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## Comment on acp-2021-206

Anonymous Referee #1

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Referee comment on "The Brewer–Dobson circulation in CMIP6" by Marta Abalos et al.,  
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The study by Abalos et al analyzes the Brewer–Dobson (BD) circulation in a subset of CMIP6 models for which relevant diagnostics are available. Both ability of the models to reproduce the observed features of the BD circulation as well as their future projections are analyzed. The main novelty of the study is that the results found in the previous generations of CMIP models, and other chemistry–climate model evaluations (e.g. CCMVal) such as acceleration of the BD circulation in response to global warming, are confirmed with the new generation of the models. On the other hand, the study also highlights considerable uncertainty in the quantitative estimates of the BD trend, both historical and predicted future trends. The uncertainty arises from the internal variability, but also from the intermodel differences. The latter is evident, in particular, from the fact that the models disagree about the driving forces of the trends.

I recommend the paper to publications and ask the authors to clarify some points listed below:

### 1. The use of CMIP6 data:

The authors use 1 member per model however I don't see a justification for this choice. There is considerable internal variability in BD diagnostics and, in order to get a better quantification of the signal, in particular the BD trends, I think all members should be considered.

### 2. Significance of $w^*$ historical trends:

This analysis is problematic. The authors conclude that  $w^*$  historical trends shown in Fig. 4 are insignificant; however, looking at Fig.5c where all individual simulations show negative trends, I wonder whether the trends are indeed insignificant. I would expect that by averaging across many members all of which agree on the sign of the trend, the internal variability would be reduced, and the signal would emerge. Further, if  $w^*$  trends are indeed insignificant then how one can see an influence of ozone hole (L137)? This need to be clarified.

Other comments:

L14: Perhaps you can refer to specific Chapter of the WMO report rather than to the whole report, here and in the other places? The reports are large, and the reader does not necessarily know which chapter to look at.

L34: I think it is enough to write either "non-significant positive trends" or "slightly positive trends" depending on what you want to emphasize.

L45: "response to an IDEALIZED 1%/year CO2 increase"

L105: Fig.2 shows that MRI and JRA55 are nearly identical, and both represent the higher bound of the model spread in the lower stratosphere. Given that both, MRI and JRA55, are based on the JMA operational model (I believe so), would that indicate that the influence of assimilation on BDC is negligible, at least in JRA-55? Would this explain the spread across the reanalyses?

Figure 4: Do contours for AoA climatology in panels a-c start from 1 year?

L162: The models simulate an acceleration of the BD circulation over 1975-2014, not deceleration. Or?

L194: "strengthening of the polar vortex ... leads to reduced equatorward refraction of planetary waves"

Fig. 3 from Hartmann et al (2000) shows that a strengthened polar vortex leads to an enhanced equatorward refraction of planetary waves, contrary to what the authors state. Also, given the spread in the widening across individual models, you could analyze the relationship between the changes in the turnaround latitudes and changes in the polar vortex across the models. At least for WACCM the mechanism does not seem to work, because this model simulates both poleward shift of the turnaround latitude (Fig. 7h) and vortex weakening (my own calculations). So, I am not convinced the proposed mechanism is valid.

Figure 9: Why AoA panels start from year 30? I understand that x-axis shows starting year, so why not start from year 0 as is done in w\*?

Figure 9 caption: "... a comparable total number of simulations for both VARIABLES" (not magnitudes)

Figure 11: I cannot understand how you indicate negative contribution with semitransparent shading, I am sorry. Is there any other way to draw it?

Reference: Hartmann, D. L., J. M. Wallace, V. Limpasuvan, D. W. J. Thompson, and J. R. Holton (2000), Can ozone depletion and global warming interact to produce rapid climate change? *Proc. Natl. Acad. Sci. U. S. A.*, 97, 1412– 1417, doi:10.1073/pnas.97.4.1412