Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2019-17-AC2, 2019

Annales Geophysicae Discussions
Open Access
EGU

Interactive comment on "Analysis of an event of short term ozone variation using a Millimiter-Wave Radiometer installed in subpolar region" *by* Pablo Facundo Orte et al.

Pablo Facundo Orte et al.

pfacundo.orte@gmail.com

Received and published: 25 April 2019

The authors acknowledge the anonymous referee and the editor for the time spent to review this manuscript and also for their constructive comments. The manuscript was revised and improving according to the referee comments and suggestions.

(A clearer version is upload as Supplement file) Answers to the referee's comments.

SpeciïňĄc comments: - The manuscript's title must be as concise and direct as possible, emphasizing the object of study instead one of the used tools. I suggest some like: "Analysis of a November 2014 southern sub-polar short-term ozone variation event".

Printer-friendly version

Discussion paper

Eventually, if the MWR instrument is cited, please change “Millimiter” by “Millimeter”.

AC: We find appropriated the title proposed by the Referee and we make some changes with the intention to include the instrument that allow the “short-term” study over sub-polar regions. The title was modified as follow:

“Analysis of a southern sub-polar short-term ozone variation event using a Millimeter-Wave Radiometer”

RC: A conceptual aspect to revise throughout the manuscript is the coherence and rigor in the use of terms “polar vortex” and “ozone hole”. The “Antarctic polar vortex” is a dynamical phenomenon which has been present probably for millions of years, and their mention is essential when the dynamics is analyzed particularly as a function of the altitude. While, the “Antarctic ozone hole” is the extreme manifestation of the stratospheric ozone layer depletion in the interior of the “Antarctic polar vortex”, which has made evident since late 1970s, and is mainly referred to either when their vertical ozone structure is afforded or their consequences on surface are analysed. To speak of “ozone hole”, for deïňĄnition the vertical total ozone column values must fall below 220 DU; authors must revise their use when appropriate. In turn, terms as “ozone hole inïňĆuence” are appropriate for sub-polar regions but in this case explicit mention to the “Antarctic ozone hole” must be made, eventually an abbreviation AOH may be useful. Similarly, phrases as (page 12, lines 19-20) “the southern part of South America has been affected by the systematic and abrupt intrusion of the polar vortex during the spring since the 1980’s” are inappropriate: as said, the Antarctic polar vortex occurs probably since millions years ago, the difference is that before the 1980s their interior produced no “ozone hole”, i.e. ozone values below 220 DU as it is deïňĄned, and without the presence of the ozone hole probably the polar vortex intrusions would have no major transcendence for the surface. Authors must take particular care about the use of these key expressions. In this phrase, also the word “systematic” is inappropriate. It could be changed by some like: “the southern part of South America has been affected by the frequent abrupt intrusions of the AOH during the spring since the 1980’s”.

Similarly, the phrase (page 11, line 14) “This decrease is related to the passage of the ozone hole over Rio Gallegos” is wrong, as TOC never falls below 220 DU. Several other paragraphs along the manuscript must be revised accordingly.

AC: The underlined sentences by the reviewer are now changed in the manuscript for better clarification and distinction between AOH influences and AOH overpass. The introduction was modified to clarify the terms used in the paper as “Ozone hole influence” and “ozone hole overpass”. Please, see pg. 3, lines 9-13.

- Given that the vertical total ozone column (TOC) values are a necessary reference when ozone anomalies are reported, I suggest a detailed mention to the TOC not only when the present case is analysed but also when mention to other cited cases to help distinguish Antarctic ozone hole “inïňĆuences” from Antarctic ozone hole “overpass”, and ozone hole “reductions” from eventual “mini ozone-holes” or real ozone hole “overpass”.

AC: As we mentioned above, the introduction was modified to clarify the terms used in the paper as “Ozone hole influence” and “ozone hole overpass”. Please, see pg. 3, lines 9-13.

- In the Introduction: as a benchmark for the speciïňĄc analysis of this work, it would have been desirable a characterization, based on references, of the known springtime typical vertical structure of the atmosphere over southern South America on both “sides” (inner/outer) of the Antarctic ozone hole.

AC: The following paragraph has been added to put in context the ozone reduction due to the ozone hole influence or the ozone hole passing over the southern South America (pg. 2, line 19):

“In spite of the fact that massive ozone depletion is produced over the South Pole, the total ozone column (TOC) and vertical reduction were also observed in non-polar regions between 1980s and 1990s (WMO, 2014). Kirchhoff et al. (1997; 1997b) reported

Printer-friendly version

Discussion paper

TOC ranging from 145 DU to 250 DU in Punta Arenas (53.0'S, 70.9'W)), during low-ozone events during September-December of 1992-1995, for which the climatological average is 330-334 DU (maximum reduction of ∼56%). More recent study reported reduction of 40-45% in TOC over Río Gallegos (Kuttippurath et al. 2010b). ECC (Electro Chemical Cell) ozone-sonde profiles measurements reflect reductions of around 30 to 50% between 15 km to 32 km of altitude in ozone hole condition (inner) respect normal condition (outer the ozone hole) in Punta Arenas (Kirchhoff et al.,1997). Similar reduction was observed from a Differential Absorption Lidar at Río Gallegos (Wolfram et al., 2006)."

- In the same sense, speciïňĄc parts of these references could be useful to compare and put in major context the results from this work.

AC: Discussion section were improved and references were added to put our results in context with other results. Please, see section 4. Discussion (pg. 11) for more details.

- Given that one of the concerns with ozone negative anomalies is the potential increase in harmful UVB solar irradiance at ground, please could you add, e.g. in Figure 6, other plot of locally-measured clear-sky UV Index (at noon, or at a given ïňĄxed solar zenith angle) allowing quantify the simultaneous UVB increase for these days?.

AC: Taking into account this comment, we decided to modify the figure 7 (ex figure 6) adding the daily maximum UVI measured from a ground-based instrument (Radiometer YES UVB-1). This instrument was installed in Río Gallegos by 2014 and it is part of the SAVER-NET radiation network (http://data.savernet-satreps.org/). We decided to present the daily maximum UVI due to the fact that most of the analysed days were partially cloudy with broken clouds, and the maximum UVI were measured near to the noon. The daily maximum UVI was added in Figure 7 as follow:

AC: In addition, a paragraph about the description of the daily maximum UVI was added in 3.2.1 Description of the case study section (pg. 11, line 13).

Minor comments:

Text - Please deïňĄne the abbreviations the ïňĄrst time the parameters are mentioned, and then use just the abbreviation. E.g. page 11, line 14: standard deviation is mentioned before, abbreviation SD should be presented the ïňĄrst time it is mentioned and then only SD used. The same for TOC in line 18.

AC: It was revised.

- Page 3, lines 1-2: please change by “due mainly to tropospheric-stratospheric dynamical processes”.

AC: It was changed.

- Page 3, lines 6-10: I think a change in the order of paragraphs would make more coherent this sentence. I suggest: “The transport of polar air masses may take the form of “ïňĄlaments” and “tongue”, which induce anomalies on the ozone and UV observations over mid-latitudes. Recently, based on satellite and ground-based observations in Uruguay and Southern Brazil, Bresciani et al. (2018) showed a decrease of ozone over these sites during October 2016 in link to this phenomenon”.

AC: Taking into account this comment, the paragraph was changed as following (pg.3, line 19):

“The air-mass transport in the stratosphere has been extensively analysed using the advected potential vorticity (APV) which is considered a suitable dynamical tracer in the stratosphere. The transport of polar air masses may take the form of “filaments” or “tongue”. These terms have been used to explain the transport of air from the edge of the polar vortex into middle latitudes by Waugh (1993) analysing potential vorticity maps, and previously by Randal et al. (1993), to explain the intrusion of tropical air into mid-latitudes. When the intrusion of air from the polar vortex reaches mid-latitudes and produce ozone decreases, it induces anomalies on the surface UV radiation. Bittencourt et al. (2018) also linked the occurrence of this event over South America to later

changes in the tropospheric and stratospheric dynamic behaviour. Thus, this parameter can be used to study the dynamics of the Antarctic polar vortex and as a tracer of poor-ozone air masses that are released from the ozone hole (Bittencourt et al., 2018; Kirchhoff et al., 1996, Pinheiro et al., 2011; Wolfram et al., 2012; Hauchecorne et al., 2002; Marchand et al., 2005; Bencherif et al., 2007)."

- Page 3, line 9: "which induce anomalies on the ozone and UV observations". Anomalies are on the ozone and UV behavior, not on the observations. Please correct.

AC: "UV observations" was change by "surface UV radiation" (pg. 3, line 24).

- Page 3, lines 22-23: phrase "The OAPA is located in sub-polar latitudes, which makes it a suitable site to study stratospheric ozone due to its closeness to the Antarctic ozone hole" is wrong. It could be: "The geographical location of OAPA makes it a suitable site to study the sub-polar stratospheric ozone due to its closeness to Antarctica".

AC: It was changed as suggested (pg.4, line 15).

- Page 3, line 31: "decreasing the ozone amount" instead "increasing the ozone amount"?.

AC: During the analysed period, decrease and local increase of ozone amount were observed at both altitudes (27 km and 37 km). In this part of the sentence we refer to the local increase, when the ozone mixing ratio at both altitudes (27 km and 37 km) present a local peak.

With the intention to clarify this point in the text, the sentence into the manuscript was changed as follow (pg. 3, line 30):

"The high temporal resolution (one hour) of the MWR observations are analysed at different altitudes (27km and 37 km) with the aim to determine the short-term variability of ozone mixing ratio and the moment when the polar vortex and its edge (as filamentary structure) with poor-ozone air masses pass over Río Gallegos and leave it at those altitudes, resulting in a local peak of ozone mixing ratio for a very short period of time

on November 2014."

- Page 4, some paragraphs of lines 1 up to 8 seem more appropriate for section 2. Materials and Methodology, other for the conclusions and future possibilities. Please redistribute them.

AC: The paragraph was modified and moved to the 2.1 Observations section. (Pg. 4, line 23)

The end of the paragraph was moved to the end of 5. Conclusion section. (Pg. 15 line 20)

- Page 7, line 11: deïňĄne AMF.

AC: It was replaced by "air mass factor" (pg. 7 line 25)

- Page 8, line 3: "into the daily cycle": did you mean "within the diurnal cycle"?. In line 4: please rewrite "that this gas suffer in this layer" in other form.

AC: - "into the daily cycle" was change by "within the diurnal cycle" (Pg. 8, line 17). - The sentence was changed by "We observe a marked difference of ozone mixing ratio between day and night measurements due to the ozone photochemistry around this altitude" (Pg. 8 line 17-18:)

- Page 9, line 22: replace "Argentina" by "South America".

AC: It was replaced (Pg. 10, line 10)

Figures

- Text of Page 11, line 10: . . . "light red". . . but in the caption of Figure 6 it is referred to as "pink".

AC: The color was unified as light red.

- Figure 9 and several paragraphs from the Introduction treating on the characteristics of the measurement site (e.g. page 3, lines 21 on) should be at the start of section 2.

Materials and Methodology.

AC:

- Figure 9 (now figure 3) was moved to section 2 (Materials and Methodology) (pg.8, line 25).

- The paragraph describing the measurements site was moved to subsection 2.1 (Observation) and it was adapted as follow (Pg. 4, line 14):

“Ground-based instruments used here are operated at OAPA, Río Gallegos, Argentina (51.5° S; 69.3°W), belonging to CEILAP (hereafter OAPA). The geographical location of OAPA makes it a suitable site to study the sub-polar stratospheric ozone due to its closeness to Antarctica. Since 2005, a Differential Absorption Lidar (DIAL) has been operated at the OAPA with the aim to retrieve stratospheric ozone profiles (Wolfram, 2006; Salvador, 2011), which were joined to the Network for the Detection Composition Change (NDACC) in 2008 (http://www.ndsc.ncep.noaa.gov). In addition, a ground-based SAOZ spectrometer instrument (Pommereau and Goutail, 1988) to retrieve TOC was installed in the OAPA by 2008 and belongs to LATMOS/CNRS. To contribute to ozone monitoring, the Solar Terrestrial Environment Laboratory, Nagoya University, Japan, installed the MWR in OAPA in 2011, which incremented the temporal resolution and increased the altitude range of the ozone profiles (Orte et al., 2011; Orte 2017). On the other hand, satellite OMI and MLS datasets are used here to inter-compare with mentioned ground based.”

- The captions of the ïňĄgures must contain all the information needed to interpret them. Please revise the captions of all ïňĄgures. In Figure 2 please correct . . . ratio for three altitudes: 27, 37 and 65 km.

AC: The captions of all figures were revised and improving. The caption of the figure 2 was corrected.

- The abscissas and ordinates legends and labels must explicit clearly the parameters

in each axis. E.g. in Figures 2, 4 and 5, the y-legends must include “ozone mixing ratio”.

AC: “Ozone mixing ratio” legend was included in the y-legends of the mentioned figure (now Figure 2, 5 and 6). Also was included in Figure 7 (right axis).

Dates in Figure 3 are better presented in Figure 2.

AC: Date of the mentioned figure was modified.

In Figures 4, 5 the altitude may be in form of title for each plot. In Figure 6 the year is not speciïňĄed, don’t use the abbreviation TOC. AC:

- The altitude was moved as a title those (Figures now 5 and 6). - The year was specified at the bottom of the figure (now figure 7) and TOC was changed by “total ozone column”

These comments may be considered as relatively “minor changes”. However, I suggest they should be taken as mandatory for a posterior re-evaluation of the manuscript.

Please also note the supplement to this comment:
https://www.ann-geophys-discuss.net/angeo-2019-17/angeo-2019-17-AC2-supplement.pdf

---

Interactive comment on Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2019-17, 2019.

Printer-friendly version

Discussion paper

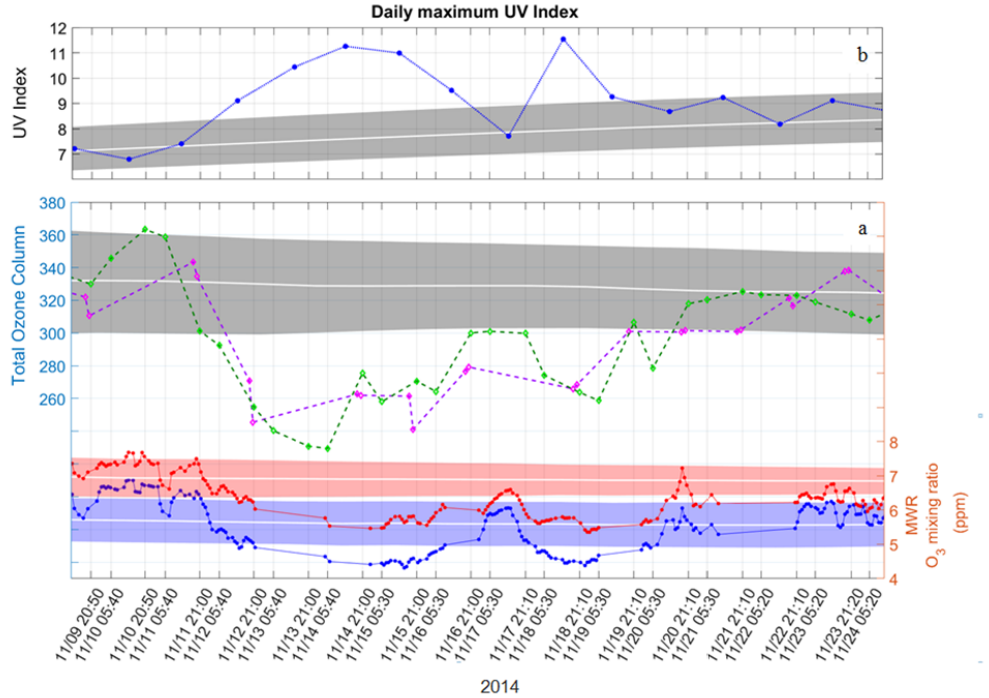

Figure 7. Atypical event of Antarctic ozone hole influence over Río Gallegos. (a) (Bottom) Time evolution of the MWR ozone mixing ratio at 27 km (red line) and 37 km (blue lines). Light red and light blue areas represent the ozone mixing ratio zonal climatology at both altitudes calculated using MLS database (2004 - 2016). (Top) Time evolution of total ozone column measured with the ground-based SAOZ instruments (green dots) and OMI (purple dots) in Dobson Units. White line and grey area represent the climatology and one SD calculated using the OMI data-base (2004 - 2017). (b) Time Evolution of the Daily maximum Ultraviolet Index measured with the ground-based solar radiometer YES UVB-1 at OAPA. White line and grey area represent the climatological UVI at noon in Río Gallegos.

Fig. 1.

Printer-friendly version

Discussion paper