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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The global overturning diabatic circulation of the stratosphere as a metric for the Brewer-Dobson Circulation" *by* Marianna Linz et al.

Anonymous Referee #3

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Linz et al. present a comparison of the global overturning diabatic circulation with a range of other metrics used to assess stratospheric circulation. They do this using both modelled and reanalysis data. The analysis and discussion presented in the paper is of a high standard and explores an important and relevant topic within the scope of SCP, and as such merits publication following revision. I have several comments the authors should address before publication:

General Comments:

1. The authors use a large number of terms to refer to stratospheric circulation in general and the global overturning diabatic circulation in particular. I feel it would aid

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Discussion paper

the reader if consistent terms were used throughout the manuscript.

2. Care should be taken when discussing the effects of transport on the distribution of ozone in both sections 1 and 6. It is misleading to say that ozone is produced in the tropics and moved to high latitudes by stratospheric circulation. Brewer and Wilson (1968) and more recently Grewe (2006) highlight that while chemical ozone production in the tropics is high, so is chemical destruction. Grewe (2006) conclude that the view of the tropical region as the global source for stratospheric ozone is highly questionable and that while the tropics tribute to extra-tropical stratospheric ozone, of far greater importance is the production of ozone in the extra-tropics.

3. I miss in the introduction any discussion on the drivers of BDC change or the feedbacks between stratospheric transport and chemical tracers. For example, recent model studies have shown that both GHG increases and polar ozone depletion accelerate the BDC, while polar ozone recovery may to some extent offset an acceleration of the BDC expected from future GHG increases. Of particular importance to this study, these processes have been shown to affect different branches of the BDC (e.g. Braesicke et al., 2014). Some discussion on how these processes change both the speed and morphology of the BDC may aide in interpretation of the correlations presented in the manuscript. Additionally, with a focus on the ozone section, changes to the BDC will alter the distribution of radical source gases, in turn altering stratospheric ozone, which will in turn alter the dynamics. Highlighting the complexity of the coupled dynamical-chemical system and elaborating on how these feed backs operate would in my view strengthen the introduction and prepare the way for the discussion that follows.

Specific comments:

P1L7: The authors could state here which reanalyses and model is used.

P1L14: insert space between 500 and K.

P2L4: perhaps change ‘surface circulation’ to ‘tropospheric circulation’ or ‘surface

transport'.

P2L20: I feel that either 'age of air' should all be in quotes, or that quotes should not be used. Additionally, throughout the manuscript different the authors use variously age tracer, age of air and age of air tracer. Where possible, it would benefit the reader to use one consistent term.

P2L31: Define TTL

P2L33: Change 10S-10N to include degree symbols to be consistent with elsewhere in the manuscript

P3L10: Please state which reanalysis was used for this study.

P3L15: Here and elsewhere, more care should be taken to stress that it is stratospheric circulation that is being examined.

P3L29: remove 'the' from 'the polar ozone'

P4L2-17: What are the resolutions of the datasets (model and reanalyses) used in the study? What are the impacts of any differences in the resolutions, particularly with regards to mixing?

P4L5: why was only one ensemble member used? What are the expected differences between the ensemble members?

P4L6: Change observe to observed

P4L14: change beneath to below

P4L14-16: I found this sentence confusing and suggest it is reworded.

P4L30: remove an on

P5L8: remove as follows

P5L24: What is meant by steady state here? This term is usually in reference to

chemical change.

P6L4: Is there a need for 'and cooling'? Cooling is just a negative heating.

P6L10: remove naturally

P6L14-16: is there a reference for this statement or is this result calculated for this study?

P7 Figure 1: Is it possible to add contour labels to the correlation figures (also figs 2 and 3) to aid the interpretation of the figures?

P7L2: it would be more accurate to say 'observed tracer distributions' rather than 'tracer measurements'

P7L9: consider changing the use of 'observations' – the authors make the point that one of the problems with the TEM is that it is not observed.

P8L6-7: What is the sensitivity to the choice of latitude bands used here? How does this compare to 10S-10N, the latitude range used earlier in the study for other metrics?

P8L8: what is meant by 'at least 4 times daily data'? 6 hourly data? Are these instantaneous values or means? Similarly for the monthly data – presumably means are required?

P8L22: What is the cause of the difference between the reanalysis and the model for the role of gravity wave drag?

P9L15-16: What is the cause of the changes to r values when using data with different temporal resolutions?

P12L4: Change ERA-I to ERA-Interim to be consistent with the text elsewhere in the manuscript. Also, please check through the manuscript for 'JRA 55', which is sometimes written with a space and sometimes not.

P15L3: Would it be possible to use total hydrogen (H2O+2*CH4) to alleviate the prob-

lems encountered due to CH4 oxidation?

P17L10: lower case ‘t’ after ‘:’

P17L1-15: Throughout the ozone section there is no discussion of ozone chemical lifetime. Many of the results discussing O3 and the branches of the BDC are surely a result of the differences in O3 chemical lifetime at different altitudes? There are recent papers looking at projections of tropical ozone which highlight the role of dynamics in the lower stratosphere and chemistry in the upper stratosphere, and base this distinction on O3 lifetime.

P17L17: Please define what is meant by ‘stratospheric entry levels’

P20L7: remove an ‘on’

P20L20: Please expand on what is meant by ‘can have complications with convergence’. I feel more detail is required on this, either here or in section 4.

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