

Unfortunately, I think that this manuscript needs another revision. The “Major comment” and the comments under “General” were not fully addressed. In addition, the number of specific comments (new ones and old ones) adds up to more than 6 pages. I have also added 10 pages of suggestions to improve language, grammar etc.

### **Title:**

I am much happier with the title now. However, while I am not a native speaker, I have the impression a native speaker would not have phrased it like this. Just “Record low ozone values over the Arctic in boreal spring 2020” sounds better to me. Or may be “assessment of”? Or “Record low [...] spring 2020 compared to other winters”?

### **General:**

**“I have to admit that I had more of a problem with the wording and readability in some places. Wording was quite awkward in some places, and sometimes the text could have been less confusing and better organized, it felt a little bit rushed in places. I have the impression that asking a native speaker to go through the text would help in many places.”**

I have the impression that you misunderstood my first comment in the “General” section or confused that with my comment under the section “Major comment”. This comment was not about phrasing things carefully and the use of the term “ozone hole”. It was about readability, conciseness, correct English language and grammar, awkward phrasing etc. Unfortunately, that means that this comment was not addressed adequately.

Maybe I did not express myself clearly enough. But in fact, your manuscript is very hard to read. I would try to improve language, grammar etc. in the manuscript in your own interest.

Even though I am not a native speaker, I can tell that there are many places of awkward writing, or not using the correct English phrases and words. In addition, the text is often very convoluted and confusing, and contains many repetitions and filler words. You probably could shorten the manuscript considerably without loss of information. As a result, you would get a more concise and readable text.

I have read the manuscript again and have compiled a long list of concrete suggestions how you could change the text (see last section “**New comments part 2: language**”). But this list is certainly not exhaustive.

### **Reply to my major comment:**

I appreciate your effort to phrase the script more carefully and I am happy that you acknowledge my major comment in your reply. The manuscript has certainly improved.

Unfortunately, you contradict what you write in your reply as early as in the first sentence of your revised manuscript. You have rephrased “atypical ozone hole feature” just to “exceptional ozone hole-like feature”. I am sorry to say that, but for the majority of the readers (and certainly for me) that will mean too much the same as before.

May be I can illustrate that with the following (tongue-in-cheek) example: Imagine you see a bike but write, “I see a car”. Somebody responds: “But this is a bike!”. You reply, “Ok, you are right. This is a car-like thing”, because you are big fan of cars. Somebody else says, “Now, that you say it, it looks a little bit like a car, and it is a vehicle after all”. I hope that makes clear where the problem is.

I will not go into detail, why I would not call it either an “ozone hole” or “ozone hole-like feature”. You got very detailed comments on this, which I do not need to repeat here.

Unfortunately, this problem is not restricted to the first sentence of the paper. Further occurrences are at **page 1, line 10, page, 1, line 14, page 6, line 29, page 7, line 22, page 7, line 31, page 11, line 7, page 13, line 5 and page 15, line 2.**

I would suggest writing “ozone minimum” or, if you prefer “pronounced ozone minimum”. That would be fine and still get to the point in a clear statement. If you insist on calling it an “ozone hole-like feature”, you unnecessarily provoke associations. As I already said in my original comments: Do not push the reader into a certain direction if you cannot back up this by facts.

Please understand that I am really not nitpicking here or trying to force my opinion on you. In my opinion, this is not something subjective, but really needs to be addressed. This was my only major comment, and I would be happy if this comment would be addressed not only reluctantly.

**From your reply: “(ii) the shape of the region of low TOC looks “ozone-hole-like””**

What do you mean by that? I think we agree that the area of the ozone minimum was only about 5% of the Antarctic ozone hole. Do you really refer to the geometrical shape here, i.e. the feature is roughly circular like the ozone hole? Does this have any relevance?

**Specific comments (I will refer to the original page and line numbers(!), so that you can quickly find the comment I am referring to)**

**Page 1, lines 11-12**

You say this has been changed. You did not really. See major comment.

**Page 1, line 14**

You say “In addition, ... sentence is added to make clear ... differences in the respective area and time”. In contrast to your statement in the reply, you discuss area here but not time. Did you forget to include this?

**Page 1, line 16**

You say this has been changed. You did not really. See major comment again.

**Page 2, lines 5-10:**

This is certainly nothing I would insist on, but I have the reader in mind here. This is one of quite a few places which are either phrased quite awkwardly or where you will make the reader wonder why you write this.

**Page 3, lines 24-28:**

I think I have to make some serious comments to Farah here (only joking). But seriously, you make the reader wonder again why you write this. At least the part with the CDO tools makes the impression as if it would have been a challenge for you to calculate a simple mean. I am quite confident that this was not the case. Maybe you can keep the information that the daily mean was based on hourly values, but everything else is detail that is not needed. You can thank the authors of the CDO tools in the acknowledgments.

**Page 4, lines 26-28:**

The reason for my comment was that this is rather hard to read. May be I did not express this clearly enough.

**Page 4, line 28:**

Ok, you did change this, but not to the established terminology, as requested.

**Page 5, line 2**

Certainly, nothing I would insist on, but that does not change my opinion that the figure is not needed. You can see the circular shape easily in Figure 1.

**Page 5, line 3**

This is still misleading and ambiguous. The radiative cooling does not mainly result from the dynamical conditions. It is there because there is no sun in the polar night. It is present in every year. It is somewhat modulated by different amounts of radiatively active gases transported to the polar regions in different years, but I do not think you have this in mind here. Temperature variations are caused by adiabatic warming (and by the triggered additional(!) radiative cooling) by the BDC. I agree that you do not need to go into detail here, but the sentence should be correct. Suggestion: "The dynamical conditions in winter 2019/2020 with low planetary wave activity result in very low temperatures..." Only a slight change, but physically correct now.

**Figure 5 and 6: Please add...**

Why don't you add Antarctic data for Figure 7 (was Figure 6), too, as for the other figures (and as suggested by me)?

**Figure 5: Can you really learn...**

**(Either relevant information is missing or there is a problem with what is shown in Figure 5, now Figure 6)**

I think you have totally confused me here and I did not get it right in my original comment. Either, something must be wrong in the description in the figure caption or with the values shown the figure, or there is not enough information given to understand what you have done. This may carry over to the text on page 9 and 10 (new manuscript) and Table 1.

What exactly do the dots show in Figure 5 (now Figure 6)? You write "minima of monthly mean temperature". But thinking about it, this would only give one dot per month (you have the monthly means of polar cap temperature for 30 years, and then take the minimum, which is one value).

Or do you mean that you first take the monthly mean at all grid points for every year, and then look for the minimum in the monthly mean field in the longitude-latitude grid? That would be consistent with the data points in the plot, but would be a rather convoluted quantity, where I am not sure if it would make sense to look at the quantity. E.g., values would by definition be higher as the daily minima, and since the minimum is not always at the same position, values would smear out.

Or is it the monthly mean of the daily minimum values north of 50 degrees for each individual year? In this case, I have the impression that the dots are placed far above the position where I would have expected them. Take for example the blue dot for January. It seems that the daily blue values (small dots) for January are almost all placed below the big blue dot. But this can't be possible if the big blue dot is the mean of the small blue dots.

I think that some area with the daily range of values would be the quantity that the reader would expect here and would immediately understand (this is usually shown in the plots in the literature). If you first take the minimum of the monthly mean values, this is a rather convoluted quantity. It certainly does give you some impression about the range of the values, but is not as straightforward as it could be.

**Page 5, lines 11-12**

I do not think that you understood the problem here. I think it is mathematically not correct and therefore confusing. A sum like the sum here is always an approximation of an integral over time, and will always yield a value similar to an integral if done correctly. If you would take values every 12 h instead of every 24 h, you would get approximately twice the value by simply summing up. If you however do consider the units, you would divide by 2 in the case of 12-hourly values. That would give a similar value as before. The point is you are already implicitly assuming a value of “days” here, because you sum up values given every 24 hours. You probably do not want to depend your result on the number of values that you sum up in a given time period.

**Figure 1: Add contours for the 220 DU contour and the vortex edge. These are things that are really hard to see in a colored contour plot. And the 220 DU contour is really central for the discussion in your paper.**

You say this is not necessary in your reply. I would not have made this comment if I would not have large problems to discern things here, and I think many people would share this view. This is not only a continuous color scale, but it also lacks contrast in the relevant range. In this context, “dark purple” is subjective at the least. And it is easy to add a line contour to the plot (say, in white). This should be feasible and easy to do with whatever graphical package you are working with. I do not think I am asking for too much work here. Same applies for the vortex edge. The new Figure 2 helps, and this shows that it should be easy to add e.g. the 36 PVU contour to Figure 1 (in a color different from the 220 DU contour). You could omit the new Figure 2 then.

**Figure 6**

Sorry, but I do not see the qualitative difference to the other figures (Figures 3, 6, 8 in the new manuscript). I cannot follow your arguments. Again, I do not think I am asking for too much work here.

**Page 6, line 22**

No, they are not, see page 5, lines 11-12.

**Page 8, lines 11-15**

Mostly OK. Page 10, line 28 of the revised manuscript: “denitrification was much stronger than in 2011”. That is not what the text says in Manney et al., 2020. My interpretation of the text is that 2011 was comparable in magnitude. Please change accordingly.

**Page 9, lines 12-14**

OK in the revised manuscript. But I do not understand your reply “The statement ... was very clear that the spring 1997 was the coldest ...” This was not clear at all in the original manuscript. There is no obvious and straightforward way to define the “coldness” of a complete winter. You can take minimum temperatures, VPSC, North Pole temperatures etc. and this will give different results.

**Page 10, line 10**

OK, but I do not think that 15% is “clearly higher”. It is only 15%. It would suffice to write “higher”.

**Page 11, lines 11-14**

I certainly do not mind. It is your freedom as an author. My concern is just how the readers conceive this. This is all about readability and conciseness.

**Page 11, lines 17-19 etc.**

You say you deleted the expression “ozone hole”. You did not. See major comment.

**Technical corrections**

**Page 8, line 1 and 3 (now page 10, lines 12 and 14)**

You did not change all occurrences. You can also just write “(PSC type 2; see” for “(PSC type 2, ICE-PSC; see”

**New comments (part 1: related to content, page and line numbers revised manuscript)**

**Page 3, lines 13-14:**

“However TOC below 220 DU have not been observed in these two years.” This is not true. Have a look at your Figure 8. Please phrase correctly, e.g. add “for an extended time period in spring”.

**Page 5, line 19:**

“In connection with Figure 1”. Sorry, I cannot follow you. The sentence would read totally correct for me if you would delete this part. This seems to be superfluous and not correct.

**Page 6, line 33 to page 7, line 2:**

It is not clear what you compare to, add “than in the Arctic” or similar.

**Page 7, line 25:**

“not shown”. This is not true anymore in the revised version.

**Page 9, lines 13-15:**

Looking at the plot, this is not really true. Daily minimum values for 2010/2011 and 2019/2020 are very similar in December and, to a lesser extent, they are also quite similar in January.

**Page 10, lines 6-7:**

That is possibly misleading. That depends on what quantity you are looking at. Vortex averaged loss was not so different, at least in my study. The maximum loss made the difference.

**Page 10, lines 19-20:**

Delete. There is an almost identical sentence only a few lines before (page 9, lines 13-15). In addition, the statement may not be quite correct (see there).

**Page 10, line 25:**

“due to heterogeneous reaction”. I do not think this is true. Don’t you just mean “by uptake of HNO<sub>3</sub>”?

**Page 10, line 28:**

See “specific comments, page 8, line 11-15”. I do not think this statement is correct.

**Page 11, lines 16-27:**

I found the information content of these lines to be small. This is well known from the literature and textbooks. Not that it would be wrong to mention this here, and it is all correct, but could you try and come a little bit more quickly to the point here?

**Page 12, lines 3-7:**

How do you compare 30 hPa North Pole temperatures from FU Berlin to the temperature metrics used in your study? These are not the same quantities, and 2019/2020 is not included in the FU time series. E.g., North Pole temperatures could be hampered by the fact that the polar vortex is not always situated over the North Pole. Wouldn't it be better to base your statement that "2019/2020 is outstanding ... since ... 1950s" on a comparison of the same quantity?

**Page 12, line 17 to Page 13, line 6:**

Again, it would help if you would come to the point here more quickly. It is totally ok to discuss this here, but this is a rather long and meandering discussion. The main topic of your paper is the 2019/2020 winter. While it is ok to compare to other winters, I do not really see the relevance of all the details given here. Where does this aim at? This seems like a repetition of facts from other sources.

**Page 13, line 11:**

"although the dynamic features are similar". What exactly do you mean by dynamic features here? I think this statement is too subjective and should be deleted.

**Page 13, lines 16-18:**

This has already been discussed. Delete. In addition, I think this statement is not really correct, see comments I have already made.

**Page 13, lines 20-24:**

Delete. You have already discussed that in preceding section in detail. You only repeat things here you have already said.

**Page 13, lines 24-26:**

Delete sentence starting with "It is obvious..." You have stated exactly the same a few lines above (lines 16-18). Lines 16-18 were already a repetition. In addition, the statement is not correct.

**Page 13, line 27-30:**

Delete. You have already said this and only repeat things here.

**Page 13, line 33:**

Probably you mean "in particular" and not "especially". However, that does not really fit either. You could delete "especially". However, here is a deeper problem. In fact, you are speculating here and cannot really back this up by facts. I would suggest either to cite a reference here or to replace "especially" by something like "possibly" or "probably".

**Page 14, line 1-2:**

This slipped through my attention in the first review. Again, this cannot really be backed up by facts. While it is plausible, you do not do an analysis of dynamical and chemical contributions to the observed ozone column. You need to phrase that more carefully.

**Page 14, line 7:**

Delete "only". I think I already made a comment that you can also learn something from the past here.

**Page 14, line 8:**

Delete “more or less”. Either it is cooling or not. This is not really a scientific statement.

**Page 29, line 4:**

As said in the specific comments, something is wrong with the “minimum of the monthly mean temperatures”, or there is not enough information given.

**New comments (part 2: language, grammar etc., page and line numbers revised manuscript)**

**Page 1, lines 23-24:**

“emphasizes the noteworthiness” does not sound like good English to me. “highlights” or “underlines” is probably better. “noteworthiness” sounds strange here. Maybe “highlights the unique evolution of...” or something similar.

**Page 2, line 4:**

Delete “especially”. You probably mean, “In particular, unusually low ozone...”

**Page 2, line 7:**

Suggestion “...are found in the stratospheric ozone layer...”

**Page 2, line 21, Page 13, line 24, Page 29, line 11:**

Change “ICE-PSC” to “ice PSC”

**Page 2, line 23:**

Replace “for instance chlorine” by “chlorine and bromine”. It is only these two species.

**Page 2, line 25:**

Would help to replace “ozone depletion begins” by “ozone is depleted by catalytic photochemical cycles” or something similar. Only a few words more, but some more relevant information.

**Page 2, line 27-30:**

This is a very long sentence and hard to read. Maybe you could just shorten “... in response to the Montreal protocol, 1987, and its amendments...”

**Page 2, line 31:**

“atmospheric content” seems not the right phrase for me. I suggest “atmospheric burden” or “atmospheric concentrations” etc.

**Page 3, line 5:**

Change “heavy ozone depletion” to “severe ozone depletion”

**Page 3, line 7:**

Delete “clearly”

**Page 3, line 10:**

You could delete “as we will see in the upcoming analysis”

**Page 3, lines 10-13:**

The sentence is somewhat convoluted and does not read well. Suggestion: “Comparable dynamical conditions in the Northern stratosphere in spring were noted in the literature for 1997 (references...) and 2011 (references...)”

**Page 3, lines 14-16:**

This is phrased awkwardly. Suggestion “Although the dynamical conditions in winter and spring 2019/2020 were unusual, they are in the expected range of stratospheric dynamical fluctuations in Arctic winter and early spring (e.g., Langematz et al., 2014).”

**Page 3, lines 28-29:**

Again, this is phrased awkwardly. Suggestion: Replace “It allows an evaluation of the current situation by the comparison with similar dynamical conditions in Arctic spring of other years” by “We compare the current winter to winters with similar dynamical conditions in Arctic spring...”

**Page 3, line 31:**

Replace “far away from the usually observed Antarctic ozone hole” by “far removed from the conditions usually observed in the Antarctic ozone hole”.

**Page 4, line 10:**

Delete “For our investigations”

**Page 4, line 17:**

“The focus is laid on stratospheric zonal winds, polar temperatures and potential vorticity (PV).” I think you do not need that sentence.

**Page 5, line 18:**

“turned out to be persistent” is phrased awkwardly. Suggestion: “Arctic winter and early spring 2019/2020 showed a persistent stratospheric polar vortex with strong zonal winds from mid-December until early April.”

**Page 5, line 20-21:**

Phrased awkwardly. Suggestion: replace “representing the dynamic state of the lower stratosphere with respect to the position and strength of the polar vortex.” by “and shows the position and strength of the polar vortex.”

**Page 5, line 21:**

Change “PV-gradients” to “PV gradients”

**Page 5, line 24:**

Phrased awkwardly. Suggestion: “Figure 3 shows strong zonal mean zonal wind speeds at 60°N, 10 hPa (about 30 km altitude) in the ERA5 data (magenta line and dots in the figure), ...”

**Page 5, line 25:**

Replace “which are high with respect to” by “which are higher than”

**Page 5, line 26-27:**

Delete “very much”. Do not exaggerate.



**Page 5, line 27:**

Delete “the respective”

**Page 5, line 31 to page 6, line 3:**

I do not think that this sentence, which is very hard to read, does convey any information that is useful in the context of this paper. Please delete.

**Page 6, line 6:**

Delete “clearly”

**Page 6, line 10:**

Change “lower stratosphere temperatures” to “lower stratospheric temperatures”

**Page 6, line 11:**

The 50 hPa level is not a height range. It would be better to say, “which is inside the height range”. I would also say “important for ozone depletion” and not “of vital importance for ozone depletion”. Better English in my opinion.

**Page 6, line 14-15:**

You can delete “(i.e. the Cl activation threshold at this altitude, see for instance Figure 4-1 of Chapter 4 in WMO, 2018)” now. You now have that in the introduction. That was exactly the reason why I was asking to write it in the introduction. You can streamline the text here.

**Page 6, line 21-22:**

That could be shorter now: “This led to conditions allowing the formation of NAT-PSCs at 50 hPa for about 3.5 months (see Figures 6 and 7).” You introduce the abbreviation in the introduction.

**Page 6, lines 24-26:**

You can shorten this significantly now. Again, that is why I asked for this in the introduction.

**Page 6, lines 31-32:**

This is phrased awkwardly. I think you should delete “exemplarily” and start with “In Figure 3 and 6, corresponding...”

**Page 7, line 26:**

You could delete “indeed”

**Page 8, lines 6-7:**

Shorter: “The maximum area with TOC below 220 DU was 0.9 million km<sup>2</sup> (= 0.9·10<sup>12</sup> m<sup>2</sup>) on March 12 (Figure 1).”

**Page 8, line 7:**

You very probably mean “polar vortex area” and not “polar vortex”.

**Page 8, lines 7-8:**

Phrased awkwardly. Suggestion: “This is in the order of 4% of the polar vortex area at the 475 K isentropic surface inside the 36 PVU contour (e.g., Wohltmann et al., 2020).”

**Page 8, line 11:**

Change to “minimum TOC is clearly higher” (singular).

**Page 8, lines 18-19:**

“spring” is mentioned twice in the sentence. You could omit “in spring”.

**Page 8, lines 24-26:**

This is an overly complicated sentence for a simple fact. Much shorter without loss of information: “The evolution of the polar vortex at 10 hPa and the minimum temperatures at 50 hPa are commonly used to examine the dynamical state of the stratosphere (see e.g. Lawrence et al., 2020).”

**Page 9, line 4:**

It is not clear what “see below” refers to.

**Page 9, line 5:**

Probably a “,” would help: “...are similar, reaching...”

**Page 9, lines 6-9:**

This is a very long sentence. It would help to split it into two and to shorten it.

**Page 9, line 10:**

Delete “the respective”

**Page 9, line 11-12:**

Suggestion: “The temporal evolution of the observed daily minimum temperatures at 50 hPa is shown in Figure 6.”

**Page 9, lines 12-13:**

Phrased awkwardly. Suggestion: “The minimum temperatures were below the threshold temperature for the formation of NAT PSCs (195 K) in February and March of all three years.”

**Page 9, line 13-15:**

Phrased awkwardly. Suggestion: “Minimum temperatures at 50 hPa in December 2019 and January 2020 were lower than the minimum temperatures in December/January 1996/1997 and December/January 2010/2011 most of the time.” (but see comments above that this not really true)

**Page 9, line 16:**

What do you mean by “indicating the characteristic of”? I am clueless.

**Page 10, line 1:**

It must be “of the two winters 1996/1997 and 2010/2011”. “to” makes no sense here.

**Page 10, line 2:**

You probably mean “in particular” and not “especially”

**Page 10, line 3:**

Phrased awkwardly. Suggestion: “Severe chemical loss was observed in spring 2020 (Manney et al., 2020).”

**Page 10, line 4:**

Change “which was mentioned in” to “according to” (or just cite the studies at the end of sentence and skip this part of the sentence).

**Page 10, line 13:**

Change “was determined with” simply to “was”

**Page 10, line 17 and 18:**

You could easily delete “To summarize” and “Our analyses show”

**Page 10, line 20:**

You could delete “It is worth mentioning that”

**Page 10, line 22:**

Delete “in” at start of line. Seems to make no sense here.

**Page 10, line 22:**

You could delete “Having”

**Page 10, line 23:**

“more efficient”. Compared to what? You could just delete “more”.

**Page 10, line 23:**

Had to think a moment about what you mean by “they”. I would just write “PSCs”.

**Page 10, line 24:**

You probably mean “in particular” and not “especially”

**Page 10, line 26:**

Suggestion: “enabled a period of ozone depletion that was longer than usual”

**Page 10, line 27:**

Unnecessarily complicated sentence (and not phrased very well). Just start with “Manney et al. (2020) analyzed...”

**Page 10, line 30:**

I was confused here over reading “July” and “June” for the Northern hemisphere, until I realized that you are talking about the seasonal evolution of ozone over the period of a complete year. Can you try to phrase that a little bit differently?

**Page 10, lines 30-32:**

A very long sentence. Please split into two sentences.

**Page 10, line 32 to page 11, line 2:**

Unnecessarily long and complicated sentence.

Suggestion: "Typical features of a strong polar vortex can be observed in February 1997 and February 2011, with low TOC values in the vortex and relatively high TOC values in the collar region of the polar vortex (not shown)"

**Page 11, lines 3-6:**

Another very long sentence. You could delete "An important point to be mentioned is that". You could also delete "and which were then followed by a typical chemical ozone loss". What is a typical loss? Does this add any important information?

**Page 11, line 7:**

"shows" and not "is showing" is probably the correct tense.

**Page 11, line 8:**

Delete "clearly"

**Page 11, lines 11-14:**

Again, a very long sentence. Can you split this in two?

**Page 11, lines 28-30:**

Phrased awkwardly. Suggestion: "The winter 2019/2020 shows an extraordinary dynamical situation with a persistent strong and cold polar vortex over the complete winter season, when compared to the last four decades (the period of the ERA5 dataset)."

**Page 11, line 31:**

You could delete "our dynamical analyses based on"

**Page 11, line 31:**

It is not clear what "*the* historical data set" refers to. Better, "An analysis of historical data was..."

**Page 12, line 5:**

Phrased awkwardly. Suggestion: "Temperatures in January 1997 were near the climatological mean value."

**Page 12, lines 5-6:**

You could delete "In combination with our research results".

**Page 12, line 7:**

Delete "for instance"

**Page 12, line 10:**

Delete "their investigations of"

**Page 12, lines 11-12:**

Delete "(i.e. in the Berlin analysis it ranked second after 2019/2020)". You stated the same a few lines before.

**Page 12, lines 12:**

Phrased awkwardly. Change "(i.e. in the Berlin analysis it indicated as a cold winter, but not extraordinary)" to "(indicated as a moderate cold winter in the Berlin analysis)"

**Page 12, lines 12:**

Change "turned out to be" to "were"

**Page 12, lines 13-15:**

Phrased awkwardly. Suggestion: "The slightly different results for the record years indicate that results depend on the considered quantity" (or "considered meteorological variable").

**Page 12, line 15:**

Delete "Further it is clear that the"

**Page 12, lines 15-16:**

Phrased awkwardly. Suggestion: "Nevertheless, it is obvious that the winter 2019/2020 was one of the coldest winters in the last 65 years, and that it showed an exceptionally strong and stable polar vortex."

**Page 12, line 17:**

Delete "We note that"

**Page 12, lines 17-19:**

I would suggest splitting this long sentence into two.

**Page 12, line 23:**

Change "(around the long-term mean)" to "(similar to the long-term mean)"

**Page 12, line 25:**

Phrased awkwardly. Suggestion: "The Southern hemisphere spring seasons of 2002 and 2019 provide two additional examples for the importance of stratospheric dynamics in the development of low ozone columns"

**Page 12, line 28:**

"The other example happened in September 2019." Phrased awkwardly. Just delete and continue with "In 2019, the polar vortex was..."

**Page 12, line 29:**

Throughout the paper, you talk of "zonal mean zonal wind", but here you say "zonal mean west wind".

**Page 12, line 30:**

Change "happened" to "was observed"

**Page 12, line 32:**

Change "Afterwards" to "After this event,"

**Page 13, line 8-9:**

Change "lower stratosphere temperatures" to "lower stratospheric temperatures"

**Page 13, line 10:**

Delete “that”. Grammatical error.

**Page 13, line 11-12:**

You could split this sentence into two.

**Page 13, line 13-14:**

I would just say, “...were similar to the conditions in early spring...”

**Page 13, line 14:**

Delete “Further”. Or write at least “Furthermore”

**Page 13, line 15:**

I would suggest “Minimum TOC values were below 220 DU for several days in March 2020, although...”

**Page 13, line 16:**

Delete “clearly”

**Page 13, lines 16-18:**

Delete “Our comparisons show that especially”

**Page 13, lines 18-19:**

Change “all the time below 195 K” to “below 195 K most of the time”

**Page 13, line 19:**

Add “,” following “In this context”

**Page 13, line 20:**

Delete “Our analyses show that”

**Page 13, line 30:**

It is not clear what “However” does refer to. Delete.

**Page 14, line 3:**

Phrased awkwardly. Suggestion: “Record low stratospheric ozone values over the Arctic in 2020 are not an unequivocal result of climate change.”

**Page 14, line 4:**

Phrased awkwardly. Suggestion: “The dynamical situations in February and March of 1997, 2011 and 2020 were similar.”

**Page 14, line 4:**

Delete “Beyond that”. It is not clear what you refer to and it is confusing to read.

**Page 14, lines 6-7:**

Awkward phrasing. “is possible” sounds like that would be a surprise, but we expect cold winters from time to time. Suggestion: “The NH winter 2019/2020 is a perfect showcase for a Northern winter with low planetary wave activity, a strong and stable vortex and low temperatures.” (replaced “less” by “low”, since you do not compare anything here).

**Page 14, line 12:**

Phrased awkwardly. Suggestion “... showed that cold Arctic winters may possibly get colder in the future.”

**Page 14, line 18:**

Delete “respective”

**Page 14, lines 23-25:**

I think that I have already made a comment that this seems strangely out of context. I would really suggest deleting this.

**Page 14, line 27:**

Why did you add “consistent” to my suggestion? That sounds strange. I would delete that. Nobody would expect an inconsistent description here.

**Page 14, line 29:**

“in the vicinity or below 220 DU”. Phrased awkwardly. Suggestion: “Record low TOC values of 220 DU and less were detected...”

**Page 14, line 29:**

It has to be “large” for “larger” and “extended” for “longer”. You do not compare anything here.

**Page 14, line 30:**

Phrased awkwardly. Suggestion: “2019/2020 is compared...” or “The situation in 2019/2020 is compared...”

**Page 14, line 31 to Page 15, line 2:**

Awkward phrasing. Suggestion: “We have used recent meteorological data from ERA5 and recent total ozone column data of GTO-ECV (based on...) in combination with TROPOMI onboard Sentinel-5P.”

**Page 15, lines 2-5:**

Extremely long sentence. Please split into two.

**Page 15, line 4:**

It seems the hyphen is not at the correct position. It should be “...mid-October) – and TOC...”

**Page 15, line 5:**

“were not observed before over a period of 5 weeks”. It should become clearer that you refer to past years and not to the same winter here.

**Page 15, line 5-6:**

You could delete “The results of our study pointed out that”

**Page 15, Line 7:**

“supporting”. Is this really what you want to say? You probably want to express that ozone depletion was more severe than in other years. Maybe “leading to enhanced ozone depletion compared to other years” or similar.

**Page 15, line 8-9:**

Shorter and not so convoluted: “The special dynamical situation in winter 2019/2020 is the cause for the significant reduction of the TOC in spring 2020 ...”. This removes also the ambiguity what “despite” refers to.

**Page 15, lines 11-14:**

Very long and complicated sentence. Suggestion: “Numerous studies of the 2019/2020 winter season can be found in a special issue of Geophysical Research Letters and Journal of Geophysical Research – Atmosphere (e.g., Manney et al., 2020; Wohltmann et al., 2020, Lawrence et al., 2020; Grooß and Müller, 2020).” Note that I removed statements that are only true at the moment of your writing. Soon, nobody will care that some of the studies were not published at the time of writing.

**Page 15, lines 18-20:**

Phrased so awkwardly that I had to read it several times to get the meaning. Suggestion: “However, in winters with a cold and stable polar vortex, a persistent region of low TOC might also develop in the Northern hemisphere in the future again.”

**Page 15, line 21:**

You probably do not mean “documented” but “considered”

**Page 15, line 22:**

“enable well founded scientific explanations of special ozone features” is phrased awkwardly. Suggestion: “Continued monitoring of ozone with a suite of instruments will be key to understand the future development of Arctic ozone” or similar...

However, this rephrasing would also mean to change the following sentences a bit.

**Page 25, lines 6-7:**

Suggestion: “The grey line is highlighting the 36 PVU contour.”

**Page 26, line 6, Page 29, line 7, Page 31, line 14:**

I would move “(attention: the respective data are shifted by six months)” to a separate sentence. Delete “attention” and write “Southern hemisphere data are shifted by six months.”

**Page 29, line 10:**

Change “broken” to “dashed”

**Page 31, line 11:**

“Note the ....” I would not write that in the figure caption without more context. I think this belongs into the main text.