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Comment on acp-2021-1048

Anonymous Referee #1

Referee comment on "Hemispheric asymmetries in recent changes in the stratospheric circulation" by Felix Ploeger and Hella Garny, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-1048-RC1, 2022

Review comments on "Hemispheric asymmetries in recent changes of the stratospheric circulation" by Ploeger and Garny

This is a very well written paper. Overall, I find the topic, the scientific work and the presentation excellent, and I have very little to comment. The topic of the paper is timely and contributes directly to current open questions in the field of stratospheric circulation and its impact on (tropospheric) climate change. The scientific approach, with CLaMS calculations based on various reanalyses and compared to observations that are contrasted to free-running chemistry-climate models, is the perfect choice for separating shorter-scale natural variability from long-term climatological trends. The analysis of the data sets is done thoroughly, with well-adjusted scientific methods and on a sound statistical basis. The presentation of the scientific work is very clear, the paper is very well written, and the argumentation is straightforward and easy to follow. I have a few comments only that are on the level of either minor or even technical corrections (I do not separate between them in the list that follows):

Abstract, line 1-3: For the first sentence of the abstract, this statement sounds a bit twisted. Maybe it is better to split it into two sentences like: "The effect of ozone recovery on the BDC is expected [from model simulations] to be a deceleration. However, on the contrary, the BDC has been found to weaken .... in observations...." or something similar.

Para from line 34 to 48: You should clearly state here whether you discuss the direct radiative effect of ODS on climate (since they are potent greenhouse gases), or the "indirect" effect via ozone destruction/recovery. Some wording (e.g. line 40/41: "... Because polar ozone depletion is strongest in the SH, also the ODS effect on the BDC is stronger in the SH than NH, ...") indicates that you are focussing on the indirect effect via ozone depletion/recovery. Some other wording like (line 37/38: "During the period of ozone depletion (before about the year 2000), when ODS concentrations were increasing due to anthropogenic emissions, the ODS increase caused ....") seem to refer to the GHG impact of ODS. It would be clearer if you said here: " ..... the ozone depletion due to the

ODS increase caused ....".

line 38: "... caused a strengthening of the BDC and hence an intensification of the BDC's response to climate change." This sentence is a bit confusing (at least to me): You say the BDC response was the strengthening, and even the strengthening was increasing? (in the sense of a second and not first derivative)?

Line 54: "reanalyses" (typo, plural)

Figure 1, figure caption: I do not see any "grey lines" in these plots. Please explain what the hatching means.

Line 157: "In the SH, ERA5 and ERA–Interim show negative trends while JRA–55 shows positive trends ..." This statement should be restricted to some areas, e.g. mid-latitudes below ~ 600 K.

Figure 2, figure caption: Here I can see the grey lines! Please explain what the hatching means.

Figure 3, figure caption: The N2O time series seem to be anomalies, given the vmr values ranging between -40 and 40 ppbv. Similar (also anomalies) for AoA?

Line 216/217: I am not a native english speaker, however this sentence sounds somewhat weird to me: "indicating a strengthening deep BDC branch above about 10 hPa and a weakening meridional circulation below ....". Do you mean " ... a strengthening OF the deep BDC .... and a weakening OF the meridional ..."

Line 231/232: the wording "since about 2000 ..." is a bit sloppy. I think you should be more careful with the exact timing. Strahan et al. (2020) pointed out that the period 2005 to 2012 was a very special one, with an extremely steep "trend"; for the longer run, the NH-SH differences of several quantities show an oscillatory behaviour with an overlaid negative tendency. Your statement should probably stick to the time period actually analyzed (i.e. 2005 to 2017).

Figure 8: I think this figure needs a bit more explanation. I am aware that one of the authors (FP) has used this way of presentation for the age spectra in previous publications. However, what is shown here is the trend of age spectra, and for some readers who are not familiar with previous papers of the authors, the way of presentation

may be a bit hard to digest. Some explanatory lines in the caption or even in the text would be helpful.

Line 282/283: I would add "negative": "... the mean age trends are generally stronger NEGATIVE in the ozone depletion period (1965–2000) ... ".

Figure 9, figure caption: The meaning of the thin black solid and dashed lines needs to be described.

Line 310: Is it just questionable, or can it be concluded from this investigation that over the 21 century observations will not provide evidence on a potential difference between NH and SH age trends?

Figure 10: Explain the meaning of the whiskers.

Line 344: It would probably be helpful to mention the "seemingly discontinuous decreases" earlier, e.g. during discussion of Fig. 3.

Line 344: a bracket "(" is missing before "Fig. 3".

Line 352: "Here we find the same low-frequency variations ..." I am not convinced, at least I do not see the same variations as in the Strahan et al. paper. I agree that the dramatic change of N2O between 2005 and 2012 (as seen by Strahan et al.) is also present in the N2O time series here. The other oscillations shown by Strahan et al., however, are much weaker. In AoA the signal is even weaker than in N2O. I think the statement in this sentence should be somewhat mitigated.

Line 353/354: " ... the time series suggest a persistent change in the hemispheric transport difference starting around 2004....". I think the time series of N2O is a bit over-interpreted. And I don't see this strong change from 2004 on in the time series of AoA in Fig. 3.

Figure 11, Figure caption: "(b) Time series of mean age hemispheric differences ..." The text says that this is the time series of the hemispheric difference of AoA TRENDS (lines 370, 372, 374), while the figure caption says it is the difference between hemispheric AoA. Please clarify. According to the units it is probably the difference of AoA and not the difference of its trend.

End of review