Anonymous Referee #2

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1. *"This article describes stratospheric ozone comparisons between the differential absorption lidar (DIAL) measurements of Rio Gallegos, Argentina, the Aura Microwave Limb Sounder (MLS) satellite observations, and the MIROC Chemistry-Transport Model (MIROC-CTM) outputs. The manuscript is well-written, and contains results from rare observations from a southern hemisphere ground-based station, making this contribution worth-publishing, after the few minor comments listed below can be addressed adequately."*
Reply: We thank the referee for the effort to carefully reading the manuscript and providing us useful comments. All of the comments are considered properly as listed below.

A list below shows differences in Figures after and before this revision.

New	Old
Fig.1: map of Rio Gallegos	
Fig.2: vertical profiles (example)	Fig.1: vertical profiles (example)
Fig.3: time series of DIAL profiles	
Fig.4: sPV maps	
Fig.5: time series (18hPa)	Fig.2: time series (18hPa)
Fig.6: time series (56hPa)	Fig.3: time series (56hPa)
Fig.7: abs diff. vs. sPV diff.	Fig.4: abs diff. vs. sPV diff.
Fig.8: abs diff. vs. MERRA-2 O3 diff.	
Fig.9: abs diff. vs. distance	Fig.5: abs diff. vs. distance
Fig.10: abs/rel diff. vs. prs	Fig.6: abs/rel diff. vs. prs
Fig.11: abs diff. (w/filtered) vs. prs	Fig.7: abs diff. (w/filtered) vs. prs
Fig.12: time series of abs diff. (8hPa)	

2. *"Page 5, lines 8-15: What altitude variable is being used for conversion to pressure? (is it the MLS-provided geopotential height?) Is geopotential height converted to geometric altitude? Please provide more details here"*
Reply: For conversion of the DIAL altitude/O3 number density into pressure/O3 mixing ratio, we used the NCEP reanalysis data, and the data are registered in NDACC. The geopotential height of the NCEP data is converted to geometric altitude. We have added a sentence in Section 3 Method for comparisons between DIAL and MLS/CTM: "For converting the original DIAL geometric altitude and O3 number density to pressure and O3 mixing ratio, the NCEP reanalysis data (Kalnay et al., 1996) are used. These data are registered in the NDACC database."

3. *"Figure 1, right panel: Can the combined (MLS and DIAL) uncertainty be added to the plot. This would show the differences in the context of their uncertainty estimates"*
Reply: We missed to mention the bars in MLS O3 profiles in the submitted version. This is precision reported for individual profiles. The combined uncertainty is added in new Figure 2 (right panel). The total uncertaintiy for DIAL is also added in new Figure 2 (left panel). We have added sentences in Section 4.1 Example of vertical profile comparison: "The bar in MLS O3 profiles shows the precision reported for individual profiles. The bar in DIAL O3 profile shows the total uncertainty. The combined uncertainty (root sum square) is shown in the right panel."

4. *"Figures 2 and figures 3: Please add approximate geometric altitude for convenience Also, I would recommend showing differences in percent as well."*
Reply: Approximate geometric altitude of DIAL are now added in new Figure 5 and Figure 6, and relative differences as 100*(X - DIAL) / DIAL are also added as another panels in new Figure 5 and Figure 6. We have added sentences in Section 4.2 Time series comparison: "For reference, Figures 5e and 5f show the relative differences for DIAL/MLS and DIAL/MIROC-CTM

comparisons, respectively." and "Figures 6e and 6f show the relative differences for DIAL/MLS and DIAL/MIROC-CTM comparisons, respectively."

5. *"Page 7, lines 26-29: The explanation of model high bias is not convincing. Could the bias be related to inaccurate/incomplete chemistry causing in-vortex ozone loss to be underestimated? Please provide additional details supporting this statement."*
Reply: For this high bias in the MIROC-CTM, one possible explanation was as follow: A higher N2O value at 18 hPa than that of MLS was seen. A higher N2O value corresponds a smaller value of Cly (ClOx), providing a higher O3 value owing to a weaker O3 destruction. We have added some sentences in Section 4.2 Time series comparison: "Another possible explanation could be due to a weaker vertical motion of air in MIROC-CTM. Although not shown, a vertical profile of nitrous oxide, N2O, from MIROC-CTM on November 14, 2009 is different from that from MLS. A tight correlation between N2O and Cly is found in the stratosphere (e.g., Schauffler et al., 2003), and used to infer the Cly value from a measured N2O value (e.g., Wetzel et al., 2010; Strahan et al., 2014). At 18 hPa, the MIROC-CTM N2O value is higher than that of MLS, resulting in a smaller value of Cly in MIROC-CTM. Thus, a smaller active chlorine (ClOx) induces a higher O3 amount in MIROC-CTM."

6. *"On the use of meteorological fields: MIROC-CTM apparently uses ERA-based meteorological fields. However meteorological fields from GEOS-5/MERRA-2 are used for the other work described here (PV calculation, pressure/altitude conversion etc.). Would it be possible to use the same dynamical fields for improved consistency? If not, some discussion on the implications of using different met fields should be added, for example in section 3."*
Reply: We did not use MERRA-2 for the conversion of the DIAL altitude/O3 number density to pressure/O3 mixing ratio. The difference between NCEP and MERRA-2 will affect the DIAL pressure/O3 mixing ratio. This will be done in a future work when we register such data to NDACC.
Regarding a nudging other meteorological data, we performed CTM runs using MERRA-2 and NCEP reanalysis data. However, we have not achieved a detailed comparison among those meteorological data (Akiyoshi et al., a presentation in Meteorological Society of Japan, 2017). This will also be done in a future work. We have added some sentences in Section 3 Method for comparisons between DIAL and MLS/CTM: "Possible deviations could be expected if we use other meteorological data for the conversion process in DIAL. However, in this study, we used the DIAL data that registered in the NDACC database. Another possible deviations could also be expected if we use other meteorological data for the nudging process in MIROC-CTM. The different reanalysis data may cause different vertical and horizontal motions of air in the model, providing different tracer correlations, hence ozone field. However, in this study, we analyze owing to the model of Akiyoshi et al. (2016) to examine the performance."

7. *"Figure 6b, (X-DIAL)/(X+DIAL)*200: I think plotting differences between instruments should not be done with respect to the mean of the 2 instruments. Biases between instruments are better identified when one instrument is used as the reference (typically, the instrument believed to have a best accuracy). I would recommend to modify figure 6b by taking DIAL as the reference, i.e., plot (X-DIAL)/DIAL*100 instead."*
Reply: The right panel of Figure 6 has been revised in new Figure 10. According to this revision, the numbers shown in Section 4.4 Comparison at other levels: summary and in Section 5 Conclusions have revised to 116% for DIAL/MLS and 292% for DIAL/MIROC-CTM.

8. *"Page 9, lines 26-34: Below 70 hPa, large percent differences between observations are typically expected due to the lower ozone mixing ratio values at the bottom of the stratosphere, and occasionally also due to the proximity of the tropopause. The lidar signal saturation is a possible reason for the low bias, but the large percent differences are likely associated with the loss of sensitivity in this region of low ozone concentration"*
Reply: Thank you for pointing out this. We have added a sentence: "Since the O3 mixing ratio from DIAL is very small below about 70 hPa, the sensitivity might be degraded along with the saturation effect."

9. *"Conclusion: There is little discussion on the CTM outputs, especially the low ozone bias inside the vortex at 18 hPa. This finding deserves some digging to my opinion, including references to published works on the subject. Finally the conclusion should emphasize the crucial importance of the DIAL station location and the dearly-needed continuation for long-term measurements there for NDACC."*

Reply: From a view of the mean difference between DIAL and CTM, there is a low bias in CTM above 18 hPa, as shown in Figure 6 (new Figure 10). However, looking at data inside the vortex, there are high biases in CTM, as shown in Figure 2d (new Figure 5d). As I mentioned above, the high biases may be associated with a weaker vertical motion of air in CTM. This partly cancelled the underestimate of O3 value, providing a mean difference of nearly zero (0.04 ppmv in Figure 2d, i.e., new Figure 5d). We have added a sentence in Section 5 Conclusions: "An insufficient model vertical motion may also be partly responsible for the O3 differences, especially inside the polar vortex."

We have also added a sentence to emphasize the continuation of DIAL observations: "Because of very sparse observations from S.H. ground-based stations, continuation for long-term measurements there for NDACC is highly recommended."

Referencers:

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