Response to reviewer #1

We thank the reviewer for his/her new technical corrections. We hope that, with the corrections suggested by the two referees, the revised manuscript will convince the reviewers that the paper can be published in ACP.

Response to reviewer #4 – M. Santee

We deeply thank Michel Santee for her new in-depth review and her new suggestions to clarify unclear sentences. The corrections made in the new version improve considerably the manuscript. We only address the main comments here below, using the same line numbers as the ones quoted by Michel Santee in her review. All the minor comments, suggestions and technical corrections have been addressed/implemented in the new version of the manuscript.

Main comments

Section 2
[L122-123, 131]:
"polar night" and "dark Antarctic winter/vortex" refer to nighttime only. There is no mention of diurnal variations anywhere in the manuscript. "...variations of HNO3..." has been changed to "depletion of HNO3" for clarity in the new version.

[L132 and Fig. 1 caption]**:**
"(Both divided by 10)" has been added in the caption of Figure 1.

Section 3
[L189-196**]:**
The sentence: "The end of the R1 period marks the start of the strong total HNO_3 decrease that intensifies later in R2." has been added at the end of the paragraph.

[L223-225]:
The sentence has been deleted.

Section 4
[L268]:
The sentence and the label on figure 5 have been corrected.

[L303-306]:
1/ The sentence has been changed to: "The red vertical dashed line indicates the annual average of the dates on which the 50 hPa drop temperatures are calculated in the area of PV$\leq$ -10×10^{-5} K.m^2.kg^{-1}.s^{-1} (194.2 ± 3.8 K; see Fig. 4)."
2/ The average date is now specifically mentioned in the text.
3/ The fact that the average date just precedes the PV contour on Figure 5 is explained by the fact the we represent a climatological PV contour based on zonal averages of PV values (contrarily to Figure 4 where the date of the 50 hPa drop temperature indeed coincides or just follows the existence of an area of the −10×10−5 K.m2.kg−1.s−1 PV value) and an average date. One can clearly see on Figure 5 that the existence of the area within the PV contour falls into the two dashed vertical lines that encompass the dates on which the drop temperature is calculated. When looking at Figure 6 that illustrates every

year, we clearly see that the dates corresponding to the 50 hPa drop temperatures better match the existence of the area of PV <= -10x10-5 k.m2.kg-1.s-1.

4/ The fact that a climatological and zonally averaged PV contour is used in now explicitly stated in the text and in the figure caption.

[L306-307] and [L312-313]:

We thank M. Santee for pointing this out.

1/ The sentence L306-307 is indeed unclear and misleading. What was underlined here is the delay between the detection of the averaged 195 K threshold temperature and the start of the HNO_3 depletion.

Because of the redundancy with the previous sentence, it has been moved below when discussing figure 6 and it now replaces L312-313:

"An exact timing or a delay of a few days between the detection of the averaged 195 K threshold temperature and the start of the HNO_3 depletion is visible every year in Fig. 6. In particular, the year 2009 shows the longest delay (see also Fig. 4)".

2/ The delay is also now specifically mentioned above when discussing Figure 4: "... (at exactly or a few days after the detection of the 195 K threshold temperature, particularly for the year 2009) ...".

3/ Actually, the mismatch in the 10-year average (Fig. 5) between the detection of the averaged 195 K threshold temperature and the average date (24 may) for the drop temperatures is not driven by the year 2009 (that in fact has the latest date for the drop temperature - the 8th of June - among all years; see text), but by the year 2013 that shows the earliest date for the drop temperature (11th of May; see text) due to the lowest temperatures in the Antarctic winter. It is now clarified at the end of section 4.1:

"Note that the mismatch observed in the 10-year average between the detection of the averaged 195 K threshold temperature and the average date for the drop temperatures (see Fig. 5 a and b) is driven by the year 2013 which is characterized by the lowest temperatures during the Antarctic winter over the 10-year study period and, hence, the earliest date for the drop temperature (11th of May; see Fig. 4 and Fig. 6)."

[Figure 7]:

The fact that some temperature contours are not closed is explained by the fact that we work in an area delimited by a PV value <= -8×10^{-5} $k.m^2.kg^{-1}.s^{-1}$. Please see, as an example, figure 1 here below that shows the spatial distribution of the temperatures (K) at 50 hPa averaged over the period 10 May –15 July for the year 2015, in a region delimited by a PV of -8×10^{-5} $K.m^2.kg^{-1}.s^{-1}$. The isocontours of 195 K at 50 hPa for the minimum (in pink) and the averaged (in red) temperatures as well as the isocontours of -10×10^{-5} $K.m^2.kg^{-1}.s^{-1}$ and of -8×10^{-5} $K.m^2.kg^{-1}.s^{-1}$ at 530 K for the minimum PV (in green and in cyan, respectively) are represented.

[L329-336]:

The fact that the Antarctic land in 2014 shows a lot of cells characterized by a high drop temperature has to be investigated in more details. Interestingly, May 2014 (and also 2016) shows a significant positive land surface temperature anomaly in that region over the 10-year study period. It probably induces measurements with a better signal-to-noise-ratio, which are less prone to rejection based on the applied quality filters, while they remain characterized by strong emissivity features. This may bias the drop temperature calculation.

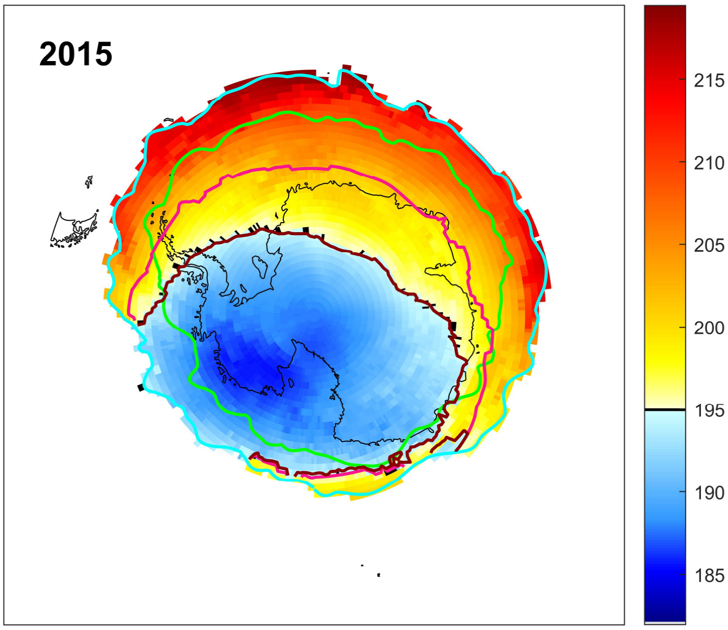

Figure 1. Spatial distribution (1°×1°) of the temperatures at 50 hPa (K), averaged over the period 10 May –15 July of the year 2015, in a region defined by a PV of -8×10^{-5} $K.m^2.kg^{-1}.s^{-1}$. The isocontours of -10×10^{-5} $K.m^2.kg^{-1}.s^{-1}$ at 530 K for the averaged PV (in green) and the minimum PV (in cyan) encountered over the selected period and the isocontours of 195 K at 50 hPa for the averaged (in red) and the minimum (in pink) temperatures over the same period are represented.