section 2.4.
In section 3, TS Corentin and TC Enawo are described (Figure 1 of the revised manuscript), the mean convective cloud cover is presented (Figure 2) and the MLS water vapor mixing ratio gridded in the SWOOSH data set at 215&100hPa averaged over January 2016 and March 2017 (Figure 3).
In section 4, the water vapor and ozone profiles are described (section 4.1, Figure 4), the relative humidity and temperature profiles (section 4.2, Figure 5) and the Lagrangian analysis of air mass origin with FLEXPART (section 4.3, Figures 6 and 7). The MLS and CFH comparison is presented in section 5.1 (Figure 8) and temperature anomalies derived from the NDACC/SHADOZ radiosonde dataset are discussed in section 5.2 (Figure 5). Finally, the water vapor anomalies, derived from the MLS climatology are discussed in section 5.3 (Figure 9).

The abstract is lacking a highlight on the scientific impact from the main findings. What can we conclude on the TTL hydration by deep convection from the two events analysis?

We added a comment at the end that explains that the paper demonstrates the need for accurate balloon-borne measurements of water vapor/ozone/aerosols in regions where TTL in-situ observations are sparse.

In addition, I found that the figures are often not referenced when due, and that implies an extra effort for the reader to figure out which panels or which figure the statements are referring to. I would advise to check in the data description paragraphs and add a precise reference to the plot (and panel) that is being described.

The figures are now properly referenced.

Specific comments:

Line 54 page 2: can you add a few references?

We have added three references: Toon et al., 2010; Jensen et al., 2017; Brunamonti et al., 2018.

Line 107 page 4: Do you identify the convection from the Lagrangian forecasting tool in the forecast mode in the same way as explained later for the analysis? How do you use the meteosat-7 information (that are in the "past") for the forecast of the storm position?

We have added the following comments: During austral summer, balloon launch planning is optimized using a Lagrangian forecasting tool. 5-day backward Lagrangian trajectories initialized from the location of the Maïdo Observatory at different altitudes (9.5, 12.5, 15.5 and 18 km) are run twice-daily and superimposed on current geostationary infrared satellite images to identify on-going convection over the SWIO (http://geosur.univ-reunion.fr/foot).

Figure1 and/or line 202 page 7: Can you give a brief definition of what you mean by "best track"?

The best track represents the best guest of the location of the tropical cyclone center every 6 hours. This comment was added in the revised manuscript.

Line 204 page 8: How do you get the pressure at the TS center?

The pressure at the tropical cyclone's center was provided in the back track data provided by Météo-France for the SWIO. Basically, the pressure at the storm center is derived from an empirical relationship between maximum surface wind speed and pressure. The surface wind speed is estimated from satellite scatterometer data.

Line 242 page 8: You should rephrase here. Looking to the upper left panel of Figure 3 and the lower left one (January 2016) the mixing ratios do not really seem in agreement, with differences in the whole longitude band between 50 and 150 E.

In the corrected manuscript, those figures are no longer present.

Line 257 page 9: Add reference to the panels you are comparing. If you are talking about the two upper panels this difference of 0.43 ppmv is not visible (as instead between the two lower panels). How do you compute this difference?

In the corrected manuscript, those figures are no longer present. The text has been modified accordingly.

Line 263 page 10: Why are you specifically mentioning here just December 2015? Is it because it corresponds to the maximum anomalies in water vapor?

Yes, December 2015 has the maximum anomaly. We have added this information in the revised version.

Lines 282-284 page 10: This statement is not very convincing. Can we really say that the 9-14 km layer is a moist one when the observations show only a small peak around 10 km?

We have corrected the text, and mention a peak at 10km and 15km.

Line 320 page 12: I would really help to have a plot of the brightness temperature with the CALIOP track and the wind direction / geopotential to show the mean circulation pattern, same for the March case.

The figure has been modified in the revised manuscript.

Lines 505-508 page 18: The sentence, as is presented now, is not really giving an indication on the capability of the trajectory method in the convective origin study. Do you have some references indicating the quality of ECMWF 0.15x0.15 analysis in resolving vertical velocities for tropical cyclones? Also, I think this paragraph is better fitting in the method presentation of section 3.

Recent improvements of the ECMWF IFS model have enhanced its forecasting skills of tropical cyclones (Magnusson et al., 2019). We have added this information in the revised manuscript, and the location of this paragraph has been modified.

Lines 577 – 579 page 20: This sentence is confusing. Do you mean the difference averaged between 316 and 261 hPa is -20% for both days and for both CFH and MLS mean? That does not seem correct.

We removed this discussion in the revised manuscript.

Line 650 page 22: "The QBO easterlies can be observed at 70 hPa"…from here?

This sentence has been removed.

Technical corrections:

Line 15 page 1: It's worth to specify also in the abstract what CFH stands for.

We removed the term CFH from the abstract and refer simply to balloon-borne measurements.

Line 57 page 2: the upper 700m of what, the sea surface?

700m of the ocean. The sentence has been corrected.

Line 58 page 2 : .. that convection deeper than 15 km…

Corrected

Line 156 page 6: Do you mean: "..cross section. More details are given in the CALIOP Algorithm …"?

Corrected

Line 229 page 8: Latitude / longitude grid (5°x20° resolution)

Corrected

Line 230 page 8: at 215 hPa (figure 3) and 100 hPa (figure 4) for January 2016 (lower left panel) as March 2017 (lower right panel)

Figure 3 and 4 are merged in a single figure in the revised manuscript.

Line 269 Page 10: The red and purple lines…

Corrected

Lines 340-341 page 12: This is one example of a needed figure reference. Does it refer to figure 7?

Yes. The figure is now properly referenced.

Line 354 page 12: reference to bottom left panel of figure 7?

Yes. The figure is now properly referenced.

Line 650 page 22: …the impact OF the 2016 strong ..

Corrected

Figure1: The green star on the grey background is not very easy to spot! Similarly for the dates label that are black and with a small font.

The figure has been modified in the revised version

Figure 5: Please, add a legend for the lines, it will ease the reading of the plot.

A legend has been added

Figure 10: The so called "brown dots" are difficult to distinguish from the red ones. The light pink is instead not very visible.

The figure has been modified

Figure 11: The panels notation must be homogeneous. I would suggest indeed to reference the panels with letters, as done here, since it makes the reading more fluid. Same thing with the label "-1 day" "-2 days" that are missing on figure 10.

The panels notation have been corrected

Reference:

Magnusson, L., J. Bidlot, M. Bonavita, A.R. Brown, P.A. Browne, G. De Chiara, M. Dahoui, S.T. Lang, T. McNally, K.S. Mogensen, F. Pappenberger, F. Prates, F. Rabier, D.S. Richardson, F. Vitart, and S. Malardel, 2019: ECMWF Activities for Improved Hurricane Forecasts. *Bull. Amer. Meteor. Soc.*, 100, 445-458, https://doi.org/10.1175/BAMS-D-18-0044.1