Review of “Hemispheric differences in ozone across the stratosphere-troposphere exchange region” by Rodrigo J. Seguel, et al.

Summary and General Comments:

This paper examines 2019 SouthTRAC aircraft and 2008-2018 Ushuaia ozonesonde data in the midlatitude Southern Hemisphere (SH), and IAGOS aircraft data in the Northern Hemisphere (NH) in various years to understand hemispheric differences in stratosphere-to-troposphere exchange, sudden stratospheric warming (SSW) events, and lower stratospheric ozone. The authors use the heavily instrumented SouthTRAC HALO aircraft to determine criteria for separating air of tropospheric and stratospheric origin in the UTLS. Ultimately, carbon monoxide (50 nmol mol-1) and relative humidity (20%) are used to make this distinction and extend the analysis of STE events beyond just 2019.

The authors identify years with (low depletion year) and without (high depletion year) SSW events, separate the ozone profile data from aircraft and ozonesondes into the low and high depletion years, and examine the differences in both hemispheres during STE events. Note that I am not sure I saw explicitly how the SSWs were defined (major SSW? A slowing of the 60N/S 10hPa winds to some magnitude?). They find that air of stratospheric origin in the SH UTLS contains much lower ozone than the NH for both the low and high depletion years. The analysis of the aircraft and ozonesonde data is supported by the CAMS chemical reanalysis showing this result throughout the entire 45-60N/S latitude band.

The text is polished and the figures are easy to digest and well-constructed. The SouthTRAC September-November 2019 aircraft data are serendipitous in that you can examine a rare Antarctic SSW and low depletion event with multiple in-situ chemical species (including some aged fire plumes). However, this paper is missing a lot of the broader context that would be provided by analysis of the Lauder (45S) and Macquarie Island (55S) ozonesonde records. Both of those records predate 2000 and would enable you to also examine the 2002 Antarctic SSW event, effectively doubling your SH low-depletion cases. Those two stations are on nearly the complete opposite side of the globe, adding longitudinal contrasts that are important, as you show in Figure 6. In fact, you might end up with different results with the inclusion of more SH data and a second SSW year in 2002. The SouthTRAC and Ushuaia ozone data are close to a local minimum in ozone according to Figures 1 and 6. In either case, you will add confidence to your results.

The study periods for the NH and SH should be aligned, something like 2002-2022 for both hemispheres, in my opinion. There should be plenty of IAGOS data in the NH to extend the study, and of course there is a dense network of ozonesonde stations in Europe and North America in your 45-60N band of interest. At the very least, why not align the study periods for both hemispheres and include the 2019 Ushuaia data?

Finally, I am curious to know who oversees the Ushuaia station and if they were offered co-authorship. Often, this recognition can help maintain a station’s support.

Recommendation:

In my assessment, this paper is not ready for publication and needs major revisions. The addition and analysis of more datasets, alignment of the study periods in both hemispheres, and a broader context and discussion of the impact of the differing STE ozone amounts between the two hemispheres will make this an important contribution.

Line-by-Line and Technical Comments:

Abstract lines 15-17: The answer to the question raised in the first sentence of the Abstract is well known and does not accurately capture what I think you are trying to demonstrate in this manuscript: Even during low depletion SH years, Southern Hemisphere UTLS ozone in STE events is far less than Northern Hemisphere high depletion years. The NH vs. SH lower stratospheric ozone differences in these latitude bands are obvious from the global ozonesonde network. See my quick analysis in Figure R1:

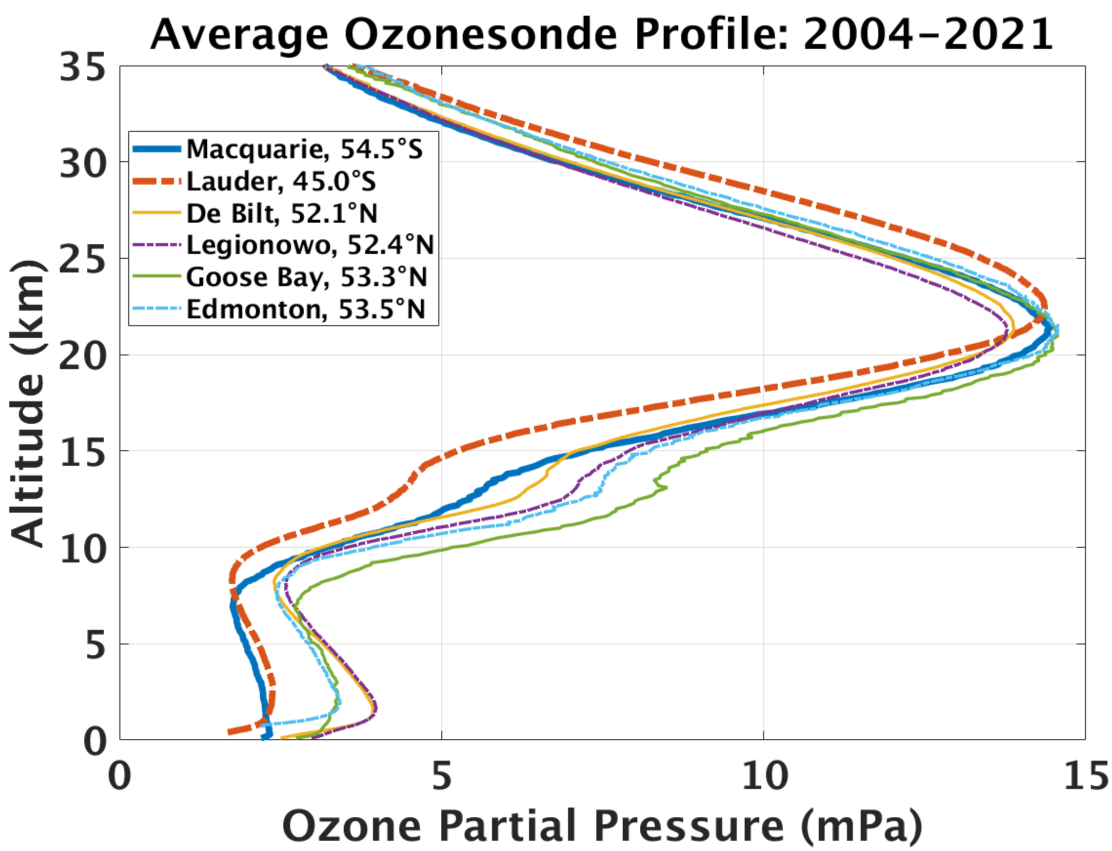

Figure R1: Average ozone partial pressure profiles from select ozonesonde sites in the 45-60° latitude band in both Northern and Southern Hemispheres.

Abstract Line 26: "…the SSW event increased SH UTLS <u>ozone</u> by 37%…"

Lines 82-83: Again, we can refer to Figure R1 to demonstrate that SH STE events will contain less ozone than NH STE events. There is simply less ozone in the SH mid-latitudes.

Line 97: It is contained in Table 1, but please state in the main text what time periods you are focusing on. Note also my concerns about mismatched time periods for the NH and SH.

Line 104: "…interannual variability of both hemispheres…"

Table 1: Why are the time periods examined not the same for NH and SH? Surely there are enough NH IAGOS data to make the analysis period for both hemispheres 2008-2022 or so? Also, extending back to 2002 will enable you to add a second SH SSW event. By adding Lauder and Macquarie Island ozonesonde data to the analysis, this can easily be accomplished for the Southern Hemisphere as well.

Line 142 and other locations: RS92 radiosondes

Lines 167 and 168: The RH measurements come from the Vaisala radiosondes, not the ozonesonde instrument

Figure 2: It looks to me like the water vapor measurements are rounded to the nearest whole μmol mol-1, but are there really measurements of just 1 μmol mol-1?

Line 219: "tracers" not "traces"

Line 226: Again, the RH measurements are from the radiosondes attached to the ozonesondes

Line 232: "…applies to the 230-220 hPa bin…"

Figure 4: Why did you not include 2019 Ushuaia data in addition to SouthTRAC?

Line 242: Are these differences statistically significant? It might be difficult to draw conclusions based on the fairly limited data from single SH low depletion case in 2019.

Figure 6: Is the UTLS here also defined as 300-200 hPa? Please state clearly in the Figure 6 caption or plots

Figure 6 Caption: "…the same for the Southern Hemisphere"

Line 287-288: This sentence is unclear. Please rewrite.

Lines 321-323: There is certainly a lack of in-situ ozone profile data in the SH, but you are not taking full advantage of what is available in this latitude band, including the Lauder and Macquarie Island ozonesonde datasets