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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The advective Brewer-Dobson circulation in the ERA5 reanalysis: variability and trends" *by* Mohamadou Diallo et al.

Mohamadou Diallo et al.

m.diallo@fz-juelich.de

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Please find enclosed the responses!

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-881, 2020.

Answer to Roland Eichinger's comments on "The advective Brewer-Dobson circulation in the ERA5 reanalysis: climatology, variability and trends" by Mohamadou Diallo et al.

Dear Editor-in-Chief, Peter H. Haynes,

We are submitting our revised article titled "The advective Brewer-Dobson circulation in the ERA5 reanalysis: climatology, variability and trends". We thank the two Reviewers for their detailed and well thought-out comments, which helped to significantly improve the paper. We have made substantial changes to the manuscript in order to thoroughly address the Reviewers' suggestions and comments. Main changes concern:

- The calculation of residual circulation from wave drag using the downward control principle, as suggested by Reviewer #1, a new figure showing these results and the related discussion.
- Addition of statistical significance using Student's t-test to the differences as suggested by Reviewer #1
- Addition of information related to S-RIP and references.
- Re-calculation of the RCTT using the w* instead of heating rates for 2010-2018.
- rephrasing of several paragraphs in order to clarify the manuscript.

With these changes, we are convinced that the paper has been significantly improved and is highly relevant for a wide-ranging journal like *Atmospheric Chemistry and Physics*. Please see below our answers point by point to all reviewers comments and suggestions.

Reviewers comments are in bold, followed by our respective replies. Changes in the manuscript are in blue, allowing them to be tracked easily.
Kind regards,
Mohamadou Diallo (on behalf of the co-authors)

Roland Eichinger, Reviewer #1 (Comments to Author):

Major issues:

1. ***P1L12-13 and P25L12-13: I did not believe this statement when I first read the abstract and I still dont do so having read the whole paper. Commonly the contribution of gravity waves on tropical upwelling is around 30% here (see Butchart et al. 2010). Stating that a weaker GW forcing reduces tropical upwelling by 40% does not go together with that. The statement seems to base on the sentence "The contribution of the planetary waves to the tropical upwelling differences is less evident" on P21L1-2 (and P26L23), which you use to entirely disregard any PW contribution or anything else. I think what could help to separate the contributions of planetary and GW waves here could be a downward control (Haynes et al. 1991) analysis, but on the basis of patchy Fig. 10, the statement seems adventurous to me. Moreover, how well do the tropopauses fit together between ERAI and ERA5? The differences seem strongly altitude-dependent. This and also Fig. 2b made me think of a possible vertical shift between the reanalyses, that could contribute to the upwelling differences, too.***

   Thank you Roland for this comment and suggestion, which we followed further with carrying out the suggested downward control analysis, what significantly improved the paper! First of all, we agree that this strong contribution due to GWs seems somewhat inconsistent with Butchart et al 2010. However, the small-scale GWs depend largely on the models resolution and parameterizations. As both (resolution, GW parameterization) clearly differ between ERA5 and ERA-Interim, a significant effect on the reanalysis GWD can be expected. Furthermore, it is important to notice (Fig. 2b) that the 40% difference in the upwelling occurs only in a shallow layer between 15-17km, above the difference decreases with height.

   The new statistical significance estimate Fig. 10 shows that the differences in GWD between the reanalysis in the lower stratosphere subtropics are indeed significant (at 95% level). Finally, our downward calculation indeed quantitatively proved that the difference in the upwelling between ERA5 and ERA-Interim is related to GW drag. The fact that PWD agrees much better between ERA5 and ERA-Interim

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Fig. 1.