

Interactive comment on “20 Years of ClO Measurements in the Antarctic Lower Stratosphere” by Gerald E. Nedoluha et al.

Anonymous Referee #1

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ClO is a tricky molecule to deal with due to its strong diurnal and temperature dependent properties. The authors have done an excellent job in being able to look at Antarctic stratospheric ClO from the ground-based platform (ChIOE) at Scott-Base as well as using satellite data (MLS missions). Analyses using temperature data from MERRA were also performed to account for the relationship between stratospheric ClO and temperature around Scott-Base. As a result of an excellent intercomparison analysis, trends around the Scott-Base region were estimated which were found to be consistent with previous studies as well as providing up to date trends for the Antarctic region.

I recommend this paper for publication after the following revisions are made.

MAJOR P3,L6: There are is one reference to the ClhOE instrument providing some

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more detailed information about its specifications and general performance. As it is the one of the main instruments focused upon here in this paper, there should be something written more that helps give the reader an idea of how well it performs. How does it validate to other measurements for example? On P2,L20 it is stated that Connor et al., compared MLS to ClhOE, maybe it would be good to provide a more detailed description in one or two lines of the results here in this paper.

P3, L14. It is stated “For these measurements we have defined day as the period from 3 hours after sunrise to 1 hour before sunset, and night as the period from 4 hours after sunset to 1 hour before sunrise.” Is there any particular reason as to why you chose these values? Do the results change significantly if using a larger/smaller range? The text needs some explanation as to why these values were chosen.

Figure 2. I like this plot, but I think there needs to be more explanation for the CIO behavior over time. As I understand it, the small difference between day and night values at the beginning and end of the time period (at both peaks) are because of low CIO activation on a diurnal scale. Is this because there is no sunlight at the beginning of the period, whilst at the end of the period, there is only daylight? I think this needs to be explained a little clearer.

Furthermore, I suggest adding a geometric altitude on the y-axis to stay consistent with Figure 1.

P5, L23: You mention you use a climatology in order to calculate anomaly CIO values. How is this climatology calculated? Do you use a simple mean, median, weighted mean, such as using the uncertainties of the measurements? Did you use all measurements or did you deal with outliers?, if so, how? A little more information is needed here to explain how the climatology was made.

P7, L20: “At the latitude of Scott Base (77.85°S) we do not expect that during these dates any of the measurements have occurred outside of the vortex (except possibly in 2002, when the Antarctic stratosphere exhibited an unusual major warming)”.

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Is there any way to actually confirm this? There are various tools that can be used to check where the vortex edge is estimated to be situated. One particular tool is Scaled Potential Vorticity (SPV) that has been provided for the MLS data using the GEOS-5 model (Manney et al., 2009).

<http://www.atmos-chem-phys.net/9/4775/2009/acp-9-4775-2009.pdf>

SPV values are provided for each MLS measurement. As MLS is used here in this paper, you should be able to get a reasonable idea as to what air mass Scott Base was situated in for these measurement periods. If you have possible access to this data, I would suggest trying to confirm this.

Figure 7: There is a good anti-correlation between T and ozone loss, which is seen clearly at most of the maxima and minima here. However, 2004 and 2005 there seems to be a lag between the two, is there any explanation for this?

P15, L12, I think one has to be a little careful concerning the turn-around of 1997. Most previous studies use this year, but it has never really been proven to be the actual turn-around, but best estimate (as far as I'm aware) for the upper stratosphere mid latitudes. I think it would be better to write 'about 1997' or 'around 1997'.

MINOR P1, L17 : I would suggest entering the range of years analyzed here as well stating austral spring. .. "We present 20 years (1996-2015) of austral springtime..". Otherwise, the comments further down about August and September seem somewhat general and could be from any 20 year period.

P1, L22: comma needed. "In order to study inter-annual differences, we focus.."

P1,L22: comma needed. "By making better use of this relationship, we can ..."

P2, L14: Any reference that could be cited about the future installation at Mauna Loa?

P3, L31: I suggest adding a temperature range/or minimum value for the term 'very cold Antarctic conditions' to which PSCs are formed. According to the WMO, PSCs

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form below 195 K.

P4, L2: Comma needed. “because of the weak signal, the best ground-based..”

P4, L3: Commas needed. “Measurements of this CIO peak, as made from the ChIOE3 instrument at Mauna Kea, have been shown in Nedoluha et al. (2011) and Connor et al. (2013).”

P4, L5. Comma needed. “Since all of the measurements shown here 5 will be with the ChIOE1 instrument, we will henceforth refer to this instrument simply as ChIOE”.

Figure 1. Caption could read better as; “The retrieved day minus night CIO mixing ratio profile for September 4, 2011 (solid line), and the a priori profile for that day (dashed line), as a function of pressure (left y-axis) and geometric altitude (right y-axis)”.

P5, L1: Comma needed. “Here, we use the..”

P5, L8: I would suggest to use pressure as an altitude reference and put the geometric altitude in brackets as a reference. This then stay consistent with the paper up to this point. Hence; whatever pressure is associated with 23 km.

P5, L15: I suggest rewording to; “Figure 3 shows measurements of day minus night CIO column from ChIOE during 2006 together with those from the coincident MLS (within $\pm 2^\circ$ latitude and $\pm 15^\circ$ longitude of Scott Base) measurements.”

P7, L9: Spelling; “solar times of its measurements..”

P7, L20: Comma needed; “At the latitude of Scott Base (77.85°S), we do not expect that”

P8, L2: suggest adjusting to; “We therefore choose September 17 as the final day of the period for which we will compare interannual variations as it provides the best representation of the atmospheric state as a result of a lower variance”.

P8, L5: Suggest adjusting to; “The choice of 5 August 28 as the first day for the com-

parisons provides us a 3-week period yielding an average of 16.4 daily measurements from ChIOE for each year.”

P9, L3: Are these really anomalies in Fig. 5? Would that not imply fluctuation around zero? I thought you used the anomalies and added them back onto the climatology, hence yielding “the annual average CIO column”?

P9, L13: Comma needed; “For the 12 years of Aura MLS CIO column measurements, the correlation..”

P9, L22: Commas needed; “The fraction of Cly, which is in the form of CIO, is sensitive..”

P9, L23: Also referring to P3, L31, you state “very low temperatures”..A minimum value should be included.

P9, L24: CALIPSO needed to be written in full before abbreviating “(Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations”

P10, L2: I would suggest trying to quantify the amount of correlation. How much is “are quite well correlated..”. This provides the reader with his/her own interpretation of the relationship between the two variables.

P11, L6: Better suited to read “The annual average MERRA temperature anomalies at three pressure levels..”

P11, L13: What does TIROS stand for? Television InfraRed Operational Sounder? Please write the full name first of the measuring instrument, before abbreviating.

P11, L19: comma needed; “Based on the biases in MERRA temperatures indicated by the sonde data, we added 4.0K to the..”

P11, L19-L20: I would reword this sentence slightly to confirm that the extra K are added to account for biases. “Due to the biases in MERRA temperatures indicated by the sonde data, we added 4.0K to the 20 hPa 1996-1998 MERRA temperatures and

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2.1K to the 30 hPa temperatures to account for this offset”.

P12, L2: comma needed: “When we estimate chlorine trends in Section 5, it will be particularly important to have. . .”

P12, L24: Please quantify the correlation value between MLS ClO Z.A. column and zonally average temperature; “showed the highest correlation”

P15, L26: So “The linear trend in the annual August 28 to September 7 ChIOE ClO anomalies (those shown in Figure 5) is $-1.1 \pm 0.4\%/yr$ ” is referring to years 1996 to 2015? Could you please just make that clear. It might be important to the reader as you state trend periods for previous analyses in your literature review.

P16, L25: Please add ‘respectively’ “The calculated trends with REAN2 temperatures are $-0.6 \pm 0.2\% yr^{-1}$, $-1.4 \pm 0.9\% yr^{-1}$, and $-0.5 \pm 0.4\% yr^{-1}$ for zonal MLS, Scott Base 25 MLS, and ChIOE, respectively”.

References: Need some work to make them all consistent with ACP standards, as well as being in chronological order if under the same leading author.

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/acp-2016-188/acp-2016-188-RC1-supplement.pdf>

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-188, 2016.

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