

Review of the revised version of:

“The advective Brewer-Dobson circulation in the ERA5 reanalysis: climatology, variability and trends”, ACPD, 2020, by Diallo, M. et al..

The authors have taken into account all comments from both reviewers, or have stated good reasons for not considering some of them. I think the paper is now good and can be published in ACP. Rereading it, I still stumbled across a number of minor or technical issues that can be corrected without problems, I list them below. Particularly in the sections 3.4, 4 and 5, there are a couple of inaccurate statements that should be handled with care, though.

Thanks for the nice study and best wishes
Roland

Note that line numbers refer to the version with the blue highlighted track changes.

Minor issues:

- P1L4: ...inter-annual variability, climatology and trends...
- P1L4: ...with the predecessor ERA-Interim...
- P1L13: The statement that the GW forcing is the reason for all of the changes here is too absolute, at least you need to add a 'mainly', because planetary waves also have a significant contribution here. But see my points below that explain the topic.
- P1L13-14: ... at the equatorward upper flank of the subtropical jet.
- P1L17: ... with observed and modeled BDC changes.
- P2L28: ozone depleting substances
- P3L4: ... consistent with observed negative ...
- P3L30: ...includes extensive improvements...
- P4L14: exchange order of '80km' and '31km', for consistency
- P4L18: Can you be more specific than 'higher up'?
- P4L19: Through the higher spatial and.... are a better..., a better Moreover, data from many recent satellite instruments are now additionally assimilated.
- P4L29: remove 'h'
- P7L21: ...normalized coefficients the QBO and
- P8L10: three distinct regions of the stratosphere (tropical pipe, mid-latitude surf zone and polar regions)

- P8L19: remove 'at 95% confidence interval'
- P8L31: To quantify the circulation differences
- P8L33: The vertical w^* profiles
- P8L34: in the w^* structure
- P9 caption Fig.1: Write more compact: '...annual (a-c), DJF (d-f) and JJA (g-i) mean ...' and remove the two sentences below (the same applies to caption of Fig. 4 and Fig. 5)
- P9 caption Fig.1: Grey line indicates the zero $\overline{w^*}$ contours. Grey dots ...
- P10 Caption Fig. 2: ... (b) tropical ...
- Fig. 2: Change header of figures: Tropical upwelling is a mass flux, but here you show w^* , the residual vertical velocity.
- Fig. 2: State in the captions or text what latitude bands you use, or if you use the turnaround latitudes to determine the regions of up- and downwelling (or did I miss that?).
- P10L1: the relative $\overline{w^*}$ differences
- P10L2 the large-scale downwelling differences
- P11 caption Fig.3: remove 'together with'
- P11 caption Fig.3: horizontal lines indicate
- P11 caption Fig.3: climatologies. (remove 'from the ERA5 and ERA-Interim reanalyses respectively')
- P11L5 Change 'errorbars' to 'the uncertainties' or to 'variability is'
- P11L15 of the $\overline{w^*}$ differences between
- P12L7: remove 'remarkably'
- P12L11-12: stream-function upwelling in the tropical pipe and the mid-latitude surf zone is weaker in ERA5 than in ...
- P15L1 with the $\overline{w^*}$ differences
- P15L12: remove 'remarkably'
- P15L25: 'increase with increasing' sounds odd. Maybe: 'increase with enhanced'
- P15L16f: Rephrase sentence to: 'Therefore, the use of...drag parameterization in ERA5 likely is the cause of...'
- P15L30: Rephrase sentence to: 'In ERA-Interim, Rayleigh drag was applied as a substitute...'

- P15L30f: Rephrase sentence to: 'For ERA5, a Warner and McIntyre (2001) type non-orographic spectral gravity wave scheme was introduced and hence the Rayleigh drag could be switched off.'
- P16L3: ... agree well in phase ...
- P16L11: ... (Fig. 7c, d). Westerly shear reduces....
- P17L15: one of the major
- P17L23: ...in $\overline{w^*}$ and ψ^* , the regression analysis...
- P17L28: ...in $\overline{w^*}$ show...
- P17L29: ...in $\overline{w^*}$ show...
- P19 caption Fig.8: Remove 'horizontal'
- P19 Fig.8: Add overbars to w^* , also in other figures, and also to ψ^* in captions and figures.
- P20L5: Change 'therefore' to 'thereby'
- P21L4-5: ...reveals larger negative $\overline{w^*}$ anomalies than ERA-Interim, which is likely due to the differences in wave activity(...).
- P21L11: Change 'This' to 'These'
- P21L30 and L31 (two times): remove 'would' and change 'weaken' to 'weakens'
- P23L5 while the ... upper stratosphere. I don't think that sentence make sense as it is, better revise it.
- P23L6 remove 'previously reported'
- P23L8 "difference is less evident'. But there are still significant differences in the lower stratosphere, that should be mentioned. Moreover, there are strong PW differences in the upper troposphere, but I know these are not meant here (still they could be mentioned, and stated that they are not meant for this or that reason). However, the text must therefore be cautiously revised as to whether the upper troposphere, or the lower stratosphere is meant. Here, you state UTLS and that is not correct. Also in Line 11 you incorrectly state UTLS, please go through the entire text to make it more precise.
- P23L13: ... two reanalyses are governed by differences in the contribution of both the planetary and...
- P23L19 ...based on the non-orographic gravity wave parameterization...
- P23L20 remove the sentence "This means that... any longer" (that is clear)

- P23L26 and L35: the gravity wave breaking differences are mostly in the lower stratosphere. There are also clear differences in planetary wave forcing, the strongest in the upper troposphere, but also some in the lower stratosphere. Please take that into account here, and add it to the text and be precise about the regions, as written above.
- P23L30 ...in both hemispheres, but can be seen in a much larger ...
- P24 Figure 11: I think you must (additionally) show the differences here, because I cannot everywhere see what you state. I see it in the SH, but in the NH, the differences are not large enough to see the differences by eye. Moreover, this will help you to quantify the contributions of GWs and of planetary waves and then you can in the text more clearly discuss how much which contribution is.
- P24 Figure 11: You need to explain why you chose 70 hPa. It is easily explainable citing that 70 hPa is traditionally (citing Butchart et al. (2010), Hardiman et al. (2014)...) used, and Dietmüller et al. 2018 (<https://doi.org/10.5194/acp-18-6699-2018>) show that 70 hPa works best for AoA and for RCTT in an inter-model correlation for almost all the stratosphere. Moreover, as all your other figures show geometric altitude, for reference, state what 70 hPa more or less refers to in km altitude.
- P24L3: correct UTLS as mentioned above
- P25L1-2 I think this sentence is somewhat too general, please specify it at least concerning the altitude and moreover, state that there are also significant differences in PW driving that contribute there, although somewhat smaller than the gravity wave changes.
- P25L13: 'boundary layer' is not a process, maybe write boundary layer physics if that is what is meant.
- P25L20 change 'projections' to 'simulations'
- P25L22 remove 'at 95%'
- P25L30 I think you want to refer to panel g in Fig. 10 here. The patterns here also indicate that the effect is stronger in the SH than in the NH, which goes together with the BDC differences
- P25L31 "MAINLY by enhanced gravity wave breaking"
- P26 figure 12: Mention in the caption that the differences are not significant on the 95% level anywhere here if that is correct. If not, include the dots.
- P26L1: Change 'Eichinger and Sacha 2020' to 'Sacha et al 2019', that fits better
- P26L6: ... using stratospheric age of air and its spectrum...
- P27L9: Here you can add the Eichinger and Sacha 2020 citation
- P27L10-11: remove: 'at 95% using student t-test with two tail distribution'

- P27L18 and 19: Provide the std declaration behind the number in brackets with unit. I.e. that way: ($\sigma = 0.053 \text{ kg} \cdot \text{s}^{-1} \cdot \text{dec}^{-1}$)
- P27L20 ... but it is significant and between 10% and 20% below 70 hPa. This indicates that....
- P27L27 In our comparisons...
- P27L27 Remove 'a remarkably'
- P27L31-32 I guess you are only talking about the deep branch (or the downwelling regions) here, include that to the sentence, otherwise it is very confusing
- P27L33-34: Again, that statement is much to absolute fo me. At least you must add a 'mostly' or alike in front of the gravity wave, because planetary waves also contribute significantly.
- P28 caption Fig. 13: A trend is a scalar, while the lines you show here are functions. Therefore, change 'trend' to 'linear regression lines' (twice).
- P28L13: change 'a very' to 'show'
- P29L9: I think 'less evident' is not a good way to put it, as the differences are after all significant. But with the difference of the downward control analysis you can make this statement more quantitative.
- P29L11 larger than what? You forgot to clearly state what reanalysis is larger here, and in the following which BDC in the UTLS is stronger. Moreover, as discussed above, UTLS is not the term you want to use here. Revise also this complete section w.r.t. that inaccuracy.
- P29L12: Therefore, these differences ...
- P29L14: ...scheme. Moreover, progress has been made....
- P29L17: Change 'Even not' to 'Although not'
- P29L17f remove 'with the student t-test'