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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Extratropical Age of Air trends and causative factors in climate projection simulations" *by* Petr Šácha et al.

Anonymous Referee #1

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This paper compares trends in the stratospheric Brewer-Dobson circulation from 5 different CCMI-1 models in terms of mean age, residual circulation, aging by mixing and wave drag trends. The study focuses on the subtropical lower stratosphere regions where all models considered robustly show largest negative mean age trends. A new and interesting aspect of the study is the consideration of the effect of the vertical shift of pressure levels under climate change on the age trend. The authors argue that the effect of such a shift should be largest in the subtropical lower stratosphere where the mean age gradient is largest, and that the shrinkage of the stratosphere likely contributes to the strong negative trends in that region.

The paper is overall well written and the results are well presented. The topic is of high relevance for the atmospheric community and the effect of a vertical shift has not

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Discussion paper

been sufficiently discussed so far. I therefore recommend publication, but have a few comments to be addressed below.

Minor comments:

1. I find it difficult to follow the discussion of wave driving in Sect. 3.3. Most arguments here are based on numerous numbers in several tables. Condensing the key information into a figure would be very helplful for the reader, e.g. to illustrate that AbM and RCTT can not easily be linked to the local quantities.

2. This point is related to the one above and concerns the missing clear link between wave drag changes and the residual circulation acceleration (e.g., stated on P1, L26ff). When looking at Fig. A1, on the contrary, there seems to be a strong (anti-) correlation between the meridional resid. circulation velocity and EPFD in the upper part of the Ex region and with GWD in the lower part of the Ex region - as expected. I guess that this is due to the different time scales considered: The stated missing link concerns long-term trends, the correlation in Fig. A1 is dominated by shorter term variability. Nevertheless, I find Fig. A1 very interesting and would suggest to move it to the main part, or a zoomed in version of it showing just time series in the Ex region and their (non-) correlation. It would then be very interesting to investigate further at which time scale the correlation between residual circulation and wave drag changes breaks down (e.g., by filtering out specific parts of the variability), and maybe similarly for correlations between other quantities (related to my comment 1).

3. I find the argumentation that the AoA distribution widens due to AbM and RCTT changes a bit hand-wavy (e.g., P16, L402). Maybe including global trends of AbM and RCTT in Fig. 8 could be useful for making the point clearer?

Specific comments:

P1, L17: What is the distinction here between "mechanisms for BDC strengthening" and "dynamical driving"? The former is said to be well understood, the latter still open

- please clarify.

P1, L26: Why are residual circulation, upwelling and wave driving here presented as individual drivers? Actually they should be all closely connected.

P4, L96ff: I would find a table containing the main information regarding the different models considered helpful.

P4, L116: I don't get the point why RCTTs and AbM starts 1970. Largest RCTTs are about 5 years. Thus for the simulations starting in 1960 it should be possible to have RCTTs already in 1965. Is it because a longer spin-up is needed for having reliable AoA and AbM?

P5, L141: Shouldn't the relation Y=Y' be just the general property of a scalar function?

P6, L172 (and throughout the paper): A somewhat picky note regarding the notation of TEM quantities: Usually the star is placed next to the overbar and not below.

P14, L336ff: I would prefer presenting percentage changes here (as is the case for the upwelling changes in the next paragraph).

P22, L535: The authors state a "weak correspondence between GWD and RC trends", however Fig. A1 shows a strong correlation between about 18-21 km. I guess this point is again related to the time scales considered (see comment 2 above). Please clarify.

Technical comments:

P2, L48: McLandress

P2, L53: Maybe better to say "best available/commonly used tools"?

P2, L62ff: Complicated sentence. Maybe change like: 2Here, we produce ... by using ...

P3, L65: has been chosen

P3, L65: Maybe better: "studies regarding BDC"

P3, L66: Maybe better: climate change based on CMAM

P3, L74: shows the additional

P8, L211: does slightly

P8, L214: Delete "text"

P11, L271: "upward shift trend" - I would suggest to write either "shift" or "trend".

P13, L304: In the next...

P14, L343: trends in geopotential

P16, L389: Figure 7...

P16, L393: moves polewards to

P18, L429: Equation 4 provides...

P18, L445: Table 1 shows...

P23, L584: Figure 4...

P25, L646: Mc Landress

P26, L670: stronger

Fig. 7: In the NH the x-label 40 has an "S" instead of "N".

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