

## ***Interactive comment on “Ozone profiles by DIAL at Maïdo Observatory (Reunion Island) Part 1. Tropospheric ozone lidar: system description, performances evaluation and comparison with ancillary data” by Valentin Duflot et al.***

**Anonymous Referee #3**

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This paper aims to be a reference for the further use of data acquired by a DIAL tropospheric ozone lidar recently installed at Maïdo Observatory (Reunion Island). Authors describe first the lidar historical context and technical evolutions. Secondly they compare the ozone profiles data set with ECC sondes, with data from a ground based FTIR spectrometer and with the space-borne IASI data. They provide (monthly averaged and seasonal) climatology and time-series to describe the ozone concentrations from the surface up to 19km (maximum) and conclude on the agreement.

General comments :

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This paper is indeed well in the scope of the journal, but needs to be improved before acceptance. The manuscript appears as not enough mature, missing frequently of accuracy with lack of definitions and arguments. Provide sections 3.2.1, 3.2.2 and 3.2.3 earlier in the manuscript because these informations should be available for the lidar when operated at l'Université de la Réunion. Equation 6, correlated text and figures are unclear and I will not address any comments there, unfortunately a key point in your study. Improve Figures and to suppress the figures or table when not enough informative and avoid repetitions. Material should be valuable with a real effort and some work to reinforce the demonstration and the benefits/limits from this new instrumentation.

Specific comments (not extensive) :

Title should be revised discarding Part 1 which is not meaningful. I suggest : “Ozone profiles from a DIAL lidar at Maïdo Observatory (Reunion Island): instrumental description, instrumental performance, and result comparison with ozone external data set.

Your paper is based on a DIAL instrument. . . but DIAL is nowhere defined as a Differential Absorption Lidar. Please define this acronym at least once.

This lidar technique is now well known and you refer to major technical points already published regarding your instrument (ex line 31 p3-line 1 p4) and data processing. Highlight what is new regarding LIO3T instrument and performance as compared to previous published papers. Please discuss the uncertainty from your figure 2 versus figure 7 and explain why the results are similar/different with respect to altitude.

Homogenize your instrument labelling. Fix it once and make it consistent all along the text, including abstract, figures and tables. Along the text, you used : ozone lidar system (LIO3TUR), LIO3T, LIO3T O3, LIO3TUR, system, current system, current LIO3T system, LIO3T system, LIO3T lidar, LIO3T low and LIO3T high (this two latest are undefined elsewhere and used also in the abstract - unclear). For example I suggest to

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replace sentence starting line 10 page 3 by : “In the following, the lidar installed at the Université de la Réunion will be referred as LIO3TUR whereas the one installed at the Maïdo Observatory will be referred as LIO3T”. Two labelling seems enough. If you need more, clearly explain.

Revise and Clarify line 5 p2 : “Ozone is a major greenhouse gas in the upper troposphere and lower stratosphere”. Insist on radiative forcing contribution and remove “major”...

Rephrase lines 14-15 p2 and justify “great interest” to document climate change.

Line 20 p2 : “To improve the operation of remote sensing instrument” remote sensing is imprecise. Do you refer to space-borne instrumentation? ... and operation seems not appropriated. Replace “a 2160m-high atmospheric facility” by “a high atmospheric facility” to avoid repetition. You provide afterwards geographical coordinates and altitude.

Figure 1 : Gillot in black is difficult to see and altitude would be here welcome (figure already published please provide reference). Additional general comment on altitude: mention once all altitudes in your manuscript will be provided in amsl and avoid to repeat latter.

Replace title section 2 by “Historical context of the lidar installed at the Université de la Réunion (LIO3TUR, 1998-2010)

Replace title section 2.1 by “Instrumental description” or “Instrumental characteristics”

Line 7 p4 : First sentence is really too short... Is that your result? Could you explain the altitude range limitation? Don't forget your goal Line24 p3 is to provide data "over the entire tropospheric column...".

Figure 2 : by “resolution” you mean “vertical resolution”. . . What is the criteria for uncertainty? It is defined lately for LIO3T. It would be valuable in addition to have uncertainty expressed with the ozone unit provided. Explain why such a change in the uncertainty

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of LIO3TUR with respect to altitude. Please modify your X-axis (top and bottom) giving a more precise scaling (more minor ticks).

Line 9 p4 : “Temporal resolution ... was chosen depending on atmospheric conditions”... Please justify what is your criteria.

Figure 3 and Figure 4 : please provide consistent figures. The number of profiles given per year is non adapted and consistent to support a monthly-averaged climatology. Note than < 10 profile per year is extremely low. Provide the monthly statistics for the ECC sondes, the LIO3TUR and LIO3T in a panel of your figure 4 , deep gaps within years could be specified in the text and you might suppress figure 3. Please replace figure 4 caption by “Monthly O3 climatology derived from ECC sondes over 2005-2015 at Gillot site between 0 and 19km (Top left panel), from LIO3TUR over 1998-2010 at Université de la Réunion campus site between X and XXkm (Top right panel) and from LIO3T over 2013-2015 at Maïdo Observatory between X and XXkm (Bottom panel)”. Comparing the ECC sondes and LIO3TUR climatology, your figure 4 points out within 10-16km greater ozone concentrations from the ECC sondes. . . Explain, please.

Replace title section 3 by “The lidar installed at the Maïdo Observatory (LIO3T, 2013-present)”

Line 31 p4 : “Many instrument” is very imprecise.

Line 32 p4 : “another lidar” is imprecise. Which one : the LI1200 ?

Replace 3.1 in title “current system”. In this paragraph, a similar description has been provided in Baray et al. (2013) and citation is missing. Is there something new? Suppress lines 18-20 from this paragraph, probably the right place would be in “conclusions and future plans”. Please consider Table 1 and Figure 5 and try to avoid repetition between both. Table 1 should be probably suppressed. Please modify in Figure 5 caption using “LIO3T instrumental schema” ... I expect you are referring here precisely to LIO3T at Maïdo Observatory???

C4

Line 23 p5 : “two backscattered lidar signal at two different wavelength” Check if correct.

Line 24 p5 : be more concise. I suggest “...wavelength, at 289nm (lon) where ozone is strongly absorbed and at 316nm (loff) where ozone absorption is weaker”.

Line 28 p5 to Line 7 p6 : please avoid repetitions. Fix once z as the altitude and l as the wavelength. Please provide the interfering gas.

Line 7 p6 : This last sentence introduces further 3.2.2, specify. Additionally replace “this” by the equation number to be precise.-

Replace 3.2.2 title I suggest to replace by Saturation, correction and consequences on the vertical resolution

Line 9 p6 : “Saturation” what is saturated and what is the cause and why below 7km.

Line 13 p6 : ‘etc’. Rephrase the sentence”... type of filter such as ...

Line 14 p6 : replace “described” by extensively detailed.

Line 15-16 p6 : “we decide”... replace by we found and rephrase but add (not shown) ...

Line 18 p6 : “the resolution rises” Modify expression. Compare the vertical resolution to figure 2 and explain.

Figure 6 : Modify the resolution lines using dashed lines and modify caption on the figure in order to discriminate ozone profiles and the vertical resolution given with respect to integration time. In the figure caption, origin of data (LIO3T) is missing.

Line 26 p6 : Please check here “to 5The”

Line 9-10 p7 : “new tropospheric ozone version...” the details on cross-sections and uncertainty you provide is not much informative and information seems different from line 25-26 p6.

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Line 11-17 p7 : not at the right place, better place could be in conclusions and future plans

Line 25-26 p7 : explain why only at night. Explain why such integration time changes with respect to the data you compare to.

Line 28-30 p7. Please rephrase this sentence. “Notably” is imprecise, how much and where, but note the consistency within ~9-11,5km and explain.

Line 4 p8 : “goes” replace by varies

Figure 7 : Why LIO3TUR uncertainty increases by a factor of 3 at least above 13km whilst the one of LIO3T decreases above 14km whatever the integration time by a factor of 2 at least.

Revise section 4 title. Comparison is really too short here. What pieces are you comparing.

Line 9 p8 ‘validate’ Do you compare, evaluate or validate?... Keep constant and take care when using validation concept. I would say here you evaluate... .

Line 13p 8 add IASI after space-borne and replace instrument by data.

Line 14-16: This paragraph is absolutely obscure... I don’t understand at all what you are dealing with and description of the equation terms is hard to follow. Be clear, concise, avoid repetition and be simple, that will help. I can’t go further here... Explain clearly how can D be negative and give a clear definition for D ??? What is LIO3Tn? What is MCDn? What is D by the end?

Line 17 p8 add sondes after ECC.

Line 23-28 p8 : For that reason I think you should use only ‘evaluate’ and not ‘validate’... as mentioned above.

Line 9 p9 “SO2 loading too strong” imprecise, please provide informations on the

C6

amount.

Line 11 p9 : “mean D” see above comment and remove LIO3Tlow which is undefined and that I do not understand. Clear definition is mandatory.

Line 15 p9: “Enhanced” by how much and provide a reference.

Line18-19 p9: Not at the right place, move to conclusions and future plans.

Figure 8 and 9 : I am not able to make any comment at the moment. Please use different line thickness for the mean and standard deviation in the figures. Text of the figure caption might be improved. Use same Yaxis altitude range in both figures.

Line 21-22 p9 : Replace 3PM by 15:00:00 LT, 7PM by 19:00:00 and 1AM by 01:00:00 LT

Line 25 p9 : replace “goes”

Line 29-30 p9: rephrase this sentence, unclear.

Line 2 p10 : This FTIR spectrometer should be added to the list of instruments operating at Maïdo Observatory and provided in introduction (line 26-27).

Line 19-20 p10 : improve text. . . both instrument are operating at the same place so their measurements are colocated. . . What has to be pointed out is the time window you consider for the comparison. Add “Thus, for the LIO3T comparison with FTIR, 114 LIO3T profiles are available”.

Line 21 p10 : just mention the selected LIO3T profiles are regridded consistently to the FTIR.

Line 22 p10 How many FTIR data are averaged within 24h.

Line 23-31 p10: Very very hard to follow...

Line 3 p11: replace “time series” by “available over the 01/2013-01/2015 period.”

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Figure 11 : The caption is imprecise and bottom plot Y-axis text is not consistent with equation 6. Is it D??? Moreover, I found 12 symbols on this bottom plot ???

Figure 12 : I wonder if figure 10 and 12 should be gathered. . . Provide minor ticks for the month on the Xaxis plots

Line 18 p11 : suppress “ hereabove for the comparison with the ground-based FTIR observations” and replace by “in section 4.2.1”.

Figure 13: refer to figure 11 comment

Line 27 p11 : I don't clearly see a seasonal cycle, I see an O3 increase particularly in 2013 and 2016 suggesting an impact of biomass burning...

Section 5 : Title is data set and times series . . . You are dealing here with data from Intensive period of observations during campaigns. . . I think it makes the difference with material in previous sections, if I well understood. Please provide a more explicit title. This section is lengthy.

Line 30 p11 – line 3 p12 : You provide LIO3T results in this section. . . Thus other lidar and details not used further are out of the scope of your study. Thus suppress. This text is very long and the Figure 14 do not provide more informations with respect to the text and is difficult to read. Shorten and improve text.

Figure 15 is not much informative and text seems to repeat what is given in Line19-21 p7.

Figure 4 : Please specify in the caption of bottom panel what the LIO3T climatology includes (data routinely performed and from intensive period of observations ???).

Figure 16 : please provide these informations (4 numbers) on Figure 17 and suppress Figure 16.

Line 16-20 p12 : bring in the light what are the benefits from your new lidar. . . For sure a better description from the upper-troposphere/lower-stratosphere than when located

C8

at UR.

Line 21-24 p12 : valuable comments and for such reasons I encourage authors to carefully and rigorously revised the manuscript. Take care to the ECC caveats already mentioned.

Figure 17 : I recommend to add informations on the seasonal sampling frequency with respect to altitude and this should be done here with an additional panel.

Section 6 : bring more in the light the benefits provided from LIO3T... if monthly climatology from ECC is equivalent and to LIO3TUR and LIO3T (i.e. range of values and seasonal patterns). Could you reinforce you study here... Your goal was to describe the whole tropospheric column with LIO3T... What is your conclusion?

Line 15-20 p12 : specify altitude range here.

Line 29-32 p12 : suggestion : A DIAL tropospheric ozone lidar was operating on the Université de la Réunion campus site from 1998 to 2010, providing 427 ozone profiles. Note that this information on 427 profiles was not mentioned before. Same remark for LIO3T profiles. Replace "family" by network.

Line 9 p13 : "we found a 7.7% D between"... revised with the D definition.

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